National Institute for Clinical Excellence

Preoperative Tests
The use of routine preoperative tests for elective surgery
Appendices, Guidelines & Information

EVIDENCE, METHODS & GUIDANCE

JUNE 2003

Developed by the National Collaborating Centre for Acute Care

Preoperative Tests

The use of routine preoperative tests for elective surgery

Appendices, Guidelines & Information

EVIDENCE, METHODS & GUIDANCE

Contents

Appendices

Appendix 1: Results of a Systematic Review of the Literature for Routine Preoperative Testing

The methods used for this systematic review are presented in Chapter 2 of the full NICE guideline for preoperative testing. The search strategy and data extraction forms used are appended to this results section.

1 Preoperative chest radiographs

1.1 Characteristics of the studies

In our search of the literature from 1995 to 2001, we identified a total of ten papers that studied preoperative chest radiographs. Nine of these papers reported abnormal outcome data, eight reported changes in clinical management and five reported postoperative complications. In combination with the 28 papers identified in the Health Technology Assessment (HTA) report, this review includes 38 papers that studied preoperative chest radiographs. The characteristics of the 38 papers are summarised in Table 1.1. All the studies identified were case series.

TABLE 1.1 Characteristics of the eligible studies of preoperative chest radiographs

First author and year of publication	Country	Study sample (age)	Type of surgery	Abnormal test	Change in clinical management	Postoperative complications
Krupski 2000[1]	USA	161 (46 to 81 years)	Major vascular surgery	✓	✓	✓
Silvestri 1999[2]	Italy	6111 (not stated)	General, orthopaedics, ophthalmology, gynaecology, urology		✓	
Pal 1998[3]	Karachi	320 (not stated)	General	✓	✓	
Ishaq 1997[4]	Karachi	477 (> 40 years)	General, urology, gynaecology, obstetrics	✓	✓	
Wattsman 1997[5]	USA	142 (17 to 76 years)	Ambulatory surgery	✓	✓	✓
Bouillot 1996[6]	France	3959 (15 to 99 years)	General, gastrointestinal	✓		✓
Clelland 1996[7]	USA	238 (37 to 94 years)	Orthopaedic	✓	✓	✓
Khong 1996[8]	Hong Kong	203 (21 to 98 years)	Orthopaedic	✓	✓	✓
Ranparia 1996[9]	USA	236 (33 to 84 years)	Prostatectomy	✓		
Boland 1995[10]	SA	100 (43 to 75 years)	Internal medicine	✓	✓	

TABLE 1.1 Characteristics of the eligible studies of preoperative chest radiographs *continued*

First author and year of publication	Country	Study sample (age)	Type of surgery	Abnormal test	Change in clinical management	Postoperative complications
Perez* 1995[11]	Spain	3131 (0 to 98 years)	General, trauma, gynaecology, paediatric	✓	✓	
Adams* 1992[12]	USA	169 (adults)	General	✓	✓	
MacDonald* 1992[13]	UK	147 (> 60 years)	Orthopaedic	✓		
Sommerville* 1992[14]	South Africa	797 (0 to 80 years)	General, obstetrics and gynaecology, ear, nose and throat (ENT), orthopaedics, urology, ophthalmology, plastic surgery, maxillofacial	✓	✓	
Bhuripanyo* 1990[15]	Thailand	1013 (> 15 years)	ENT, general, gynaecology, obstetrics, ophthalmology, orthopaedics	✓	✓	✓
Gagner* 1990[16]	Canada	1000 (0 to 70 years)	Not stated	✓	✓	
McCleane* 1989[17]	UK	687 (0 to 81 years)	Not stated	✓		
Charpak* 1988[18]	France	866 (not stated)	General, orthopaedic, gynaecology, obstetrics	✓	✓	✓
Ogunseyinde* 1988[19]	Nigeria	203 (1 to 79 years)	Not stated	✓		
Tape* 1988[20]	USA	318 (24 to 90 years)	Vascular	✓		✓
Umbach* 1988[21]	Germany	1175 (0 to > 80 years)	Gynaecology	✓	✓	✓
Boghosian* 1987[22]	USA	136 (60 to 93 years)	General, ophthalmology, orthopaedics, urology	✓		✓
McKee* 1987[23]	UK	397 (not stated)	Genera	✓	✓	✓
Mendelson* 1987[24]	USA	369 (not stated)	General	✓		
Turnbull* 1987[25]	Canada	1010 (adults)	General	✓	✓	✓
Weibman* 1987[26]	USA	734 (adults)	Not stated	✓	✓	
Wiencek* 1987[27]	USA	403 (mean 54 years)	Not stated	✓	✓	
Muskett* 1986[28]	SA	200 (mean 56 years)	Cardiothoracic, ENT, general, neurosurgery, ophthalmology, orthopaedics, plastic surgery, urology	✓	✓	

TABLE 1.1 Characteristics of the eligible studies of preoperative chest radiographs *continued*

First author and year of publication	Country	Study sample (age)	Type of surgery	Abnormal test	Change in clinical management	Postoperative complications
Rucker* 1983[29]	USA	905 (not stated)	Plastic surgery, gynaecology, general ophthalmology, ENT, orthopaedics	✓	✓	
Seymour* 1982[30]	UK	233 (> 60 years)	Not stated	✓		✓
Törnebrant* 1982[31]	Sweden	100 (> 70 years)	General, orthopaedics, urology	✓		
Wood* 1981[32]	USA	1924 (0 to 19 years)	ENT, general, ophthalmology, orthopaedics, urology	✓	✓	
Farnsworth* 1980[33]	USA	350 (0 to 14 years)	Not stated	✓		
Rossello* 1980[34]	Peurto Rico	690 (< 14 years)	Not stated	✓	✓	
Loder* 1978[35]	UK	1000 (not stated)	Dental, gynaecology, ENT, ophthalmology, general, orthopaedics	✓		
Petterson* 1977[36]	USA	1530 (adult + children)	Dental, ENT, gastrointestinal, ophthalmology, orthopaedics, urology	✓	✓	
Sane* 1977[37]	USA	1500 (0 to 19 years)	Not stated	✓	✓	
Rees* 1976[38]	UK	667 (not stated)	Not stated	✓		

* Papers included in the HTA review

The results of the 38 studies, which documented the findings from a total of 27,432 preoperative chest radiographs, are summarised in Table 1.2.

TABLE 1.2 **Summary of preoperative chest radiograph results (includes routine and indicated tests)**

FIRST AUTHOR	NUMBER OF TESTS# (N)	ABNORMAL RESULTS N (%)	CHANGES IN CLINICAL MANAGEMENT N (%)	POSTOPERATIVE COMPLICATIONS N (%)	ROUTINE	PROSPECTIVE DATA	CONSECUTIVE RECRUITMENT	ASA GRADES STATED
Krupski[1]	161	42 (28.1)	8 (5.0)	8 (5.0)	Not stated	x	✓	x
Silvestri[2]	6111	1116 (18.3)	313 (5.1)		Routine only	✓	x	ASA I to V
Pal[3]	320	192 (60)	1 (0.3)		Routine only	x	x	x
Ishaq[4]	452	203 (44.9)	1 (0.2)		Routine only	x	✓	x
Wattsman[5]	22	3 (13.6)	0	0	Routine & indicated	✓	✓	ASA I to III
Bouillot[6]	2092	125 (6.0)		2 (0.1)	Routine only	✓	✓	x
Clelland[7]	238	Not stated	1 (0.4)	1.4 (5.0)	Not stated	✓	x	x
Khong[8]	203	93 (45.8)	3 (1.5)	3 (1.5)	Routine only	x	✓	ASA I to II
Ranparia[9]	236	28 (11.9)			Not stated	x	x	x
Boland[10]	61	4 (6.6)	1(1.6)		Routine only	x	x	x
Perez[11]*	2151	485 (22.6)	45 (2.1)		Routine only	x	x	ASA I to II
Adams[12]*	133	6 (4.5)	0		Routine only	x	x	x
MacDonald[13]*	145	7 (4.8)			Routine only	✓	x	x
Sommerville[14]*	319	48 (15.0)	4 (1.3)		Routine & indicated	x	x	ASA I to IV
Bhuripanyo[15]*	933	181 (19.4)	34 (3.6)	0	Routine only	✓	✓	x
Gagner[16]*	1000	74 (7.4)	0		Not stated	x	x	x
McCleane[17]*	297	127 (43.3)			Routine & indicated	✓	x	ASA I to V
Charpak[18]*	1101	568 (52.0)	51 (4.6)	193 (34.0)	Routine & indicated	✓	x	x
Ogunseyinde[19]*	203	122 (60.1)	(13.3)		Routine only	x	✓	x
Tape[20]*	336	116 (34.5)		12 (3.6)	Routine only	x	x	x
Umbach[21]*	1175	118 (10.0)	15 (1.3)	14 (1.2)	Routine & indicated	x	✓	x

TABLE 1.2 **Summary of preoperative chest radiograph results (includes routine and indicated tests)** *continued*

FIRST AUTHOR	NUMBER OF TESTS# (N)	ABNORMAL RESULTS N (%)	CHANGES IN CLINICAL MANAGEMENT N (%)	POSTOPERATIVE COMPLICATIONS N (%)	ROUTINE	PROSPECTIVE DATA	CONSECUTIVE RECRUITMENT	ASA GRADES STATED
Boghosian[22]*	136	88 (64.7)		12 (8.8)	Routine only	x	x	x
McKee[23]*	327	121 (37)	1 (0.3)	27(8.3)	Routine & indicated	✓	x	x
Mendelson[24]*	332	62 (18.7)			Routine only	x	x	x
Turnbull[25]*	691	38 (5.5)	8 (1.2)	3(0.4)	Routine only	x	x	x
Weibman[26]*	734	213 (29.0)	38 (5.2)		Routine only	x	✓	x
Wiencek[27]*	237	101 (42.6)	10 (4.0)		Routine & indicated	✓	✓	x
Muskett[28]*	119	35 (29.4)	6 (5.0)		Routine & indicated	x	✓	x
Rucker[29]*	368	1 (0.3)	0	0	Routine only	x	x	x
Seymour[30]*	233	134 (57.5)		10 (5.8)	Routine only	✓	x	x
Törnebrandt[31]*	91	43 (47.3)			Routine & indicated	x	✓	x
Wood[32]*	749	35 (4.7)	3 (0.4)		Routine only	x	x	x
Farnsworth[33]*	350	31 (8.9)			Routine & indicated	x	x	x
Rossello[34]*	682	20 (2.9)	2 (2.4)	0	Routine & indicated	x	x	x
Loder[35]*	1000	97 (9.7)			Routine only	x	✓	x
Petterson[36]*	1527	134 (8.8)	2(0.01)		Routine only	x	✓	x
Sane[37]*	1500	111 (7.4)	57(3.8)		Routine only	✓	✓	x
Rees[38]*	667	299 (44.8)			Routine only	x	✓	x

*Papers included in the HTA review

#The number of tests carried out may differ from the sample size in some studies. This occurs in papers reporting the results of multiple preoperative tests because not all of patients in the study sample received all the preoperative tests detailed in the paper.

Table 1.2 shows that the proportion of abnormal preoperative chest radiographs varied greatly across studies and ranged from 0.3%[29] to 64.7%.[22] The proportion of patients who had had a preoperative chest radiograph and who subsequently underwent a change in clinical management ranged from 0% in four studies[5,12,16,29] to 13.3% in a further study.[19] The proportion of patients who had had a preoperative chest radiograph and who suffered postoperative complications ranged from 0% in four studies[5,15,29,34] to 34.0% in a further study.[18]

The wide variation in the results may be explained at least in part by heterogeneity in the study populations and outcome measures. The impact of four major sources of heterogeneity on the outcome of the studies was explored in this review. The quality of the study design was the first source of variation. For example the quality of the study design was regarded as highest in papers where data had been collected prospectively and where patients had been recruited consecutively. The second source of variation was the composition of the study population. Variation arose for example, from differences in the age range of study participants and their American Society of Anesthesiologists (ASA) grades. The third source of variation considered arose from differences in the criteria that each study used as a basis for testing. For example, some studies included patients having routine preoperative chest radiographs only, whereas other studies included patients who had either routine or indicated preoperative tests. Finally, the fourth important source of variation arose from differences in the definitions of the outcome variables. Differences occurred between studies in, for example, the definitions used to determine abnormal test results, in what was considered a change in clinical management and in the postoperative complications that were reported.

These four major sources of heterogeneity are considered separately in the following sections. In each section, we have tried to identify the effect of variations in a particular feature across all studies and, where possible, the effect of variations in that feature within each of the studies. This univariate approach assumes that different aspects of heterogeneity are independent of each other, for example that the choice of different criteria for patient inclusion is not associated with differences in the study populations. Although this assumption may not be true, there were too few data (insufficient number of papers within strata of different aspects of heterogeneity) or inadequate information (papers did not report data in sufficient detail) to explore heterogeneity in a multivariate manner. However, we were able to explore variation both between studies, where confounding from different aspects of heterogeneity that are not independent of each other is likely to have existed, and within studies, where confounding of this kind is controlled to some extent.

1.2 Heterogeneity in the quality of the study design

Studies in which data are collected prospectively or in which patients are recruited consecutively are more likely to be representative and have complete data and, therefore, are less likely to be susceptible to bias than studies in which data are collected retrospectively or where patients are recruited selectively. We hypothesised that the proportions of abnormal preoperative chest radiographs, changes in clinical management and postoperative complications may differ between the studies with high (prospective studies with consecutive recruitment of patients) and low (retrospective studies with nonconsecutive recruitment of patients) quality designs.

We investigated the effects of variations in the quality of the study design on the proportions of abnormal preoperative chest radiographs, changes in clinical management and postoperative complications across the identified studies. Five studies collected data prospectively and recruited consecutive patients,[5,6,15,27,37] and seven studies collected data prospectively but did not state that the sample of patients was consecutive.[2,7,13,17,18,23,30] Eleven studies collected data retrospectively for a sample of consecutive patients,[1,4;8,19,21,27,28,31,35,36,38] while 15 studies collected data retrospectively and did not state that the sample patients was consecutive.[3,9-12,14,16,20,22,24,25,29,32-34] The results of these studies are summarised in Table 1.3.

There was little difference in the average proportion of postoperative complications, the proportions of abnormal preoperative chest radiographs and changes in clinical management by quality of study design.

TABLE 1.3 Summary of abnormal chest radiographs and changes in clinical management or postoperative complications in study populations according to study quality indicators

QUALITY INDICATOR	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
P C	12.0 (5	42.6	6.0	2.2 (4)	4.0	0	0 (3)	0.1	0
P N	35.5 (6)	57.5	4.8	2.6 (4)	5.1	0.3	13.1 (4)	34.0	5.0
R C	21.9 (11)	60.1	9.6	6.9 (8)	13.3	0.2	0.4 (3)	5.0	1.2
R N	14.8 (15)	64.7	0.3	0.9 (10)	2.4	0	0.3 (5)	8.8	0

P = prospective data collection; R = retrospective data collection; C = consecutive recruitment of patients; N = nonconsecutive recruitment of patients; * weighted means were produced to reflect the different numbers of patients in each study. It was not possible to produce a distributional statistic reflecting this weight.

1.3 Heterogeneity in the composition of the study population

1.3.1 Age range

Given that the prevalence of cardiopulmonary disease increases with age, we hypothesised that the proportion of patients with abnormal preoperative chest radiographs would be higher in studies of older patient populations.

We investigated the effects of variations in the age range of the study population on the proportions of abnormal preoperative chest radiographs, changes in clinical management and postoperative complications across the identified studies. Twenty of the studies included adults only[1,4-10,12,15,18,20,25-28] with four of these studies including adults over 60 years only.[13,22,30,31] Ten studies included both adults and children[2,11,14,16,17,19,21,24,29,36] and four studies included children only.[32-34,37] The remaining four studies did not specify the age range of their study population.[3,23,35,38] The proportions of abnormal chest radiographs, changes in clinical management and postoperative complications in the study populations according to age group are summarised in Table1.4.

TABLE 1.4 Summary of abnormal chest radiographs and changes in clinical management or postoperative complications in study populations according to age group

AGE RANGE	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
Adults > 60 years	43.6 (4)	64.7	4.8	(0)	(0)	(0)	7.3 (2)	8.8	5.8
Adults only	24.9 (15)	52.0	5.5	2.5 (13)	5.2	0	5.5 (9)	34.0	0
Children & adults	20.5 (10)	60.1	0.3	1.4 (7)	5.1	0	0.6 (2)	1.2	0
Children only	6.0 (4)	8.9	2.9	2.2 (3)	3.8	0.4	0 (2)	0	0
Not stated	37.9 (4)	60.0	9.7	0.3 (2)	0.3	0.3	8.3 (1)		

*weighted means

After calculating weighted means, we found that the average proportion of abnormal preoperative chest radiographs tended to be highest in studies that included adults aged 60 years or over (43.6%), followed by studies that included adults only (24.9%) and studies that included both adults and children (20.5%). The mean proportion of abnormal preoperative chest radiographs tended to be lowest in studies that included children only (6.0%). A similar pattern occurred with the mean proportion of patients requiring a change in clinical management and patients with postoperative complications.

We then investigated the effects of variations in the age of the study population on the proportion of abnormal preoperative chest radiographs within the identified studies. This was possible for 11 of the studies, where the proportion of abnormal chest radiographs was stratified according to patient's age group.[2,4,14-17,19,21,23,29,38] The results of these studies are summarised in Table 1.5.

The proportion of abnormalities found on preoperative chest radiographs rose with age in all of the studies, except that by Ogunseyinde et al.[19] Between the ages of 40 and 60 years the rise in the number of abnormal preoperative chest radiograph findings appeared to be the greatest.

1.3.2 ASA grades

We hypothesised that the proportion of patients with abnormal preoperative chest radiographs would be greater in studies reporting test results for patients with higher ASA grades.

We investigated the effects of variations in the ASA grade of patients in the study population on the proportions of abnormal preoperative chest radiographs, changes in clinical management and postoperative complications across the identified studies. Only six of the 38 studies reported ASA grades.[2,5,8,11,14,17] Two studies consisted of ASA grade I and II patients only,[8,11] one study consisted of patients of ASA grades I to III only,[5] one study consisted of patients of ASA grades I to IV only[14] and the remaining two studies consisted of patients of ASA grades I to V.2,[17] Table 1.6 summarises the proportions of abnormal chest radiographs, changes in clinical management and postoperative complications according to the ASA grade of the patients in the study population.

TABLE 1.5 Summary of abnormal preoperative chest radiograph findings (%) by age

	AGE (YEARS)								
First author	0 to 10	11 to 20	21 to 30	31 to 40	41 to 50	51 to 60	61 to 70	71 to 80	80+
Ishaq[4]					3.2		15.6		
McKee[23]	7.7				17.0	40	44.2		
Silvestri[2]*	2						8.8		
Bhuripanyo[15]			5.4	8.3		28.7	40.8		
Rees[38]	0	0	3.2	12.9	19.3	39.7	43.3	61.8	68.8
Rucker[29]**	10		10	8	16	45	40		
Ogunseyinde[19]	0	0	0	0	61.9	91.8	40	57.1	
McCleane[17]	0	11	30	9	0	59	58	52	45
Gagner[16]	3	3	1	n/s	n/s	n/s	n/s	56	
Sommerville[14]	2.8	1.2	2.4	1.5	6.3	7.7	9.8	13.3	20.0
Umbach[21]	3.0				6.2	10.9	13.3	27.2	33.3

*Figures show change in anaesthetic management in patients with abnormal chest radiographs;

** % abnormal findings in patients with risk factors for abnormal chest radiographs; n/s = not stated.

TABLE 1.6 Summary of abnormal chest radiographs and changes in clinical management or postoperative complications in study populations according to ASA grades

ASA GRADE	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
Stated	19.3 (6)	45.8	4.0	4.0 (5)	5.1	0	0 (2)	1.5	0
I to II	24.8 (2)	45.8	22.8	2.0 (2)	2.1	1.5	1.5 (1)		
I to III	13.6 (1)			0 (1)			0 (1)		
I to IV	15.0 (1)			1.3 (1)					
I to V	17.6 (2)	18.3	4.0	5.1 (1)			(0)		
Not stated	16.2 (32)	64.7	0.3	1.4 (20)	13.3	0	0.6 (12)	8.8	0

*weighted means

Given the small number of studies that included patients of ASA grades I to II, I to III, I to IV and I to V, and the fact that we do not know the distribution of patients within each of the ASA categories, it is difficult interpret whether the apparent trend for a decrease in the mean proportion of abnormal chest radiographs with increasing ASA grade is real, arises from confounding or represents a chance association. However, when we investigated the effects of variations in ASA grade on the proportion of abnormal preoperative chest radiographs in the two studies that stratified the proportion of abnormal preoperative chest radiographs by ASA grade,[2,17] the proportion of abnormal preoperative chest radiographs increased with patients' ASA grades. The results are summarised in Table 1.7.

TABLE 1.7 Summary of abnormal preoperative chest radiograph findings (%) according to patients ASA grade

	ASA GRADE			
Study	I	II	III	IV + V
McCleane[17]	4	25	52	81
Silvestri[2]	3.1		15.5	

1.4 Heterogeneity in criteria for preoperative testing

Although authors did not state their definitions of 'routine' preoperative tests, we have assumed a routine preoperative investigation to be a test that is carried out preoperatively on all patients and is not directly related to the planned procedure or the patients' condition. In some studies, authors included patients who were described as undergoing routine preoperative tests as well as patients undergoing indicated preoperative tests. None of these studies presented the proportions of abnormal preoperative tests, changes in clinical management and postoperative complications separately for patients who had routine or indicated tests; the data were combined for both groups of patients. Therefore, we hypothesised that the proportions of abnormal preoperative chest radiographs, changes in clinical management and postoperative complications would be lower in study populations where all the patients had routine preoperative chest radiographs compared to study populations containing patients undergoing routine or indicated preoperative chest radiographs.

We investigated the effects of variations in the criteria for preoperative testing on the proportions of abnormal preoperative chest radiographs, changes in clinical management and postoperative complications across the identified studies. Twenty three studies included patients undergoing routine

TABLE 1.8 **Summary of abnormal chest radiographs, changes in clinical management and postoperative complications according to the criteria for preoperative testing**

CRITERIA FOR TEST	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
Routine only	17.7 (23)	64.7	0.3	2.6 (15)	13.3	0	0.2 (8)	8.8	0
Routine & indicated	18.1 (11)	52.0	2.9	1.5 (7)	5.0	0	1.0 (4)	34.0	0
Not stated	9.0 (3)	28.1	7.4	0.6 (3)	5.0	0	5.0 (2)	5.0	5.0

*weighted means

preoperative chest radiographs only,[2-4,6,8,10-13,15,19,20,22,24-26,29,30,32,35-38] whereas 11 studies included a combination of patients undergoing either routine and indicated tests (Table 1.2).[5,14,17,18,21,23,27,28,31,33,34] The other four studies did not state whether they included patients receiving routine or indicated preoperative chest radiographs.[1,7,9,16] Table 1.8 summarises the proportions of abnormal chest radiographs, changes in clinical management and postoperative complications according to whether the study population included routine only or both routine and indicated preoperative chest radiographs.

Table 1.8 shows that in the studies including routine tests only, the average proportion of abnormal chest radiographs (17.7%) was similar to that in studies including both routine and indicated tests (18.1%). Given that none of the authors defined routine or indicated tests, the similarity in the results in Table 1.8 might have arisen because the authors described the basis for testing differently. In any series of patients, some of the individuals having preoperative chest radiographs may have had comorbid conditions that would be classified as indications for carrying out the test although the test may have been administered on a routine basis. In such cases, the preoperative chest radiograph may have been classified as routine by some authors because it was carried out regardless of the fact that the patient had a comorbid condition, while other authors may have classified the test as indicated simply because of the presence of the comorbid condition.

It was not possible to investigate the effects of variations in the criteria for preoperative testing on the proportions of abnormal preoperative chest radiographs, changes in clinical management and postoperative complications within the identified studies because studies that included only patients for whom preoperative tests were indicated were excluded in the initial stages of our systematic review. In addition, none of the eligible studies reported data separately for routine and indicated preoperative chest radiographs.

1.5 Heterogeneity in the definition of the outcome variables

1.5.1 Definition of an abnormal chest radiograph

We investigated the variability of the definition of abnormal preoperative chest radiographs across the identified studies. Twelve of the 38 papers included definitions of an abnormal chest radiograph.[2,4,8,20-22,30,32-34,37,38] The definition of an abnormal chest radiograph in each of the studies is summarised in Table 1.9.

TABLE 1.9 Summary of the definitions of an abnormal preoperative chest radiograph

	1	2	3	4	5	6	7	8	9	10	11	12
Cardiovascular Abnormality												
Cardiomegaly	✓			✓	✓	✓	✓			✓	✓	✓
Left ventricle enlargement		✓			✓	✓					✓	
Unfolded/right sided aorta	✓	✓			✓	✓						
Enlarged pulmonary artery											✓	✓
Abnormal cardiac vasculature			✓									
Prominent right cardiac border								✓			✓	
Aortic aneurysm				✓						✓		
Aortic calcification										✓		
Pulmonary Abnormality												
Active tuberculosis	✓											✓
Old pulmonary tuberculosis	✓				✓	✓						✓
Chronic obstructive pulmonary disease	✓	✓		✓	✓	✓		✓		✓		
Fibrosis	✓			✓	✓	✓						✓
Bronchiectasis	✓			✓					✓		✓	✓
Large bulla	✓	✓		✓	✓	✓						
Pleural thickening	✓	✓			✓	✓				✓		
Asbestosis		✓			✓	✓						
Pulmonary infarction		✓			✓	✓				✓		✓
Pleural effusion		✓				✓						
Abnormality of chest wall			✓									
Abnormal pulmonary vasculature			✓				✓					
Abnormality of diaphragm			✓									
Hyperated lung field			✓	✓								
Severe congestive failure				✓	✓	✓						✓
Pulmonary infiltrate			✓	✓					✓	✓	✓	
Accentuation of lung markings								✓	✓			
Pulmonary congestion				✓						✓		
Cancer												
Metastases	✓	✓			✓	✓						
Lung masses				✓								
Lung nodule(s)				✓						✓		
Apical soft tissue density				✓								
Mediastinal masses							✓	✓				
Granuloma									✓	✓		

TABLE 1.9 **Summary of the definitions of an abnormal preoperative chest radiograph** *continued*

	1	2	3	4	5	6	7	8	9	10	11	12
Skeletal abnormality												
Collapsed T5 vertebra									✓			
Rib deformity	✓											
Old rib fracture	✓				✓	✓						✓
Disc degeneration	✓	✓				✓				✓		✓
Hemivertebra and spina bifida		✓			✓	✓						
Osteogenesis imperfecta							✓					
Degenerative joint disease							✓			✓		
Other												
Calcified lymph nodes	✓	✓		✓	✓	✓				✓		
Cervical spondylosis		✓				✓					✓	✓
Kyphosis and scoliosis		✓			✓	✓	✓				✓	✓
Pectus excavatum		✓			✓	✓						
Goitre						✓						✓
Pneumoconiosis		✓			✓	✓						
Ecchondroma					✓	✓						
Arthritides					✓	✓						
Atelectasis				✓			✓	✓		✓	✓	✓
Thyroglossal cyst								✓				
Pneumonia								✓			✓	

1: Khong[8]; 2: Ishaq[4]; 3: Silvestri[2]; 4: Tape[20]; 5: Seymour[30]; 6: Rees[38]; 7: Sane[37]; 8: Farnsworth[33]; 9: Rossello[34]; 10: Boghosian[22]; 11: Wood[32]; 12: Umbach[21].

Table 1.9 shows that the definitions of an abnormal chest radiograph were not consistent across the studies. These differences in definitions may represent a source of heterogeneity amongst the study results. However, authors did not report whether these definitions of abnormal chest radiographs were determined prior to assessment, or whether the published definitions merely reflected the abnormalities that were observed. Given this uncertainty it is not sensible to investigate further differences in the definitions of an abnormal preoperative chest radiograph.

1.5.2 Definition of a change in clinical management

We investigated the variability of the definition of a change in clinical management in patients who had had a preoperative chest radiograph in the identified studies. Twenty four studies reported changes in clinical management as an outcome variable.[1-9,11,12,14,15,18,23,25-27,30,32-34,36,37] Of these 24 studies, 13 specified definitions of a change in clinical management. These definitions are summarised in Table 1.10 along with the proportion of all patients with abnormal chest radiographs who underwent that change in clinical management where these data were available.

TABLE 1.10 Summary of changes in clinical management in patients who had had abnormal preoperative chest radiographs

	1	2	3	4	5	6	7	8	9	10	11	12	13
Surgery delayed	1.5		0.7	0.4	0.8		0.4	0.3		0.3	0.01		0.4
Change in medical decision										1.9			
Change of operation													
Different surgical approach													
Refusal of surgery						5.0							
Change to anaesthetic		0.2	2.3						✓	2.4			0.6
Chest physiotherapy												0.4	
Specific monitoring									✓				
Change in drugs													
New consultation			0.8		3.2								1.1
Total	**1.5**	**0.2**	**3.8**	**0.4**	**4.0**	**5.0**	**0.4**	**0.3**	**5.1**	**4.6**	**0.01**	**0.4**	**2.1**

1: Khong[8]; 2: Ishaq[4]; 3: Sane[37]; 4: Wood[32]; 5: Wiencek[27]; 6: Krupski[1]; 7: Clelland[7]; 8: McKee[23]; 9: Silvestri[2]; 10: Charpak[18]; 11: Petterson[36]; 12: Turnbull[25]; 13: Perez[11].

Table 1.10 shows that the definitions of a change in clinical management were not consistent across the studies. Six of the 13 studies in Table 1.10 reported a delay in surgery or changes in anaesthetic technique as the only changes in clinical management. The remaining seven studies used a broader definition for changes in clinical management and, therefore, are likely to report higher rates of change in clinical management than the studies using the narrower definition. However, as with the definition of an abnormal preoperative chest radiograph, these data may simply reflect changes in clinical management that occurred, rather than predefined actions that were considered to represent changes in clinical management. Again, given this uncertainty it is not sensible to investigate further differences in the definitions as a source of heterogeneity across the study populations.

1.5.3 Definition of postoperative complications

We investigated the variability of the definition of postoperative complications in patients who had had preoperative chest radiographs. Fifteen papers investigated postoperative complications.[1,4-9,15,18,21-23,25,30,34] Six of the studies reported the proportion of postoperative complications in patients with abnormal preoperative chest radiographs although they did not specify what the complications were.[7,18,22,23,30,34] In the remaining nine papers[1,4-6,8,9,15,21,25], there were no postoperative complications in four studies[1,5,15,25] and the results of the other five studies[4,6,8,9,21] are summarised in Table 1.11.

Table 1.11 shows that the postoperative complications that were reported were not consistent across the studies. Again these data may simply reflect postoperative complications that were observed so it is not sensible to investigate further differences in the definitions as a source of heterogeneity across the study populations.

TABLE 1.11 Summary of changes in clinical management in patients who had had abnormal preoperative chest radiographs

POSTOPERATIVE COMPLICATION	Khong[8]	Bouillot[6]	Krupski[1]	Turnbull[25]	Umbach[21]
Pulmonary					
Pleural effusion		✓			
Pneumothorax		✓			
Pulmonary oedema		✓			
Acute respiratory distress syndrome		✓			
Pulmonary embolism		✓			
Lung complication				0.4	
Extrathoracic complications					0.9
Cardiopulmonary complications					0.3
Cardiac					
Malignant hypertension	0.5				
Femoral artery pseudoaneurysm			1.2		
Myocardial infarction					
Skeletal					
Limb loss			1.2		
Other					
Nonspecific fever	1.0				
Atelectasis		✓			
Pneumonia		✓			
Prosthetic graft infection			0.6		
Wound infection			0.6		
Anoxic brain injury			0.6		
Death					
Total	**1.5**	**0.1**	**5.0**	**0.4**	**1.2**

It is also difficult to interpret the meaning of the postoperative complication data because the postoperative complications recorded in the data were not necessarily complications related to preoperative chest radiographs. Despite the fact that the patient had had a preoperative chest radiograph, postoperative complications still occurred.

1.6 Diagnostic accuracy

None of the studies investigated the diagnostic accuracy of the preoperative chest radiograph for predicting changes in clinical management. However, from the data presented it was possible to calculate positive predictive values for a change in clinical management for 20 papers. The positive predictive values indicate the percentage of patients with abnormal chest radiographs who subsequently underwent changes in clinical management. The results are summarised in Table 1.12.

The positive predictive value for predicting a change in clinical management ranged from 0% in four studies[12,16,20,22] to 51.4% in a further study.[37] However, it is difficult to interpret the meaning of the positive predictive values from Table 1.12 because of the heterogeneous nature of the studies as outlined in Section 1.

TABLE 1.12 Calculated estimates of the positive predictive value of preoperative chest radiographs to predict changes in clinical management

First author	Positive predictive value for predicting a change in clinical management (%)
Krupski[1]	19.0
Ishaq[4]	0.5
Bouillot[6]	7.4
Khong[8]	3.2
Adams[12]	0
Sommerville[14]	8.3
Bhuripanyo[15]	18.8
Gagner[16]	0
Charpak[18]	9.5
Tape[20]	0
Umbach[21]	12.7
Boghosian[22]	0
McKee[23]	0.8
Turnbull[25]	21.1
Weibman[26]	17.8
Wiencek[27]	9.9
Wood[32]	8.6
Rossello[34]	10.0
Petterson[36]	1.5
Sane[37]	51.4

2 Preoperative electrocardiograms

2.1 Characteristics of the studies

In our search of the literature from 1995 to 2001, we identified a total of 13 papers that studied preoperative electrocardiograms (ECGs). Twelve of these papers reported abnormal outcome data, two reported changes in clinical management and nine reported postoperative complications. In combination with the 16 papers identified in the HTA report, this review includes 29 papers that studied preoperative ECGs. The characteristics of the 29 papers are summarised in Table 2.1. All of the studies were case series.

TABLE 2.1 Characteristics of the eligible studies of preoperative ECGs

First author and year of publication	Country	Study sample (age)	Type of surgery	Abnormal test	Change in clinical management	Postoperative complications
Gauss 2001[39]	Germany	185 (> 38 years)	Vascular and abdominal	✓		✓
French 1999[40]	UK	127 (> 55 years)	Orthopaedic	✓		✓
Haug 1999[41]	USA	380 (15 to 54 years)	Dentoalveolar	✓		
Murdoch 1999[42]	Scotland	1185 (not stated)	Day surgery	✓	✓	✓
Rosenfeld 1999[43]	USA	1006 (20 to 96 years)	Cataract surgery	✓	✓	
Polanczyk 1998[44]	USA	4181 (> 50 years)	Orthopaedic, thoracic, abdominal, vascular, general			✓
Biavati 1997[45]	USA	355 (< 18 years)	Otolaryngology	✓		✓
Landesberg 1997[46]	USA and Israel	405 (adults)	Vascular	✓		✓
Tait 1997[47]	USA	1000 (18 to 88 years)	Not stated	✓		✓
Callaghan 1995[48]*	UK	354 (> 16 years)	Dental, general, ENT vascular, neurosurgery, ophthalmology, urology	✓		
Lui 1995[49]	USA	952 (21 to 96 years)	Not stated	✓		
Perez 1995[11]*	Spain	3131 (not stated)	Not stated	✓	✓	
Allman 1994[50]	UK	325 (> 40 years)	General, vascular	✓		
Kirwin 1993[51]	USA	96 (42 to 96 years)	Vascular	✓		✓
Older 1993[52]	Australia	187 (> 60 years)	Abdominal	✓		✓
Adams 1992[12]*	USA	169 (adult)	General	✓	✓	

TABLE 2.1 Characteristics of the eligible studies of preoperative ECGs *continued*

First author and year of publication	Country	Study sample (age)	Type of surgery	Abnormal test	Change in clinical management	Postoperative complications
Bhuripanyo 1992[53]*	Thailand	395 (40 to 77 years)	Gynaecology, ENT, orthopaedics, obstetrics, general ophthalmology,	✓	✓	✓
Gold 1992[54]*	USA	751 (14 to 88 years)	Not stated	✓		✓
MacDonald 1992[13]*	UK	147 (> 60 years)	Orthopaedics	✓	✓	
Somerville 1992[14]*	South Africa	797 (0 to 80 years)	Not stated	✓	✓	
McCleane 1990[55]*	UK	877 (not stated)	Not stated	✓		
Yipintsoi 1989[56]*	Thailand	424 (not stated)	General, gynaecology, ENT, ophthalmology, orthopaedics	✓		✓
Charpak 1988[57]*	France	3866 (adults)	General, gynaecology, ophthalmology, plastic surgery, obstetrics	✓	✓	
Johnson 1988[58]*	USA	212 (adults)	General, gynaecology, ENT, ophthalmology, orthopaedics, urology, plastic surgery	✓	✓	✓
Turnbull 1987[25]*	Canada	1010 (adults)	General	✓	✓	✓
Carliner 1986[59]*	USA	198 (> 40 years)	Cardiothoracic, general, r vascula	✓		✓
Muskett 1986[28]*	USA	200 (not stated)	Cardiothoracic, , urology, neurosurgery, plastic surgery, ENT, general orthopaedics, ophthalmology	✓	✓	✓
Paterson 1983[60]*	UK	267 (not stated)	Not stated	✓	✓	✓
Seymour 1983[61]*	UK	222 (> 65 years)	General	✓		✓

*Papers included in the HTA review

The results of the 29 studies, which documented the findings from a total of 16,754 preoperative ECGsECGs are reported in Table 2.2.

TABLE 2.2 **Summary of preoperative electrocardiogram study results from the eligible studies (includes routine and indicated tests)**

STUDY	NUMBER OF TESTS# (N)	ABNORMAL RESULTS N (%)	CHANGES IN CLINICAL MANAGEMENT N (%)	POSTOPERATIVE COMPLICATIONS N (%)	ROUTINE	PROSPECTIVE DATA	CONSECUTIVE RECRUITMENT	ASA GRADES STATED
Gauss[39]	185	40 (21.6)		16 (8.6)	Routine only	✓	✓	ASA I to IV
French[40]	127	42 (33.1)			Routine only	x	x	ASA I to III
Haug[41]	24	0		0	Routine & indicated	x	x	ASA I to II
Murdoch[42]	154	40 (26.0)	8 (5.3)	0	Routine & indicated	x	x	x
Rosenfeld[43]	1006	523 (54.5)	376 (37.4)		Routine only	✓	✓	x
Polanczyk[44]	4181			256 (6.1)	Routine only	✓	✓	ASA I to IV
Biavati[45]	65	4 (6.2)		4 (6.2)	Not stated	x	x	x
Landesberg[46]	405	134 (33.1)		19 (4.7)	Routine only	x	x	x
Tait[47]	573	211 (36.8)		129 (22.5)	Routine only	✓	✓	ASA I to II
Callaghan[48]*	230	57 (24.8)			Routine & indicated	x	x	X
Lui[49]	537	17 (3.2)			Not stated	x	x	ASA I to IV
Perez[11]*	2401	250(10.4)	25 (1.0)		Routine only	x	x	ASA I to II
Allman[50]	325	64 (19.7)			Routine only	x	x	ASA I to II
Kirwin[51]	96	9 (9.4)		21 (21.9)	Routine only	x	x	x
Older[52]	187	55 (29.4)		14 (7.5)	Not stated	x	x	x
Adams[12]*	90	12 (13.3)	0		Routine only	x	x	x
Bhuripanyo[53]*	395	130 (32.9)	10 (2.5)	5 (1.3)	Routine only	✓	✓	x
Gold[54]*	751	321 (42.7)		12 (1.6)	Routine & indicated	x	x	ASA I to III
Macdonald[13]*	145	3 (2.1)	3 (2.1)	3 (2.1)	Routine only	x	x	x

TABLE 2.2 **Summary of preoperative electrocardiogram study results from the eligible studies (includes routine and indicated tests)** *continued*

STUDY	NUMBER OF TESTS# (N)	ABNORMAL RESULTS N (%)	CHANGES IN CLINICAL MANAGEMENT N (%)	POSTOPERATIVE COMPLICATIONS N (%)	ROUTINE	PROSPECTIVE DATA	CONSECUTIVE RECRUITMENT	ASA GRADES STATED
Sommerville[14]*	290	52 (17.9)	4 (1.4)		Routine only	x	x	ASA I to IV
McCleane[55]*	877	395 (45.0)			Routine only	x	x	ASA I to V
Yipintsoi[56]*	424	61 (14.4)		7 (1.7)	Routine only	x	x	x
Charpak[57]*	1610	609 (37.8)	116 (7.2)		Routine & indicated	✓	✓	x
Johnson[58]*	212	140 (66.0)	0	0	Not stated	✓	✓	x
Turnbull[25]*	632	101(6.0)	0	12 (1.9)	Not stated	x	x	x
Carliner[59]*	198	125 (63.1)		6 (3.0)	Routine only	✓	✓	x
Muskett[28]*	145	53 (36.5)	2 (1.4)	0	Routine & indicated	✓	✓	x
Paterson[60]*	267	82 (22.3)	4 (1.5)	0	Routine only	✓	✓	x
Seymour[61]*	222	175 (78.8)		18 (8.1)	Routine only	x	x	x

*Papers included in the HTA review #The number of tests carried out may differ from the sample size in some studies. This occurs in papers reporting the results of multiple preoperative tests because not all of patients in the study sample received all the preoperative tests detailed in the paper.

We found wide variation in the reported proportion of abnormal preoperative ECGs. The proportion of abnormal ECGs ranged from 0% in one study[41] to 78.8% in a further study.[61] The proportion of patients who had had preoperative ECGs and subsequently underwent a change in clinical management ranged from 0% in three studies[12,25,58] to 37.4% in a further study.[43] The proportion of patients who had had preoperative ECGs and who then suffered postoperative complications ranged from 0% in five studies[28,41,42,58,60] to 22.5% in a further study.47

As described in Section 1, the wide variation in the results may be explained at least in part by heterogeneity in the study populations. The impact of four major sources of heterogeneity on the outcome of the preoperative ECG studies will be considered separately in the following sections.

2.2 Heterogeneity in the quality of the study design

As described in Section 1, studies in which data are collected prospectively and in which patients are recruited consecutively are less susceptible to bias than studies in which data are collected retrospectively or where patients are recruited selectively. Therefore, we hypothesised that the proportions of abnormal preoperative ECGs, changes in clinical management and postoperative complications might differ according to the quality of the study design.

We investigated the effects of variations in the quality of the study design on the proportions of abnormal ECGs, changes in clinical management and postoperative complications across the identified studies. Ten studies collected data prospectively and recruited consecutive patients[28,39,43,44,47,53,57-60] and 19 studies collected data retrospectively and did not state that the sample of patients was consecutive.[11-14,25,40-42,45,46,48-52,54-56,61]

Table 2.3 provides a summary of the proportions of abnormal preoperative ECGs, changes in clinical management and postoperative complications across studies according to study quality indicators.

There was little difference in the proportion of abnormal preoperative ECGs between prospective and retrospective studies (21.8% and 22.5%, respectively). However, the average proportion of patients undergoing a change in clinical management or postoperative complications tended to be higher in the prospective studies compared to the retrospective studies (4.9% and 1.2%, respectively).

2.3 Heterogeneity in the composition of the study population

2.3.1 Age range

Given that the prevalence of comorbid diseases increases with age, we hypothesised that the proportion of patients with abnormal preoperative ECGs would be higher in studies of older patient populations.

TABLE 2.3 Summary of abnormal ECGs, changes in clinical management and postoperative complications in study populations according to study quality indicators

QUALITY INDICATOR	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
P C	21.8 (9)	66.0	21.6	5.8 (6)	37.4	0	4.9 (8)	22.5	0
P N	(0)								
R C	22.5 (19)	91.4	0	0.5 (6)	5.3	0	1.2 (11)	8.1	0
R N	(0)								

P = prospective data collection; R = retrospective data collection; C = consecutive recruitment of patients; N = recruitment of patients that was not stated as consecutive; * weighted means were produced to reflect the different numbers of patients in each study. It was not possible to produce a distributional statistic reflecting this weight.

TABLE 2.4 Summary of abnormal preoperative ECGs, changes in clinical management and postoperative complications in study populations by age group

AGE RANGE	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
Adults > 60 years	42.1 (3)	78.8	2.1	2.1 (1)			6.3 (3)	8.1	2.1
Adults only	19.9 (16)	66.0	3.2	12.7 (6)	37.4	0	6.7 (8)	22.5	0
Children & adults	35.0 (3)	42.7	0	1.4 (1)			1.5 (2)	1.6	0
Children only	6.2 (1)			(0)			6.2 (1)		
Not stated	20.6 (6)	45.0	10.4	1.3 (4)	5.2	1	0.7 (4)	1.7	0

*weighted means

We investigated the effects of variations in the age range of the study population on the proportions of abnormal preoperative ECGs, changes in clinical management and postoperative complications across the identified studies. Nineteen studies included adults only,[12,13,25,39,40,43,44,46-53,57-59,61] one study included children only,[45] three studies included both adults and children[14,41,54] and the remaining studies did not specify the age range of their patient population.[11,28,42,55,56,60]

Table 2.4 provides a summary of the proportions of abnormal preoperative ECGs, changes in clinical management and postoperative complications across studies according to age group of the study population.

Table 2.4 shows that the average proportion of abnormal preoperative ECGs tended to be highest in studies that included elderly adults (42.1%), followed by studies that included both adults and children (35.0%) and tended to be lowest in studies that included children only (6.2%).

We then investigated the effects of variations in the age of the study population on the proportion of abnormal preoperative ECGs within the identified studies. This was possible for five of the studies, which stratified the proportion of electrocardiogram abnormalities by age.[14,53-55,60] The results are summarised in Table 2.5.

TABLE 2.5 Summary of abnormal preoperative electrocardiogram findings (%) by age

	AGE (YEARS)								
First author	0 to 10	11 to 20	21 to 30	31 to 40	41 to 50	51 to 60	61 to 70	71 to 80	80+
Sommerville[14]	0	0	0	2.9	4.5	17.6	16.4	16.7	20.0
Paterson[60]	–	–	–	3.8	5.7	26.3	42.6	61.2	64.3
McCleane[55]	0	0	12	7	21	41	58	79	64
Bhuripanyo[53]	–	–	–	–	26.9	30.0	34.0	35.2	
Gold[54]	37				36	44	62		

From Table 2.5 it can be seen that in all of the studies the proportion of abnormal preoperative ECGs rose as age increased. The rise in the ECG abnormality rate appeared to be greatest between the ages of 40 and 60 years, increasing from an average of 4.6% in 30 to 40-year-olds to 18.9% and 31.8% in 40 to 50 and 50 to 60-year-olds, respectively.

2.3.2 ASA grades

We hypothesised that the proportion of patients with abnormal preoperative ECGs would be greater in studies reporting the results for patients with higher ASA grades.

We investigated the effects of variations in the ASA grade of patients in the study population on the proportions of abnormal preoperative ECGs, changes in clinical management and postoperative complications across the identified studies. Only 11 of the 29 studies reported ASA grades.[11,14,39-41,44,47,49,50,54,55] Four of the studies included patients of ASA grades I and II only,[11,41,47,50] two studies included patients of ASA grade I, II and III only,[40,54] four studies included patients of ASA grades I to IV only[14,39,44,49] and one study included patients of ASA grades I to V.[55] Table 2.6 summarises the proportions of abnormal ECGs, changes in clinical management and postoperative complications according to the ASA grade of the patients in the study population.

The mean proportions of preoperative ECGs that were abnormal tended to be highest in studies that included patients of ASA grades I to V (45.0%) and lowest in studies that included patients of ASA grades I and IV only (10.8%) and in studies that included patients of ASA grades I and II only (15.8%). However, given the small number of studies that stated patients' ASA grades, and the fact that we do not know the distribution of patients within each of the ASA categories, it is difficult interpret whether any trend exists.

We then investigated the effects that variations in the ASA grade of patients in the study population had on the proportion of abnormal preoperative ECGs within the identified studies. Of the 11 studies that reported ASA grades, only two categorised the proportion of electrocardiogram abnormalities according to patients' ASA grade.[54,55] The results are summarised in Table 2.7

It appears that the proportion of abnormal preoperative ECGs increases with a patient's ASA grade (Table 2.7), although based on only two studies.

TABLE 2.6 Summary of abnormal chest radiographs, changes in clinical management and postoperative complications according to the criteria for preoperative testing

CRITERIA FOR TEST	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
Stated	13.7 (11)	45.0	0	1.1 (2)	1.4	1	7.2 (5)	22.5	0
I to II	15.8 (4)	36.8	0	1.0 (1)			21.6 (2)	22.5	0
I to III	41.3 (2)	42.7	33.1	(0)			1.6 (1)		
I to IV	10.8 (4)	21.6	3.2	1.4 (1)			6.2 (2)	8.6	6.1
I to V	45.0 (1)			(0)			(0)		
Not stated	34.7 (18)	91.4	0	11.5 (10)	37.4	0	3.1 (14)	21.6	0

*weighted means; (0) no data available.

TABLE 2.7 Summary of abnormal preoperative electrocardiogram findings (%) by ASA grade

		ASA GRADE			
	Study Number of patients	I	II	III	IV + V
McCleane[55]	877	1	31	79	91
Gold[54]	751	31	47	67	

2.4 Heterogeneity in criteria for preoperative testing

Although authors did not state their definitions of 'routine' preoperative tests, we have assumed a routine preoperative investigation to be a test carried out on all patients preoperatively that is not directly related to the planned procedure or the patients' condition. In some studies, authors included patients who were described as undergoing routine preoperative tests as well as patients undergoing indicated preoperative tests. None of these studies presented the proportions of abnormal preoperative tests, changes in clinical management and postoperative complications separately for patients who had routine tests and for patients who had indicated tests, instead the data were combined for both groups of patients. Therefore, we hypothesised that the proportions of abnormal preoperative ECGs, changes in clinical management and postoperative complications would be lower in study populations where all the patients had routine preoperative ECGs compared to study populations containing patients undergoing either routine or indicated preoperative ECGs.

We investigated the effects of variations in the criteria for preoperative testing on the proportions of abnormal preoperative ECGs, changes in clinical management and postoperative complications across the identified studies. Eighteen of the studies included patients undergoing routine preoperative ECGs only, whereas six of the studies included a combination of both routine and indicated tests (Table 2.2). Table 2.8 provides a summary of the proportions of abnormal preoperative ECGs, changes in clinical management and postoperative complications in study populations according to whether the study population included routine only or both routine and indicated tests.

Table 2.8 shows that in the studies that included routine tests only, the mean proportion of abnormal preoperative ECGs tended to be lower (18.4 %) than in studies which included both routine and indicated tests (37.0%).

It was not possible to investigate the effects of variations in the criteria for preoperative testing on the proportions of abnormal preoperative ECGs,

TABLE 2.8 Summary of abnormal preoperative ECGs, changes in clinical management and postoperative complications according to the criteria for preoperative testing

QUALITY FOR TEST	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
Routine only	18.4 (18)	91.4	0	8.9 (7)	37.4	0	14.3 (11)	22.5	0
Routine & indicated	37.0 (6)	42.7	0	4.3 (3)	7.2	1.4	1.1 (4)	1.6	0
Not stated	19.4 (5)	66.0	3.2	0 (2)	0	0	2.7 (4)	7.5	0

*weighted means

changes in clinical management and postoperative complications within the identified studies because studies that included only patients for whom preoperative tests were indicated were excluded in the initial stages of our systematic review and none of the eligible studies reported data separately for routine and indicated preoperative ECGs.

2.5 Heterogeneity in the definition of the outcome variables

2.5.1 Definition of an abnormal ECG

We investigated the variability of the definition of an abnormal preoperative ECG across the identified studies. Eleven papers reported definitions of an abnormal ECG. The reported definitions are summarised in Table 2.9.

Table 2.9 shows that the definitions of an abnormal ECG were not consistent across the studies. These differences in definitions may represent a source of heterogeneity amongst the study results. However, authors did not report whether their definitions of abnormal ECGs were determined prior to assessment, or whether their published definitions merely reflected the abnormalities that were observed. Given this uncertainty it is not sensible to investigate further differences in the definitions of an abnormal ECG.

TABLE 2.9 Summary of the definitions of an abnormal preoperative ECG

	1	2	3	4	5	6	7	8	9	10	11
Presence of ST segment depression (20%)	✓	✓							✓	✓	✓
Q waves > 0.4 seconds duration			✓	✓	✓	✓					
>25% R wave			✓	✓	✓	✓					
ST segment depressions of 0.1 mV or more			✓	✓	✓	✓					
PR interval							✓				
AV conduction abnormalities							✓	✓	✓		
Atrial or left ventricular hypertrophy							✓	✓	✓		✓
Myocardial ischaemia and infarction							✓		✓		✓
Minnesota codes to identify Q/QS patterns								✓			
QRS axis deviation								✓	✓		
T wave items								✓	✓		
Ventricular function defects								✓			
Arrhythmias								✓			
Left axis deviation without left anterior hemiblock								✓			
Counterclockwise rotation								✓			✓
Clockwise rotation								✓			
Sinus tachycardia								✓			
Sinus bradycardia								✓			✓
Atrial fibrillation								✓			
Supraventricular tachycardia								✓			
Frequent ventricular ectopic beats								✓			
Bundle branch block									✓		✓

1: Allman[50]; 2: French[40]; 3: Tait[47]; 4: Gauss[39]; 5: Kirwin[51]; 6: Landesberg[46]; 7: Carliner[59]; 8: Lui[49]; 9: Seymour[61]; 10: Paterson[60]; 11: Bhuripanyo[53].

TABLE 2.10 Summary of the change in management (%) in patients who had had a preoperative ECG

Change in clinical management	Charpak[57]	MacDonald[13]	Perez[11]
Surgery postponed pending further investigation	✓		
Anaesthetic management altered			0.1
Blood component therapy	✓	0.7	0.7
Change in therapy	✓	1.4	0.2
Total	**7.2**	**2.1**	**1.0**

2.5.2 Definition of a change in clinical management

We investigated the variability of the definition of a change in clinical management in patients who had had a preoperative ECG in the identified studies. Twelve of the 29 studies reported changes in clinical management.[11-14,25,28,42,43,53,57,58,60] Of these 12 studies only three specified definitions of a change in clinical management. These definitions are summarised in Table 2.10.

The definition of a change in clinical management varied between the studies outlined in Table 2.10. However, as with the definition of abnormalities these data may simply reflect changes in clinical management that occurred, rather than the predefined actions that were considered to represent changes in clinical management. Again, given this uncertainty, it is not sensible to investigate further differences in the definitions as a source of heterogeneity across the study populations.

2.5.3 Definition of a postoperative complication

We investigated the variability of the definition of a postoperative complication in patients who had had a preoperative ECG. Nineteen studies reported postoperative complications in patients who had had preoperative ECGs.[13,25,28,39,41,42,44-47,51-54,56,58-61] Of these 19 studies, five specified definitions of postoperative complications. These definitions are summarised in Table 2.11.

Table 2.11 shows that the postoperative complications that were reported were not wholly consistent across the studies. Again these data may simply reflect postoperative complications that were observed rather than all the postoperative complications that potentially could have arisen so it is not sensible to investigate further differences in the definitions as a source of heterogeneity across the study populations. Also, it is difficult to interpret the meaning of the postoperative complication data

TABLE 2.11 Summary of the postoperative complications in patients who had had a preoperative electrocardiogram

Postoperative complication	1	2	3	4	5
Cardiovascular					
Postoperative myocardial infarction	15.6	4.2			1.5
Arrhythmias				2.1	
Other					
Death	6.3	0.5	7.5		1.5
Total	**21.9**	**4.7**	**7.5**	**2.1**	**3.0**

1: Kirwin[51]; 2: Landesberg[46]; 3: Older[52]; 4: MacDonald[13]; 5: Carliner[59].

TABLE 2.12 Summary of the diagnostic accuracy of preoperative ECGs

STUDY	OUTCOME	SENSITIVITY (%)	SPECIFICITY (%)	POSITIVE PREDICTIVE VALUE (%)	NEGATIVE PREDICTIVE VALUE (%)
Allman[50]	Detecting silent myocardial ischaemia in patients who are hypertensive and taking antihypertensive medication	25	95	55	84
Biavati[45]	Detecting a complicated postoperative course in children < 18 years	8	100	73	100
Gauss[39]	Detecting postoperative cardiac morbidity and mortality	53	82	22	95
Tait[47]	Detecting postoperative cardiovascular events	Not stated	Not stated	25.4* 17.6**	78.7* 77.5**
Gold[54]	Detecting adverse events	75	58	Not stated	Not stated
Carliner[59]	Detecting adverse cardiovascular events	85	41	22	Not stated

*Patients with cardiovascular risk factors; ** patients with no cardiovascular risk factors.

because the postoperative complications recorded in the data were not necessarily complications relating to the preoperative ECGs. Despite the fact that the patient had had a preoperative ECG, postoperative complications still occurred.

2.6 Diagnostic accuracy

Six of the studies investigated the diagnostic accuracy of the preoperative ECG. The results of these six studies are summarised in Table 2.12.

Sensitivity ranged from 8% in one study[45] to 85% in a further study.[59] Specificity and positive predictive values ranged from 41% and 22%, respectively, in one study[59] to 100% and 73%, respectively, in a further study.[45] Negative predictive values ranged from 77.5% in one study[47] to 100% in a further study.[45]

From the data presented in each of the papers it was possible to calculate positive predictive values for predicting a change in clinical management for seven studies. The positive predictive value indicates the percentage of people with an abnormal preoperative ECG that subsequently underwent changes in clinical management. The results are summarised in Table 2.13.

TABLE 2.13 Calculated estimates of the positive predictive value of preoperative ECGs to predict changes in clinical management

First author	Positive predictive value for predicting a change in clinical management (%)
Murdoch[42]	20.0
Rosenfeld[43]	36.3
Perez[11]	9.5
Adams[12]	0
Bhuripanyo[53]	7.7
Turnbull[25]	0
Paterson[60]	4.9

The positive predictive value for predicting a change in clinical management ranged from 0% in two studies[12,25] to 36.3% in a further study.[43] However, it is difficult to interpret the meaning of the positive predictive values from Table 2.13 because of the heterogeneous nature of the studies as outlined in Section 1.

3 Preoperative haemoglobin, haematocrit and full blood count tests

3.1 Characteristics of the studies

In our search of the literature from 1995 to 2001 we identified six studies of preoperative haemoglobin, haematocrit and full blood counts (FBCs). All of these papers reported abnormal outcome data, three papers also reported changes in clinical management and three papers reported postoperative complications. In combination with the 23 papers identified in the HTA report, this review included 29 papers that studied preoperative haemoglobin, haematocrit and FBCs. The characteristics of the 29 papers are summarised in Table 3.1. All studies were case series.

TABLE 3.1 Characteristics of eligible studies of preoperative haemoglobin, haematocrit and FBC tests

First author and year of publication	Country	Study sample (age)	Type of surgery	Abnormal test	Change in clinical management	Postoperative complications
Dzankic 2001[62]	USA	544 (70 to 100 years)	Not stated	✓		
Gabriel 2000[63]	France	1706 (0 to 15 years)	ENT	✓	✓	✓
Haug 1999[41]	USA	458 (15 to 54 years)	Oral, maxillofacial	✓	✓	
Wojtkowski 1999[64]	USA	140 (0 to 19 years)	Cardiology	✓		
Cherng 1998[65]	Taiwan	74 (not stated)	Cardiac	✓		✓
Meneghini 1998[66]	USA	1884 (0 to 8 years)	Not stated	✓	✓	✓
Houry 1995[67]*	USA	3242 (16 to 99 years)	Urology, gynaecology, thoracic, vascular, general, endocrine	✓		
Perez 1995[11]*	Spain	3131 (not stated)	Not stated	✓		✓
Close 1994[68]*	USA	96 (1 to 40 years)	ENT	✓		✓
Kozak 1994[69]*	USA	305 (not stated)	Fibre-optic bronchoscopy	✓		✓
Hoare 1993[70]*	UK	372 (2 to 15 years)	ENT	✓	✓	✓
MacPherson 1993[71]*	South Africa	159 (not stated)	Cardiothoracic, general	✓		✓
Adams 1992[12]*	USA	169 (adults)	General	✓	✓	
Baron 1992[72]*	USA	1863 (< 18 years)	Not stated	✓	✓	
MacDonald 1992[13]*	UK	147 (> 60 years)	Orthopaedics	✓		

TABLE 3.1 **Characteristics of eligible studies of preoperative haemoglobin, haematocrit and FBC tests** *continued*

First author and year of publication	Country	Study sample (age)	Type of surgery	Abnormal test	Change in clinical management	Postoperative complications
Narr 1991[73]*	USA	3782 (not stated)	Not stated	✓	✓	
Roy 1991[74]*	Canada	2000 (0 to 18 years)	Not stated	✓	✓	✓
Bolger 1990[75]*	USA	52 (not stated)	ENT	✓		✓
Nigam 1990[76]*	UK	250 (3 to 12 years)	ENT	✓	✓	
O'Connor 1990[77]*	USA	486 (< 18 years)	ENT, general, urology orthopaedics	✓	✓	
Jones 1989[78]*	UK	346 (children)	Orthopaedics	✓		
Charpak 1988[57]*	France	3866 (adults)	General, gynaecology, obstetrics, plastic surgery, orthopaedics	✓	✓	
Rohrer 1988[79]*	USA	282 (not stated)	General, vascular	✓	✓	
Turnbull 1987[25]*	Canada	1010 (adults)	General	✓	✓	✓
Muskett 1986[28]*	USA	200 (not stated)	Cardiothoracic, ENT, general, neurosurgery, ophthalmology, urology, orthopaedics, plastic surgery	✓	✓	
Kaplan 1985[80]*	USA	2000 (0 to 75 years)	Not stated	✓	✓	✓
Ramsey 1983[81]*	USA	92 (0 to 75 years)	Cardiothoracic	✓	✓	
Wood 1981[32]*	USA	1924 (0 to 14 years)	Urology, ophthalmics, orthopaedics, general ENT	✓	✓	✓
Rossello 1980[34]*	Puerto Rico	690 (< 14 years)	Not stated	✓	✓	

*papers included in the HTA review

The results of the 29 papers, which documented the findings from a total of 29,362 preoperative haemoglobin and haematocrit tests, 15,283 preoperative platelet counts and 5,101 preoperative white blood cell counts are reported in Table 3.2.

TABLE 3.2 **Summary of preoperative haemoglobin and haematocrit and full blood count test results from the eligible studies (includes routine and indicated tests)**

STUDY	NUMBER OF TESTS# (N)	ABNORMAL RESULTS N (%)	CHANGES IN CLINICAL MANAGEMENT N (%)	POSTOPERATIVE COMPLICATIONS N (%)	ROUTINE	PROSPECTIVE DATA	CONSECUTIVE RECRUITMENT	ASA GRADES STATED
Haemoglobin and haematocrit								
Dzankic[62]	526	55 (10.5)	0		Not stated	✓	✓	ASA I & II
Haug[41]	235	1 (0.4)	0		Not stated	✓	x	ASA I & II
Meneghini[66]	1884	226 (12.0)	0	0	Not stated	✓	x	ASA I & II
Perez[11]	3091	44 (1.4)	18a (0.6)		Routine only	x	x	ASA I & II
Kozak[69]	274	9 (3.3)		3 (1.1)	Routine only	x	x	x
Hoare[70]	372	18 (4.8)	10 (2.7)	0	Routine only	x	x	x
Baron[72]	1863	21 (1.1)	0		Not stated	x	✓	x
Macdonald[13]	145	5 (3.4)			Routine only	x	✓	x
Narr[73]	3782	30 (0.8)	3 (0.1)		Routine only	x	x	ASA I
Roy[74]	2000	11 (0.6)	3 (0.2)	0	Not stated	x	x	ASA I & II
Nigam[76]	250	2 (0.8)	1 (0.4)		Not stated	x	✓	x
O'Connor[77]	484	85 (17.6)	2 (0.4)		Not stated	x	x	x
Jones[78]	307	2 (0.7)			Not stated	x	x	x
Charpak[57]	2138	688 (32.2)	140 (6.5)		Routine & indicated	✓	✓	x
Turnbull[25]	1005	7 (0.7)	2 (0.2)	2 (0.2)	Routine only	x	✓	x
Wood[32]	1918	16 (0.8)	1 (0.1)		Not stated	x	x	x
Rossello[34]	689	5 (0.7)	0		Not stated	x	x	x
Platelet count								
Dzankic[62]	520	10 (1.9)	0		Not stated	✓	✓	ASA I & II
Gabriel[63]	1479	1 (0.1)	0	50 (3.0)	Not stated	✓	x	x
Wojtkowski[64]	135	20 (14.8)			Routine only	x	x	x

TABLE 3.2 **Summary of preoperative haemoglobin and haematocrit and full blood count test results from the eligible studies (includes routine and indicated tests)** *continued*

STUDY	NUMBER OF TESTS# (N)	ABNORMAL RESULTS N (%)	CHANGES IN CLINICAL MANAGEMENT N (%)	POSTOPERATIVE COMPLICATIONS N (%)	ROUTINE	PROSPECTIVE DATA	CONSECUTIVE RECRUITMENT	ASA GRADES STATED
Cherng[65]	68	34 (50)		2 (2.7)	Routine only	✓	x	x
Perez[11]	3072	13 (0.4)		18a (0.6)	Routine only	x	x	ASA I & II
Close[68]	90	1 (1.1)		0	Routine only	✓	x	x
Kozak[69]	274	9 (3.3)	0		Routine only	x	x	x
Macpherson[71]	111	1 (0.9)		0	Routine only	x	x	x
Narr[73]	3782	46 (1.2)		0	Routine only	x	x	ASA I
Bolger[75]	52	0		0	Not stated	x	x	x
Charpak[57]	290	65 (8.0)	1(0.3)		Routine & indicated	✓	✓	x
Rohrer[79]	163	13 (8.0)	0		Routine only	✓	x	X
Turnbull[25]	1005	0	0	0	Routine only	x	✓	x
Kaplan[80]	407	3 (0.7)	0	0	Routine only	x	x	x
Ramsey[81]	92	0	0		Not stated	x	x	x
White blood cell count								
Haug[41]	235	1 (0.4)	0		Not stated	✓	x	ASA I & II
Perez[11]	3053	27 (0.9)		18a (0.6)	Routine only	x	x	ASA I & II
Turnbull[25]	1005	1 (0.1)	0	0	Routine only	x	✓	x
Muskett[28]	155	54 (34.8)	8 (5.2)		Not stated	x	✓	x
Rossello[34]	686	120 (17.5)	9 (1.3)		Not stated	x	x	x

*Papers included in the HTA review

The proportions of abnormal preoperative haemoglobin and haematocrit tests ranged from 0.4% in one study[41] to 32.2% in a further study.[57] The proportion of patients who had had preoperative haemoglobin and haematocrit tests and who subsequently underwent a change in clinical management ranged from 0% in five studies[34,41,62,66,72] to 6.5% in a further study.[57] The proportion of patients who had had preoperative haemoglobin and haematocrit tests and who then suffered postoperative complications ranged from 0% in three studies[66,70,74] to 1.1% in a further study.[69]

The proportions of abnormal preoperative platelet counts ranged from 0% in three studies[25,75,81] to 50% in a further study.[65] The proportion of patients who had had preoperative platelet count tests and subsequently underwent a change in clinical management ranged from 0% in seven studies[25,62,63,69,79-81] to 0.3% in a further study.[57] The proportion of patients who had had preoperative platelet count tests and who then suffered postoperative complications ranged from 0% in seven studies[25,68,71,73,75,80] to 3% in a further study.[63]

The proportions of abnormal preoperative white blood cell counts ranged from 0.1% in one study[25] to 34.8% in a further study.[28] The proportion of patients who had had preoperative white blood cell counts and subsequently underwent a change in clinical management ranged from 0% in two studies[25,41] to 5.2% in a further study.[28] The proportion of patients who had had preoperative white blood cell counts and who then suffered postoperative complications ranged from 0% in one study[25] to 0.6% in a further study.[11]

As described in Section 1, the wide variation in the results may be explained at least in part by heterogeneity in the study populations. The impact of four major sources of heterogeneity on the outcome of the preoperative haemoglobin, haematocrit and FBC test studies will be considered separately in the following sections.

