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UK Liver Transplant Audit

In patients who received a Liver Transplant
between 1st March 1994 and 31st March 2012

ANNUAL REPORT | Advisory Group for National Specialised Services

Prepared by:

The Clinical Effectiveness Unit at
the Royal College of Surgeons &
The London School of Hygiene
and Tropical Medicine

Susan Charman

Lynn Copley

Chutwichai Tovikkai

Jan van der Meulen

Statistics and Clinical Audit, NHS
Blood and Transplant

Claire Counter

Sally Rushton

Dave Collett

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Table of Contents

Executive Summary	1
1. Introduction	6
2. Procedures and Methods	7
2.1 Patient Exclusions and analysis subgroups	7
2.2 Outcomes and adjustment	7
2.3 Risk Models	7
2.4 Missing Values	8
2.5 Descriptions of specific risk models	8
2.5.1 Super-urgent transplants	8
2.5.2 Elective transplants	8
2.5.3 Second Transplants	9
2.6 Centre Comparisons	9
2.7 Continuous monitoring of centre performance	9
3. Results in Adults	11
3.1 All Transplants	11
3.2 Super-urgent transplants	11
3.2.1 Centre-specific graft loss and mortality during the entire audit	11
3.2.2 Centre-specific mortality during the latest three years of the audit	12
3.2.3 Centre-specific mortality during the latest year of the audit	12
3.3 Elective Transplants	12
3.3.1 Centre-specific mortality and graft loss during the entire audit	12
3.3.2 Centre-specific mortality during the latest three years of the audit	13
3.3.3 Centre-specific mortality and graft loss during the latest year of the audit	13
3.4 Second Transplants	13
3.4.1 Centre-specific mortality and graft loss during the entire audit	13
3.4.2 Centre-specific mortality in the latest three years of the audit	14
3.4.3 Centre-specific mortality and graft loss during the latest year of the audit	14
3.5 Continuous Monitoring	14

4. Results in Paediatric patients	15
4.1 <i>Distribution of patient and donor characteristics</i>	<i>15</i>
4.2 <i>First transplants</i>	<i>15</i>
4.2.1 Centre-specific mortality during the entire audit	15
4.2.2 Centre-specific mortality during the latest year of the audit	15
4.3 <i>Second Transplants</i>	<i>16</i>
4.4 <i>Continuous monitoring.....</i>	<i>16</i>
5. Results for other categories	17
5.1 <i>Mortality after a third and fourth liver transplant</i>	<i>17</i>
5.2 <i>Multi-organ transplants</i>	<i>17</i>
5.3 <i>Donation after cardiac death transplants</i>	<i>17</i>
5.4 <i>Living donor transplants.....</i>	<i>17</i>
5.5 <i>Reduced and split liver transplants</i>	<i>17</i>
6. Comments.....	18

Tables

Table 1	Patient mortality by transplant centre for all adults during the whole audit period.....	20
Table 2	Patient mortality by transplant centre for all adult super-urgent cases during the whole audit period	21
Table 3	Graft loss by transplant centre for all adult super-urgent cases during the whole audit period	22
Table 4	Mortality & graft loss for super-urgent cases during the most recent year	23
Table 5	Distributions of the patient and donor characteristics, by transplant centre, for adults who received a first liver transplant as super-urgent between 1 st April 2009 and 31 st March 2012 in the UK.	24
Table 6	Hazard Ratios and 95% confidence intervals for the multivariable risk model for 5 year survival of adult super-urgent first liver transplants, performed between 1 st March 1994 and 31 st March 2012 in the UK.	30
Table 7	1-year mortality for adult super-urgent cases during the whole audit period	33
Table 8	1-year mortality for adult super-urgent cases during the last three years of the audit	33
Table 9	3-year mortality for adult super-urgent cases during the whole audit period	34
Table 10	5-year mortality for adult super-urgent cases during the whole audit period	34
Table 11	Patient mortality by transplant centre for all adult elective cases during the whole audit period	35
Table 12	Graft loss by transplant centre for all adult elective cases during the whole audit period ..	36
Table 13	Mortality and graft loss for adult elective cases during the most recent year of the audit .	37
Table 14	Distributions of the patient and donor characteristics, by transplant centre, for adults who received a first liver transplant as elective between 1 st April 2011 and 31 st March 2012 (most recent year) in the UK.	38
Table 15	Hazard ratios and 95% confidence intervals for the multivariable risk model for 5-year survival of adult, elective first transplant patients, for transplants performed between 1 st March 1994 and 31 st March 2012 in the UK.....	45
Table 16	1-year mortality for adult elective cases during the whole audit period.....	49
Table 17	1-year mortality for adult elective cases during the last three years of the audit.....	49
Table 18	3-year mortality for adult elective cases during the whole audit period.....	50
Table 19	5-year mortality for adult elective cases during the whole audit period.....	50

Table 20 Patient mortality (%) by transplant centre up to 5 years post liver transplantation for all adult patients who received a second liver transplant between 1 st March 1994 and 31 st March 2012 in the UK.....	51
Table 21 Graft loss (%) by transplant centre up to 5 years post liver transplantation for all adult patients who received a second liver transplant between 1 st March 1994 and 31 st March 2012 in the UK.	52
Table 22 Patient mortality and graft loss by transplant centre at 90 days post liver transplantation for adults who received a second liver transplant between 1 st April 2011 and 31 st March 2012 (most recent year) in the UK.	53
Table 23 Hazard ratios and 95% confidence interval for the multivariable risk model for 1-year survival for adult patients who received a second liver transplant between 1 st March 1994 and 31 st March 2012 in the UK.	54
Table 24 Unadjusted and risk-adjusted mortality (%) in the first year after liver transplantation in adults who received a second liver transplant between 1 st March 1994 and 31 st March 2012 in the UK.	56
Table 25 Unadjusted and risk-adjusted mortality (%) in the first year after liver transplantation in adults who received a second liver transplant between 1 st April 2009 and 31 st March 2012 in the UK.	57
Table 26 Distribution of the patient and donor characteristics in 68 paediatric patients who received a first liver transplant between 1 st April 2011 and 31 st March 2012 (most recent year).....	58
Table 27 Patient mortality (%) by transplant centre up to 1 year post liver transplantation for paediatric patients who received a first liver transplant between 1 st March 1994 and 31 st March 2012 in the UK.....	61
Table 28 Patient mortality (%) and graft loss (%) by transplant centre at 90 days post liver transplantation for paediatric patients who received a first liver transplant between 1 st April 2011 and 31 st March 2012 (most recent year) in the UK.....	62
Table 29 Patient mortality (%) and graft loss (%) by transplant centre post liver transplantation for paediatric patients who received a second liver transplant between 1 st March 1994 and 31 st March 2012 in the UK.....	63
Table 30 Patient mortality (%) and graft loss (%) post liver transplantation for patients who received a liver transplant between 1 st March 1994 and 31 st March 2012 in the UK.	64

Figures

Figure 1	Count of exclusions and unusable cases from the main analysis of first liver transplants to 31 st March 2012.....	65
Figure 2	Unadjusted and risk-adjusted observed – expected plots for 90-day mortality in adult super-urgent liver transplantation performed between 1 st January 2006 and 31 st March 2012 in the UK	66
Figure 3	Tabular CUSUM plots for 90-day mortality in adult super-urgent liver transplantation performed between 1 st January 2006 and 31 st March 2012 in the UK	67
Figure 4	Unadjusted and risk-adjusted observed – expected plots for 90-day mortality in adult elective liver transplantation performed between 1 st January 2006 and 31 st March 2012 in the UK	68
Figure 5	Tabular CUSUM plots for 90-day mortality in adult elective liver transplantation performed between 1 st January 2006 and 31 st March 2012 in the UK.....	69
Figure 6	Unadjusted observed – expected, and tabular CUSUM plots for 90-day mortality in paediatric super-urgent liver transplantation performed between 1 st January 2006 and 31 st March 2012 in the UK.....	70
Figure 7	Unadjusted observed – expected, and tabular CUSUM plots for 90-day mortality in paediatric elective liver transplantation performed between 1 st January 2006 and 31 st March 2012 in the UK.....	71

This annual report describes patient mortality, graft loss and complications up to five years for patients who received liver transplantation between 1st March 1994 and 31st March 2012 in the United Kingdom (UK). The results are described separately for adults (aged 17 or over) and paediatric patients (younger than 17). The results are also presented according to the urgency for transplantation, super-urgent or elective, based on being listed as super-urgent at the time of transplantation or not.

Separate analyses are also included for the most recent year (between 1st April 2011 and 31st March 2012) of the audit and the latest three years of the audit. The centre-specific results in adults are adjusted for differences in major risk factors (case mix) between centres, except for 90 day survival during the most recent year. In paediatric patients, only unadjusted results are presented. This report also reports results for 'Other categories'. These result from the analysis of second, third, fourth or higher, multi-organ transplants, donors after cardiac death and living donor transplants.

Results of continuous monitoring of 90 day mortality are also presented using CUSUM and risk- adjusted CUSUM plots. As the CUSUM are presented retrospectively, they can help show changes in mortality over time.

1. Adult Patients

⇒ Super-urgent first transplants

The **1 year** unadjusted mortality in adults transplanted as super-urgent over the **entire audit period** was 22.7% (95% CI 20.4% to 25.1%), and the mortality varied from 14.2% (95% CI 8.3% to 23.6%) in the centre with the lowest mortality to 26.9% (95% CI 21.1% to 33.9%) in the centre with the highest. The range of adjusted 1 year mortality rates was from 18.5% (95% CI 10.5% to 32.5%) to 27.4% (95% CI 20.7% to 36.1%).

The **3 year** unadjusted mortality in adults transplanted as super-urgent over the **entire audit period** was 25.7% (95% CI 23.4% to 28.3%) and the centre-specific mortality varied from 18.3% (95% CI 11.4 to 28.5%) to 29.9% (95% CI 23.8% to 37.1%). The centre-specific adjusted 3 year mortality varied from 23.1% (95% CI 19.0% to 28.0%) to 31.0% (95% CI 23.8% to 40.4%).

The **5 year** unadjusted mortality in adults transplanted as super-urgent over the **entire audit period** was 28.4% (95% CI 25.9% to 31.1%) and the centre-specific mortality varied from 18.3% (95% CI 11.4% to 28.5%) to 33.1% (95% CI 26.7% to 40.5%). The corresponding adjusted mortality ranged from 24.7% (95% CI 20.4% to 29.9%) to 35.1% (95% CI 27.3% to 45.2%).

The **1 year** unadjusted mortality in adults transplanted as super-urgent during the **last three years** of audit was 12.9% (95% CI 8.6% to 18.8%) and the centre-specific mortality varied

from 6.7% (95% CI 1.0% to 38.7%) to 30.0% (95% CI 10.8% to 67.1%). The corresponding adjusted mortality ranged from 5.9% (95% CI 2.2% to 15.8 %) to 29.5% (95% CI 9.5% to 91.5%).

The **90 day** unadjusted mortality in 55 adults transplanted as super-urgent during the **most recent year** of the audit was 9.1% (95% CI 3.8% to 20.5%) and the centre-specific mortality varied from 0 to 33.3% (95% CI 5.5% to 94.6%). All these rates had very wide confidence intervals since the number of transplants ranged from 3 to 17 and the number of deaths from 0 to 2. Since the number of transplants and the number of deaths was so small, no risk-adjusted estimates are reported. Risk estimates and risk-adjusted rates are difficult to both compute and interpret with such small sample sizes.

⇒ Elective first transplants

The **1 year** unadjusted mortality in adults transplanted as elective over the **entire audit period** was 12.5% (95% CI 11.8% to 13.3%), and the mortality varied from 10.3% (95% CI 9.0% to 11.8%) in the centre with the lowest mortality to 14.7% (95% CI 12.8% to 16.8%) in the centre with the highest. The range of adjusted mortality was 9.1% (95% CI 7.9% to 10.6%) to 16.1% (95% CI 13.5% to 19.2%).

The **3 year** unadjusted mortality in adults transplanted as elective over the **entire audit period** was 18.8% (95% CI 17.9% to 19.7%) and the centre-specific mortality varied from 17.1% (95% CI 14.4% to 20.3%) to 20.9% (18.6% to 23.5%). The centre-specific adjusted 3 year mortality varied from 15.2% (95% CI 13.6% to 17.1%) to 22.1% (19.0% to 25.6%).

The **5 year** unadjusted mortality in adults transplanted as elective over the **entire audit period** was 24.9% (95% CI 23.9% to 26.0%) and the centre-specific mortality varied from 23.0% (95% CI 19.8% to 26.7%) to 27.5% (95% CI 23.4% to 32.1%). After risk adjustment the lowest centre-specific mortality was 20.8% (95% CI 18.7% to 23.0%) and the highest was 29.0% (95% CI 25.8% to 32.6%).

The **1 year** unadjusted mortality in adults transplanted as elective during the **last three years** of the audit was 8.8% (95% CI 7.3% to 10.5%) and the centre-specific mortality varied from 6.4% (95% CI 3.6% to 11.4%) to 11.3% (95% CI 5.8% to 21.6%). After risk adjustment the lowest centre-specific mortality was 5.4% (95% CI 3.0% to 9.8%) and the highest was 12.8% (95% CI 6.4% to 25.7%).