3.2 Heterogeneity in the quality of the study design

As described in Section 1, studies in which data are collected prospectively and in which patients are recruited consecutively are less susceptible to bias than studies in which data are collected retrospectively and where patients are recruited selectively. Therefore, we hypothesised that the proportions of abnormal preoperative haemoglobin, haematocrit and FBC tests, changes in clinical management and postoperative complications might differ according to the quality of the study design.

We investigated the effects of variations in the quality of the study design on the proportions of abnormal preoperative haemoglobin, haematocrit and FBC tests, changes in clinical management and postoperative complications across the identified studies. Three studies collected data prospectively and recruited consecutive patients,[57,62,67] six studies collected data prospectively and did not state that the sample of patients was consecutive,[41,63,65,66,68,79] five studies collected data retrospectively and recruited consecutive patients[13,25,28,72,76] and 15 studies collected data retrospectively and did not state that the sample of patients was consecutive.[11,12,32,64,69-71,73-75,77-81] Table 3.3 provides a summary of the proportions of abnormal preoperative haemoglobin, haematocrit and FBC tests and changes in clinical management and postoperative complications across studies according to study quality indicators.

TABLE 3.3 Summary of abnormal preoperative haemoglobin, haematocrit and FBC tests, changes in clinical management or postoperative complications in study populations according to study quality indicators

QUALITY INDICATOR	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
Haemoglobin and haematocrit									
P C	27.9 (2)	32.2	10.5	5.3 (2)	6.5	0	(0)		
P N	10.7 (2)	12.0	0.4	0 (2)	0	0	0 (1)		
R C	1.1 (4)	3.4	0.7	0.1 (3)	0.4	0	0.2 (1)		
R N	1.7 (9)	17.6	0.6	0.3 (7)	2.7	0	0 (3)	1.1	0
Platelet count									
P C	9.3 (2)	22.4	1.9	0 (2)	0.3	0	(0)		
P N	2.7 (4)	50.0	0.1	0 (2)	0	0	3.2 (3)	3.4	0
R C	0 (1)			0 (1)			0 (1)		
R N	1.2 (8)	14.8	0	0 (5)	0.2	0	0.2 (6)	0.6	0
White blood cell count									
P C	(0)								
P N	0.1 (1)			0 (1)			(0)		
R C	4.7 (2)	34.8	0.1	0.7 (2)	5.2	0	0 (1)		
R N	4.0 (2)	17.5	0.9	1.3 (1)			0.6 (1)		

P = prospective data collection; R = retrospective data collection; C = consecutive recruitment of patients; N = nonconsecutive recruitment of patients; *weighted means were produced to reflect the different numbers of patients in each study. It was not possible to produce a distributional statistic reflecting this weight.

The average proportions of abnormal preoperative haemoglobin and haematocrit tests and changes in clinical management tended to be higher in prospective studies compared to retrospective studies. There were no other clear patterns with preoperative haemoglobin, haematocrit and FBC test results for changes in clinical management or postoperative complications with quality of study design.

3.3 Heterogeneity in the composition of the study population

3.3.1 Age range

Given that the prevalence of comorbid diseases increases with age, we hypothesised that the proportion of patients with abnormal preoperative haemoglobin, haematocrit and FBC tests would be higher in studies of older patient populations.

We investigated the effects of variations in the age range of the study population on the proportions of abnormal preoperative haemoglobin, haematocrit and FBC tests, changes in clinical management and postoperative complications across the identified studies. Five of the studies included adults only,[12,13,25,57,62], two of which only included adults aged over 60 years,[13,62] ten of the studies included children only,[32,34,63,66,70,72,74,76-78] six of the studies included adults and children[41,64,67,68,80,81] and eight of the studies did not state the age range of their study population.[11,28,65,69,71,73,75,79] Table 3.4 provides a summary of the proportions

TABLE 3.4 **Summary of abnormal preoperative haemoglobin, haematocrit and FBC tests, changes in clinical management or postoperative complications in study populations according to age group**

AGE GROUP	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
Haemoglobin and haemotocrit									
Adults > 60 years	6.1 (2)	6.9	3.4	0 (1)			(0)		
Adults only	22.1 (2)	32.2	0.7	4.5 (2)	6.5	0.2	0.2 (1)		
Children & adults	0.4 (1)			0 (1)			(0)		
Children only	3.9 (9)	17.6	0.5	0.2 (8)	2.7	0	0 (3)	0	0
Not stated	2.3 (3)	3.3	0.4	0.3 (2)	0.6	0.1	1.1 (1)		
Platelet count									
Adults > 60 years	6.9 (1)			0 (1)			(0)		
Adults only	0.6 (2)	2.8	0	0.1 (2)	0.3	0	0 (1)		
Children & adults	0.8 (5)	14.8	0	0 (2)	0	0	0 (2)	0	0
Children only	0.06 (1)			0 (1)			3.0 (1)		
Not stated	1.6 (8)	28.4	0	0 (3)	0.2	0	0.2 (5)	2.7	0
White blood cell count									
Adult > 60 years	(0)			(0)			(0)		
Adults only	0.1 (1)			0 (1)			0 (1)		
Children & adults	0.4 (1)			0 (1)			(0)		
Children only	17.5 (1)			1.3 (1)			(0)		
Not stated	2.6 (2)	34.8	0.9	5.2 (1)			0.6 (1)		

*weighted means

of abnormal preoperative haemoglobin, haematocrit and FBC tests, changes in clinical management or postoperative complications across studies according to age group of the study population.

None of the studies stratified the proportions of abnormal preoperative haemoglobin, haematocrit and FBC tests according to age and, therefore, it was not possible to assess the impact of the different age groups within each study population.

3.3.2 ASA grades

We hypothesised that the proportions of patients with abnormal preoperative haemoglobin, haematocrit and FBC tests would be greater in studies reporting the results for patients with higher ASA grades.

We investigated the effects of variations in the ASA grades of patients in the study population on the proportions of abnormal preoperative haemoglobin, haematocrit and FBC tests, changes in clinical management and postoperative complications across the identified studies.

Of the 30 studies of preoperative haemoglobin, haematocrit and FBC tests, only six categorised patients according to ASA grade. These six studies included patients of ASA grades I and II only.[11,41,62,66,73,74] Table 3.5 summarises the proportions of abnormal haemoglobin, haematocrit and FBC tests, changes in clinical management and postoperative complications according to the ASA grade of the patients in the study population.

The average proportions of abnormal preoperative haemoglobin and haematocrit tests and white blood cell counts tended to be higher in studies that did not state ASA grades (9.0% and 9.5%, respectively) compared to studies that included patients of ASA grades I and II only (3.7% and 0.9%, respectively).

None of the identified studies stratified the proportions of abnormal preoperative haemoglobin, haematocrit and FBC tests according to ASA grades. Therefore it was not possible to investigate the effects of variations in the ASA grade of patients in the study population on the proportions of abnormal preoperative haemoglobin, haematocrit and FBC tests within the identified studies.

3.4 Heterogeneity in criteria for preoperative testing

Although authors did not state their definitions of 'routine' preoperative tests, we have assumed a routine preoperative investigation to be a test carried out on all patients preoperatively that is not directly related to the planned procedure or the patients' condition. In some studies, authors included patients who were described as undergoing routine preoperative tests as well as patients undergoing indicated preoperative tests. None of these studies presented the proportions of abnormal preoperative tests, changes in clinical management and

TABLE 3.5 Summary of abnormal haemoglobin, haematocrit and FBC tests, changes in clinical management and postoperative complications in study populations according to ASA grades

ASA GRADE	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
Haemoglobin and haematocrit									
I to II	3.7 (6)	12	0.4	0.2 (6)	0.6	0	0 (2)	0	0
Not stated	9.0 (11)	32.2	0.5	1.6 (8)	6.5	0	0.1 (3)	1.1	0
Platelet count									
I to II	1.5 (3)	6.9	1.0	0 (1)			0.2 (2)	0.6	0
Not stated	1.1 (14)	28.4	0	0 (8)	0.3	0	0.7 (7)	3	0
White blood cell count									
I to II	0.9 (2)	0.9	0.4	0 (1)			0. 6 (1)		
Not stated	9.5 (3)	34.8	0.1	0.9 (3)	5.2	0	0 (1)		

*weighted means

TABLE 3.6 **Summary of abnormal preoperative haemoglobin, haematocrit and FBC tests, changes in clinical management and postoperative complications according to the criteria for preoperative testing**

CRITERIA FOR TEST	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
Haemoglobin and haematocrit									
Routine only	2.2 (6)	4.8	0.7	0.4 (4)	2.7	0.1	0.1 (3)	1.1	0
Routine & indicated	32.2 (1)			6.5 (1)			0.1 (1)		
Not stated	3.9 (10)	17.6	0.4	0.1 (9)	0.4	0	0 (2)	0	0
Platelet count									
Routine only	4.1 (9)	28.4	0	0 (3)	0	0	0.2 (7)	2.7	0
Routine & indicated	2.8 (3)	8	0.7	0.2 (3)	0.3	0	(0)		
Not stated	1.6 (4)	6.9	0	0 (3)	0	0	2.2 (2)	3	0
White blood cell count									
Routine only	0.7 (2)	0.9	0.1	0 (1)			0 (2)	0.6	0
Routine & indicated	(0)			(0)			(0)		
Not stated	16.3 (3)	34.8	0.4	1.6 (3)	5.2	0	(0)		

*weighted means

postoperative complications separately for patients who had routine tests and for patients who had indicated tests, instead the data were combined for both groups of patients. Therefore, we hypothesised that the proportions of abnormal preoperative haemoglobin or haematocrit, and FBC tests, changes in clinical management and postoperative complications would be lower in study populations where all the patients had routine preoperative tests compared to study populations containing patients undergoing either routine or indicated preoperative tests.

We investigated the effects of variations in the criteria for preoperative testing on the proportions of abnormal preoperative haemoglobin or haematocrit FBC tests, changes in clinical management and postoperative complications across the identified studies. Thirteen of the studies included patients undergoing routine preoperative haemoglobin, haematocrit or FBC tests, three of the studies included a combination of both routine and indicated preoperative haemoglobin, haematocrit or FBC tests and 14 studies did not state their criteria for preoperative testing. Table 3.6 provides a summary of the proportions of abnormal preoperative haemoglobin, haematocrit or FBC tests, changes in clinical management and postoperative complications in study populations according to whether the study population included routine only or both routine and indicated tests.

There were too few studies that included both routine and indicated tests to be able to compare the effects of differences in the criteria for testing in the studies of preoperative haemoglobin, haematocrit and FBC investigations.

It was not possible to investigate the effects of variations in the criteria for preoperative testing on the proportions of abnormal preoperative haemoglobin and haematocrit and FBC tests, changes in clinical management and postoperative complications within the identified studies because studies that included only patients for whom preoperative tests were indicated were excluded in the initial stages of our systematic review and none of the eligible studies reported data separately for routine and indicated preoperative haemoglobin, haematocrit and FBC tests.

3.5 Heterogeneity in the definition of the outcome variables

3.5.1 Definition of normal/ abnormal preoperative haemoglobin, haematocrit and FBC tests

We investigated the variability of the definition of normal/abnormal preoperative haemoglobin, haematocrit and FBC tests across the identified studies. Ten studies provided a definition of their criteria for normal/abnormal preoperative haemoglobin and haematocrit tests, platelet count and white blood cell count. These definitions are summarised in Table 3.7.

TABLE 3.7 Definition of normal preoperative haemoglobin and haematocrit, platelet count and white blood cell count

	1	2	3	4	5	6	7	8	9
Haemoglobin									
Male 14 to 17 g/dl; female 12 to 16 g/dl								✓	
Male 14 to 18 g/dl; female 12 to 16 g/dl									
Male 13.5 to 17.5 g/dl, female 12 to 16 g/dl						✓			
10 to 17 g/dl					✓				
> 100 g/l				✓					
0 to 3 months > 100 g/dl; 4 to 12 months > 105 g/dl									✓
Haematocrit									
Male 41 to 53%; female 36 to 46%							✓		
Male 42 to 52%; female 37 to 47%									
Platelet count									
100 to 400 103/mm3					✓				
130 to 400 103/mm3									
140 to 450 103/mm3						✓			
150 to 400 103/mm3								✓	
150 to 450 103/mm3		✓	✓						
100,000 to 400,000 /ml							✓		
> 100 000/l	✓								
White blood cell count									
3.1 to 11 103/mm3						✓			
4.8 to 10.8 k/mm3									

1: Houry[67]; 2: Cherng[65]; 3: MacPherson[71]; 4: Roy[74]; 5: Narr[73]; 6: Kaplan[80]; 7: Ramsey81; 8: Charpak[57]; 9: O'Connor[77].

TABLE 3.8 Summary of changes in clinical management (%) in patients who had had preoperative haemoglobin, haematocrit and FBC tests

Change in clinical management	1	2	3	4	5	6	7	8
Postponed operations		✓		✓	✓	✓	✓	✓
Additional tests				✓	✓			
New treatment				✓				
Anaesthetic vigilance						✓		
Change in anaesthetic	✓			✓	✓			
Blood transfusion				✓			✓	
Careful haemostasis			✓					
Alteration in surgery		✓		✓				
Reoperation					✓			
Total	**0**	**0.05**	**0.2**	**6.5**	**0.6**	**0.1**	**0.2**	**2.7**

1: Haug[41]; 2: Wood[32]; 3: Turnbull[25]; 4: Charpak[57]; 5: Perez[11]; 6: Narr[73]; 7: Roy[74]; 8: Hoare[70].

Table 3.7 shows that there were differences between the definitions of normal/abnormal preoperative haemoglobin, haematocrit and FBC tests. However, the differences in the definitions were small and therefore, were not likely to have been a great source of heterogeneity across the different studies.

3.5.2 Definition of a change in clinical management

We investigated the variability of the definition of a change in clinical management in patients who had had preoperative haemoglobin, haematocrit and FBC tests in the identified studies. Eight of the studies reported definitions of changes in clinical management in patients who had had preoperative haemoglobin, haematocrit and FBC tests. These definitions are summarised in Table 3.8.

Table 3.8 shows that the definitions of changes in clinical management differ across the identified studies. However, these data may simply reflect changes in clinical management that took place rather than predefined actions that were considered to represent changes in clinical management. Therefore, it is not sensible to investigate further differences in the definitions as a source of heterogeneity across the study populations.

3.5.3 Definition of postoperative complications

We investigated the variability of the definitions of postoperative complications in patients who had had preoperative haemoglobin, haematocrit and FBC tests. Two studies reported definitions of postoperative complications. These definitions are summarised in Table 3.9.

TABLE 3.9 Summary of the definitions of postoperative complications (%) in patients who had preoperative haemoglobin, haematocrit and FBC tests

Postoperative complications	Perez[11]	Hoare[70]
Perioperative blood loss	✓	
Hospital admission after day case surgery		✓
Total	**0.6**	**0**

3.6 Diagnostic accuracy

Two of the identified studies investigated the diagnostic accuracy of preoperative haemoglobin and haematocrit tests and white blood cell counts.[25,82] The results are summarised in Table 3.10.

TABLE 3.10 Summary of the diagnostic accuracy of preoperative haemoglobin and haematocrit tests and white blood cell count

STUDY	OUTCOME	TEST	SENSITIVITY (%)	SPECIFICITY (%)	POSITIVE PREDICTIVE VALUE (%)	NEGATIVE PREDICTIVE VALUE (%)
Williams[82]	Not stated	Haematocrit	36	79		
Turnbull[25]	Determining operative complications/change in clinical management	Haemoglobin White blood cell count			28.6 0	98.6 89.0

From the data presented in each of the papers it was possible to calculate positive predictive values for predicting a change in clinical management in nine of the studies of preoperative haemoglobin or haematocrit tests, four of the studies of preoperative platelet counts and three of the studies of preoperative white blood cell counts. The positive predictive value indicates the percentage of patients with abnormal haemoglobin, haematocrit and FBCs that subsequently underwent a change in clinical management. The results are summarised in Table 3.11.

The positive predictive value of preoperative haemoglobin and haematocrit tests for predicting a change in clinical management ranged from 0% in 2 studies[34,72] to 55.6% in a further study.[70] The positive predictive value of preoperative platelet counts for predicting a change in clinical management was 0% in all of the studies in which this value was calculated.[25,73,79,80] The positive predictive value of preoperative white blood cell counts for predicting a change in clinical management ranged from 0% in one study[25] to 14.8% in a further study.[28] However, it is difficult to interpret the meaning of the positive predictive values from Table 3.9 because of the heterogeneous nature of the studies as outlined in Section 1.

TABLE 3.11 Calculated estimates of the positive predictive value of preoperative haemoglobin, haematocrit and FBC tests to predict changes in clinical management

First author	Positive predictive value for predicting a change in clinical management (%)
Haemogloblin and haematocrit	
Hoare[70]	55.6
Baron[72]	0
Narr[73]	10.0
Nigam[76]	50.0
O'Connor[77]	2.4
Turnbull[25]	28.6
Wood[32]	10.0
Rossello[34]	0
Roy[74]	27.3
Platelet count	
Rohrer[79]	0
Turnbull[25]	0
Kaplan[80]	0
Narr[73]	0
White blood cell count	
Turnbull[25]	0
Rossello[34]	7.5
Muskett[28]	14.8

4 Preoperative haemostasis tests

4.1 Characteristics of the studies

In our search of the literature from 1995 to 2001 we identified eight papers of preoperative haemostasis tests. Six of these papers reported abnormal outcome data, four studies reported changes in clinical management and three studies reported postoperative complications. In combination with the 22 papers identified in the HTA report, this review included 29 papers that studied preoperative haemostasis tests. The characteristics of the 29 papers are summarised in Table 4.1. All studies were case series.

TABLE 4.1 Characteristics of eligible studies of preoperative haemostasis

First author and year of publication	Country	Study sample (age)	Type of surgery	Abnormal test	Change in clinical management	Postoperative complications
Gabriel 2000[63]	France	1706 (0 to 15 years)	ENT	✓	✓	
Williams 1999[82]	USA	494 (0 to 11 years)	Cardiac		✓	
Wojtkowski 1999[64]	USA	135 (0 to 19 years)	Cardiac	✓		✓
Cherng 1998[65]	Taiwan	74 (not stated)	Cardiac	✓		✓
Howells 1997[83]	USA	382 (0 to 12 years)	ENT	✓		✓
Wattsman 1997[5]	USA	142 (17 to 76 years)	General	✓	✓	
Zwack 1997[84]	USA	4374 (not stated)	ENT		✓	
Gewirtz 1996[85]	USA	167 (5 to 91 years)	Nephrology, ENT, plastic surgery, vascular, ophthalmology, urology, cardiovascular, general, gynaecology, orthopaedics	✓		
Houry 1995[67]*	France	3242 (16 to 99 years)	Cardiothoracic, general, gynaecology, urology, vascular		✓	✓
Perez 1995[11]*	Spain	3131 (not stated)	Not stated	✓	✓	
Close 1994[68]*	USA	96 (1 to 40 years)	ENT	✓	✓	
Myers 1994[86]*	USA	351 (adults)	Gynaecology	✓		✓
MacPherson 1993[71]*	South Africa	159 (not stated)	Cardiothoracic, general	✓		✓
Burk 1992[87]*	USA	1603 (3 to 16 years)	ENT	✓	✓	✓
Aghajanian 1991[88]*	USA	1546	Gynaecology (adults)	✓	✓	✓

TABLE 4.1 Characteristics of eligible studies of preoperative haemostasis *continued*

First author and year of publication	Country	Study sample (age)	Type of surgery	Abnormal test	Change in clinical management	Postoperative complications
Bolger 1990[75]*	USA	52 (not stated)	ENT	✓		
Schmidt 1990[89]*	USA	91 (not stated)	ENT	✓		✓
Charpak 1988[57]*	France	3866 (adults)	General, gynaecology, obstetrics, plastic surgery, orthopaedics	✓	✓	
Rohrer 1988[79]*	USA	282 (not stated)	General, vascular	✓	✓	
Manning 1987[90]*	USA	994 (children)	ENT	✓		✓
Turnbull 1987[25]*	Canada	1010 (adults)	General	✓	✓	✓
Muskett 1986[28]*	USA	200 (not stated)	Cardiothoracic, ENT, general, neurosurgery, ophthalmology, urology, orthopaedics, plastic surgery	✓	✓	
Suchman 1986[91]*	USA	2134 (not stated)	Not stated	✓		✓
Kaplan 1985[80]*	USA	2000 (not stated)	Not stated	✓	✓	
Ramsey 1983[81]*	USA	92 (0 to 75 years)	Cardiothoracic	✓		
Eisenberg 1982[93]*	USA	750 (not stated)	General, obstetrics, gynaecology	✓		✓
Rossello 1980[34]*	Puerto Rico	690 (< 14 years)	Not stated	✓	✓	✓
Robbins 1979[94]*	USA	1025 (not stated)	Not stated	✓		
Rader 1978[95]*	USA	165	Urology (adults)	✓		

* Papers included in the HTA review

The results of the 29 studies, which documented the findings from a total of 20,705 preoperative prothrombin (PT) and 21,626 preoperative partial thromboplastin (PTT) tests are reported in Table 4.2.

TABLE 4.2 **Summary of preoperative haemostasis test study results from the eligible studies (includes routine and indicated tests)**

STUDY	NUMBER OF TESTS# (N)	ABNORMAL RESULTS N (%)	CHANGES IN CLINICAL MANAGEMENT N (%)	POSTOPERATIVE COMPLICATIONS N (%)	ROUTINE	PROSPECTIVE DATA	CONSECUTIVE RECRUITMENT	ASA GRADES STATED
Prothrombin								
Gabriel[63]	1479	3 (0.2)	0		Not stated	x	,	x
Williams[82]	494	0	24 (4.9)		Not stated	✓	✓	x
Howells[83]	261	0		7 (2.7)	Routine only	x	✓	x
MacPherson[71]*	111	0		0	Routine only	x	✓	x
Turnbull[25]*	213	0	0	0	Routine only	✓	✓	x
Rader[95]*	165	0			Routine & indicated	x	✓	x
Zwack[84]	4374	1		43a (1.0)	Not stated	✓	✓	x
Rohrer[79]*	123	1 (0.8)	0		Routine only	✓	✓	ASA I to IV
Close[68]*	90	1 (1.1)		6a (6.6)	Routine only	x	✓	ASA I to II
Schmidt[89]*	91	1 (1.1)		0	Routine only	x	✓	x
Charpak[57]*	935	121 (12.9)	27 (2.9)		Routine only	x	x	ASA I to V
Kaplan[80]*	201	2 (1.0)			Routine only	x	✓	x
Burk[87]*	1603	3 (0.2)	0	0	Routine only	x	✓	x
Ramsey[81]*	92	3 (3.3)			Routine only	x	✓	x
Bolger[75]*	52	3 (5.8)			Not stated	x	✓	x
Aghajanian[88]*	1546	30 (1.9)	0	0	Routine only	x	✓	x
Cherng[65]	68	34 (50.0)		6a (8.1)	Routine & indicated	✓	✓	x
Gewirtz[85]	167	39 (23.4)			Routine only	x	✓	x
Myers[86]*	351	4 (1.1)	0	0	Routine only	x	✓	x
Eisenberg[93]*	256	4 (1.6)		0	Routine only	x	✓	x
Manning[90]*	993	48 (4.8)		2 (0.2)	Not stated	✓	✓	x

TABLE 4.2 **Summary of preoperative haemostasis test study results from the eligible studies (includes routine and indicated tests)** *continued*

STUDY	NUMBER OF TESTS# (N)	ABNORMAL RESULTS N (%)	CHANGES IN CLINICAL MANAGEMENT N (%)	POSTOPERATIVE COMPLICATIONS N (%)	ROUTINE	PROSPECTIVE DATA	CONSECUTIVE RECRUITMENT	ASA GRADES STATED
Muskett[28]*	128	5 (3.9)	0		Routine only	x	x	x
Houry[67]*	3242	512 (15.8)	27 (0.8)	79 (2.4)	Not stated	x	✓	x
Perez[11]*	3044	7 (0.2)	47a (1.5)		Not stated	x	✓	x
Rossello[34]*	626	9 (1.4)	0	0	Not stated	✓	✓	x
Wojtkowski[64]	135 134	9 (6.7)		6 (4.4)	Not stated	✓	✓	x
Partial thromboplastin								
Gabriel[63]	1479	48 (3.2)	0		Not stated	x	✓	x
Williams[82]	494	0	24 (4.9)		Not stated	✓	✓	x
Wojtkowski[64]	135	13 (10.0)	6 (4.4)	6 (4.4)	Routine only	x	✓	x
Cherng[65]	68	34a (50.0)		6 (8.1)	Routine only	x	✓	x
Howells[83]	261	39 (14.9)	3 (1.1)	0	Routine only	✓	✓	x
Wattsman[5]	31	5 (16.1)	0	0	Routine & indicated	✓	✓	ASA I to III
Zwack[84]	4374			43a (1.0)	Routine & indicated	x	✓	x
Gewirtz[85]	167	34 (20.4)			Not stated	✓	✓	x
Houry[67]*	2291	340(14.8)	1(0.0)	79 (3.4)	Routine only	✓	✓	ASA I to IV
Perez[11]*	2957	8 (0.3)	47a (1.5)		Routine only	✓	✓	ASA I & II
Close[68]*	90	14 (15.6)		6 a (6.7)	Routine only	x	✓	x
Myers[86]*	351	8 (2.3)	1 (0.3)	0	Routine only	x	x	ASA I to V
MacPherson[71]*	111	8 (7.2)		0	Routine only	x	✓	x
Burk[87]*	1603	27 (1.7)	0	0	Routine only	x	✓	x
Bolger[75]*	52	6 (11.5)			Not stated	x	✓	x
Schmidt[89]*	91	4 (4.4)		0	Routine only	x	✓	x

TABLE 4.2 **Summary of preoperative haemostasis test study results from the eligible studies (includes routine and indicated tests)** *continued*

STUDY	NUMBER OF TESTS# (N)	ABNORMAL RESULTS N (%)	CHANGES IN CLINICAL MANAGEMENT N (%)	POSTOPERATIVE COMPLICATIONS N (%)	ROUTINE	PROSPECTIVE DATA	CONSECUTIVE RECRUITMENT	ASA GRADES STATED
Charpak[57]*	952	76 (8.0)	27 (2.8)		Routine & indicated	✓	✓	x
Rohrer[79]*	123	3(2.4)	0		Routine only	x	✓	x
Manning[90]*	993	11 (1.1)	0		Routine only	x	✓	x
Turnbull[25]*	210	3 (1.4)	3 (1.4)	0	Routine only	x	✓	x
Muskett[28]*	126	5 (4.0)	0		Not stated	✓	✓	x
Suchman[91]*	2134	347 (16.3)		130 (6.1)	Routine only	x	✓	x
Kaplan[80]*	199	1 (0.5)			Routine only	x	x	x
Ramsey[81]*	92	11 (12.0)			Not stated	x	✓	x
Eisenberg[93]*	147	3 (2.0)		1 (0.7)	Not stated	x	x	x
Rossello[34]*	678	25 (3.6)	1 (0.1)	0	Not stated	✓	✓	x
Robbins[94]*	1025	143 (14.0)			Routine only	x	✓	x
Rader[95]*	165	0			Not stated	✓	✓	x

*Papers included in the HTA review

#The number of tests carried out may differ from the sample size in some studies. This occurs in papers reporting the results of multiple preoperative tests because not all of patients in the study sample received all the preoperative tests detailed in the paper

[a]PT and PTT combined

TABLE 4.3 Summary of abnormal haemostasis tests and changes in clinical management or postoperative complications in study populations by study quality indicators

QUALITY INDICATOR	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
Prothrombin									
P C	13.6 (6)	23.4	0	1.5 (5)	4.9	0	1.4 (3)	2.7	0
R C	1.0 (16)	50.0	0	0.4 (8)	1.5	0	0.1 (10)	8.1	0
R N	1.1 (2)	1.1	1	0 (1)			0 (1)		
Partial thromboplastin									
P C	2.1 (8)	20.4	0	3.4 (8)	7.3	0	0.8 (4)	2.3	0
R C	5.3 (15)	45.9	1	0.4 (8)	4.4	0	0.9 (8)	8.1	0
R N	1.7 (2)	2.3	0.5	0.3 (1)			0 (1)		

P = prospective data collection; R = retrospective data collection; C = consecutive recruitment of patients; N = nonconsecutive recruitment of patients; * weighted means were produced to reflect the different numbers of patients in each study. It was not possible to produce a distributional statistic reflecting this weight.

There was a wide variation in the reported proportions of abnormal preoperative haemostasis tests. The proportions of abnormal preoperative PT test results ranged from 0% in three studies[63,87,11] to 50.0% in a further study.[65] The proportion of patients who had had preoperative PT tests and who subsequently underwent a change in clinical management ranged from 0% in eight studies[25,28,34,63,79,86-88] to 4.9% in a further study.[82] The proportion of patients who had had preoperative PT tests and who subsequently suffered postoperative complications ranged from 0% in six studies[25,34,71,86-89,93] to 8.1% in a further study.[65]

The proportions of abnormal preoperative PTT test results ranged from 0% in one study[95] to 50.0% in a further study.[65] The proportion of patients who had had preoperative PTT tests and who subsequently underwent a change in clinical management ranged from 0% in six studies[5,28,63,79,87,90] to 4.9% in a further study.[82] The proportion of patients who had had preoperative PTT tests and who subsequently suffered postoperative complications ranged from 0% in eight studies[5,25,34,71,83,86,87,89] to 8.1% in a further study.[65]

As described in Section 1, the wide variation in the results may be explained at least in part by heterogeneity in the study populations. The impact of four major sources of heterogeneity on the outcome of the preoperative haemostasis test studies will be considered separately in the following sections.

4.2 Heterogeneity in the quality of the study design

As described in Section 1, studies in which data are collected prospectively and in which patients are recruited consecutively are less likely to be susceptible to bias than studies in which data are collected retrospectively and where patients are recruited selectively. Therefore, we hypothesised that the proportions of abnormal preoperative haemostasis tests, changes in clinical management and postoperative complications might differ according to the quality of the study design.

We investigated the effects of variations in the quality of the study design on the proportions of abnormal haemostasis tests, changes in clinical management and postoperative complications across the identified studies. Ten studies collected data

prospectively and recruited consecutive patients, 18 studies collected data retrospectively recruited consecutive patients and two papers collected data retrospectively and did not state that the sample of patients was consecutive. The results are summarised in Table 4.3.

The average proportions of abnormal preoperative PT tests, changes in clinical management and postoperative complications tended to be higher in prospective studies compared to retrospective studies. For preoperative PTT tests, there was no clear pattern with abnormal test results, changes in clinical management and postoperative complications and study design.

4.3 Heterogeneity in the composition of the study population

4.3.1 Age range

Given that the prevalence of comorbid diseases increases with age, we hypothesised that the proportion of patients with abnormal preoperative haemostasis tests would be higher in studies reporting older patient populations.

We investigated the effects of variations in the age range of the study population on the proportions of abnormal preoperative haemostasis tests, changes in clinical management and postoperative complications across the identified studies. Five studies included adults only,[25,57,86,88,95] six studies included children only,[34,63,82,83,87,90] seven studies included both adults and children[5,64,67,68,80,81,85] and 11 studies did not state the age range of their patient population.[11,28,65,71,75,79,84,89,91,93,94] Table 4.4 provides a summary of the mean proportions of abnormal preoperative haemostasis tests, changes in clinical management and postoperative complications across studies according to age group of the study population.

Table 4.4 shows that the average proportion of abnormal preoperative haemostasis test tended to be higher in studies that included adults only (PT 4.8%, PTT 5.2%) compared to studies that included adults

TABLE 4.4 Summary of abnormal preoperative haemostasis tests, changes in clinical management and postoperative complications in study populations by age group

AGE GROUP	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
Prothrombin									
Adults only	4.8 (5)	12.9	0	0.8 (4)	2.9	0	0 (3)	0	0
Adults & children	1.4 (5)	23.4	1	7.3 (1)			2.2 (3)	6.6	2.4
Children only	2.2 (5)	14.9	0.1	0.4 (4)	4.9	0	0.2 (4)	2.7	0
Not stated	0.7 (10)	50.0	0	0.7 (6)	1.5	0	0.1 (5)	8.1	0
Partial thromboplastin									
Adults only	5.2 (4)	8	0	1.8 (3)	2.8	0.3	0 (2)	0	0
Adults & children	2.0 (6)	20.4	0.5	6.1 (3)	7.3	0	2.2 (4)	6.7	0
Children only	2.6 (5)	14.9	1.1	0.5 (6)	4.9	0	0 (3)	0	0
Not stated	5.0 (11)	45.9	0.3	0.5 (5)	1.5	0	1.0 (5)	8.1	0

*weighted means

and children or children only. However, the average proportion of patients who had preoperative haemostasis tests and who subsequently underwent changes in clinical management or who had postoperative complications tended to be highest in studies that included adults and children. None of the studies stratified the proportion of abnormal haemostasis tests according to age, therefore it was not possible to assess the impact of the different age groups within each study population on the results.

4.3.2 ASA grades

We hypothesised that the proportion of patients with abnormal preoperative haemostasis tests would be greater in studies reporting results for patients with higher ASA grades.

We investigated the effects of variations in the ASA grade of patients in the study population on the proportions of abnormal preoperative haemostasis tests, changes in clinical management and postoperative complications across the identified studies. Of the 30 studies of preoperative haemostasis only four classified comorbidities by grading patients according to ASA status.[5,11,67,86] One of the studies included patients of ASA grades I and II only,[11] one of the studies included patients of ASA grades I to III only,[5] one study included patients of ASA grades I to IV only[67] and one study included patients of ASA grades I to V.[86] Table 4.5 summarises the proportions of abnormal haemostasis tests, changes in clinical management and postoperative complications by the ASA grade of the patients in the study population.

Given the small number of studies that included patients of known ASA grades and the fact that we do not know the distribution of patients within each of the ASA categories it is difficult to interpret the data for separate ASA grade groups.

TABLE 4.5 Summary of abnormal haemostasis tests, changes in clinical management or postoperative complications in study populations according to ASA grade

ASA GRADE	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
Prothrombin									
Stated	7.7 (3)	15.0	0.2	1.1 (3)	1.5	0	2.4 (1)		
I to II	0.2 (1)			1.5 (1)			(0)		
I to III	(0)			(0)			(0)		
I to IV	15.8 (1)			0.8 (1)			2.4 (1)		
I to V	1.1 (1)			0 (1)			0 (1)		
Not stated	2.6 (22)	45.9	0	0.7 (11)	4.9	0	0.2 (12)	8.1	0
Partial thromboplastin									
Stated	6.4 (4)	16.1	0.3	3.8 (4)	7.3	0	1.1 (3)	3.4	0
I to II	0.3 (1)			1.5 (1)			(0)		
I to III	16.1 (1)			0 (1)			0 (1)		
I to IV	(0)			7.3 (1)			2.3 (1)		
I to V	2.3 (1)			0.3 (1)			0 (1)		
Not stated	5.3 (23)	45.9	0	0.7 (13)	4.9	0	0.7 (11)	8.1	0

*weighted means

We then investigated the effects that variations in the ASA grade of patients in the study population had on the proportion of abnormal preoperative haemostasis tests within the identified studies. Only one of the studies categorised the proportion of abnormal preoperative haemostasis tests according to ASA grade.67 The results are summarised in Table 4.6.

TABLE 4.6 Summary of abnormal preoperative haemostasis tests (%) by ASA grade

STUDY	ASA GRADE I AND II	ASA GRADE III AND IV
Houry[67]	8.6	91.4

As there is only one study, we cannot conclude that these data (Table 4.6) indicate the proportion of abnormal preoperative haemostasis test results increased with patients' ASA grades.

4.4 Heterogeneity in criteria for preoperative testing

Although authors did not state their definitions of 'routine' preoperative tests, we have assumed a routine preoperative investigation to be a test carried out on all patients preoperatively that is not directly related to the planned procedure or the patients' condition. In some studies, authors included patients who were described as undergoing routine preoperative tests as well as patients undergoing indicated preoperative tests. None of these studies presented the proportions of abnormal preoperative tests, changes in clinical management and postoperative complications separately for patients who had routine tests and for patients who had indicated tests, instead the data were combined for both groups of patients. Therefore, we hypothesised that the proportions of abnormal preoperative haemostasis tests, changes in clinical management and postoperative complications would be lower in study populations where all the patients had routine preoperative haemostasis tests compared to study populations containing patients undergoing either routine or indicated preoperative haemostasis tests.

We investigated the effects of variations in the criteria for preoperative testing on the proportions of abnormal preoperative haemostasis tests, changes in clinical management and postoperative complications across the identified studies. Seventeen of the studies

TABLE 4.7 Summary of abnormal preoperative haemostasis tests, changes in clinical management and postoperative complications according to criteria for preoperative testing

CRITERIA FOR TEST	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
Prothrombin									
Routine only	3.2 (14)	50.0	0	1.1 (7)	1.5	0	0.8 (12)	8.1	0
Routine & indicated	2.2 (2)	12.9	0.5	1.3 (3)	2.9	0	(0)		
Not stated	2.5 (8)	23.4	0	0.7 (4)	4.9	0	0 (2)	0	0
Partial thromboplastin									
Routine only	4.9 (15)	50.0	0.3	1.9 (9)	7.3	0	1.4 (11)	8.1	0
Routine & indicated	1.5 (3)	16.1	1	1.3 (4)	2.8	0	0 (1)		
Not stated	3.8 (8)	20.4	0	0.7 (4)	4.9	0	0 (2)	0.7	0

*weighted means

TABLE 4.8 **Definition of normal haemostasis tests**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Prothrombin																		
> 10 seconds							✓											
9 to 13 seconds								✓										
10 to 13 seconds										✓								
10.5 to 12.5 seconds	✓								✓									
11.5 to 13.5 seconds					✓													
< 11.5 seconds																		
< 12.6 seconds																		✓
< 13.6 seconds													✓					
Prolonged by 1.5 seconds#				✓												✓		
> 70% of control data																		
Partial thromboplastin																		
18 to 26 seconds								✓										
23 to 36 seconds															✓			
24 to 36 seconds	✓																	
24 to 38 seconds									✓									
25 to 40 seconds										✓								
25 to 44 seconds												✓						
26 to 32 seconds		✓																
32 to 46 seconds					✓													
< 26.5 seconds														✓				
< 33 seconds																		
< 36 seconds																		✓
< 37.5 seconds													✓					
< 39 seconds											✓							
Prolonged by 1.5 seconds#			✓															
Prolonged by 2 seconds#																	✓	
1.2 times < control data				✓														
2 SD < or > mean control data						✓												

1: Wattsman[5]; 2: Cherng[65]; 3: Howells[83]; 4: Houry[67]; 5: Gabriel[63]; 6: Wojtkowski[64]; 7: Charpak[57]; 8: Ramsey[81]; 9: Kaplan[80]; 10: Rohrer[79]; 11: MacPherson[71]; 12: Robbins[94]; 13: Eisenberg[93]; 14: Suchman[91]; 15: Schmidt[89]; 16: Aghajanian[88]; 17: Burk[87]; 18: Myers.[86]

#definition of an abnormal haemostasis test

included patients undergoing routine preoperative haemostasis tests only, whereas four of the studies included a combination of routine and indicated preoperative haemostasis tests. Table 4.7 provides a summary of the proportions of abnormal preoperative haemostasis tests, changes in clinical management and postoperative complications in study populations according to whether the study population included routine only or both routine and indicated tests.

Table 4.7 shows that in those studies including routine tests only the average proportions of abnormal preoperative PT and PTT tests, changes in clinical management and postoperative complications tended to be higher than in studies including both routine and indicated tests.

It was not possible to investigate the effects of variations in the criteria for preoperative testing on the proportions of abnormal preoperative haemostasis tests, changes in clinical management and postoperative complications within the identified studies because studies that included only patients for whom preoperative tests were indicated were excluded in the initial stages of our systematic review and none of the eligible studies reported data separately for routine and indicated preoperative haemostasis tests.

4.5 Heterogeneity in the definition of the outcome variables

4.5.1 Definition of a normal/ abnormal haemostasis test

We investigated the variability of the definition of normal/abnormal preoperative haemostasis tests across the identified studies. Eighteen of the studies specified definitions of normal preoperative haemostasis tests. These definitions are listed in Table 4.8.

Table 4.8 shows that definitions of normal/abnormal preoperative haemostasis tests varied across studies. However, the differences in the definitions were small and, therefore, were not likely to have been a great source of heterogeneity across the studies.

4.5.2 Definition of a change in clinical management

We investigated the variability of the definition of a change in clinical management in patients who had had preoperative haemostasis tests in the identified studies. Nine of the identified studies of preoperative haemostasis testing specified their definition of a change in clinical management. In five a change in clinical management was defined as blood transfusion requirement,[64,67,93,95,96] and in the other four a broader definition of changes were used (Table 4.9).

TABLE 4.9 Summary of the changes in management (%) in patients who had had preoperative haemostasis tests

Change in clinical management	1	2	3	4
Postponed operations		✓	0.2	
Modification in surgery		✓		✓
Additional tests		✓		
New treatment	0.6			
Anaesthetic vigilance			0.1	
Change in anaesthetic technique	7.3			
Blood transfusion	0.8			
Careful haemostasis			1.2	
Total	**8.7**	**2.8**	**1.5**	**0**

1: Houry[67]; 2: Charpak[57]; 3: Perez[11]; 4: Aghajanian[88].

The changes in clinical management described in each of the papers outlined in Table 4.9 vary across the studies. However, these data may simply reflect changes in clinical management that were observed rather than predefined actions that were considered to represent changes in clinical management. Again, given this uncertainty, it is not sensible to investigate further differences in the definitions as a source of heterogeneity across the study populations.

4.5.3 Definition of postoperative complications

We investigated the variability of the definition of a postoperative complication in patients who had had preoperative haemostasis tests. Nine studies reported peri- or postoperative bleeding as the only postoperative complication and three studies detailed broader definitions of postoperative complications (Table 4.10).

TABLE 4.10 Summary of postoperative complications (%) in patients who had had preoperative haemostasis tests

Postoperative complication	1	2	3
Mortality	1.5		
Haemorrhage related mortality	0.2		
Reoperation to control haemorrhage	0.7		
Early bleeders < 24h postoperative			0
Delayed bleeders			0
Haemorrhage		2.1	0
Treatment required for bleeding		4.0	
Total	**2.4**	**6.1**	**0**

1: Houry[67]; 2: Suchman[91]; 3: Aghajanian[88].

These data may simply reflect postoperative complications that were observed so it is not sensible to investigate further differences in the definitions as a source of heterogeneity across the study populations. Also, it is difficult to interpret the meaning of the postoperative complication data because the postoperative complications recorded in the data were not necessarily complications relating to preoperative haemostasis tests. Despite the fact that the patient had had a preoperative haemostasis test, postoperative complications still occurred.

4.6 Diagnostic accuracy

Four of the studies investigated the diagnostic accuracy of preoperative haemostasis tests. The results from these four studies are presented in Table 4.11.

Sensitivity ranged from 3% for PT and PTT combined in one study[87] to 54% for PT in a further study.[82] Specificity ranged from 70% for PT in one study[82] to 99% for PT and PTT combined in a further study.[87] Positive and negative predictive values ranged from 0% and 93.4%, respectively, for PT in one study[25] to 7% and 98%, respectively, for PT and PTT combined in a further study.[87]

From the data presented in each of the papers it was possible to calculate positive predictive values of preoperative haemostasis tests for predicting a change in clinical management for nine studies. The positive predictive values indicate the percentage of patients with abnormal haemostasis tests who underwent a change in clinical management. The results are summarised in Table 4.12.

TABLE 4.11 Summary of the diagnostic accuracy of preoperative haemostasis tests

STUDY	OUTCOME	SENSITIVITY (%)	SPECIFICITY (%)	POSITIVE PREDICTIVE VALUE (%)	NEGATIVE PREDICTIVE VALUE (%)
Williams[82]	Identifying bleeders	PT – 54 PTT – 27	PT – 70 PTT – 90		
Turnbull[25]	Determining operative complications/ change in clinical management			PT – not stated PTT – 0	PT – 93.4 PTT – 93.7
Suchman[91]	Determining intra- or postoperative haemorrhagic complications	PTT – 33.3	PTT – 83.9	PTT – 2.1*	PTT – 0.9**
Burk[87]	Predicting postoperative bleeding	PT + PTT – 3	PT + PTT – 99	PT + PTT – 7	PT + PTT – 98

*positive likelihood ratio; **negative likelihood ratio.

TABLE 4.12 Calculated estimates of the positive predictive value of preoperative haemostasis tests for predicting changes in clinical management

First author	Positive predictive value for predicting a change in clinical management (%)
Prothrombin	
Gabriel[63]	0
Cherng[65]*	17.6
Myers[86]	0
Burk[87]	0
Aghajanian[88]	0
Rohrer[79]	0
Turnbull[25]	0
Muskett[28]	0
Kaplan[80]	0
Partial thromboplastin	
Gabriel[63]	0
Howells[83]	7.7
Wattsman[5]	0
Myers[86]	12.5
Burk[87]	0
Rohrer[79]	0
Turnbull[25]	100
Muskett[28]	0
Kaplan[80]	0

The positive predictive value of preoperative PT tests for predicting a change in clinical management ranged from 0% in eight studies[25,28,63,79,80,86-88] to 17.6% in a further study.[65] The positive predictive value of preoperative PTT tests for predicting a change in clinical management ranged from 0% in six studies[5,28,63,79,80,87] to 100% in a further study.[25] However, it is difficult to interpret the meaning of the positive predictive values from Table 4.12 because of the heterogeneous nature of the studies as outlined in Section 1.

5 Preoperative biochemistry tests

5.1 Characteristics of the studies

In our search of the literature from 1995 to 2001, we identified two studies of preoperative biochemistry testing. Both of these papers reported abnormal test outcome data, one reported changes in clinical management and one reported postoperative complications. In combination with the seven papers identified in the HTA report, this review includes nine studies of preoperative biochemical testing. The characteristics of the nine papers are summarised in Table 5.1. All the studies identified were case series.

The results of the nine studies, which documented the findings from a total of 7,623 preoperative electrolyte tests, 6,988 preoperative urea/creatinine tests and 8,215 preoperative glucose tests, are summarised in Table 5.2.

TABLE 5.1 Characteristics of eligible studies of preoperative biochemical testing

First author and year of publication	Country	Study sample (age)	Type of surgery	Abnormal test	Change in clinical management	Postoperative complications
Dzankic 2001[62]	USA	544 (70 to 100 years)	Not stated	✓		✓
Meneghini 1998[66]	USA	1884 (0 to 8 years)	Not stated	✓	✓	✓
Perez 1995[11]*	Spain	3131 (not stated)	Not stated	✓	✓	
Adams 1992[12]*	USA	1050 (adults)	General	✓	✓	
Narr 1991[73]*	USA	3782 (not stated)	Not stated	✓	✓	
Jones 1989[78]*	UK	346 (children)	Orthopaedics	✓		
Charpak 1988[57]*	France	3866 (adults)	General, gynaecology, obstetrics, plastic surgery, orthopaedic	✓	✓	
Turnbull 1987[25]*	Canada	1010 (adults)	General	✓	✓	✓
Kaplan 1985[80]*	USA	2000 (not stated)	Not stated	✓		

*Papers included in the HTA review

TABLE 5.2 **Summary of preoperative biochemical testing results from eligible studies (includes routine and indicated tests)**

STUDY	NUMBER OF TESTS# (N)	ABNORMAL RESULTS N (%)	CHANGES IN CLINICAL MANAGEMENT N (%)	POSTOPERATIVE COMPLICATIONS N (%)	ROUTINE	PROSPECTIVE DATA	CONSECUTIVE RECRUITMENT	ASA GRADES STATED
Electrolytes								
Dzankic[62]	sodium: 403 postassium:402	sodium: 8 (1.7) postassium: 38 (9.0)		sodium: 0 potassium: 0	Not stated	✓	✓	ASA I to V
Perez[11]*	814	6 (0.7)	18a (2.2)		Routine only	x	x	ASA I to II
Adams[12]*	1050	2 (0.2)	0		Not stated	x	x	x
Narr[73]*	3782	potassium: 7 (0.2)	potassium: 1 (0.03)		Not stated	x	x	ASA I to II
Jones[78]*	28	2 (7.1)	0		Not stated	x	x	x
Charpak[57]*	1001	813 (81.3)	105 (10.5)		Routine & indicated	✓	✓	x
Turnbull[25]*	995	sodium: 5 (0.5)	0	0	Routine only	x	x	x
Kaplan[80]	514	41 (8.0)			Routine & indicated	x	x	x
Urea/creatinine								
Dzankic[62]	360	42 (12.0)		0	Not stated	✓	✓	ASA I to V
Meneghini[66]	1884	508 (27.0)	5 (0.3)		Not stated	x	x	ASA I and II
Perez[11]*	urea: 2754 creatinine: 2276	urea: 68 (2.5) creatinine: 28 (1.2)		18a (0.8)	x	x	ASA I to II	ASA I and II
Jones[78]*	28	2 (7.1)			Not stated	x	x	x
Charpak[57]*	995	261 (26.2)	55 (5.5)		Routine & indicated	✓	✓	X
Turnbull[25]*	995	1 (0.1)	0	0	Routine only	x	x	X
Kaplan[80]	514	41 (8.0)			Routine & indicated	x	x	X

TABLE 5.2 **Summary of preoperative biochemical testing results from eligible studies (includes routine and indicated tests)** *continued*

STUDY	NUMBER OF TESTS# (N)	ABNORMAL RESULTS N (%)	CHANGES IN CLINICAL MANAGEMENT N (%)	POSTOPERATIVE COMPLICATIONS N (%)	ROUTINE	PROSPECTIVE DATA	CONSECUTIVE RECRUITMENT	ASA GRADES STATED
Glucose								
Dzankic[62]	251	17 (7.0)		0	Not stated	✓	✓	ASA I to II
Perez[11]*	2772	143 (5.2)		18a (0.7)	Routine only	x	X	ASA I to II
Narr[73]*	3782	70 (1.9)	6 (0.2)		Not stated	x	X	ASA I to II
Charpak[57]*	705	504 (71.5)	15 (2.1)		Routine & indicated	✓	✓	X
Turnbull[25]*	random: 396 fasting: 40	1 (2.5)	0	1 (0.3)	Routine only	x	X	X
Kaplan[80]	464	25 (5.4)			Routine & indicated	x	x	X

*Papers included in the HTA review

#The number of tests carried out may differ from the sample size in some studies. This occurs in papers reporting the results of multiple preoperative tests because not all of patients in the study sample received all the preoperative tests detailed in the paper

[a]Figure represents proportion for all biochemistry tests

There was wide variation in the reported proportion of abnormal preoperative biochemistry tests. For example, Table 5.2 shows that the proportions of abnormal preoperative electrolyte tests ranged from 0.2% for sodium and potassium in one study[12] to 81.3% for sodium and potassium in another study.[57] The proportions of abnormal preoperative creatinine/urea tests ranged from 0.1% in one study[25] to 27.0% in a further study[66] and the proportions of abnormal preoperative glucose tests ranged from 1.9% in one study[73] to 71.5% in another study.[57]

There was also variation in the reported proportion of patients who had had preoperative biochemistry tests and who subsequently underwent a change in clinical management. For example, the proportion of patients who had preoperative electrolyte tests and who underwent a change in clinical management ranged from 0% for sodium and potassium in three studies[12,25,78] to 10.5% in a further study.[57] The proportion of patients who had preoperative creatinine/urea tests and who subsequently underwent a change in clinical management ranged from 0% in one study[25] to 5.5% in a further study.[57] The proportion of patients who had preoperative glucose tests and who subsequently underwent a change in clinical management ranged from 0% in one study[25] to 2.1% in a further study.[57]

There was less variation in the reported proportion of patients who had had preoperative biochemistry tests and who subsequently suffered postoperative complications. For example, the proportion of patients who had preoperative electrolyte tests and who suffered postoperative complications was 0% in both studies that measured this outcome variable.[25,62] The proportion of patients who had preoperative creatinine/urea tests and who suffered postoperative complications ranged from 0% in two studies[25,62] to 0.8% in a further study[11] and the proportion of patients who had preoperative glucose tests and who suffered postoperative complications ranged from 0% in one study[62] to 0.7% in a further study.[11]

As described in Section 1, the variation in the results may be explained at least in part by heterogeneity in the study populations. The impact of four major sources of heterogeneity on the outcome of the preoperative biochemistry test studies will be considered separately in the following sections.

5.2 Heterogeneity in the quality of the study design

As described in Section 1, studies in which data are collected prospectively and in which patients are recruited consecutively are less susceptible to bias than studies in which data are collected retrospectively or where patients are recruited selectively. Therefore, we hypothesised that the proportions of abnormal preoperative biochemistry tests, changes in clinical management and postoperative complications might differ according to the quality of the study design.

We investigated the effects of variations in the quality of the study design on the proportions of abnormal biochemistry tests, changes in clinical management and postoperative complications across the identified studies. Two studies collected prospective data and recruited consecutive patients[57,62] and seven studies collected data retrospectively and did not state that the sample of patients was consecutive.[11,12,25,66,73,78,80] The results from these studies are summarised in Table 5.3.

TABLE 5.3 Summary of abnormal biochemistry tests,changes in clinical management and postoperative complications in study populations according to study quality indicators

QUALITY INDICATOR	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
Electrolytes									
P C	1.0 (2)	81.3	1.7	10.5 (1)			0(1)		
R N	1.6 (6)	7.1	0	0.4 (5)	2.2	0	0 (1)	0	0
Urea/Creatinine									
P C	1.0 (2)	26.2	12.0	5.5 (1)			0 (1)		
R N	9.7 (5)	27.0	0.2	0.1 (2)	0.3	0	0.3 (2)	0.8	0
Glucose									
P C	1.0 (2)	71.5	7.0	2.1 (1)			0 (1)		
R N	1.6 (4)	5.4	0.4	0.1 (2)	0.2	0	0.4 (2)	0.7	0.3

P = prospective data collection; R = retrospective data collection; C = consecutive recruitment of patients; N = nonconsecutive recruitment of patients; * weighted means were produced to reflect the different numbers of patients in each study. It was not possible to produce a distributional statistic reflecting this weight.

There was little difference in the average proportion of abnormal preoperative electrolyte and glucose tests between prospective and retrospective studies (1.0% and 1.6%, respectively). However, the average proportion of abnormal preoperative urea/creatinine tests tended to be higher in retrospective studies compared to prospective studies (9.7% and 1.0%, respectively). For all preoperative biochemistry tests the average proportion of patients undergoing a change in clinical management tended to be higher in the prospective studies compared to the retrospective studies. Similarly for preoperative urea/creatinine and glucose tests, the average proportion of postoperative complications tended to be higher in the prospective studies compared to the retrospective studies.

5.3 Heterogeneity in the composition of the study population

5.3.1 Age range

Given that the prevalence of comorbid diseases increases with age, we hypothesised that the proportion of patients with abnormal preoperative biochemistry tests would be higher in studies of older patient populations.

We investigated the effects of variations in the age range of the study population on the proportions of abnormal preoperative biochemistry tests, changes in clinical management and postoperative complications across the identified studies. Three papers did not state an age range,[11,73,80] three papers included studies of adults only[12,25,57] and one study included adults over 60-years-old only.[62] The remaining two studies included children only.[66,78] The proportions of abnormal biochemistry tests, changes in clinical management and postoperative complications in the study populations according to age group are summarised in Table 5.4.

TABLE 5.4 Summary of abnormal preoperative biochemistry tests, changes in clinical management and postoperative complications in study populations by age group

AGE RANGE	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
Electrolytes									
Adults > 60 years	1.7 (1)			(0)			0 (1)		
Adults only	28.0 (3)	81.3	0	3.4 (3)	10.5	0	0 (1)		
Children only	7.1 (1)			0 (1)			(0)		
Not stated	0.5 (3)	0.8	0.2	0.6 (2)	2.2	0	(0)		
Urea/Creatinine									
Adults > 60 years	12.0 (1)			(0)			0 (1)		
Adults only	13.2 (2)	26.2	0.2	2.8 (2)	5.5	0	0 (1)		
Children only	26.7 (2)	27.0	7.1	0.3 (1)			(0)		
Not stated	1.2 (2)	1.3	0.8	(0)			0.8 (1)		
Glucose									
Adults > 60 years	7.0 (1)			(0)			0 (1)		
Adults only	46.4 (2)	71.5	1.8	1.3 (2)	2.1	0	0.3 (1)		
Children only	(0)			(0)			(0)		
Not stated	1.6 (3)	5.4	0.4	0.2 (1)			0.7 (1)		

*weighted means

Table 5.4 shows that the average proportion of abnormal preoperative electrolyte tests was highest in studies that included adults (28.0%) and lowest in studies that included children only (7.1%). However, the average number of abnormal preoperative urea/creatinine tests was highest in studies of children (26.7%) and lowest in elderly adults (12.0%).

As one of the studies stratified the proportion of abnormal biochemistry tests by age, it was not possible to assess the impact of the different age groups within each study population.

5.3.2 ASA grades

We hypothesised that the proportion of patients with abnormal preoperative biochemistry tests would be greater in studies reporting test results for patients with higher ASA grades.

We investigated the effects of variations in the ASA grade of patients in the study population on the proportions of abnormal preoperative biochemistry tests, changes in clinical management and postoperative complications across the identified studies. Presence of comorbidities were classified according to ASA grades in four of the nine papers.[11,62,66,73] Three of these studies included patients of ASA grades I and II only[11,66,73] and

TABLE 5.5 **Summary of abnormal biochemistry tests and changes in clinical management or postoperative complications in study populations by ASA grade**

ASA GRADE	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
Electrolytes									
Stated	1.4 (3)	9.0	0.2	0.6 (2)	2.2	0	0 (1)		
I to II	1.4 (2)	0.7	0.2	0.6 (2)	2.2	0	(0)		
I to V	1.7 (1)			(0)			0 (1)		
Not stated	23.9 (5)	81.3	0	2.9 (4)	10.5	0	0 (1)		
Urea/Creatinine									
Stated	13.0 (3)	27.0	1.3	0.3 (1)			0.4 (2)	0.8	0
I to II	13.1 (2)	27.0	1.3	0.3 (1)			0.8 (1)		
I to V	12.0 (1)			(0)			0 (1)		
Not stated	10.6 (2)	26.2	0.2	2.2 (2)	5.5	0	0 (1)		
Glucose									
Stated	1.5 (3)	1.9	0.4	0.2 (1)			0.3 (2)	0.7	0
I to II	1.0 (3)	1.9	0.4	0.2 (1)			0.7 (1)		0
I to V	7.0 (1)			(0)			0 (1)		
Not stated	34.3 (3)	71.5	1.8	0.9 (2)	2.1	0	0.3 (1)		

*weighted means

the fourth study included patients of ASA grades I to V.[62] Table 5.5 summarises the proportions of abnormal biochemistry tests, changes in clinical management and postoperative complications according to the ASA grade of the patients in the study population.

Given the small number of studies that included patients of ASA grades I to II, or I to V, and the fact that we do not know the distribution of patients within each of the ASA categories it is not possible to interpret the data for separate ASA grade groups.

None of the identified studies stratified the proportion of abnormal preoperative biochemistry tests according to ASA grade. Therefore it was not possible to investigate the effects of variations in the ASA grade of patients on the proportion of abnormal preoperative biochemistry tests within the identified studies.

5.4 Heterogeneity in criteria for preoperative testing

Although authors did not state their definitions of 'routine' preoperative tests, we have assumed a routine preoperative investigation to be a test carried out on all patients preoperatively that is not directly related to the planned procedure or the patients' condition. In some studies, authors included patients who were described as undergoing routine preoperative tests as well as patients undergoing indicated preoperative tests. None of these studies presented the proportions of abnormal preoperative tests, changes in clinical management and postoperative complications separately for patients who had routine tests and for patients who had indicated tests, instead the data were combined for both groups of patients. Therefore, we hypothesised that the proportions of abnormal preoperative biochemistry tests, changes in clinical management

and postoperative complications would be lower in study populations where all the patients had routine preoperative biochemistry tests compared to study populations containing patients undergoing either routine or indicated preoperative biochemistry tests.

We investigated the effects of variations in the criteria for preoperative testing on the proportions of abnormal preoperative biochemistry tests, changes in clinical management and postoperative complications across the identified studies. Two of the studies included patients undergoing routine preoperative biochemistry tests only, whereas two of the studies included a combination of patients undergoing either routine and indicated tests (Table 5.1). Five studies did not state their criteria for preoperative testing. Table 5.6 provides a summary of the proportions of abnormal preoperative biochemistry tests, changes in clinical management and postoperative complications in study populations according to whether the study population included routine only or both routine and indicated tests.

Table 5.6 shows that for all biochemistry tests, the mean proportions of abnormal preoperative tests tended to be lower in studies that included routine tests only compared to studies that included both routine and indicated biochemistry tests.

It was not possible to investigate the effects of variations in the criteria for preoperative testing on the proportions of abnormal preoperative biochemistry tests, changes in clinical management and postoperative complications within the identified studies because studies including only patients for whom preoperative tests were indicated were excluded in the initial stages of our systematic review and none of the eligible studies reported data separately for routine and indicated preoperative biochemistry tests.

TABLE 5.6 Summary of abnormal preoperative biochemistry tests, changes in clinical management and postoperative complications according to the criteria for preoperative testing

CRITERIA FOR TEST	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
Electrolytes									
Routine only	0.5 (2)	0.7	0	0.6 (2)	2.2	0	0 (1)		
Routine & indicated	53.7 (2)	81.3	0.8	10.5 (1)			(0)		
Not stated	0.4 (4)	9.0	0.2	0 (3)	0	0	0 (1)		
Urea/creatinine									
Routine only	1.0 (2)	1.3	0.2	0 (1)			0.5 (2)	0.8	0
Routine & indicated	17.5 (2)	26.2	0.8	5.5 (1)			(0)		
Not stated	13.0 (3)	27.0	7.1	0.3 (1)			0 (1)	0.8	0
Glucose									
Routine only	0.6 (2)	1.8	0.4	0 (1)			0.5 (2)	0.7	0.3
Routine & indicated	45.3 (2)	71.5	5.4	2.1 (1)			(0)		
Not stated	2.2 (2)	7.0	1.9	0.2 (1)			0 (1)		

*weighted means

5.5 Heterogeneity in the definition of the outcome variables

5.5.1 Definition of a normal/abnormal biochemistry test

We investigated the variability of the definition of a normal/abnormal preoperative biochemistry test across the identified studies. Four studies specified definitions of normal preoperative biochemistry test results.[57,73,80,62] These definitions are listed in Table 5.7.

Table 5.7 shows that the definitions of normal/abnormal preoperative biochemistry tests varied across studies. However, the differences in the definitions were small and, therefore, were not likely to have been a great source of heterogeneity across the studies.

5.5.2 Definition of a change in clinical management

We investigated the variability of the definition of a change in clinical management in patients who had had a preoperative biochemistry test in the identified studies. Nine of the studies reported changes in clinical management. Change in clinical management was reported as delay or cancellation of surgery in three studies[25,57,66] and alterations in treatment in two studies.[11,12] No studies specified their definitions of change in clinical management further.

TABLE 5.7 Summary of the reported definitions of normal preoperative biochemistry test results

	Charpak[57]	Narr[73]	Kaplan[80]	Dzankic[62]
Electrolytes – Sodium				
126 to 147 mEq/l				✓
135 to 145 mmol/l	✓			
135 to 147 mEq/l				
136 to 144 µmol/l			✓	
< 2 times SD of mean				
Electrolytes – Potassium				
3.5 to 5 mmol/l	✓			✓
3.5 to 5.3 µmol/l			✓	
< 2 times SD of mean		✓		
Creatinine				
40 to 110 µmol/l	✓			
0.5 to 1.2 mg/dl			✓	
0.5 to 1.4 mg/dl				
> 1.5 mg/dl				✓
Urea				
7 to 22 mg/dl				
<7.5 mmol/l	✓			
Glucose				
3.5 to 5.5 mmol/l	✓			
65 to 110 mg/dl			✓	
70 to 110 mg/dl				
< 200 mg/dl				✓

5.5.3 Definition of postoperative complications

We investigated the variability of the definition of postoperative complications in patients who had had preoperative biochemistry tests. Three studies reported postoperative complications.[25,62,66] Two of these three studies provided a definition of this outcome variable[62,66] and these definitions are summarised in Table 5.8.

TABLE 5.8 Summary of the definitions of postoperative complications in studies of preoperative biochemistry testing

Postoperative complications	Dzankic[621]	Meneghini[66]
Cardiovascular		
Ischaemic cardiac complications	✓	
Myocardial infarctions	✓	
Heart failure	✓	
Dysrhythmia	✓	
CVA/TIA	✓	
Pulmonary		
Respiratory failure	✓	
Pleural effusion	✓	
Other		
Death	✓	
Hepatic/gastrointestinal complications	✓	
Infection	✓	
Delirium	✓	
Aspiration pneumonia	✓	
Renal complications	✓	
Reoperation	✓	
Thromboembolic events		✓
Mild perioperative oxygen desaturation		✓
Laryngospasm		✓
Persistent vomiting		✓
Fever		✓
Postoperative restlessness		✓
Wound complications		✓

The postoperative complications described in each of the papers outlined in Table 5.8 are varied. However, these data may simply reflect postoperative complications that were observed rather than all the postoperative complications that potentially could have arisen. Given this uncertainty it is not sensible to investigate further differences in the definitions as a source of heterogeneity across the study populations. Also, it is difficult to interpret the meaning of the postoperative complication data because the postoperative complications recorded in the data were not necessarily related to preoperative biochemistry tests. Despite the fact that the patient had had preoperative biochemistry tests, postoperative complications still occurred.

5.6 Diagnostic accuracy

Of the nine studies investigating preoperative biochemistry testing, only one reported the diagnostic accuracy of the tests.[25] This study found that the positive predictive values for electrolyte and glucose determinations were 2.6% and 8.8%, respectively, and the negative predictive values were 98.0% and 87.5%, respectively.

From the data presented in each of the papers, it was possible to calculate positive predictive values of preoperative biochemistry tests for predicting a change in clinical management for three studies. The positive predictive values indicate the percentage of patients with abnormal biochemistry tests who subsequently underwent a change in clinical management. The results are summarised in Table 5.9.