The **90 day** unadjusted mortality in adults transplanted as elective during the **most recent year** of the audit was 3.5% (95% CI 2.3% to 5.5%), and the centre-specific mortality varied from 0 to 7.3% (95% CI 3.9% to 13.5%). All these rates had very wide confidence intervals and their interpretation is difficult. Since the number of deaths was small, no risk-adjusted estimates were calculated.

⇒ Second transplant patients

The **1 year** unadjusted mortality in adults who received a second liver transplant over the **entire audit period** was 26.6% (95% CI 23.8% to 29.6%). The centre-specific mortality varied

from 22.3% (95% CI 17.3% to 28.4%) to 34.3% (95% CI 25.2% to 45.4%). After risk-adjustment, the range was 22.8% (95% CI 17.3% to 30.2%) to 31.7 (95% CI 22.1% to 45.7%).

The **1 year** unadjusted mortality in adults who received a second liver transplant during the **last three years** of audit was 23.1% (95% CI 16.6% to 31.7%). The centre-specific mortality varied from 4.4% (95% CI 0.6% to 27.1%) to 51.5% (95% CI 30.9% to 75.8%). After risk-adjustment the range was 12.7% (95% CI 3.2% to 50.8%) to 36.3% (95% CI 11.7% to 100%).

In the 46 adults who received a second liver transplant during the **most recent year** of the audit there were 4 deaths within **90 days** of transplantation. Since the number of transplants and the number of deaths were very small, no Kaplan Meier estimates, confidence intervals or risk-adjusted estimates were calculated.

2. Paediatric Transplants

The **90 day** mortality in paediatric patients over the **entire audit period** was 8.1% (95% CI 6.8% to 9.8%), and the centre-specific mortality varied from 6.2% (95% CI 4.6% to 8.4%) to 17.5% (95% CI 8.8% to 33.2%). The **1 year** mortality in paediatric patients over the **entire audit period** was 10.5% (95% CI 9.0% to 12.4%) and the centre-specific mortality varied from 8.3% (95% CI 6.4% to 10.7%) to 22.8% (95% CI 12.6% to 39.3%).

The **90 day** mortality in paediatric patients transplanted as super-urgent over the **entire audit period** was 19.1% (95% CI 14.8% to 24.6%). The **90 day** mortality in paediatric patients transplanted as elective over the **entire audit period** was 5.3% (95% CI 4.1% to 6.9%).

The **90 day** mortality in 55 elective paediatric patients during the **most recent year** of the audit was 5.5% (95% CI 1.8% to 16.0%).

3. Other Categories

The overall **90 day** mortality for patients who received a liver transplant during the **entire audit period** was 10.5% (95% CI 10.0% to 11.1%) and the **90 day** graft loss was 13.8% (95% CI 13.2% to 14.4%). The **1 year** mortality for the same patient categories was 15.3% (95% CI 14.7% to 15.9%) and the **1 year** graft loss was 19.5% (95% CI 18.8% to 20.2%).

4. Continuous monitoring

Continuous monitoring plots did not show significant deviations from the expected national mortality rates during the audit period.

5. Conclusions

The interpretation of the results presented in this report is not straightforward. There are several caveats:

Some of the analyses are unadjusted for risk factors

Risk adjustment (where performed) is always incomplete

We can not take account of the differences in the management of patients on the waiting list for liver transplantation.

This report shows that the outcomes of liver transplantation in adults and paediatric patients are within acceptable limits for all the centres.

1. Introduction

This report presents patient mortality and graft loss after first and second liver transplantation, as well as results for other categories, for all seven centres that carry out liver transplantation in the UK. In addition to estimates for all patients who received a liver transplant between March 1994 and March 2012, estimates are reported for patients who received a transplant during the most recent year of the audit (April 2011 through March 2012) and the last 3 years of the audit (April 2009 through March 2012). Results are described separately for adults (at least 17 years of age) and for paediatric patients (under 17 years) and according to the urgency of the transplantation (super-urgent versus elective).

The centre-specific results for the first transplants in adults are adjusted for differences in major risk factors (case mix) between the centres on the basis of risk models that were specifically developed for this audit. The risk models used for this report have recently been updated and a brief summary of the model development is in section 2 of the report.

The UK Liver Transplant Audit is a multi-centre prospective cohort. The Audit has information relating to donors, recipients and outcomes for all liver transplants performed in the UK since 1st March 1994. Centres submit information to NHS Blood and Transplant at the time of transplantation, three months after transplantation and annually thereafter. This data is then transferred to the UK Liver Transplant Audit at the Royal College of Surgeons of England (RCS). At the beginning of April 2012, a total of 12,263 transplants had been registered with the Audit. The current dataset has been subjected to computer validation for missing values as well as inconsistent data up to November 2012.

2. Procedures and Methods

2.1 Patient Exclusions and analysis subgroups

After the omission of 17 patients with missing survival time information, 10,475 patients who received a first transplant between 1st March 1994 and 31st March 2012 were included in the main analysis (see figure 1). Mortality data was separately analysed for adult and paediatric patients.

In adult patients, 1,243 super-urgent first transplantations and 7,953 elective first transplantations were analysed. There were 252 super-urgent first transplantations and 1,027 elective first transplantations in the paediatric group to be analysed, these figures included patients who received a liver, bowel and pancreas/ multi-visceral transplant. Mortality rates for the liver, bowel and pancreas/ multi-visceral transplant recipients are presented separately.

1,771 transplants were excluded (1,262 re-transplants, 276 multi-organ transplants and 233 atypical donors) from the main analysis. These exclusions and the counts of excluded cases are given in figure 1. These transplants were analysed separately.

2.2 Outcomes and adjustment

Patient mortality and graft loss as a function of time after transplantation is reported. Graft loss is defined as occurring when a patient undergoes a re-transplant or dies, irrespective of the cause of death.

Kaplan-Meier methods were used to estimate unadjusted patient mortality and graft loss. This method allows the inclusion of all the patients in the analysis irrespective of the duration of follow-up recorded in the database. If a patient is still alive at the end of follow-up, then the information about the survival of the patient or the graft is censored.

Risk models were used to estimate the relationship of mortality at several time points with risk factors that have proved their utility in previous reports and published research. The risk models and methods of risk adjustment are described below. The risk models were used to adjust centre-specific rates for the effects of the risk factors included in the models.

2.3 Risk Models

Risk models were estimated for the survival times reported here, these are, 90 days, 1 year, 3 years and 5 years for adult transplants. Risk models were estimated separately for super-urgent and elective transplants and for adult second transplants.

In previous reports the risk models used for case-mix adjustment were based on the models developed for and described in the NSCAG Report of July 2004. Case mix adjustment for this report is based on our recent update of these models. The new model was, briefly, developed as follows. The main factors for inclusion in the risk model were decided on a

priori and based on factors used in previous multivariable risk models for this report, other post transplant survival models used by NHSBT and those found from a review of the literature of prognostic factors. Some factors could not be included because of a high proportion of missing data. We did not adopt a selection procedure in order to avoid over-fitting. However, best fitting fractional polynomials of continuous variables were found using a selection procedure as was the inclusion of potential interactions. This later selection was adjusted for multiple testing. Models for elective and super-urgent transplants were evaluated separately. The performance of each model was assessed by evaluating the ability of the risk model to distinguish between patients who died within 5 years after transplantation and those who survived (discrimination), and the ability to predict the risk of death accurately (calibration). The recipient, donor and transplant characteristics included are shown in Tables 6 and 15. Further work is being undertaken to validate these models.

Statistical adjustment for case mix is always incomplete and case mix, can therefore, never be fully excluded as a source of differences between centres, even when risk-adjusted estimates are available. This is due to what is sometimes referred to as 'residual confounding'. This affects the size of the adjustment rather than its direction. It is therefore useful to consider not only the risk-adjusted mortality estimate itself but also the direction in which the risk-adjusted mortality differs from the unadjusted mortality.

2.4 Missing Values

Multiple imputations were used to estimate plausible values for missing covariates. Missing values were imputed ten times using chained equations (Royston, 2004). Model estimates (hazard ratios) are calculated by pooling the ten estimates according to Rubin's rules. Variables used to predict values of the missing data were all the risk factors considered in the analysis model, survival or censoring time and survival status. This was done separately for the adult super-urgent and the adult elective models.

2.5 Descriptions of specific risk models

2.5.1 Super-urgent transplants

Table 6 shows the estimated risk model for mortality at 5 years among super-urgent transplants in adult patients. The risk of mortality is higher in older recipients. Recipient ethnicity, pre-transplant renal support, previous abdominal surgery all increase the risk of death within 5 years of liver transplantation. Higher recipient serum potassium and greater BMI increase risk although these associations do not quite reach statistical significance at traditional threshold of 5%. Non-identical blood groups confer a higher risk of death as do segmental grafts compared to whole grafts. Longer cold ischaemic time increases the risk of mortality and the risk of mortality is higher for transplants undertaken before 31st December 2004.

2.5.2 Elective transplants

Table 15 shows the estimated risk model for mortality at 5 years among elective transplants in adult patients. Older recipient age, higher serum potassium concentrations, pre-transplant renal support and longer time on the waiting list are risk factors for increasing mortality. However, higher serum albumin reduces risk of death within 5 years. Higher

donor BMI, abnormal graft appearance and segmental grafts are risk factors for increasing mortality. The risk of mortality after receiving a graft from donation after cardiac death is higher than after receiving a graft from donation after brain death. Risk of mortality was higher in all three previous periods of the audit.

2.5.3 Second Transplants

Table 23 shows the results of the risk model for mortality at 1 year among second transplants for adult patients. The risk of mortality is higher in patients 60 years or older than in younger patients. Although sex, urgency status, time from first transplant and cause of failure of the graft are included, there appears to be no association between these factors and mortality at 1 year. Risk of mortality was higher before 1st October 1998 than after.

2.6 Centre Comparisons

Kaplan-Meier estimates were used for unadjusted centre-specific mortality rates.

A method of indirect standardization was used to compute adjusted rates and confidence intervals for each centre. For each centre, the expected mortality rate for patients with risk characteristics treated at the centre, estimating a probability for each patient from the risk model was calculated. The ratio of the observed mortality rate to the expected mortality rate (O/E ratio) was then calculated, which is an indirectly standardized ratio. The centre-specific O/E ratios were then multiplied by the overall mortality for all the centres combined. The resulting adjusted mortality can be interpreted as the expected rate for that centre if the centre had the same case mix as the whole cohort of patients (all centres combined).

The criterion used for divergent performance was, whether or not, the 95% confidence interval of the adjusted rate excluded the overall rate.

2.7 Continuous monitoring of centre performance

The continuous monitoring of centre outcomes combines the use of two types of cumulative sum (CUSUM) charts: the 'Observed- Expected' (O-E) chart and the tabular CUSUM, to monitor 90-day patient mortality for all first liver transplants since 1st January 2006. Recipients of a liver, bowel and pancreas/ multivisceral, heterotopic or auxillary liver transplant are excluded.

The O-E chart plots the cumulative difference between the observed and expected patient mortality. A downward trend in the O-E chart indicates a lower than expected mortality rate whereas an upward trend points to an observed mortality rate that is higher than expected. Expected rates have been determined from the national average mortality rate for transplants performed between 2002 and 2005, with more recent transplants given greater weight.

The tabular CUSUM chart is used to signal when a significant increase in mortality rates has been observed. The chart limit is set to signal when there is sufficient evidence to indicate that the mortality rate has doubled. Signals from the tabular CUSUM are superimposed on

the O-E charts presented and are identified by the associated transplant date. A signal may indicate divergence from the national average.

An analysis of the properties of the CUSUM charts being used indicates that if mortality rates after adult elective liver transplantation are consistent with the expected rates, a centre can, on average, expect two false signals in a ten-year period. Naturally, high volume centres may experience slightly more and low volume centres can expect fewer false signals in that time. CUSUM charts monitoring the number of deaths following adult super-urgent transplants are expected to signal, on average, once in a ten-year period if there has been no change in the underlying mortality rate. Due to the low numbers and lower mortality rates both elective and super-urgent paediatric CUSUM charts are expected to signal even less frequently when rates are consistent with what was expected.

Risk-adjusted monitoring is also performed for both adult elective and super-urgent liver transplantation using logistic regression. The risk factors used are those reported in the 90-day mortality models following adult elective and super-urgent liver transplantation described in the July 2004 audit report. Coefficients for both models have been re-estimated for transplants performed in the same time period used to determine the national average mortality rate (2002 to 2005). As a result, our model estimates for predicting mortality are independent of the observations monitored. For some patients the level of a categorical variable, used in the risk-adjustment process, is missing. In such cases, the level assigned to the patient is that corresponding to the lowest risk, hence the expected mortality is underestimated for those individuals.

No risk adjustment is performed for paediatric transplantation.

The O-E charts that are presented for each centre display the non-risk adjusted CUSUM as well as the corresponding risk-adjusted CUSUM for adult transplants. The tabular CUSUM chart shows the threshold that would indicate where there is evidence that an increase in unadjusted mortality rates has occurred.