TABLE 5.9 Calculated estimates of the positive predictive value of preoperative biochemistry tests to predict changes in clinical management

First author	Positive predictive value for predicting a change in clinical management (%)
Electrolytes	
Adams[12]	0
Narr[73]	14.3
Turnbull[25]	0
Urea/creatinine	
Meneghini[66]	1.0
Turnbull[25]	0

The positive predictive value of preoperative electrolyte tests for predicting a change in clinical management ranged from 0% in two studies[12,25] to 14.3% in a further study.[73] The positive predictive value of preoperative urea/creatinine tests for predicting a change in clinical management ranged from 0% in one study[25] to 1.0% in a further study.[66] The positive predictive value of preoperative glucose tests for predicting a change in clinical management ranged from 0% in one study[25] to 8.6% in a further study.[73] However, it is difficult to interpret the meaning of the positive predictive values from Table 5.9 because of the heterogeneous nature of the studies as outlined in Section 1.

6 Preoperative urine testing

6.1 Characteristics of the results

In our search of the literature from 1995 to 2001, we identified a total of six papers of preoperative urine testing. All of the papers reported abnormal test result data and changes in clinical management or postoperative complications. In combination with the nine papers identified in the HTA report, this review includes 15 studies of preoperative urine testing. The characteristics of these studies are summarised in Table 6.1. All of the studies were case series.

TABLE 6.1 Characteristics of eligible studies of preoperative urine testing

First author and year of publication	Country	Study sample (age)	Type of surgery	Abnormal test	Change in clinical management	Postoperative complications
Haug 1999[41]	USA	458 (15 to 54 years)	Oral, maxillofacial	✓	✓	
Meneghini 1998[66]	USA	1884 (0 to 8 years)	Not stated	✓	✓	
Wattsman 1997[5]	USA	142 (17 to 76 years)	General	✓	✓	
Bhuripanyo 1995[97]	Thailand	1316 (> 15 years)	Not stated	✓	✓	
Boland 1995[10]	USA	100 (43 to 75 years)	Not stated	✓	✓	
Adams 1992[12]*	UK	169 (adults)	General	✓	✓	
MacDonald 1992[13]*		147 (> 60 years)	Orthopaedics		✓	
O'Connor 1990[77]*	USA	486 (< 18 years)	ENT, general, urology, orthopaedics	✓	✓	
Lawrence 1988[98]*	USA	200 (> 15 years)	Orthopaedics	✓	✓	✓
Akin 1987[99]*	USA	301 (adults)	Not stated	✓	✓	
Turnbull 1987[25]*	Canada	1010 (adults)	General	✓	✓	✓
Kroenke 1986[100]*	USA	3987	Not stated (19 to 95 years)	✓	✓	

TABLE 6.1 Characteristics of eligible studies of preoperative urine testing *continued*

First author and year of publication	Country	Study sample (age)	Type of surgery	Abnormal test	Change in clinical management	Postoperative complications
Muskett 1986[28]*	USA	200 (not stated)	Cardiothoracic, ENT, neurosurgery, general, ophthalmology, plastic surgery, urology, orthopaedics	✓	✓	
Wood 1981[32]*	USA	1924 (0 to 19 years)	ENT, ophthalmology, general, orthopaedics, urology	✓	✓	
Rossello 1980[34]*	Puerto Rico	690 (< 14 years)	Not stated	✓	✓	

*papers included in the HTA review

The results of the 15 studies, which documented the findings from a total of 8,083 preoperative urine tests, are summarised in Table 6.2.

We found a wide variation in the results. The proportion of preoperative urine tests that were abnormal ranged from 0.8% in one study[41] to 34.1% in a further study.[99] The proportion of patients who had preoperative urine tests and who subsequently underwent a change in clinical management ranged from 0% in two studies[41,66] to 14.3% in a further study (although this was from a very small sample size).[5] The proportion of patients who had preoperative urine tests and who subsequently suffered postoperative complications was only reported in two studies (0% in one study[98] and 0.6% in the other[25]).

As described in Section 1, the wide variation in the results may be explained at least in part by heterogeneity in the study populations. The impact of four major sources of heterogeneity on the outcome of the preoperative urine test studies will be considered separately in the following sections.

6.2 Heterogeneity in the quality of the study design

As described in Section 1, studies in which data are collected prospectively and in which patients are recruited consecutively are less susceptible to bias than studies in which data are collected retrospectively and where patients are recruited selectively. Therefore, we hypothesised that the proportions of abnormal preoperative urine tests, changes in clinical management and postoperative complications might differ according to the quality of the study design.

We investigated the effects of variations in the quality of the study design on the proportions of abnormal urine tests, changes in clinical management and postoperative complications across the identified studies. Two studies collected data prospectively and recruited consecutive patients, two studies collected data prospectively and did not state that the sample of patients was consecutive. Four studies collected data retrospectively and recruited consecutive patients and seven papers collected data retrospectively and did not state that the sample of patients was consecutive. The results of these studies are summarised in Table 6.3.

TABLE 6.2 **Summary of preoperative urine test results from the eligible studies (includes routine and indicated tests)**

STUDY	NUMBER OF TESTS# (N)	ABNORMAL RESULTS N (%)	CHANGES IN CLINICAL MANAGEMENT N (%)	POSTOPERATIVE COMPLICATIONS N (%)	ROUTINE	PROSPECTIVE DATA	CONSECUTIVE RECRUITMENT	ASA GRADES STATED
Haug[41]	380	3 (0.8)	0		Not stated	✓	x	ASA I to II
Meneghini[66]	1884	199 (10.6)	0		Routine & indicated	x	x	ASA I to II
Wattsman[5]	14	4 (28.6)	2 (14.3)		Routine & indicated	✓	✓	ASA I to III
Boland[10]	87	12 (13.8)	1 (1.5)		Routine only	x	x	x
Bhuripanyo 1995[97]	422	112 (26.5)	27 (6.4)		Routine only	✓	✓	x
Adams[12]*	164	4 (2.4)	3 (1.8)		Routine only	x	x	x
MacDonald[13]*	145		9 (6.2)		Routine only	✓	x	x
O'Connor[77]*	453	36 (7.9)	2 (0.4)		Not stated	x	x	x
Lawrence[98]*	200	34 (17)	7 (3.5)	0	Routine & indicated	x	✓	x
Akin[99]*	123	42 (34.1)	3 (3.7)		Routine only	x	✓	x
Turnbull[25]*	995	43 (4.3)	1 (0.1)	6 (0.6)	Routine only	x	x	x
Kroenke[100]*	746	135 (18.0)	45 (6.0)		Routine only	x	x	x
Muskett[28]*	174	39 (22.4)	9 (5.2)		Routine only	x	✓	x
Wood[32]*	1859	130 (7.0)	1 (0.1)		Not stated	x	x	x
Rossello[34]*	688	52 (7.6)	2 (0.3)		Not stated	x	✓	x

*papers included in the HTA review;

the number of tests carried out may differ from the sample size in some studies. This occurs in papers reporting the results of multiple preoperative tests because not all of patients in the study sample received all the preoperative tests detailed in the paper

TABLE 6.3 Summary of abnormal preoperative urine tests and changes in clinical management or postoperative complications in study populations according to study quality indicators

QUALITY INDICATOR	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
P C	26.6 (2)	28.6	26.5	6.7 (2)	14.3	6.4	(0)		
P N	0.9 (1)			2.4 (2)	6.2	0	(0)		
R C	14.6 (4)	51.9	7.6	1.8 (4)	5.2	0.3	0 (1)		
R N	9.1 (7)	18.1	1.0	0.8 (7)	6.0	0	0.6 (1)		

P = prospective data collection; R = retrospective data collection; C = consecutive recruitment of patients; N = nonconsecutive recruitment of patients; * weighted means were produced to reflect the different numbers of patients in each study. It was not possible to produce a distributional statistic reflecting this weight.

The average proportions of abnormal preoperative urine tests and changes in clinical management tended to be higher in prospective consecutive studies, compared to retrospective consecutive studies. However there are too few data on which to base any conclusions.

6.3 Heterogeneity in the composition of the study population

6.3.1 Age range

Given that the prevalence of comorbid diseases increases with age, we hypothesised that the proportion of patients with abnormal preoperative urine tests would be higher in studies of older patient populations.

We investigated the effects of variations in the age range of the study population on the proportions of abnormal preoperative urine tests, changes in clinical management and postoperative complications across the identified studies. One study included adults > 60-years-only,[13] five studies included adults only,[10,12,25,99,100] four studies included adults and children,[5,41,98,101] four studies included children only[32,34,66,77] and one study did not state the age range of its patient population.[28] Table 6.4 provides a summary of the mean proportions of abnormal preoperative urine tests, changes in clinical management or postoperative complications across studies according to age group of the study population.

Table 6.4 shows that the average proportion of abnormal preoperative urine tests tended to be higher in studies that included adults and children (17.4%) than in studies that included children only (8.6%). The average proportion of patients who had preoperative urine tests and who subsequently underwent a change in clinical management tended to be highest in studies including adults aged over 60 years (6.2%) and lowest in studies including children only (0.1%).

We then investigated the effects of variations in the age of the study population on the proportion of abnormal preoperative urine tests within the identified studies. Only one study stratified the proportion of patients with abnormal preoperative urine test results by age.[101] This study showed that adults ≤ 40-years-old had fewer abnormal urine test results (28.1%) than adults > 40-years-old (48.7%); however, this is evidence from one study only.

TABLE 6.4 Summary of abnormal preoperative urine tests, changes in clinical management and postoperative complications in study populations according to age group

AGE RANGE	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
Adults > 60 years	(0)			6.2 (1)			(0)		
Adults only	11.6 (5)	51.9	1	2.5 (5)	6	0	0.6 (1)		
Adults & children	17.4 (4)	28.6	0.9	4.1 (4)	14.3	0	0 (1)		
Children only	8.6 (4)	10.6	7	0.1 (4)	0.4	0	(0)		
Not stated	22.4 (1)			5.2 (1)			(0)		

*weighted means

6.3.2 ASA grades

We hypothesised that the proportion of patients with abnormal preoperative urine tests would be greater in studies reporting test results for patients with higher ASA grades.

We investigated the effects of variations in the ASA grade of patients in the study population on the proportions of abnormal preoperative urine tests, changes in clinical management and postoperative complications across the identified studies. Three of the 15 studies stated patients' ASA grades.[5,41,66] Two of these studies included patients of ASA grades I and II only[41,66] and the third study included patients of ASA grades I to III only.[5] Table 6.5 summarises the proportions of abnormal urine tests, changes in clinical management and postoperative complications according to the ASA grade of the patients in the study population.

Based on data from only three studies, Table 6.5 shows that the average proportions of abnormal urine test results and changes in clinical management rise with increasing ASA grade. None of the identified studies stratified the proportion of abnormal preoperative biochemistry

TABLE 6.5 Summary of abnormal urine tests, changes in clinical management and postoperative complications in study populations according to ASA grades

ASA GRADE	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
Stated	9.6 (3)	28.6	0.9	0.1 (3)	14.3	0	(0)		
I to II	9.5 (2)	10.6	0.9	0.0 (2)	0	0	(0)		
I to III	28.6 (1)			14.3 (1)			(0)		
Not stated	10.7 (11)	51.9	1	17.6 (12)	6.4	0	0.1 (2)	0.6	0

*weighted means

tests according to ASA grade. Therefore it was not possible to investigate the effects of variations in the ASA grade of patients on the proportion of abnormal preoperative urine tests within the identified studies.

6.4 Heterogeneity in criteria for preoperative testing

Although authors did not state their definitions of 'routine' preoperative tests, we have assumed a routine preoperative investigation to be a test carried out on all patients preoperatively that is not directly related to the planned procedure or the patients' condition. In some studies, authors included patients undergoing routine preoperative tests as well as patients undergoing indicated preoperative tests. None of these studies presented the proportions of abnormal preoperative tests, changes in clinical management and postoperative complications separately for patients who had routine tests and for patients who had indicated tests, instead the data were combined for both groups of patients. Therefore, we hypothesised that the proportions of abnormal preoperative urine tests, changes in clinical management and postoperative complications would be lower in study populations where all the patients had routine preoperative urine tests compared to study populations containing patients undergoing either routine or indicated preoperative urine tests.

We investigated the effects of variations in the criteria for preoperative testing on the proportions of abnormal preoperative urine tests, changes in clinical management and postoperative complications across the identified studies. Eight studies included patients undergoing routine preoperative urine tests only, whereas three studies included a combination of patients undergoing either routine or indicated tests, and a further three studies did not specify their criteria (Table 6.1). The proportions of abnormal preoperative urine tests, changes in clinical management and postoperative complications in study populations according to whether the study population included routine only or both routine and indicated tests is summarised in Table 6.6.

Table 6.6 shows, contrary to our hypothesis, that for those studies including routine tests only, the average proportions of abnormal urine tests and changes in clinical management or postoperative complications tended to be higher than in studies including both routine and indicated tests.

It was not possible to investigate the effects of variations in the criteria for preoperative testing on the proportions of abnormal preoperative urine tests, changes in clinical management and postoperative complications within the identified studies because studies that only included patients for whom preoperative tests were indicated were excluded in the initial stages of our systematic review and none of the eligible studies reported data separately for routine and indicated preoperative urine tests.

TABLE 6.6 Summary of abnormal preoperative urine tests, changes in clinical management and postoperative complications according to the criteria for preoperative testing

CRITERIA FOR TEST	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
Routine only	14.0 (7)	51.9	1.0	3.5 (8)	6.4	0	0.6 (1)		
Routine & indicated	11.3 (3)	28.6	10.6	0.4 (3)	14.3	0	0 (1)		
Not stated	6.8 (4)	7.9	0.9	0.1 (4)			(0)		

*weighted means

6.5 Heterogeneity in the definition of the outcome variables

6.5.1 Definition of a normal/ abnormal urine test

We investigated the variability of the definition of normal/abnormal preoperative urine tests across the identified studies. Six studies specified definitions of normal/abnormal preoperative urine test results.[5,32,77,98,100,101] These definitions are listed in Table 6.7.

Table 6.7 shows that there were differences between the definitions of normal/abnormal preoperative urine tests. However, the differences in the definitions were small and, therefore, were not likely to have been a great source of heterogeneity across the different studies.

6.5.2 Definition of a change in clinical management

We investigated the variability of the definition of a change in clinical management in patients who had had preoperative urine tests in the identified studies. All of the studies reported changes in clinical management as a result of abnormal preoperative urine test results. The change in clinical management outcome variable was reported as delay or cancellation of surgery in six studies[25,32,34,58,77,98] and alterations in treatment in a further four studies.[12,28,99,100] Four studies specified a broader definition of changes in clinical management,[10,13,66,101] and these descriptions are summarised in Table 6.8.

TABLE 6.7 Summary of the reported definitions of normal preoperative urine test results

	1	2	3	4	5	6
Urine protein						
< trace	✓			✓	✓	✓
< 1+		✓	✓			
Urine glucose						
< trace	✓				✓	✓
< 1+						
White blood cells						
< 2 cells per high power field					✓	
< 3 cells per high power field						✓
< 5 cells per high power field	✓		✓	✓		
< 10 per high power field		✓				
Red blood cells						
< 2 cells per high power field				✓	✓	✓
< 5 cells per high power field	✓		✓			
< 10 per high power field		✓				
Bacteria						
< 1+		✓				
Acetone						
< 1+		✓				

1: Bhuripanyo[97]; 2: Wood[32]; 3: O'Connor[77]; 4: Lawrence[98]; 5: Kroenke[100]; 6: Wattsman[5].

TABLE 6.8 Summary of the definitions of change in clinical management (%) in studies of preoperative urine testing

	1	2	3	4
Medical consultation		✓		
Changes in anaesthetic technique				✓
Medication or additional investigation required	0.05		✓	
Postponement or cancellation of surgery		✓		
Longer hospital stay			✓	
Total	**0.05**	**6.2**	**0**	**1.5**

1: Bhuripanyo[101]; 2: MacDonald[13]; 3: Meneghini[66]; 4: Boland[10].

The changes in clinical management described in each of the papers outlined in Table 6.8 vary across the studies. However, these data may simply reflect changes in clinical management that were observed rather than predefined actions that were considered to represent changes in clinical management. Therefore, it is not sensible to investigate further differences in the definitions as a source of heterogeneity across the study populations.

6.5.3 Definition of postoperative complications

We attempted to investigate the variability of the definition of a postoperative complications in patients who had had preoperative urine tests. However, neither of the two papers that reported postoperative complications provided a definition of this outcome variable.

6.6 Diagnostic accuracy

Of the 15 studies investigating preoperative urine testing, only one reported the diagnostic accuracy of the test.[25] This study found that the positive predictive value for preoperative urine tests was 11.7% and the negative predictive value was 95.7%.

From the data presented in each of the papers it was possible to calculate positive predictive values of preoperative urine tests for predicting a change in clinical management for 11 studies. The positive predictive values indicate the percentage of patients with abnormal preoperative urine tests that subsequently underwent a change in clinical management. The results are summarised in Table 6.9.

TABLE 6.9 Calculated estimates of the positive predictive value of preoperative urine tests for predicting changes in clinical management

First author	Positive predictive value for predicting a change in clinical management (%)
Haug[41]	0
Meneghini[66]	0
Wattsman[5]	50
Bhuripanyo[97]	24.1
Boland[10]	8.3
Adams[12]	0
Turnbull[25]	2.3
Kroenke[100]	33.3
Muskett[28]	23.1
Wood[32]	0.4
Rossello[34]	3.8

The positive predictive value of preoperative urine tests for predicting a change in clinical management ranged from 0% in three studies[12,41,66] to 33.3% in a further study.[100] However, it is difficult to interpret the meaning of the positive predictive values from Table 6.9 because of the heterogeneous nature of the studies as outlined in Section 1.

7 Preoperative pregnancy tests

7.1 Characteristics of the results

In our search of the literature from 1966 to 2001 we identified a total of seven papers that studied preoperative (urine) pregnancy tests. All of these papers reported positive test data and changes in clinical management and one study reported postoperative complications. The HTA report did not include studies of preoperative pregnancy testing, therefore this review includes only the seven papers we identified. The characteristics of the seven papers are summarised in Table 7.1. All the studies were case series.

The results of the seven papers, which documented the findings from a total of 4,902 preoperative pregnancy tests, are summarised in Table 7.2.

The proportion of preoperative pregnancy tests that were positive varied from 0% in one study[107] to 2.2% in a further study.[106] In all studies, except one[103], where previously unknown pregnancy was discovered, all patients with a positive test had a change in clinical management.[102,104-106,107,108]

7.2 Variation in the results

The variation in the positive test findings may be explained by the differences in the ages of the study populations. For example, the highest rate of positive preoperative pregnancy test findings (2.2%) occurred in the only study of adults only[106] and the lowest rate (0%) occurred in the study of children aged 10 to 17 years only.[107]

There were no data to analyse differences in results according to quality of papers, ASA grade or age.

7.3 Consistency of the results

In all but one of the studies, where a positive preoperative test was identified surgery was always either cancelled or postponed because of the risk of fetal injury or loss. In only one patient with a positive preoperative pregnancy test was surgery carried out without change in anaesthetic technique (due to the urgent nature of the operation) and miscarriage followed surgery.[103] Previously unknown pregnancies were subsequently terminated after surgery had been cancelled in four of seven women in one study[106] and in three of seven women in a further study.[105] The changes in clinical management in patients with positive preoperative pregnancy tests are summarised in Table 7.3.

TABLE 7.1 Characteristics of eligible studies of preoperative pregnancy testing

First author and year of publication	Country	Study sample (age)	Type of surgery	Abnormal test	Change in clinical management	Postoperative complications
Hennrikus 2001[102]	USA	532 (12 to 19 years)	Orthopaedic surgery	✓	✓	(0)
Wheeler 1999[103]	USA	261 (10 to 34 years)	Not stated	✓	✓	✓
Pierre 1998[105]	USA	801 (12 to 21 years)	Not stated	✓	✓	(0)
Twersky 1996[106]	USA	315 (24 to 35 years)	Not stated	✓	✓	(0)
Azzam 1996[104]	USA	412 (10.5 to 20 years)	Not stated	✓	✓	(0)
Malviya 1995[107]	USA	525 (10 to 17 years)	Not stated	✓	✓	(0)
Manley 1995[108]	USA	2056 (not stated)	Not stated	✓	✓	(0)

(0) not applicable because surgery cancelled in all cases of previously unknown pregnancy

TABLE 7.2 **Summary of preoperative pregnancy testing study results**

STUDY	NUMBER OF TESTS# (N)	ABNORMAL RESULTS N (%)	CHANGES IN CLINICAL MANAGEMENT N (%)	POSTOPERATIVE COMPLICATIONS N (%)	ROUTINE	PROSPECTIVE DATA	CONSECUTIVE RECRUITMENT	ASA GRADES STATED
Hennrikus[102]	532	5 (0.9)	5 (0.9%)		Routine only	x	✓	x
Wheeler[103]	235	3 (1.3)	3 (1.3)	1 (0.4)	Routine only	✓	x	x
Pierre[105]	801	4 (0.5)	4 (0.5)		Routine only	x	x	x
Twerskey[106]	315	7 (2.2)	7 (2.2)		Routine only	✓	✓	x
Azzam[104]	412	5 (1.2)	5 (1.2)		Routine only	✓	x	x
Malviya[107]	508	0	0		Routine only	✓	x	x
Manley[108]	2056	7 (0.3)	7 (0.3)		Routine only	✓	x	x

#The number of tests carried out may differ from the sample size in some studies. This occurs in papers reporting the results of multiple preoperative tests because not all of patients in the study sample received all the preoperative tests detailed in the paper

TABLE 7.3 **Changes in clinical management in patients (%) with positive preoperative pregnancy tests**

Change in clinical management	Hennrikus[102]	Wheeler[103]	Pierre[105]	Manley[108]	Twersky[106]	Azzam[104]
Surgery postponed	100 (n=5)	67 (n=2)	100 (n=4)	100 (n=7)	100 (n=7)	60 (n=3)
Anaesthetic technique altered						40 (n=2)

7.4 Is history a reliable marker for pregnancy?

Four of the papers addressed the question of whether history is a reliable marker for pregnancy.[103,105,107,108] In one of the papers, asking a patient if there was any possibility that she might be pregnant was found to be a sufficient marker for pregnancy.[107] In this study no previously unknown pregnancies were identified in a series of 508 10 to 17-year-olds. Although eight patients stated that there was a possibility that they may be pregnant, their pregnancy tests were negative. The remaining three studies found that for all women of child bearing age, history was not a sufficient marker for

pregnancy.[103,105,108] For example, in one of the studies, seven previously unknown pregnancies were identified in a series of 2056 women of child bearing age. In all seven cases, the women had denied the possibility of pregnancy in preoperative interview.[108] In another of the studies where four previously unknown pregnancies were identified in a series of 801 adolescents aged 12 to 21 years, three of the four patients denied the possibility of pregnancy and two of the four patients denied being sexually active.[105] In the third of the studies, three previously unknown pregnancies were identified in a series of 235 women aged 10 to 34 years.

8 Preoperative sickle cell tests

In our search of the literature from 1966 to 2001 we did not identify any papers that reported primary outcome data for children or adults undergoing elective surgery who had had generic ('routine') preoperative sickle cell tests.

9 Preoperative lung function tests

9.1 Characteristics of the studies

In our search of the literature from 1966 to 2001, we identified a total of ten papers that studied preoperative lung function tests. All of these papers reported abnormal outcome data, none reported changes in clinical management and eight reported postoperative complications. The characteristics of the ten papers are summarised in Table 9.1. All the identified studies were case series.

The results of the ten studies, which documented the findings from a total of 2,407 preoperative lung function tests, are summarised in Table 9.2.

TABLE 9.1 Characteristics of the eligible studies of preoperative lung function tests

First author and year of publication	Country	Study sample (age)	Type of surgery	Abnormal test	Change in clinical management	Postoperative complications
Brady 2000[109]	USA	820 (60 to 80 years)	Vascular	✓		✓
Chandra 1998[110]	USA	22 (14 to 52 years)	Cardiac	✓		
Kuwano 1998[111]	India	178 (not stated)	Oncology	✓		✓
Barisione 1997[112]	Italy	361 (25 to 91 years)	Laparotomy	✓		✓
Castro 1996[113]	USA	362 (not stated)	Liver transplant	✓		
Durand 1994[114]	France	114 (53 to 75 years)	Vascular	✓		✓
Durand 1993[115]	France	149 (58 to 60 years)	Cardiac	✓		✓
Poe 1988[116]	USA	209 (20 to 70 years)	Cholecystectomy	✓		✓
Kim 1987[117]	Korea	78 (not stated)	Abdominal surgery	✓		✓
Crapo 1986[118]	USA	114 (29 to 46 years)	Gastrointestinal	✓		✓

TABLE 9.2 Summary of preoperative lung function test results

FIRST AUTHOR	NUMBER OF TESTS# (N)	ABNORMAL RESULTS N (%)	CHANGES IN CLINICAL MANAGEMENT N (%)	POSTOPERATIVE COMPLICATIONS N (%)	ROUTINE	PROSPECTIVE DATA	CONSECUTIVE RECRUITMENT	ASA GRADES STATED
Brady[109]	820	376 (45.9)		22 (2.7)	Not stated	x	x	x
Chandra[110]	22	Restrictive 16 (72.7) Obstructive 6 (27.2)			Not stated	✓	x	x
Kuwano[111]	178	73 (41.0)		43 (24.2)	Not stated	x	x	x
Barisione[112]	361	Restrictive 91 (25.2) Obstructive 79 (21.9)		Restrictive 1 (0.3) Obstructive 35 (9.7)	Not stated	x	✓	x
Castro[113]	362	Restrictive 56 (15.5) Obstructive 23 (6.4)			Not stated	x	x	x
Durand[114]	114	FEV_1 14 (12.0) VC 15 (13.0) FEV_1:VC 38 (33.0)			Not stated	x	✓	x
Durand[115]	149	FEV_1 9 (6.0) VC 23 (15.4)		FEV_1 3 (2.0) VC 5 (3.4)	Not stated	x	✓	x
Poe[116]	209	FEV_1 5 (2.4) VC 16 (7.7)		31 (14.8%)	Not stated	✓	x	x
Kim[117]	78	FEV_1 5 (6.4)		5 (6.4)	Not stated	x	x	x
Crapo[118]	114	FEV_1 6 (5.3) VC 4 (3.5) FEV_1:VC 7 (6.1)		4 (3.5)	Not stated	✓	✓	x

FEV_1 = forced expiratory volume in 1 second; VC = vital capacity; FEV_1:VC = ratio of forced expiratory volume in 1 second to vital capacity

Table 9.2 shows that the proportion of abnormal preoperative lung function tests varied greatly across studies. For restrictive disease the proportion of abnormal preoperative lung function tests ranged from 15.5%[113] to 72.7%.[110] For obstructive disease the proportion of abnormal preoperative lung function tests ranged from 6.4%[113] to 27.2%.[110] The proportion of patients who suffered postoperative complications ranged from 0.3% in patients with restrictive disease[112] to 24.2% in patients with either restrictive or obstructive disease.[111]

For the different preoperative lung function tests individually, the proportion of abnormal preoperative FEV1 tests ranged from 2.4%[116] to 12.0%.[114] The proportion of abnormal preoperative VC tests ranged from 3.5%[118] to 15.4%.[115] The proportion of patients with an abnormal preoperative FEV1:VC ratio ranged from 6.1%[118] to 33.3%.[114]

As described in Section 1, the wide variation in the results may be explained at least in part by heterogeneity in the study populations. The impact of four major sources of heterogeneity on the outcome of the preoperative lung function test studies will be considered separately in the following sections.

9.2

Heterogeneity in the quality of the study design

As described in Section 1, studies in which data are collected prospectively and in which patients are recruited consecutively are less susceptible to bias than studies in which data are collected retrospectively or where patients are recruited selectively. Therefore, we hypothesised that the proportions of abnormal preoperative lung function tests and postoperative complications might differ according to the quality of the study design.

TABLE 9.3 **Summary of abnormal lung function tests and postoperative complications in study populations according to study quality indicators**

QUALITY INDICATOR	% ABNORMAL TEST (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
P C	FEV_1 5.3 (1) VC 3.5 (1) FEV_1:VC 6.1 (1)				3.5	
P N	Restrictive 72.7 (1) Obstructive 27.2 (1) FEV_1 2.4 (1) VC 7.7 (1)				14.8 (1)	
R C	Restrictive 25.2 (1) Obstructive 21.9 (1) FEV_1 8.6 (2) VC 14.4 (2) $FEV_1$1:VC 33.0 (1)	FEV_1 12.0 VC 15.4	FEV_1 6.0V C 13.0		Restrictive 0.3 (1) Obstructive 9.7 (1) FEV_1 2.0 (1) VC 3.4 (1)	
R N	45.0 (2)# Restrictive 15.5 (1) Obstructive 6.4 (1) FEV_1 6.4 (1)	45.9#	41.0#	6.5 (2)# FEV_1 3.5 (1)	24.2#	2.7#

P = prospective data collection; R = retrospective data collection; C = consecutive recruitment of patients; N = nonconsecutive recruitment of patients; *weighted means were produced to reflect the different numbers of patients in each study. It was not possible to produce a distributional statistic reflecting this weight. #restrictive and obstructive disease combined

We investigated the effects of variations in the quality of the study design on the proportions of abnormal lung function tests and postoperative complications across the identified studies. One study collected data prospectively and recruited consecutive patients,[118] two studies collected data prospectively and did not state that the sample of patients was consecutive,[110,116] three studies collected data retrospectively for a sample of consecutive patients[112,114,115] and four studies collected data retrospectively and did not state that the sample of patients was consecutive.[109,111,113,117] The results from these studies are summarised in Table 9.3.

Table 9.3 shows that there were too few studies within each of the quality indicator categories to be able to compare trends in the proportions of abnormal preoperative lung function tests and postoperative complications across the studies.

9.3 Heterogeneity in the composition of the study population

9.3.1 Age range

Given that the prevalence of comorbid diseases increases with age, we hypothesised that the proportion of patients with abnormal preoperative lung function tests would be higher in studies of older patient populations.

We investigated the effects of variations in the age range of the study population on the proportions of abnormal preoperative lung function tests and postoperative complications across the identified studies. Six studies included adults only,[109,112,114-116,118] one of which was in adults aged 60 years and over,[109] one study included both adults and children[110] and the remaining three studies did not specify the age range of their patient populations.[111,113,117] Table 9.4 provides a summary of the proportions of abnormal preoperative lung function tests and postoperative complications across studies according to the age group of the study population.

Table 9.4 shows that there were too few studies within each of the age group categories to be able to compare trends in the proportions of abnormal preoperative lung function tests and postoperative complications across the studies.

None of the studies stratified the proportion of abnormal lung function tests according to age,

TABLE 9.4 Summary of abnormal preoperative lung function tests and postoperative complications in study populations by age group

AGE RANGE	% ABNORMAL TEST (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
Adult > 60 years	45.9 (1)				2.7 (1)	
Adults only	Restrictive 25.2 (1) Obstructive 21.9 (1) FEV_1 5.7 (4) VC 9.9 (4) FEV_1:VC 19.6 (2)	 FEV_1 12.0 (4) VC 15.4 (4) FEV_1:VC 33.0 (2)	 FEV_1 2.4 (4) VC 3.5 (4) FEV_1:VC 6.1 (2)	Restrictive 0.3 (1) Obstructive 9.7 (1) FEV_1 2.0 (1) VC 3.4 (1) 9.2 (2) $	 14.8 $	 3.5 $
Children & adults	Restrictive 72.7 (1) Obstructive 27.2 (1)				(0)	
Not stated	41.0 (1)# Restrictive 15.5 (1) Obstructive 6.4 (1) FEV_1 6.4 (1)			24.2 (1)# FEV_1 3.5 (1)	24.2#	2.7#

*weighted means; #data for restrictive and obstructive disease combined; $data for FEV1 and VC combined.

therefore it was not possible to assess the impact of different age groups within each study population on the results.

9.3.2 ASA grades

We hypothesised that the proportion of patients with abnormal preoperative lung function tests would be greater in studies of patients with higher ASA grades. However, none of the studies of preoperative lung function tests reported the ASA grades of the patients in the study population. Therefore, it was not possible to assess the impact of different ASA grades either across or within each study population on the results.

9.4 Heterogeneity in criteria for preoperative testing

Although authors did not state their definitions of 'routine' preoperative tests, we have assumed a routine preoperative investigation to be a test carried out on all patients preoperatively that is not directly related to the planned procedure or the patients' condition. In some studies, authors included patients undergoing routine preoperative tests as well as patients undergoing indicated preoperative tests. None of these studies presented the proportions of abnormal preoperative tests and postoperative complications separately for patients who had routine tests and for patients who had indicated tests, instead the data were combined for both groups of patients. Therefore, we hypothesised that the proportions of abnormal preoperative lung function tests and postoperative complications would be lower in study populations where all the patients had routine preoperative lung function tests compared to study populations containing patients undergoing either routine or indicated preoperative lung function tests. However, none of the studies of preoperative lung function tests included their criteria for carrying out the preoperative lung function test. Therefore, it was not possible to assess the impact of the criteria for testing on the results either across or within each study population.

9.5 Heterogeneity in the definition of the outcome variables

9.5.1 Definition of an abnormal lung function tests

We investigated the variability of the definition of normal/abnormal preoperative lung function tests across the identified studies. Eight papers reported definitions of an abnormal lung function test. The reported definitions are summarised in Table 9.5.

Table 9.5 shows that the definitions of an abnormal lung function test were not consistent across the studies. However, the differences in the definitions were small and, therefore, were not likely to have been a great source of heterogeneity across the studies.

9.5.2 Definition of a change in clinical management

None of the studies of preoperative lung function tests reported changes in clinical management in patients who had abnormal results.

9.5.3 Definition of postoperative complications

We investigated the variability of the definition of a postoperative complication in patients who had had a preoperative lung function test. Eight studies reported postoperative complications in patients who had had preoperative ECGs. Each of these eight studies specified definitions of postoperative complications. These definitions are summarised in Table 9.6.

TABLE 9.5 Summary of the definitions of an abnormal preoperative lung function test

	1	2	3	4	5	6	7	8
FEV_1								
FEV_1 < 70% of theoretical values		✓			✓			
FEV_1 < 1.5 l						✓		
FEV_1 < 1.0 litre							✓	
FEV_1 < 1 95% confidence interval below the predicted value								
VC								
VC < 75% of theoretical values					✓			
VC < 80%		✓						
VC < 2.5 litre						✓		
VC < 1 95% confidence interval below the predicted value								
FEV_1:VC								
FEV_1:VC < 65% of theoretical values								
FEV_1:VC < 1 95% confidence interval below the predicted value								✓
Obstructive disease								
Observed values < 80% of the predicted values for FVC, FEV_1, MEF, PEFR and MVV	✓							
FEV_1:IVC below normal range			✓					
FEV_1:FVC 2SD below the predicted normal range				✓				
Restrictive disease								
Observed FVC value > 80% of predicted value and FEV_1:FVC ratio < 70% of predicted value	✓							
TLC < lower limit of normal range			✓					
TLC 2 SD below the predicted normal value				✓				

1: Chandra[110]; 2:Kuwano[111]; 3: Barisione[112]; 4: Castro[113]; 5: Durand (1994)[114]; 6: Durand (1993)[115]; 7: Kim[117]; 8: Crapo[118].

VC = forced vital capacity; FEV_1 = forced expiratory volume in one second; MEF = mid expiratory flow rate; PEFR = peak expiratory flow rate; MVV = maximum volume ventilation; IVC = inspiratory vital capacity; TLC = total lung capacity.

TABLE 9.6 Summary of the postoperative complications (%) in patients who had had a preoperative lung function test

Postoperative complication	1	2	3	4	5	6	7	8
Death within 30 days of surgery	2.7	3.4		1.8	4.7	0		0.9
Pulmonary complications (atelectasis, bronchitis, pneumonia)		7.9		15.0		14.8	6.4	
Severe respiratory complications: atelectasis, pleural effusion/infection, chest infection, productive cough, dyspnoea, chest pain or discomfort, tachycardia, acute respiratory failure, requirement for intubation			10.0					
Cardiac complications				12.0				
Renal failure				11.0				
Any complications		12.9						2.6
Total		**2.7**	**24.2**	**10.0**	**n/s**	**n/s**	**14.8**	**6.4 3.5**

1: Brady[109]; 2: Kuwano[111]; 3: Barisione[112]; 4: Durand (1994)[114]; 5: Durand (1993)[115]; 6: Poe[116]; 7: Kim[117]; 8: Crapo[118]; n/s not stated.

Table 9.6 shows that the range of postoperative complications were not clearly reported across the studies. Therefore, these data are difficult to interpret.

9.6 Diagnostic accuracy

None of the studies investigated the diagnostic accuracy of the preoperative lung function tests. Given that none of the studies reported data for changes in clinical management in patients who had had preoperative lung function tests, it was not possible to calculate positive predictive values for predicting a change in clinical management for any of the studies.

10 Preoperative blood gas tests

10.1 Characteristics of the studies

In our search of the literature from 1966 to 2001, we identified a total of four papers that studied preoperative blood gas tests. All of these papers reported abnormal outcome data, one reported changes in clinical management and three reported postoperative complications. The characteristics of the four papers are summarised in Table 10.1. All the identified studies were case series.

The results of the four studies, which documented the findings from a total of 372 preoperative blood gas tests, are summarised in Table 10.2.

TABLE 10.1 Characteristics of the eligible studies of preoperative blood gas tests

First author and year of publication	Country	Study sample (age)	Type of surgery	Abnormal test	Change in clinical management	Postoperative complications
Durand 1993[115]	France	149 (58 to 60 years)	Cardiac	✓		✓
Durand 1994[114]	France	114 (53 to 75 years)	Vascular	✓		✓
Kim 1987[117]	Korea	78 (not stated)	Abdominal surgery	,		✓
Turnbull 1987[25]	Canada	1010 (not stated)	Cholecystectomy	✓	✓	

TABLE 10.2 Summary of preoperative blood gas test results

FIRST AUTHOR	NUMBER OF TESTS# (N)	ABNORMAL RESULTS N (%)	CHANGES IN CLINICAL MANAGEMENT N (%)	POSTOPERATIVE COMPLICATIONS N (%)	ROUTINE	PROSPECTIVE DATA	CONSECUTIVE RECRUITMENT	ASA GRADES STATED
Durand[114]	114	PaO_2 25 (22.0)			Not stated	x	✓	x
Durand[115]	149	PaO_2 8 (5.4)		PaO_2 2 (1.8)	Not stated	x	✓	x
Kim[117]	78	PaO_2 6 (7.7)		PaO_2 4 (5.1)	Not stated	x	x	x
Turnbull[25]	31	PaO_2 & $PaCO_2$ 0 (0)	0 (0)		Not stated	✓	x	x

Table 10.2 shows that the proportion of abnormal preoperative blood gas tests varied across studies. For example, the proportion of abnormal preoperative PaO2 tests ranged from 0%[25] to 22.0%.[114] There were no changes in clinical management in the single study that reported this outcome measure.[25] The proportion of patients who suffered postoperative complications ranged from 1.8% in one study[115] to 5.1% in a further study.[117]

As described in Section 1, the variation in the results may be explained at least in part by heterogeneity in the study populations. The impact of four major sources of heterogeneity on the outcome of the preoperative blood gas test studies will be considered separately in the following sections.

10.2 Heterogeneity in the quality of the study design

As described in Section 1, studies in which data are collected prospectively and in which patients are recruited consecutively are less susceptible to bias than studies in which data are collected retrospectively or where patients are recruited selectively. Therefore, we hypothesised that the proportions of abnormal preoperative blood gas tests, changes in clinical management and postoperative complications might differ according to the quality of the study design.

We investigated the effects of variations in the quality of the study design on the proportions of abnormal blood gas tests, changes in clinical management and postoperative complications across the identified studies. One study collected data prospectively and did not state that the sample of patients was consecutive,[25] two studies collected data retrospectively for a sample of consecutive patients[114,115] and one study collected data retrospectively and did not state that the sample of patients was consecutive.[117] The results from these studies are summarised in Table 10.3.

TABLE 10.3 Summary of abnormal blood gas tests, changes in clinical management and postoperative complications in study populations according to study quality indicators

QUALITY INDICATOR	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
P N	0 (1)			0 (1)			(0)		
R C	13.7 (2)	22.0	5.4	(0)			1.8 (1)		
R N	7.7 (1)			(0)			5.1 (1)		

P = prospective data collection; R = retrospective data collection; C = consecutive recruitment of patients; N = recruitment of patients that was not stated as consecutive; * weighted means were produced to reflect the different numbers of patients in each study. It was not possible to produce a distributional statistic reflecting this weight.

Table 10.3 shows that there were too few studies within each of the quality indicator categories to be able to compare trends in the proportions of abnormal preoperative blood gas tests and postoperative complications across the studies.

10.3 Heterogeneity in the composition of the study population

10.3.1 Age range

Given that the prevalence of comorbid diseases increases with age, we hypothesised that the proportion of patients with abnormal preoperative blood gas tests would be higher in studies of older patient populations.

We investigated the effects of variations in the age range of the study population on the proportions of abnormal preoperative blood gas tests, changes in clinical management and postoperative complications across the identified studies. Two studies included adults only[114,115] and the remaining two studies did not specify the age range of their patient population.[25,117] Table 10.4 provides a summary of the proportions of abnormal preoperative blood gas tests, changes in clinical management and postoperative complications across studies according to the age group of the study population.

Table 10.4 shows that there were too few studies within each of the age group categories to be able to compare trends in the proportions of abnormal preoperative blood gas tests and postoperative complications across the studies.

None of the studies stratified the proportion of abnormal blood gas tests according to age, therefore it was not possible to assess the impact of the different age groups within each study population on the results.

TABLE 10.4 Summary of abnormal preoperative blood gas tests, changes in clinical management and postoperative complications in study populations by age group

AGE RANGE	% ABNORMAL TEST (Number of Studies)			% CHANGE IN CLINICAL MANAGEMENT (Number of Studies)			% POSTOPERATIVE COMPLICATIONS (Number of Studies)		
	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum	Mean*	Maximum	Minimum
Adults only	13.7 (2)	22.0	5.4	(0)			1.8 (1)		
Not stated	3.9 (2)	7.7	0	0 (1)			5.1 (1)		

*weighted means

10.3.2 ASA grades

We hypothesised that the proportion of patients with abnormal preoperative blood gas tests would be greater in studies of patients with higher ASA grades. However, none of the studies of preoperative blood gas tests reported the ASA grades of the patients in the study population. Therefore, it was not possible to assess the impact of different ASA grades either across or within each study population on the results.

10.4 Heterogeneity in criteria for preoperative testing

Although authors did not state their definitions of 'routine' preoperative tests, we have assumed a routine preoperative investigation to be a test carried out on all patients preoperatively that is not directly related to the planned procedure or the patients' condition. In some studies, authors included patients undergoing routine preoperative tests as well as patients undergoing indicated preoperative tests. None of these studies presented the proportions of abnormal preoperative tests, changes in clinical management and postoperative complications separately for patients who had routine tests and for patients who had indicated tests, instead the data were combined for both groups of patients. Therefore, we hypothesised that the proportions of abnormal preoperative blood gas tests, changes in clinical management and postoperative complications would be lower in study populations where all the patients had routine preoperative blood gas tests compared to study populations containing patients undergoing either routine or indicated preoperative blood gas tests. However, none of the studies of preoperative blood gas tests included their criteria for carrying out the test. Therefore, it was not possible to assess the impact of the criteria for testing on the results either across or within each study population.

10.5 Heterogeneity in the definition of the outcome variables

10.5.1 Definition of an abnormal blood gas tests

We investigated the variability of the definition of normal/abnormal preoperative blood gas tests across the identified studies. Three papers reported definitions of an abnormal blood gas test. The reported definitions are summarised in Table 10.5.

TABLE 10.5 Summary of the definitions of an abnormal preoperative blood gas test

	Durand (1994)[114]	Durand (1993)[115]	Kim[117]
PaO_2			
< 9 kPa	✓		
< 8.5 kPa		✓	
< 65 mmHg			✓

Table 10.5 shows that the definitions of an abnormal blood gas test were not consistent across the studies. However, the differences in the definitions were small and, therefore, were not likely to have been a great source of heterogeneity across the studies.

10.5.2 Definition of a change in clinical management

Only one of the four studies of preoperative blood gas tests reported changes in clinical management in patients who had abnormal results and no definition of what constituted a change in clinical management was presented.[25]

10.5.3 Definition of postoperative complications

We investigated the variability of the definition of a postoperative complication in patients who had had a preoperative blood gas test. Two of the four studies reported postoperative complications in patients who had had preoperative blood gas tests. Both of these studies specified definitions of postoperative complications (Table 10.6).

TABLE 10.6 Summary of the postoperative complications (%) in patients who had had preoperative blood gas tests

Postoperative complication	Durand (1994)[114]	Kim[117]
Postoperative mortality	1.8	
Pulmonary complications (atelectasis, respiratory failure, mild hypoxaemia)		5.1
Total	**1.8**	**5.1**

Table 10.6 shows that the definitions of postoperative complications reported in the two studies differed.

10.6 Diagnostic accuracy

None of the studies investigated diagnostic accuracy of the preoperative blood gas test for predicting changes in clinical management. However, from the data presented it was possible to calculate a positive predictive value for predicting a change in clinical management for one paper. The positive predictive value indicates the percentage of patients with abnormal preoperative blood gas tests who subsequently underwent changes in clinical management. In the single study where it was possible to calculate this value, the positive predictive value of preoperative blood gas tests for predicting a change in clinical management was 0%.[25]

TABLE A1.i Search Terms for Medline for All Tests

No. Search strategy

Type of patient settig

1. explode 'Ambulatory-Care'/all subheadings in MIME,MJME
2. explode 'Ambulatory-Surgical-Procedures'/all subheadings in MIME,MJME
3. explode 'Surgical-Procedures-Elective'/all subheadings in MIME,MJME
4. explode 'Preoperative-Care'/all subheadings in MIME,MJME
5. 'Surgery-'/all subheadings in MIME,MJME
6. elective surg*
7. ambulatory surg*
8. preop or pre-op or preoperative or pre operative or preoperative
9. 1 or 2 or 3..... or 8

Diagnostic tests study designs

10. 'Diagnostic-Tests-Routine'/all subheadings in MIME,MJME
11. (diagnostic or laboratory) near (test or tests or testing)
12. explode 'Sensitivity-and-Specificity'/all subheadings in MIME,MJME
13. 'ROC-Curve'/all subheadings in MIME,MJME
14. 'Predictive-Value-of-Tests'/all subheadings in MIME,MJME
15. explode 'Mass-Screening'/all subheadings in MIME,MJME
16. sensitivit*
17. specificit*
18. predictive value*
19. accuracy
20. likelihood ratio*
21. screening
22. false negative*
23. 10 or 11 or 12..... or 22

Excluded citation terms

24. (animal in tg) not ((human and animal) in tg)
25. (comment or editorial or letter or news) in pt)
26. 24 or 25

Combination of above terms

27. (9 and 23) not 26

The terms for each test were combined using the AND boolean operator with the above search strategy

Search Terms for Medline for Specific Tests

Phase A Tests

Chest x-rays

1 'Radiography-'/all subheadings in MIME,MJME
2 explode 'Radiography-Thoracic'/all subheadings in MIME,MJME
3 (chest or thoracic) and (xray* or x-ray* or radiograph* or roentgenography)
4 1 or 2 or 3

ECG

1. explode 'Electrocardiography-'/all subheadings in MIME,MJME
2. ecg or electrocardiogra*
3. 1 or 2

Haemoglobin and Blood Counts

1. explode 'Hemoglobins-'/all subheadings in MIME,MJME
2. hemoglobin* or haemoglobin*
3. explode 'Blood-Cell-Count'/all subheadings in MIME,MJME
4. blood count
5. white blood cell count
6. leukocyte count
7. platelet count
8. 1 or 2 or 3 ..... or 7

Haemostasis

1. 'Hemostasis-'/all subheadings in MIME,MJME
2. 'Hemostasis-Surgical'/all subheadings in MIME,MJME
3. 'Hematologic-Tests'/all subheadings in MIME,MJME
4. haemostasis or hemostasis
5. hematologic test* or haematologic test*
6. explode 'Blood-Coagulation-Tests'/all subheadings in MIME,MJME
7. 'Blood-Coagulation'/all subheadings in MIME,MJME
8. blood coagulation test*
9. partial thromboplastin time or PTT
10. international normalized ratio or international normalised ratio or INR
11. prothrombin time
12. bleeding time
13. whole blood coagulation time
14. 1 or 2 or 3.....or 13

Biochemistry Tests

1. 'Biochemistry-'/all subheadings in MIME,MJME
2. 'Blood-Chemical-Analysis'/all subheadings in MIME,MJME
3. 'Glucose-Tolerance-Test'/all subheadings in MIME,MJME
4. glucose tolerance or glucose test or glucose tests
5. 'Diagnostic-Techniques-Urological'/all subheadings in MIME,MJME
6. 'Urinalysis-'/all subheadings in MIME,MJME
7. urine analysis or urinalysis or dipstick
8. 'Kidney-Function-Tests'/all subheadings in MIME,MJME
9. (kidney function or renal function) near (test or tests or testing)
10. 'Electrolytes-'/all subheadings in MIME,MJME
11. electrolyte*
12. 'Creatinine-'/all subheadings in MIME,MJME
13. creatinine
14. 'Blood-Urea-Nitrogen'/all subheadings in MIME,MJME
15. blood urea nitrogen
16. 1 or 2 or 3 .....or 15

Blood Sugar

1. 'Blood-Glucose'/all subheadings in MIME,MJME
2. blood sugar or blood glucose
3. glucose test*
4. 1 or 2 or 3

Pregnancy Tests

1. explode 'Pregnancy-Tests'/all subheadings in MIME,MJME
2. pregnancy test or pregnancy tests
3. 1 or 2

Sickle Cell

1. explode 'Hemoglobinopathies-'/all subheadings in MIME,MJME
2. hemoglobinopath* or haemoglobinopath*
3. sickle cell
4. 1 or 2 or 3

Phase B Tests

Respiratory Function Tests

1. 'Respiratory Function Tests'/all subheadings in MIME,MJME
2. 'Airway-Resistance'/all subheadings in MIME,MJME
3. 'Lung-Volume-Measurements'/all subheadings in MIME,MJME
4. 'Vital-Capacity'/all subheadings in MIME,MJME
5. explode 'Forced-Expiratory-Flow-Rates'/all subheadings in MIME,MJME
6. explode 'Forced-Expiratory-Volume'/all subheadings in MIME,MJME
7. (pulmonary function or respiratory function or lung function) near (test or tests or testing)
8. forced expiratory volume or fev
9. peak expiratory flow rate or pef
10. forced expiratory flow rate*
11. vital capacity or VC
12. 1 or 2 or 3 ..... or 11

Blood Gases

1. explode 'Blood-Gas-Analysis'/all subheadings in MIME,MJME
2. blood gas or blood gases
3. 1 or 2

Search Terms for All Embase Tests

Type of patient setting

1. "Elective-Surgery"/all subheadings
2. "Ambulatory-Surgery"/all subheadings
3. explode "Preoperative-Period"/all subheadings

4. explode "Ambulatory-Care"/ all subheadings
5. "Surgery"/ all subheadings
6. preop or pre-op or preoperative or preoperative or "pre operative"
7. elective surg*
8. ambulatory surg*
9. 1 or 2 or 3 .....or 8

Diagnostic tests study designs

10. "Sensitivity-and-Specificity"/ all subheadings
11. explode "Prediction-and-Forecasting"/ all subheadings
12. explode "Mass-Screening"/ all subheadings
13. sensitiv*
14. specificit*
15. predictive value*
16. accuracy
17. likelihood ratio*
18. screening
19. false negative*
20. "Diagnostic Test"/ all subheadings
21. (diagnostic or laboratory) near (test or tests or testing)
22. 10 OR 11 OR 12.....OR 21

Excluded citation terms

23. (animal in tg) not ((human and animal) in tg)

Combination of above terms

24. (9 and 22) not 23

The terms for each test were combined using the AND boolean operator with the above search strategy

Search Terms for Embase for Specific Tests

Phase A Tests

Chest x-rays

1. 'Radiography-'/all subheadings
2. explode 'Thorax-Radiography'/all subheadings
3. (chest or thoracic) and (xray* or x-ray* or radiograph* or roentgenography)
4. 1 or 2 or 3

ECG

1. 'Electrocardiography-'/all subheadings
2. ecg or electrocardiogra*
3. 1 or 2

Haemoglobin and Blood Counts

1. explode 'Hemoglobins-'/all subheadings
2. hemoglobin* or haemoglobin*
3. explode 'Blood-Cell-Count'/all subheadings
4. blood count
5. white blood cell count
6. leukocyte count
7. platelet count
8. 1 or 2 or 3 ..... or 7

Haemostasis

1. 'Hemostasis-'/all subheadings
2. 'Blood-Examination'/all subheadings
3. haemostasis or hemostasis
4. hematologic test* or haematologic test*
5. explode 'Blood-Clotting-Tests'/all subheadings
6. 'Blood-Coagulation'/all subheadings
7. blood coagulation test*
8. partial thromboplastin time or PTT
9. international normalized ratio or international normalised ratio or INR
10. prothrombin time
11. bleeding time
12. whole blood coagulation time
13. 1 or 2 or 3.....or 12

Biochemistry Tests

1. 'Biochemistry-'/all subheadings
2. 'Blood-Chemistry'/all subheadings
3. explode 'Glucose-Tolerance-Test'/all subheadings
4. glucose tolerance or glucose test or glucose tests
5. 'Diagnostic-Techniques-Urological'/all subheadings
6. explode 'Urinalysis-'/all subheadings
7. urine analysis or urinalysis or dipstick
8. 'Kidney-Function-Tests'/all subheadings
9. (kidney function or renal function) near (test or tests or testing)
10. 'Electrolytes-'/all subheadings
11. electrolyte*
12. 'Creatinine-'/all subheadings
13. creatinine
14. 'Urea-Nitrogen-Blood-Level'/all subheadings
15. blood urea nitrogen
16. 1 or 2 or 3 .....or 15

Blood Sugar

1. "Glucose-Blood-Level"/ all subheadings
2. blood sugar or blood glucose
3. glucose test*
4. 1 or 2 or 3

Pregnancy Tests

1. explode 'Pregnancy-Tests'/all subheadings
2. pregnancy test or pregnancy tests
3. 1 or 2

Sickle Cell

1. explode 'Hemoglobinopathies-'/all subheadings
2. hemoglobinopath* or haemoglobinopath*
3. sickle cell
4. 1 or 2 or 3

Phase B Tests

Respiratory Function Tests

1. "Lung-Function-Test"/ all subheadings
2. explode "Lung-Volume"/ all subheadings
3. explode "Respiratory-Airflow"/ all subheadings
4. (pulmonary function or respiratory function or lung function) near (test or tests or testing)
5. peak expiratory flow or pef
6. forced expiratory flow
7. forced expiratory volume or fev
8. vital capacity or vc
9. forced respiratory function
10. 1 or 2 or 3 ..... or 9

Blood Gases

1. explode "Blood-Gas-Analysis"/ all subheadings
2. blood gas or blood gases
3. 1 or 2

Search Terms to Filter Economic Papers from Search Results for Medline and Embase

cost OR costs OR cost-effective OR cost-effectiveness OR costeffective OR costeffectiveness OR cost-benefit OR benefit-cost OR cost-effect* OR costeffect* OR cost-benefi* OR benefit-cost* OR benefitcost* OR costbenefi* OR cost-utility OR economic OR cost-utility* OR costutility* OR economics OR econom* OR economics[MESH] OR "cost-effective" OR "cost-effectiveness" OR "cost-benefit" OR "benefit-cost" OR "cost-utility"OR costing OR costings OR costed OR QALY OR life-year OR "life year"

TABLE A1.ii: Data extraction form

Study ID, authors
Type of paper
Year
Country
Tests considered
Population from which sample was drawn
Number
Age group
Diagnostic group
Study design
Clinical Setting
Surgical Specialities
Inclusion/exclusion criteria
Methods
Objectives specified in methods section
Outcomes specified in methods section (incl process, criteria etc)
Prospective or retrospective data collection
Recruitment of consecutive patients
Test status: routine; indicated or mixture
Results
Number of tests performed
Results of tests
Number of abnormal results
Number of 'significant' abnormal results (?)
Outcome (process, criteria etc) if in results
Type of management changes recorded, if specified
Number of abnormal results leading to management changes
Types of adverse patient events, if recorded
Number of abnormal results in which an adverse patient event was recorded
Number of adverse events in which abnormal results were not recorded
Is test judged to be clinical useful?
Main findings

Table A1.iii: Data extraction form to assess quality of case series papers

Quality assessment for case series

1. Case series collected in more than one centre, ie multicentre study
2. Is the hypothesis/aim/objective of the study clearly described?
3. Are the inclusion and exclusion criteria (case definition) clearly reported?

4. Is there a clear definition of the outcomes reported?
5. Were data collected prospectively?
6. Is there an explicit statement that patients were recruited consecutively?
7. Are the main findings of the study clearly described?
8. Are outcomes stratified? (eg by disease stage, abnormal test results, patient characteristics)

   Yes=1

   No =0

   Score: __/ 8

Bibliography

1. Krupski WC, Nehler MR, Whitehill TA, Lawson RC, Strecker PK, Hiatt WR. Negative impact of cardiac evaluation before vascular surgery. *Vasc Med* 2000; **5**:3–9.
2. Silvestri L, Maffessanti M, Gregori D, Berlot G, Gullo A. Usefulness of routine pre-operative chest radiography for anaesthetic management: a prospective multicentre pilot study. *Eur J Anaesthesiol* 1999; **16**:749–760.
3. Pal KM, Khan IA, Safdar B. Preoperative work up: are the requirements different in a developing country? *J Pak Med Assoc* 1998; **48**:339–341.
4. Ishaq M, Kamal RS, Aqil M. Value of routine preoperative chest X-ray in patients over the age of 40 years. *J Pak Med Assoc* 1997; **47**:279–281.
5. Wattsman TA, Davies RS. The utility of preoperative laboratory testing in general surgery patients for outpatient procedures. *Am Surg* 1997; **63**:81–90.
6. Bouillot JL, Fingerhut A, Paquet JC, Hay JM, Coggia M. Are routine preoperative chest radiographs useful in general surgery? A prospective, multicentre study in 3959 patients. Association des Chirurgiens de l'Assistance Publique pour les Evaluations medicales. *Eur J Surg* 1996; **162**:597–604.
7. Clelland C, Worland RL, Jessup DE, East D. Preoperative medical evaluation in patients having joint replacement surgery: added benefits. *South Med J* 1996; **89**:958–960.
8. Khong PL, Peh WCG, Irwin MG, Gunawardene WMS, Luk KDK. Utility of routine pre-operative chest x-rays. *Asian J Surg* 1996; **19**:41–44.
9. Ranparia DJ, Hart L, Assimos DG. Utility of chest radiography and cystoscopy in the evaluation of patients with localized prostate cancer. *Urology* 1996; **48**:72–74.
10. Boland BJ, Wollan PC, Silverstein MD. Review of systems, physical examination, and routine tests for case-finding in ambulatory patients. *Am J Med Sci* 1995; **309**:194–200.
11. Perez A, Planell J, Bacardaz C, Hounie A, Franci J, Brotons C *et al*. Value of routine preoperative tests: a multicentre study in four general hospitals. *Br J Anaesth* 1995; **74**:250–256.
12. Adams JG, Weigelt JA, Poulos E. Usefulness of preoperative laboratory assessment of patients undergoing elective herniorrhaphy. *Arch Surg* 1992; **127**:801–804.
13. MacDonald JB, Dutton MJ, Stott DJ, Hamblen DL. Evaluation of pre-admission screening of elderly patients accepted for major joint replacement. *Health Bull (Edinb)* 1992; **50**:54–60.
14. Sommerville TE, Murray WB. Information yield from routine pre-operative chest radiography and electrocardiography. *S Afr Med J* 1992; **81**:190–196.
15. Bhuripanyo K, Prasertchuang C, Chamadol N, Laopaiboon M, Bhuripanyo P. The impact of routine preoperative chest X-ray in Srinagarind Hospital, Khon Kaen. *J Med Assoc Thai* 1990; **73**:21–28.
16. Gagner M, Chiasson A. Preoperative chest x-ray films in elective surgery: a valid screening tool. *Can J Surg* 1990; **33**:271–274.
17. McCleane GJ. Routine preoperative chest X-rays. *Ir J Med Sci* 1989; **158**:67–68.
18. Charpak Y, Blery C, Chastang C, Szatan M, Fourgeaux B. Prospective assessment of a protocol for selective ordering of preoperative chest x-rays. *Can J Anaesth* 1988; **35**:259–264.
19. Ogunseyinde AO. Routine preoperative chest radiographs in non-cardiopulmonary surgery. *Afr J Med Med Sci* 1988; **17**:157–161.
20. Tape TG, Mushlin AI. How useful are routine chest x-rays of preoperative patients at risk for postoperative chest disease? *J Gen Intern Med* 1988; **3**:15–20.
21. Umbach GE, Zubek S, Deck HJ, Buhl R, Bender HG, Jungblut RM. The value of preoperative chest x-rays in gynecological patients. *Arch Gynecol Obstet* 1988; **243**:179–185.
22. Boghosian SG, Mooradian AD. Usefulness of routine preoperative chest roentgenograms in elderly patients. *J Am Geriatr Soc* 1987; **35**:142–146.
23. McKee RF, Scott EM. The value of routine preoperative investigations. *Ann R Coll Surg Engl* 1987; **69**:160–162.
24. Mendelson DS, Khilnani N, Wagner LD, Rabinowitz JG. Preoperative chest radiography: value as a baseline examination for comparison. *Radiology* 1987; **165**:341–343.
25. Turnbull JM, Buck C. The value of preoperative screening investigations in otherwise healthy individuals. *Arch Intern Med* 1987;**147**:1101–1105.
26. Weibman MD, Shah NK, Bedford RF. Influence of preoperative chest x-rays on the preoperative management of cancer patients. *Anesthesiology* 1987; **67**:A332.

27. Wiencek RG, Weaver DW, Bouwman DL, Sachs RJ. Usefulness of selective preoperative chest x-ray films. A prospective study. *Am Surg* 1987; **53**:396–398.

28. Muskett AD, McGreevy JM. Rational preoperative evaluation. *Postgrad Med J* 1986; **62**:925–928.

29. Rucker L, Frye EB, Staten MA. Usefulness of screening chest roentgenograms in preoperative patients. *JAMA* 1983; **250**:3209–3211.

30. Seymour DG, Pringle R, Shaw JW. The role of the routine pre-operative chest x-ray in the elderly general surgical patient. *Postgrad Med J* 1982; **58**:741–745.

31. Tõrnebrandt K, Fletcher R. Pre-operative chest x-rays in elderly patients. *Anaesthesia* 1982; **37**:901–902.

32. Wood RA, Hoekelman RA. Value of the chest x-ray as a screening test for elective surgery in children. *Pediatrics* 1981; **67**:447–452.

33. Farnsworth PB, Steiner E, Klein RM, SanFilippo JA. The value of routine preoperative chest roentgenograms in infants and children. *JAMA* 1980; **244**:582–583.

34. Rossello PJ, Ramos CA, Mayol PM. Routine laboratory tests for elective surgery in pediatric patients: are they necessary? *Bol Asoc Med P R* 1980; **72**:614–623.

35. Loder RE. Routine pre-operative chest radiography. 1977 compared with 1955 at Peterborough District General Hospital. *Anaesthesia* 1978; **33**:972–974.

36. Petterson SR, Janower ML. Is the routine preoperative chest film of value? *Appl Radiol* 1977; **6**:70.

37. Sane SM, Worsing RA, Wiens CW, Sharma RK. Value of preoperative chest x-ray examinations in children. *Pediatrics* 1977; **60**:669–672.

38. Rees AM, Roberts CJ, Bligh AS, Evans KT. Routine preoperative chest radiography in non-cardiopulmonary surgery. *BMJ* 1976; **1**:1333–1335.

39. Gauss A, Rohm HJ, Schauffelen A, Vogel T, Mohl U, Straehle A *et al.* Electrocardiographic exercise stress testing for cardiac risk assessment in patients undergoing noncardiac surgery. *Anesthesiology* 2001; **94**:38–46.

40. French GW, Lam WH, Rashid Z, Sear JW, Foex P, Howell S. Peri-operative silent myocardial ischaemia in patients undergoing lower limb joint replacement surgery: an indicator of postoperative morbidity or mortality? *Anaesthesia* 1999; **54**:235–240.

41. Haug RH, Reifeis RL. A prospective evaluation of the value of preoperative laboratory testing for office anesthesia and sedation. *J Oral Maxillofac Surg* 1999; **57**:16–20.

42. Murdoch CJ, Murdoch DR, McIntyre P, Hosie H, Clark C. The pre-operative ECG in day surgery: a habit? *Anaesthesia* 1999; **54**:907–908.

43. Rosenfeld SI, Litinsky SM, Snyder DA, Plosker H, Astrove AW, Schiffman J. Effectiveness of monitored anesthesia care in cataract surgery. *Ophthalmology* 1999; **106**:1256–1260.

44. Polanczyk CA, Goldman L, Marcantonio ER, Orav EJ, Lee TH. Supraventricular arrhythmia in patients having noncardiac surgery: clinical correlates and effect on length of stay. *Ann Intern Med* 1998; **129**:279–285.

45. Biavati MJ, Manning SC, Phillips DL. Predictive factors for respiratory complications after tonsillectomy and adenoidectomy in children. *Arch Otolaryngol Head Neck Surg* 1997; **123**:517–521.

46. Landesberg G, Einav S, Christopherson R, Beattie C, Berlatzky Y, Rosenfeld B *et al.* Perioperative ischemia and cardiac complications in major vascular surgery: importance of the preoperative twelve-lead electrocardiogram. *J Vasc Surg* 1997; **26**:570–578.

47. Tait AR, Parr HG, Tremper KK. Evaluation of the efficacy of routine preoperative electrocardiograms. *J Cardiothorac Vasc Anesth* 1997; **11**:752–755.

48. Callaghan LC, Edwards ND, Reilly CS. Utilisation of the pre-operative ECG. *Anaesthesia* 1995; **50**:488–490.

49. Liu S, Paul GE, Carpenter RL, Stephenson C, Wu R. Prolonged PR interval is a risk factor for bradycardia during spinal anesthesia. *Reg Anesth* 1995; **20**:41–44.

50. Allman KG, Muir A, Howell SJ, Hemming AE, Sear JW, Foex P. Resistant hypertension and preoperative silent myocardial ischaemia in surgical patients. *Br J Anaesth* 1994; **73**:574–578.

51. Kirwin JD, Ascer E, Gennaro M, Mohan C, Jonas S, Yorkovich W *et al.* Silent myocardial ischemia is not predictive of myocardial infarction in peripheral vascular surgery patients. *Ann Vasc Surg* 1993; **7**:27–32.

52. Older P, Smith R, Courtney P, Hone R. Preoperative evaluation of cardiac failure and ischemia in elderly patients by cardiopulmonary exercise testing. *Chest* 1993; **104**:701–704.

53. Bhuripanyo K, Prasertchuang C, Viwathanatepa M, Khumsuk K, Sornpanya N. The impact of routine preoperative electrocardiogram in patients age > or = 40 years in Srinagarind Hospital. *J Med Assoc Thai* 1992; **75**:399–406.

54. Gold BS, Young ML, Kinman JL, Kitz DS, Berlin J, Schwartz JS. The utility of preoperative electrocardiograms in the ambulatory surgical patient. *Arch Intern Med* 1992; **152**:301–305.

55. McCleane GJ,.McCoy E. Routine pre-operative electrocardiography. *Br J Clin Pract* 1990; **44**:92–95.

56. Yipintsoi T, Vasinanukorn P, Sanguanchua P. Is routine pre-operative electrocardiogram necessary? *J Med Assoc Thai* 1989; **72**:16–20.

57. Charpak Y, Blery C, Chastang C, Ben Kemmoun R, Pham J, Brage D *et al.* Usefulness of selectively ordered preoperative tests. *Med Care* 1988; **26**:95–104.

58. Johnson H, Knee-Ioli S, Butler TA, Munoz E, Wise L. Are routine preoperative laboratory screening tests necessary to evaluate ambulatory surgical patients? *Surgery* 1988; **104**:639–645.

59. Carliner NH, Fisher ML, Plotnick GD, Moran GW, Kelemen MH, Gadacz TR *et al.* The preoperative electrocardiogram as an indicator of risk in major noncardiac surgery. *Can J Cardiol* 1986; **2**:134–137.

60. Paterson KR, Caskie JP, Galloway DJ, McArthur K, McWhinnie DL. The preoperative electrocardiogram: an assessment. *Scott Med J* 1983; **28**:116–118.

61. Seymour DG, Pringle R, MacLennan WJ. The role of the routine pre-operative electrocardiogram in the elderly surgical patient. *Age Ageing* 1983; **12**:97–104.

62. Dzankic S, Pastor D, Gonzalez C, Leung JM. The prevalence and predictive value of abnormal preoperative laboratory tests in elderly surgical patients. *Anesth Analg* 2001; **93**:301–308.

63. Gabriel P, Mazoit X, Ecoffey C. Relationship between clinical history, coagulation tests, and perioperative bleeding during tonsillectomies in pediatrics. *J Clin Anesth* 2000; **12**:288–291.

64. Wojtkowski TA, Rutledge JC, Matthews DC. The clinical impact of increased sensitivity PT and APTT coagulation assays. *Am J Clin Pathol* 1999; **112**:225–232.

65. Cherng YG, Chao A, Shih RL, Lin CS, Chan WH, Huang CH *et al.* Preoperative evaluation and postoperative prediction of hemostatic function with thromboelastography in patients undergoing redo cardiac surgery. *Acta Anaesthesiol Sin* 1998; **36**:179–186.

66. Meneghini L, Zadra N, Zanette G, Baiocchi M, Giusti F. The usefulness of routine preoperative laboratory tests for one-day surgery in healthy children. *Paediatr Anaesth* 1998; **8**:11–15.

67. Houry S, Georgeac C, Hay JM, Fingerhut A, Boudet MJ. A prospective multicenter evaluation of preoperative hemostatic screening tests. The French Associations for Surgical Research. *Am J Surg* 1995; **170**:19–23.

68. Close HL, Kryzer TC, Nowlin JH, Alving BM. Hemostatic assessment of patients before tonsillectomy: a prospective study. *Otolaryngol Head Neck Surg* 1994; **111**:733–8.

69. Kozak EA,.Brath LK. Do "screening" coagulation tests predict bleeding in patients undergoing fiberoptic bronchoscopy with biopsy? *Chest* 1994; **106**:703–705.

70. Hoare TJ. Pre-operative haemoglobin estimation in paediatric ENT surgery. *J Laryngol Otol* 1993; **107**:1146–1148.

71. MacPherson CR, Jacobs P, Dent DM. Abnormal peri-operative haemorrhage in asymptomatic patients is not predicted by laboratory testing. *S Afr Med J* 1993; **83**:106–108.

72. Baron MJ, Gunter J, White P. Is the pediatric preoperative hematocrit determination necessary? *South Med J* 1992; **85**:1187–1189.

73. Narr BJ, Hansen TR, Warner MA. Preoperative laboratory screening in healthy Mayo patients: cost- effective elimination of tests and unchanged outcomes. *Mayo Clin Proc* 1991; **66**:155–159.

74. Roy WL, Lerman J, McIntyre BG. Is preoperative haemoglobin testing justified in children undergoing minor elective surgery? *Can J Anaesth* 1991; **38**:700–703.

75. Bolger WE, Parsons DS, Potempa L. Preoperative hemostatic assessment of the adenotonsillectomy patient. *Otolaryngol Head Neck Surg* 1990; **103**:396–405.

76. Nigam A, Ahmed K, Drake-Lee AB. The value of preoperative estimation of haemoglobin in children undergoing tonsillectomy. *Clin Otolaryngol* 1990; **15**:549–551.

77. O'Connor ME, Drasner K. Preoperative laboratory testing of children undergoing elective surgery. *Anesth Analg* 1990; **70**:176–180.

78. Jones MW, Harvey IA, Owen R. Do children need routine preoperative blood tests and blood cross matching in orthopaedic practice? *Ann R Coll Surg Engl* 1989; **71**:1–3.

79. Rohrer MJ, Michelotti MC, Nahrwold DL. A prospective evaluation of the efficacy of preoperative coagulation testing. *Ann Surg* 1988; **208**:554–557.

80. Kaplan EB, Sheiner LB, Boeckmann AJ, Roizen MF, Beal SL, Cohen SN *et al.* The usefulness of preoperative laboratory screening. *JAMA* 1985; **253**:3576–3581.

81. Ramsey G, Arvan DA, Stewart S, Blumberg N. Do preoperative laboratory tests predict blood transfusion needs in cardiac operations? *J Thorac Cardiovasc Surg* 1983;**85**:564–569.

82. Williams GD, Bratton SL, Riley EC, Ramamoorthy C. Coagulation tests during cardiopulmonary bypass correlate with blood loss in children undergoing cardiac surgery. *J Cardiothorac Vasc Anesth* 1999; **13**:398–404.

83. Howells RC, Wax MK, Ramadan HH. Value of preoperative prothrombin time/partial thromboplastin time as a predictor of postoperative hemorrhage in pediatric patients undergoing tonsillectomy. *Otolaryngol Head Neck Surg* 1997; **117**:628–632.

84. Zwack GC, Derkay CS. The utility of preoperative hemostatic assessment in adenotonsillectomy. *Int J Pediatr Otorhinolaryngol* 1997; **39**:67–76.

85. Gewirtz AS, Miller ML, Keys TF. The clinical usefulness of the preoperative bleeding time. *Arch Pathol Lab Med* 1996; **120**:353–356.

86. Myers ER, Clarke-Pearson DL, Olt GJ, Soper JT, Berchuck A. Preoperative coagulation testing on a gynecologic oncology service. *Obstet Gynecol* 1994; **83**:438–444.

87. Burk CD, Miller L, Handler SD, Cohen AR. Preoperative history and coagulation screening in children undergoing tonsillectomy. *Pediatrics* 1992; **89**:691–695.

88. Aghajanian A, Grimes DA. Routine prothrombin time determination before elective gynecologic operations. *Obstet Gynecol* 1991; **78**:837–839.

89. Schmidt JL, Yaremchuk KL, Mickelson SA. Abnormal coagulation profiles in tonsillectomy and adenoidectomy patients. *Henry Ford Hosp Med J* 1990; **38**:33–35.

90. Manning SC, Beste D, McBride T, Goldberg A. An assessment of preoperative coagulation screening for tonsillectomy and adenoidectomy. *Int J Pediatr Otorhinolaryngol* 1987; **13**:237–244.

91. Suchman AL, Mushlin AI. How well does the activated partial thromboplastin time predict postoperative hemorrhage? *JAMA* 1986; **256**:750–753.

92. Lundberg GD. Is there a need for routine preoperative laboratory tests? *JAMA* 1985; **253**:3589.

93. Eisenberg JM, Clarke JR, Sussman SA. Prothrombin and partial thromboplastin times as preoperative screening tests. *Arch Surg* 1982; **117**:48–51.

94. Robbins JA, Rose SD. Partial thromboplastin time as a screening test. *Ann Intern Med* 1979; **90**:796–797.

95. Rader ES. Hematologic screening tests in patients with operative prostatic disease. *Urology* 1978; **11**:243–246.

96. MacPherson DS, Snow R, Lofgren RP. Preoperative screening: value of previous tests. *Ann Intern Med* 1990; **113**:969–973.

97. Bhuripanyo K, Prasertchuang C, Khumsuk K, Sornpanya N, Patoombal N, Wangsai W. The impact of routine preoperative urinalysis in Srinagarind Hospital, Khon Kaen. *J Med Assoc Thai* 1995; **78**:94–98.

98. Lawrence VA, Kroenke K. The unproven utility of preoperative urinalysis. Clinical use. *Arch Intern Med* 1988; **148**:1370–1373.

99. Akin BV, Hubbell FA, Frye EB, Rucker L, Friis R. Efficacy of the routine admission urinalysis. *Am J Med* 1987; **82**:719–22.

100. Kroenke K, Hanley JF, Copley JB, Matthews JI, Davis CE, Foulks CJ *et al*. The admission urinalysis: impact on patient care. *J Gen Intern Med* 1986; **1**:238–242.

101. Bhuripanyo K, Khumsuk K, Sornpanya N, Wangsai W, Patoombal N. The impact of routine preoperative complete blood count (CBC) in elective operations in Srinagarind Hospital. *J Med Assoc Thai* 1995; **78**:42–47.

102. Hennrikus WL, Shaw BA, Gerardi JA. Prevalence of positive preoperative pregnancy testing in teenagers scheduled for orthopedic surgery. *J Pediatr Orthop* 2001; **21**:677–679.

103. Wheeler M, Cote CJ. Preoperative pregnancy testing in a tertiary care children's hospital: a medico-legal conundrum. *J Clin Anesth* 1999; **11**:56–63.

104. Azzam FJ, Padda GS, DeBoard JW, Krock JL, Kolterman SM. Preoperative pregnancy testing in adolescents. *Anesth Analg* 1996; **82**:4–7.

105. Pierre N, Moy LK, Redd S, Emans SJ, Laufer MR. Evaluation of a pregnancy-testing protocol in adolescents undergoing surgery. *J Pediatr Adolesc Gynecol* 1998; **11**:139–141.

106. Twersky RS, Singleton G. Preoperative pregnancy testing: "justice and testing for all". *Anesth Analg* 1996; **83**:438–439.

107. Malviya S, D'Errico C, Reynolds P, Huntington J, Voepel-Lewis T, Pandit UA. Should pregnancy testing be routine in adolescent patients prior to surgery? *Anesth Analg* 1996; **83**:854–858.

108. Manley S, de Kelaita G, Joseph NJ, Salem MR, Heyman HJ. Preoperative pregnancy testing in ambulatory surgery. Incidence and impact of positive results. *Anesthesiology* 1995; **83**:690–693.

109. Brady AR, Fowkes FGR, Greenhalgh RM, Powell JT, Ruckley CV, Thompson SG. Risk factors for postoperative death following elective surgical repair of abdominal aortic aneurysm: Results from the UK Small Aneurysm Trial. *Br J Surg* 2000; **87**:742–749.

110. Chandra A, Srivastava S, Dilip D. Spirometric changes following open-heart surgery on rheumatic mitral valves. *Asian Cardiovasc Thorac Ann* 1998; **6**:28–33.

111. Kuwano H, Sumiyoshi K, Sonoda K, Kitamura K, Tsutsui S, I, Toh Y *et al*. Relationship between preoperative assessment of organ function and postoperative morbidity in patients with oesophageal cancer. *Eur J Surg* 1998; **164**:581–586.

112. Barisione G, Rovida S, Gazzaniga GM, Fontana L. Upper abdominal surgery: Does a lung function test exist to predict early severe postoperative respiratory complications? *Eur Respir J* 1997; **10**:1301–1308.

113. Castro M, Krowka MJ, Schroeder DR, Beck KC, Plevak DJ, Rettke SR *et al*. Frequency and clinical implications of increased pulmonary artery pressures in liver transplant patients. *Mayo Clin Proc* 1996; **71**:543–551.

114. Durand M, Combes P, Drouet N, Chichignoud B, Magne JL, Girardet P. Predictive value of preoperative pulmonary function tests and blood gases analysis before abdominal aortic surgery. *J Cardiothorac Vasc Anesth* 1994; **8**:9.

115. Durand M, Combes P, Eisele JH, Contet A, Blin D, Girardet P. Pulmonary function tests predict outcome after cardiac surgery. *Acta Anaesthesiol Belg.* 1993; **44**:17–23.

116. Poe RH, Kallay MC, Dass T, Celebic A. Can postoperative pulmonary complications after elective cholecystectomy be predicted? *Am J Med Sci* 1988; **295**:29–34.

117. Kim SK, Chang J, Ahn CM, Sohn HY, Kim K. Relationship between the result of preoperative pulmonary function test and postoperative pulmonary complications. *J Korean Med Sci* 1987; **2**:71–74.

118. Crapo RO, Kelly TM, Elliott CG, Jones SB. Spirometry as a preoperative screening test in morbidly obese patients. *Surgery* 1986; **99**:763–768.

Appendix 2: Examples of Surgical Procedures by Severity Grading

Grade 1

AF1 Release of entrapment of peripheral nerve at wrist (A61)

DA1 Clearance of external auditory canal (D07)

DB3 Drainage of middle ear (D15)

EA1 Operations on septum of nose (E03)

EA2 Operations on external nose (E09)

E36 Diagnostic endoscopic examination of larynx

EE2 Endoscopic operations on bronchus (E48-E51)

FB2 Simple extraction of tooth (F10)

G16 Diagnostic fibreoptic endoscopic examination/oesophagus

G45 Diagnostic fibreoptic endoscopic exam/upper gastrointe

M45 Diagnostic endoscopic examination of bladder

NA2 Operations on hydrocele sac (N11)

NB1 Excision of vas deferens (N17)

NC1 Operations on prepuce (N30)

PA1 Operations on bartholin gland (P03)

SA1 Extirpation of lesion of skin or subcutaneous tissue (S05-S11)

SA4 Suture of skin or subcutaneous tissue (S41-S42)

SA5 Incision of skin or subcutaneous tissue (S47)

Grade 2

AC1 Extracranial extirpation of vagus nerve (A27)

AG1 Electroconvulsive therapy (A83)

B28 Other excision of breast

CG1 Extraction of lens (C71,C72,C74)

CG2 Prosthesis of lens (C75)

DB1 Operations on mastoid (D10-D12)

DB2 Repair of eardrum (D14)

EC1 Operations on adenoids (E20)

E34 Microtherapeutic endoscopic operations on larynx

E35 Other therapeutic endoscopic operations on larynx

FB1 Surgical removal of tooth (F09)

FD1 Excision of tonsil (F34)

FE1 Excision of salivary gland (F44)

G14, G15, G17-G19 Endoscopic operations on oesophagus

G43, G44 Endoscopic operations on upper gastrointestinal tract

HB2 Endoscopic operations on colon (H20-H28)

HD1 Operations on haemorrhoid (H51-H53)

JC1 Endoscopic operations on bile and pancreatic ducts (J38-J45)

KC3 Transluminal operations on coronary artery (K49-K51)

Grade 3

BB1 Excision of thyroid gland (B08)

B27 Total excision of breast

EE1 Operations on trachea (E39-E44)

GA2 Operations on diaphragmatic hernia (G23-G25)

MC1 Open operations on bladder (M34-M41)

MD1 Operations on outlet of female bladder (M51-M58)

MD2 Open excision of prostate (M61)

M65 Endoscopic resection of outlet of male bladder

LG1 Operations on varicose vein of leg (L85-L87)

MA3 Endoscopic operations on kidney (M09-M11)

MB1 Endoscopic operations on ureter (M26-M30)

M42-M44 Endoscopic operations on bladder

NA1 Placement of testis in scrotum (N08-N09)

QA1 Operations on cervix uteri (Q01-Q05)

QA3 Evacuation of contents of uterus (Q10-Q11)

QB2 Open occlusion of fallopian tube (Q27-Q28)

QB3 Endoscopic occlusion of fallopian tube (Q35-Q36)

M66 Other therapeutic endoscopic operations on outlet of male bladder

M67 Other therapeutic endoscopic operations on prostate

PB1 Repair of prolapse of vagina (P22-P23)

QA2 Excision of uterus (Q07-Q08)

QB1 Excision of adnexa of uterus (Q22-Q24)

QB4 Other endoscopic operations on fallopian tube (Q37-Q39)

RB1 Caesarean delivery (R17-R18)

Grade 3

SA2 Skin flap operations (S17-S31)

WB1 Excision of bone (W06-W08)

WC3 Prosthetic replacement of head of femur (W46-W48)

WC4 Prosthetic replacement of other articulation (W49-W54)

WC5 Fixation of joint (W59-W64)

XA1 Amputation (X07-X12)

XA2 Operations for sexual transformation (X15)

XA3 Corrections of congenital deformity of limb (X19-X27)

Grade 4

EF1 Operations on lung (E53-E59)

GB1 Excision of stomach (G27-G28)

HB1 Excision of colon (H04-H11)

HC1 Excision of rectum (H33)

MA1 Transplantation of kidney (M01)

MA2 Excision of kidney (M02-M03)

WC1 Total prosthetic replacement of hip joint (W37-W39)

WC2 Total prosthetic replacement of other joint (W40-W45)

RB2 Manipulative delivery (R19-R23)

RB3 Normal delivery (R24)

SA3 Skin graft operations (S33-S39)

TB1 Operations on inguinal hernia (T19-T21)

TB2 Operations on other abdominal hernia (T22-T27)

TC1 Endoscopic operations on peritoneum (T42-T43)

WB2 Division of bone (W12-W16)

Grade 2

WB3 Reduction of fracture of bone (W19-W26)

WB4 Graft of bone marrow (W34)

WC6 Reduction of traumatic dislocation of joint (W65-W67)

WC7 Open operations on semilunar cartilage (W70)

WC8 Endoscopic operations on joint (W82-W88)

XB1 Compensation for renal failure (X40-X42)

Neurosurgery

AA1 Excision of lesion of tissue of brain (A02)

Cardiovascular surgery

KC1 Replacement of coronary artery (K40-K44)

KC2 Other bypass of coronary artery (K45-K46)

Appendix 3: Phase A Consensus Questionnaire (Results)

ADULTS, CHEST X-RAY

Cost estimates: **low £10.00** **mid £20.50** **upper £31.00**

To what extent is a chest x-ray indicated for 'normal healthy patients' (ie ASA Grade 1) of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements by ringing one or more numbers in each column:

ADULTS, CHEST X-RAY

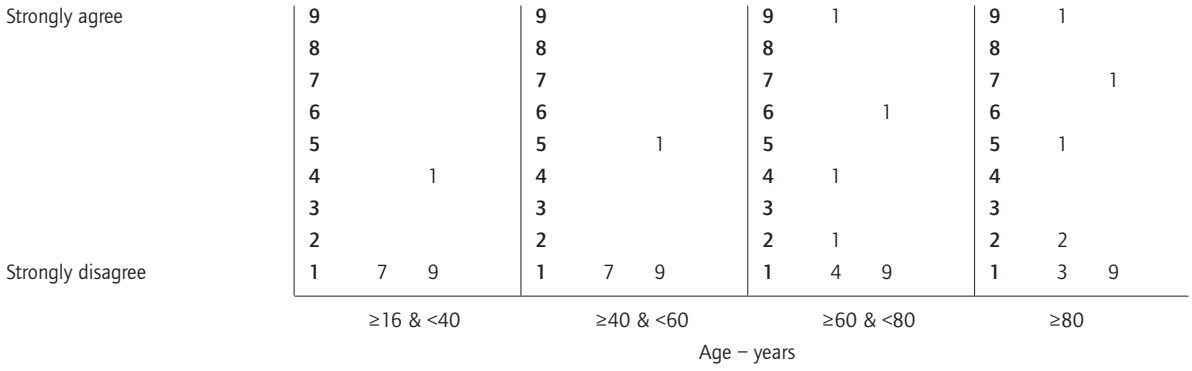
1.1 "A **chest x-ray** is indicated preoperatively in a **normal healthy adult** having **elective Grade 1 surgery**, aged as shown."

	≥16 & <40	≥40 & <60	≥60 & <80	≥80
Strongly agree	9	9	9	9
	8	8	8	8
	7	7	7	7
	6	6	6	6
	5	5	5	5
	4	4	4	4
	3	3	3	3
	2	2	2	2
Strongly disagree	1	1	1	1
	7	7	6	4
	9	9	9	9
	1	1	1	1

Age – years

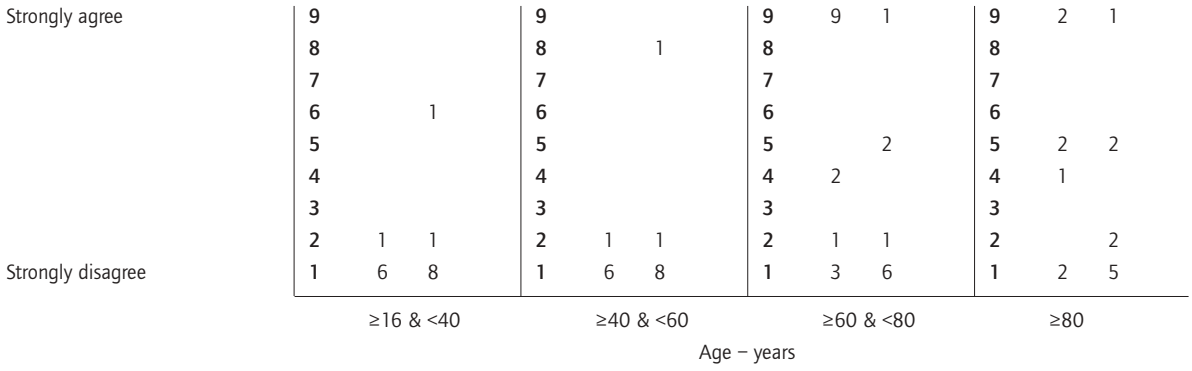
Comments:

1.2 "A **chest x-ray** is indicated preoperatively in a **normal healthy adult** having **elective Grade 2 surgery**, aged as shown."



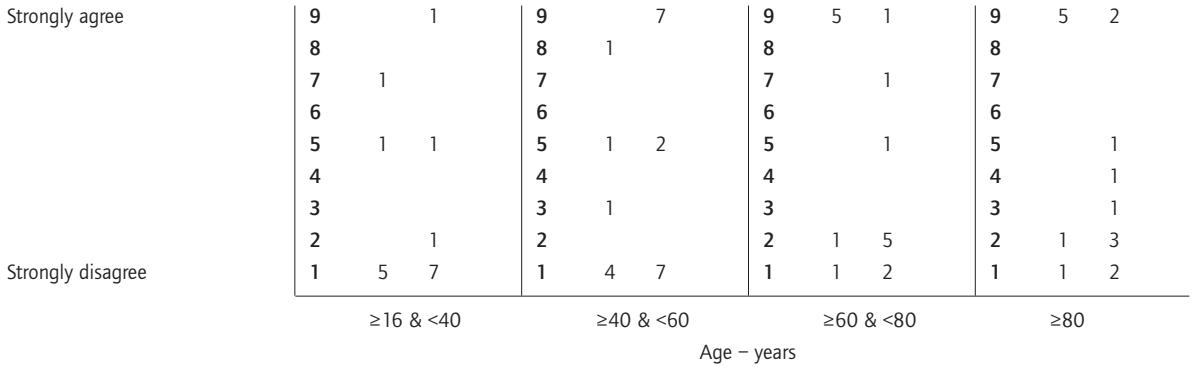
Comments:

1.3 "A **chest x-ray** is indicated preoperatively in a **normal healthy adult** having **elective Grade 3 surgery**, aged as shown."



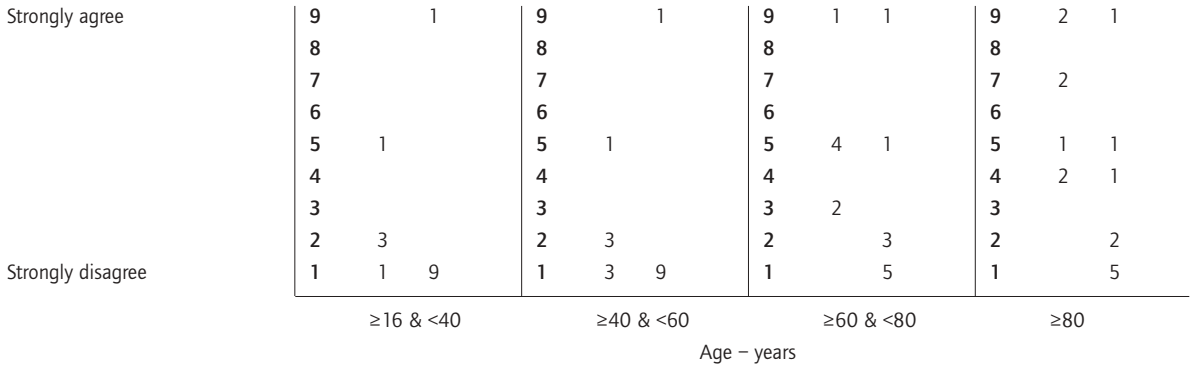
Comments:

1.4 "A **chest x-ray** is indicated preoperatively in a **normal healthy adult** having **elective Grade 4 surgery**, aged as shown."



Comments:

1.5 "A **chest x-ray** is indicated preoperatively in a **normal healthy adult** having **elective neurosurgery**, aged as shown."



Comments:

1.6 "A **chest x-ray** is indicated preoperatively in a **normal healthy adult** having **elective cardiac surgery**, aged as shown."

	≥16 & <40	≥40 & <60	≥60 & <80	≥80
Strongly agree	**9** 7 9	**9** 7 9	**9** 7 9	**9** 7 9
	8	**8**	**8**	**8**
	7	**7**	**7**	**7**
	6	**6**	**6**	**6**
	5 1	**5** 1	**5** 1	**5** 1
	4	**4**	**4**	**4**
	3	**3**	**3**	**3**
	2	**2**	**2**	**2**
Strongly disagree	**1**	**1**	**1**	**1**

Age – years

Comments:

ADULTS, RESTING ECG

Cost estimates: **low £11.00** **mid £26.00** **upper £37.00**

To what extent is a resting ECG indicated for 'normal healthy patients' (ie ASA Grade 1) of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements by ringing one or more numbers in each column:

2.1 "A resting **ECG** is indicated preoperatively in a **normal healthy adult** having **elective Grade 1 surgery**, aged as shown."

	≥16 & <40	≥40 & <60	≥60 & <80	≥80
Strongly agree	**9** 1	**9** 1 3	**9** 3 7	**9** 3 8
	8	**8** 1	**8** 1 1	**8** 1
	7	**7** 1 1	**7**	**7** 1
	6	**6**	**6**	**6**
	5 1	**5** 1 2	**5** 3 1	**5** 2 1
	4	**4**	**4**	**4**
	3	**3**	**3**	**3** 1
	2 1	**2**	**2** 1	**2**
Strongly disagree	**1** 6 8	**1** 4 3	**1**	**1**

Age – years

Comments:

2.2 "A resting **ECG** is indicated preoperatively in a **normal healthy adult** having **elective Grade 2 surgery**, aged as shown."

	≥16 & <40	≥40 & <60	≥60 & <80	≥80
Strongly agree	9 1	9 1 3	9 3 8	9 4 8
	8	8 2	8 1	8 1
	7	7 1 1	7	7
	6	6	6	6 1
	5 1	5 1 1	5 3 1	5 1 1
	4	4	4	4
	3	3	3	3 1
	2 1	2	2 1	2
Strongly disagree	1 6 8	1 4 3	1	1

Age – years

Comments:

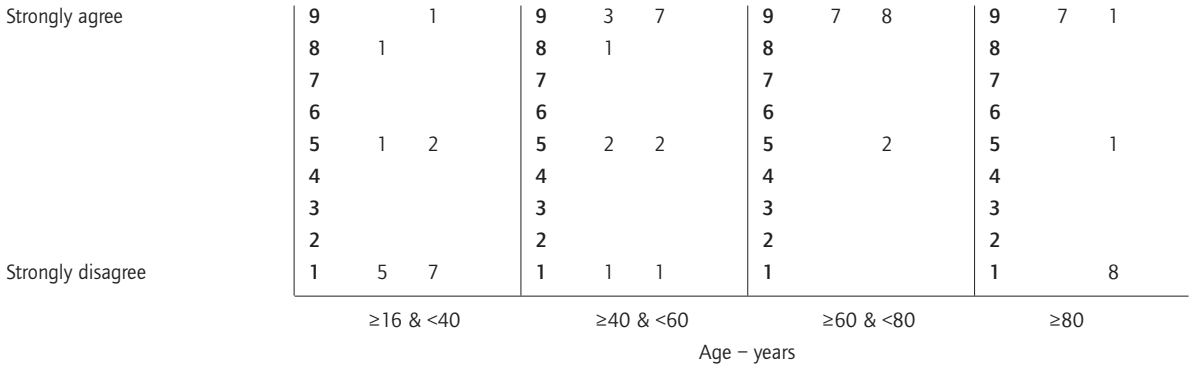
2.3 "A resting **ECG** is indicated preoperatively in a **normal healthy adult** having **elective Grade 3 surgery**, aged as shown."

	≥16 & <40	≥40 & <60	≥60 & <80	≥80
Strongly agree	9 1	9 3 4	9 6 9	9 6 9
	8	8 1 1	8	8
	7	7 1	7 1	7 1
	6	6	6	6
	5 2 1	5 1 2	5	5 1
	4	4	4 1	4
	3	3	3	3
	2	2	2	2
Strongly disagree	1 5 8	1 2 2	1	1

Age – years

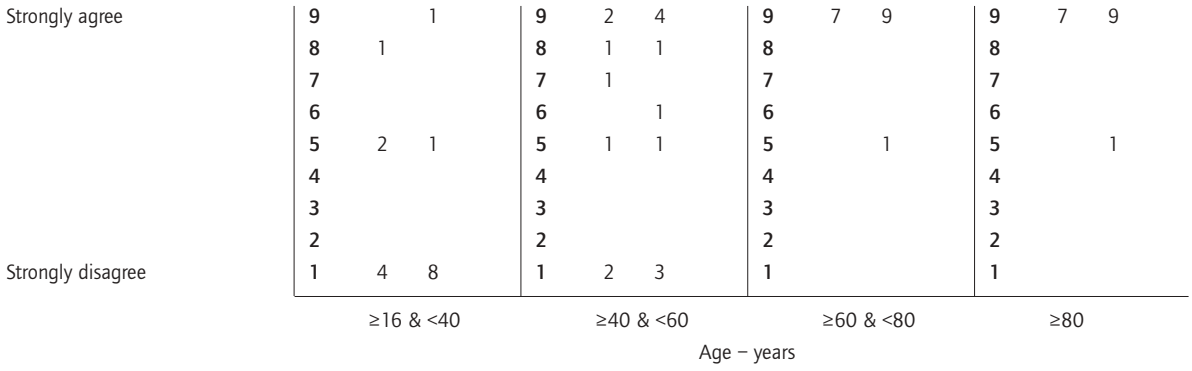
Comments:

2.4 "A resting **ECG** is indicated preoperatively in a **normal healthy adult** having **elective Grade 4 surgery**, aged as shown."



Comments:

2.5 "A resting **ECG** is indicated preoperatively in a **normal healthy adult** having **elective neurosurgery**, aged as shown."



Comments:

2.6 "A resting **ECG** is indicated preoperatively in a **normal healthy adult** having **elective Grade cardiac surgery**, aged as shown."

	≥16 & <40	≥40 & <60	≥60 & <80	≥80
Strongly agree	9 7 10	9 7 10	9 7 10	9 7 10
	8	8	8	8
	7	7	7	7
	6	6	6	6
	5	5	5	5
	4	4	4	4
	3	3	3	3
	2	2	2	2
Strongly disagree	1	1	1	1

Age – years

Comments:

ADULTS, FULL BLOOD COUNT

Cost estimates: **low £0.70** **mid £2.35** **upper £4.05**

To what extent is a full blood count indicated for 'normal healthy patients' (ie ASA Grade 1) of different ages **and gender**, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for males (**M**) and females (**F**), by ringing one or more numbers in each column:

3.1 "A **full blood count** is indicated preoperatively in a **normal healthy adult** having **elective Grade 1 surgery,** aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Strongly agree	9	1		1	9	1	1	1	1	9	3	3	7	7	9	3	3	7	7
	8				8				1	8	1	1			8	1	1	1	1
	7				7					7					7				
	6				6			1		6			1	1	6				
	5		1		5					5	1	1			5	2	2	1	1
	4				4					4	1	1			4				
	3				3	1	1	1	1	3	1	1			3	1	1		
	2	1	1		2	2	2			2					2				
Strongly disagree	1	6	5	9	9	1	3	3	7	7	1			2	2	1			1	1

Age – years

Comments:

3.2 "A **full blood count** is indicated preoperatively in a **normal healthy adult** having **elective Grade 2 surgery,** aged as shown."

		≥16 & <40				≥40 & <60				≥60 & <80				≥80			
		M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Strongly agree	**9**		1	1	2	1	1	1	2	4	4	7	7	4	4	8	8
	8					1	1		1	1	1			1	1		
	7			1	1			1	1			1	1				
	6							1						1	1		
	5					1	1			1	1					1	1
	4																
	3					1	1			1	1			1	1		
	2	3	3			1	1	1	1								
Strongly disagree	**1**	4	3	8	7	2	2	6	5			2	2			1	1

Age – years

Comments:

3.3 "A **full blood count** is indicated preoperatively in a **normal healthy adult** having **elective Grade 3 surgery,** aged as shown."

		≥16 & <40				≥40 & <60				≥60 & <80				≥80			
		M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Strongly agree	**9**	7	7	8	8	7	7	9	9	7	7	9	9	7	7	9	9
	8				1												
	7			1												1	1
	6																
	5			1	1			1	1			1	1				
	4																
	3																
	2																
Strongly disagree	**1**																

Age – years

Comments:

3.4 "A **full blood count** is indicated preoperatively in a **normal healthy adult** having **elective Grade 4 surgery,** aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Strongly agree 9	7	7	10	10	7	7	10	10	7	7	10	10	7	7	10	10
8																
7																
6																
5																
4																
3																
2																
Strongly disagree 1																

Age – years

Comments:

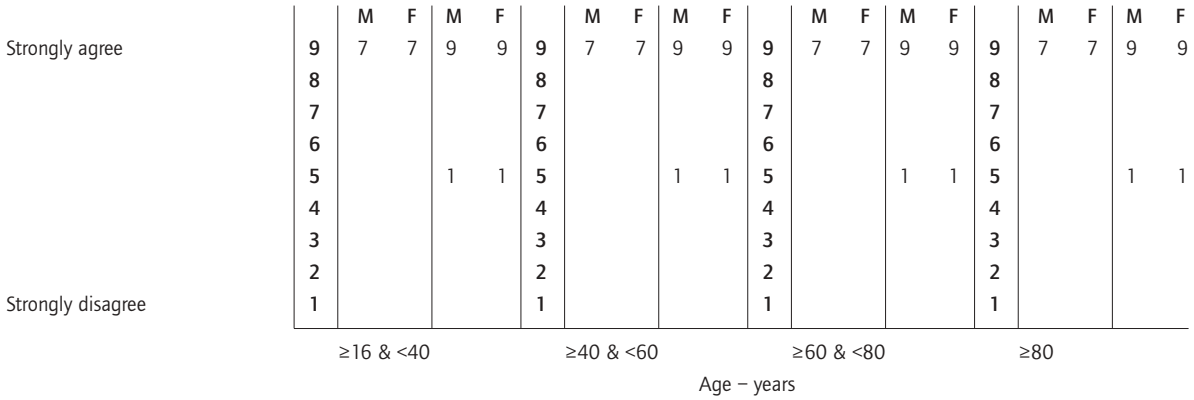
3.5 "A **full blood count** is indicated preoperatively in a **normal healthy adult** having **elective neurosurgery,** aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Strongly agree 9	7	7	6	6	7	7	6	6	7	7	6	6	7	7	7	7
8											1	1			1	1
7			1	1			1	1			1	1				
6																
5			3	3			3	3			2	2			2	2
4																
3																
2																
Strongly disagree 1																

Age – years

Comments:

3.6 "A **full blood count** is indicated preoperatively in a **normal healthy adult** having **elective cardiac surgery,** aged as shown."



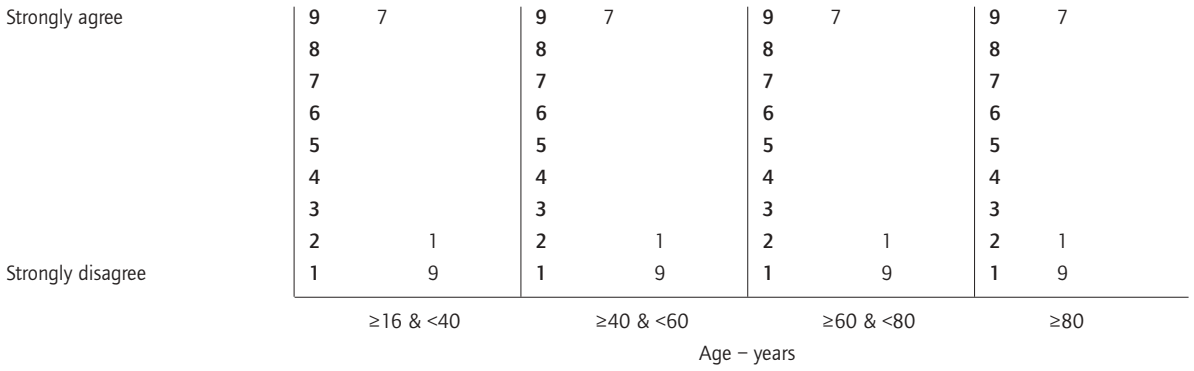
Comments:

ADULTS, TESTS OF HAEMOSTASIS

Cost estimates: **low £1.50** **mid £3.65** **upper £5.85**

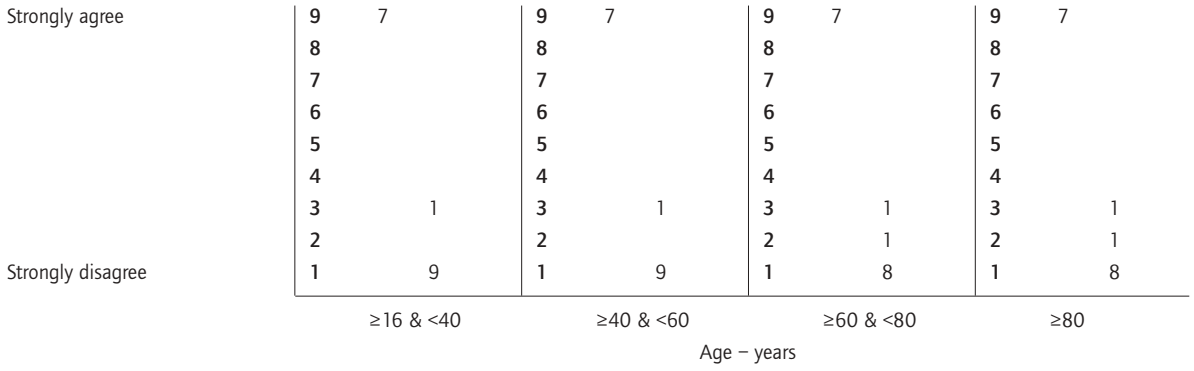
To what extent are tests of haemostasis indicated for 'normal healthy patients' (ie ASA Grade 1) of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements by ringing one or more numbers in each column:

4.1 **"Tests of haemostasis** are indicated preoperatively in a **normal healthy adult** having **elective Grade 1 surgery**, aged as shown."



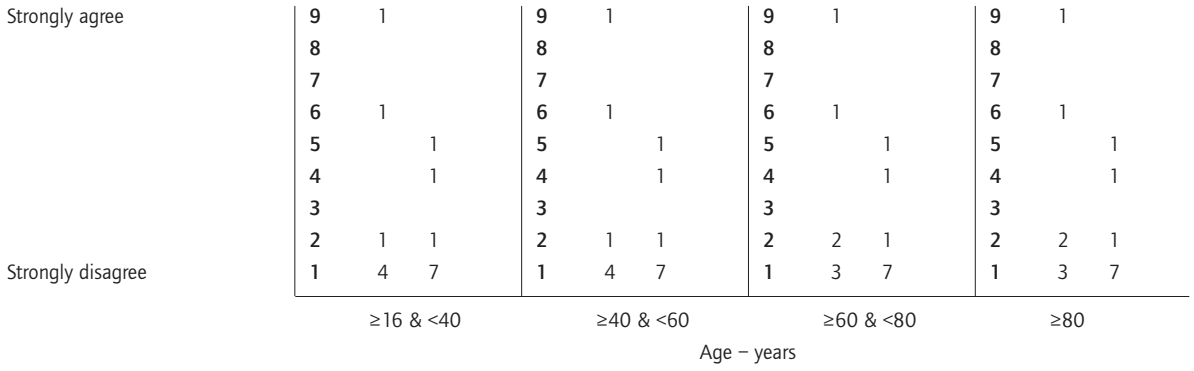
Comments:

4.2 **"Tests of haemostasis** are indicated preoperatively in a **normal healthy adult** having **elective Grade 2 surgery**, aged as shown."



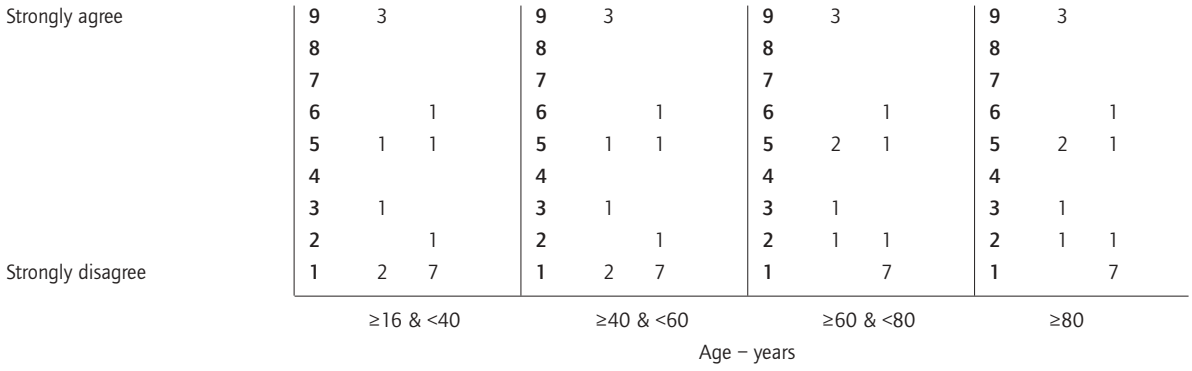
Comments:

4.3 **"Tests of haemostasis** are indicated preoperatively in a **normal healthy adult** having **elective Grade 3 surgery**, aged as shown."



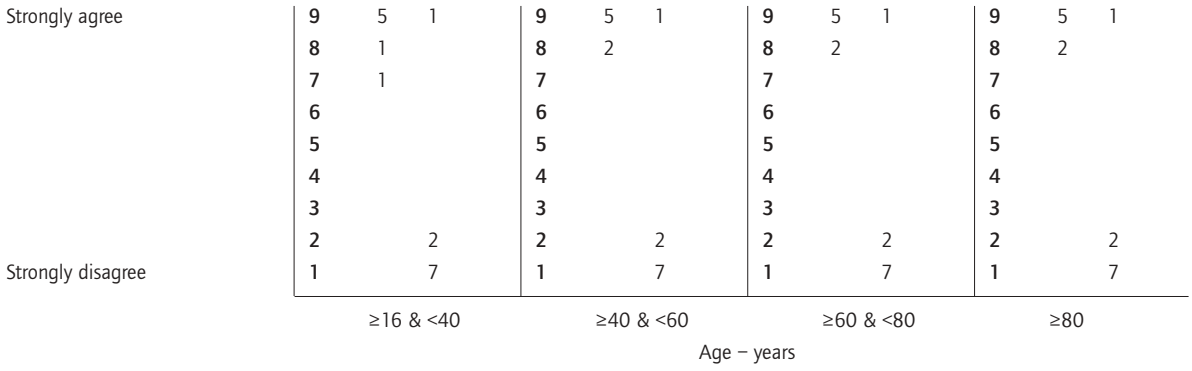
Comments:

4.4 **"Tests of haemostasis** are indicated preoperatively in a **normal healthy adult** having **elective Grade 4 surgery**, aged as shown."



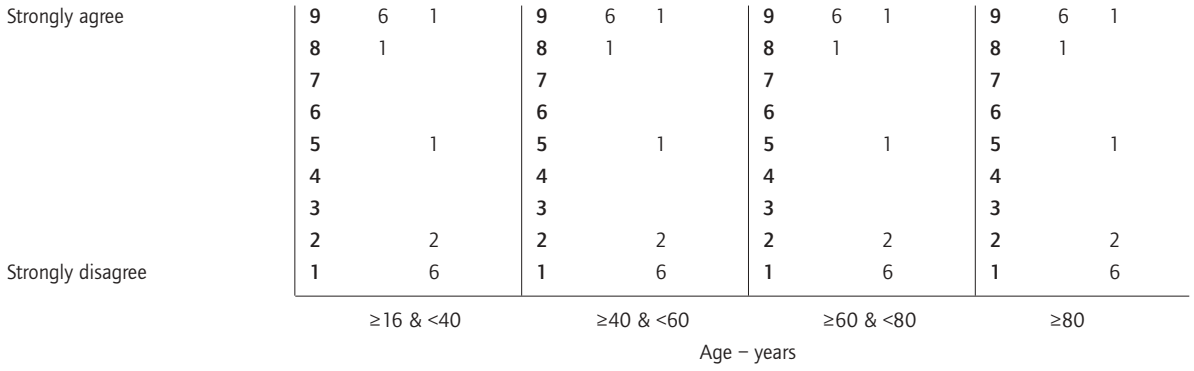
Comments:

4.5 **"Tests of haemostasis** are indicated preoperatively in a **normal healthy adult** having **elective neurosurgery** aged as shown."



Comments:

4.6 **"Tests of haemostasis** are indicated preoperatively in a **normal healthy adult** having **elective cardiac surgery** aged as shown."



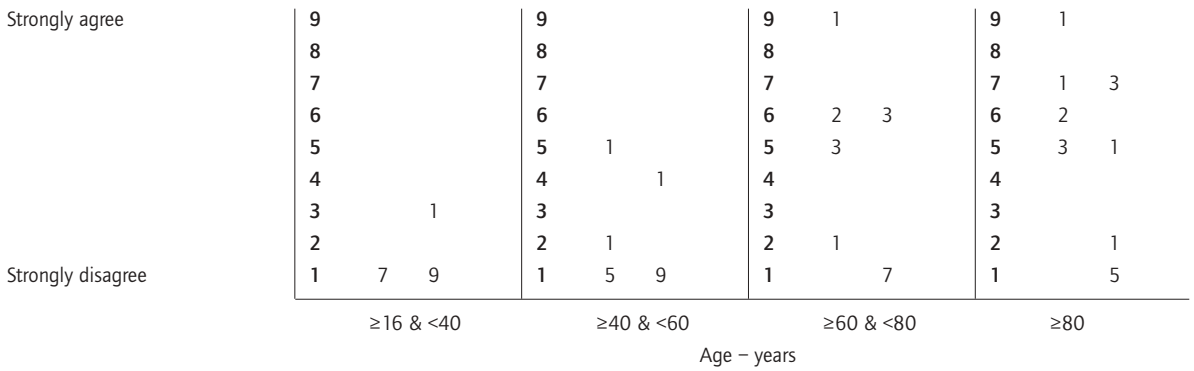
Comments:

ADULTS, RENAL FUNCTION TESTS (ie potassium, sodium, creatinine, urea)

Cost estimates: **low £1.40** **mid £3.40** **upper £5.40**

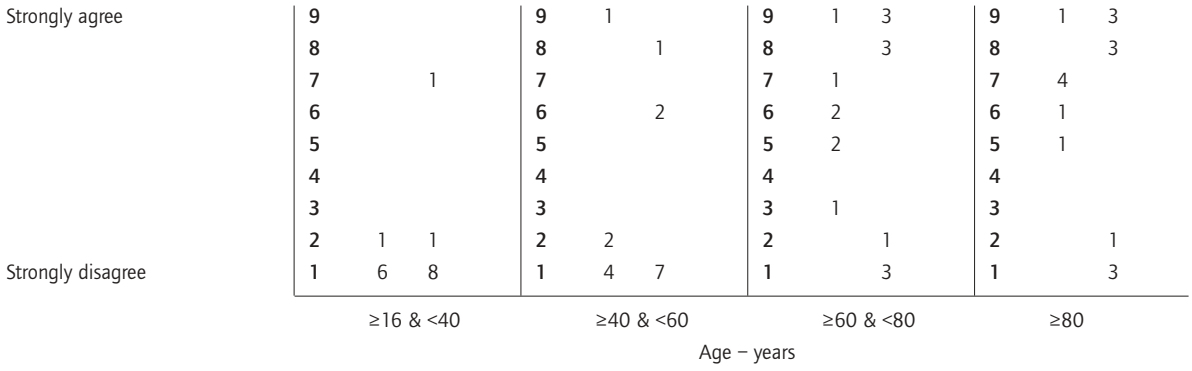
To what extent are renal function tests indicated for 'normal healthy patients' (ie ASA Grade 1) of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements by ringing one or more numbers in each column:

5.1 **"Renal function tests** are indicated preoperatively in a **normal healthy adult** having **elective Grade 1 surgery,** aged as shown."



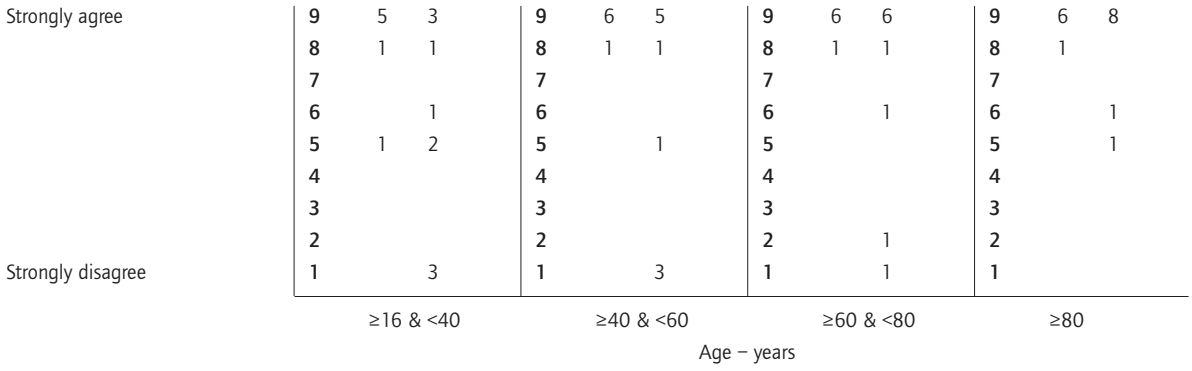
Comments:

5.2 **"Renal function tests** are indicated preoperatively in a **normal healthy adult** having **elective Grade 2 surgery,** aged as shown."



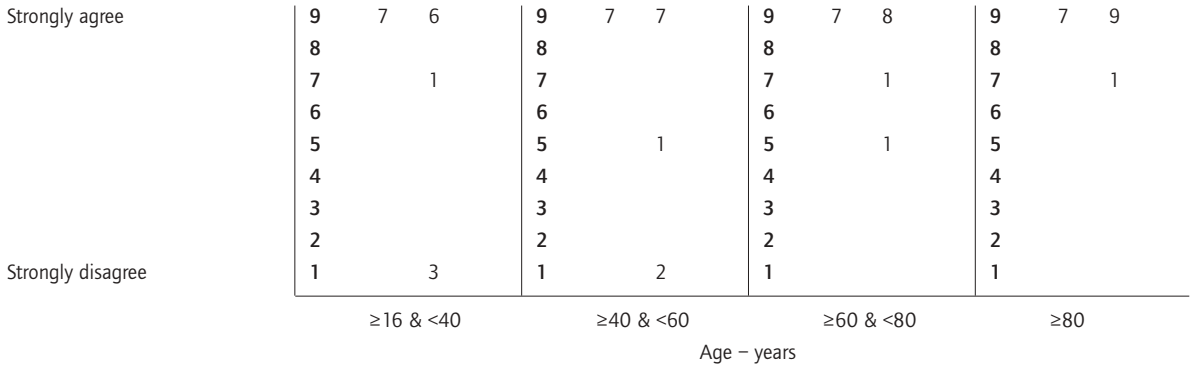
Comments:

5.3 **"Renal function tests** are indicated preoperatively in a **normal healthy adult** having **elective Grade 3 surgery,** aged as shown."



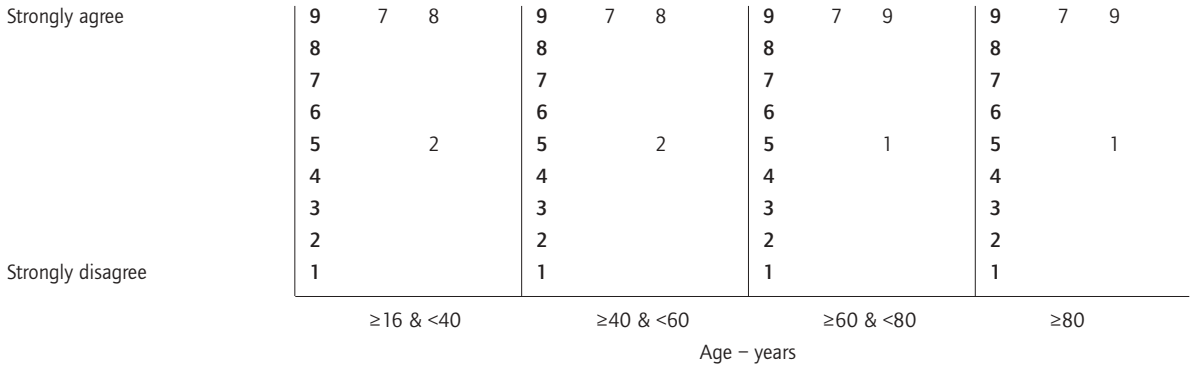
Comments:

5.4 **"Renal function tests** are indicated preoperatively in a **normal healthy adult** having **elective Grade 4 surgery,** aged as shown."



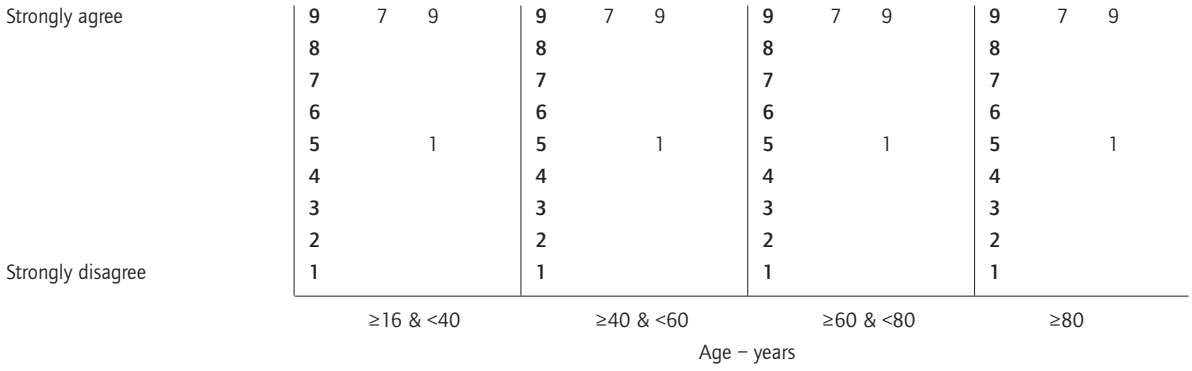
Comments:

5.5 **"Renal function tests** are indicated preoperatively in a **normal healthy adult** having **elective neurosurgery,** aged as shown."



Comments:

5.6 **"Renal function tests** are indicated preoperatively in a **normal healthy adult** having **elective cardiac surgery,** aged as shown."



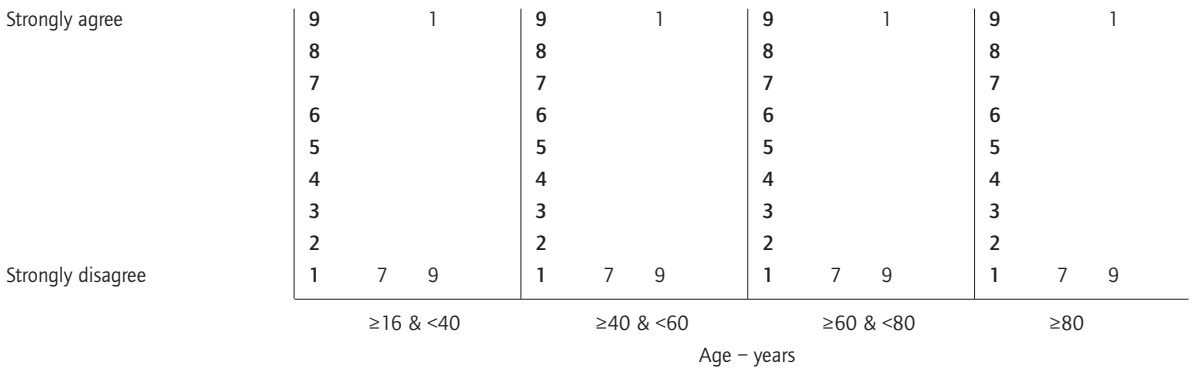
Comments:

ADULTS, BLOOD GLUCOSE TESTING

Cost estimates: **low £1.05** **mid £2.30** **upper £3.60**

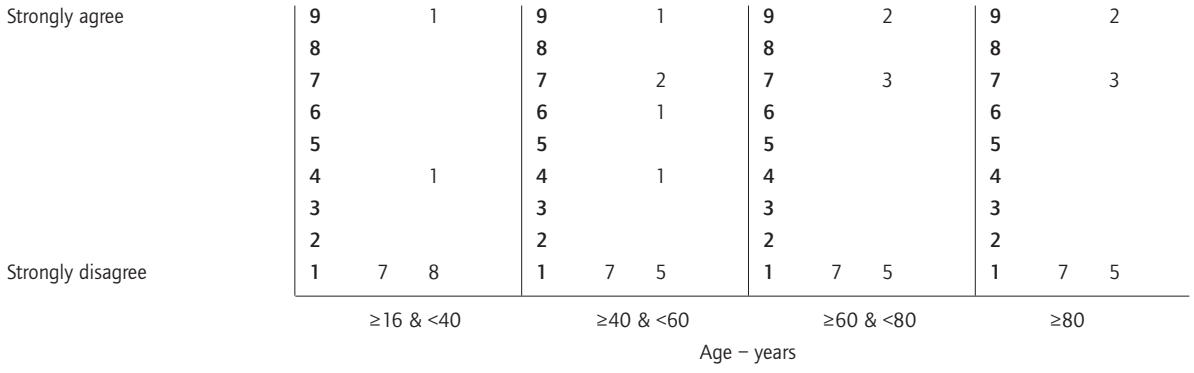
To what extent is blood glucose testing indicated for 'normal healthy patients' (ie ASA Grade 1) of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements by ringing one or more numbers in each column:

6.1 **"Blood glucose testing** is indicated preoperatively in a **normal healthy adult** having **elective Grade 1 surgery,** aged as shown."



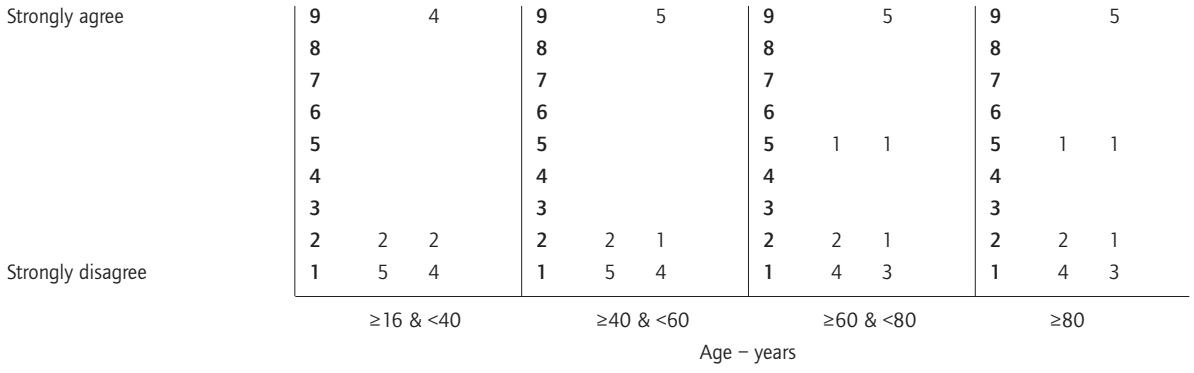
Comments:

6.2 **"Blood glucose testing** is indicated preoperatively in a **normal healthy adult** having **elective Grade 2 surgery,** aged as shown."



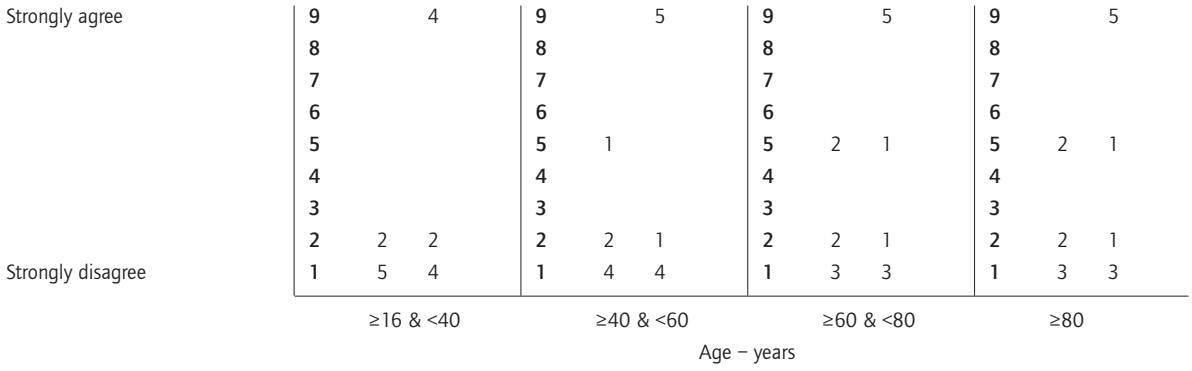
Comments:

6.3 **"Blood glucose testing** is indicated preoperatively in a **normal healthy adult** having **elective Grade 3 surgery,** aged as shown."



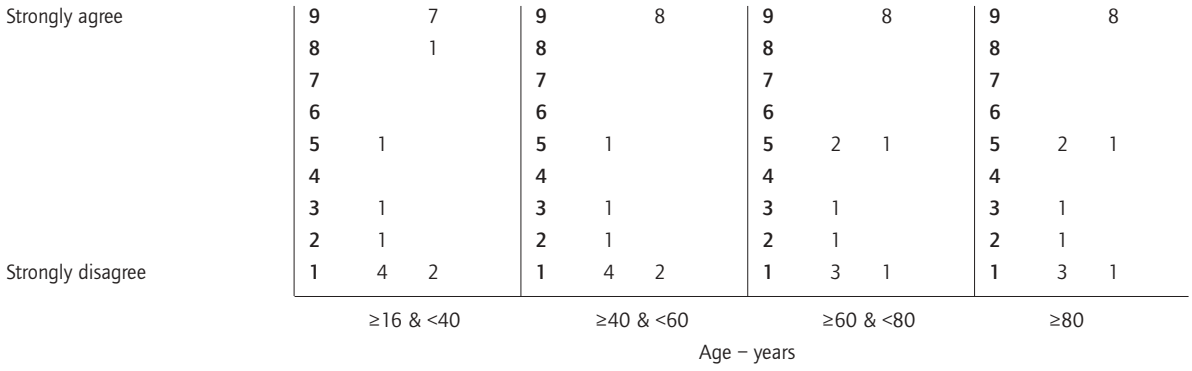
Comments:

6.4 **"Blood glucose testing** is indicated preoperatively in a **normal healthy adult** having **elective Grade 4 surgery,** aged as shown."



Comments:

6.5 **"Blood glucose testing** is indicated preoperatively in a **normal healthy adult** having **elective neurosurgery,** aged as shown."



Comments:

6.6 **"Blood glucose testing** is indicated preoperatively in a **normal healthy adult** having **elective cardiac surgery,** aged as shown."

	≥16 & <40	≥40 & <60	≥60 & <80	≥80
Strongly agree	9 7	9 8	9 8	9 8
	8 1	8	8	8
	7	7	7	7
	6	6	6	6
	5	5	5 1 1	5 1 1
	4	4	4	4
	3	3	3	3
	2 2	2 2	2 2	2 2
Strongly disagree	1 5 2	1 5 2	1 4 1	1 4 1Gr

Age – years

Comments:

ADULTS, URINE ANALYSIS ('dipstick' for protein, bilirubin, glucose, ketones, blood, UTIs)

Cost estimates: **low £0.15** **mid £0.21** **upper £0.27**

To what extent is urine analysis indicated for 'normal healthy patients' (ie ASA Grade 1) of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements by ringing one or more numbers in each column:

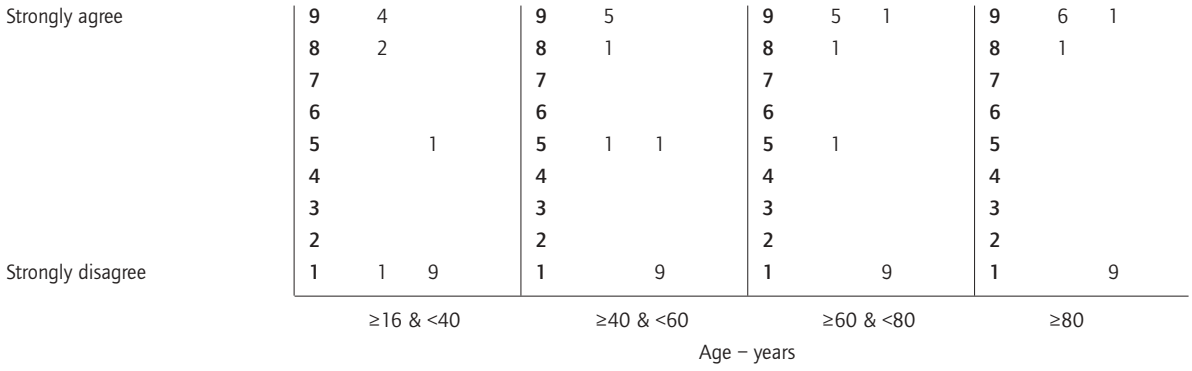
7.1 **"Urine analysis** is indicated preoperatively in a **normal healthy adult** having **elective Grade 1 surgery,** aged as shown."