3. Results in Adults

3.1 All Transplants

Table 1 shows the unadjusted mortality up to 5 years after first transplantation for adult patients transplanted between 1st March 1994 and 31st March 2012 for each centre. Of the 9,196 patients included, 9.2% died within 90 days and 25.3% died within 5 years of transplantation. The unadjusted 90 day mortality varied from 6.3% in Cambridge to 11.0% in Leeds. The unadjusted 5-year mortality varied from 24.0% in Birmingham and Edinburgh to 28.3% in Newcastle.

3.2 Super-urgent transplants

3.2.1 Centre-specific graft loss and mortality during the entire audit

Table 2 shows the unadjusted mortality up to 5 years after transplantation for adult patients who underwent a first transplant as super-urgent between 1st March 1994 and 31st March 2012. Of the 1,243 patients, 20.0% died within 90 days and 28.4% died within 5 years of transplantation. The 90-day mortality varied from 12.9% in Cambridge to 24.1% in Leeds.

Table 3 shows the unadjusted graft loss, including mortality, up to 5 years after transplantation for adult patients who underwent a first transplant as super-urgent between 1st March 1994 and 31st March 2012. The 90-day and 5-year graft loss for 1,243 transplants were 22.9% and 33.8% respectively. The 90-day graft loss varied from 18.8% in Cambridge to 26.8% in Leeds. The 5 year graft loss varied from 32.0% in Cambridge and Birmingham to 38.0% in Newcastle.

Table 7 gives the unadjusted and risk-adjusted 1-year mortality for adult patients who underwent a first transplant as super-urgent between 1st March 1994 and 31st March 2012. The expected mortality for the risk adjustment is obtained from a risk model including the factors described and shown in Table 6. The risk-adjusted mortality ranged from 18.5% in Cambridge to 27.4% in Leeds. The 95% confidence intervals of the centre-specific adjusted rates all included the overall rate of 22.7%, indicating that there was no evidence of higher or lower than expected mortality in any centre.

Table 9 shows the unadjusted and risk-adjusted 3-year mortality for adult patients who received their first liver transplant as super-urgent between 1st March 1994 and 31st March 2012. The adjusted mortality ranged from 23.1% at King's to 31.0% in Leeds. The centre-specific 95% confidence intervals for the adjusted 3-year mortality all included the overall rate of 25.7%. This indicates that there was no evidence that any centre has higher or lower than expected 3-year mortality.

Table 10 shows the unadjusted and adjusted 5-year mortality for adult patients who received their first liver transplant as super-urgent between 1st March 1994 and 31st March 2012. The risk model for mortality is shown in Table 6. The adjusted mortality ranged from 23.8% in Cambridge to 35.1% in Leeds. The centre-specific 95% confidence intervals for the adjusted 5-year mortality all included the overall rate of 28.4%. This indicates that there was no evidence that any centre has higher or lower than expected 5-year mortality.

3.2.2 Centre-specific mortality during the latest three years of the audit

Table 8 gives the unadjusted and risk-adjusted 1 year mortality for adult patients who received their first liver transplant as super-urgent between 1st April 2009 and 31st March 2012. The unadjusted rates were generally lower than those for the full period, but the confidence intervals were very wide. The risk-adjusted mortality ranged from 5.9% at King's to 29.5% in Leeds. The 95% confidence intervals of the centre-specific adjusted rates all included the overall rate of 12.9%, indicating that there was no evidence of higher or lower than expected mortality in any centre but the confidence intervals were very wide.

3.2.3 Centre-specific mortality during the latest year of the audit

Table 4 shows the unadjusted 90 day patient mortality and graft loss by transplant centre for adults who received a first liver transplant as super-urgent during the most recent year of the audit. There were 5 deaths and an additional graft failure among 55 transplants, so estimates had very wide confidence intervals. The overall mortality rate was 9.1% and the overall graft loss was 10.9%. There no deaths or graft failures in Newcastle, The Royal Free and Edinburgh.

3.3 Elective Transplants

3.3.1 Centre-specific mortality and graft loss during the entire audit

Table 11 shows the unadjusted mortality rates up to 5 years after transplantation for adult patients who underwent a first transplant as elective between 1st March 1994 and 31st March 2012. Of the 7,953 patients, 7.6% died within 90 days and 24.9% died within 5 years of transplantation. The 90-day mortality varied from 5.2% at King's to 9.6% in Birmingham. The 5-year mortality varied from 23.0% in Edinburgh to 27.5% in Newcastle and Leeds.

Table 12 shows the unadjusted graft loss rates up to 5 years after transplantation. The 90-day and 5-year graft loss for all transplants was 10.7% and 29.5% respectively. The 90 day-graft loss varied from 7.9% at King's to 13.1% at The Royal Free. The 5-year graft loss varied from 27.6% in Birmingham to 33.7% in Newcastle.

Table 16 gives the unadjusted and risk-adjusted 1-year mortality for adult patients who received their first liver transplant as elective between 1st March 1994 and 31st March 2012. The adjusted 1-year mortality ranges from 9.1% at King's to 16.1 % at The Royal Free. After risk adjustment, two centres had a higher rate than the overall rate, indicated by the centre-

specific confidence interval where the lower limit exceeded the overall rate of 12.5%: Leeds and The Royal Free. King's had lower than expected mortality, since the upper limit of the centre-specific confidence interval was lower than the overall average.

Table 18 shows the unadjusted and risk-adjusted 3-year mortality for adult patients who received their first liver transplant as elective between 1st March 1994 and 31st March 2012. The unadjusted mortality ranged from 17.1% in Edinburgh to 20.9% in Leeds. The risk-adjusted mortality ranged from 15.2% at King's to 22.1% at The Royal Free. King's had lower than expected mortality, since the upper limit of the centre-specific confidence interval was lower than the overall average. Leeds and The Royal Free had higher than expected mortality indicated by the centre-specific confidence intervals where the lower limits exceeded the overall rate of 18.8%

Table 19 shows the unadjusted and risk-adjusted 5-year mortality for adult patients who received their first liver transplant as elective between 1st March 1994 and 31st March 2012. The unadjusted mortality ranged from 23.0% in Edinburgh to 27.5% in Leeds and Newcastle. The risk-adjusted mortality ranged from 20.8% at King's to 29.0% in Leeds. There was some evidence that Leeds had slightly higher than expected mortality.

3.3.2 Centre-specific mortality during the latest three years of the audit

Table 17 shows the unadjusted and risk-adjusted 1-year mortality for 1,490 adult patients who received their first transplant as elective between 1st April 2009 and 31st March 2012. The unadjusted mortality ranges from 6.4% in Cambridge to 11.3% in Newcastle. The risk-adjusted mortality ranges from 5.4% in Cambridge to 12.8% in Newcastle. The overall rate was 8.8%.

3.3.3 Centre-specific mortality and graft loss during the latest year of the audit

Table 13 shows the 90-day patient mortality and graft loss by transplant centre for 538 adult patients who received a first liver transplant as elective during the most recent year of the audit. The overall rates were 3.5% and 6.9%, respectively. Mortality varied from 0% in Newcastle to 7.3% in Birmingham. Graft loss varied from 3.2% in Newcastle to 11.5% in Leeds.

3.4 Second Transplants

3.4.1 Centre-specific mortality and graft loss during the entire audit

Table 20 shows the unadjusted mortality up to 5 years after transplantation for adult patients who received a second transplant during the audit period. The overall 90-day mortality was 20.3% and centres varied from 14.6% in Edinburgh to 29.4% at The Royal Free. The overall 5 year mortality was 39.1% and centres varied from 32.9% in Birmingham to 50.6% in Leeds.

Table 21 shows the unadjusted graft loss rates up to 5 years after transplantation for adult patients who received a second transplant during the audit period. The overall 90-day rate was 23.7% and centres varied from 18.8% in Edinburgh and King's to 30.6% at The Royal Free. The overall 5 year rate was 44.5% and centres varied from 38.8% in Birmingham to 53.2% in Leeds.

Table 24 gives the unadjusted and the risk-adjusted mortality for adult patients who received their second liver transplant between 1st March 1994 and 31st March 2012. The risk model used for adjustment is shown in Table 23. Risk-adjusted mortality ranged from 22.8% at King's to 31.7% at The Royal Free. The centre-specific 95% confidence intervals all included the overall 1 year mortality rate, 26.6%, indicating that there was no evidence that any centre had lower or higher 1-year mortality than expected.

3.4.2 Centre-specific mortality in the latest three years of the audit

Table 25 gives the unadjusted and risk-adjusted mortality for 136 adult patients who received their second liver transplant between 1st April 2009 and 31st March 2012. The expected mortality for the risk adjustment is obtained from the risk model in Table 23. The overall unadjusted 1-year mortality was 23.1%, ranging from 4.4% at King's and 51.5% in Leeds. After risk-adjustment mortality ranged from 12.7% at The Royal Free to 36.3% in Newcastle. The centre-specific 95% confidence intervals all included the overall 1-year mortality, indicating that there was no evidence that any centre had a different rate than expected.

3.4.3 Centre-specific mortality and graft loss during the latest year of the audit

Table 22 shows the 90-day mortality and graft loss by transplant centre for 46 adult patients who received a second liver transplant during the most recent year of the audit. Only the number of transplants, number of deaths and the number of graft losses are shown for each centre due to the small numbers. There were 4 deaths and 1 additional graft loss in total.

3.5 Continuous Monitoring

The O-E CUSUM plots for the continuous monitoring of 90-day mortality are generally horizontal, indicating that mortality rates, across most centres, are as expected according to national average rates between 2002 and 2005 for both super-urgent (Figure 2) and elective (Figure 4) liver transplants. The O-E chart for elective transplants at King's College continues to show a downward trend, indicating an observed mortality rate which is lower than the national average (Figure 4).

4. Results in Paediatric patients

4.1 Distribution of patient and donor characteristics

There were a total of 1,279 paediatric (under 17 years of age) first liver transplants in the UK between March 1994 and March 2012. The bulk of these transplants were performed at Leeds (154), King's (627) and Birmingham (458). All other centres combined did 40 transplants and those have been pooled for this report.

There were 68 transplants in the most recent year. Table 26 shows the distribution of patient and donor characteristics for patients who received a first liver transplant between 1st April 2010 and 31st March 2012.

4.2 First transplants

4.2.1 Centre-specific mortality during the entire audit

Among 1,279 paediatric patients who received a first liver transplant between 1st March 1994 and 31st March 2012, 8.1% died within 90 days and 10.5% died within 1 year after transplantation (Table 27). The 90-day mortality varied from 6.2% at King's to 17.5% in all the others. The 1-year mortality rate varied from 8.3% at King's to 22.8% in all the other centres.

Of 251 paediatric patients who received a super-urgent (excluding cirrhosis intestinal failure patients) first transplant between 1st March 1994 and 31st March 2012, 19.1% died within 90 days of transplant, varying from 15.3% at King's to 40.0% in the others. The overall rate at one year was 23.8%, varying from 18.9% at King's to 50.0% in the others.

Of the 1,015 paediatric patients who received an elective transplant (excluding cirrhosis intestinal failure patients), 5.3% died within 90 days post transplant and the mortality varied from 3.4% in Leeds to 10.0% in the others. The 1-year mortality was 7.2% overall and varied from 5.2% in Leeds to 13.6% in the others.

4.2.2 Centre-specific mortality during the latest year of the audit

Table 28 shows that of the 68 paediatric patients transplanted during the most recent year of the audit, 4 patients died within 90 days. The overall 90 day mortality for elective patients in the most recent year was 5.5%. Of the 13 super-urgent patients in the most recent year, there was 1 death within 90 days.

4.3 Second Transplants

Overall, 172 paediatric patients received a second transplant (Table 29). The overall 90-day mortality was 16.3%. The 90-day mortality varied between 12.8% at King's and 21.7% in Birmingham. The overall 1-year mortality was 22.9%. The 1-year mortality varied between 11.1% in Leeds and 32.3% in the others.

4.4 Continuous monitoring

CUSUM plots for recent performance for all paediatric transplant centres show that there has been no significant deviation from the expected national mortality rates (Figures 6 & 7).

5. Results for other categories

Table 30 provides the overall 90-day and 1-year results for patients, who received a first transplant, second transplant, third transplant, fourth transplant, multi-organ transplant, donation after cardiac death transplant, living donor transplant, reduced and split liver transplant during the study period.

5.1 Mortality after a third and fourth liver transplant

The 90-day and 1-year mortality for 170 patients who received a third transplant were 35.9% and 44.3%, respectively. The 90-day and 1-year patient mortality for the 24 patients who received a fourth or higher graft were 37.5% and 70.8%, respectively.

5.2 Multi-organ transplants

In the 276 patients who received a multi-organ transplant, the 90-day and 1-year mortality were 14.5% and 21.9%, respectively. The 90-day and 1-year graft loss were 16.3% and 24.9%, respectively.

5.3 Donation after cardiac death transplants

There were 599 liver transplants performed using organs retrieved from donors after cardiac death during the study period. The 90-day mortality was 6.7% and the 1-year mortality was 12.2%. The 90-day and 1-year graft loss rates were 10.4% and 16.8%, respectively.

5.4 Living donor transplants

The 90-day and 1-year patient mortality in these 233 patients were 6.9% and 11.8%, respectively. The 90-day and 1-year graft loss rates were 8.2% and 13.6%, respectively.