	≥16 & <40	≥40 & <60	≥60 & <80	≥80
Strongly agree	9 4	9 5	9 5 1	9 5 1
	8 2	8 1	8 1	8 1
	7	7	7	7
	6	6	6	6
	5 1	5 1 1	5 1	5
	4	4	4	4
	3	3	3	3
	2	2	2	2
Strongly disagree	1 1 9	1 9	1 9	1 1 9

Age – years

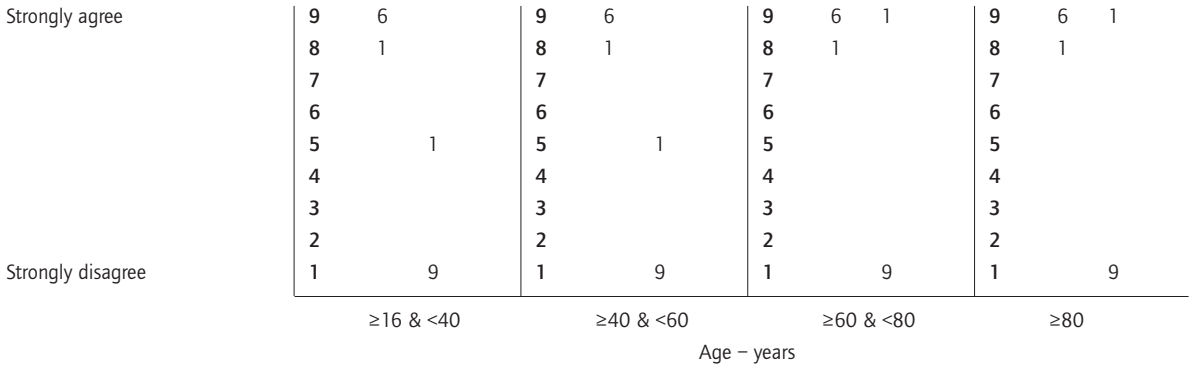
Comments:

7.2 **"Urine analysis** is indicated preoperatively in a **normal healthy adult** having **elective Grade 2 surgery,** aged as shown."



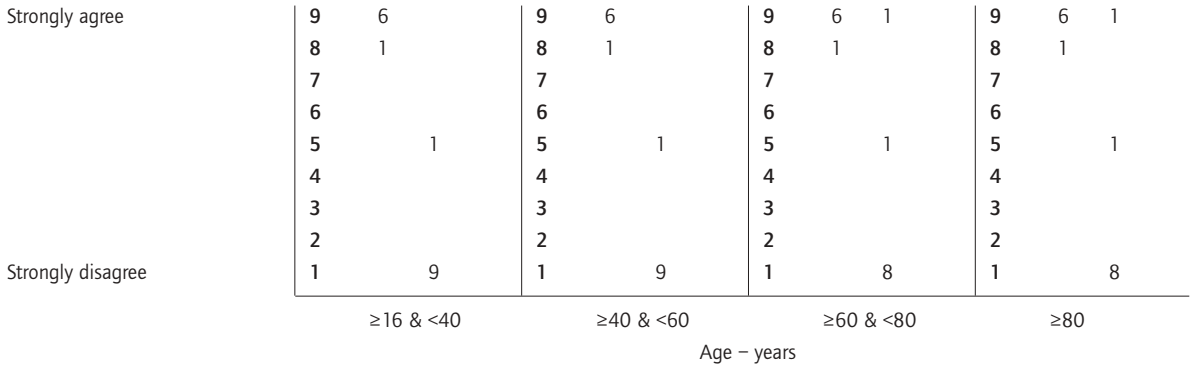
Comments:

7.3 **"Urine analysis** is indicated preoperatively in a **normal healthy adult** having **elective Grade 3 surgery,** aged as shown."



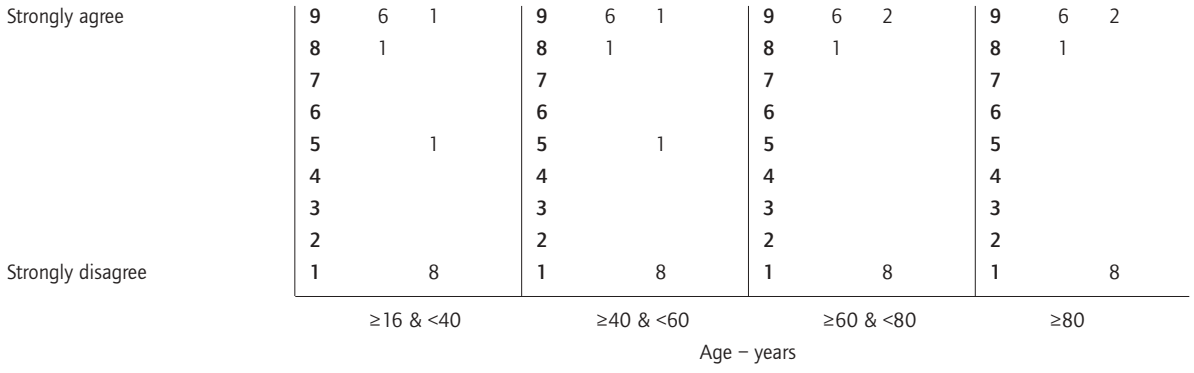
Comments:

7.4 **"Urine analysis** is indicated preoperatively in a **normal healthy adult** having **elective Grade 4 surgery,** aged as shown."



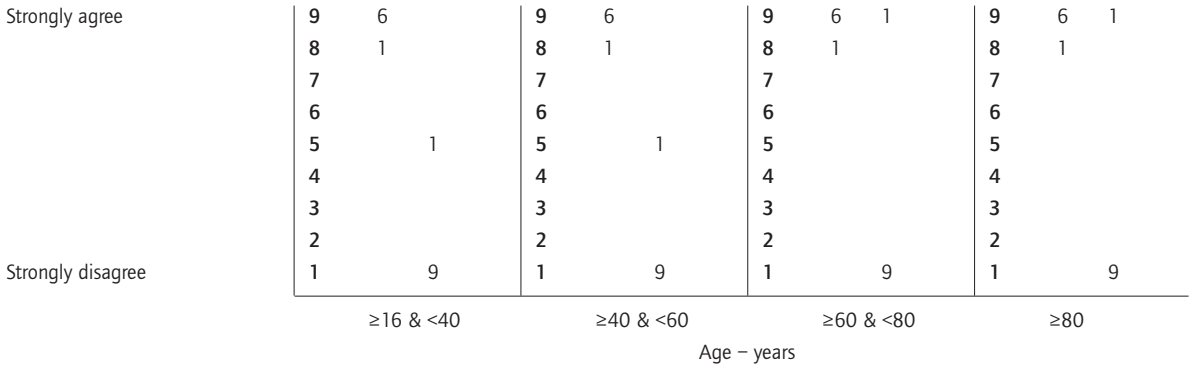
Comments:

7.5 **"Urine analysis** is indicated preoperatively in a **normal healthy adult** having **elective neurosurgery,** aged as shown."



Comments:

7.6 **"Urine analysis** is indicated preoperatively in a **normal healthy adult** having **elective cardiac surgery,** aged as shown."



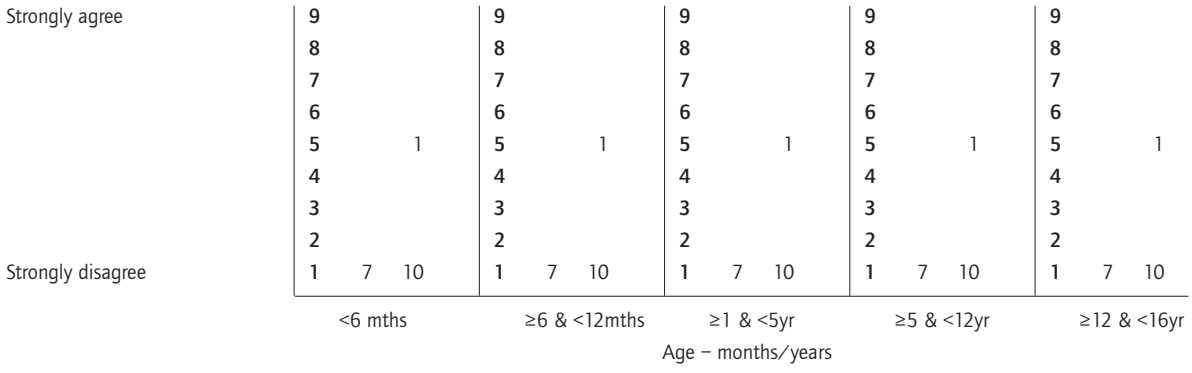
Comments:

CHILDREN, CHEST X-RAY

Cost estimates: **low £10.00** **mid £20.50** **upper £31.00**

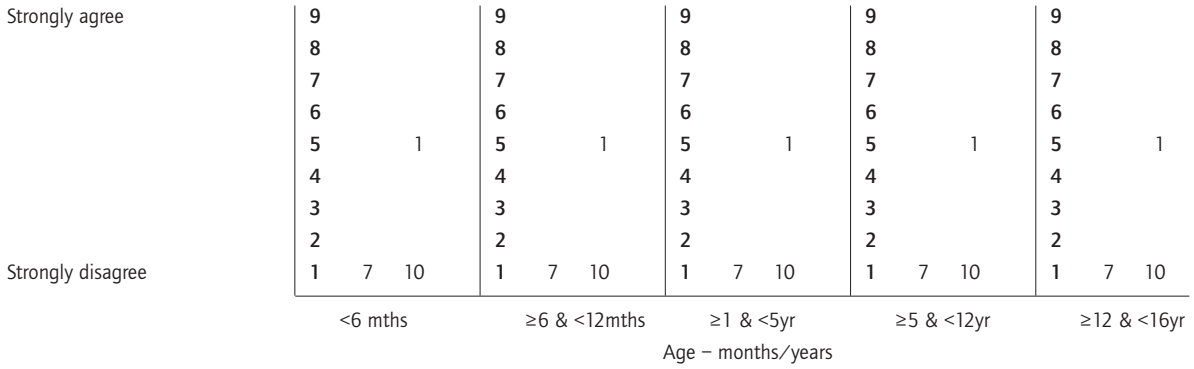
To what extent is urine analysis indicated for 'normal healthy patients' (ie ASA Grade 1) of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements by ringing one or more numbers in each column:

8.1 "A **chest x-ray** is indicated preoperatively in a **normal healthy child** having **elective Grade 1 surgery,** aged as shown."



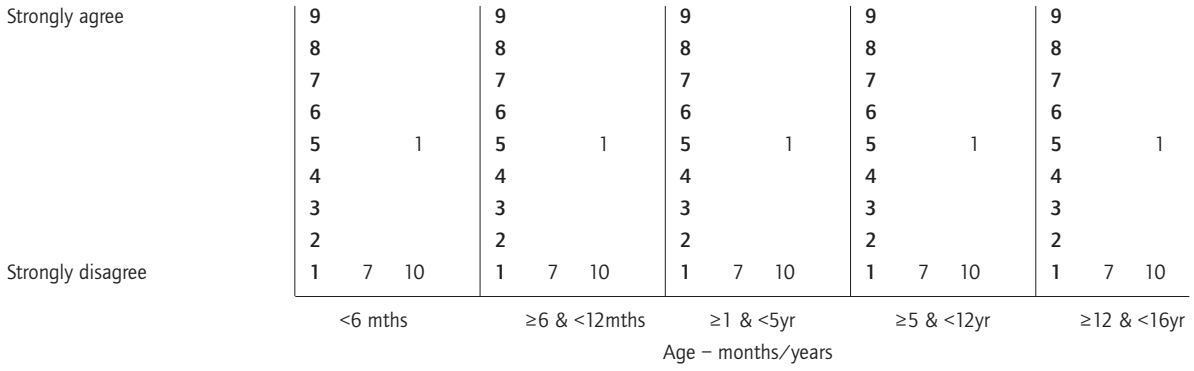
Comments:

8.2 "A **chest x-ray** is indicated preoperatively in a **normal healthy child** having **elective Grade 2 surgery,** aged as shown."



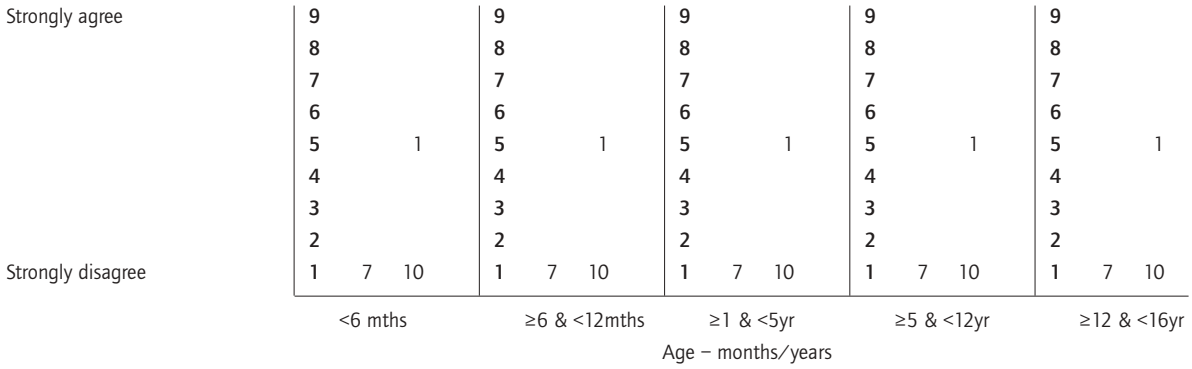
Comments:

8.3 "A **chest x-ray** is indicated preoperatively in a **normal healthy child** having **elective Grade 3 surgery,** aged as shown."



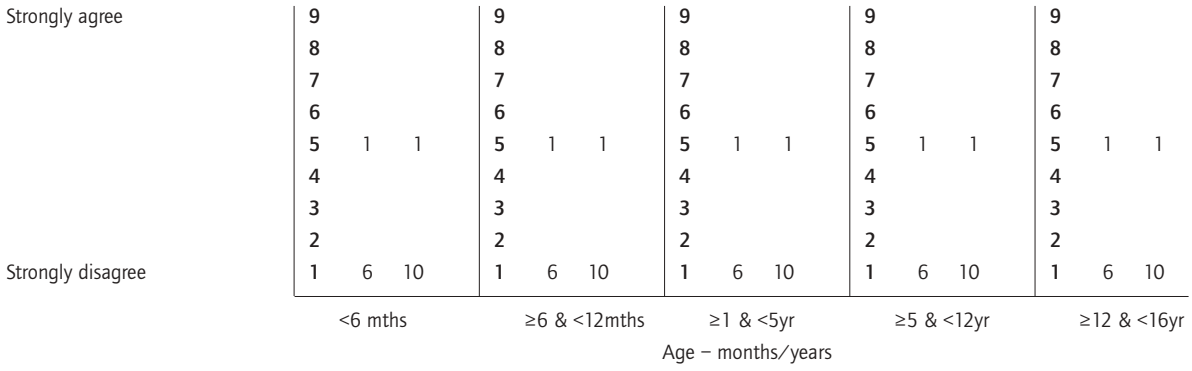
Comments:

8.4 "A **chest x-ray** is indicated preoperatively in a **normal healthy child** having **elective Grade 4 surgery,** aged as shown."



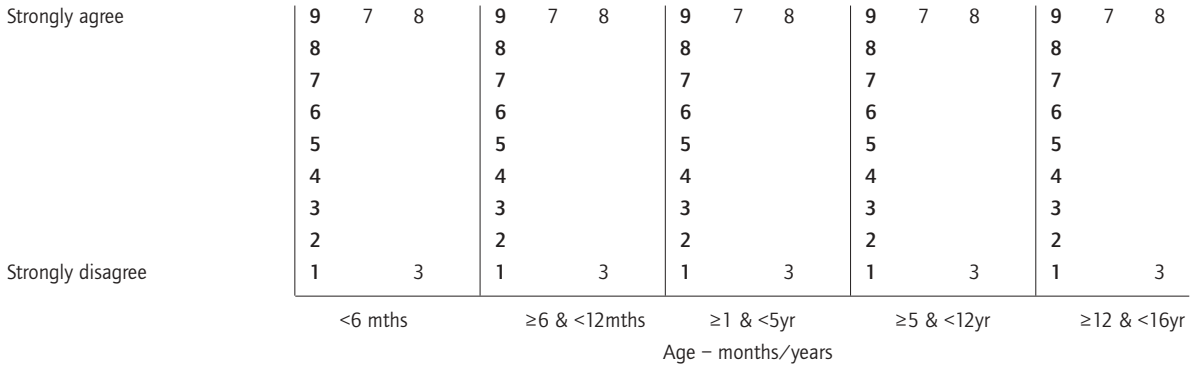
Comments:

8.5 "A **chest x-ray** is indicated preoperatively in a **normal healthy child** having **elective neurosurgery,** aged as shown."



Comments:

8.6 "A **chest x-ray** is indicated preoperatively in a **normal healthy child** having **elective cardiac surgery,** aged as shown."



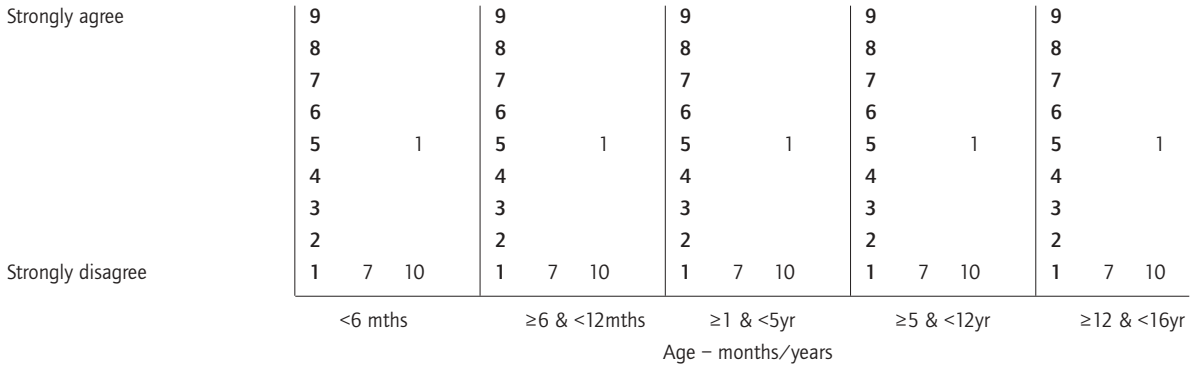
Comments:

CHILDREN, RESTING ECG

Cost estimates: **low £11.00** **mid £26.00** **upper £37.00**

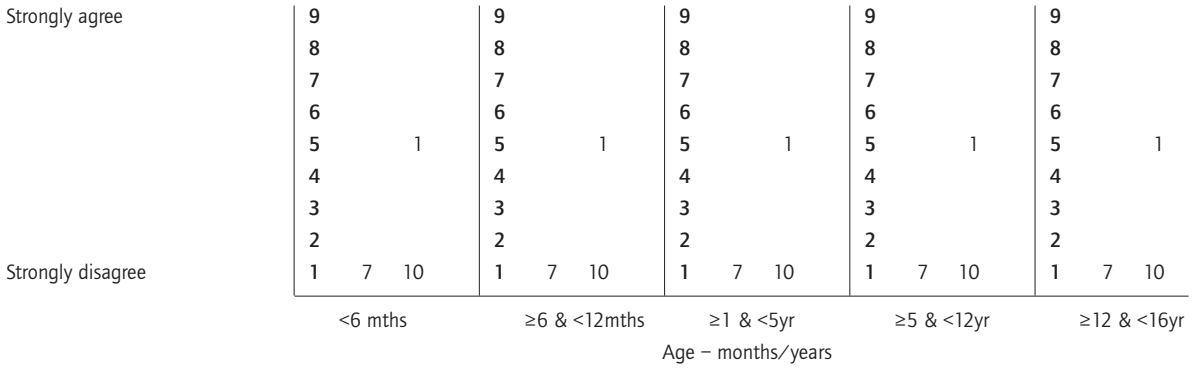
To what extent is a resting ECG indicated for 'normal healthy children' (ie ASA Grade 1) of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements by ringing one or more numbers in each column:

9.1 "A **resting ECG** is indicated preoperatively in a **normal healthy child** having **elective Grade 1 surgery,** aged as shown."



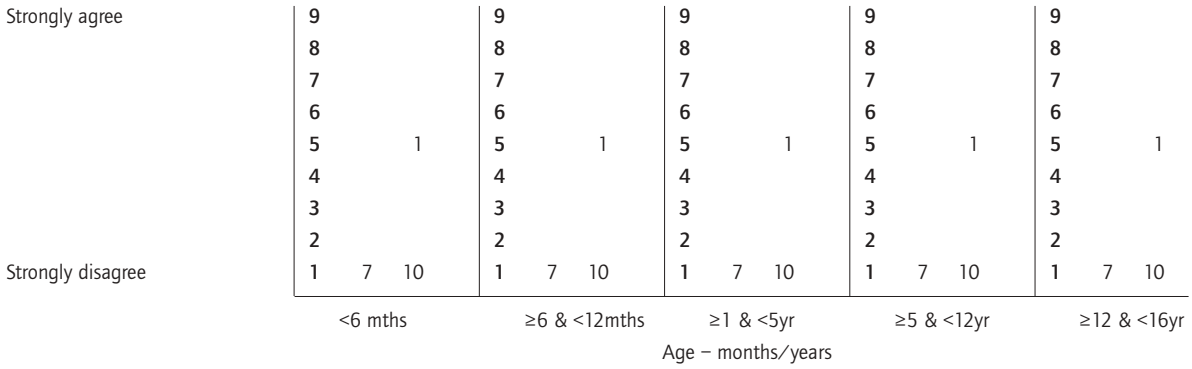
Comments:

9.2 "A **resting ECG** is indicated preoperatively in a **normal healthy child** having **elective Grade 2 surgery,** aged as shown."



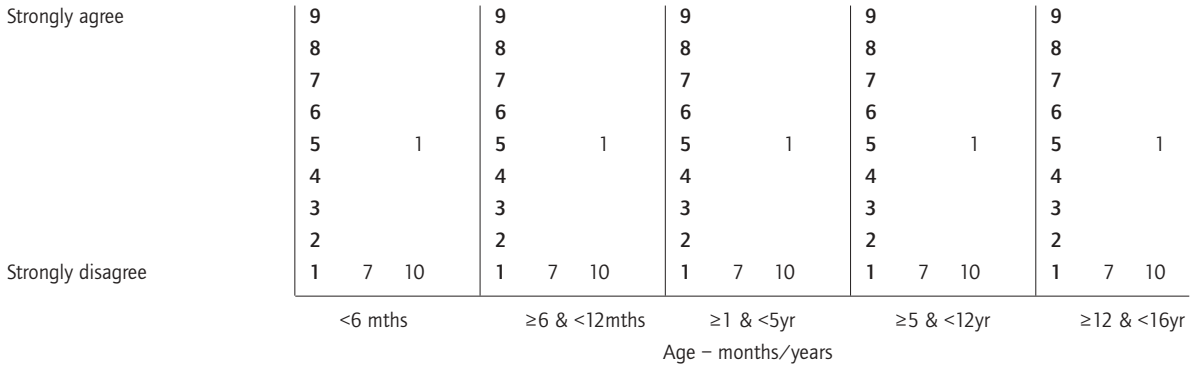
Comments:

9.3 "A **resting ECG** is indicated preoperatively in a **normal healthy child** having **elective Grade 3 surgery,** aged as shown."



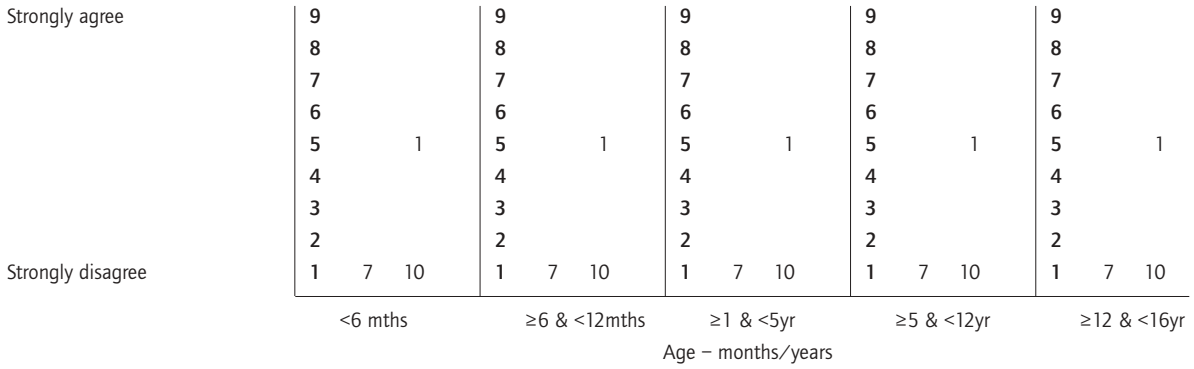
Comments:

9.4 "A **resting ECG** is indicated preoperatively in a **normal healthy child** having **elective Grade 4 surgery,** aged as shown."



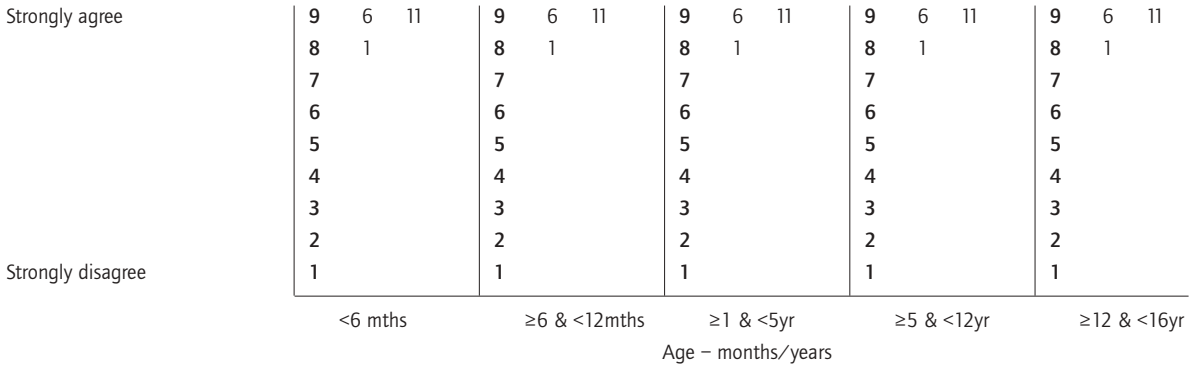
Comments:

9.5 "A **resting ECG** is indicated preoperatively in a **normal healthy child** having **elective neurosurgery,** aged as shown."



Comments:

9.6 "A **resting ECG** is indicated preoperatively in a **normal healthy child** having **elective Grade cardiac surgery,** aged as shown."



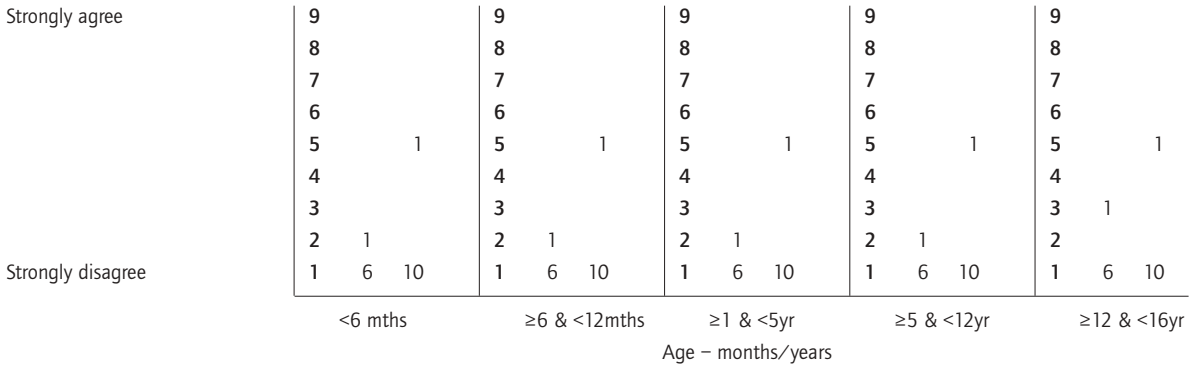
Comments:

CHILDREN, FULL BLOOD COUNT

Cost estimates: **low £0.70** **mid £2.35** **upper £4.05**

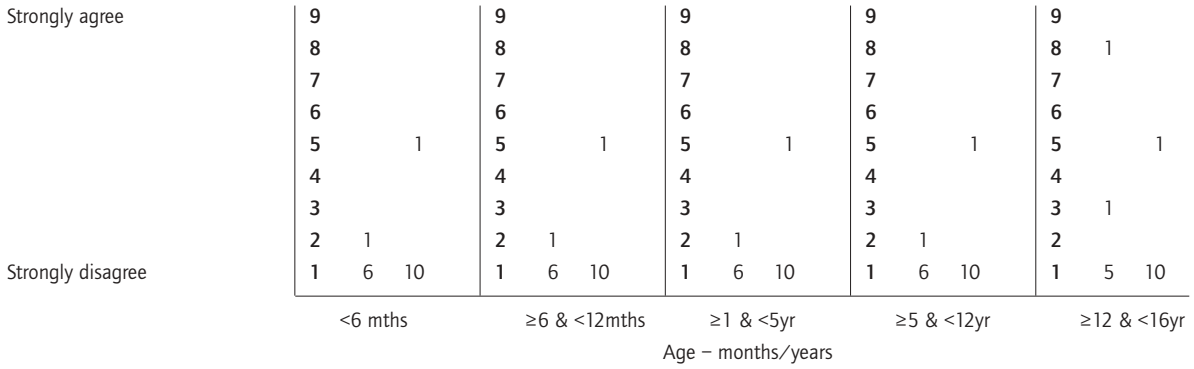
To what extent is a resting ECG indicated for 'normal healthy children' (ie ASA Grade 1) of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements by ringing one or more numbers in each column:

10.1 "A **full blood count** is indicated preoperatively in a **normal healthy child** having **elective Grade 1 surgery,** aged as shown."



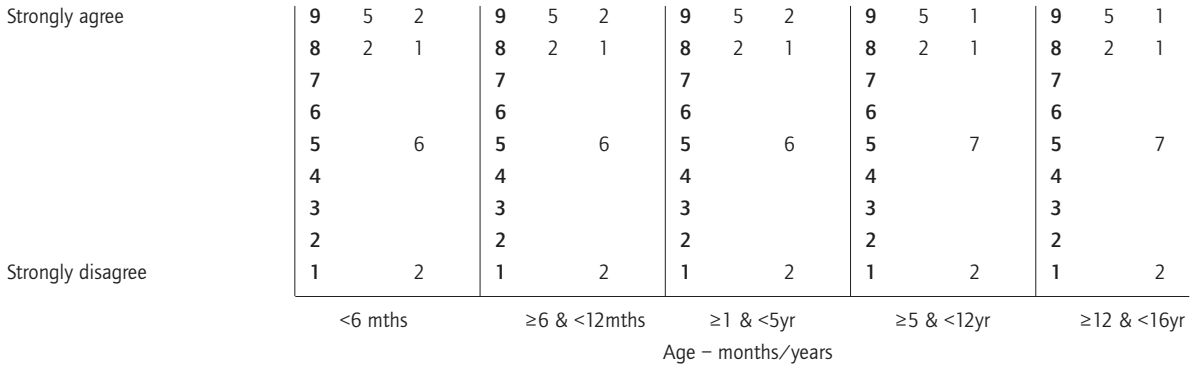
Comments:

10.2 "A **full blood count** is indicated preoperatively in a **normal healthy child** having **elective Grade 2 surgery,** aged as shown."



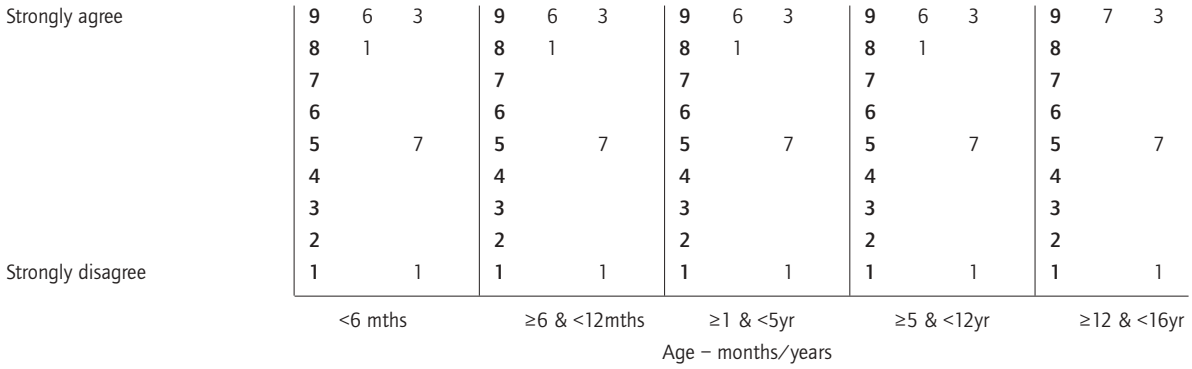
Comments:

10.3 "A **full blood count** is indicated preoperatively in a **normal healthy child** having **elective Grade 3 surgery,** aged as shown."



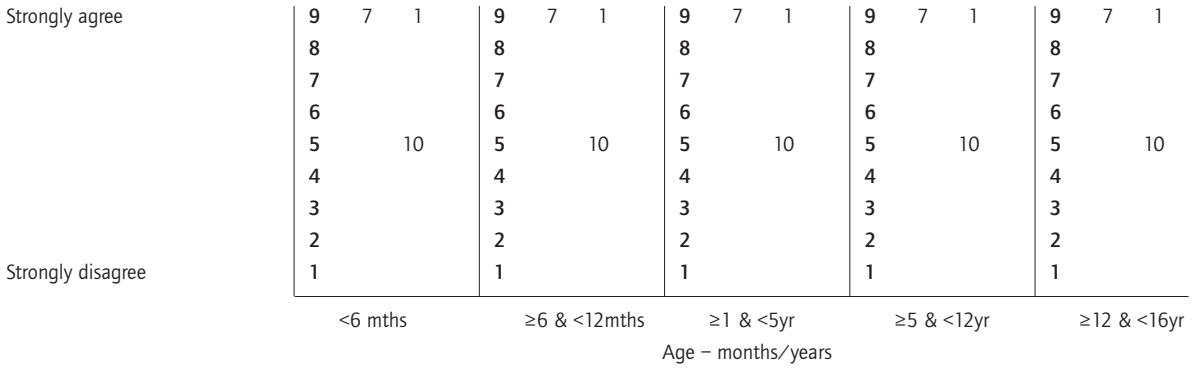
Comments:

10.4 "A **full blood count** is indicated preoperatively in a **normal healthy child** having **elective Grade 4 surgery,** aged as shown."



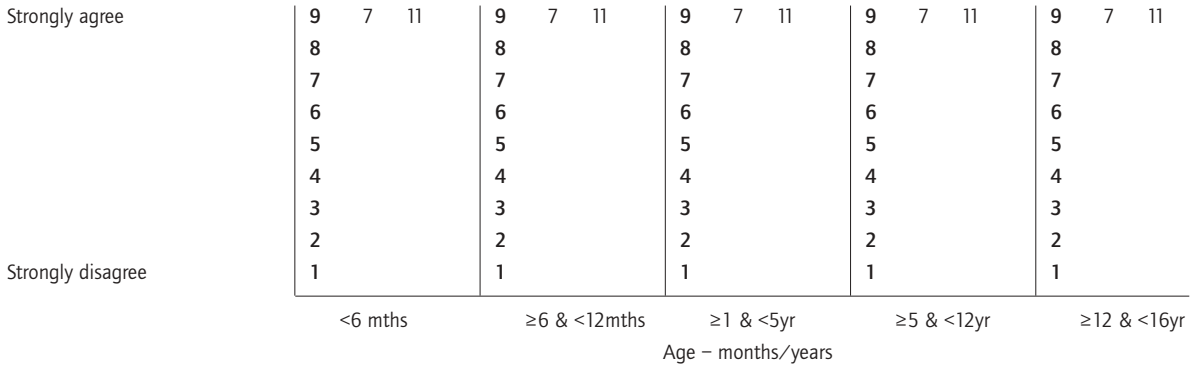
Comments:

10.5 "A **full blood count** is indicated preoperatively in a **normal healthy child** having **elective neurosurgery,** aged as shown."



Comments:

10.6 "A **full blood count** is indicated preoperatively in a **normal healthy child** having **elective cardiac surgery,** aged as shown."



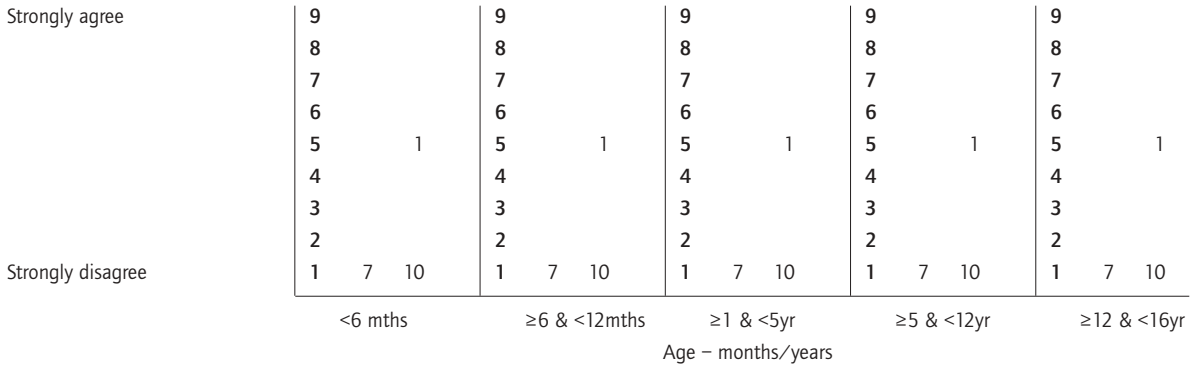
Comments:

CHILDREN, TESTS OF HAEMOSTASIS

Cost estimates: **low £1.50** **mid £3.65** **upper £5.85**

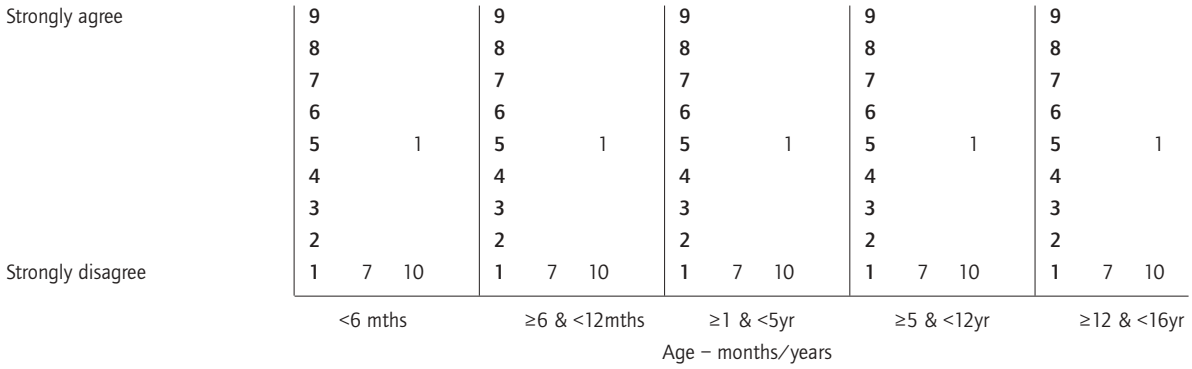
To what extent are tests of haemostasis indicated for 'normal healthy children' (ie ASA Grade 1) of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements by ringing one or more numbers in each column:

11.1 **"Tests of haemostasis** are indicated preoperatively in a **normal healthy child** having **elective Grade 1 surgery,** aged as shown."



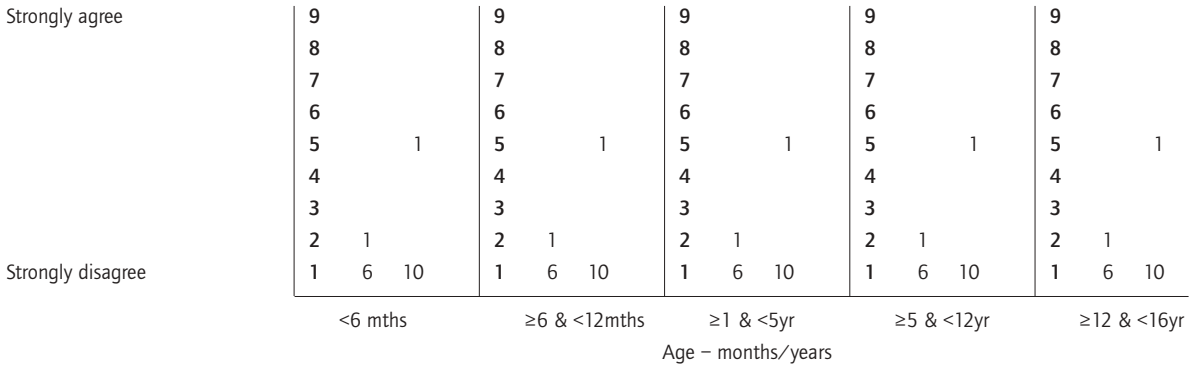
Comments:

11.2 **"Tests of haemostasis** are indicated preoperatively in a **normal healthy child** having **elective Grade 2 surgery,** aged as shown."



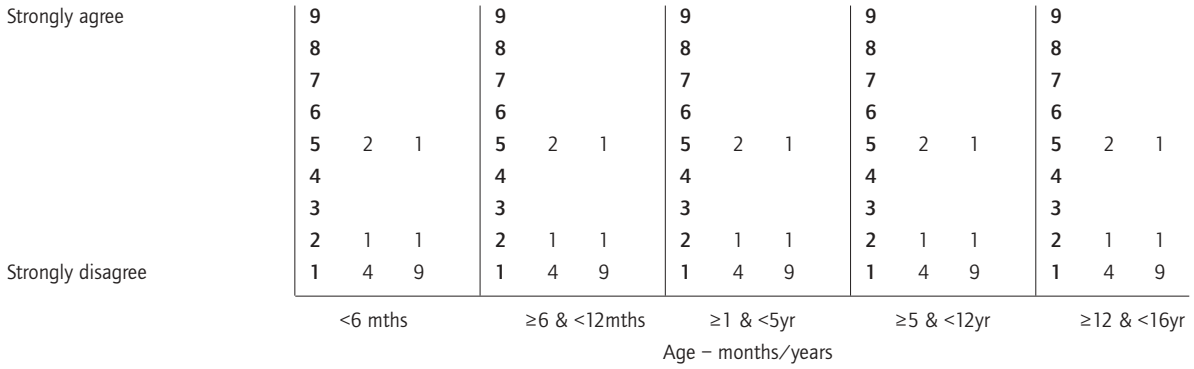
Comments:

11.3 **"Tests of haemostasis** are indicated preoperatively in a **normal healthy child** having **elective Grade 3 surgery,** aged as shown."



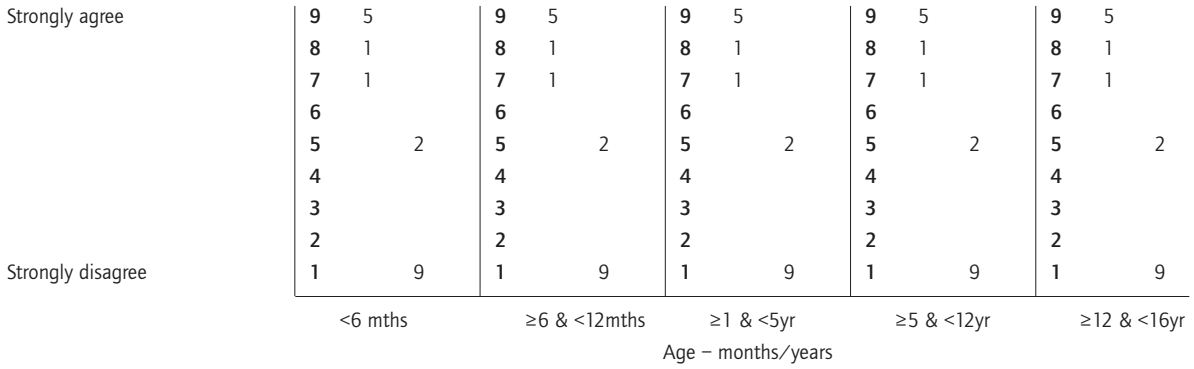
Comments:

11.4 **"Tests of haemostasis** are indicated preoperatively in a **normal healthy child** having **elective Grade 4 surgery,** aged as shown."



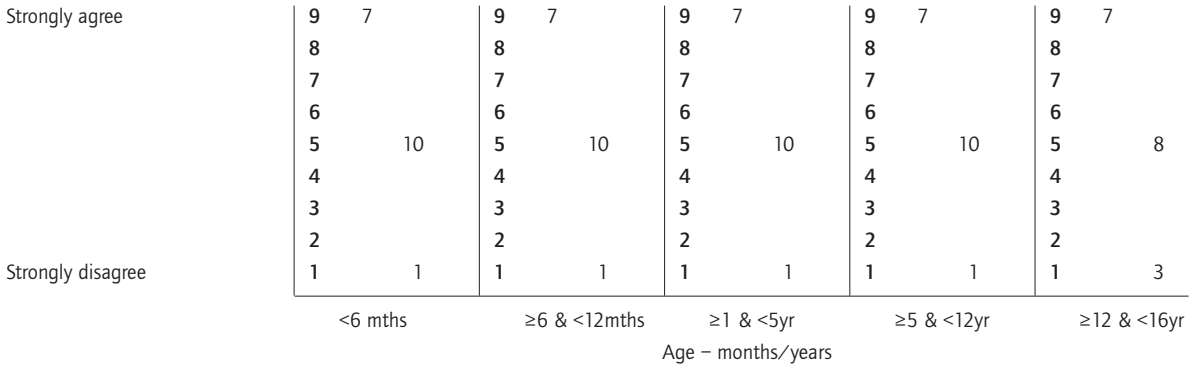
Comments:

11.5 **"Tests of haemostasis** are indicated preoperatively in a **normal healthy child** having **elective neurosurgery,** aged as shown."



Comments:

11.6 **"Tests of haemostasis** are indicated preoperatively in a **normal healthy child** having **elective cardiac surgery,** aged as shown."



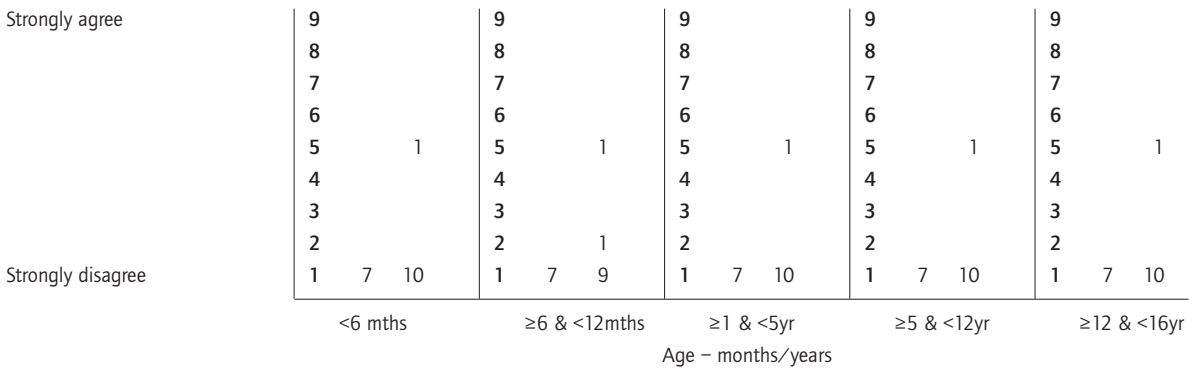
Comments:

CHILDREN, RENAL FUNCTION TESTS (ie potassium, sodium, creatinine, urea)

Cost estimates: **low £1.40** **mid £3.40** **upper £5.40**

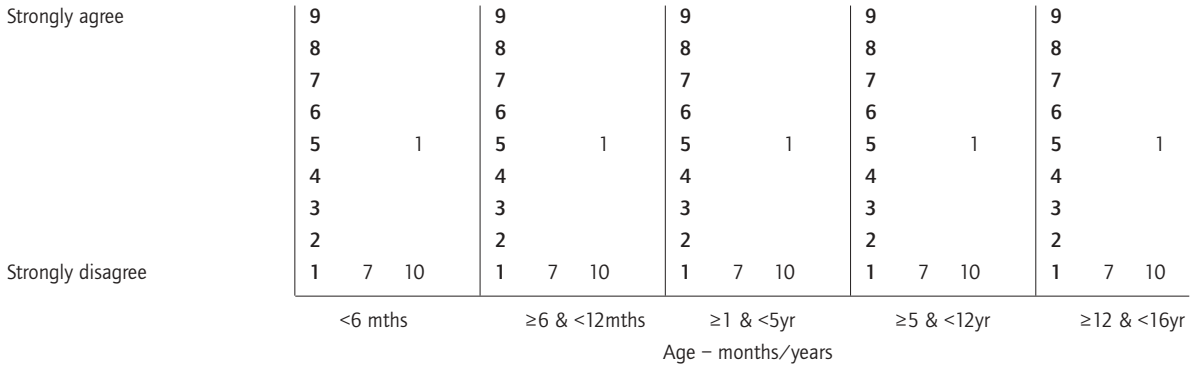
To what extent are renal function tests indicated for 'normal healthy children' (ie ASA Grade 1) of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements by ringing one or more numbers in each column:

12.1 **"Renal function tests** are indicated preoperatively in a **normal healthy child** having **elective Grade 1 surgery,** aged as shown."



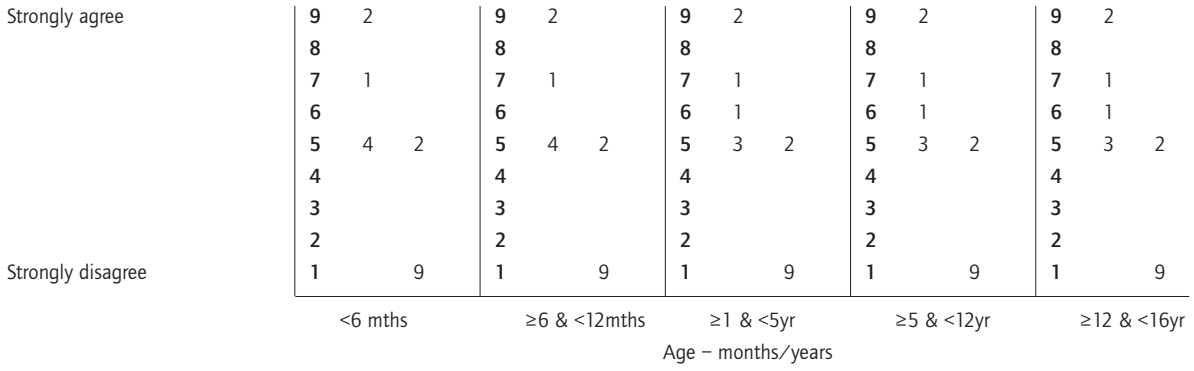
Comments:

12.2 **"Renal function tests** are indicated preoperatively in a **normal healthy child** having **elective Grade 2 surgery,** aged as shown."



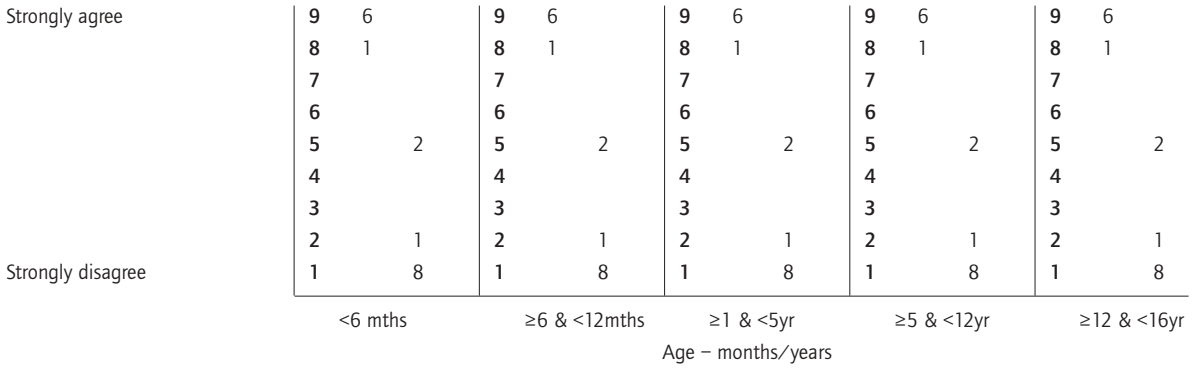
Comments:

12.3 **"Renal function tests** are indicated preoperatively in a **normal healthy child** having **elective Grade 3 surgery,** aged as shown."



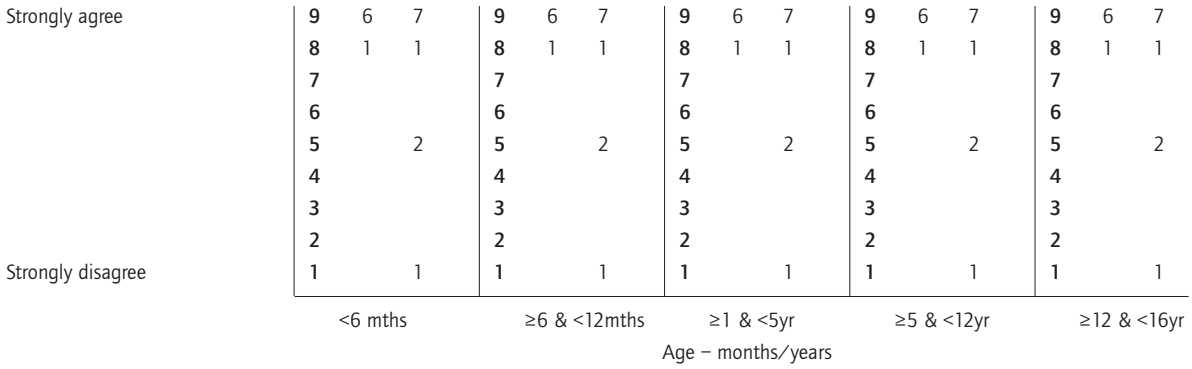
Comments:

12.4 **"Renal function tests** are indicated preoperatively in a **normal healthy child** having **elective Grade 4 surgery,** aged as shown."



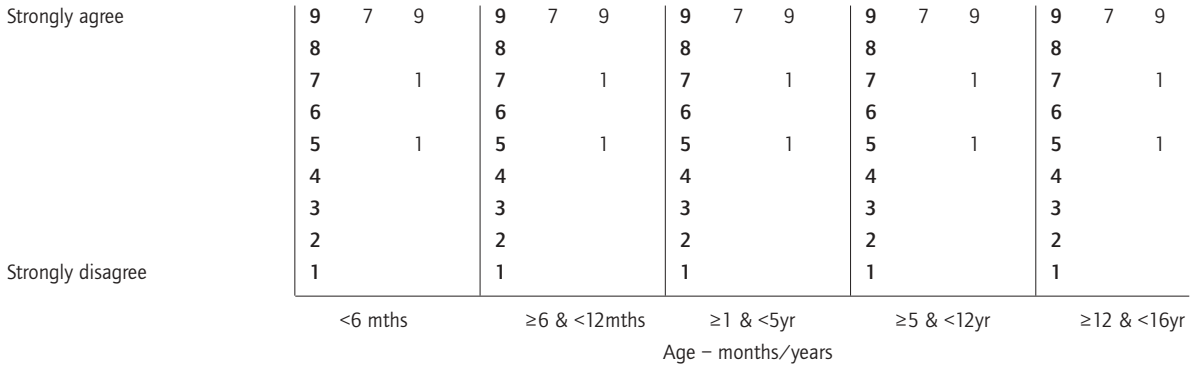
Comments:

12.5 **"Renal function tests** are indicated preoperatively in a **normal healthy child** having **elective neurosurgery,** aged as shown."



Comments:

12.6 **"Renal function tests** are indicated preoperatively in a **normal healthy child** having **elective cardiac surgery,** aged as shown."



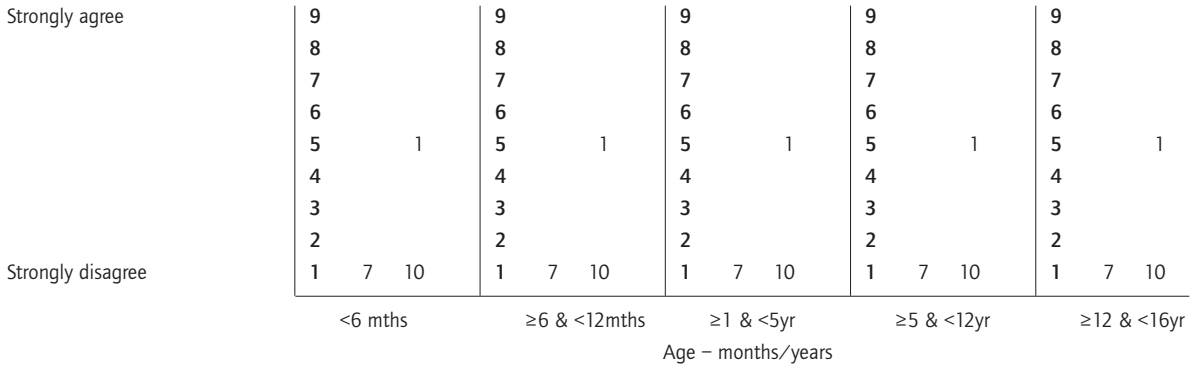
Comments:

CHILDREN, BLOOD GLUCOSE TESTING

Cost estimates: **low £1.05** **mid £2.30** **upper £3.60**

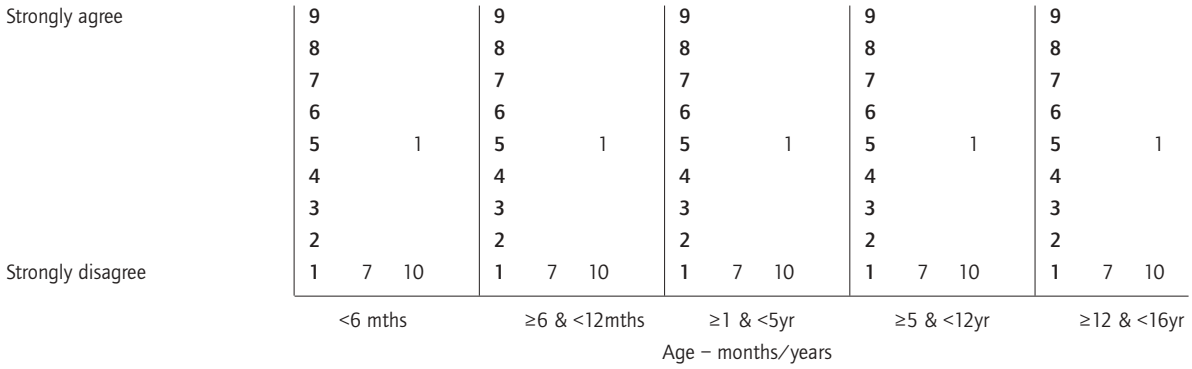
To what extent is blood glucose testing indicated for 'normal healthy children' (ie ASA Grade 1) of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements by ringing one or more numbers in each column:

13.1 **"Blood glucose testing** are indicated preoperatively in a **normal healthy child** having **elective Grade 1 surgery,** aged as shown."



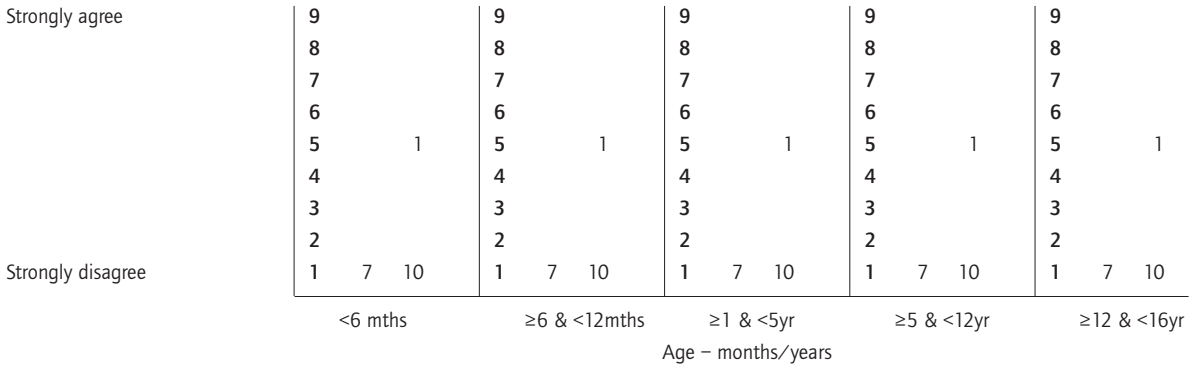
Comments:

13.2 **"Blood glucose testing** are indicated preoperatively in a **normal healthy child** having **elective Grade 2 surgery,** aged as shown."



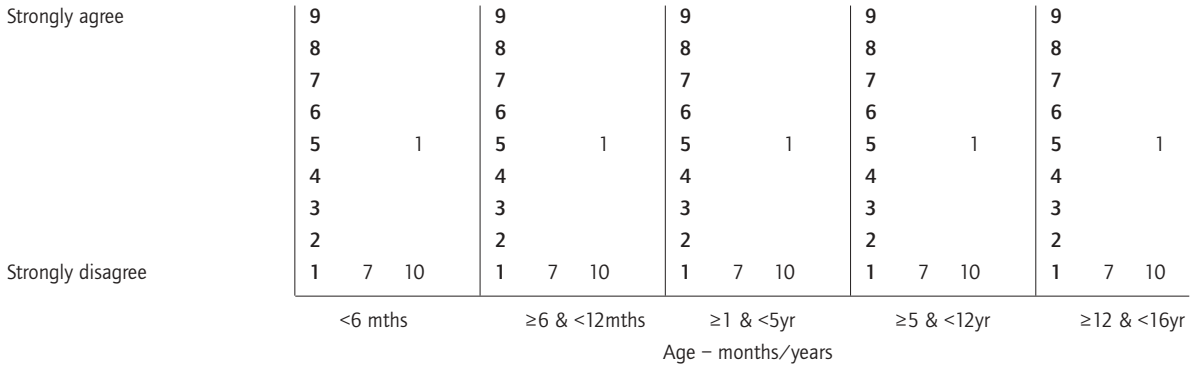
Comments:

13.3 **"Blood glucose testing** are indicated preoperatively in a **normal healthy child** having **elective Grade 3 surgery,** aged as shown."



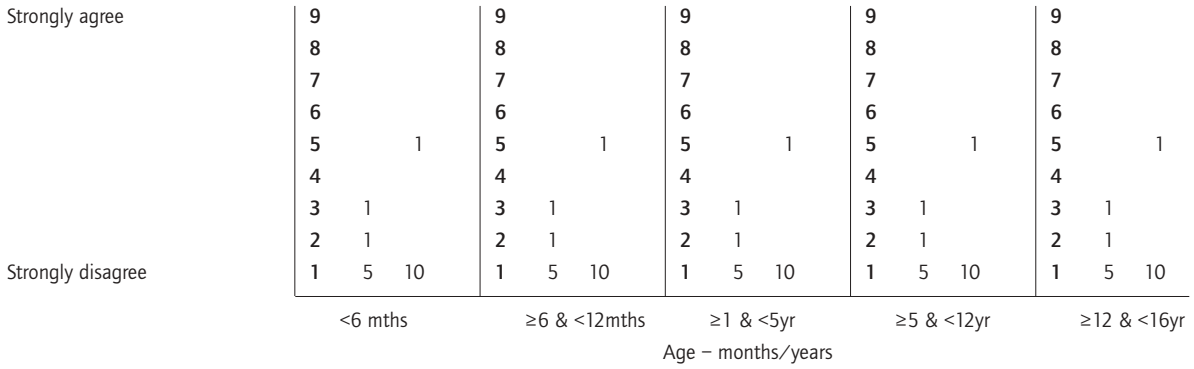
Comments:

13.4 **"Blood glucose testing** are indicated preoperatively in a **normal healthy child** having **elective Grade 4 surgery,** aged as shown."



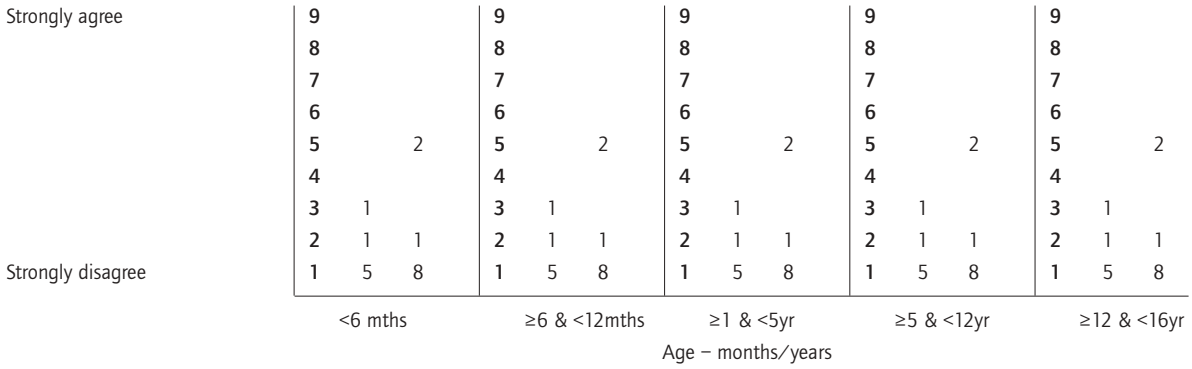
Comments:

13.5 **"Blood glucose testing** are indicated preoperatively in a **normal healthy child** having **elective neurosurgery,** aged as shown."



Comments:

13.6 **"Blood glucose testing** are indicated preoperatively in a **normal healthy child** having **elective cardiac surgery,** aged as shown."