5.5 Reduced and split liver transplants

There were 426 reduced liver transplants and 1,038 split liver transplants performed between 1st March 1994 and 31st March 2012. For the reduced liver transplants, the 90-day and 1-year mortality were 17.4% and 21.2%, respectively. The respective graft loss rates were 21.1% and 27.2%. The 90-day and 1-year patient mortality for split liver transplants were 6.8% and 10.1%, and the graft loss at 90 days and 1 year was 12.7% and 17.1%, respectively.

6. Comments

In this report centre-specific results are compared for many different categories and cohorts of patients. No centres were identified as outliers.

When interpreting these results one should take two issues into account. First, when making these comparisons we have to strike a balance between relevance and patient numbers. For example, the results for the patients transplanted in the most recent year of audit are most relevant as a measure of current centre performance. However, the number of included patients is often rather small which makes estimates imprecise. Second, the comparisons of centres are based on a statistical criterion, which implies that the problem of multiple comparisons has to be considered. Due to the fact that we report a large number of comparisons, we can expect to find evidence of 'divergent performance' in certain cases even if the 'true results' of all centres are the same.

Another issue that we always highlight in this report is that variation in outcomes can be the result of case mix with respect to donors as well recipients. Although, we are constantly improving our methods for risk- adjustment, the risk- adjustment will always be incomplete. As a consequence, a considerable part of the variation among the centres in the risk-adjusted results may be due to 'residual confounding'. However, we consider risk-adjustment as an essential part of the audit process. The differences between the unadjusted and risk- adjusted ratios of the observed odds of mortality to the expected odds give an indication to what extent observed differences among the unadjusted results might be due to differences in the risk profile of patients in the centres. It is this difference between the unadjusted and the risk- adjusted result in isolation that can be considered as most informative.

Real-time monitoring provides a tool for internal auditing and enables the prompt detection of any significant changes in mortality rates compared to a centre's own past performance. Real-time CUSUM monitoring has been performed on a monthly basis since October 2006 and is ongoing. Unadjusted O-E charts, with any signals resulting from a tabular CUSUM superimposed, and tabular CUSUM charts are sent to centres and show performance since 1 January 2006. The expected mortality rate used for the real-time monitoring of a centre-specific rate is based on the outcome of transplants performed between 2002 and 2005 with more recent transplants given greater weight. A signal in the real-time monitoring may indicate a deterioration in centre performance or a change in case-mix.

No signals have been recorded at any of the seven liver transplant centres since the one recorded at Newcastle in January 2011. The centre then conducted an internal review of their service.

Table 1 - Patient mortality by transplant centre for all adults during the whole audit period

Centre	Number of transplants	90-day mortality % (95% CI)	1-year mortality % (95% CI)	3-year mortality % (95% CI)	5-year mortality % (95% CI)
Newcastle	580	10.1 (8.0, 13.0)	14.7 (12.0, 17.8)	19.6 (16.6, 23.2)	28.3 (24.5, 32.5)
Leeds	1,440	11.0 (9.5, 12.7)	16.3 (14.4, 18.3)	22.0 (19.8, 24.4)	28.0 (25.5, 30.7)
Cambridge	1,045	6.3 (5.0, 8.0)	11.3 (9.5, 13.4)	17.5 (15.3, 20.1)	24.2 (21.5, 27.2)
Royal Free	975	10.5 (8.7, 12.6)	15.8 (13.6, 18.2)	21.3 (18.8, 24.1)	26.5 (23.7, 29.6)
King's	2,240	7.8 (6.8, 9.0)	12.6 (11.3, 14.1)	19.3 (17.6, 21.1)	24.8 (22.8, 26.9)
Birmingham	2,070	10.7 (9.4, 12.1)	14.4 (13.0, 16.0)	19.5 (17.8, 21.3)	24.0 (22.1, 26.0)
Edinburgh	846	8.2 (6.5, 10.2)	12.6 (10.5, 15.1)	18.3 (15.7, 21.2)	24.0 (20.9, 27.4)
All	9,196	9.2 (8.7, 9.9)	13.9 (13.2, 14.6)	19.7 (18.8, 20.5)	25.3 (24.4, 26.3)

Patient mortality by transplant centre for 90 days, 1 year, 3 years and 5 years post liver transplantation for all adult patients who received a liver transplant between 1st March 1994 and 31st March 2012 in the UK. Multi-organ transplants and atypical donors are excluded.

Table 2 - Patient mortality by transplant centre for all adult super-urgent cases during the whole audit period

Centre	Number of transplants	90-day mortality % (95% CI)	1-year mortality % (95% CI)	3-year mortality % (95% CI)	5-year mortality % (95% CI)
Newcastle	103	18.5 (12.2, 27.4)	21.4 (14.7, 30.7)	23.6 (16.4, 33.1)	31.9 (23.3, 42.7)
Leeds	187	24.1 (18.6, 31.0)	26.9 (21.1, 33.9)	29.9 (23.8, 37.1)	33.1 (26.7, 40.5)
Cambridge	85	12.9 (7.4, 22.2)	14.2 (8.3, 23.6)	18.3 (11.4, 28.5)	18.3 (11.4, 28.5)
Royal Free	100	22.0 (15.1, 31.5)	26.1 (18.6, 36.0)	28.3 (20.5, 38.4)	29.6 (21.6, 39.8)
King's	383	20.1 (16.4, 24.5)	23.8 (19.8, 28.4)	27.2 (23.0, 32.1)	28.8 (24.4, 33.8)
Birmingham	261	18.4 (14.2, 23.7)	20.0 (15.6, 25.4)	23.1 (18.4, 28.8)	25.3 (20.3, 31.3)
Edinburgh	124	21.0 (14.8, 29.2)	22.6 (16.2, 31.0)	25.3 (18.5, 34.0)	29.9 (22.4, 39.3)
All	1,243	20.0 (17.9, 22.3)	22.7 (20.4, 25.1)	25.7 (23.4, 28.3)	28.4 (25.9, 31.1)

Patient mortality by transplant centre up to 5 years post liver transplantation for all adult patients who received a first liver transplant as super-urgent between 1st March 1994 and 31st March 2012 in the UK.

Table 3 - Graft loss by transplant centre for all adult super-urgent cases during the whole audit period

Centre	Number of transplants	90-day graft loss % (95% CI)	1-year graft loss % (95% CI)	3-year graft loss % (95% CI)	5-year graft loss % (95% CI)
Newcastle	103	21.4 (14.6, 30.6)	24.3 (17.1, 33.8)	31.0 (22.9, 41.2)	38.0 (28.8, 48.8)
Leeds	187	26.8 (21.1, 33.8)	30.2 (24.1, 37.3)	33.7 (27.4, 41.1)	37.0 (30.4, 44.5)
Cambridge	85	18.8 (12.0, 28.9)	24.9 (17.0, 35.6)	30.3 (21.6, 41.6)	32.0 (22.9, 43.4)
Royal Free	100	24.0 (16.8, 33.6)	29.2 (21.3, 39.2)	30.3 (22.3, 40.4)	32.9 (24.5, 43.3)
King's	383	22.0 (18.1, 26.4)	26.4 (22.3, 31.2)	29.9 (25.5, 34.9)	32.6 (28.0, 37.8)
Birmingham	261	22.6 (18.0, 28.2)	24.6 (19.8, 30.3)	29.2 (24.0, 35.3)	32.0 (26.5, 38.3)
Edinburgh	124	23.4 (16.9, 31.9)	28.3 (21.2, 37.1)	30.2 (22.9, 39.2)	34.9 (26.9, 44.5)
All	1,243	22.9 (20.6, 25.3)	26.7 (24.4, 29.3)	30.5 (28.0, 33.2)	33.8 (31.2, 36.7)

Graft loss by transplant centre up to 5 years post liver transplantation for all adult patients who received a first liver transplant as super-urgent between 1st March 1994 and 31st March 2012 in the UK.

Table 4 - Mortality & graft loss for super-urgent cases during the most recent year

Centre	Number of transplants	90-day mortality (95% CI)	90-day graft Loss (95% CI)
Newcastle	3	0	0
Leeds	3	33.3 (5.5, 94.6)	33.3 (5.5, 94.6)
Cambridge	6	16.7 (2.5, 72.7)	33.3 (9.6, 80.5)
Royal Free	6	0	0
King's	17	5.9 (0.9, 35.0)	5.9 (0.9, 35.0)
Birmingham	13	15.4 (4.1, 48.8)	15.4 (4.1, 48.8)
Edinburgh	7	0	0
All	55	9.1 (3.9, 20.5)	10.9 (5.1, 22.7)

Patient mortality (%) and graft loss (%) by transplant centre at 90 days post liver transplantation for all adult patients who received a first liver transplant as super-urgent between 1st April 2011 and 31st March 2012 (most recent year) in the UK.

Table 5- Distributions of the patient and donor characteristics, by transplant centre, for adults who received a first liver transplant as super-urgent between 1st April 2009 and 31st March 2012 in the UK.

The count is shown for each centre with the percentage of the total in parentheses for categorical variables. Median (inter-quartile range) is shown for continuous variables.

Characteristics		Newcastle	Leeds	Cambridge	Royal Free	King's	Birmingham	Edinburgh
Number		15	10	12	14	56	49	20
Sex	Male	5 (33)	2 (20)	4 (33)	7 (50)	24 (43)	15 (31)	7 (35)
	Female	10 (67)	8 (80)	8 (67)	7 (50)	32 (57)	34 (69)	13 (65)
Recipient ethnicity	White	13 (87)	9 (90)	11 (92)	5 (36)	49 (88)	40 (82)	20 (100)
	Non-white	2 (13)	1 (10)	1 (8)	9 (64)	7 (13)	9 (18)	0 (0)
HCV status	No	15 (100)	4 (40)	11 (92)	14 (100)	56 (100)	45 (92)	20 (100)
	Yes	0 (0)	0 (0)	1 (8)	0 (0)	0 (0)	1 (2)	0 (0)
	Missing	0 (0)	6 (60)	0 (0)	0 (0)	0 (0)	3 (6)	0 (0)
Pre-transplant	Out-patient	0 (0)	0 (0)	0 (0)	2 (14)	0 (0)	1 (2)	0 (0)
In-patient status	In-patient	15 (100)	10 (100)	12 (100)	12 (86)	56 (100)	48 (98)	20 (100)
Ascites	Absence	10 (67)	9 (90)	5 (42)	12 (86)	49 (88)	29 (59)	16 (80)
	Presence	5 (33)	1 (10)	7 (58)	2 (14)	6 (11)	20 (41)	4 (20)
	Missing	0 (0)	0 (0)	0 (0)	0 (0)	1 (2)	0 (0)	0 (0)

Characteristics		Newcastle	Leeds	Cambridge	Royal Free	King's	Birmingham	Edinburgh
Number		15	10	12	14	56	49	20
Encephalopathy	Absence	0 (0)	1 (10)	1 (8)	0 (0)	3 (5)	1 (2)	0 (0)
	Presence	15 (100)	9 (90)	10 (83)	14 (100)	52 (93)	48 (98)	19 (95)
	Missing	0 (0)	0 (0)	1 (8)	0 (0)	1 (2)	0 (0)	1 (5)
Pre-transplant renal support	No	3 (20)	5 (50)	1 (8)	11 (79)	19 (34)	27 (55)	7 (35)
	Yes	12 (80)	5 (50)	10 (83)	3 (21)	37 (66)	22 (45)	13 (65)
	Missing	0 (0)	0 (0)	1 (8)	0 (0)	0 (0)	0 (0)	0 (0)
Previous abdominal surgery	No	13 (87)	9 (90)	12 (100)	13 (93)	49 (88)	48 (98)	17 (85)
	Yes	2 (13)	1 (10)	0 (0)	1 (7)	6 (11)	1 (2)	2 (10)
	Missing	0 (0)	0 (0)	0 (0)	0 (0)	1 (2)	0 (0)	1 (5)
Varices & shunt	Absence	6 (40)	7 (70)	5 (42)	14 (100)	49 (88)	49 (100)	11 (55)
	Presence	9 (60)	3 (30)	7 (58)	0 (0)	7 (13)	0 (0)	9 (45)
Life style activity	Normal	2 (13)	1 (10)	2 (17)	0 (0)	0 (0)	0 (0)	1 (5)
	Restricted	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Self-care	0 (0)	2 (20)	1 (8)	0 (0)	0 (0)	0 (0)	0 (0)
	Confined	4 (27)	1 (10)	0 (0)	0 (0)	10 (18)	11 (22)	3 (15)

Characteristics		Newcastle	Leeds	Cambridge	Royal Free	King's	Birmingham	Edinburgh
Number		15	10	12	14	56	49	20
Life style activity	Reliant	9 (60)	6 (60)	7 (58)	14 (100)	46 (82)	38 (78)	16 (80)
	Missing	0 (0)	0 (0)	2 (17)	0 (0)	0 (0)	0 (0)	0 (0)
Graft appearance	Normal	13 (87)	8 (80)	9 (75)	10 (71)	5 (9)	44 (90)	20 (100)
	Abnormal	2 (13)	2 (20)	2 (17)	4 (29)	2 (4)	5 (10)	0 (0)
	Missing	0 (0)	0 (0)	1 (8)	0 (0)	49 (88)	0 (0)	0 (0)
Age, years	Median (IQR)	43 (31, 49)	35 (24, 44)	36 (24, 48)	36 (27, 45)	42 (32, 53)	39 (26, 49)	42 (24, 58)
	Missing (N)	0	0	0	0	0	0	0
BMI, kg/m ²	Median (IQR)	26.1 (22.8, 27.5)	23.8 (19.2, 28.1)	23.6 (21.3, 24.9)	25.4 (23.6, 29.8)	24.2 (22.1, 27.7)	24.2 (21.7, 27.8)	25.0 (22.2, 29.3)
	Missing (N)	0	0	0	5	1	0	0
Serum Bilirubin, μmol/l	Median (IQR)	274 (98, 460)	166 (97, 355)	189 (92, 513)	315 (179, 422)	149 (85, 282)	289 (131, 374)	132 (78, 457)
	Missing (N)	0	0	0	0	0	0	0
Serum Creatinine, μmol/l	Median (IQR)	128 (87, 156)	101 (90, 161)	168 (118, 233)	89 (47, 146)	142 (92, 186)	80 (58, 146)	155 (96, 261)
	Missing (N)	0	0	0	0	0	0	0

Characteristics		Newcastle	Leeds	Cambridge	Royal Free	King's	Birmingham	Edinburgh
Number		15	10	12	14	56	49	20
Serum sodium, mmol/l	Median (IQR)	135 (130, 138)	139 (134, 141)	141 (136, 142)	142 (139, 144)	143 (140, 148)	143 (138, 149)	137 (135, 140)
	Missing (N)	0	0	0	0	0	0	0
Serum potassium, mmol/l	Median (IQR)	3.8 (3.5, 4.0)	4.5 (4.2, 5.0)	4.3 (4.0, 4.6)	3.8 (3.3, 4.3)	4.3 (4.0, 4.8)	3.9 (3.5, 4.3)	3.9 (3.7, 4.5)
	Missing (N)	0	0	0	0	0	0	0
INR	Median (IQR)	2.3 (1.5, 3.3)	3.5 (2.1, 5.6)	5.0 (2.9, 7.8)	3.3 (2.1, 5.8)	2.3 (1.8, 3.2)	3.1 (2.1, 5.6)	2.7 (1.9, 4.4)
	Missing (N)	0	0	0	0	0	0	0
Serum albumin, g/l	Median (IQR)	29 (23, 33)	26 (24, 30)	24 (18, 28)	26 (21, 28)	23 (20, 27)	26 (23, 29)	26 (24, 30)
	Missing (N)	0	0	0	1	0	0	0
Cold ischaemic time, minutes	Median (IQR)	599 (474, 663)	526 (395, 610)	528 (444, 570)	510 (443, 588)	486 (416, 585)	472 (402, 559)	495 (384, 559)
	Missing (N)	0	0	1	0	18	0	0
Time on waiting list, days	Median (IQR)	2 (1, 4)	2 (1, 3)	2 (1, 3)	3 (1, 3)	2 (1, 3)	1 (1, 2)	2 (1, 3)
	Missing (N)	0	1	0	0	0	0	0
Donor sex	Male	7 (47)	3 (30)	6 (50)	2 (14)	31 (55)	23 (47)	9 (45)
	Female	8 (53)	7 (70)	6 (50)	12 (86)	25 (45)	26 (53)	11 (55)

Characteristics		Newcastle	Leeds	Cambridge	Royal Free	King's	Birmingham	Edinburgh
Number		15	10	12	14	56	49	20
Donor ethnicity	White	15 (100)	10 (100)	11 (92)	12 (86)	54 (96)	47 (96)	20 (100)
	Non-white	0 (0)	0 (0)	1 (8)	2 (14)	2 (4)	2 (4)	0 (0)
Donor cause of death	Trauma	1 (7)	1 (10)	1 (8)	0 (0)	10 (18)	6 (12)	2 (10)
	CVA	10 (67)	8 (80)	10 (83)	12 (86)	37 (66)	28 (57)	11 (55)
	Others	4 (27)	1 (10)	1 (8)	2 (14)	9 (16)	14 (29)	7 (35)
	Missing	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (2)	0 (0)
Donor history of diabetes	No	14 (93)	9 (90)	12 (100)	14 (100)	51 (91)	48 (98)	19 (95)
	Yes	1 (7)	1 (10)	0 (0)	0 (0)	5 (9)	1 (2)	1 (5)
Donor type	Donor after brain death	14 (93)	10 (100)	12 (100)	14 (100)	55 (98)	49 (100)	20 (100)
	Donor after cardiac death	1 (7)	0 (0)	0 (0)	0 (0)	1 (2)	0 (0)	0 (0)
ABO match	Identical	10 (67)	4 (40)	9 (75)	8 (57)	39 (70)	32 (65)	18 (90)
	Compatible	4 (27)	6 (60)	2 (17)	5 (36)	17 (30)	15 (31)	2 (10)
	Incompatible	1 (7)	0 (0)	1 (8)	1 (7)	0 (0)	2 (4)	0 (0)
Graft type	Whole	14 (93)	8 (80)	12 (100)	14 (100)	51 (91)	48 (98)	20 (100)
	Segmental	1 (7)	2 (20)	0 (0)	0 (0)	5 (9)	1 (2)	0 (0)

Characteristics		Newcastle	Leeds	Cambridge	Royal Free	King's	Birmingham	Edinburgh
Number		15	10	12	14	56	49	20
Donor age, years	Median (IQR)	49 (39, 54)	54 (36, 61)	51 (38, 62)	45 (39, 55)	48 (30, 55)	43 (31, 51)	46 (34, 65)
	Missing (N)	0	0	0	0	0	0	0
Donor BMI, kg/m ²	Median (IQR)	23.4 (21.6, 26.6)	24.8 (21.4, 27.1)	25.6 (23.4, 26.6)	23.6 (22.1, 26.0)	25.3 (23.7, 27.3)	24.7 (22.6, 27.5)	24.6 (22.2, 26.4)
	Missing (N)	0	0	0	0	0	0	0

Table 6 - Hazard Ratios and 95% confidence intervals for the multivariable risk model for 5 year survival of adult super-urgent first liver transplants, performed between 1st march 1994 and 31st March 2012 in the UK.

Variable	Categories or values	Hazard ratio	95% CI
Age	per 1 year increase	1.02	1.01, 1.03
Sex	Male	1	
	Female	1.01	0.79, 1.29
BMI	per 1 kg/m ² increase	1.01	0.98, 1.03
Recipient ethnicity	White	1	
	Non-white	1.86	1.39, 2.48
HCV status	No	1	
	Yes	1.75	0.81, 3.79
Pre-transplant In-patient status	Out-patient	1	
	In-patient	0.98	0.21, 4.44
Ascites	Absence	1	
	Presence	0.96	0.74, 1.26
Encephalopathy	Absence	1	
	Presence	1.83	0.83, 4.02
Pre-transplant renal support	No	1	
	Yes	1.44	1.10, 1.88
Previous abdominal surgery	No	1	
	Yes	1.69	1.17, 2.43
Varices & shunt	Absence	1	
	Presence without treatment	0.85	0.66, 1.10
	Presence with surgical shunt	2.38	0.51, 11.19
	Presence with TIPS	0.58	0.07, 4.50

Variable	Categories or values	Hazard ratio	95% CI
Life style activity	Normal	1	
	Restricted	2.01	0.19, 20.95
	Self-care	1.10	0.23, 5.22
	Confined	1.09	0.34, 3.49
	Reliant	1.31	0.45, 3.82
Serum creatinine, μmol/l	100	1	
	130	1.52	1.43, 1.61
	160	2.11	1.90, 2.35
	190	2.77	2.40, 3.20
Serum albumin	per 5 g/l increase	1.04	0.96, 1.12
INR	per 1 unit increase	0.99	0.96, 1.03
Serum bilirubin, μmol/l	100	1	
	200	0.97	0.93, 1.01
	300	0.96	0.90, 1.01
	400	0.95	0.89, 1.01
Serum sodium	per 10 mmol/l increase	0.98	0.83, 1.66
Serum potassium	per 1 mmol/l increase	1.18	0.99, 1.41
Donor age	per 1 year increase	1.01	1.00, 1.02
Donor sex	Male	1	
	Female	0.86	0.68, 1.08
Donor BMI	per 1 kg/m ² increase	0.98	0.95, 1.01
Donor ethnicity	White	1	
	Non-white	1.45	0.74, 2.84
Donor cause of death	Trauma	1	
	CVA	1.15	0.83, 1.60
	Others	1.46	0.99, 2.15

Variable	Categories or values	Hazard ratio	95% CI
Donor history of diabetes	No	1	
	Yes	0.90	0.32, 2.50
Graft appearance	Normal	1	
	Abnormal	1.27	0.92, 1.75
ABO match	Identical	1	
	Compatible	1.42	1.13, 1.80
	Incompatible	1.34	0.70, 2.54
Graft type	Whole	1	
	Segmental	1.53	1.03, 2.27
Cold ischaemic time	per 1 hour increase	1.04	1.00, 1.08
Time on waiting list	per 1 day increase	0.99	0.92, 1.05
Time period	1 st Apr 2009 - 31 st Mar 2012	1	
	1 st Jan 2005 - 31 st Mar 2009	1.22	0.82, 1.83
	1 st Jan 2000 - 31 st Dec 2004	1.79	1.20, 2.65
	Before 31 st Dec 1999	2.22	1.46, 3.38

*** There were only 6 recipients for in whom the donor organ was received after cardiac death. These transplants are included in the analysis but DCD is not included as a factor in risk model as estimates are likely to be unreliable.**

Table 7 - 1-year mortality for adult super-urgent cases during the whole audit period

Centre	Number of transplants	1-year mortality % (95% CI)	
		Unadjusted *	Risk-adjusted**
Newcastle	103	21.4 (14.7, 30.7)	22.9 (15.1, 34.8)
Leeds	187	26.9 (21.1, 33.9)	27.4 (20.7, 36.1)
Cambridge	85	14.2 (8.3, 23.6)	18.5 (10.5, 32.5)
Royal Free	100	26.1 (18.6, 36.0)	27.2 (18.5, 39.9)
King's	383	23.8 (19.8, 28.4)	20.0 (16.3, 24.6)
Birmingham	261	20.0 (15.6, 25.4)	22.8 (17.3, 29.9)
Edinburgh	124	22.6 (16.2, 31.0)	24.3 (16.8, 35.2)
Overall	1,243	22.7 (20.4, 25.1)	NA

Unadjusted and risk-adjusted mortality (%) in the first year after liver transplantation in adults who received a liver transplant as super-urgent between 1st March 1994 and 31st March 2012 in the UK.

Table 8 - 1-year mortality for adult super-urgent cases during the last three years of the audit

Centre	Number of transplants	1-year mortality % (95% CI)	
		Unadjusted *	Risk-adjusted**
Newcastle	15	6.7 (1.0, 38.7)	6.5 (0.9, 45.9)
Leeds	10	30.0 (10.8, 67.1)	29.5 (9.5, 91.5)
Cambridge	12	8.3 (1.2, 46.1)	8.2 (1.2, 58.3)
Royal Free	14	23.8 (8.2, 57.9)	21.6 (7.0, 67.0)
King's	56	7.6 (2.9, 19.0)	5.9 (2.2, 15.8)
Birmingham	49	16.8 (8.8, 30.9)	23.9 (11.9, 47.7)
Edinburgh	20	10.0 (2.6, 34.4)	10.9 (2.7, 43.7)
Overall	176	12.9 (8.6, 18.8)	NA

Unadjusted and risk-adjusted mortality (%) in the first year after liver transplantation in adults who received a first liver transplant as super-urgent between 1st April 2009 and 31st March 2012 in the UK .

* Kaplan Meier estimates ** Adjustment based on the model in Table 6

Table 9 - 3-year mortality for adult super-urgent cases during the whole audit period

Centre	Number of transplants	3-year mortality % (95% CI)	
		Unadjusted *	Risk-adjusted**
Newcastle	103	23.6 (16.4, 33.1)	24.8 (16.6, 37.0)
Leeds	187	29.9 (23.8, 37.1)	31.0 (23.8, 40.4)
Cambridge	85	18.3 (11.4, 28.5)	23.3 (14.0, 38.6)
Royal Free	100	28.3 (20.5, 38.4)	28.6 (19.7, 41.4)
King's	383	27.2 (23.0, 32.1)	23.1 (19.0, 28.0)
Birmingham	261	23.1 (18.4, 28.8)	25.7 (19.9, 33.1)
Edinburgh	124	25.3 (18.5, 34.0)	27.3 (19.2, 38.8)
Overall	1,243	25.7 (23.4, 28.3)	NA

Unadjusted and risk-adjusted mortality (%) in the first three years after liver transplantation in adults who received a first liver transplant as super-urgent between 1st March 1994 and 31st March 2012 in the UK.