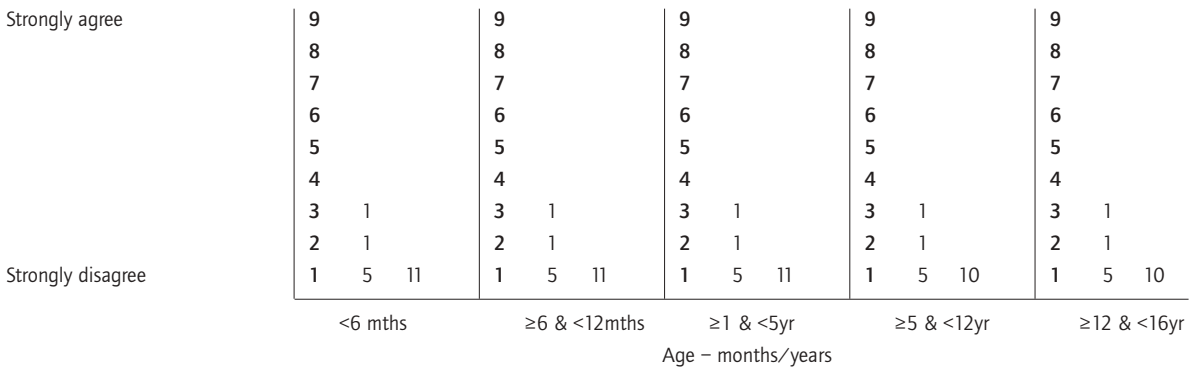
Comments:

CHILDREN, URINE ANALYSIS ('dipstick' for protein, bilirubin, glucose, ketones, blood, UTIs)

Cost estimates: **low £0.15** **mid £0.21** **upper £0.27**

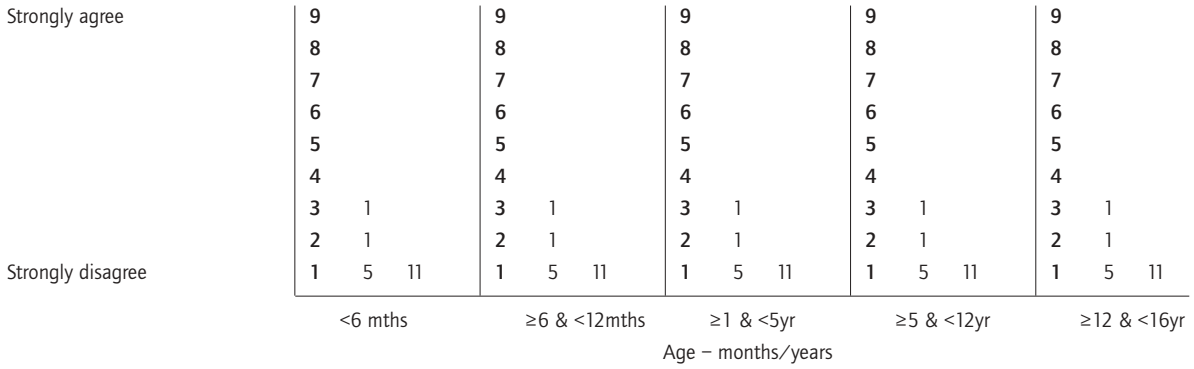
To what extent is urine analysis indicated for 'normal healthy children' (ie ASA Grade 1) patients of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements by ringing one or more numbers in each column:

14.1 **"Urine analysis** is indicated preoperatively in a **normal healthy child** having **elective Grade 1 surgery,** aged as shown."



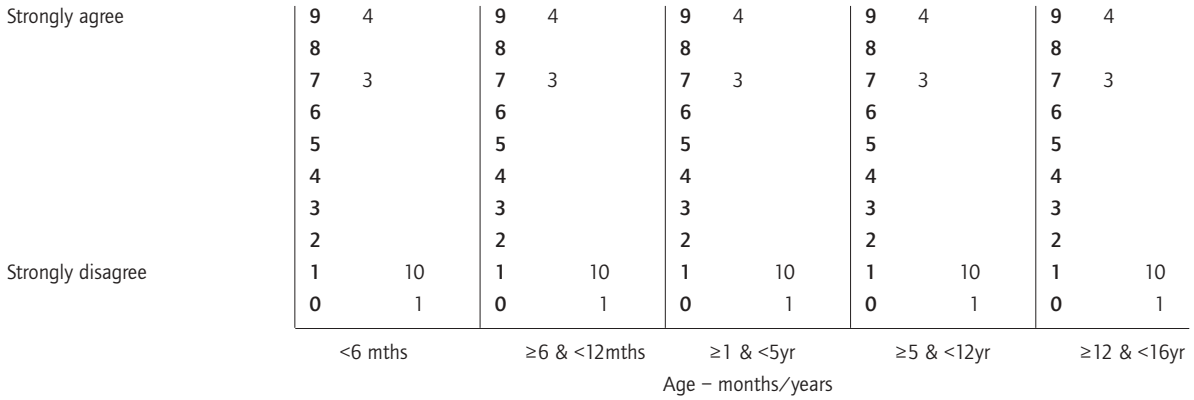
Comments:

14.2 **"Urine analysis** is indicated preoperatively in a **normal healthy child** having **elective Grade 2 surgery,** aged as shown."



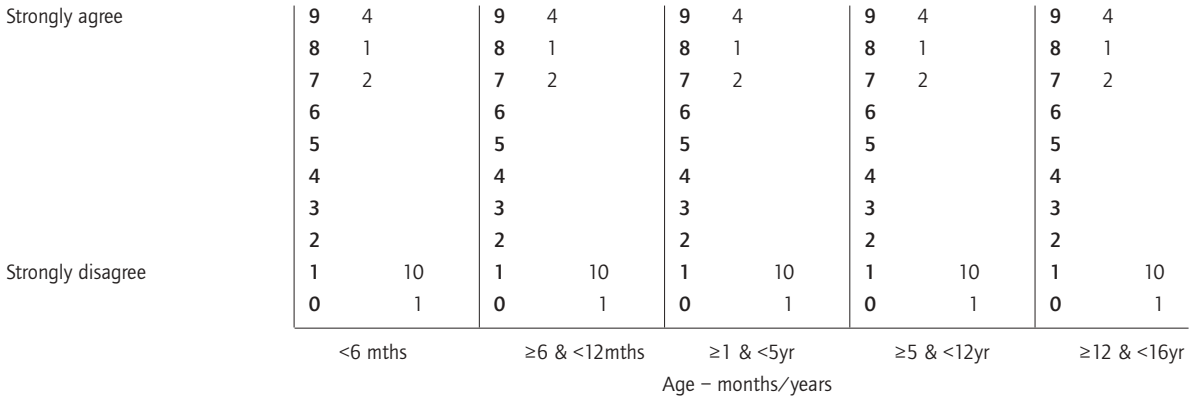
Comments:

14.3 **"Urine analysis** is indicated preoperatively in a **normal healthy child** having **elective Grade 3 surgery,** aged as shown."



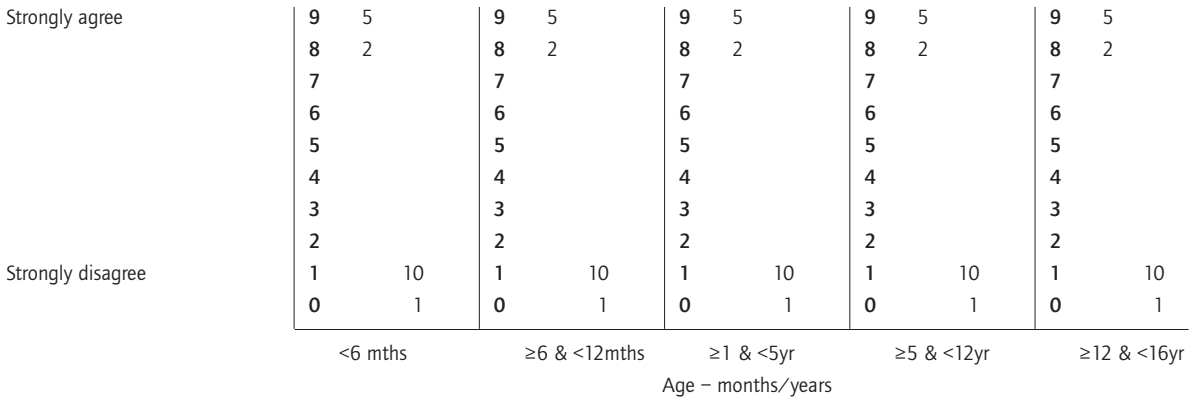
Comments:

14.4 **"Urine analysis** is indicated preoperatively in a **normal healthy child** having **elective Grade 4 surgery,** aged as shown."



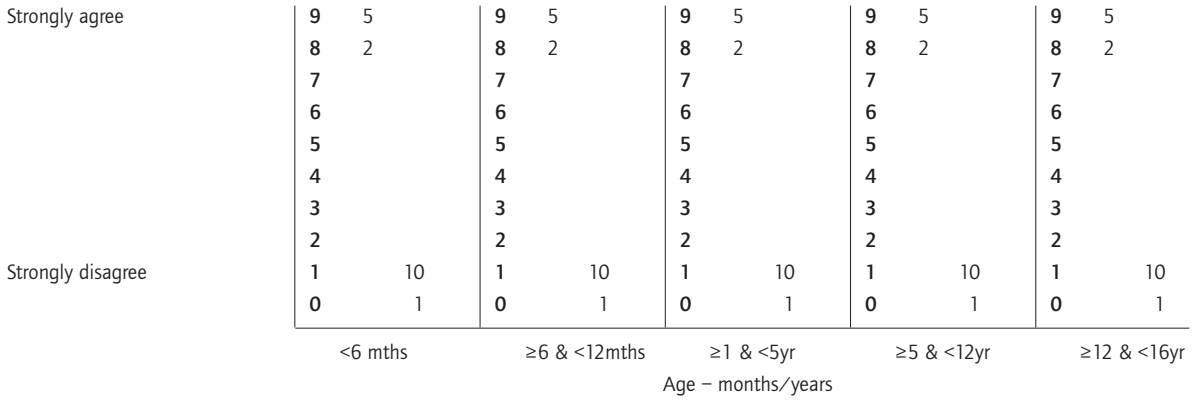
Comments:

14.5 **"Urine analysis** is indicated preoperatively in a **normal healthy child** having **elective neurosurgery,** aged as shown."



Comments:

14.6 **"Urine analysis** is indicated preoperatively in a **normal healthy child** having **elective cardiac surgery,** aged as shown."



Comments:

TESTING FOR SICKLE CELL DISEASE/TRAIT

Cost estimates: **low £1.50** **mid £2.30** **upper £3.10**

ETHNICITY

To what extent is testing for sickle cell disease / trait indicated for 'normal healthy patients' (ie ASA Grade 1) with differing ethnic origins, undergoing elective surgery? Please indicate your agreement with the following statements by ringing one or more numbers in each row.

15.1 **Testing for sickle cell disease/trait** is indicated preoperatively in a **normal healthy patient** with a southern European/Mediterranean ethnic origin.

					1		1	1	4
1	3	2			3	1			1
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Disagree									Agree

15.2 **Testing for sickle cell disease/trait** is indicated preoperatively in a **normal healthy patient** with a Middle Eastern/Arabic ethnic origin.

					2			1	4
1	3	2			3	1			1
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Disagree Agree

15.3 **Testing for sickle cell disease/trait** is indicated preoperatively in a **normal healthy patient** with a south Asian (Indian sub-continent) ethnic origin.

					2			1	4
1	3	2			3	1			1
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Disagree Agree

15.4 **Testing for sickle cell disease/trait** is indicated preoperatively in a **normal healthy patient** with some other Asian (ex-Soviet republics, etc.) ethnic origin.

	1	1			1				4
1	4	2			3	1			
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Disagree Agree

15.5 **Testing for sickle cell disease/trait** is indicated preoperatively in a **normal healthy patient** with an Oriental/Far eastern (Chinese/Japanese) ethnic origin.

	5	1			1				
1	5	1			3	1			
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Disagree Agree

15.6 **Testing for sickle cell disease/trait** is indicated preoperatively in a **normal healthy patient** with a north African ethnic origin

					1				6
1	1				1			1	7
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Disagree									Agree

15.7 **Testing for sickle cell disease/trait** is indicated preoperatively in a **normal healthy patient** with a west African ethnic origin.

					1				6
1					1				9
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Disagree									Agree

15.8 **Testing for sickle cell disease/trait** is indicated preoperatively in a **normal healthy patient** with a south/sub-saharan African ethnic origin.

					1				6
1					1				9
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Disagree									Agree

15.9 **Testing for sickle cell disease/trait** is indicated preoperatively in a **normal healthy patient** with

					1				6
1	1				1				9
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Disagree									Agree

15.10 **Testing for sickle cell disease/trait** is indicated preoperatively in a **normal healthy patient** with a North American Indian ethnic origin.

	5	1			1				
1	5	1			3	1			
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Disagree Agree

15.11 **Testing for sickle cell disease/trait** is indicated preoperatively in a **normal healthy patient** with a South American Indian ethnic origin.

	5	1			1				
1	5	1			3	1			
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Disagree Agree

15.12 **Testing for sickle cell disease/trait** is indicated preoperatively in a **normal health patient** with an Aboriginal/Maori ethnic origin.

	5	1			1				
1	5	1			3	1			
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Disagree Agree

Comments:

DETERMINING ETHNICITY

How should the ethnic origin of a patient be determined? Please indicate your agreement with the following statements by ringing one or more numbers in each row. ('Relevant ethnic origin' means an ethnic origin for which sickle cell testing is indicated, as documented by your responses to the above questions.)

16.1 Ethnicity should be determined by asking the patient about the ethnic origin of his/her parents.

	1				2			1	3
1	1					1	2		6
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Disagree									Agree

16.2 If either of the patient's parents has a relevant ethnic origin (consistent with the answers given above), the patient should be tested for sickle cell disease/trait.

	1				1			2	3
1								1	9
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Disagree									Agree

16.3 Ethnicity should be determined from the patient's appearance.

	2				1			1	3
1	1	1			2	1	4		1
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Disagree									Agree

16.4 If the patient has a foreign appearance and his/her parentage cannot be determined, the patient should be tested for sickle cell disease/trait

	1			1	2			1	2
1	1					1	3	1	4
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Disagree									Agree

16.5 If the patient does not have a foreign appearance and his/her parentage cannot be determined, the patient should be tested for sickle cell disease/trait.

	4				1			1	1
1	3	2	1		3				1
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Disagree									Agree

16.6 If it is not possible to establish that a patient has a North-European/Caucasian ethic origin, the patient should be tested for sickle cell disease/trait.

	2	1			3				1
1	3		3				3		1
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Disagree									Agree

16.7 The difficulties of establishing confidently whether or not testing for sickle cell disease/trait is indicated mean that all patients undergoing elective surgery should be tested for sickle cell disease/trait.

	6				1				
1	7	2		1					
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Disagree									Agree

CONSENT TO TEST FOR SICKLE CELL DISEASE/TRAIT

The following statements are about the need to obtain consent to test for sickle cell disease/trait in a patient undergoing elective surgery, for whom sickle cell testing has been judged to be advisable. Please indicate your agreement with the following statements by ringing one or more numbers in each row.

17.1 There is no need to obtain consent from the patient if testing for sickle cell disease/trait is indicated.

	4	1	1	1					
1	7	1				1		1	
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Disagree									Agree

17.2 When testing for sickle cell disease/trait is indicated, consent to carry out the test should be obtained.

							1	1	5
1	1			1					8
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Disagree									Agree

Comments:

TESTING FOR PREGNANCY

Cost estimates: **low £1.50** **mid £2.25** **upper £3.00**

To what extent is testing for pregnancy indicated for 'normal healthy women' (ie ASA Grade 1) of reproductive age, undergoing elective surgery? Please indicate your agreement with the following statements by ringing one or more numbers in each row.

17.1 **Testing for pregnancy** is indicated preoperatively in a **normal health female patient** of reproductive age, despite having a history of last menstrual period

	1	1			2			1	2
1	1		1				1	3	4
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Disagree									Agree

17.2 **Testing for pregnancy** is indicated preoperatively in a **normal healthy female patient** of reproductive age, who asserts that it is impossible that she is pregnant

	5	1							1
1					1	1		3	5
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Disagree									Agree

17.3 **Testing for pregnancy** is indicated preoperatively in a **normal healthy female patient** of reproductive age, who says that it is possible she may be pregnant

									7
1									10
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Disagree									Agree

17.4 **Testing for pregnancy** is indicated preoperatively in a **normal healthy female patient** aged between 12 and 16 years

	2	1			1			1	2
1	1	2			1			1	5
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Disagree									Agree

Comments:

CONSENT TO TESTING FOR PREGNANCY

The following statements are about the need to obtain consent to test for pregnancy in a female patient of reproductive age, undergoing elective surgery. Please indicate your agreement with the following statements by ringing one or more numbers in each row.

18.1 There is no need to obtain consent from the patient if she is of reproductive age.

	6	1							
1	5	4			1				
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Disagree									Agree

18.2	When testing for pregnancy in a female patient of reproductive age, consent to carry out the test should be obtained.									
							1			6
	1					1			2	7
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	Disagree									Agree

Comments:

Appendix 4: Phase B Consensus Questionnaire (Results)

ADULTS, CHEST X-RAY

Cost estimates: **low £10.00** **mid £20.50** **upper £31.00**

To what extent is a chest X-ray indicated for patients with **cardiovascular comorbidity** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) cardiovascular comorbidity, by ringing one or more numbers in each column:

1.1 "A **chest X-ray** is indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 1 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**		5	1	**9**	2	4	1	**9**	3	7	1	**9**	3	7	1
	8				**8**		1		**8**				**8**	1		
	7	1	1		**7**	1	1		**7**	1			**7**	1		1
	6			1	**6**			1	**6**	1		1	**6**	1		
	5	1		1	**5**				**5**	1		1	**5**	1	1	3
	4	1	1		**4**	2	1		**4**	2	2		**4**	2	1	
	3	1	1		**3**		1		**3**			1	**3**	2		
	2	2		3	**2**	2		4	**2**			2	**2**			1
Strongly disagree	**1**	6	6	3	2	**1**	4	7	3	2	**1**	4	7	2	2	**1**	4	4	2	2

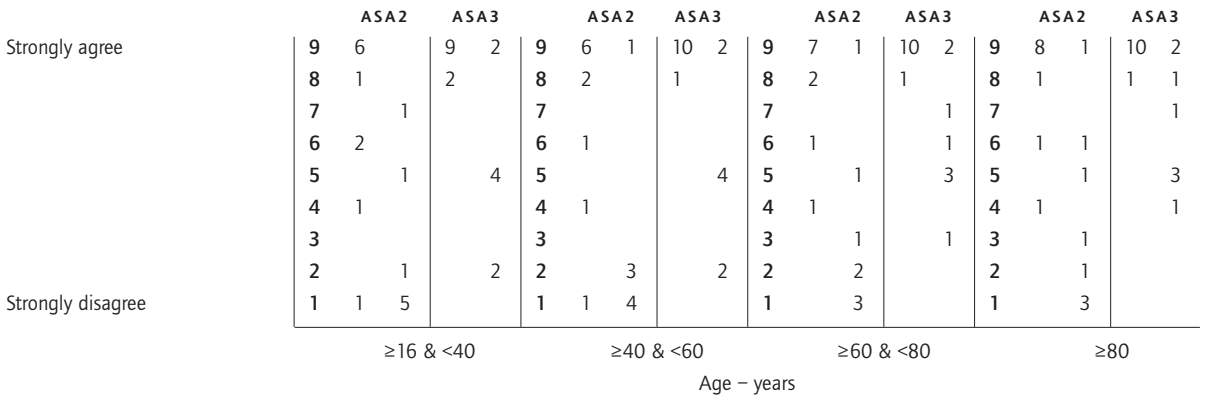
Age – years

1.2 "A **chest X-ray** is indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 2 surgery**, aged as shown."

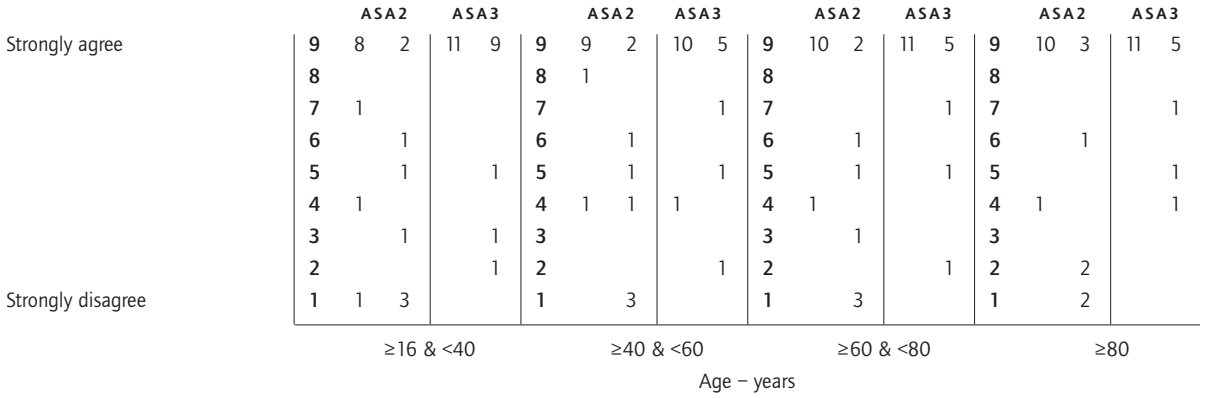
	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	1	5	1	**9**	1	5	1	**9**	3	8	1	**9**	3	1	8	2
	8	1	1		**8**	2	2		**8**	2	1		**8**	3		1	
	7	3	3		**7**	3	2		**7**	2	1		**7**	3		1	
	6	1		1	**6**			1	**6**	1		1	**6**				
	5	2		1	**5**	1	1		**5**	1		1	**5**			1	2
	4	1			**4**	2	1		**4**	2	1		**4**	1			1
	3	1		1	**3**			1	**3**			1	**3**	2			
	2			2	**2**			3	**2**			2	**2**				1
Strongly disagree	**1**	3	6	2	2	**1**	2	7	1	2	**1**	1	7	2	**1**	1	5	2

Age – years

1.3 "A **chest X-ray** is indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 3 surgery**, aged as shown."



1.4 "A **chest X-ray** is indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 4 surgery**, aged as shown."



To what extent is a chest X-ray indicated for patients with **respiratory comorbidity** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **respiratory comorbidity**, by ringing one or more numbers in each column:

1.5 "A **chest X-ray** is indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 1 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2			ASA3			ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**		9	7	1	**9**	2	1	7	1	**9**	3	1	9	1	**9**	4	1	1	2
	8	1		2		**8**			2		**8**			1	1	**8**			1	
	7					**7**			1	1	**7**	3				**7**	2			1
	6	1			1	**6**	1				**6**					**6**	1			
	5	1		1	1	**5**	5			2	**5**	2		1	3	**5**	2	1	1	2
	4			1		**4**			1	1	**4**	1	1			**4**				1
	3				2	**3**	1	1		1	**3**	1			1	**3**	1	1		
	2	2	2		1	**2**	3	2		1	**2**		2		1	**2**		1		1
Strongly disagree	**1**	6	5		2	**1**	3	4		1	**1**	1	4		1	**1**	1	4		1

Age – years

1.6 "A **chest X-ray** is indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 2 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2			ASA3			ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	2	1	9	1	**9**	2	1	9	1	**9**	4	1	9	1	**9**	5	1	10	2
	8	1		1		**8**	2		1		**8**	1		1	1	**8**	2		1	
	7	1				**7**				1	**7**	1				**7**	1	1		1
	6	2			1	**6**	2				**6**	1				**6**				
	5	2			1	**5**	3			2	**5**	2			3	**5**	2			2
	4					**4**				1	**4**		1			**4**				1
	3		1		2	**3**		1		1	**3**				1	**3**		1		
	2		1		1	**2**		2		1	**2**		2		1	**2**		1		1
Strongly disagree	**1**	3	5	1	2	**1**	2	4	1	1	**1**	2	4	1	1	**1**	1	4		1

Age – years

1.7 "A **chest X-ray** is indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 3 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	7	1	11	2	**9**	8	2	11	3	**9**	9	2	11	3	**9**	11	2	11	3
	8				1	**8**					**8**	1				**8**				1
	7		1			**7**	1				**7**					**7**				1
	6	1				**6**	1				**6**				1	**6**				
	5	1			4	**5**				5	**5**				4	**5**		1		3
	4					**4**					**4**					**4**				
	3				1	**3**					**3**					**3**		1		
	2		1			**2**		1			**2**		1			**2**		1		
Strongly disagree	**1**	1	5			**1**	1	5			**1**	1	5			**1**		3		

Age – years

1.8 "A **chest X-ray** is indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 4 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	9	2	11	3	**9**	9	2	11	4	**9**	10	2	11	4	**9**	10	2	11	5
	8				1	**8**	1			1	**8**				1	**8**				1
	7	1				**7**					**7**				1	**7**				
	6					**6**					**6**					**6**				1
	5				3	**5**				3	**5**				2	**5**		5		1
	4					**4**					**4**		1			**4**				
	3	1			1	**3**	1				**3**	1				**3**	1	2		
	2		2			**2**		2			**2**		1			**2**		1		
Strongly disagree	**1**		4			**1**		4			**1**		4			**1**		2		

Age – years

To what extent is a chest X-ray indicated for patients with **comorbidity from renal disease** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **comorbidity from renal disease**, by ringing one or more numbers in each column:

1.9 "A **chest X-ray** is indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 1 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**				**9**				**9**		1		**9**	1		1
	8				**8**				**8**				**8**			1
	7		1		**7**		1		**7**	1	1		**7**	1		1
	6				**6**				**6**		1		**6**			2
	5		1	1	**5**		1	2	**5**		1	2	**5**	1		2
	4		1		**4**		1		**4**	1	1		**4**			2
	3	1	1		**3**	1	2		**3**		1		**3**	1		1 1
	2	1 1	1	2	**2**	2 2	1	2	**2**	1 2	2	2	**2**	1 3		1
Strongly disagree	**1**	9 7	6	5	**1**	8 6	5	4	**1**	8 6	3	4	**1**	6 5	3	4

Age – years

1.10 "A **chest X-ray** is indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 2 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**				**9**				**9**	1	3		**9**	2	3	
	8				**8**				**8**				**8**			
	7		1		**7**		1		**7**	1	1		**7**	1	1	
	6				**6**		1		**6**		2		**6**		3	
	5		3	1	**5**		2	2	**5**	1	1	2	**5**	1		
	4		1		**4**		1		**4**	4			**4**		1	2
	3	1	1		**3**	1	2		**3**	1	2		**3**	2	1	1
	2	2 1	3	3	**2**	2 2	2	2	**2**	2 2	1	2	**2**	1 3	1	1
Strongly disagree	**1**	8 7	2	4	**1**	8 6	2	4	**1**	4 6	1	4	**1**	4 5	1	4

Age – years

1.11 "A **chest X-ray** is indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 3 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	1	3		**9**		5		**9**	3	6		**9**	3	6	
	8		5		**8**		4		**8**		3		**8**		3	2
	7		1		**7**	2			**7**		1		**7**	2	1	
	6	3			**6**	3		1	**6**	3		2	**6**	2	1	
	5	1			**5**	2	1	2	**5**	1	1	1	**5**			1
	4	1	1	1	**4**				**4**			1	**4**	1		
	3			1 3	**3**			1	**3**				**3**		1	1
	2			1	**2**		1		1	**2**	1	1	1	**2**		1	
Strongly disagree	**1**	5	7	4	**1**	4	6	4	**1**	3	6	4	**1**	3	5	4

Age – years

1.12 "A **chest X-ray** is indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 4 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	4	8		**9**	5		9		**9**	6	2	9	2	**9**	5	2	10	2
	8	2	1	3	1	**8**	1	1	2	1	**8**	1		2		**8**	2		1	
	7					**7**		1		1	**7**	1				**7**				
	6					**6**					**6**					**6**	1			
	5	1	1		2	**5**	2			1	**5**				1	**5**				1
	4	1				**4**	1				**4**	1				**4**	1			
	3					**3**					**3**	1				**3**	1			1
	2	1			1	**2**	1			1	**2**				1	**2**		1		
Strongly disagree	**1**	2	6		4	**1**	1	6		4	**1**	1	6		4	**1**	1	5		4

Age – years

Also, please consider:

- **whether there are special kinds of surgery for which a chest X-ray may be required?**
- **If a patient had two or more of the three co-morbidities considered here (but, overall, still classified as ASA grade 2 (or ASA grade 3)), would additional tests be required, ie tests over and above the tests you have indicated would be required for each comorbidity separately?**

ADULTS, ELECTROCARDIOGRAPHY (resting ECG)

Cost estimates: **low £11.00** **mid £26.00** **upper £37.00**

To what extent is a **resting ECG** indicated for patients with **cardiovascular comorbidity** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **cardiovascular comorbidity**, by ringing one or more numbers in each column:

2.1 "A **resting ECG** is indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 1 surgery**, aged as shown."

	≥16 & <40		≥40 & <60		≥60 & <80		≥80	
	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3
Strongly agree	**9** 10 4	10 5	**9** 10	10 7	**9** 10 6	10 7	**9** 10 6	10 7
	8 1	1 1	**8** 1	1 1	**8** 1	1 1	**8** 1	1 1
	7 1	2	**7**		**7**		**7**	
	6 1		**6**		**6**		**6**	
	5		**5**		**5**		**5**	
	4 1		**4**		**4**		**4**	
	3		**3**		**3**		**3**	
	2		**2**		**2**		**2**	
Strongly disagree	**1** 1		**1**		**1**		**1**	

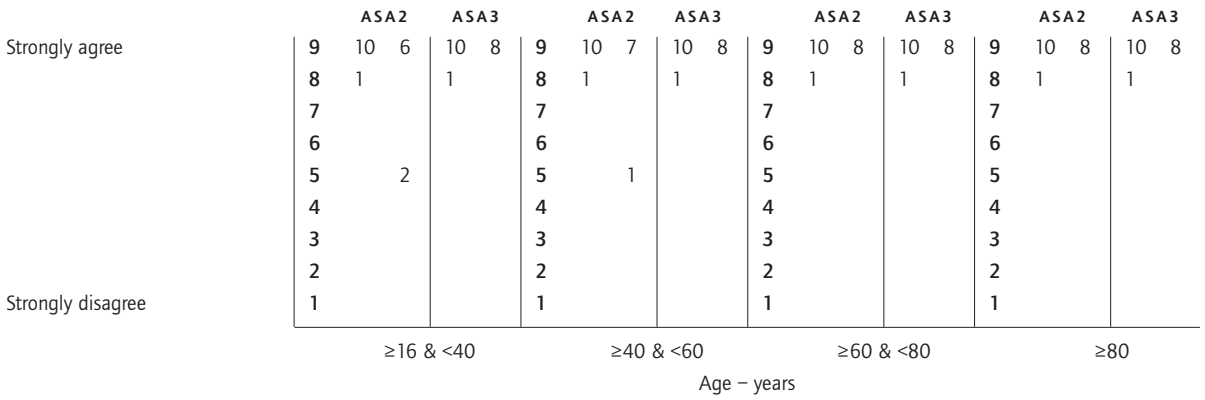
Age – years

2.2 "A **resting ECG** is indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 2 surgery**, aged as shown."

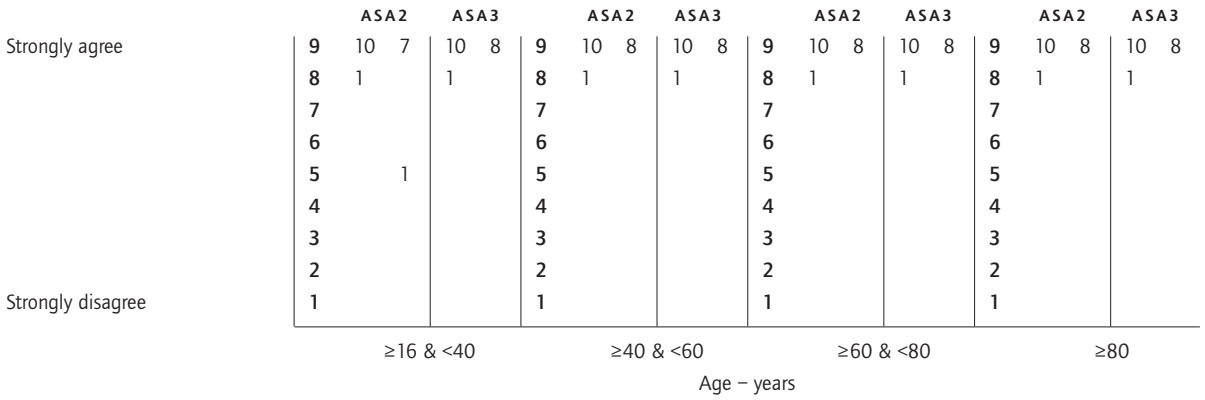
	≥16 & <40		≥40 & <60		≥60 & <80		≥80	
	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3
Strongly agree	**9** 10 6	10 8	**9** 10 6	10 8	**9** 10 6	10 8	**9** 10 6	10 8
	8 1	1	**8** 1	1	**8** 1	1	**8** 1	1
	7		**7**		**7**		**7**	
	6		**6**		**6**		**6**	
	5 1		**5** 1		**5** 2		**5** 2	
	4		**4**		**4**		**4**	
	3		**3**		**3**		**3**	
	2		**2**		**2**		**2**	
Strongly disagree	**1** 1		**1** 1		**1**		**1**	

Age – years

2.3 "A **resting ECG** is indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 3 surgery**, aged as shown."



2.4 "A **resting ECG** is indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 4 surgery**, aged as shown."



To what extent is a **resting ECG** indicated for patients with **respiratory comorbidity** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **respiratory comorbidity**, by ringing one or more numbers in each column:

2.5 "A **resting ECG** is indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 1 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**		1	2	**9**			2	**9**	8	3	10	4	**9**	7	3	10	4
	8		1		**8**		4		**8**	2		1		**8**	3		1	1
	7	1	1		**7**	2	2		**7**	1	1		1	**7**	1	1		
	6		1	1	**6**	2	1	1	**6**					**6**		1		
	5	1	1	2	**5**	1	1	3	**5**		1		3	**5**		1		3
	4				**4**	2	4	1	**4**		1			**4**				
	3				**3**				**3**					**3**				
	2	2	1	1	**2**	1	1		**2**		2			**2**		2		
Strongly disagree	**1**	7	6	5	3	**1**	3	5	2	2	**1**				**1**			

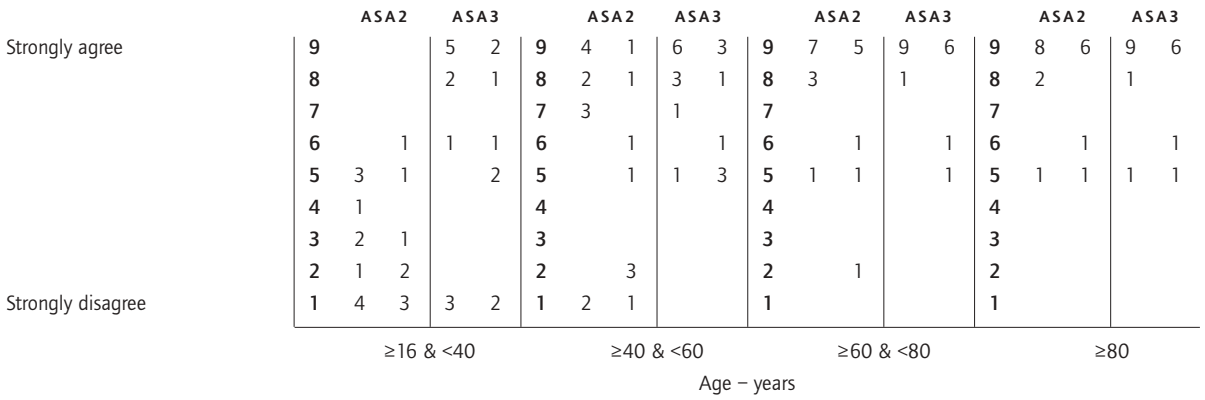
Age – years

2.6 "A **resting ECG** is indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 2 surgery**, aged as shown."

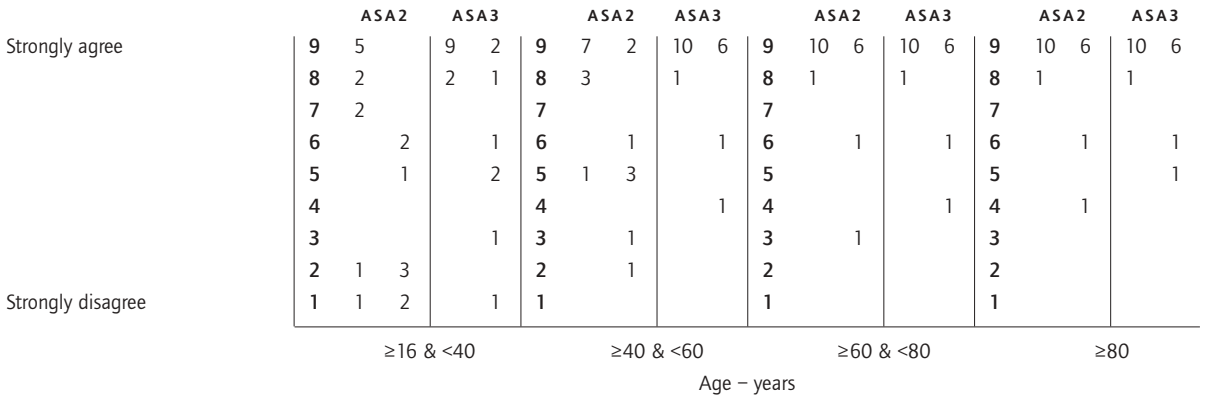
	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**		2	2	**9**	1	3	2	**9**	7	2	9	4	**9**	7	4	9	5
	8		2		**8**		2		**8**	3	2	1	2	**8**	3	1	1	1
	7			1	**7**	3	1	1	**7**					**7**				
	6		1	1	**6**	2	1	1	**6**					**6**				
	5	1	2	1	1	**5**	1	2	2	**5**	1	3	1	2	**5**	1	2	1	2
	4					**4**	1	1	**4**					**4**				
	3	1		1		**3**		1	**3**					**3**				
	2	1	2			**2**	1	1	**2**					**2**		1		
Strongly disagree	**1**	8	4	4	3	**1**	3	4	2	1	**1**		1		**1**			

Age – years

2.7 "A **resting ECG** is indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 3 surgery**, aged as shown."



2.8 "A **resting ECG** is indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 4 surgery**, aged as shown."



To what extent is a resting ECG indicated for patients with **comorbidity from renal disease** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **comorbidity from renal disease**, by ringing one or more numbers in each column:

2.9 "A **resting ECG** is indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 1 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**		2	1	**9**	2		3	1	**9**	4	4	9	4	**9**	4	5	10	5
	8		1		**8**			2		**8**	4		2		**8**	4		1	
	7		1		**7**			1		**7**		1		1	**7**	2			
	6		2	1	1	**6**		2	1	1	**6**	1				**6**			
	5					**5**		1		2	**5**	1				**5**	1		
	4	2		1		**4**	2		1		**4**					**4**			
	3		1	1	2	**3**	3	1		1	**3**		2		2	**3**		2		3
	2	3	1			**2**	1				**2**		1		1	**2**		1		
Strongly disagree	**1**	6	4	4	4	**1**	3	4	3	3	**1**	1	1			**1**				

Age – years

2.10 "A **resting ECG** is indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 2 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**		1	5	1	**9**	3	1	6	1	**9**	5	5	10	5	**9**	7	6	10	6
	8				1	**8**			1	1	**8**	3		1		**8**	3		1	
	7					**7**			1		**7**		1		1	**7**				
	6			1		**6**		1	1	1	**6**					**6**				
	5		2	1	1	**5**	1	3		3	**5**	2				**5**	1			
	4	2		1	2	**4**	3				**4**					**4**				
	3	1	3			**3**	1				**3**		1		1	**3**		1		2
	2	2	1			**2**					**2**		1		1	**2**		1		
Strongly disagree	**1**	6	3	3	3	**1**	3	3	2	2	**1**	1				**1**				

Age – years

2.11 "A **resting ECG** is indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 3 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	3	1	6	2	**9**	5	2	7	4	**9**	8	6	10	6	**9**	9	6	10	6
	8		1	1	1	**8**			1	1	**8**	2		1		**8**	2		1	
	7			1	1	**7**	2		2		**7**	1				**7**				
	6	1		1		**6**		1			**6**					**6**				
	5	2	1	1		**5**	3	1	1		**5**					**5**				
	4					**4**					**4**					**4**				1
	3	1	2		1	**3**		2		1	**3**		2		2	**3**		2		1
	2	1	1		1	**2**		1		1	**2**					**2**				
Strongly disagree	**1**	3	2	1	2	**1**	1	1		1	**1**					**1**				

Age – years

2.12 "A **resting ECG** is indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 4 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	7	1	9	1	**9**	8	2	9	5	**9**	9	6	10	6	**9**	10	6	10	6
	8		1	1	2	**8**	2		1	1	**8**	2		1		**8**	1		1	
	7	3				**7**		1	1		**7**					**7**				
	6					**6**	1				**6**					**6**				
	5		1	1	3	**5**		2			**5**					**5**				
	4		1			**4**					**4**					**4**				1
	3	1				**3**					**3**		2		2	**3**		2		1
	2		2		1	**2**		2		1	**2**					**2**				
Strongly disagree	**1**		2		1	**1**		1		1	**1**					**1**				

Age – years

Also, please consider:

> **whether there are special kinds of surgery for which a resting ECG may be required?**

> **If a patient had two or more of the three co-morbidities considered here (but, overall, still classified as ASA grade 2 (or ASA grade 3)), would additional tests be required, ie tests over and above the tests you have indicated would be required for each comorbidity separately?**

ADULTS, FULL BLOOD COUNT

Cost estimates: **low £0.70** **mid £2.35** **upper £4.05**

To what extent is a **full blood count** indicated for patients with **cardiovascular comorbidity** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **cardiovascular comorbidity** and for males (**M**) and females (**F**), by ringing one or more numbers in each column:

3.1 "A **full blood count** is indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 1 surgery**, aged as shown."

	ASA2					ASA3					ASA2					ASA3					ASA2					ASA3					ASA2					ASA3				
	M			F		M			F		M			F		M			F		M			F		M			F		M			F		M			F	
Strongly agree	**9**	2	2	4	3	**9**	4	3	8	4	**9**	4	2	7	3	**9**	5	3	7	4	**9**	6	3	7	3	**9**	8	4	9	4	**9**	6	3	7	3	**9**	8	4	9	4
	8	1		3		**8**			1		**8**			2		**8**	1	1	3	1	**8**	3		3		**8**	2		2		**8**	3		3		**8**	3		2	
	7			1		**7**	3	1	2	1	**7**	3	1	1	1	**7**	3		1		**7**					**7**					**7**					**7**				
	6	3	1		1	**6**	2				**6**	1				**6**					**6**					**6**					**6**					**6**				
	5	2		1		**5**	1				**5**	1				**5**	1				**5**	1				**5**	1				**5**	1				**5**		2		2
	4	1		1	1	**4**				1	**4**				1	**4**				1	**4**		1		1	**4**		1		1	**4**		1		1	**4**				
	3		1			**3**		1			**3**		1			**3**		1			**3**					**3**					**3**					**3**				
Strongly disagree	**2**					**2**					**2**					**2**					**2**					**2**					**2**					**2**				
	1	2	4	1	3	**1**	1	3		2	**1**	2	4	1	3	**1**	1	3		2	**1**	1	4	1	4	**1**		3		3	**1**	1	4	1	4	**1**		2		2
	≥16 & <40										≥40 & <60										≥60 & <80										≥80									

3.2 "A **full blood count** is indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 2 surgery**, aged as shown."

	ASA2					ASA3					ASA2					ASA3					ASA2					ASA3					ASA2					ASA3				
	M			F		M			F		M			F		M			F		M			F		M			F		M			F		M			F	
Strongly agree	**9**	5	2	6	3	**9**	6	3	7	4	**9**	6	2	7	3	**9**	6	4	7	5	**9**	6	4	7	4	**9**	8	5	9	5	**9**	8	4	9	4	**9**	9	5	10	5
	8			1		**8**	1	1	3	1	**8**	1	1	3	1	**8**	2		3		**8**	4		3		**8**	3		2		**8**	3		2		**8**	2		1	
	7	1	1	2	1	**7**	2		1		**7**	2				**7**	3		1		**7**					**7**					**7**					**7**				
	6	4		1		**6**	2				**6**	1				**6**					**6**					**6**					**6**					**6**				
	5					**5**		1		1	**5**					**5**		1		1	**5**		1		1	**5**		2		2	**5**		3		3	**5**		3		3
	4				1	**4**				1	**4**				1	**4**				1	**4**		1		1	**4**					**4**					**4**				
	3		1			**3**		1			**3**		1			**3**		1			**3**					**3**					**3**					**3**				
Strongly disagree	**2**					**2**					**2**					**2**					**2**					**2**					**2**					**2**				
	1	1	4	1	3	**1**		2		1	**1**	1	4	1	3	**1**		2		1	**1**	1	2	1	2	**1**		1		1	**1**		1		1	**1**				
	≥16 & <40										≥40 & <60										≥60 & <80										≥80									

3.3 "A full **blood count** is indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 3 surgery**, aged as shown."

	ASA2				ASA3				ASA2				ASA3				ASA2				ASA3				ASA2				ASA3			
	M		F		M		F		M		F		M		F		M		F		M		F		M		F		M		F	
Strongly agree	**9**	8	6	8	6	**9**	9	6	9	6	**9**	8	6	9	6	**9**	9	6	9	6	**9**	10	7	10	7	**9**	10	7	10	7	**9**	10	8	10	8	**9**	10	8	10	8
	8	2		3	1	**8**	2		2	1	**8**	3		2	1	**8**	2		2	1	**8**	1		1		**8**	1		1		**8**	1		1		**8**	1		1	
	7	1	1			**7**		1			**7**		1			**7**		1			**7**					**7**					**7**					**7**				
	6					**6**					**6**					**6**					**6**					**6**					**6**					**6**				
	5					**5**		1		1	**5**					**5**		1		1	**5**					**5**					**5**					**5**				
	4					**4**					**4**					**4**					**4**					**4**					**4**					**4**				
	3					**3**					**3**					**3**					**3**		1		1	**3**					**3**					**3**				
Strongly disagree	**2**		1		1	**2**					**2**		1		1	**2**					**2**					**2**					**2**					**2**				
	1					**1**					**1**					**1**					**1**					**1**					**1**					**1**				
	≥16 & <40								≥40 & <60								≥60 & <80								≥80																

3.4 "A full **blood count** is indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 4 surgery**, aged as shown."

	ASA2				ASA3				ASA2				ASA3				ASA2				ASA3				ASA2				ASA3			
	M		F		M		F		M		F		M		F		M		F		M		F		M		F		M		F	
Strongly agree	**9**	10	8	10	8	**9**	10	8	10	8	**9**	10	8	10	8	**9**	10	8	10	8	**9**	10	8	10	8	**9**	10	8	10	8	**9**	10	8	10	8	**9**	10	8	10	8
	8	1		1		**8**	1		1		**8**	1		1		**8**	1		1		**8**	1		1		**8**	1		1		**8**	1		1		**8**	1		1	
	7					**7**					**7**					**7**					**7**					**7**					**7**					**7**				
	6					**6**					**6**					**6**					**6**					**6**					**6**					**6**				
	5					**5**					**5**					**5**					**5**					**5**					**5**					**5**				
	4					**4**					**4**					**4**					**4**					**4**					**4**					**4**				
	3					**3**					**3**					**3**					**3**					**3**					**3**					**3**				
Strongly disagree	**2**					**2**					**2**					**2**					**2**					**2**					**2**					**2**				
	1					**1**					**1**					**1**					**1**					**1**					**1**					**1**				
	≥16 & <40								≥40 & <60								≥60 & <80								≥80																

To what extent is a **full blood count** indicated for patients with **respiratory comorbidity** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **respiratory comorbidity** and for males (**M**) and females (**F**), by ringing one or more numbers in each column:

3.5 "A **full blood count** is indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 1 surgery**, aged as shown."

	ASA2				ASA3				ASA2				ASA3				ASA2				ASA3				ASA2				ASA3			
	M		F		M		F		M		F		M		F		M		F		M		F		M		F		M		F	
Strongly agree	**9**		1		1	**9**	5	2	6	2	**9**	1	1	2	1	**9**	7	2	7	2	**9**	5	2	5	2	**9**	9	3	9	3	**9**	6	2	6	2	**9**	9	5	9	5
	8					**8**	1	1	1	1	**8**	1		1		**8**	2	1	2	1	**8**	4		4		**8**	2	2	2	2	**8**	4	1	4	1	**8**	2		2	
	7					**7**	2		2		**7**	2		3		**7**		1	1	1	**7**		1	1	1	**7**					**7**		1		1	**7**				
	6	2		2		**6**		1	1	1	**6**			1		**6**	2		1		**6**	1	1		1	**6**					**6**					**6**		1		1
	5	1		2		**5**	1			1	**5**	1	1		1	**5**		1		2	**5**					**5**		2		2	**5**		2		2	**5**		1		1
	4	1	1	1	2	**4**			1		**4**	1		1	1	**4**		1			**4**		1		1	**4**					**4**					**4**				
	3	1	1	1	1	**3**		1			**3**	1	1	1	1	**3**					**3**					**3**					**3**					**3**				
Strongly disagree	**2**	1	1			**2**	1				**2**	1	1	1		**2**					**2**					**2**		1		1	**2**		2		1	**2**		1		1
	1	5	4	5	4	**1**	1	3		3	**1**	3	4	1	4	**1**		2		2	**1**	1	3	1	3	**1**					**1**	1	1	1	1	**1**				
	≥16 & <40					≥40 & <60										≥60 & <80										≥80									

3.6 "A **full blood count** is indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 2 surgery**, aged as shown."

	ASA2				ASA3				ASA2				ASA3				ASA2				ASA3				ASA2				ASA3			
	M		F		M		F		M		F		M		F		M		F		M		F		M		F		M		F	
Strongly agree	**9**	3	1	5	1	**9**	7	2	8	2	**9**	3	1	5	1	**9**	8	2	10	3	**9**	7	2	9	2	**9**	10	3	10	3	**9**	8	3	10	3	**9**	10	5	10	5
	8					**8**	2	1	3	1	**8**	3		2		**8**	3	2	1	2	**8**	3		2		**8**	1	2	1	2	**8**	2		1		**8**	1		1	
	7	1		2		**7**	2	1		1	**7**	1		2		**7**					**7**		1		1	**7**					**7**		1		1	**7**				
	6	4		1		**6**					**6**	1	1		1	**6**					**6**	1	1		1	**6**					**6**	1				**6**		1		1
	5		1		1	**5**		1		2	**5**	1	2		2	**5**		2		3	**5**		3		3	**5**		3		3	**5**		3		3	**5**		2		2
	4				1	**4**					**4**		1		2	**4**		1			**4**					**4**					**4**					**4**				
	3	2	1	2	1	**3**		1			**3**	1		1		**3**					**3**					**3**					**3**					**3**				
Strongly disagree	**2**		2		1	**2**					**2**		1			**2**					**2**					**2**					**2**					**2**				
	1	1	1	1	3	**1**		2		2	**1**	1	2	1	2	**1**		1			**1**		1		1	**1**					**1**		1		1	**1**				
	≥16 & <40					≥40 & <60										≥60 & <80										≥80									

3.7 "A **full blood count** is indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 3 surgery**, aged as shown."

	ASA2				ASA3				ASA2				ASA3				ASA2				ASA3				ASA2				ASA3			
	M		F		M		F		M		F		M		F		M		F		M		F		M		F		M		F	
Strongly	**9**	10	4	10	4	**9**	10	5	10	5	**9**	10	5	10	5	**9**	10	5	10	5	**9**	10	5	10	5	**9**	10	6	10	6	**9**	10	6	10	6
agree	**8**	1	2	1	2	**8**	1	1	1	1	**8**	1	1	1	1	**8**	1	1	1	1	**8**	1	1	1	1	**8**	1	2	1	2	**8**	1	2	1	2
	7					**7**					**7**					**7**					**7**		1		1	**7**		1		1	**7**				
	6				1	**6**		1		1	**6**				1	**6**		1		1	**6**					**6**					**6**				
	5		1			**5**					**5**		1			**5**		1		1	**5**		1		1	**5**					**5**				
	4					**4**					**4**					**4**					**4**					**4**					**4**				
	3					**3**					**3**					**3**					**3**					**3**					**3**				
Strongly	**2**					**2**					**2**					**2**					**2**					**2**					**2**				
disagree	**1**		1		1	**1**		1		1	**1**		1		1	**1**					**1**					**1**					**1**				
	≥16 & <40					≥40 & <60										≥60 & <80										≥80									

3.8 "A **full blood count** is indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 4 surgery**, aged as shown."

	ASA2				ASA3				ASA2				ASA3				ASA2				ASA3				ASA2				ASA3			
	M		F		M		F		M		F		M		F		M		F		M		F		M		F		M		F	
Strongly	**9**	10	7	10	7	**9**	10	8	10	8	**9**	10	8	10	8	**9**	10	8	10	8	**9**	10		10		**9**	110	8	10	8	**9**	10	8	10	8
agree	**8**	1	1	1	1	**8**	1		1		**8**	1		1		**8**	1		1		**8**	1		1		**8**	1		1		**8**	1		1	
	7					**7**					**7**					**7**					**7**					**7**					**7**				
	6					**6**					**6**					**6**					**6**					**6**					**6**				
	5					**5**					**5**					**5**					**5**					**5**					**5**				
	4					**4**					**4**					**4**					**4**					**4**					**4**				
	3					**3**					**3**					**3**					**3**					**3**					**3**				
Strongly	**2**					**2**					**2**					**2**					**2**					**2**					**2**				
disagree	**1**					**1**					**1**					**1**					**1**					**1**					**1**				
	≥16 & <40					≥40 & <60										≥60 & <80										≥80									

To what extent is a **full blood count** indicated for patients with **comorbidity from renal disease** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **comorbidity from renal disease** and for males (**M**) and females (**F**), by ringing one or more numbers in each column:

3.9 "A **full blood count** is indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 1 surgery**, aged as shown."

	ASA2					ASA3					ASA2					ASA3					ASA2					ASA3				
	M			F		M			F		M			F		M			F		M			F		M			F	
Strongly	**9**	4	3	4	3	**9**	10	7	11	7	**9**	4	4	5	4	**9**	10	7	11	7	**9**	8	5	8	5	**9**	11	7	11	7	**9**	10	5	10	5	**9**	11	7	11	7
agree	**8**	3		4		**8**					**8**	2	1	2	1	**8**	1				**8**	1		1		**8**					**8**	1		1		**8**				
	7	1	1	1	1	**7**					**7**	1		1		**7**					**7**	1		1		**7**					**7**					**7**				
	6	1				**6**	1				**6**	2		1		**6**					**6**	1		1		**6**					**6**					**6**				
	5	1	3	1	4	**5**		1		1	**5**		3		3	**5**		1		1	**5**		3		3	**5**		1		1	**5**		3		3	**5**		1		1
	4					**4**					**4**	1		1		**4**					**4**					**4**					**4**					**4**				
	3					**3**					**3**					**3**					**3**					**3**					**3**					**3**				
Strongly	**2**					**2**					**2**					**2**					**2**					**2**					**2**					**2**				
disagree	**1**	1	1	1		**1**					**1**	1		1		**1**					**1**					**1**					**1**					**1**				
	≥16 & <40										≥40 & <60										≥60 & <80										≥80									

3.10 "A **full blood count** is indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 2 surgery**, aged as shown."

	ASA2					ASA3					ASA2					ASA3					ASA2					ASA3				
	M			F		M			F		M			F		M			F		M			F		M			F	
Strongly	**9**		4	7	4	**9**	11	7	11	7	**9**	6	4	8	4	**9**	10	7	11	7	**9**	9	5	10	5	**9**	11	7	11	7	**9**	11	5	11	5	**9**	11	7	11	7
agree	**8**	1		1		**8**					**8**	3	1	2	1	**8**	1				**8**	2		1		**8**					**8**					**8**				
	7	1	1	1	1	**7**					**7**	1				**7**					**7**					**7**					**7**					**7**				
	6					**6**					**6**					**6**					**6**					**6**					**6**		1		1	**6**				
	5	1	3	1	3	**5**		1		1	**5**		3		3	**5**		1		1	**5**		3		3	**5**		1		1	**5**		2		2	**5**		1		1
	4					**4**					**4**					**4**					**4**					**4**					**4**					**4**				
	3					**3**					**3**					**3**					**3**					**3**					**3**					**3**				
Strongly	**2**					**2**					**2**					**2**					**2**					**2**					**2**					**2**				
disagree	**1**	1		1		**1**					**1**	1		1		**1**					**1**					**1**					**1**					**1**				
	≥16 & <40										≥40 & <60										≥60 & <80										≥80									

3.11 "A **full blood count** is indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 3 surgery**, aged as shown."

	ASA2				ASA3				ASA2				ASA3				ASA2				ASA3				ASA2				ASA3			
	M		F		M		F		M		F		M		F		M		F		M		F		M		F		M		F	
Strongly agree	9	11	7	11	7	9	11	8	11	8	9	11	7	11	7	9	11	8	11	8	9	11	8	11	8	9	11	8	11	8	9	11	8	11	8
	8					8					8					8					8					8					8			
	7		1		1	7					7		1		1	7					7					7					7			
	6					6					6					6					6					6					6			
	5					5					5					5					5					5					5			
	4					4					4					4					4					4					4			
	3					3					3					3					3					3					3			
Strongly disagree	2					2					2					2					2					2					2			
	1					1					1					1					1					1					1			
	≥16 & <40					≥40 & <60										≥60 & <80										≥80								

3.12 "A **full blood count** is indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 4 surgery**, aged as shown."

	ASA2				ASA3				ASA2				ASA3				ASA2				ASA3				ASA2				ASA3			
	M		F		M		F		M		F		M		F		M		F		M		F		M		F		M		F	
Strongly agree	9	11	8	11	8	9	11	8	11	8	9	11	8	11	8	9	11	8	11	8	9	11	8	11	8	9	11	8	11	8	9	11	8	10	8
	8					8					8					8					8					8					8			
	7					7					7					7					7					7					7			
	6					6					6					6					6					6					6			
	5					5					5					5					5					5					5			
	4					4					4					4					4					4					4			
	3					3					3					3					3					3					3			
Strongly disagree	2					2					2					2					2					2					2			
	1					1					1					1					1					1					1			
	≥16 & <40					≥40 & <60										≥60 & <80										≥80								

ADULTS, TESTS OF HAEMOSTASIS

Cost estimates: **low £1.50** **mid £3.65** **upper £5.85**

To what extent are **tests of haemostasis** indicated for patients with **cardiovascular comorbidity** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **cardiovascular comorbidity**, by ringing one or more numbers in each column:

4.1 "**Tests of haemostasis** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 1 surgery**, aged as shown."

	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3
Strongly agree	9		9		9		9	
	8		8		8		8	
	7		7		7		7	
	6		6		6		6	
	5		5		5		5	
	4		4		4		4	
	3 1	1	3 1	1	3 1	1	3 1	1
	2		2		2		2	
Strongly disagree	1 11 7	11 7	1 11 7	11 7	1 11 7	11 7	1 11 7	11 7
	≥16 & <40		≥40 & <60		≥60 & <80		≥80	

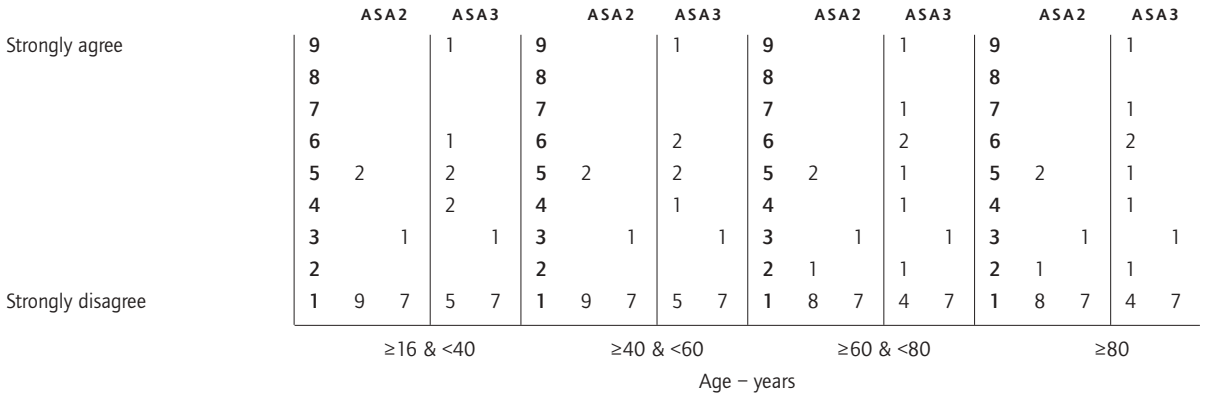
Age – years

4.2 "**Tests of haemostasis** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 2 surgery**, aged as shown."

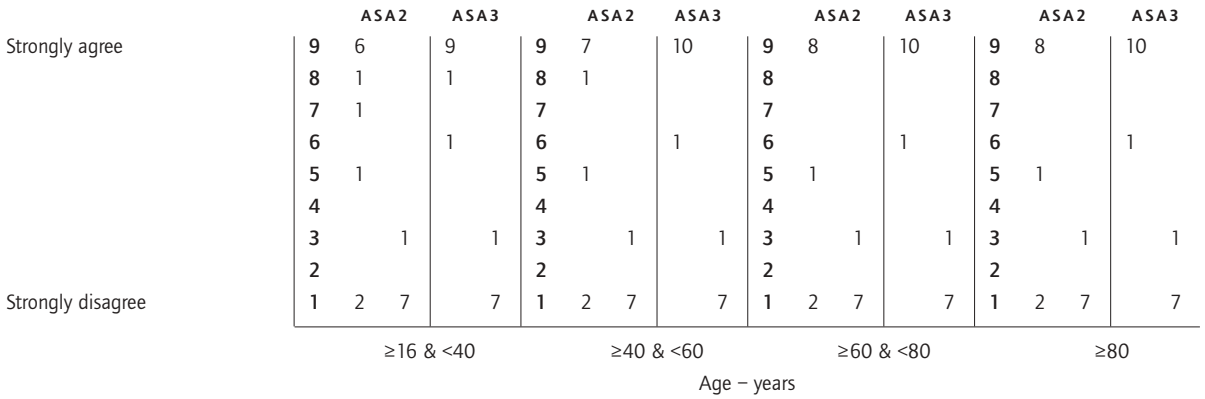
	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3
Strongly agree	9		9		9		9	
	8		8		8		8	
	7		7		7		7	
	6		6		6		6	
	5		5		5		5	
	4		4		4		4	
	3 1	1	3 1	1	3 1	1	3 1	1
	2		2		2		2	
Strongly disagree	1 11 7	11 7	1 11 7	11 7	1 11 7	11 7	1 11 7	11 7
	≥16 & <40		≥40 & <60		≥60 & <80		≥80	

Age – years

4.3 "**Tests of haemostasis** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 3 surgery**, aged as shown."



4.4 "**Tests of haemostasis** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 4 surgery**, aged as shown."



To what extent are **tests of haemostasis** indicated for patients with **respiratory comorbidity** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **respiratory comorbidity**, by ringing one or more numbers in each column:

4.5 "**Tests of haemostasis** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 1 surgery**, aged as shown."

	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3
Strongly agree	9		9		9		9	
	8		8		8		8	
	7		7		7		7	
	6		6		6		6	
	5		5		5		5	
	4		4		4		4	
	3	1	3	1	3	3	3	1
	2		2		2		2	
Strongly disagree	1 11 7	11 7	1 11 7	11 7	1 11 7	11 7	1 11 7	11 7
	≥16 & <40		≥40 & <60		≥60 & <80		≥80	

Age – years

4.6 "**Tests of haemostasis** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 2 surgery**, aged as shown."

	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3
Strongly agree	9		9		9		9	
	8		8		8		8	
	7		7		7		7	
	6		6		6		6	
	5		5		5		5	
	4		4		4		4	
	3	1	3	1	3	1	3	1
	2		2		2		2	
Strongly disagree	1 11 7	11 7	1 11 7	11 7	1 11 7	11 7	1 11 7	11 7
	≥16 & <40		≥40 & <60		≥60 & <80		≥80	

Age – years

4.7 "**Tests of haemostasis** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 3 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**				**9**				**9**				**9**		1	
	8				**8**				**8**				**8**			
	7				**7**				**7**				**7**			
	6				**6**				**6**				**6**			
	5				**5**				**5**				**5**			
	4				**4**				**4**				**4**			
	3		1		**3**		1		**3**		1		**3**		1	
	2	1		1	**2**	1		1	**2**	2		2	**2**	2		2
Strongly disagree	**1**	10	7	10	**1**	10	7	10	**1**	9	7	9	**1**	9	7	8	7

Age – years

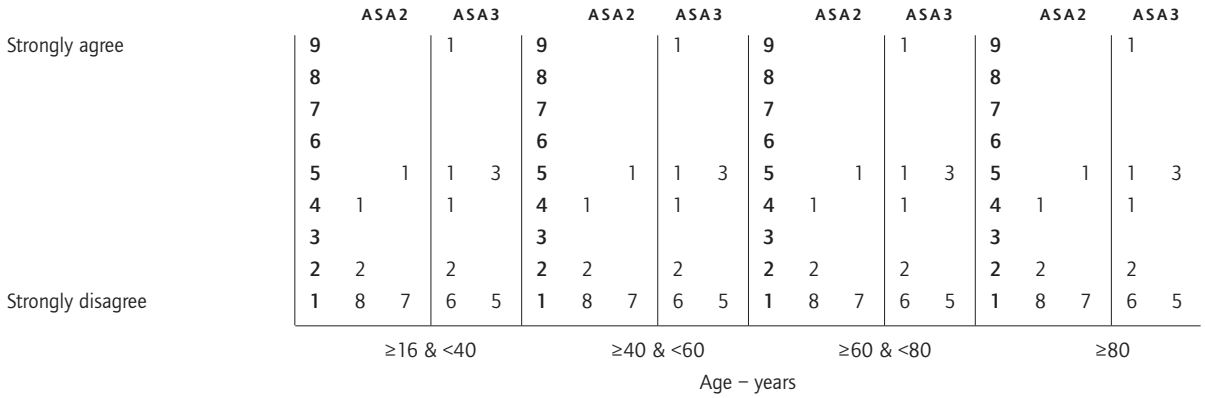
4.8 "**Tests of haemostasis** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 4 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	5		6	**9**	6		6	**9**	6		6	**9**	6		5
	8	1			**8**				**8**				**8**			
	7				**7**				**7**				**7**			
	6	2		2	**6**	2		2	**6**	2		2	**6**	2		1
	5	1		1	**5**	1		1	**5**	1		1	**5**	1		1
	4				**4**				**4**				**4**			
	3		1		**3**		1		**3**		1		**3**		1	
	2				**2**				**2**				**2**			1
Strongly disagree	**1**	2	7	2	**1**	2	7	2	**1**	2	7	2	**1**	2	7	3	7

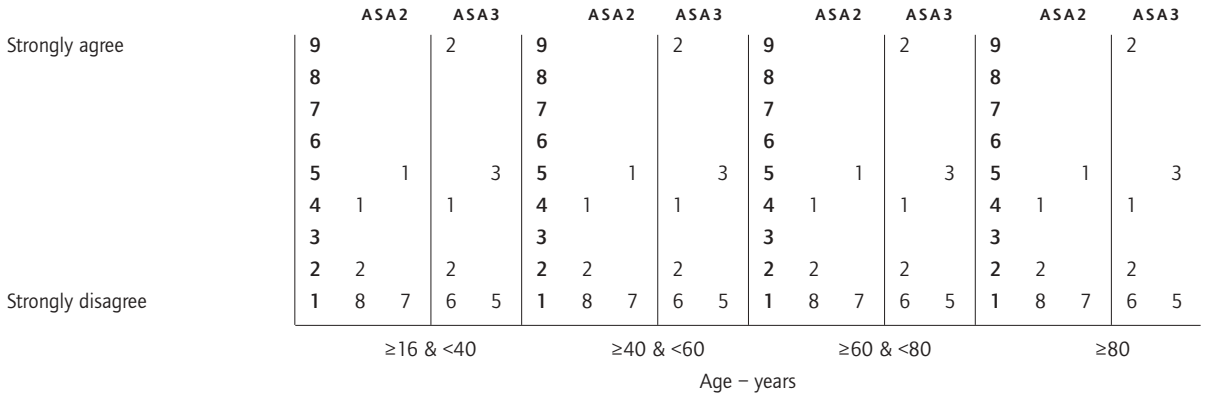
Age – years

To what extent are tests of haemostasis indicated for patients with **comorbidity from renal disease** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **comorbidity from renal disease**, by ringing one or more numbers in each column:

4.9 "**Tests of haemostasis** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 1 surgery**, aged as shown."