Table 10 - 5-year mortality for adult super-urgent cases during the whole audit period

Centre	Number of transplants	5-year mortality % (95% CI)	
		Unadjusted *	Risk-adjusted**
Newcastle	103	31.9 (23.3, 42.7)	30.6 (21.4, 43.7)
Leeds	187	33.1 (26.7, 40.5)	35.1 (27.3, 45.2)
Cambridge	85	18.3 (11.4, 28.5)	23.8 (14.3, 39.4)
Royal Free	100	29.6 (21.6, 39.8)	30.5 (21.2, 43.8)
King's	383	28.8 (24.4, 33.8)	24.7 (20.4, 29.9)
Birmingham	261	25.3 (20.3, 31.3)	28.4 (22.2, 36.4)
Edinburgh	124	29.9 (22.4, 39.3)	31.0 (22.3, 43.2)
Overall	1,243	28.4 (25.9, 31.1)	NA

Unadjusted and risk-adjusted mortality (%) in the first five years after liver transplantation in adults who received a first liver transplant as super-urgent between 1st March 1994 and 31st March 2012 in the UK.

* Kaplan Meier estimates ** Adjustment based on the model in Table 6

Table 11 - Patient mortality by transplant centre for all adult elective cases during the whole audit period

Centre	Number of transplants	90-day mortality % (95% CI)	1-year mortality % (95% CI)	3-year mortality % (95% CI)	5-year mortality % (95 % CI)
Newcastle	477	8.4 (6.2, 11.3)	13.2 (10.5, 16.6)	18.8 (15.5, 22.7)	27.5 (23.4, 32.1)
Leeds	1,253	9.0 (7.6, 10.8)	14.7 (12.8, 16.8)	20.9 (18.6, 23.5)	27.5 (24.8, 30.4)
Cambridge	960	5.7 (4.4, 7.4)	11.1 (9.2, 13.3)	17.5 (15.1, 20.1)	24.7 (21.9, 27.9)
Royal Free	875	9.1 (7.4, 11.3)	14.6 (12.4, 17.1)	20.5 (17.9, 23.5)	26.2 (23.2, 29.5)
King's	1,857	5.2 (4.3, 6.4)	10.3 (9.0, 11.8)	17.7 (15.9, 19.7)	24.1 (21.9, 26.5)
Birmingham	1,809	9.6 (8.3, 11.0)	13.6 (12.1, 15.3)	18.9 (17.2, 20.9)	23.8 (21.7, 25.9)
Edinburgh	722	6.0 (4.5, 8.0)	10.9 (8.8, 13.5)	17.1 (14.4, 20.3)	23.0 (19.8, 26.7)
All	7,953	7.6 (7.0, 8.2)	12.5 (11.8, 13.3)	18.8 (17.9, 19.7)	24.9 (23.9, 26.0)

Patient mortality by transplant centre up to 5 years post liver transplantation for all adult patients who received a first liver transplant as elective between 1st March 1994 and 31st March 2012 in the UK.

Table 12 - Graft loss by transplant centre for all adult elective cases during the whole audit period

Centre	Number of transplants	90-day graft loss % (95% CI)	1-year graft loss % (95% CI)	3-year graft loss % (95% CI)	5-year graft loss % (95% CI)
Newcastle	477	13.0 (10.3, 16.4)	18.5 (15.3, 22.3)	24.1 (20.4, 28.3)	33.7 (29.4, 38.5)
Leeds	1,253	11.8 (10.2, 13.8)	18.2 (16.1, 20.5)	24.8 (22.4, 27.5)	31.0 (28.2, 34.0)
Cambridge	960	9.6 (7.9, 11.7)	16.6 (14.3, 19.1)	23.5 (20.8, 26.4)	31.2 (28.1, 34.5)
Royal Free	875	13.1 (11.1, 15.6)	18.9 (16.5, 21.7)	25.3 (22.5, 28.4)	31.2 (28.0, 34.6)
King's	1,857	7.9 (6.8, 9.3)	13.5 (11.9, 15.1)	21.4 (19.5, 23.5)	28.1 (25.9, 30.6)
Birmingham	1,809	12.1 (10.7, 13.7)	16.7 (15.0, 18.5)	22.5 (20.6, 24.6)	27.6 (25.5, 29.9)
Edinburgh	722	9.7 (7.8, 12.1)	16.0 (13.4, 18.9)	21.7 (18.7, 25.0)	28.3 (24.8, 32.1)
All	7,953	10.7 (10.1, 11.4)	16.4 (15.6, 17.3)	23.0 (22.1, 24.0)	29.5 (28.4, 30.6)

Graft loss by transplant centre up to 5 years post liver transplantation for all adult patients who received a first liver transplant as elective between 1st March 1994 and 31st March 2012 in UK.

Table 13 - Mortality and graft loss for adult elective cases during the most recent year of the audit

Centre	Number of transplants	90-day mortality (95% CI)	90-day graft loss (95% CI)
Newcastle	31	0	3.2 (0.5, 20.8)
Leeds	61	4.9 (1.6, 14.5)	11.5 (5.6, 22.6)
Cambridge	71	1.4 (0.2, 9.6)	5.6 (2.2, 14.3)
Royal Free	50	2.0 (0.3, 13.4)	4.0 (1.0, 15.1)
King's	123	2.5 (0.8, 7.4)	4.9 (2.2, 10.6)
Birmingham	124	7.3 (3.9, 13.5)	11.3 (6.9, 18.3)
Edinburgh	78	2.6 (0.7, 9.9)	3.9 (1.3, 11.5)
All	538	3.5 (2.3, 5.5)	6.9 (5.1, 9.4)

Patient mortality (%) and graft loss (%) by transplant centre at 90 days post liver transplantation for all adult patients who received a first liver transplant as elective between 1st April 2011 and 31st March 2012 (most recent year) in the UK.

Table 14 - Distributions of the patient and donor characteristics, by transplant centre, for adults who received a first liver transplant as elective between 1st April 2011 and 31st March 2012 (most recent year) in the UK.

The count is shown for each centre with the percentage of the total in parentheses for categorical variables. Median (inter-quartile range) is shown for continuous variables.

Characteristics		Newcastle	Leeds	Cambridge	Royal Free	King's	Birmingham	Edinburgh
Number		31	61	71	50	123	124	78
Sex	Male	21 (68)	44 (72)	47 (66)	34 (68)	90 (73)	77 (62)	47 (60)
	Female	10 (32)	17 (28)	24 (34)	16 (32)	33 (27)	47 (38)	31 (40)
Recipient ethnicity	White	27 (87)	55 (90)	64 (90)	43 (86)	101 (82)	106 (85)	76 (97)
	Non-white	4 (13)	6 (10)	7 (10)	7 (14)	22 (18)	18 (15)	2 (3)
Indication	Cancer	7 (23)	22 (36)	18 (25)	14 (28)	29 (24)	21 (17)	25 (32)
	HCV	4 (13)	4 (7)	7 (10)	6 (12)	16 (13)	15 (12)	4 (5)
	PSC	3 (10)	8 (13)	8 (11)	9 (18)	12 (10)	15 (12)	4 (5)
	HBV	0 (0)	2 (3)	0 (0)	1 (2)	2 (2)	2 (2)	0 (0)
	PBC	1 (3)	5 (8)	8 (11)	6 (12)	10 (8)	18 (15)	9 (12)
	ALD	12 (39)	11 (18)	18 (25)	8 (16)	23 (19)	25 (20)	14 (18)
	Metabolic	3 (10)	2 (3)	6 (8)	5 (10)	12 (10)	10 (8)	15 (19)
	Other liver disease	1 (3)	3 (5)	2 (3)	1 (2)	11 (9)	8 (6)	4 (5)

Characteristics		Newcastle	Leeds	Cambridge	Royal Free	King's	Birmingham	Edinburgh
Number		31	61	71	50	123	124	78
HCV status	No	24 (77)	25 (41)	53 (75)	36 (72)	96 (78)	98 (79)	68 (87)
	Yes	7 (23)	7 (11)	16 (23)	14 (28)	26 (21)	24 (19)	9 (12)
	Missing	0 (0)	29 (48)	2 (3)	0 (0)	1 (1)	2 (2)	1 (1)
Pre-transplant In-patient status	Out-patient	25 (81)	47 (77)	57 (80)	46 (92)	97 (79)	120 (97)	61 (78)
	In-patient	6 (19)	14 (23)	14 (20)	4 (8)	24 (20)	4 (3)	17 (22)
	Missing	0 (0)	0 (0)	0 (0)	0 (0)	2 (2)	0 (0)	0 (0)
Ascites	Absence	6 (19)	33 (54)	37 (52)	26 (52)	63 (51)	54 (44)	24 (31)
	Presence	25 (81)	28 (46)	34 (48)	24 (48)	59 (48)	70 (56)	54 (69)
	Missing	0 (0)	0 (0)	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)
Encephalopathy	Absence	8 (26)	44 (72)	54 (76)	49 (98)	88 (72)	76 (61)	43 (55)
	Presence	23 (74)	17 (28)	17 (24)	1 (2)	34 (28)	48 (39)	27 (35)
	Missing	0 (0)	0 (0)	0 (0)	0 (0)	1 (1)	0 (0)	8 (10)
Pre-transplant renal support	No	28 (90)	57 (93)	67 (94)	48 (96)	115 (94)	118 (95)	74 (95)
	Yes	3 (10)	4 (7)	4 (6)	2 (4)	6 (5)	6 (5)	4 (5)
	Missing	0 (0)	0 (0)	0 (0)	0 (0)	2 (2)	0 (0)	0 (0)

Characteristics		Newcastle	Leeds	Cambridge	Royal Free	King's	Birmingham	Edinburgh
Number		31	61	71	50	123	124	78
Previous abdominal surgery	No	25 (81)	47 (77)	64 (90)	43 (86)	109 (89)	108 (87)	68 (87)
	Yes	6 (19)	14 (23)	7 (10)	7 (14)	13 (11)	16 (13)	9 (12)
	Missing	0 (0)	0 (0)	0 (0)	0 (0)	1 (1)	0 (0)	1 (1)
Varices & shunt	Absence	2 (6)	28 (46)	13 (18)	14 (28)	66 (54)	47 (38)	11 (14)
	Presence without treatment	26 (84)	31 (51)	56 (79)	35 (70)	54 (44)	74 (60)	67 (86)
	Presence with surgical shunt	0 (0)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Presence with TIPS	3 (10)	1 (2)	2 (3)	1 (2)	2 (2)	3 (2)	0 (0)
	Missing	0 (0)	0 (0)	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)
Life style activity	Normal	2 (6)	2 (3)	14 (20)	2 (4)	1 (1)	0 (0)	13 (17)
	Restricted	6 (19)	19 (31)	16 (23)	2 (4)	58 (47)	58 (47)	24 (31)
	Self-care	13 (42)	24 (39)	25 (35)	44 (88)	38 (31)	60 (48)	25 (32)
	Confined	9 (29)	13 (21)	8 (11)	2 (4)	16 (13)	6 (5)	10 (13)
	Reliant	1 (3)	3 (5)	4 (6)	0 (0)	7 (6)	0 (0)	6 (8)
	Missing	0 (0)	0 (0)	4 (6)	0 (0)	3 (2)	0 (0)	0 (0)

Characteristics		Newcastle	Leeds	Cambridge	Royal Free	King's	Birmingham	Edinburgh
Number		31	61	71	50	123	124	78
Graft appearance	Normal	23 (74)	45 (74)	45 (63)	31 (62)	18 (15)	82 (66)	74 (95)
	Abnormal	8 (26)	16 (26)	26 (37)	19 (38)	6 (5)	42 (34)	4 (5)
	Missing	0 (0)	0 (0)	0 (0)	0 (0)	99 (80)	0 (0)	0 (0)
Age, years	Median (IQR)	57 (55, 63)	55 (46, 63)	54 (46, 60)	52 (48, 59)	55 (44, 61)	54 (46, 60)	58 (53, 64)
	Missing (N)	0	0	0	0	0	0	0
BMI, kg/m ²	Median (IQR)	28.2 (25.5,32.1)	26.0 (23.0,28.5)	28.5 (24.4,32.1)	25.6 (22.0,29.7)	25.1 (22.7,29.3)	26.6 (23.4,30.7)	25.8 (23.1,30.9)
	Missing (N)	0	0	0	0	0	0	0
Serum bilirubin, μmol/l	Median (IQR)	48 (20, 126)	40 (18, 103)	50 (20, 87)	37 (18, 86)	63 (40, 102)	44 (25, 83)	53 (24, 153)
	Missing (N)	0	0	0	1	2	0	0
Serum creatinine, μmol/l	Median (IQR)	80 (63, 108)	83 (74, 98)	81 (65, 101)	73 (61, 86)	86 (67, 113)	74 (62, 91)	77 (60, 109)
	Missing (N)	0	0	0	0	2	0	0
Serum sodium, mmol/l	Median (IQR)	138 (134, 140)	136 (132, 139)	137 (134, 139)	139 (137, 142)	141 (138, 143)	138 (134, 141)	136 (132, 138)
	Missing (N)	0	0	0	0	2	0	0

Characteristics		Newcastle	Leeds	Cambridge	Royal Free	King's	Birmingham	Edinburgh
Number		31	61	71	50	123	124	78
Serum potassium, mmol/l	Median (IQR)	4.3 (3.8, 4.5)	4.2 (3.9, 4.6)	4.1 (3.7, 4.4)	4.2 (3.9, 4.3)	4.2 (3.9, 4.5)	4.1 (3.9, 4.4)	4.2 (3.8, 4.5)
	Missing (N)	0	1	0	0	2	0	0
INR	Median (IQR)	1.3 (1.1, 2.0)	1.3 (1.1, 1.5)	1.3 (1.2, 1.7)	1.3 (1.2, 1.5)	1.6 (1.4, 1.9)	1.3 (1.1, 1.7)	1.4 (1.2, 1.7)
	Missing (N)	0	0	0	0	3	0	0
Serum albumin, g/l	Median (IQR)	34 (30, 38)	35 (31, 40)	29 (26, 33)	34 (29, 40)	26 (23, 30)	35 (30, 39)	28 (25, 34)
	Missing (N)	0	0	0	1	2	0	1
Cold ischaemic time, minutes	Median (IQR)	597 (482, 685)	483 (415, 594)	452 (380, 545)	399 (356, 507)	463 (382, 563)	494 (430, 595)	546 (442, 646)
	Missing (N)	0	0	1	1	27	0	0
Time on waiting list, days	Median (IQR)	105 (49, 270)	85 (37, 185)	96 (37, 216)	106 (60, 203)	134 (50, 335)	79 (30, 134)	58 (19, 136)
	Missing (N)	1	0	1	0	0	0	0
Donor sex	Male	11 (35)	28 (46)	41 (58)	23 (46)	64 (52)	56 (45)	38 (49)
	Female	19 (61)	33 (54)	30 (42)	27 (54)	58 (47)	68 (55)	40 (51)
	Missing	1 (3)	0 (0)	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)

Characteristics		Newcastle	Leeds	Cambridge	Royal Free	King's	Birmingham	Edinburgh
Number		31	61	71	50	123	124	78
Donor ethnicity	White	30 (97)	59 (97)	70 (99)	45 (90)	110 (89)	119 (96)	77 (99)
	Non-white	0 (0)	2 (3)	1 (1)	5 (10)	10 (8)	5 (4)	1 (1)
	Missing	1 (3)	0 (0)	0 (0)	0 (0)	3 (2)	0 (0)	0 (0)
Donor cause of death	Trauma	1 (3)	4 (7)	6 (8)	7 (14)	9 (7)	3 (2)	7 (9)
	CVA	25 (81)	47 (77)	46 (65)	27 (54)	81 (66)	93 (75)	57 (73)
	Others	5 (16)	10 (16)	19 (27)	16 (32)	33 (27)	28 (23)	14 (18)
Donor history of diabetes	No	28 (90)	55 (90)	64 (90)	49 (98)	111 (90)	116 (94)	71 (91)
	Yes	0 (0)	4 (7)	5 (7)	1 (2)	8 (7)	6 (5)	4 (5)
	Missing	3 (10)	2 (3)	2 (3)	0 (0)	4 (3)	2 (2)	3 (4)
Donor type	Donor after brain death	27 (87)	54 (89)	50 (70)	39 (78)	78 (63)	91 (73)	69 (88)
	Donor after cardiac death	3 (10)	7 (11)	21 (30)	11 (22)	44 (36)	33 (27)	9 (12)
	Missing	1 (3)	0 (0)	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)

Characteristics		Newcastle	Leeds	Cambridge	Royal Free	King's	Birmingham	Edinburgh
Number		31	61	71	50	123	124	78
ABO match	Identical	30 (97)	57 (93)	71 (100)	48 (96)	118 (96)	121 (98)	75 (96)
	Compatible	0 (0)	0 (0)	0 (0)	0 (0)	3 (2)	0 (0)	0 (0)
	Incompatible	0 (0)	4 (7)	0 (0)	2 (4)	1 (1)	3 (2)	3 (4)
	Missing	1 (3)	0 (0)	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)
Graft type	Whole	30 (97)	58 (95)	66 (93)	48 (96)	111 (90)	113 (91)	69 (88)
	Segmental	1 (3)	3 (5)	5 (7)	2 (4)	9 (7)	11 (9)	9 (12)
	Missing	0 (0)	0 (0)	0 (0)	0 (0)	3 (2)	0 (0)	0 (0)
Donor age, years	Median (IQR)	50 (43, 59)	50 (41, 58)	56 (44, 64)	46 (26, 59)	53 (39, 63)	52 (42, 60)	54 (42, 65)
	Missing (N)	1	0	0	0	1	0	0
Donor BMI, kg/m ²	Median (IQR)	26.7 (23.9, 30.7)	25.1 (23.9, 27.9)	26.0 (23.5, 29.1)	24.8 (21.0, 26.4)	25.4 (22.6, 28.4)	25.8 (23.3, 28.8)	25.8 (22.4, 29.9)
	Missing (N)	2	0	0	0	2	0	0

Table 15 - Hazard ratios and 95% confidence intervals for the multivariable risk model for 5-year survival of adult, elective first transplant patients, for transplants performed between 1st March 1994 and 31st March 2012 in the UK.

Variable	Categories or values	Hazard ratio	95% CI
Age	per 1 year increase	1.01	1.00, 1.01
Sex	Male	1	
	Female	1.03	0.91, 1.15
BMI	per 1 kg/m ² increase	0.99	0.98, 1.00
Recipient ethnicity	White	1	
	Non-white	1.14	0.98, 1.32
Indication	Cancer	1	
	HCV	0.70	0.57, 0.85
	PSC	0.54	0.43, 0.68
	HBV	0.37	0.27, 0.51
	PBC	0.40	0.32, 0.50
	ALD	0.56	0.46, 0.67
	AID	0.60	0.48, 0.73
	Metabolic	0.65	0.48, 0.87
	Others	0.64	0.50, 0.81
HCV status	No	1	
	Yes	0.97	0.80, 1.18
Pre-transplant In-patient status	Out-patient	1	
	In-patient	1.15	0.98, 1.35
Ascites	Absence	1	
	Presence	1.01	0.90, 1.13

Variable	Categories or values	Hazard ratio	95% CI
Encephalopathy	Absence	1	
	Presence	0.98	0.86, 1.10
Pre-transplant renal support	No	1	
	Yes	1.25	1.03, 1.52
Previous abdominal surgery	No	1	
	Yes	1.01	0.89, 1.15
Varices & shunt	Absence	1	
	Presence without treatment	0.91	0.81, 1.02
	Presence with surgical shunt	1.39	0.85, 2.26
	Presence with TIPS	1.05	0.82, 1.34
Life style activity	Normal	1	
	Restricted	1.15	0.88, 1.52
	Self-care	1.24	0.95, 1.62
	Confined	1.33	0.98, 1.80
	Reliant	1.91	1.33, 2.74
Serum creatinine, μmol/l	70	1	
	90	1.36	1.31, 1.41
	110	1.73	1.62, 1.85
	130	2.12	1.93, 2.32
Serum albumin	per 5 g/l increase	0.93	0.89, 0.96
INR	per 1 unit increase	1.01	0.99, 1.04
Serum bilirubin, μmol/l	30	1.00	
	50	0.93	0.91, 0.94
	70	0.90	0.88, 0.92
	90	0.88	0.86, 0.91

Variable	Categories or values	Hazard ratio	95% CI
Serum sodium	per 10 mmol/l increase	0.96	0.87, 1.06
Serum potassium	per 1 mmol/l increase	1.06	1.01, 1.12
Donor age	per 1 year increase	1	1.00, 1.01
Donor sex	Male	1	
	Female	0.99	0.89, 1.10
Donor BMI	per 1 kg/m ² increase	1.01	1.00, 1.02
Donor ethnicity	White	1	
	Non-white	1.30	0.96, 1.76
Donor cause of death	Trauma	1	
	CVA	1.00	0.87, 1.15
	Others	1.01	0.85, 1.20
Donor history of diabetes	No	1	
	Yes	1.31	0.97, 1.77
Donor type	Donor after brain death	1	
	Donor after cardiac death	1.40	1.11, 1.76
Graft appearance	Normal	1	
	Abnormal	1.19	1.04, 1.35
ABO match	Identical	1	
	Compatible	0.88	0.63, 1.21
	Incompatible	1.24	0.92, 1.67
Graft type	Whole	1	
	Segmental	1.24	1.01, 1.53
Cold ischaemic time	per 1 hour increase	1.02	1.00, 1.03
Time on waiting list	per 1 month increase	1.02	1.00, 1.03

Variable	Categories or values	Hazard ratio	95% CI
Time period	1 st Apr 2009 - 31 st Mar 2012	1	
	1 st Jan 2005 - 31 st Mar 2009	1.34	1.12, 1.59
	1 st Jan 2000 - 31 st Dec 2004	1.76	1.48, 2.10
	Before 31 st Dec 1999	2.27	1.88, 2.73

Table 16 - 1-year mortality for adult elective cases during the whole audit period

Centre	Number of transplants	1-year mortality % (95% CI)	
		Unadjusted *	Risk-adjusted**
Newcastle	477	13.2 (10.5, 16.6)	14.0 (10.9, 17.9)
Leeds	1,253	14.7 (12.8, 16.8)	14.9 (12.8, 17.3)
Cambridge	960	11.1 (9.2, 13.3)	10.7 (8.8, 13.0)
Royal Free	875	14.6 (12.4, 17.1)	16.1 (13.5, 19.2)
King's	1,857	10.3 (9.0, 11.8)	9.1 (7.9, 10.6)
Birmingham	1,809	13.6 (12.1, 15.3)	14.0 (12.3, 15.9)
Edinburgh	722	10.9 (8.8, 13.5)	11.7 (9.3, 14.7)
Overall	7,953	12.5 (11.8, 13.3)	NA

Unadjusted and risk-adjusted mortality (%) in the first year after liver transplantation in adults who received a liver transplant as elective between 1st March 1994 and 31st March 2012 in the UK

Table 17 - 1-year mortality for adult elective cases during the last three years of the audit

Centre	Number of transplants	1-year mortality % (95% CI)	
		Unadjusted *	Risk-adjusted**
Newcastle	78	11.3 (5.8, 21.6)	12.8 (6.4, 25.7)
Leeds	209	9.0 (5.6, 14.1)	8.9 (5.6, 14.4)
Cambridge	196	6.4 (3.6, 11.4)	5.4 (3.0, 9.8)
Royal Free	138	9.8 (5.4, 17.4)	10.1 (5.6, 18.3)
King's	334	7.9 (5.2, 11.8)	6.6 (4.3, 10.0)
Birmingham	339	9.5 (6.7, 13.4)	11.5 (8.1, 16.5)
Edinburgh	196	10.3 (6.5, 16.1)	9.9 (6.1, 15.9)
Overall	1,490	8.8 (7.3, 10.5)	NA

Unadjusted and risk-adjusted mortality (%) in the first year after liver transplantation in adults who received a first liver transplant as elective between 1st April 2009 and 31st March 2011 in the UK

* Kaplan Meier estimates ** Adjustment based on the model in Table 15

Table 18 - 3-year mortality for adult elective cases during the whole audit period

Centre	Number of transplants	3-year mortality % (95% CI)	
		Unadjusted *	Risk-adjusted**
Newcastle	477	18.8 (15.5, 22.7)	19.7 (16.0, 24.4)
Leeds	1,253	20.9 (18.6, 23.5)	22.0 (19.3, 25.0)
Cambridge	960	17.5 (15.1, 20.1)	16.7 (14.3, 19.5)
Royal Free	875	20.5 (17.9, 23.5)	22.1 (19.0, 25.6)
King's	1,857	17.7 (15.9, 19.7)	15.2 (13.6, 17.1)
Birmingham	1,809	18.9 (17.2, 20.9)	20.3 (18.2, 22.7)
Edinburgh	722	17.1 (14.4, 20.3)	18.7 (15.5, 22.5)
Overall	7,953	18.8 (17.9, 19.7)	NA

Unadjusted and risk-adjusted mortality (%) in the first three years after liver transplantation in adults who received a first liver transplant as elective between 1st March 1994 and 31st March 2012 in the UK.

Table 19 - 5-year mortality for adult elective cases during the whole audit period

Centre	Number of transplants	5-year mortality % (95% CI)	
		Unadjusted *	Risk-adjusted**
Newcastle	477	27.5 (23.4, 32.1)	28.1 (23.5, 33.8)
Leeds	1,253	27.5 (24.8, 30.4)	29.0 (25.8, 32.6)
Cambridge	960	24.7 (21.9, 27.9)	22.9 (20.0, 26.3)
Royal Free	875	26.2 (23.2, 29.5)	27.8 (24.2, 31.8)
King's	1,857	24.1 (21.9, 26.5)	20.8 (18.7, 23.0)
Birmingham	1,809	23.8 (21.7, 25.9)	25.9 (23.5, 28.6)
Edinburgh	722	23.0 (19.8, 26.7)	24.6 (20.8, 29.0)
Overall	7,953	24.9 (23.9, 26.0)	NA

Unadjusted and risk-adjusted mortality (%) in the first three years after liver transplantation in adults who received a first liver transplant as elective between 1st March 1994 and 31st March 2012 in the UK.

* Kaplan Meier estimates ** Adjustment based on the model in Table 15

Table 20 - Patient mortality (%) by transplant centre up to 5 years post liver transplantation for all adult patients who received a second liver transplant between 1st March 1994 and 31st March 2012 in the UK.