4.10 "**Tests of haemostasis** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 2 surgery**, aged as shown."



4.11 "**Tests of haemostasis** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 3 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	1	4	1	**9**	1	4	1	**9**	1	4	1	**9**	1	4	1
	8				**8**				**8**				**8**			
	7				**7**				**7**		1		**7**		1	
	6	1	1		**6**	1	1		**6**	1	1		**6**	1	1	
	5	1	2	4	**5**	1	2	4	**5**	1	1	4	**5**	1	1	4
	4	1	1		**4**	1	1		**4**	2	1		**4**	2	1	
	3				**3**				**3**				**3**			
	2	1			**2**	1			**2**	1			**2**	1		
Strongly disagree	**1**	6	3	3	**1**	6	3	3	**1**	5	3	3	**1**	5	3	3

Age – years

4.12 "**Tests of haemostasis** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 4 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	6	9	1	**9**	7	9	1	**9**	7	9	1	**9**	7	9	1
	8	1			**8**				**8**				**8**			
	7				**7**				**7**	1			**7**	1		
	6	2	1		**6**	2	1		**6**	1	1		**6**	1	1	
	5	3		5	**5**	3		5	**5**	3		5	**5**	3		5
	4				**4**				**4**				**4**			
	3	1		1	**3**	1		1	**3**	1		1	**3**	1		1
	2				**2**				**2**				**2**			
Strongly disagree	**1**	2	1	1	**1**	2	1	1	**1**	2	1	1	**1**	2	1	1

Age – years

ADULTS, RENAL FUNCTION TESTS (ie potassium, sodium, creatine, urea)

Cost estimates: **low £1.40** **mid £3.40** **upper £5.40**

To what extent are **renal function tests** indicated for patients with **cardiovascular comorbidity** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **cardiovascular comorbidity**, by ringing one or more numbers in each column:

5.1 "**Renal function tests** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 1 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	4 3	8 5		**9**	7 3	8 5		**9**	7 4	9 7		**9**	8 5	9 7	
	8	1	2 1		**8**	1	2 1		**8**	1 1	2		**8**	1	2	
	7	3 1			**7**	3	1		**7**	3			**7**	2		
	6	1			**6**	1			**6**				**6**			
	5	1 2	1 1		**5**	2	1		**5**	1			**5**	1		
	4				**4**				**4**				**4**			
	3				**3**				**3**				**3**			
	2				**2**				**2**				**2**			
Strongly disagree	**1**	1 2	1		**1**	2	1		**1**	2	1		**1**	2	1	

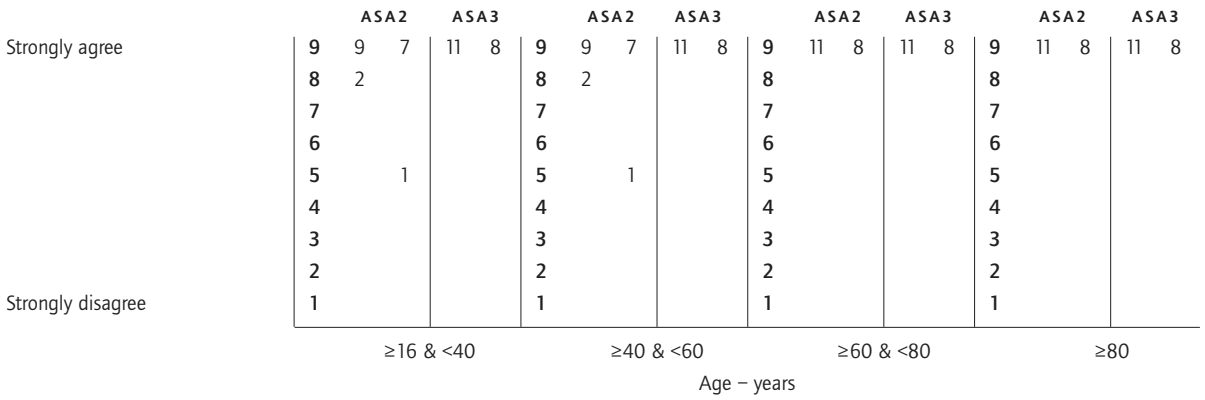
Age – years

5.2 "**Renal function tests** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 2 surgery**, aged as shown."

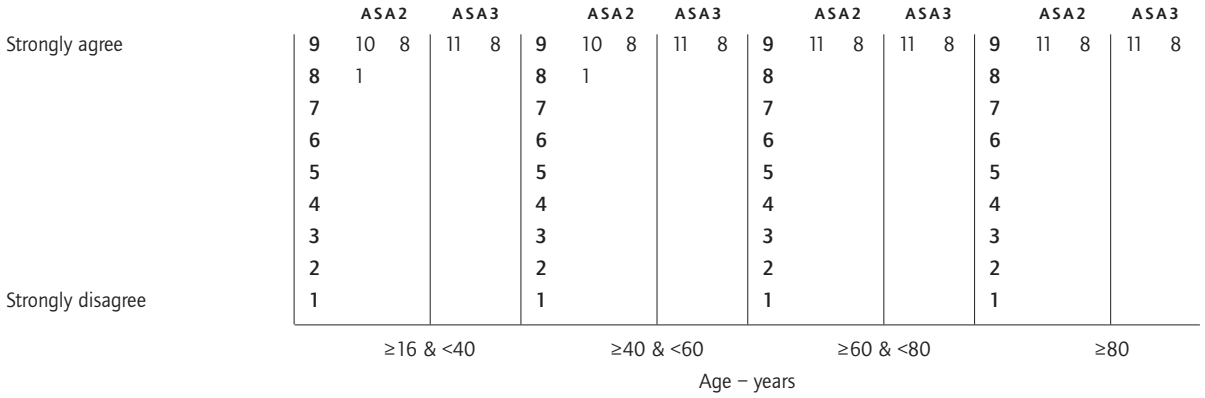
	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	5 3	7 7		**9**	7 3	9 7		**9**	5	9 8		**9**	8 6	9 8	
	8	1 1	4 1		**8**	1 1	2 1		**8**	1	2		**8**	1	2	
	7	5			**7**	3			**7**				**7**	2		
	6				**6**				**6**				**6**			
	5	4			**5**	4			**5**	2			**5**	2		
	4				**4**				**4**				**4**			
	3				**3**				**3**				**3**			
	2				**2**				**2**				**2**			
Strongly disagree	**1**				**1**				**1**				**1**			

Age – years

5.3 "**Renal function tests** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 3 surgery**, aged as shown."



5.4 "**Renal function tests** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 4 surgery**, aged as shown."



To what extent are **renal function tests** indicated for patients with **respiratory comorbidity** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **respiratory comorbidity**, by ringing one or more numbers in each column:

5.5 "**Renal function tests** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 1 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	9		9		9		10		9		10	1	9		10	1
	8		1		8				8	1			8	1		
	7				7				7				7	2		
	6				6				6	1			6	1		1
	5	2		2	5	2		3	5	2	3	2	5	1	3	1	2
	4				4			1	4		1	1	2	4			1
	3	2	1	1	3	3	1	1	3	2				3	2		
	2	3			2	4			2	1				2	1		
Strongly disagree	1	6	5	1	5	1	4	5	1	3	1	4	4	3	1	4	4	3

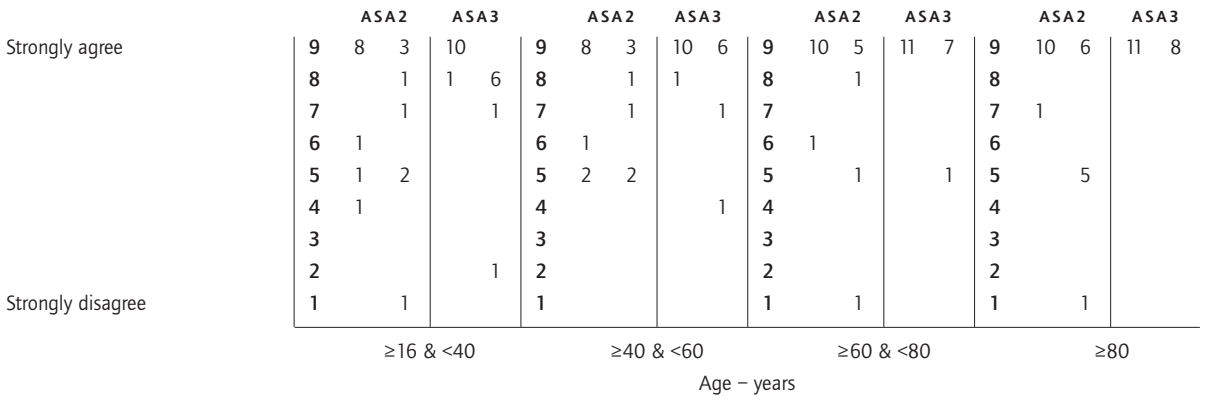
Age – years

5.6 "**Renal function tests** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 2 surgery**, aged as shown."

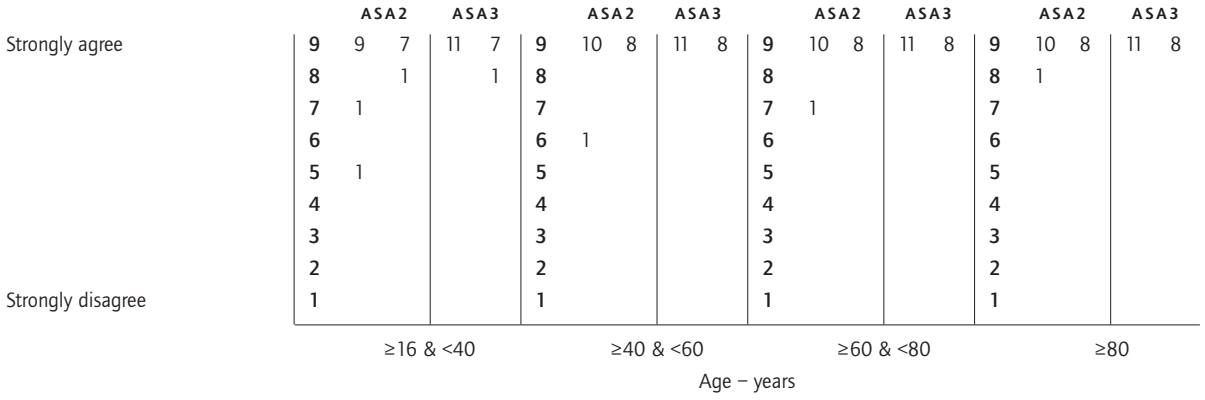
	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	9		9		9	1	10	1	9	2	1	10	1	9	2	1	10	1
	8		1		8				8	1				8	1			
	7	1			7				7	2				7	3			
	6				6				6					6		1		1
	5		2	2	5		2	2	5	1	2	2		5		2	1	2
	4				4	1	1	2	4		1	1	2	4				1
	3	3	1	1	3	4			3	2				3	2			
	2	3			2	1			2	1				2	1			
Strongly disagree	1	4	5	1	5	1	4	5	1	3	1	2	4	3	1	2	4	3

Age – years

5.7 "**Renal function tests** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 3 surgery**, aged as shown."

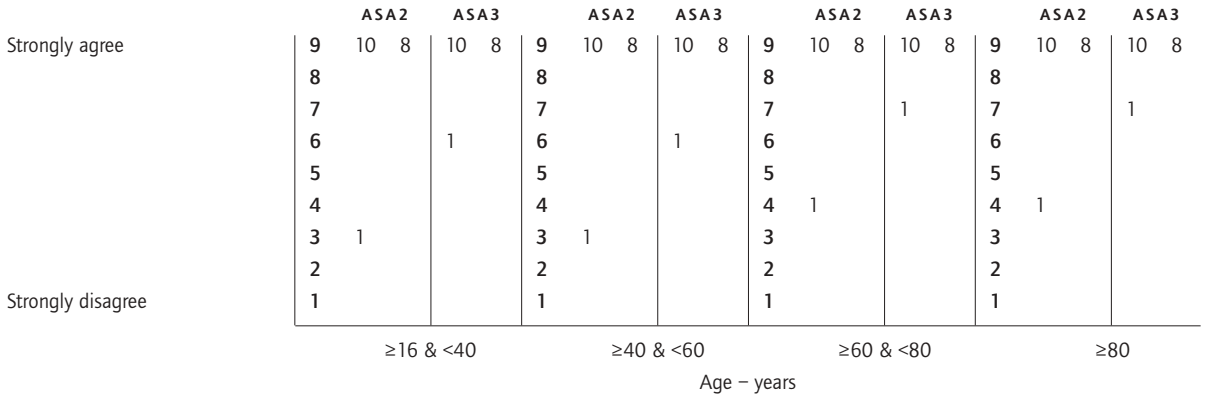


5.8 "**Renal function tests** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 4 surgery**, aged as shown."

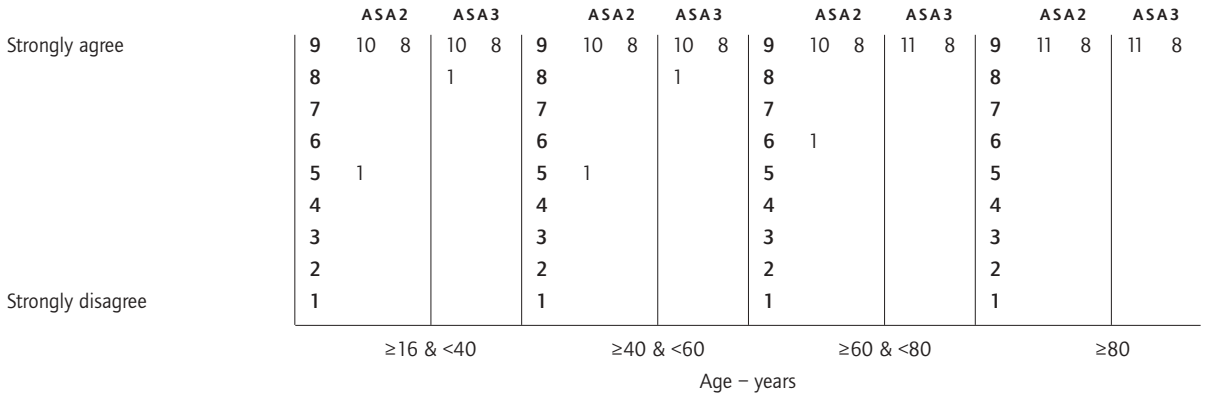


To what extent are **renal function tests** indicated for patients with **comorbidity from renal disease** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **comorbidity from renal disease**, by ringing one or more numbers in each column:

5.9 "**Renal function tests** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 1 surgery**, aged as shown."

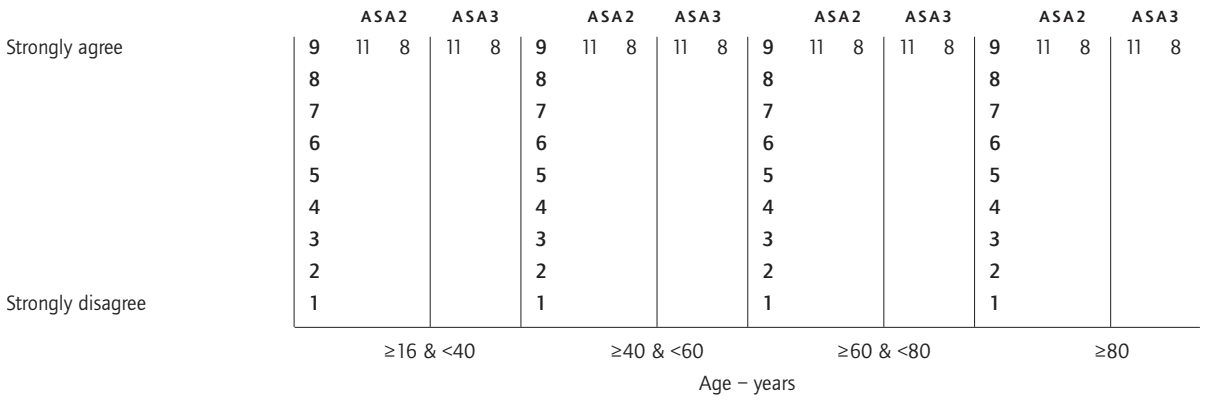


5.10 "**Renal function tests** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 2 surgery**, aged as shown."

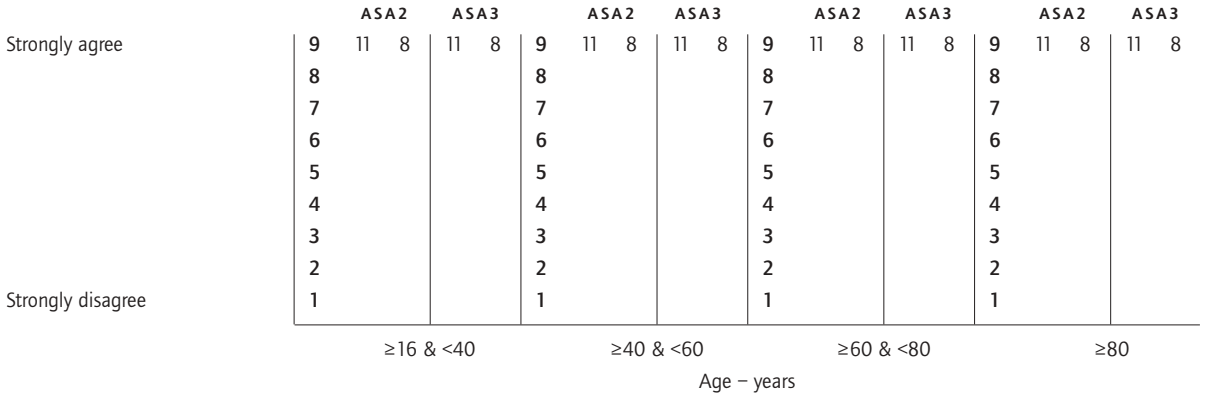


.

5.11 "**Renal function tests** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 3 surgery**, aged as shown."



5.12 "**Renal function tests** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 4 surgery**, aged as shown."



Also, please consider:

> **whether there are special kinds of surgery for which renal function tests may be required?**

> **If a patient had two or more of the three co-morbidities considered here (but, overall, still classified as ASA grade 2 (or ASA grade 3)), would additional tests be required, ie tests over and above the tests you have indicated would be required for each comorbidity separately?**

ADULTS, RANDOM BLOOD GLUCOSE TESTING

Cost estimates: **low £1.05** **mid £2.30** **upper £3.60**

To what extent is random **blood glucose testing** indicated for patients with **cardiovascular comorbidity** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **cardiovascular comorbidity**, by ringing one or more numbers in each column:

6.1 "**Blood glucose testing** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 1 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	9				9				9				9			
	8				8				8				8			
	7				7				7				7			
	6				6				6				6			
	5	2		2	5	2		2	5	2		2	5	2		2
	4				4		1		4		1		4		1	
	3	1		1	3	1		1	3	1		1	3	1		1
	2				2				2				2			
Strongly disagree	1	10	8	10	6	1	10	6	9	8	1	10	6	9	6	1	10	6	9	6

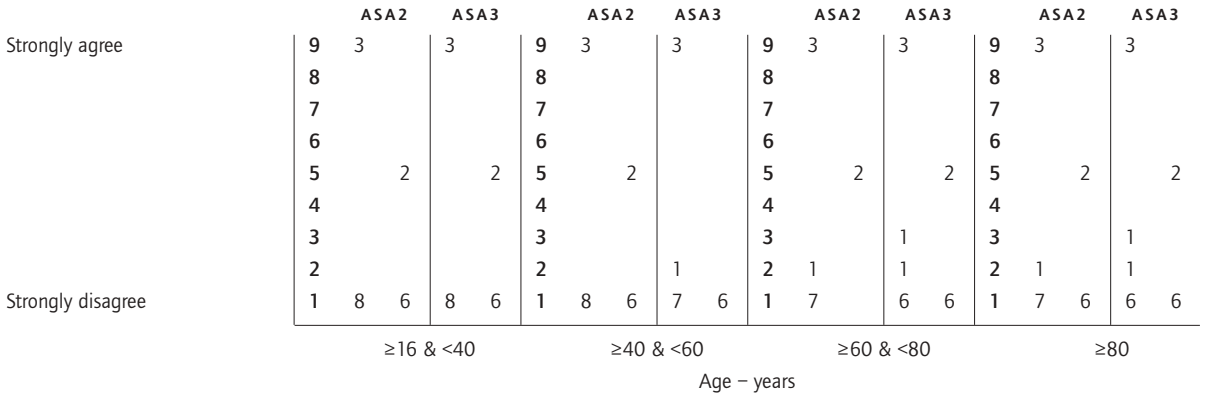
Age – years

6.2 "**Blood glucose testing** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 2 surgery**, aged as shown."

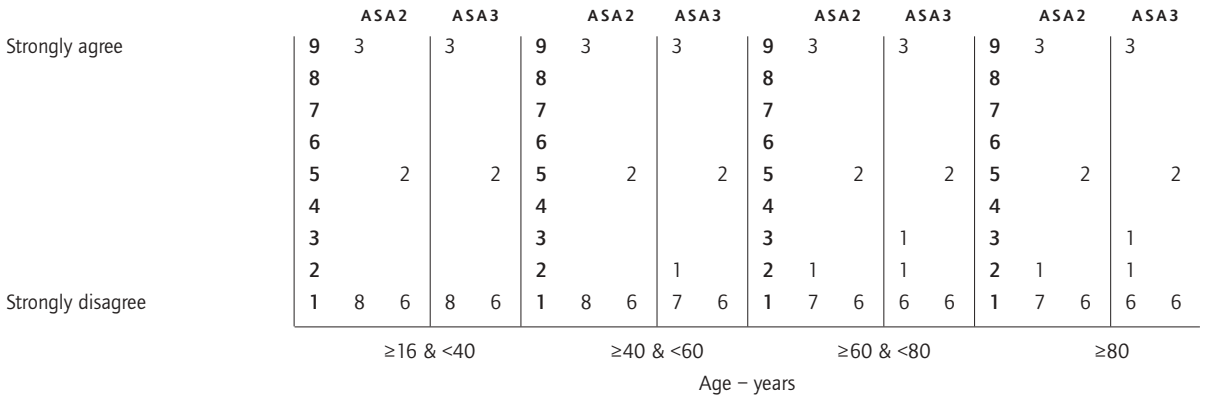
	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	9				9	1		1	9	1		1	9	1		1
	8	1		1	8				8				8			
	7				7				7				7			
	6				6				6				6			
	5	2		2	5	2		2	5	2		2	5	2		2
	4				4				4				4			
	3	1		1	3	1		1	3	1		1	3	1		1
	2				2		1		2		1		2		1	
Strongly disagree	1	9	6	9	6	1	9	6	8	6	1	9	6	8	6	1	9	6	8	6

Age – years

6.3 "**Blood glucose testing** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 3 surgery**, aged as shown."



6.4 "**Blood glucose testing** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 4 surgery**, aged as shown."



To what extent is random **blood glucose testing** indicated for patients with **respiratory comorbidity** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **respiratory comorbidity**, by ringing one or more numbers in each column:

6.5 "**Blood glucose testing** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 1 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	9				9				9				9			
	8				8				8				8			
	7		1		7		1		7		1		7		1	
	6				6				6				6			
	5	1		1	5	1		1	5	1		1	5	1		1
	4				4				4				4			
	3				3				3				3			
	2				2				2				2			
Strongly disagree	1	11	7	10 7	1	11	7	10 7	1	11	7	10 7	1	11	7	10 7

Age – years

6.6 "**Blood glucose testing** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 2 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	9				9	1		1	9	2		2	9	2		2
	8				8	1		1	8				8			
	7		1		7			1	7		1		7		1	
	6				6				6				6			
	5	1	1	1 1	5		1	1	5		1	1	5		1	1
	4				4				4				4			
	3				3				3				3			
	2				2				2				2			
Strongly disagree	1	10	7	9 7	1	9	7	8 7	1	9	7	8 7	1	9	7	8 7

Age – years

6.7 "**Blood glucose testing** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 3 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	1	2		**9**	2	3		**9**	2	3		**9**	2	3	
	8				**8**				**8**				**8**			
	7		1		**7**		1		**7**		1		**7**		1	
	6				**6**				**6**				**6**			
	5	1		1	**5**		1		**5**			1	**5**		1	
	4		1		**4**				**4**				**4**			
	3				**3**				**3**				**3**			
	2				**2**		1		**2**	1	1		**2**	1	1	
Strongly disagree	**1**	9	7	7	**1**	9	7	6	**1**	8	6	7	**1**	8	7	6	7

Age – years

6.8 "**Blood glucose testing** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 4 surgery**, aged as shown."

	≥16 & <40					≥40 & <60					≥60 & <80					≥80				
	ASA2			ASA3		ASA2			ASA3		ASA2			ASA3		ASA2			ASA3	
Strongly agree	**9**	1	1	2	1	**9**	2	1	3	1	**9**	2	1	3	1	**9**	2	1	3	1
	8					**8**					**8**					**8**				
	7	1		1		**7**			1		**7**			1		**7**			1	
	6					**6**					**6**					**6**				
	5		1		1	**5**		1		1	**5**		1		1	**5**		1		1
	4			1		**4**					**4**					**4**				
	3					**3**					**3**					**3**				
	2					**2**			1		**2**	1		1		**2**	1		1	
Strongly disagree	**1**	9	6	7	6	**1**	9	6	6	6	**1**	8	6	6	6	**1**	8	6	6	6

Age – years

To what extent is random **blood glucose testing** indicated for patients with **comorbidity from renal disease** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **comorbidity from renal disease**, by ringing one or more numbers in each column:

6.9 "**Blood glucose testing** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 1 surgery**, aged as shown."

	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3
Strongly agree	9	1	9	1	9 1	1	9 1	1
	8		8		8		8	
	7		7		7		7	
	6 1		6 1		6		6	
	5 2	1 3	5 2	1 3	5 2	1 3	5 2	1 3
	4		4		4		4	
	3		3		3		3	
	2		2	1	2 1	1	2 1	1
Strongly disagree	1 10 6	9 5	1 10 6	8 5	1 9 6	8 5	1 9 6	8 5
	≥16 & <40		≥40 & <60		≥60 & <80		≥80	

Age – years

6.10 "**Blood glucose testing** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 2 surgery**, aged as shown."

	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3
Strongly agree	9	1	9	1	9 1	1	9 1	1
	8		8		8		8	
	7		7		7		7	
	6 1	1	6 1	1	6	1	6	1
	5 2	2	5 2	1 2	5 2	1 2	5 1 2	1 2
	4		4		4		4	
	3		3		3		3	
	2		2	1	2 1	1	2 1	1
Strongly disagree	1 10 6	10 5	1 10 6	8 5	1 9 6	8 5	1 8 6	8 5
	≥16 & <40		≥40 & <60		≥60 & <80		≥80	

Age – years

6.11 "**Blood glucose testing** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 3 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	1	1		**9**	2	2		**9**	2	2		**9**	2	2	
	8	1	1		**8**				**8**				**8**			
	7	1		2	**7**	1		2	**7**	1		2	**7**	1		2
	6				**6**				**6**				**6**			
	5	2		3	**5**	2		3	**5**	1	2	1 3	**5**	1	2	1 3
	4	1			**4**	1			**4**		1		**4**		1	
	3				**3**				**3**				**3**			
	2		1		**2**		1		**2**	1		1	**2**	1		1
Strongly disagree	**1**	9	4	8 3	**1**	9	4	8 3	**1**	7	4	7 3	**1**	7	4	7 3

Age – years

6.12 "**Blood glucose testing** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 4 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	2	1	2 1	**9**	2	1	3 1	**9**	3	1	3 1	**9**	3	1	3 1
	8		1	2	**8**		1	2	**8**		1	2	**8**		1	2
	7				**7**				**7**				**7**			
	6				**6**				**6**				**6**			
	5		1	1	**5**		1	1	**5**		1	1	**5**		1	1
	4				**4**				**4**				**4**			
	3				**3**				**3**				**3**			
	2				**2**			1	**2**	1		1	**2**	1		1
Strongly disagree	**1**	9	5	9 4	**1**	9	5	7 4	**1**	7	5	7 4	**1**	7	5	7 4

Age – years

ADULTS, URINE ANALYSIS ('dipstick' for protein, bilirubin, glucose, ketones, blood, UTIs)

Cost estimates: **low £0.15** **mid £0.21** **upper £0.27**

To what extent is **urine analysis** indicated for patients with **cardiovascular comorbidity** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **cardiovascular comorbidity**, by ringing one or more numbers in each column:

7.1 "**Urine analysis** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 1 surgery**, aged as shown."

	ASA2			ASA3		ASA2			ASA3		ASA2			ASA3		ASA2			ASA3	
Strongly agree	**9**	5	2	6	2	**9**	7	2	8	2	**9**	7	2	8	2	**9**	7	2	8	2
	8	1	1	1	1	**8**		1		1	**8**		1		1	**8**		1		1
	7					**7**					**7**					**7**				
	6					**6**					**6**					**6**				
	5					**5**					**5**					**5**				
	4					**4**					**4**					**4**				
	3					**3**					**3**					**3**				
	2					**2**					**2**					**2**				
Strongly disagree	**1**	5	5	4	5	**1**	4	5	3	5	**1**	4	5	3	5	**1**	4	5	3	5
	≥16 & <40					≥40 & <60					≥60 & <80					≥80				

Age – years

7.2 "**Urine analysis** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 2 surgery**, aged as shown."

	ASA2			ASA3		ASA2			ASA3		ASA2			ASA3		ASA2			ASA3	
Strongly agree	**9**	5	2	6	2	**9**	6	2	7	2	**9**	7	2	8	2	**9**	7	2	8	2
	8	1	1	1	1	**8**	1	1	1	1	**8**		1		1	**8**		1		1
	7					**7**					**7**					**7**				
	6					**6**					**6**					**6**				
	5					**5**					**5**					**5**				
	4					**4**					**4**					**4**				
	3					**3**					**3**					**3**				
	2					**2**					**2**					**2**				
Strongly disagree	**1**	5	5	4	5	**1**	4	5	3	5	**1**	4	5	3	5	**1**	4	5	3	5
	≥16 & <40					≥40 & <60					≥60 & <80					≥80				

Age – years

7.3 "**Urine analysis** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 3 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	8	2	8	2	**9**	9	2	9	2	**9**	9	2	9	2	**9**	9	2	9	2
	8	1	1	1	1	**8**		1		1	**8**		1		1	**8**		1		1
	7					**7**					**7**					**7**				
	6					**6**					**6**					**6**				
	5					**5**					**5**					**5**				
	4					**4**					**4**					**4**				
	3					**3**					**3**					**3**				
	2					**2**					**2**					**2**				
Strongly disagree	**1**	2	5	2	5	**1**	2	5	2	5	**1**	2	5	2	5	**1**	2	5	2	5

Age – years

7.4 "**Urine analysis** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 4 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	9	3	9	3	**9**	9	3	9	3	**9**	9	3	9	3	**9**	9	3	9	3
	8		1		1	**8**		1		1	**8**		1		1	**8**		1		1
	7				1	**7**				1	**7**				1	**7**				1
	6					**6**					**6**					**6**				
	5		1			**5**		1			**5**		1			**5**		1		
	4					**4**					**4**					**4**				
	3					**3**					**3**					**3**				
	2					**2**					**2**					**2**				
Strongly disagree	**1**	2	3	2	3	**1**	2	3	2	3	**1**	2	3	2	3	**1**	2	3	2	3

Age – years

To what extent is **urine analysis** indicated for patients with **respiratory comorbidity** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **respiratory comorbidity**, by ringing one or more numbers in each column:

7.5 "**Urine analysis** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 1 surgery**, aged as shown."

	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3
Strongly agree	9 5 2	5 2	9 7 2	7 2	9 7 2	7 2	9 7 2	7 2
	8 1 1	1 1	8 1	1	8 1	1	8 1	1
	7		7		7		7	
	6		6		6		6	
	5		5		5		5	
	4		4		4		4	
	3		3		3		3	
	2		2		2		2	
Strongly disagree	1 5 5	5 5	1 4 5	4 5	1 4 5	4 5	1 4 5	4 5
	≥16 & <40		≥40 & <60		≥60 & <80		≥80	

Age – years

7.6 "**Urine analysis** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 2 surgery**, aged as shown."

	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3
Strongly agree	9 5 2	6 2	9 6 2	7 2	9 8 2	8 2	9 8 2	7 2
	8 1 1	1 1	8 1 1	1 1	8 1	1	8 1	1 1
	7 1	1	7		7		7	
	6		6		6		6	
	5		5		5		5	
	4		4		4		4	
	3		3		3		3	
	2		2		2		2	
Strongly disagree	1 4 5	3 5	1 4 5	3 5	1 3 5	3 5	1 3 5	3 5
	≥16 & <40		≥40 & <60		≥60 & <80		≥80	

Age – years

7.7 "**Urine analysis** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 3 surgery**, aged as shown."

	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	8	2	9	2	**9**	9	2	9	2	**9**	9	2	9	2	**9**	9	2	9	2
	8	1	1		1	**8**		1		1	**8**		1		1	**8**		1		1
	7					**7**					**7**					**7**				
	6					**6**					**6**					**6**				
	5					**5**					**5**					**5**				
	4					**4**					**4**					**4**				
	3					**3**					**3**					**3**				
	2					**2**					**2**					**2**				
Strongly disagree	**1**	2	5	2	5	**1**	2	5	2	5	**1**	2	5	2	5	**1**	2	5	2	5
	≥16 & <40					≥40 & <60					≥60 & <80					≥80				

Age – years

7.8 "**Urine analysis** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 4 surgery**, aged as shown."

	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	9	3	9	3	**9**	9	3	9	3	**9**	9	3	9	3	**9**	9	3	9	3
	8		1		1	**8**		1		1	**8**		1		1	**8**		1		1
	7					**7**					**7**					**7**				
	6					**6**					**6**					**6**				
	5					**5**					**5**					**5**				
	4					**4**					**4**					**4**				
	3					**3**					**3**					**3**				
	2					**2**					**2**					**2**				
Strongly disagree	**1**	2	4	2	4	**1**	2	4	2	4	**1**	2	4	2	4	**1**	2	4	2	4
	≥16 & <40					≥40 & <60					≥60 & <80					≥80				

Age – years

To what extent is **urine analysis** indicated for patients with **comorbidity from renal disease** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **comorbidity from renal disease**, by ringing one or more numbers in each column:

7.9 "**Urine analysis** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 1 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	8	8	1	**9**	9	9	1	**9**	9	9	1	**9**	9	9	1
	8	1		1	**8**	1		1	**8**	1		1	**8**	1		1
	7				**7**				**7**				**7**			
	6				**6**				**6**				**6**			
	5				**5**				**5**				**5**			
	4				**4**				**4**				**4**			
	3				**3**				**3**				**3**			
	2	1		1	**2**	1		1	**2**	1		1	**2**	1		1
Strongly disagree	**1**	3	3	5	**1**	2	2	5	**1**	2	2	5	**1**	2	2	5

Age – years

7.10 "**Urine analysis** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 2 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	8	8	1	**9**	9	9	1	**9**	9	9	1	**9**	9	9	1
	8	1	1	1	**8**	1		1	**8**	1		1	**8**	1		1
	7				**7**				**7**				**7**			
	6				**6**				**6**				**6**			
	5				**5**				**5**				**5**			
	4				**4**				**4**				**4**			
	3				**3**				**3**				**3**			
	2	1		1	**2**	1		1	**2**	1		1	**2**	1		1
Strongly disagree	**1**	2	2	5	**1**	2	2	5	**1**	2	2	5	**1**	2	2	5

Age – years

7.11 "**Urine analysis** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 3 surgery**, aged as shown."

	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	9	1	9	1	**9**	9	1	9	1	**9**	9	1	9	1	**9**	9	1	9	1
	8		1		1	**8**		1		1	**8**		1		1	**8**		1		1
	7					**7**					**7**					**7**				
	6					**6**					**6**					**6**				
	5					**5**					**5**					**5**				
	4					**4**					**4**					**4**				
	3					**3**					**3**					**3**				
	2		1		1	**2**		1		1	**2**		1		1	**2**		1		1
Strongly disagree	**1**	2	5	2	5	**1**	2	5	2	5	**1**	2	5	2	5	**1**	2	5	2	5
	≥16 & <40					≥40 & <60					≥60 & <80					≥80				

Age – years

7.12 "**Urine analysis** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 4 surgery**, aged as shown."

	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	9	1	9	1	**9**	9	1	9	1	**9**	9	1	9	1	**9**	9	1	9	1
	8		1		1	**8**		1		1	**8**		1		1	**8**		1		1
	7					**7**					**7**					**7**				
	6					**6**					**6**					**6**				
	5					**5**					**5**					**5**				
	4					**4**					**4**					**4**				
	3					**3**					**3**					**3**				
	2		1		1	**2**		1		1	**2**		1		1	**2**		1		1
Strongly disagree	**1**	2	5	2	5	**1**	2	5	2	5	**1**	2	5	2	5	**1**	2	5	2	5
	≥16 & <40					≥40 & <60					≥60 & <80					≥80				

Age – years

ADULTS, TESTING OF BLOOD GASES

Cost estimates: **low £2.60** **mid £3.10** **upper £3.60**

To what extent is **testing of blood gases** indicated for patients with **cardiovascular comorbidity** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **cardiovascular comorbidity**, by ringing one or more numbers in each column:

8.1 "**Testing of blood gases** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 1 surgery**, aged as shown."

	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3
Strongly agree	9		9		9		9	
	8		8		8		8	
	7		7		7		7	
	6		6		6		6	
	5		5		5		5	
	4		4		4		4	
	3		3		3		3	
	2		2		2		2	
Strongly disagree	1 11 8	11 8	1 11 8	11 8	1 11 8	11 8	1 11 8	11 8
	≥16 & <40		≥40 & <60		≥60 & <80		≥80	

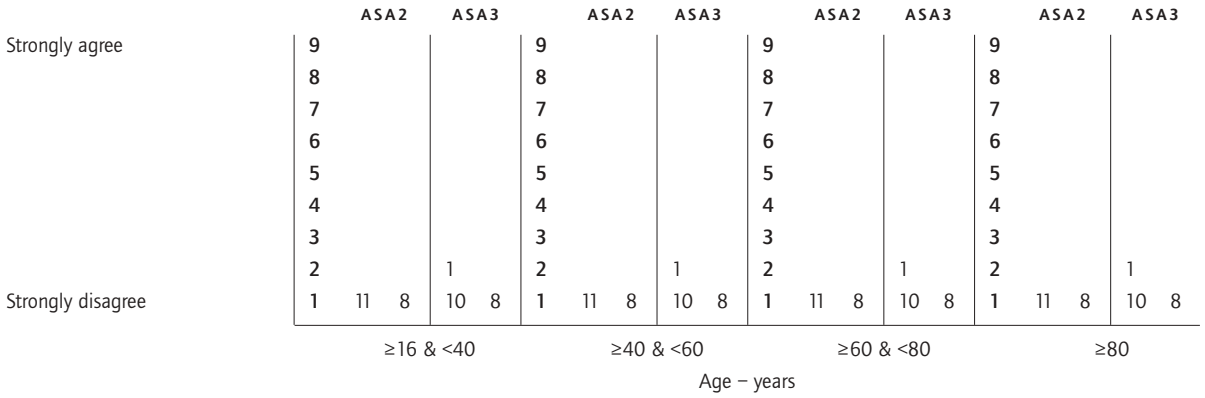
Age – years

8.2 "**Testing of blood gases** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 2 surgery**, aged as shown."

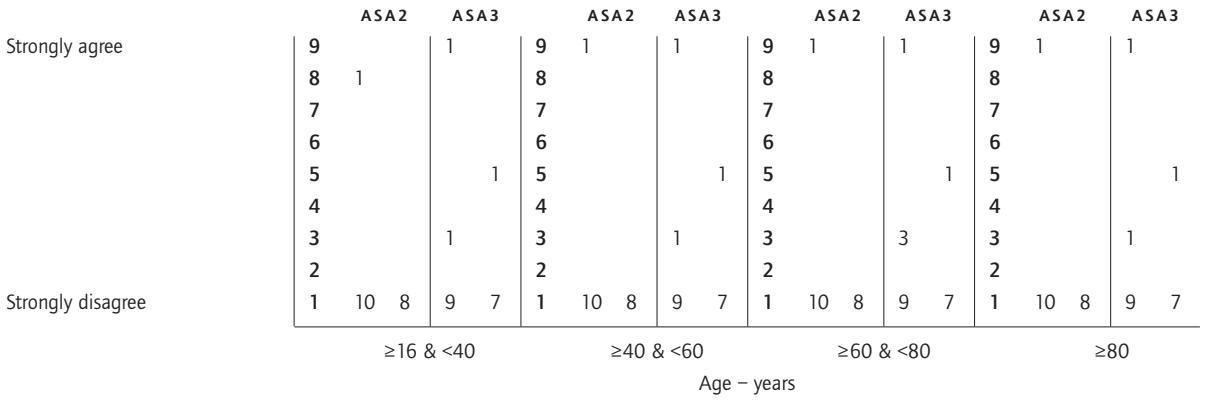
	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3
Strongly agree	9		9		9		9	
	8		8		8		8	
	7		7		7		7	
	6		6		6		6	
	5		5		5		5	
	4		4		4		4	
	3		3		3		3	
	2		2		2		2	
Strongly disagree	1 11 8	11 8	1 11 8	11 8	1 11 8	11 8	1 11 8	11 8
	≥16 & <40		≥40 & <60		≥60 & <80		≥80	

Age – years

8.3 "**Testing of blood gases** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 3 surgery**, aged as shown."



8.4 "**Testing of blood gases** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 4 surgery**, aged as shown."



To what extent is **testing of blood gases** indicated for patients with **respiratory comorbidity** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **respiratory comorbidity**, by ringing one or more numbers in each column:

8.5 "**Testing of blood gases** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 1 surgery**, aged as shown."

	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3
Strongly agree	9	1	9	1	9	1	9	1
	8		8		8		8	
	7		7		7		7	
	6		6		6		6	
	5	1	5	1	5	2	5	2
	4		4		4		4	
	3		3	1	3		3	
	2 1	1	2 1		2 1		2 1	
Strongly disagree	1 11 7	10 6	1 11 7	10 6	1 11 7	10 6	1 11 7	10 6
	≥16 & <40		≥40 & <60		≥60 & <80		≥80	

Age – years

8.6 "**Testing of blood gases** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 2 surgery**, aged as shown."

	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3
Strongly agree	9	1	9	1	9	1	9	1
	8		8		8		8	
	7		7		7		7	
	6		6		6	1	6	1
	5	2	5	2	5	2	5	2
	4		4		4		4	
	3		3	1	3		3	
	2 1	2	2 1	1	2 1	1	2 1	1
Strongly disagree	1 11 7	10 4	1 11 7	10 4	1 11 7	10 4	1 11 7	10 4
	≥16 & <40		≥40 & <60		≥60 & <80		≥80	

Age – years

8.7 "**Testing of blood gases** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 3 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	1	2		**9**	1	2		**9**	1	2		**9**	1	2	
	8			1	**8**			1	**8**			1	**8**			1
	7			1	**7**			1	**7**			3	**7**			3
	6		1	1	**6**		1	1	**6**		1		**6**		1	
	5			3	**5**			5	**5**	1	1	2	**5**	1	5	1	2
	4				**4**				**4**				**4**			
	3		1		**3**		1		**3**				**3**			
	2		1		**2**		1		**2**		1		**2**		1	
Strongly disagree	**1**	10	6	8	2	**1**	10	6	8	2	**1**	9	6	7	2	**1**	9	6	7	2

Age – years

8.8 "**Testing of blood gases** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 4 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	1	2	1	**9**	1	2	1	**9**	1	3	1	**9**	1	3	1
	8				**8**				**8**				**8**			
	7			3	**7**			3	**7**	1		4	**7**	1		4
	6		1		**6**		1		**6**		1		**6**		1	
	5	1	1	2	**5**	1	1	2	**5**	1	1	1	**5**	1	1	1
	4	1	1		**4**	1	1		**4**	1	1		**4**	1	1	
	3	1			**3**	1			**3**				**3**			
	2	1			**2**	1			**2**	1			**2**			
Strongly disagree	**1**	8	6	6	2	**1**	8	6	6	2	**1**	8	6	5	2	**1**	8	6	5	2

Age – years

To what extent is **testing of blood gases** indicated for patients with **comorbidity from renal disease** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **comorbidity from renal disease**, by ringing one or more numbers in each column:

8.9 "**Testing of blood gases** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 1 surgery**, aged as shown."

	≥16 & <40		≥40 & <60		≥60 & <80		≥80	
	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3
Strongly agree	9		9		9		9	
	8		8		8		8	
	7		7		7		7	
	6	1	6	1	6	1	6	1
	5		5		5		5	
	4		4		4		4	
	3		3		3		3	
	2	1	2	1	2	1	2	1
Strongly disagree	1 11 7	11 7	1 11 7	11 7	1 11 7	11 7	1 11 7	11 7

Age – years

8.10 "**Testing of blood gases** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 2 surgery**, aged as shown."

	≥16 & <40		≥40 & <60		≥60 & <80		≥80	
	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3
Strongly agree	9		9		9		9	
	8		8		8 1		8	1
	7		7		7 1		7	
	6	1	6	1	6	1	6	1
	5 1	1	5 1	1	5 1	1	5 1	1
	4		4		4		4	
	3		3		3		3	
	2 1		2 1		2 1		2 1	
Strongly disagree	1 11 6	11 6	1 11 6	11 6	1 10 6	10 6	1 11 6	10 6

Age – years

8.11 "**Testing of blood gases** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 3 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	9		1		9		1		9		1		9		1	
	8			1	8			1	8			1	8			1
	7				7				7				7			
	6				6				6				6			
	5	1		1	5	1		1	5	1		1	5	1		1
	4				4				4				4			
	3				3				3				3			
	2	1			2	1			2	1			2	1		
Strongly disagree	1	11	6	10 6	1	11	6	10 6	1	11	6	10 6	1	11	6	10 6

Age – years

8.12 "**Testing of blood gases** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 4 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	9		1		9		1		9		1		9		1	
	8			1	8			1	8			1	8			1
	7				7				7				7			
	6				6				6				6			
	5	8		3	5	1		3	5	1		3	5	1		3
	4				4				4				4			
	3				3				3				3			
	2	1		1	2	1		1	2	1		1	2	1		1
Strongly disagree	1	11	6	10 3	1	11	6	10 3	1	11	6	10 3	1	11	6	10 3

Age – years

ADULTS, LUNG FUNCTION TESTS (forced expiratory volume and vital capacity)

Cost estimates: **low £1.40** **mid £2.10** **upper £2.80**

To what extent are l**ung function tests** indicated for patients with **cardiovascular comorbidity** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **cardiovascular comorbidity**, by ringing one or more numbers in each column:

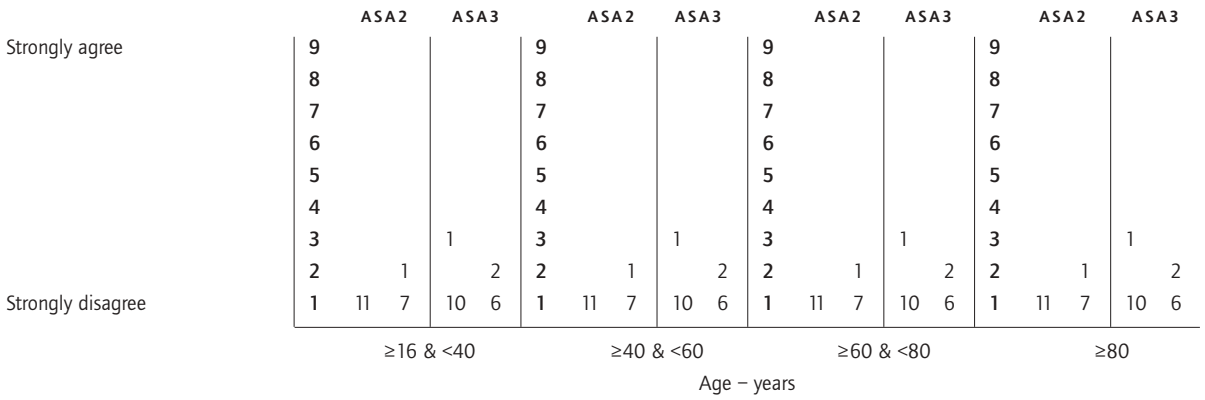
9.1 "**Lung function tests** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 1 surgery**, aged as shown."

	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	9				9				9				9			
	8				8				8				8			
	7				7				7				7			
	6				6				6				6			
	5				5				5				5			
	4				4				4				4			
	3				3				3				3			
	2				2				2				2			
Strongly disagree	1	11	8	11	8	1	11	8	11	8	1	11	8	11	8	1	11	8	11	8
	≥16 & <40					≥40 & <60					≥60 & <80					≥80				
	Age – years																			

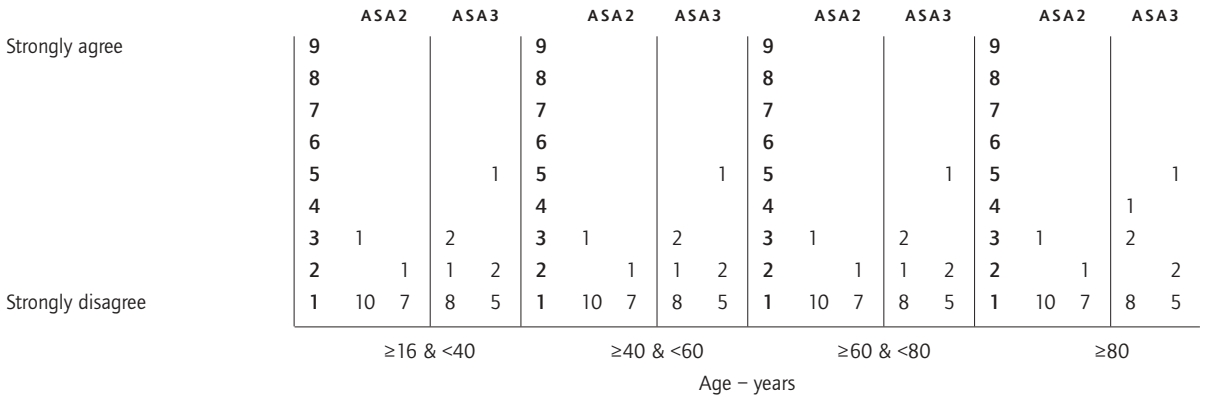
9.2 "**Lung function tests** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 2 surgery**, aged as shown."

	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	9				9				9				9			
	8				8				8				8			
	7				7				7				7			
	6				6				6				6			
	5				5				5				5			
	4				4				4				4			
	3				3				3				3			
	2				2				2				2			
Strongly disagree	1	11	8	11	8	1	11	8	11	8	1	11	8	11	8	1	11	8	11	8
	≥16 & <40					≥40 & <60					≥60 & <80					≥80				
	Age – years																			

9.3 "**Lung function tests** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 3 surgery**, aged as shown."



9.4 "**Lung function tests** are indicated preoperatively in an **adult** with **cardiovascular comorbidity** having **elective Grade 4 surgery**, aged as shown."



To what extent are **lung function tests** indicated for patients with **respiratory comorbidity** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **respiratory comorbidity**, by ringing one or more numbers in each column:

9.5 "**Lung function tests** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 1 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**		1		**9**		3		**9**		3		**9**		3	1
	8		1		**8**				**8**			1	**8**			
	7			1	**7**			1	**7**				**7**			
	6				**6**				**6**				**6**			
	5			1	**5**			1	**5**			1	**5**			1
	4		1		**4**				**4**				**4**			
	3		3		**3**		3		**3**		3		**3**		3	
	2	1	1		**2**	1	1		**2**	1	1		**2**	1	1	
Strongly disagree	**1**	10 7	4	6	**1**	10 7	4	6	**1**	10 7	4	6	**1**	10 7	4	6

Age – years

9.6 "**Lung function tests** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 2 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	1	4		**9**	1	4		**9**	1	4		**9**	1	4	1
	8				**8**				**8**			1	**8**			
	7			1	**7**			1	**7**			1	**7**			1
	6			1	**6**			1	**6**		1	1	**6**		1	1
	5		1	1	**5**		1	1	**5**		1		**5**		1	
	4				**4**				**4**				**4**			
	3		3		**3**		3		**3**		3		**3**		3	
	2				**2**				**2**				**2**			
Strongly disagree	**1**	10 7	3	5	**1**	10 7	3	5	**1**	10 6	3	4	**1**	10 6	3	4

Age – years

9.7 "**Lung function tests** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 3 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	1	3	2	**9**	1	3	2	**9**	1	3	3	**9**	1	3	3
	8			3	**8**			3	**8**			3	**8**			3
	7			1	**7**			1	**7**				**7**			
	6	1	1		**6**	1	1		**6**	1	2		**6**	1	2	
	5	1	1		**5**	1	1	1	**5**	1	1	1	**5**	1	1	1
	4		1	1	**4**		1		**4**	1	1		**4**		1	
	3	1	1		**3**	1	1		**3**		1		**3**		1	
	2	1			**2**				**2**				**2**			
Strongly disagree	**1**	10	4	4	1	**1**	10	4	4	1	**1**	10	4	4	1	**1**	10	4	4	1

Age – years

9.8 "**Lung function tests** are indicated preoperatively in an **adult** with **respiratory comorbidity** having **elective Grade 4 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	**9**	1	1	3	4	**9**	1	1	3	4	**9**	1	1	3	5	**9**	1	1	3	5
	8			3		**8**		1		3	**8**		2		2	**8**		2		2
	7	1		2		**7**	1		2		**7**	1	1	2		**7**	1	1	2	
	6		1	2		**6**		2	2		**6**		1	3		**6**		1	3	
	5			1	1	**5**		1	1		**5**				1	**5**				1
	4		2	1		**4**			1		**4**			1		**4**			1	
	3					**3**					**3**					**3**				
	2		1			**2**					**2**					**2**				
Strongly disagree	**1**	9	3	2		**1**	9	3	2	1	**1**	9	3	2		**1**	9	3	2	

Age – years

To what extent are **lung function tests** indicated for patients with **comorbidity from renal disease** of different ages, undergoing different types of surgery? For each of the ages shown below, please indicate your agreement with the following statements, separately for patients with **mild** (ie ASA Grade 2) and **severe** (ie ASA Grade 3) **comorbidity from renal disease**, by ringing one or more numbers in each column:

9.9 "**Lung function tests** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 1 surgery**, aged as shown."

	≥16 & <40		≥40 & <60		≥60 & <80		≥80	
	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3
Strongly agree	9		9		9		9	
	8		8		8		8	
	7		7		7		7	
	6		6		6		6	
	5		5		5		5	
	4		4		4		4	
	3		3		3		3	
	2		2		2		2	1
Strongly disagree	1 11 8	11 8	1 11 8	11 8	1 11 8	11 8	1 11 8	10 8

Age – years

9.10 "**Lung function tests** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 2 surgery**, aged as shown."

	≥16 & <40		≥40 & <60		≥60 & <80		≥80	
	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3	ASA2	ASA3
Strongly agree	9		9		9		9	
	8		8		8		8	
	7		7		7		7	
	6		6		6		6	
	5		5		5		5	
	4		4		4		4	
	3		3		3		3	1
	2		2		2	1	2	
Strongly disagree	1 11 8	11 8	1 11 8	11 8	1 11 8	10 8	1 11 8	10 8

Age – years

9.11 "**Lung function tests** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 3 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	9				9				9				9			
	8				8				8				8			
	7				7				7				7			
	6				6				6				6			
	5				5				5				5		1	
	4				4				4				4			
	3		1		3		1		3		1		3			
	2				2				2		1		2	1	2	
Strongly disagree	1	11	10	8	1	11	10	8	1	11	9	8	1	10	9	8

Age – years

9.12 "**Lung function tests** are indicated preoperatively in an **adult** with **comorbidity from renal disease** having **elective Grade 4 surgery**, aged as shown."

	≥16 & <40				≥40 & <60				≥60 & <80				≥80			
	ASA2		ASA3		ASA2		ASA3		ASA2		ASA3		ASA2		ASA3	
Strongly agree	9				9				9				9			
	8			1	8			1	8			1	8			1
	7				7				7				7			
	6				6				6				6			
	5				5				5				5		1	
	4			1	4			1	4		1	1	4			1
	3		1		3		1		3	1			3			
	2				2				2		1		2	1	1	
Strongly disagree	1	11	10	6	1	11	10	6	1	10	9	6	1	10	9	6

Age – years

Appendix 5: Economics of Routine Preoperative Testing

1.1 Introduction

Preoperative testing represents a major drain on health service resources internationally. It has been estimated that the annual cost of preoperative evaluation in the USA was as much as $30bn in the 1980s[1] with diagnostic testing being a substantial component. The figure for the UK is unknown. The cost is likely to be substantially less in the UK, given that salaries, overheads and the frequency of testing are all lower and that the US figure may reflect charges rather than costs. However, with 6.2 million admissions in England containing at least one surgical procedure in the financial year 2000/2001 (source: Hospital Episode Statistics: http://www.doh.gov.uk/hes/) the annual cost of 'routine' preoperative testing is likely to be at least in the 10s of £m. It is the subject of the economic component of this review to try to assess whether this is money that is well spent or whether the UK NHS could increase health gain by redeploying its valuable resources. Certainly a particular test is likely to be good value for money (ie cost-effective) for some groups of patients and less good value for others.

1.2 Background

1.2.1 Health economics and clinical guidelines

The explicit use of economic evaluation in clinical guideline development is a recent, but international, phenomenon. In the USA, the Committee on Clinical Practice Guidelines has recommended that every clinical guideline include cost information for alternative patient management strategies.[2] In the UK, the remit of the National Institute for Clinical Excellence (NICE) is to produce national clinical guidelines that address cost-effectiveness as well as clinical effectiveness.

The reasoning behind the application of economic criteria to clinical guidelines is that no health system anywhere in the world has enough resources to provide every potentially beneficial preventative, diagnostic, curative and palliative procedure. Therefore, there is a need to redeploy resources to those procedures where the potential health gain is greatest. This requires abandoning practices that are relatively poor value for money.

There is a well-developed methodological literature for assessing the relative cost-effectiveness (value for money) of different health care procedures[2–6]. There is still some debate over some of the specific methods of economic evaluation in health care but essentially there are six steps to evaluating the relative efficiency of any procedure.

1. Identify the target group (eg male preoperative patients aged > 50 years), the procedure to be evaluated (eg preoperative resting ECG) and its alternative strategy (eg no preoperative resting ECG).
2. Identify all the important health and resource outcomes that are likely to differ between the procedure and its alternative.
3. Measure the differences in identified health and resource outcomes.
4. Estimate the value of the health gain and the value of the resource use. [Resource use is valued in terms of its monetary value, its economic cost. Health gain is sometimes valued in monetary terms, but more often a nonpecuniary measure such as the quality-adjusted life-year (QALY) is used].

5. Estimate the ratio of net health gain to net resource cost (eg the cost per QALY gained) and compare this with the ratios estimated for other commonly used health programmes to assess its relative efficiency. The estimation of net health gain and net cost requires some kind of model (such as a decision analysis) to combine probability and outcome information.
6. Consider the robustness of the cost-effectiveness estimate in terms of statistical precision and generalisability to other settings.

Ideally one would repeat each of these steps for each procedure considered within the guideline (and within each procedure, for each relevant patient subgroup). This would allow us to see for which group of patients the procedure is good value for money.

1.2.2 Health and resource outcomes for routine preoperative testing

Step 1 – Eleven tests were identified for inclusion in the systematic review (Chapter 3): chest x-ray, resting ECG, full blood count (FBC), haemostasis, renal function, random glucose, urine dipstick, sickle cell, pregnancy, blood gases and lung function.

Patient subgroups identified for the purposes of the consensus process were defined by the following characteristics:

- **Gender (pregnancy test only)**
- **Age group**
- **ASA grade**
- **Presence of a particular (common) comorbidity**
- **Grade of surgery**
- **Ethnic group (sickle cell test only)**

Step 2 – A general scheme for the health and resource outcomes of preoperative testing is shown in Table 1. The level of each component will differ between tests and patient subgroups. Description of some of the components (eg changes to surgical practice arising from the test and complications occurring) can be found for each test under the relevant section of the systematic review (Chapter 3). However, quantitative measurement of the change in resource use resulting from these clinical outcomes is not available anywhere in the published literature.

Some components are of less importance than others are. For example, the iatrogenic effects of testing should (hopefully) be small (perhaps negligible) compared with the health gain from avoiding complications. Testing has both positive and negative effects on health; likewise there are both positive and negative effects on resource use (see Table 1). For some of the components we cannot even say which direction the change in outcome will be. Hence it is impossible to say a priori whether or not the test is beneficial overall and whether or not it is cost saving overall without having some kind of measurement and valuation of the component parts.

Steps 3 & 4 – In the literature there has been some measurement of A1 and A2 (Table 1), but only in terms of number of patients affected not in terms of the health gain per patient (see main systematic review Chapter 3). The cost of items B2 and B4 appear in the literature; evidence is presented in Sections 1.4.1 and 1.4.2. There is no evidence for any of the other components in the literature.

Steps 5 & 6 – In Section 1.4.3 below, an attempt is made to combine all the available evidence to try to assess the cost-effectiveness of the different preoperative tests.

1.2.3 Current practice in England and Wales

There are no widely accepted clinical guidelines on preoperative testing. However, the Oxford Handbook of Clinical Medicine, currently in its fifth edition, is perhaps a reasonable indicator of typical current practice in the UK. The recommendations are essentially as follows:

Routine testing – 'most patients'

- **Urine and electrolytes**
- **FBC**
- **Blood glucose**

Age indications

- **Chest x-ray: > 65 years**
- **Resting ECG: > 65 years**

Other indications

- **Chest x-ray: diagnosis/pathology/symptoms of cardiorespiratory disease**
- **Resting ECG: poor exercise tolerance or history of heart disease, hypertension or rheumatic fever**
- **Haemostasis: history of liver disease, massive blood loss or use of heparin/warfarin**
- **Blood glucose – diabetes**
- **Sickle cell test: origins in Africa, West Indies, Mediterranean and other malarial regions (including most of India)**

Anecdotal evidence would suggest that the adherence to these guidelines is variable between institutions and, in particular, the sickle cell test is rarely performed on potential surgical candidates.

Recommendations were also made for a few other specific tests, not considered in this review, including liver function, thyroid function, HIV and cross-matching.

The recommendations in other medical textbooks do differ from these. For example the Oxford Handbook of Surgery recommends the use of ECG in all patients over the age of 50 (rather than 65). However, the Oxford Handbook of Clinical Medicine is more influential in the UK medical education system and is therefore more likely to reflect current practice. Having an approximate definition of current practice is important when it comes to estimating the cost impact of the guidelines – see Section 1.3.4.

1.3 Methods

The Health Technology Assessment (HTA) programme's systematic review of routine preoperative testing did not investigate cost and cost-effectiveness.[7] Indeed, after thorough searching, we did not come across a comprehensive review of this subject in the published literature. Hence the systematic literature review that follows (see Section 1.3.2) may be useful. However, such a review is unlikely to capture all of the resource and health implications of preoperative testing strategies that would be relevant to the NHS.

The economic review presented in this chapter has four components:

- **estimation of unit costs of the tests under consideration;**
- **a review of the literature around the economics of preoperative testing;**
- **simple economic modelling of the cost-effectiveness of preoperative testing in England and Wales; and**
- **simple economic modelling of the cost impact of preoperative testing in England and Wales.**

1.3.1 Unit costs of tests

A dual methodology was used to collect unit cost figures:

- **review of the literature of the last six years; and**
- **collection of cost data from a small sample of hospital laboratories.**

For each test, the upper and lower estimates of unit cost (from both methods combined) were noted and the mid-point calculated. These figures were incorporated into the consensus documents.

Literature review

A search was carried out to find any costing or economic information regarding the selected tests (Table A1.i, Appendix 1). This was not restricted to the surgical context, as the cost of the test should be identical or similar regardless of the setting (with the exception of point-of-care testing). It is worth noting that any search for published unit costs is likely to be relatively insensitive because a unit cost is usually only a small component of an economic evaluation and hence is unlikely to get a mention in the abstract or Medical Subject Headings (MeSH®). The search was initially limited to studies conducted in the UK NHS because staff costs and overheads vary considerably between health systems. Given the rapidly developing technology in the diagnostic field the search was limited to the years 1995-2001. In addition to the databases searched for the main

systematic review (Chapter 3), two specific health economic databases were searched:

- **Health Economic Evaluations Database (http://www.ohe-heed.com); and**
- **NHS Economic Evaluations Database (http://nhscrd.york.ac.uk/nhsdhp.htm).**

Both databases include studies from the UK and overseas and both have relatively complex and comprehensive strategies for screening the medical and economic literature. The latter database reviews only full economic evaluations (ie those that systematically consider both cost and health effect), whereas the former has a broader remit and reviews all identified economic analyses. Abstracts and/or database reviews of the papers found were reviewed by the health economist and were discarded if they appeared not to contain a unit cost for any of the tests under study. Costs extracted were inflated to April 2001 prices using the health component of the Retail Prices Index.

Given the low number of relevant UK studies found, data were also collected from overseas studies. These costs were converted to pound sterling using GDP purchasing power parities for the relevant year and then inflated. Most of the overseas costs pertained to the USA. After converting charges to costs using ratios from the US Government's Health Care Financing Administration, the estimates were in the region of five to ten times higher than those estimated for the UK, as would be expected. Consequently all non-UK unit cost estimates were excluded on the grounds of noncomparability.

Primary data collection

Six district general hospital laboratories around England and Wales were approached for unit cost information. Three hospitals responded, supplying almost complete information as requested: Luton and Dunstable Hospital, South Tyneside Hospital and Sunderland City Hospital. Unit costs were also available from research recently conducted at Central Middlesex Hospital.

The chief scientific officers in both the haematology and biochemistry laboratories filled in a questionnaire. They were asked to specify what components were included in their cost estimates and how the estimates were calculated. Additional information was also collected, such as model of equipment used; volume of tests performed etc. The data were collected using a study form (see Annex at the end of this chapter). The form was developed after detailed discussion with staff at one of the centres (Luton and Dunstable Hospital).

For the urinalysis dipstick, costs were extracted from the British National Formulary.

1.3.2 Review of preoperative evaluation costing studies

Using the same search strategy as for the main systematic review in Chapter 3, but with an additional filter to locate costing information (Table A1.i, Appendix 1), a search was performed on the databases searched in the main review plus the two health economic databases referred to above. Abstracts of papers found were reviewed by the health economist and were discarded only if:

- **they appeared not to contain any economic data; or**
- **if their focus was not preoperative testing.**

Relevant references in the bibliographies of reviewed papers were also identified and reviewed. Unlike the extraction of unit costs, overseas studies were included. This was justified because

- **there were very few UK studies;**
- **the studies contain, in addition to unit costs, resource use data, which does not vary between health systems as much as unit costs do; and**
- **study of overseas methods might be useful for the development of our own cost analysis (see Section 1.3.3).**

As with the main review formal differentiation of study quality was not carried out because all studies were case series. This meant that methodological quality was consistently poor across all studies reported. The data summarised for each study include country, surgical setting, sample size, incremental cost, incremental cost per patient, incremental cost-effectiveness and cost comparison

made. In some cases incremental cost or cost-effectiveness was not presented in the paper, but could be calculated from evidence that was presented. Some studies looked at the cost of preoperative testing as part of an evaluation of preoperative evaluation clinics. These studies were summarised separately.

1.3.3 Modelling of cost-effectiveness of preoperative testing for England and Wales

For each test a very simple decision analytic model was constructed like the one represented by the decision tree in Figure 1. A decision analysis simply calculates an overall outcome, for example cost, as the sum of all the individual outcomes, each weighted by the probability of that individual outcome occurring. The costs of the tests themselves were estimated from the literature and from a small sample of NHS Trusts (see Section 1.3.1). However, as noted in Table 1, the overall 'incremental' cost of testing to the NHS also includes certain costs arising as a consequence of testing (B2-B9) and there may be costs incurred by the patient and their families (C1-C5). An approximate cost of further diagnostic testing (B2) was estimated by assuming that it consisted of one extra outpatient appointment for all those patients with an initial positive test. This cost is clearly tentative as the real cost is unknown and varies according to the test taken, and we know that for a proportion of tests the results are not read. The mean cost of a surgical outpatient appointment was extracted from the NHS Reference Costs 2000 database.

The NHS reference cost database[8] contains accounting cost data from every NHS hospital trust. Each trust reports an average cost per hospital episode, categorised by type of visit (eg outpatient, elective inpatient etc), clinical specialty and Healthcare Resource Group (HRG). The NHS Reference Costs 2000 database contains information for 69.4 million hospital episodes amounting to 88% of annual expenditure on services by NHS hospitals. Accounting practices do vary between hospitals but the costs should reflect the full cost of the service (including direct, indirect and overhead costs), as described in the NHS Costing Manual.[9]

The health outcomes and the remaining potential cost components were considered too difficult to quantify, even approximately, using the available evidence. Usable evidence would require specifically designed prospective studies of each test.

The systematic review did not find any evidence of changes to health outcomes. Some studies provided enough evidence to allow the calculation of the proportion of tests that resulted in a change in management. Hence cost-effectiveness for each test was calculated in terms of the incremental cost per change in management. To estimate the probability of a change in management, data on the following were taken from the main systematic review (Chapter 3):

- **abnormal test result rates (for each test this was the average of all relevant studies that included only ASA 1 and 2 patients weighted by study size); and**
- **positive predictive value (for each test this was the average of all relevant studies weighted by study size).**

Comparisons between tests would have to be very cautious given that the typical change in patient management and the resulting health outcome are likely to vary greatly between the tests. Sensitivity analyses were conducted to test the sensitivity of the results to the model parameters.

- **For the unit costs, the range was used.**
- **For the cost of an outpatient visit, the range was used.**
- **For the probabilities, the most extreme estimates from the literature review were taken (except where the most extreme estimate was zero – in this case the lowest estimate above zero was used).**

1.3.4 Modelling the cost impact of the new preoperative testing guidelines

The cost of implementing the guidelines proposed in this document (Chapter 6) was calculated by estimating the expected number of each test that would be indicated by the guidelines and multiplying these numbers by the unit costs (Section 1.3.1).

The number of surgical procedures

Data on all the elective hospital Finished Consultant Episodes (FCEs) in England in 2000/2001 that contained at least one surgical procedure (n=4.7 million FCEs) were obtained from the Hospital Episode Statistics (HES) section of the Department of Health. The data were categorised by procedure code (OPCS4) and five year age bands. Emergency and maternity episodes were not included.

Severity of surgical procedures

Three surgical research fellows filled in a survey. They were given a list of the summary groups of procedures (HES Table 4) and asked to grade each one according to the severity of surgery (related to the physiological stress involved). The responders felt that some categories were too broad. For each of these cases the broad category was broken down into their three-digit OPCS4 codes (for example we omitted BD1 excision of breast and replaced it with two separate categories: B27 Total excision of breast and B28 Other excision of breast). After all three responders had completed the questionnaire, differences between responses were noted and the responders were asked to reach a consensus on each category. The resulting scheme is presented in Table 2. Applying this grading system to the HES data allowed the breakdown of FCEs by age and severity of surgery as in Table 3. The severity grading system covered 57% of surgical procedures. The remaining 43% were then allocated to each of the severity categories so as to keep the proportions of each grade the same within each age band (Table 4).

Number of patients with comorbidity

The guideline outlined in Chapter 6 recommends testing by severity score, age and evidence of comorbidity. Using more HES data, the number of FCEs were categorised according to whether they had one of the three comorbidities. All of the nonprimary diagnosis fields were searched for the ICD-10 codes presented in Table 5. It was assumed that the incidence of comorbidity would be age-related but would be independent of severity of surgery, a logistically necessary simplification. Hence the age-specific incidence of each comorbidity was multiplied with the age-specific relative frequency of each severity category, giving the number of FCEs presented in Table 6.

The costs of testing

The annual cost of testing was calculated simply by considering the categories of patients where testing is recommended, finding the estimated numbers of patients in these categories (Tables 4 and 6) and multiplying them by the mid-point estimates of the unit costs. Our estimates omit the cost of further diagnostic testing, which we tentatively estimated in Section 1.3.3. Also omitted were the cost components B3-B9 and C1-C5 identified in Table 1 for which evidence is not currently available.

For a number of patient categories the Guideline Development Group (GDG) could not come to a consensus on whether or not to test. For the purpose of costing the guideline we took two extreme scenarios. In the first scenario, we assume that in the areas that a consensus had not been achieved, the test is ALWAYS carried out (the 'broad guideline'). In the alternative scenario, we assume that for these grey areas the test is NEVER carried out (the 'narrow guideline').

Finally to get number of tests for England and Wales instead of just England, all the figures were adjusted up by a factor of 5.9%. (The populations of England and Wales are 50.0 and 2.9 million, respectively; Source: ONS estimate for mid-2000.)

The cost impact

To estimate the cost impact of the guideline we need to know the number of routine preoperative tests being carried out at present. We do not know the frequency of testing currently so the current system was estimated by taking a set of existing guidelines, the Oxford Handbook of Clinical Medicine (see Section 1.2.3). The following, slightly stylised, definition of these guidelines used was:

- **FBC, renal function and random blood glucose tests for all patients.**
- **chest x-ray and ECG for all patients over 65.**
- **chest x-ray for those with respiratory comorbidity.**
- **ECG and chest x-ray for those with cardiovascular comorbidity.**

The cost impact was estimated to be approximately equal to the cost of these guidelines subtracted from the cost of the guidelines presented in Chapter 6.

If not an accurate estimate of the actual cost impact, this should at least indicate the difference in cost between the new guidelines and one set of existing guidelines. However, even this cost difference does not include the broader and longer term cost consequences (Table 1). A range was calculated for the cost impact using the ranges for the unit costs.

Pregnancy testing and sickle cell testing

These two tests were treated separately both because they were not related to severity of surgery and because there were no obvious differences between these guidelines and those of the Oxford handbook. The number of surgical FCEs relating to women between the ages of 15 and 50 years was taken from HES data. Data on the breakdown of the general population (for Great Britain 2000-01) were taken from the official statistics. The incidence of surgical operations was assumed to be the same for these groups as for the rest of the population (adjustments were not made for age).

1.4 Results

1.4.1 Unit costs of tests

Unit cost data was collected from four laboratories and extracted from 16 articles relating to the UK NHS.10-25 Data were also extracted from a further 34 overseas studies (28 from USA). However, as expected the unit costs appeared to be quite different in the overseas papers (in the case of the USA, the reported costs/charges were up to ten times the cost estimated in UK studies) and therefore all non-UK studies were excluded on the grounds of noncomparability. Initially 1437 abstracts were reviewed to see if they were likely to contain unit costs.

Table 7 presents the range and mid-point estimates of unit cost for each test based on the UK cost estimates. Chest x-ray and ECG were, not surprisingly, considerably more expensive than laboratory tests. The urinalysis dipstick was cheapest of all. Full blood count had the broadest relative range and ECG the broadest absolute range.

Components of cost estimates

The cost estimates, both collected directly, or taken from the literature, essentially include the following components:

- **cost of consumables, eg x-ray film, chemical reagents, testing kit, etc;**
- **laboratory staff time; and**
- **capital equipment costs, eg laboratory analysers, etc.**

The exceptions are the Sickledex test, pregnancy test and urinalysis dipstick, where the cost estimates include only the cost of the kit itself. Calculating overheads for diagnostic tests is a difficult task and is not carried out consistently in all institutions. The laboratories approached did not include nondepartmental overheads in their estimates, although this component may have been included in some of the estimates from the literature. Hence these unit costs are underestimates inasmuch as they do not necessarily include overheads nor do they include the cost of the clinicians' time in ordering and interpreting these results. These omissions are unlikely to affect the estimates greatly in absolute terms (as the clinician time involved will be small for most instances of testing), however, for the urinalysis dipstick the difference will be proportionately quite high, as the cost of the kit itself is minimal.

Also excluded were the economic costs associated with testing incurred by the patients themselves. If patients are given an additional appointment for the purposes of testing then the patient cost might be fairly substantial. If, however, the tests are carried out while patients are attending the hospital for some other reason, perhaps as part of the normal work-up for the surgery, then the incremental private cost of testing is likely to be negligible.

Cost savings from elimination of unwarranted tests

If the number of the tests were to be reduced, the proportion of the cost that would be saved in the short term varies between the tests.

- **For the kits (pregnancy, urinalysis and Sickledex), the full cost of the kit would be recovered.**

- **For the other pathology tests, the reagent costs would be recovered in the short term. Many laboratories now purchase their equipment on the basis of 'reagent contracts', such that there is no fixed cost for the equipment but laboratories pay a mark-up on the reagents they purchase. In this case the capital cost as well as the reagent cost is recovered in the short term. Also in the short term, laboratory staff time will be freed up.**
- **For ECG and chest x-ray, consumable costs will be recovered in the short term and staff time will be freed up, but capital costs will only be recovered in the long term if at all. Although these capital cost savings may not be realised financially, they should still be considered to be opportunity costs as they may allow the use of the facilities for additional patients.**

1.4.2 Review of preoperative evaluation costing studies

Cost analyses of preoperative testing

We identified 13 papers that had conducted formal or informal cost analyses of preoperative testing. A further six studies had considered the cost of preoperative testing in the context of evaluating preoperative evaluation clinics; these are reported separately. The characteristics of the 13 studies are summarised in Table 8.

All the studies were coming from the perspective of seeking to reduce preoperative testing, hence total cost savings (at the sample, hospital or national level) or costs saved per patient were the outcomes used. Three studies used charges instead of economic costs.26-28

The studies were heterogeneous in the following respects:

- **tests being evaluated;**
- **target population (age, type of surgery etc);**
- **collection of data (prospectiveness, consecutiveness);**
- **health service setting (country, health financing system, specialist ordering the test, timing of test etc); and**
- **cost measures employed.**

In addition they varied as to the testing strategies being compared. The comparisons made were as follows:

1. Routine testing versus indicated testing;[26–29]
2. Observed current practice versus indicated testing;[10,28,30–32]
3. Observed current practice versus not testing;[26,33,34]
4. Routine testing versus no testing;[15,27,35–37] and
5. Observed change in practice over time.[28]

In these studies 'observed current practice' was different to routine testing, inasmuch as for each test not every patient was tested. 'Indicated testing' varied between studies. They included specific clinical indications ascertained from physical examination or case history, as well as age, gender and occasionally some other sociodemographic variable. It would seem that only Kaplan et al[30] did not include age as an indication. Comparison 1, best answers the theoretical question about what is the incremental cost of routine testing. However comparison 2 may give a more realistic estimate of cost savings actually achievable, given that it is quite rare for every patient to receive every test at a given institution. Comparison 3 may give an accurate estimate of cost savings but only if not testing really is a clinically acceptable option. Likewise comparison 4 is relevant if routine testing is in current practice. The 'not testing' option is more acceptable if the population is narrowly defined (eg only ASA grade 1 patients) and/or the study is concentrating on a single test. This was the case for all those studies that conducted comparisons 3 and 4.

The comparison chosen was related to the methodology taken (or vice versa). For example, a study calculating the cost savings of not testing compared with routine testing, only requires knowledge of the unit cost of the test and the size of the target population. One comparing current

practice with indicated testing must measure the prevalence of the test in a sample population and must identify in which cases that test was indicated according to a specific protocol.

The results of the studies are summarised in Table 9. The largest estimate of potential cost saving was $190 per patient.[29] Narr et al[33] estimated a potential cost saving achievable in the USA of between $3bn and $4bn. Macario et al[28] found that expenditure on preoperative testing was already declining by 1987, but that the reduction in test ordering was only a fraction of what could be achieved if a move to indication-only testing were to take place. They reported that there had been a reduction in indicated testing, as well as a reduction in nonindicated testing. Routine testing was by definition more costly than either of its comparators. Likewise, observed practice was by definition more costly than not testing. Those studies comparing current practice with indicated practice all found potential for cost saving. The South African study[31] found that indicated testing would imply less use of chest x-rays but more use of ECG, however the cost savings attributable to the former more than offset the additional costs of the latter. An additional unpublished study, not included in the table, found potential cost savings of moving from current practice to indication-only testing of £21,000-£28,000 for a particular district general hospital in England (personal communication: John Carlisle).

With one exception, all studies considered only the cost of the test itself in the calculation of incremental cost. Hoare[36] included the costs attributable to lost theatre time and the cost of following up positive test results in terms of extra clinic visits. They attributed £50 for waste of theatre time and another £50 for an extra clinic visit for each of the occasions (10/372) when surgery was delayed due to a positive test result.

Cost-effectiveness of preoperative testing

Of course the lowest cost strategy need not be the best value for money. Routine testing could, in theory, be good value for money (ie cost-effective) if there is a relatively substantial health gain.

Of the 13 cost studies identified, six provided some kind of estimate of cost-effectiveness (Tables 8 and 9). The measure of effectiveness varied between the studies as follows:

- **Number of clinically significant abnormal test results;**[27,30,31,35]
- **Number of clinically significant abnormal test results that changed treatment;**[26]
- **Number of complications averted;**[34,35] **and**
- **Number of lives saved.**[30]

By definition, these studies found that testing did detect clinically significant surgical risk factors as well as increasing costs (even in ASA grade 1 patients).

Only the study that estimated the number of lives saved[30] can be compared with other interventions and at $4.2m per life-saved this is considerably less cost-effective than a lot of publicly funded health care interventions. However, their calculation of effectiveness is questionable. They assume that surgical mortality for patients with an abnormal test result is only 1 in 500 and that acting on the test results prevents half of these deaths. They do not support this assumption with evidence.

The estimates of cost per complication averted, from Turnbull and Buck[34] (various tests) and from Archer et al[35] (chest x-ray), would represent good value for money if the complication averted were death. The less serious the complication, the less cost-effective is the test.

The cost of preoperative assessment clinics

We identified eight papers that had conducted formal or informal cost analyses of preoperative evaluation clinics. One study was excluded because it only considered the cost of the clinic itself and did not estimate the incremental cost savings. This was an important omission given that one of the main reasons for establishing such a clinic is to reduce unnecessary expenditure. The characteristics of the remaining studies are summarised in Table 10.

All seven studies compared the cost of preoperative evaluation in an anaesthetist-led outpatient clinic with the cost of surgeon-led preoperative evaluation

after inpatient admission. Each study compared two patient cohorts apart from:

- **Pollard et al[38] who made a before and after comparison of financial records (a top-down costing approach compared with the bottom-up costing method of the other studies); and**
- **France et al[39] who, after calculating the cost of preoperative testing in Belgium using a cohort of patients, applied the 59.3% reduction in cost estimated by Fischer.[40] This method is only likely to be accurate if the testing norms in Belgium are similar to those observed by Fischer before the introduction of the preoperative evaluation clinic.**

Not every study stated the timing of the clinic relative to surgery, and there was some disparity between those that did. Two studies saw all of their patients within the two weeks before surgery, whereas in MacDonald et al[41] patients were seen within three months of surgery.

Four studies[39,40–43] measured only the cost of preoperative testing (Table 11). McDonald et al[41] also measured the other running costs of the outpatient clinic, as did Boothe et al[44] who also considered the cost of operating theatre time and time in hospital. Pollard et al[38] estimated the cost of time in hospital but not the cost of preoperative testing.

The studies were also heterogeneous in the following respects:

- **Preoperative tests being included (although those that did measure them included a whole battery of tests);**
- **target population (age, type of surgery etc);**
- **collection of data (prospectiveness, consecutiveness);**
- **health service setting (country, health financing system, specialist ordering the test, timing of test etc); and**
- **cost measures employed.**

The results of the studies are summarised in Table 12. All studies measuring preoperative testing found a cost saving associated with reduced testing in the preoperative evaluation clinic arm, with the exception of MacDonald et al[41] who only measured laboratory costs in that arm. The three studies that considered other cost components, all found overall cost savings with the introduction of the preoperative evaluation clinic. The largest estimate of potential cost saving from reduced preoperative testing was $112 per patient.[40] Boothe et al[44] estimated an overall cost saving of Can$366 per patient.

Only one study has attempted to estimate the cost savings associated with fewer surgical cancellations,[44] however other studies have measured the change in the number of cancellations and these have been summarised by Fischer.[40] Estimates range between 20% and 88% (see Table 13), so clearly the potential for cost saving in this area could be quite substantial.

1.4.3 Cost-effectiveness of preoperative testing in England and Wales

Table 14 shows estimates of the cost per change in management. On the basis of these cost per change in management figures, pregnancy testing, urine dipsticks and full blood count appear to be the most cost-effective for the asymptomatic patient; haemostasis, renal function and chest x-ray the least cost-effective. Interestingly these estimated cost-effectiveness rankings are almost identical to those of Robbins and Mushlin[37] published more than twenty years earlier, despite very different absolute estimates of the cost per case (see Table 15). The only anomaly is urinalysis, which drops down to fifth ranking if just protein is analysed, but moves up to first place if both bacteriuria and chronic renal disease are included. Given the uncertainty about unit costs and detection rates the overall correlation might be largely spurious.

Table 16 shows that the results, in terms of cost per change in management, were sensitive to the estimates of the model parameters. In particular, the model was highly sensitive to the broad range of estimates of the probability of a positive test result and the positive predictive value.

Even if the estimates of cost per change in management were relatively precise, it would still not be clear which tests are cost-effective (ie good value for money) and which are not. To properly assess cost-

effectiveness, we would need to know how often a change in management affects patient outcomes and what these outcomes are. If a life was saved in every ten changes of management, then it is likely that all of these tests would be considered cost-effective (Table 17). The tests could also be cost-effective, if they were to lead to substantial improvements in quality of life but no improvement in life expectancy. On the other hand, if for example a life was saved in every 10,000 tests and there was no substantial improvement in patient quality of life then none of the tests are likely to be cost-effective in nonindicated patients (Table 17).

1.4.4 The cost impact of these preoperative testing guidelines

Tables 18 to 20 show the annual number of tests for England associated with these guidelines and those of the Oxford Handbook of Clinical Medicine. It would appear that the expected number of routine preoperative tests associated with these NICE guidelines are 3.2m (0.7 per patient), with an additional 13.6m tests (2.9 per patient) up to the discretion of clinicians for those areas where the guidelines were inconclusive (the broad guideline). For each test the narrow NICE guideline represents fewer tests than the Oxford Handbook. The broad guideline, however, represents fewer of some (chest x-ray, FBC, renal function and blood glucose) and more of others (urine, haemostasis, blood gases, lung function and ECG).

Table 21 shows the costs of the tests for England and Wales. The tests recommended in this guideline would cost approximately £35.6m compared with an estimated cost of £130.9m associated with the guidelines contained in the Oxford Handbook. However, in the unlikely event that tests were carried out in all those cases where this guideline could not make a recommendation, then the cost of testing could be as much as £138.5m. Testing for pregnancy could cost another £2.0m and the sickle cell test possibly £0.8m

The comparison with the Oxford Handbook suggests that the NICE guidelines could potentially save tens of £m but this would depend on the current situation in Trusts across the country and this we do not know. Anecdotal evidence would suggest that sickle cell testing is not common at present. This would represent an additional cost. None of these calculations take into account the broader resource consequences in terms of subsequent further diagnostic testing and changes to surgical procedures. Neither can the precise effect of this change in practice on quality of care and health outcomes be determined. The magnitude of costs and cost savings were quite sensitive to the unit costs used, as represented by the sensitivity intervals in Table 21.

1.5 Discussion

The literature review appears to show that there is potential for substantial cost savings when preoperative testing is reduced. Naturally the extent of potential cost savings depends, among other factors, on one's starting point. This varies not just between countries but also between and within institutions. In England and Wales, the current situation is not very clear. The magnitudes of cost savings as estimated in the literature are unlikely to be accurate for the NHS. In particular, the results of those studies conducted overseas are inapplicable. Our own cost impact analysis suggested that the guidelines contained in this document could potentially reduce testing costs in England and Wales, when compared with an alternative set of guidelines. However, current practice across the country is unclear and therefore the magnitude and even the direction of the change in cost are uncertain. Furthermore, the reduction of testing might not save money overall. For example, testing might lead to a reduction in the number of (risky) surgical procedures carried out; it might reduce litigation costs and the resource consequences of diagnosing chronic conditions are uncertain. Quantitative evidence for these resource outcomes and for the net health gain associated with testing is nonexistent.

A model of the cost-effectiveness of routine preoperative testing was constructed for England and Wales. This went further than the evidence in the literature, because it used unit cost estimates that are more suitable for the NHS and because it included an approximate estimate of the costs of further investigations. However, the results were not robust to the variability in its parameters (especially

those taken from the systematic review) and the model omitted a number of potentially important health and resource outcomes.

The effect on patient outcomes (in terms of morbidity and mortality) of these interventions has not been measured, hence all estimates of cost-effectiveness have been based on intermediate outcomes or have been entirely speculative (or both). There are iatrogenic effects associated with some tests. One would hope that these risks are outweighed by the health gain associated with testing but again there is no quantitative evidence to support this assertion.

In conclusion, there is no good evidence that routine preoperative testing is or is not cost-effective. In particular the evidence base is lacking in terms of:

- **the quality of evidence for the number of cases detected;**
- **the health outcomes associated with detecting a case; and**
- **resources used (and their cost) as a consequence of detecting a case.**

The context of testing may have important resource implications. A number of studies have found that anaesthetist-led preoperative evaluation clinics can save substantially on resource use. The literature suggests that valuable health service resources could be saved if:

- **staff responsible for ordering tests are those that are best informed about the utility of testing (be they surgeons or anaesthetists);**
- **wherever possible tests should be conducted in advance of the day of surgery to avoid last-minute cancellations and to ensure optimal use of operating theatres (perhaps in a dedicated preoperative evaluation clinic); and**
- **staff should check that the test has not already been recently ordered.**

1.6 Acknowledgements

For assistance in collecting data from hospital laboratories we would like to thank Reinhold Gruen, Andrew Hutchings and Jenny Roberts (London School of Hygiene and Tropical Medicine), Richard Gray (South Tyneside Health Care NHS Trust), Colin Smith (City Hospitals Sunderland NHS Trust), David Mills and Richard Ball (Luton and Dunstable Hospitals Trust).

TABLE 1 **Health and resource consequences of preoperative testing**

Consequences of testing	Net social effect*
A. Patient health	
A1. Reduced number of perioperative complications ↑ Life expectancy ↑ Quality of life	+ve
A2. Early diagnosis of serious condition ↑ Life expectancy ↑ Quality of life	+ve
A3. Increased knowledge about own health ↑ Quality of life	+ve (-ve?)
A4. Iatrogenic effects of tests (eg effects of radiation) ↓ Life expectancy ↓ Quality of life	-ve
A5. Iatrogenic effects of additional diagnostic procedures arising from +ve initial tests (eg complications from diagnostic surgical procedures) ↓ Life expectancy ↓ Quality of life	-ve
A6. Anxiety associated with positive test results (including false positive results) ↓ Quality of life	-ve
B. Health service resource use	
B1. Use of test itself ↑ Consumables ↑ Staff time ↑ Equipment ↑ Overheads	-ve
B2. Use of additional diagnostic procedures arising from +ve initial tests ↑ Consumables ↑ Staff time ↑ Equipment ↑ Overheads	-ve
B3. Treatment of iatrogenic effects of testing and further diagnostic procedures ↑ Consumables ↑ Staff time ↑ Equipment ↑ Overheads	-ve
B4. Delay to surgical procedure arising from +ve test result ↑ Wasted theatre time	-ve
B5. Change to surgical procedure (including cancellation) arising from +ve diagnosis ↑/↓ Consumables ↑/↓ Staff time ↑/↓ Equipment ↑/↓ Overheads	+ve/-ve

TABLE 1 **Health and resource consequences of preoperative testing** *continued*

Consequences of testing	Net social effect*
B. Health service resource use (continued)	
B6. Treatment of surgical complications ↓ Consumables ↓ Staff time ↓ Equipment ↓ Overheads	+ve
B7. Care for newly diagnosed serious condition ↑/↓ Consumables ↑/↓ Staff time ↑/↓ Equipment ↑/↓ Overheads	+ve/-ve
B8. Change in lifetime care associated with change in life expectancy ↑/↓ Consumables ↑/↓ Staff time ↑/↓ Equipment ↑/↓ Overheads	+ve/-ve
B9. Litigation costs arising from failure to avoid a complication ↓ Legal expenses [↑ Compensation – in social terms this is a transfer rather than a cost]	+ve
C. Resource use of patient & family members	
C1. Attendance for test ↓ Income from work (or leisure time) ↑ Transport to clinic	-ve
C2. Attendance for further diagnostic procedures ↓ Income from work (or leisure time) ↑ Transport to clinic	-ve
C3. Treatment of iatrogenic effects of testing and further diagnostic procedures ↓ Income from work (or leisure time) ↑ Transport to clinic ↑ Non-NHS resources (eg private prescriptions)	-ve
C4. Treatment of surgical complications ↑ Income from work (or leisure time) ↓ Transport to clinic ↓ Non-NHS resources (eg private prescriptions)	+ve
C5. Treatment of diagnosed serious condition ↑/↓ Income from work (or leisure time) ↑/↓ Transport to clinic ↑/↓ Non-NHS resources (eg private prescriptions)	+ve/-ve+ve/-ve

* Any kind of resource use has a negative effect for society because those resources can not then be used for some other beneficial purpose.

TABLE 2 **Surgical procedures by severity grading**

Grade 1

AF1 Release of entrapment of peripheral nerve at wrist (A61)

DA1 Clearance of external auditory canal (D07)

DB3 Drainage of middle ear (D15)

EA1 Operations on septum of nose (E03)

EA2 Operations on external nose (E09)

E36 Diagnostic endoscopic examination of larynx

EE2 Endoscopic operations on bronchus (E48-E51)

FB2 Simple extraction of tooth (F10)

G16 Diagnostic fibreoptic endoscopic examination/oesophagus

G45 Diagnostic fibreoptic endoscopic exam/upper gastrointe

M45 Diagnostic endoscopic examination of bladder

NA2 Operations on hydrocele sac (N11)

NB1 Excision of vas deferens (N17)

NC1 Operations on prepuce (N30)

PA1 Operations on bartholin gland (P03)

SA1 Extirpation of lesion of skin or subcutaneous tissue (S05-S11)

SA4 Suture of skin or subcutaneous tissue (S41-S42)

SA5 Incision of skin or subcutaneous tissue (S47)

Grade 2

AC1 Extracranial extirpation of vagus nerve (A27)

AG1 Electroconvulsive therapy (A83)

B28 Other excision of breast

CG1 Extraction of lens (C71,C72,C74)

CG2 Prosthesis of lens (C75)

DB1 Operations on mastoid (D10-D12)

DB2 Repair of eardrum (D14)

EC1 Operations on adenoids (E20)

E34 Microtherapeutic endoscopic operations on larynx

E35 Other therapeutic endoscopic operations on larynx

FB1 Surgical removal of tooth (F09)

FD1 Excision of tonsil (F34)

FE1 Excision of salivary gland (F44)

G14, G15, G17-G19 Endoscopic operations on oesophagus

G43, G44 Endoscopic operations on upper gastrointestinal tract

HB2 Endoscopic operations on colon (H20-H28)

HD1 Operations on haemorrhoid (H51-H53)

JC1 Endoscopic operations on bile and pancreatic ducts (J38-J45)

KC3 Transluminal operations on coronary artery (K49-K51)

Grade 3

BB1 Excision of thyroid gland (B08)

B27 Total excision of breast

EE1 Operations on trachea (E39-E44)

GA2 Operations on diaphragmatic hernia (G23-G25)

MC1 Open operations on bladder (M34-M41)

MD1 Operations on outlet of female bladder (M51-M58)

MD2 Open excision of prostate (M61)

M65 Endoscopic resection of outlet of male bladder

M66 Other therapeutic endoscopic operations on outlet of male bladder

M67 Other therapeutic endoscopic operations on prostate

PB1 Repair of prolapse of vagina (P22-P23)

QA2 Excision of uterus (Q07-Q08)

QB1 Excision of adnexa of uterus (Q22-Q24)

QB4 Other endoscopic operations on fallopian tube (Q37-Q39)

RB1 Caesarean delivery (R17-R18)

LG1 Operations on varicose vein of leg (L85-L87)

MA3 Endoscopic operations on kidney (M09-M11)

MB1 Endoscopic operations on ureter (M26-M30)

M42-M44 Endoscopic operations on bladder

NA1 Placement of testis in scrotum (N08-N09)

QA1 Operations on cervix uteri (Q01-Q05)

QA3 Evacuation of contents of uterus (Q10-Q11)

QB2 Open occlusion of fallopian tube (Q27-Q28)

QB3 Endoscopic occlusion of fallopian tube (Q35-Q36)

RB2 Manipulative delivery (R19-R23)

RB3 Normal delivery (R24)

SA3 Skin graft operations (S33-S39)

TB1 Operations on inguinal hernia (T19-T21)

TB2 Operations on other abdominal hernia (T22-T27)

TC1 Endoscopic operations on peritoneum (T42-T43)

WB2 Division of bone (W12-W16)

TABLE 2 **Surgical procedures by severity grading** *continued*

Grade 3

SA2 Skin flap operations (S17-S31)

WB1 Excision of bone (W06-W08)

WC3 Prosthetic replacement of head of femur (W46-W48)

WC4 Prosthetic replacement of other articulation (W49-W54)

WC5 Fixation of joint (W59-W64)

XA1 Amputation (X07-X12)

XA2 Operations for sexual transformation (X15)

XA3 Corrections of congenital deformity of limb (X19-X27)

Grade 4

EF1 Operations on lung (E53-E59)

GB1 Excision of stomach (G27-G28)

HB1 Excision of colon (H04-H11)

HC1 Excision of rectum (H33)

MA1 Transplantation of kidney (M01)

MA2 Excision of kidney (M02-M03)

WC1 Total prosthetic replacement of hip joint (W37-W39)

WC2 Total prosthetic replacement of other joint (W40-W45)

Grade 2

WB3 Reduction of fracture of bone (W19-W26)

WB4 Graft of bone marrow (W34)

WC6 Reduction of traumatic dislocation of joint (W65-W67)

WC7 Open operations on semilunar cartilage (W70)

WC8 Endoscopic operations on joint (W82-W88)

XB1 Compensation for renal failure (X40-X42)

Neurosurgery

AA1 Excision of lesion of tissue of brain (A02)

Cardiovascular surgery

KC1 Replacement of coronary artery (K40-K44)

KC2 Other bypass of coronary artery (K45-K46)

TABLE 3 **FCEs with surgical operations**

Surgery	0-14	15-39	40-59	60-80	80+	All ages
Grade 1	97,116	192,466	291,724	366,247	87,214	1,034,767
Grade 2	71,671	367,694	318,908	402,523	144,538	1,305,334
Grade 3	5,906	30,113	64,321	64,891	12,106	177,337
Grade 4	629	3,589	18,740	74,151	15,109	112,218
Neurosurgery	131	338	368	222	7	1,066
Cardiovascular	7	100	5,144	11,826	283	17,360
All graded	175,460	594,300	699,205	919,860	259,257	2,648,082
Not graded	130,343	404,265	657,572	710,880	129,114	2,032,174
All	305,803	998,565	1,356,777	1,630,740	388,371	4,680,256

TABLE 4 FCEs with surgical operations (after allocating previously ungraded FCEs)

Surgery	0-14	15-39	40-59	60-80	80+	All ages
Grade 1	169,260	323,389	566,078	649,288	130,648	1,838,662
Grade 2	124,913	617,813	618,827	713,598	216,520	2,291,671
Grade 3	10,293	50,597	124,812	115,040	18,135	318,877
Grade 4	1,096	6,030	36,364	131,456	22,634	197,580
Neurosurgery	228	568	714	394	10	1,914
Cardiovascular	12	168	9,982	20,965	424	31,551

TABLE 5 Definition of comorbidities (ICD-10 codes)

Cardiovascular

Any of:

- I00-I052 Diseases of the heart
- C38, C781, D15, D383 Cancer of the heart

Respiratory (chronic)

Any of:

- J41-J99 Chronic diseases of the lung
- A15-A19 TB
- C33, C34, C39, C780-C783, D02, D14, D38 Lung and other respiratory cancers

Renal

Any of:

- N00-N19 Chronic diseases of the kidney
- C64, C790, D300, D301, D410, D411 Cancer of the kidney

TABLE 6 FCEs with surgical operations (after allocating previously ungraded FCEs)

Cardiovascular comorbidity						
Surgery	**0-14**	**15-39**	**40-59**	**60-80**	**80+**	**All ages**
Grade 1	811	3,015	41,203	128,428	29,905	203,363
Grade 2	599	5,760	45,043	141,149	49,561	242,111
Grade 3	49	472	9,085	22,755	4,151	36,512
Grade 4	5	56	2,647	26,002	5,181	33,891
Neurosurgery	1	5	52	78	2	139
Cardiovascular	0	0	0	0	0	0
	1,466	9,308	98,030	318,411	88,800	516,015
Respiratory comorbidity						
Surgery	**0-14**	**15-39**	**40-59**	**60-80**	**80+**	**All ages**
Grade 1	6,511	9,437	24,718	42,212	5,887	87,868
Grade 2	4,805	18,028	27,022	46,393	9,756	109,516
Grade 3	396	1,476	5,450	7,479	817	15,239
Grade 4	42	176	1,588	8,546	1,020	9,442
Neurosurgery	9	17	31	26	0	91
Cardiovascular	0	5	436	1,363	19	1,508
	11,763	29,139	59,245	106,018	17,499	223,664
Renal comorbidity						
Surgery	**0-14**	**15-39**	**40-59**	**60-80**	**80+**	**All ages**
Grade 1	982	1,796	6,940	9,650	1,473	20,651
Grade 2	725	3,431	7,586	10,606	2,441	25,739
Grade 3	60	281	1,530	1,710	204	3,582
Grade 4	6	33	446	1,954	255	2,219
Neurosurgery	1	3	9	6	0	22
Cardiovascular	0	1	122	312	5	354
	1,774	5,545	16,633	24,237	4,378	52,567

TABLE 7 **Unit costs of tests**

	Cost per patient tested (April 2001 UK£):		
	Lower	Mid	Upper
Chest x-ray	10.00	20.50	31.00
Resting ECG	11.00	26.00	37.00
Full blood count	0.70	2.35	4.05
Haemostasis (PT & PTT)	1.50	3.65	5.85
Urinalysis dipstick	0.15	0.21	0.27
Blood glucose	1.05	2.30	3.60
Renal function (Na, K, Cr, U)	1.40	3.40	5.40
Sickle cell (Sickledex)	1.50	2.30	3.10
Pregnancy	1.50	2.25	3.00
Arterial blood gases	2.60	3.10	3.60
Lung function (spirometry)	1.40	2.10	2.80

TABLE 8 **Economic analyses of preoperative testing – study characteristics**

First author	Year	Country	Patients	Type of surgery	Type of test	Cost comparison	Type of analysis	Economic outcome measure
Adams[26]	1992	USA	Group 1 (n=105) had no comorbidity Group 2 (n=64) had known comorbidity(s) (13 to 80 years)	Elective Herniorrhaphy	Various	Observed practice vs not testing (charges not costs)	Cost-effectiveness analysis	Cost per abnormal test that changed treatment
Archer[35]	1993	Canada	Review of 21 studies	Various	Chest x-ray	Routine testing vs not testing	Cost-effectiveness analysis	1. Cost per abnormality 2. Cost per clinically significant abnormality 3. Cost per health benefit
Kaplan[30]	1985	USA	2000 patients	Various	Various laboratory tests	Observed practice vs indicated testing	Cost-effectiveness analysis	1. Cost of Non-indicated tests per hospital per year 2. Cost per extra significant abnormality 3. Cost per life-saved
Kettler[27]	1996	USA	Azzam et al,199645 412 (10 to 20 years)	Various	Pregnancy	Routine testing vs not testing (charges not costs)	Cost-effectiveness analysis	Cost per pregnancy detected
Robbins[37]	1979	USA	UK & US morbidity survey data on prev	Various	Various	Routine testing vs not testing	Cost-effectiveness analysis	Cost per case found
Sommerville[31]	1992	South Africa	797 patients (0 to 80 years)	General, obstetrics and gynaecology, ENT, orthopaedics, urology, ophthalmology, plastic surgery, maxillofacial	Chest x-ray, ECG	Observed practice vs indicated testing	Cost-effectiveness analysis	1. Cost savings for sample 2. Cost per case detected
Turnbull[34]	1987	Canada	2570	Cholecystectomy	Various	Observed practice vs not testing	Cost-effectiveness analysis	1. Costs saved per patient 2. Cost per complication averted
Callaghan[10]	1995	UK	354 adults (17 to 89 years)	General, neurology, ENT, ophthalmology, urology, dental, vascular	ECG	Observed practice vs indicated testing	Cost analysis	Potential cost savings
Hoare[36]	1993	UK	372 children (2 to 15 years)	ENT	FBC	Routine testing vs not testing	Cost analysis	Cost savings of testing, clinic visits & theatre time

TABLE 8 **Economic analyses of preoperative testing – study characteristics**

First author	Year	Country	Patients	Type of surgery	Type of test	Cost comparison	Type of analysis	Economic outcome measure
Livesey[15]	1993	UK	64 adults and 198 children	Tonsillectomy & Adenoidectomy	FBC	Routine testing vs not testing	Cost analysis	Potential cost savings per year for a 3 consultant unit
Macario[28]	1992	USA	2,093 patients	Various	Various	a. 1979 vs 1987 b. Observed practice vs indicated testing (Charges not costs)	Cost analysis	1. Cost savings per patient 2. Annual cost savings in USA
Narr[33]	1991	USA	3,782 patients		Various	Observed practice vs not testing	Cost analysis	1. Cost savings per patient 2. Annual cost savings in USA
Velanovich[29]	1993	USA	Velanovich, 199146 Velanovich, 199447 420 patients	General, vascular, head and neck, thoracic (non cardiac)	Various	Routine testing vs indicated testing	Cost analysis	1. Cost savings per patient 2. Cost savings for sample
Wattsman[32]	1997	USA	142 patients	General surgery	Various	Observed practice vs indicated testing	Cost analysis	1. Cost savings for sample 2. Cost savings per patient 3. Annual cost savings for medical facility

TABLE 9 **Economic analyses of preoperative testing – cost of routine testing**

First author	Year	Currency	Cost comparison	Type of test	Incremental cost per patient	Incremental total cost	Incremental cost-effectiveness
Adams[26]	1992	US$ 1991	Observed practice vs not testing (charges not costs)	Various	Group1: $175 Group2: $66	Group1: $18,397 for sample Group2: $12,707 for sample	Group1: $18,397 per abnormal test that changed treatment Group2: $4,236 per abnormal test that changed treatment
Archer[35]	1993	Canada$ 1992	Routine testing vs not testing	Chest x-ray	$23		Can$2,300 Cost per abnormality Can$23,000 per clinically significant abnormality Can$115,000-Can$460,000 per health benefit
Kaplan[30]	1985	US$ 1985	Observed practice vs indicated testing	Various laboratory tests		$95,800 annually for institution	$4,170 per extra significant abnormality $4.2m per life saved
Kettler[27]	1996	US$ 1995	Routine testing vs not testing (charges not costs)	Pregnancy	$25		$1,050 per pregnancy detected in adolescents $7,750 per pregnancy detected in adults
Robbins[37]	1979	US$ 1978	Routine testing vs not testing	Various			Various from $1,400 per case found with pregnancy testing to $1.1m with PTT
Sommerville[31]	1992	South African Rand 1991	Observed practice vs indicated testing	Chest x-ray	R5.73	R4,565 for sample	Indicated: R134 per case detected; Non-indicated age>60: R262 per case detected; Non-indicated age<60: R2,361 per case detected
				ECG	-R3.70	-R2,952 for sample	Indicated: R58 per case detected; Non-indicated age>40: R243 per case detected; Non-indicated age<40: R396 per case detected
Turnbull[34]	1987	US?$	Observed practice vs not testing	Various	$102.97	$104,000	$26,000 per complication averted
Callaghan[10]	1995	UK£ 1994	Observed practice vs indicated testing	ECG	£2.50	£885 for sample (2 week intake for unit)	
Hoare[36]	1993	UK£ 1993	Routine testing vs not testing	FBC	Lab costs: £21.51 Wasted theatre time: £1.04 Extra clinic visits: £1.04	Costs for unit per year: Lab costs: £8000 Wasted theatre time: £500 Extra clinic visits: £500	

TABLE 9 **Economic analyses of preoperative testing – cost of routine testing** *continued*

First author	Year	Currency	Cost comparison	Type of test	Incremental cost per patient	Incremental total cost	Incremental cost-effectiveness
Livesey[15]	1993	UK£ 1992	Routine testing vs not testing	FBC	£2.50	£2,000 for a 3 consultant unit per year	
Macario[28]	1992	US$ 1991	a. 1979 vs 1987 b. Observed practice vs indicated testing (Charges not costs)	Various	a. $7.08 b. $48.47	a. $320m in USA per year b. $1.3bn in USA per year	
Narr[33]	1991	US$ 1988	Observed practice vs not testing	Various	$35.95	$2.9bn-$4.3bn in USA per year	
Velanovich[29]	1993	US$	Routine testing vs indicated testing	Various	$190.48	>$80,000 for sample	
Wattsman[32]	1997	US$ 1994	Observed practice vs indicated testing	Various	$60.37	$8,573 for sample $413,467 for medical facility	

TABLE 10 **Cost analyses of preoperative evaluation clinics – study characteristics**

First author	Year	Country	Methods*	Patients*	Type of surgery	Time between evaluation and surgery
Boothe[44]	1995	Canada	Retrospective comparison of two cohorts (matched for postoperative LOS)	A=53; B=11	Laparoscopic cholecystectomy	Not specified
Fischer[40]	1996	USA	Retrospective comparison of two cohorts	A=4,313 ; B=3,576	Various	Not specified
France[39]	1997	Belgium	Single retrospective cohort for current cost and used 59% reduction from Fischer40	B=2,103 patients (Haucotte et al, 199648)	Various	Not applicable
MacDonald[41]	1992	UK	Cost measured for single cohort. Number that would have needed surgery postponed was estimated on the basic of test results	A=147 elderly patients	Major joint replacement	Within 3 months
Pollard[38]	1996	USA	Before and after comparison of financial records	Not applicable	Not specified	Within 30 days
Power[42]	1999	Australia	Comparison of a prospective cohort with a retrospective cohort	A=201; B=168	General, ENT	Within 2 weeks
Starsnic[43]	1997	USA	Comparison of two prospective concurrent cohorts	A=1,519; B=1,543	Same-day surgery	Within 2 weeks

* A = preoperative evaluation in anaesthetist-led outpatient clinic; B = preoperative evaluation on inpatient surgical admission.

TABLE 11 Cost analyses of preoperative evaluation clinics – cost components measured

FIRST AUTHOR	YEAR	COSTS INCLUDED				ECONOMIC OUTCOME MEASURE
		Clinic costs	Tests	Theatre time	Inpatient stay	
Boothe[44]	1995	Yes	Yes	Yes	Yes	1. Cost savings per patient 2. Annual cost savings at institution
Fischer[40]	1996	No	Yes	No	No	1. Cost savings per patient 2. Annual cost savings at institution
France[39]	1997	No	Yes	No	No	Annual cost savings in Belgium
MacDonald[41]	1992	Yes	Yes*	No	Yes	Cost of clinic for sample
Pollard[38]	1996	No	No	No	Yes	Annual cost savings of the clinic
Power[42]	1999	No	Yes	No	No	1. Cost savings per patient 2. Annual cost savings for hospital per year
Starsnic[43]	1997	No	Yes	No	No	1. Cost savings per patient 2. Annual cost savings for hospital

* MacDonald et al calculated additional costs instead of cost savings. This is because this cost component was not measured incrementally; testing costs were not estimated for the control group.

TABLE 12 Cost analyses of preoperative evaluation clinics – cost savings

FIRST AUTHOR	YEAR	CURRENCY	INCREMENTAL COST SAVINGS – PREOPERATIVE TESTING		INCREMENTAL COST SAVINGS – ALL COMPONENTS	
			per patient	total	per patient	total
Boothe[44]	1995	Canadian $ 1992/3	Lab: Can$1.17 Rad: Can$25.49		Can$366.38	Can$758,767 annually for hospital
Fischer[40]	1996	US $ 1995	$112.09	$1.01m annually for hospital		
France[39]	1997	Belgian Franc 1996	2,212BEF	1,247m BEF annually for Belgium		
MacDonald[41]	1992	UK £ 1991	-£25.37*	£3,730 for sample	£33.74	£4,960 for sample
Pollard[38]	1996	US $ 1995				$530,000 annually for hospital
Power[42]	1999	Australian $ 1997	AUS$25.44	AUS$57,600 annually for hospital		
Starsnic[43]	1997	US $ 1996	$20.89	$173,799		

* MacDonald et al calculated additional costs instead of cost savings. This is because this cost component was not measured incrementally; testing costs were not estimated for the control group.

TABLE 13 **Reduction in day-of-surgery cancellations attributable to preoperative evaluation clinics**

First author	Year	Sample size*	% decrease
Boothe[44]	1995	A=53; B=11	60%
Fischer[40]	1996	A=4,313 ; B=3,576	88%
Hand[49]	1990	4,100	50%
Macarthur[50]	1991	1,042	80%
Pollard[38]	1996	Not specified	20%

* Total sample, not just cancellations. A=preoperative evaluation in anaesthetist-led outpatient clinic; B=preoperative evaluation on inpatient surgical admission.

TABLE 14 **Estimated cost per change in management in ASA grade 1 and 2 patients**

TEST	COST OF TEST PER PATIENT	PATIENTS WITH AN ABNORMAL TEST RESULT	POSITIVE PREDICTED VALUE OF TEST	PATIENTS WITH A CHANGE IN MANAGEMENT	COST PER CHANGE IN MANAGEMENT	
	a	b	c	d=bc	e=(a+89b)/d	Rank
Chest x-ray	£20.50	4.0%	11.7%	0.5%	£5,100	6
ECG	£26.00	16.0%	13.2%	2.1%	£1,900	4
Haemoglobin		3.7%	14.1%	0.5%		
White cells		0.9%	4.3%	0.0%		
Platelet count		1.5%	0.0%	0.0%		
FBC	£2.35	6.1%		0.6%	£1,400	3
Prothrombin		0.2%	0.1%	0.00%		
PTT		0.3%	14.1%	0.04%		
Haemostasis	£3.65	0.5%		0.04%	£9,600	8
Electrolytes		1.4%	10.9%	0.2%		
Cr/U		13.1%	0.7%	0.1%		
Kidney	£3.40	14.5%		0.2%	£6,900	7
Glucose	£2.30	1.0%	6.8%	0.1%	£4,700	5
Urine	£0.21	9.5%	15.4%	1.5%	£590	2
Pregnancy	£2.25	0.6%	97.7%	0.6%	£480	1

A=mid-point estimate from Table 7 above.
b=weighted mean for ASA grade 1-2 only.
In e, £89 is the average cost for a general surgery outpatient appointment. For ease of presentation, the figures in column e are presented to two significant figures.

TABLE 15 Comparison with Robbins and Mushlin

TEST	THIS STUDY		ROBBINS AND MUSHLIN[37]	
	Cost per change	Rank	Cost per case	Rank
Chest x-ray	£5,100	6	$500,000	7
ECG	£1,900	4	$20,000	4
FBC	£1,400	3	$1,100	2
Haemostasis	£9,600	8	$1.1m	8
Kidney	£6,900	7	$30,000	5
Glucose	£4,700	5	$4,000	3
Urinalysis	£590	2	$30,000*	5
Pregnancy	£480	1	$1,400	1

* Urine protein test only. If bacteriuria and chronic renal disease are also tested this figure falls to $1,100 per case found.

TABLE 16 Cost per change in management – sensitivity analysis

TEST	BASELINE ESTIMATE	UNIT COST OF TEST		COST OF FURTHER DIAGNOSIS		PROBABILITY OF POSITIVE TEST RESULT		POSITIVE PREDICTIVE VALUE	
		Low	High	Low	High	Low	High	Low	High
Chest x-ray	£5,100	£2,887	£7,357	£4,603	£5,948	£58,946	£1,028	£120,300	£1,170
ECG	£1,900	£1,198	£2,432	£1,447	£2,647	£6,847	£892	£5,133	£693
FBC	£1,400	£1,092	£1,689	£723	£2,440	£4,670	£976	£8,760	£355
Haemostasis	£9,600	£4,562	£14,765	£8,889	£10,742	£9,605	£1,527	£17,727	£1,222
Kidney	£6,900	£6,013	£7,694	£3,136	£12,766	£16,256	£812	*	£4,923
Glucose	£4,700	£2,858	£6,615	£3,801	£6,129	£9,783	£1,359	*	£3,709
Urinalysis	£590	£589	£597	£196	£1,224	£730	£581	£4,561	£182
Pregnancy	£480	£347	£603	£412	£574	£858	£196	£696	£464

* The only study(s) with a lower estimate of positive predictive value had an estimate of zero. In this case a low estimate of cost-effectiveness can not be computed as the estimated.

TABLE 17 Estimated cost per life saved in ASA grade 1 and 2 patients

	Proportion of changes in management that save a life (speculative)			
Test	10%	1%	0.1%	0.01%
Chest x-ray	£51,000	£510,000	£5,100,000	£51,000,000
ECG	£19,000	£190,000	£1,900,000	£19,000,000
FBC	£14,000	£140,000	£1,400,000	£14,000,000
Haemostasis	£96,000	£960,000	£9,600,000	£96,000,000
Kidney	£69,000	£690,000	£6,900,000	£69,000,000
Glucose	£47,000	£470,000	£4,700,000	£47,000,000
Urine	£5,900	£59,000	£590,000	£5,900,000
Pregnancy	£4,800	£48,000	£480,000	£4,800,000

The numbers in bold would be considered cost-effective using the UK Department of Transport threshold of £902,500 per life saved.[51]

TABLE 18 Recommended tests – NICE guideline (narrow)

	TESTS PERFORMED REGARDLESS OF COMORBIDITY	ADDITIONAL TESTS FOR COMORBID PATIENTS			ALL TESTS
		Cardiovascular	Respiratory	Renal	
Chest x-ray	31,551	0	0	0	31,551
ECG	667,669	376,857	0	11,052	1,055,579
FBC	1,467,141	0	0	0	1,467,141
Haemostasis	0	0	0	0	0
Renal	363,124	200,266	0	45,733	609,123
Blood glucose	0	0	0	0	0
Urine	0	0	0	0	0
Blood gases	0	0	0	0	0
Lung function	0	0	0	0	0
ALL TESTS	2,529,486	577,123	0	56,785	3,163,394

TABLE 19 Recommended tests – NICE guideline (broad)

	TESTS PERFORMED REGARDLESS OF COMORBIDITY	ADDITIONAL TESTS FOR COMORBID PATIENTS			ALL TESTS
		Cardiovascular	Respiratory	Renal	
Chest x-ray	319,219	453,366	182,753	16,822	972,160
ECG	3,376,636	9,303	1,652	3,745	3,391,336
FBC	2,878,804	49,978	52,183	12,166	2,993,131
Haemostasis	229,949	0	0	3,725	233,675
Renal	2,259,977	95,021	27,022	19,752	2,401,772
Blood glucose	2,087,238	0	0	0	2,087,238
Urine	4,386,083	0	0	0	4,386,083
Blood gases	0	70,485	211,901	6,871	289,257
Lung function	0	0	26,973	0	26,973
ALL TESTS	15,537,906	678,153	502,484	63,082	16,781,625

TABLE 20 Recommended tests – Oxford Handbook

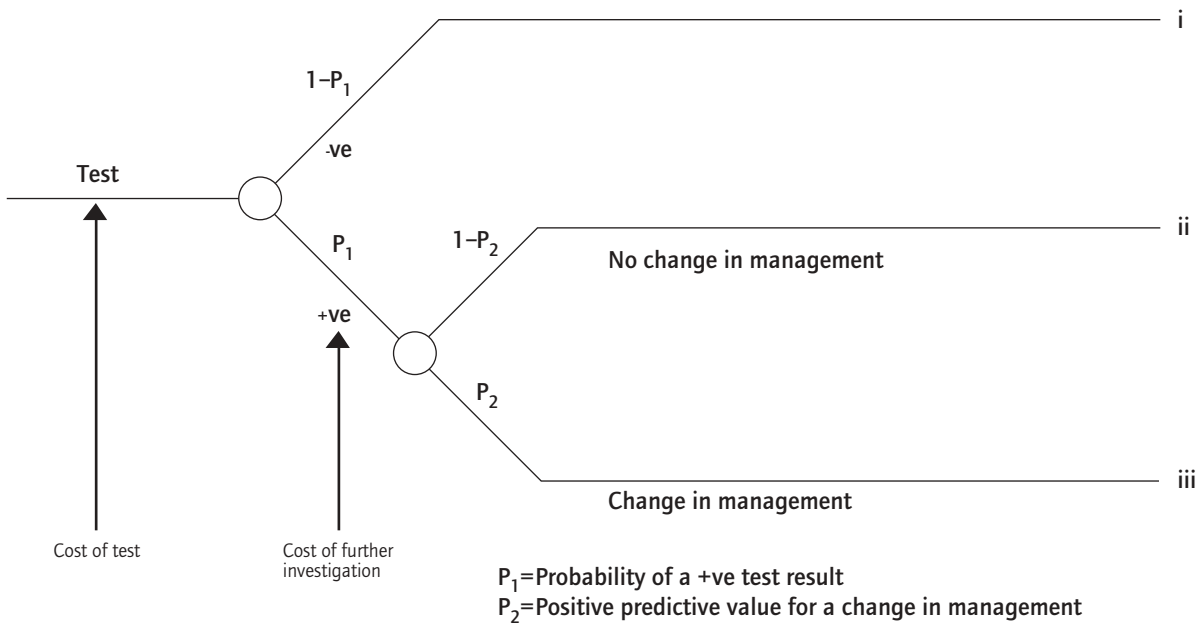
	TESTS PERFORMED REGARDLESS OF COMORBIDITY	ADDITIONAL TESTS FOR COMORBID PATIENTS			ALL TESTS
		Cardiovascular	Respiratory	Renal	
Chest x-ray	1,627,448	170,243	113,614	0	1,911,305
ECG	1,627,448	170,243	0	0	1,797,691
FBC	4,680,256	0	0	0	4,680,256
Haemostasis	0	0	0	0	0
Renal	4,680,256	0	0	0	4,680,256
Blood glucose	4,680,256	0	0	0	4,680,256
Urine	0	0	0	0	0
Blood gases	0	0	0	0	0
Lung function	0	0	0	0	0
ALL TESTS	17,295,664	340,486	113,614	0	17,749,764

TABLE 21 Cost of routine preoperative testing in England and Wales

	NUMBER OF TESTS PER YEAR MILLION	COST PER YEAR (£MILLION)	
		Mid-point	Sensitivity range
NICE guidelines* – narrow	3.35	35.59	(14.62, 52.17)
NICE guidelines* – broad	17.77	138.54	(59.80, 203.20)
Oxford Handbook*	18.80	130.88	(56.79, 197.85)
Increment (Oxford vs narrow)	15.45	95.29	
Increment (Oxford vs broad)	1.03	-7.66	
Pregnancy test (women aged 15-50)	0.87	1.97	(1.31, 2.62)
Sickle cell test (all black)	0.12	0.27	(0.18, 0.37)
Sickle cell test (all non-white)	0.35	0.81	(0.53, 1.09)

* Excluding pregnancy and sickle cell tests.

FIGURE 1 **Cost-effectiveness model**



Annex: Unit costs – data collection form

Annex Table 1 Unit cost of preoperative tests

Type of test	Name & type of capital equipment used (or if kit used instead, name of kit)	Volume of tests (total number carried out by the lab in one year)	Total cost per patient tested (£)	
			excluding overheads	including overheads (if known)
Renal function tests (U, Cr, Na, K)				
Glucose tests				
Urine analysis (dipstick)				
Full haemoglobin count				
Haemostasis				
Sickle solubility test				
Hb electrophoresis				
Pregnancy test				
Liver function tests (please specify)				
Thyroid function tests				
Blood viscosity test				
Theophylline test				
Calcium test				
Blood gases test				

Annex Table 2 Components of unit cost

For each test, which items were included in the estimate of unit cost recorded in Annex Table 1? (please tick)*

Type of test	Reagents	Capital equipment	Staff time	Quality control (Int & Ext)	Maintenance	Other consumables
Renal function tests (U, Cr, Na, K)						
Glucose tests						
Urine analysis (dipstick)						
Full haemoglobin count						
Haemostasis						
Sickle solubility test						
Hb electrophoresis						
Pregnancy test						
Liver function tests (please specify)						
Thyroid function tests						
Blood viscosity test						
Theophylline test						
Calcium test						
Blood gases test						

Annex Table 3 Breakdown of unit cost

If information available, for each test please give a break down of the cost per test:

Type of test	**Cost per patient tested (£)**						
	Reagents	**Capital equipment**	**Staff time**	**Quality control (Int & Ext)**	**Maintenance**	**Other consumables**	**Total cost per patient tested (excluding overheads)**
Renal function tests (U, Cr, Na, K)							
Glucose tests							
Urine analysis (dipstick)							
Full haemoglobin count							
Haemostasis							
Sickle solubility test							
Hb electrophoresis							
Pregnancy test							
Liver function tests (please specify)							
Thyroid function tests							
Blood viscosity test							
Theophylline test							
Calcium test							
Blood gases test							

Bibliography

1 Marcello PW, Roberts PL. "Routine" preoperative studies. Which studies in which patients? *Surg Clin North Am* 1996; **76**:11-23.

2 Institute of Medicine. *Guidelines for clinical practice: from development to use*. Washington DC: National Academy Press; 1992.

3 Drummond MF, O'Brien B, Stoddart GL, Torrance GW. *Methods for the economic evaluation of health care programmes. Second Edition*. Oxford: Oxford Medical Publications; 1997.

4 Gold MR, Siegel JE, Russell LB, Weinstein MC (Eds.). *Cost-effectiveness in health and medicine*. New York City: Oxford University Press; 1996.

5 National Institute for Clinical Excellence. *Guidance for manufacturers and sponsors*. London: National Institute for Clinical Excellence; 2001.

6 Weinstein MC, Siegel JE, Gold MR, Kamlet MS, Russell LB. Recommendations of the Panel on Cost-effectiveness in Health and Medicine. *JAMA* 1996; **276**:1253-1258.

7 Munro J, Booth A, Nicholl J. Routine preoperative testing: a systematic review of the evidence. *Health Technol Assess* 1997; **1**(12).

8 NHS Executive. Reference Costs 2000. London: Department of Health; 2001.

9 NHS Executive. NHS Costing Manual. Leeds: Department of Health; 2001.

10 Callaghan LC, Edwards ND, Reilly CS. Utilisation of the pre-operative ECG. *Anaesthesia* 1995; **50**:488-490.

11 Fenwick EA, Briggs AH, Hawke CI. Management of urinary tract infection in general practice: a cost-effectiveness analysis. *Br J Gen Pract* 2000; **50**:635-639.

12 Hayes PD, Lloyd AJ, Lennard N, Wolstenholme JL, London NJ, Bell PR et al. Transcranial Doppler-directed Dextran-40 therapy is a cost-effective method of preventing carotid thrombosis after carotid endarterectomy. *Eur J Vasc Endovasc Surg* 2000; **19**:56-61.

13 Hunt MT, Woodhouse CR. Cost-effectiveness of investigations for invasive bladder cancer. *J R Soc Med* 1987; **80**:143-144.

14 Karnon J, Zeuner D, Ades AE, Efimba W, Brown J, Yardumian A. The effects of neonatal screening for sickle cell disorders on lifetime treatment costs and early deaths avoided: a modelling approach. *J Public Health Med* 2000; **22**:500-511.

15 Livesey JR. Are haematological tests warranted prior to tonsillectomy? *J Laryngol Otol* 1993; **107**:205-207.

16 Molyneux EM, Robson WJ. A dipstick test for urinary tract infections. *J Accid Emerg Med* 1995; **12**:191-193.

17 Murray ET, Fitzmaurice DA, Allan TF, Hobbs FD. A primary care evaluation of three near patient coagulometers. *J Clin Pathol* 1999; **52**:842-845.

18 Pearson M, Layton C. Value of the chest radiograph before cardiac catheterisation in adults. *Br Heart J* 1994; **72**:505.

19 Preston A, O'Donnell T, Phillips CA. Screening for urinary tract infections in a gynaecological setting: validity and cost-effectiveness of reagent strips. *Br J Biomed Sci* 1999; **56**:253-257.

20 Ratcliffe J, Ryan M, Tucker J. The costs of alternative types of routine antenatal care for low-risk women: shared care vs care by general practitioners and community midwives. *J Health Serv Res Policy* 1996;1:135-140.

21 Roberts JA, Upton PA, Azene G. *Escherichia coli* O157:H7; an economic assessment of an outbreak. *J Public Health Med* 2000; **22**:99-107.

22 Robertson JF, Whynes DK, Dixon A, Blamey RW. Potential for cost economies in guiding therapy in patients with metastatic breast cancer. *Br J Cancer* 1995; **72**:174-177.

23 Scott A, Currie N, Donaldson C. Evaluating innovation in general practice: a pragmatic framework using programme budgeting and marginal analysis. *Fam Pract* 1998; **15**:216-222.

24 Underwood SR, Godman B, Salyani S, Ogle JR, Ell PJ. Economics of myocardial perfusion imaging in Europe—the EMPIRE Study. *Eur Heart J* 1999; **20**:157-66.

25 Zeuner D, Ades AE, Karnon J, Brown J, Dezateux C, Anionwu EN. Antenatal and neonatal haemoglobinopathy screening in the UK: review and economic analysis. *Health Technol Assess* 1999; **3**(11).

26 Adams JG, Weigelt JA, Poulos E. Usefulness of preoperative laboratory assessment of patients undergoing elective herniorrhaphy. *Arch Surg* 1992; **127**:801-804.

27 Kettler RE. The cost of preoperative pregnancy testing. *Anesth Analg*. 1996; **83**:439-440.

28 Macario A, Roizen MF, Thisted RA, Kim S, Orkin FK, Phelps C. Reassessment of preoperative laboratory testing has changed the test-ordering patterns of physicians. *Surg Gynecol Obstet* 1992; **175**:539-547.

29 Velanovich V. How much routine preoperative laboratory testing is enough? *Am J Med Qual* 1993; **8**:145-151.

30 Kaplan EB, Sheiner LB, Boeckmann AJ, Roizen MF, Beal SL, Cohen SN et al. The usefulness of preoperative laboratory screening. *JAMA* 1985; **253**:3576-81.

31 Sommerville TE, Murray WB. Information yield from routine pre-operative chest radiography and electrocardiography. *S Afr Med J* 1992; **81**:190-196.

32 Wattsman TA, Davies RS. The utility of preoperative laboratory testing in general surgery patients for outpatient procedures. *Am Surg* 1997; **63**:81-90.

33 Narr BJ, Hansen TR, Warner MA. Preoperative laboratory screening in healthy Mayo patients: cost- effective elimination of tests and unchanged outcomes. *Mayo Clin Proc* 1991; **66**:155-159.

34 Turnbull JM, Buck C. The value of preoperative screening investigations in otherwise healthy individuals. *Arch Intern Med* 1987; **147**:1101-1105.

35 Archer C, Levy AR, McGregor M. Value of routine preoperative chest x-rays: a meta-analysis. *Can J Anaesth* 1993; **40**:1022-1027.

36 Hoare TJ. Pre-operative haemoglobin estimation in paediatric ENT surgery. *J Laryngol Otol* 1993; **107**:1146-1148.

37 Robbins JA, Mushlin AI. Preoperative evaluation of the healthy patient. *Med Clin North Am* 1979; **63**:1145-1156.

38 Pollard JB, Zboray AL, Mazze RI. Economic benefits attributed to opening a preoperative evaluation clinic for outpatients. *Anesth Analg* 1996; **83**:407-410.

39 France FH, Lefebvre C. Cost-effectiveness of preoperative examinations. *Acta Clin Belg* 1997; **52**:275-286.

40 Fischer SP. Development and effectiveness of an anesthesia preoperative evaluation clinic in a teaching hospital. *Anesthesiology* 1996; **85**:196-206.

41 MacDonald JB, Dutton MJ, Stott DJ, Hamblen DL. Evaluation of pre-admission screening of elderly patients accepted for major joint replacement. *Health Bull (Edinb)* 1992; **50**:54-60.

42 Power LM, Thackray NM. Reduction of preoperative investigations with the introduction of an anaesthetist-led preoperative assessment clinic. *Anaesth Intensive Care* 1999; **27**:481-488.

43 Starsnic MA, Guarnieri DM, Norris MC. Efficacy and financial benefit of an anesthesiologist-directed university preadmission evaluation center. *J Clin Anesth* 1997; **9**:299-305.

44 Boothe P, Finegan BA. Changing the admission process for elective surgery: an economic analysis. *Can J Anaesth* 1995; **42**:391-394.

45 Azzam FJ, Padda GS, DeBoard JW, Krock JL, Kolterman SM. Preoperative pregnancy testing in adolescents. *Anesth Analg* 1996; **82**:4-7.

46 Velanovich V. The value of routine preoperative laboratory testing in predicting postoperative complications: a multivariate analysis. *Surgery* 1991; **109**:236-243.

47 Velanovich V. Preoperative laboratory screening based on age, gender, and concomitant medical diseases. *Surgery.* 1994; **115**:56-61.

48 Haucotte G, Lefèbvre CH, Bauwens P, Vandermeersch E. Etude BIOMED, Evaluation du bilan préopératoire. *Rapport au Ministère de la Santé Publique et de l'Environnement*, Brussels; 1996.

49 Hand R, Levin P, Stanziola A. The cause of cancelled elective surgery. *Qual Asur Utilization Rev* 1990, **5**:2-6.

50 Macarthur A, Macarthur C, Bevan J. Preoperative assessment clinic reduces day surgery cancellations [abstract]. *Anesthesiology* 1991; **75**:A11091.

51 Department for Transport, Local Government and the Regions. Highway economics note 1: 2000. London: Department for Transport, Local Government and the Regions; 2000.