Centre	Number of transplants	90-day mortality % (95% CI)	1-year mortality % (95% CI)	3-year mortality % (95% CI)	5-year mortality % (95% CI)
Newcastle	72	27.8 (18.9, 39.7)	30.6 (21.3, 42.7)	39.7 (29.3, 52.2)	46.9 (35.7, 59.6)
Leeds	113	24.8 (17.8, 33.9)	29.4 (21.9, 38.8)	41.6 (32.9, 51.6)	50.6 (41.3, 60.7)
Cambridge	143	18.9 (13.4, 26.3)	25.4 (19.0, 33.4)	33.2 (26.0, 41.8)	37.9 (30.2, 46.9)
Royal Free	85	29.4 (20.9, 40.3)	34.3 (25.2, 45.4)	38.5 (29.0, 50.0)	38.5 (29.0, 50.0)
King's	224	16.5 (12.3, 22.1)	22.3 (17.3, 28.4)	29.8 (24.0, 36.5)	35.9 (29.5, 43.2)
Birmingham	163	19.0 (13.8, 25.9)	25.2 (19.3, 32.7)	30.0 (23.5, 37.8)	32.9 (26.2, 40.9)
Edinburgh	96	14.6 (8.9, 23.4)	27.8 (19.9, 38.1)	39.0 (29.7, 50.0)	40.4 (31.0, 51.6)
All	896	20.3 (17.8, 23.1)	26.6 (23.8, 29.6)	34.4 (31.3, 37.7)	39.1 (35.8, 42.5)

Table 21 - Graft loss (%) by transplant centre up to 5 years post liver transplantation for all adult patients who received a second liver transplant between 1st March 1994 and 31st March 2012 in the UK.

Centre	Number of transplants	90-day graft loss % (95% CI)	1-year graft loss % (95% CI)	3-year graft loss % (95% CI)	5-year graft loss % (95% CI)
Newcastle	72	29.2 (20.1, 41.1)	32.1 (22.6, 44.2)	39.7 (29.3, 52.1)	46.8 (35.6, 59.5)
Leeds	113	27.4 (20.2, 36.7)	34.9 (26.8, 44.5)	44.0 (35.2, 53.9)	53.2 (43.8, 63.2)
Cambridge	143	28.0 (21.4, 36.1)	34.5 (27.3, 42.9)	42.4 (34.7, 51.2)	47.1 (39.0, 56.0)
Royal Free	85	30.6 (22.0, 41.6)	36.7 (27.4, 47.9)	41.0 (31.2, 52.4)	41.0 (31.2, 52.4)
King's	224	18.8 (14.2, 24.5)	26.4 (21.1, 32.8)	37.1 (30.9, 44.1)	41.9 (35.3, 49.2)
Birmingham	163	20.9 (15.4, 27.9)	27.7 (21.5, 35.3)	34.5 (27.6, 42.4)	38.8 (31.6, 47.0)
Edinburgh	96	18.8 (12.3, 28.1)	33.1 (24.5, 43.6)	44.0 (34.4, 54.9)	48.4 (38.4, 59.5)
All	896	23.7 (21.0, 26.6)	31.1 (28.2, 34.3)	39.6 (36.4, 42.9)	44.5 (41.2, 48.0)

Table 22 - Patient mortality and graft loss by transplant centre at 90 days post liver transplantation for adults who received a second liver transplant between 1st April 2011 and 31st March 2012 (most recent year) in the UK.

Centre	Number of transplants	Number of deaths within 90 days of transplantation	Number of graft losses within 90 days of transplantation
Newcastle	4	1	1
Leeds	7	2	2
Cambridge	7	0	0
Royal Free	3	0	0
King's	11	0	0
Birmingham	8	0	1
Edinburgh	6	1	1
All	46	4	5

Table 23 - Hazard ratios and 95% confidence interval for the multivariable risk model for 1-year survival for adult patients who received a second liver transplant between 1st March 1994 and 31st March 2012 in the UK.

Variable	Categories	Hazard ratio	95% CI
Time period	1 st January 2008 - 31 st March 2012	1	
	1 st January 2004 - 31 st December 2007	1.26	(0.81, 1.95)
	1 st October 1998 - 31 st December 2003	1.46	(0.96, 2.21)
	Before 1 st October 1998	2.02	(1.36, 3.00)
Age, years	< 40	1	
	40- 49	0.88	(0.59, 1.31)
	50- 59	1.13	(0.82, 1.57)
	≥ 60	1.69	(1.14, 2.49)
Sex	Male	1	
	Female	0.84	(0.64, 1.10)
Urgency status	Elective	1	
	Super-urgent	1.13	(0.72, 1.77)
Time from first transplant, days	≤ 7	1.00	
	8- 30	1.05	(0.63, 1.75)
	31- 90	1.36	(0.70, 2.67)
	≥ 91	1.18	(0.59, 2.34)
	Unknown	1.17	(0.48, 2.87)
Life style activity	Normal	1	
	Restricted	0.31	(0.10, 1.00)
	Self-care	0.40	(0.14, 1.13)
	Confined	0.38	(0.13, 1.07)
	Reliant	0.80	(0.28, 2.24)

Variable	Categories	Hazard ratio	95% CI
Cause of failure of first graft	Vascular	1	
	Acute rejection	1.93	(0.76, 4.88)
	Chronic or ductopenic rejection	1.04	(0.62, 1.73)
	Primary Non- function	1.34	(0.79, 2.26)
	Recurrent disease	1.18	(0.63, 2.21)
	Biliary complications	0.92	(0.37, 2.24)
	Other	0.82	(0.45, 1.49)
	Unknown	1.16	(0.61, 2.21)

Table 24 - Unadjusted and risk-adjusted mortality (%) in the first year after liver transplantation in adults who received a second liver transplant between 1st March 1994 and 31st March 2012 in the UK.

Centre	Number of transplants	1-year mortality % (95% CI)	
		Unadjusted *	Risk-adjusted**
Newcastle	72	30.6 (21.3, 42.7)	31.6 (20.8, 48.0)
Leeds	113	29.4 (21.9, 38.8)	27.7 (19.7, 38.9)
Cambridge	143	25.4 (19.0, 33.4)	26.4 (19.1, 36.7)
Royal Free	85	34.3 (25.2, 45.4)	31.7 (22.1, 45.7)
King's	224	22.3 (17.3, 28.4)	22.8 (17.3, 30.2)
Birmingham	163	25.2 (19.3, 32.7)	24.8 (18.3, 33.7)
Edinburgh	96	27.8 (19.9, 38.1)	27.5 (18.7, 40.4)
Overall	896	26.6 (23.8, 29.6)	NA

* Kaplan Meier estimates ** Adjustment based on the model in Table 23

Table 25 - Unadjusted and risk-adjusted mortality (%) in the first year after liver transplantation in adults who received a second liver transplant between 1st April 2009 and 31st March 2012 in the UK.

Centre	Number of transplants	1-year mortality % (95% CI)	
		Unadjusted *	Risk-adjusted**
Newcastle	11	36.4 (15.5, 70.3)	36.3 (11.7, 100)
Leeds	18	51.5 (30.9, 75.8)	33.0 (13.7, 79.3)
Cambridge	18	19.2 (6.5, 49.0)	26.6 (11.1, 63.9)
Royal Free	10	22.9 (6.1, 65.5)	12.7 (3.2, 50.8)
King's	32	4.4 (0.6, 27.1)	13.1 (5.5, 31.5)
Birmingham	23	13.3 (4.5, 35.7)	22.5 (9.4, 54.1)
Edinburgh	24	33.3 (17.2, 57.9)	24.2 (10.9, 54.0)
Overall	136	23.1 (16.6, 31.7)	NA

* Kaplan Meier estimates ** Adjustment based on the model in Table 23

Table 26 - Distribution of the patient and donor characteristics in 68 paediatric patients who received a first liver transplant between 1st April 2011 and 31st March 2012 (most recent year).

Variable	Categories	Number (%)
Age, years	<1	11 (16.2)
	1 - 4	28 (41.2)
	5 - 12	21 (30.9)
	13 -16	8 (11.8)
Sex	Male	32 (47.1)
	Female	36 (52.9)
Indication group	Super-urgent	13 (19.1)
	Biliary atresia	24 (35.3)
	Other cholestatic	5 (7.4)
	Metabolic	12 (17.7)
	Others	14 (20.6)
Pre-transplant In-patient status	Out-patient	47 (69.1)
	In-patient	21 (30.9)
Ventilatory status	Not ventilated	57 (83.8)
	Ventilated	11 (16.2)
Renal status	Normal	63 (92.7)
	Supported	5 (7.4)
Ascites	Absence	51 (75.0)
	Presence	16 (23.5)
	Missing	1 (1.5)

Variable	Categories	Number (%)
Previous abdominal surgery	No	44 (64.7)
	Yes	24 (35.3)
Serum albumin, g/l	≤ 25	10 (14.7)
	26- 35	31 (45.6)
	> 35	21 (30.9)
	Missing	6 (8.8)
Serum bilirubin, μ mol/l	≤ 40	23 (33.8)
	41- 160	25 (36.8)
	161- 350	15 (22.1)
	≥ 351	5 (7.4)
INR	≤ 1.0	16 (23.5)
	1.1-1.5	23 (33.8)
	1.6- 3.0	21 (30.9)
	≥ 3.1	7 (10.3)
	Missing	1 (1.5)
Serum sodium, mmol/l	< 135	7 (10.3)
	≥ 135	61 (89.7)
Donor age, years	< 5	6 (8.8)
	5 - 16	12 (17.7)
	17 - 30	27 (39.7)
	≥ 31	23 (33.8)
Donor sex	Male	34 (50.0)
	Female	34 (50.0)
Donor type	Donor after brain death	65 (95.6)
	Donor after cardiac death	3 (4.4)

Variable	Categories	Number (%)
Donor organ appearance	Normal	33 (48.5)
	Missing	35 (51.5)
Type of graft	Whole	16 (23.5)
	Reduced	4 (5.9)
	Split	45 (66.2)
	Missing	3 (4.4)
Cold ischaemic time, hours	≤ 10	37 (54.4)
	10- 12	7 (10.3)
	> 12	8 (11.8)
	Missing	16 (23.5)
Urgency status	Elective	55 (80.9)
	Super-urgent	13 (19.1)

Table 27 - Patient mortality (%) by transplant centre up to 1 year post liver transplantation for paediatric patients who received a first liver transplant between 1st March 1994 and 31st March 2012 in the UK.

Centre	Indication	Number of transplants	90-day mortality (95% CI)	1-year mortality (95% CI)
Leeds	All	154	7.2 (4.0, 12.5)	10.6 (6.7, 16.8)
	Super-urgent	37	19.0 (9.6, 35.8)	28.4 (16.3, 46.5)
	Elective	117	3.4 (1.3, 8.9)	5.2 (2.4, 11.3)
King's	All	627	6.2 (4.6, 8.4)	8.3 (6.4, 10.7)
	Super-urgent	118	15.3 (9.9, 23.1)	18.9 (12.9, 27.3)
	Elective	509	4.1 (2.7, 6.3)	5.8 (4.1, 8.3)
Birmingham	All	458	10.3 (7.8, 13.4)	12.5 (9.8, 15.9)
	Super-urgent	86	22.1 (14.7, 32.4)	25.7 (17.7, 36.3)
	Elective	359	7.2 (5.0, 10.5)	9.3 (6.7, 12.8)
	Cirrhosis Intestinal Failure	13	15.4 (4.1, 48.8)	15.4 (4.1, 48.8)
Others	All	40	17.5 (8.8, 33.2)	22.8 (12.6, 39.3)
	Super-urgent	10	40.0 (17.3, 74.7)	50.0 (24.7, 81.6)
	Elective	30	10.0 (3.3, 27.9)	13.6 (5.3, 32.3)
All	All	1,279	8.1 (6.8, 9.8)	10.5 (9.0, 12.4)
	Super-urgent	251	19.1 (14.8, 24.6)	23.8 (19.0, 29.6)
	Elective	1,015	5.3 (4.1, 6.9)	7.2 (5.8, 9.0)
	Cirrhosis Intestinal Failure	13	15.4 (4.1, 48.8)	15.4 (4.1, 48.8)

Table 28 - Patient mortality (%) and graft loss (%) by transplant centre at 90 days post liver transplantation for paediatric patients who received a first liver transplant between 1st April 2011 and 31st March 2012 (most recent year) in the UK.

Centre	Indication	Number of transplants	90-day mortality (95% CI)	90-day graft loss (95% CI)
Leeds	All	11	0	0
	Super-urgent	4	0	0
	Elective	7	0	0
King's	All	36	5.6 (1.4, 20.4)	5.6 (1.4, 20.4)
	Super-urgent	7	14.3 (2.1, 66.6)	14.3 (2.1, 66.6)
	Elective	29	3.5 (.5, 22.1)	3.5 (.5, 22.1)
Birmingham	All	21	9.5 (2.5, 33.0)	19.1 (7.6, 43.1)
	Super-urgent	2	0	0
	Elective	19	10.5 (2.7, 35.9)	15.8 (5.4, 41.4)
All	All	68	5.9 (2.3, 14.9)	8.8 (4.1, 18.6)
	Super-urgent	13	7.7 (1.1, 43.4)	15.4 (4.1, 48.8)
	Elective	55	5.5 (1.8, 16.0)	7.3 (2.8, 18.2)

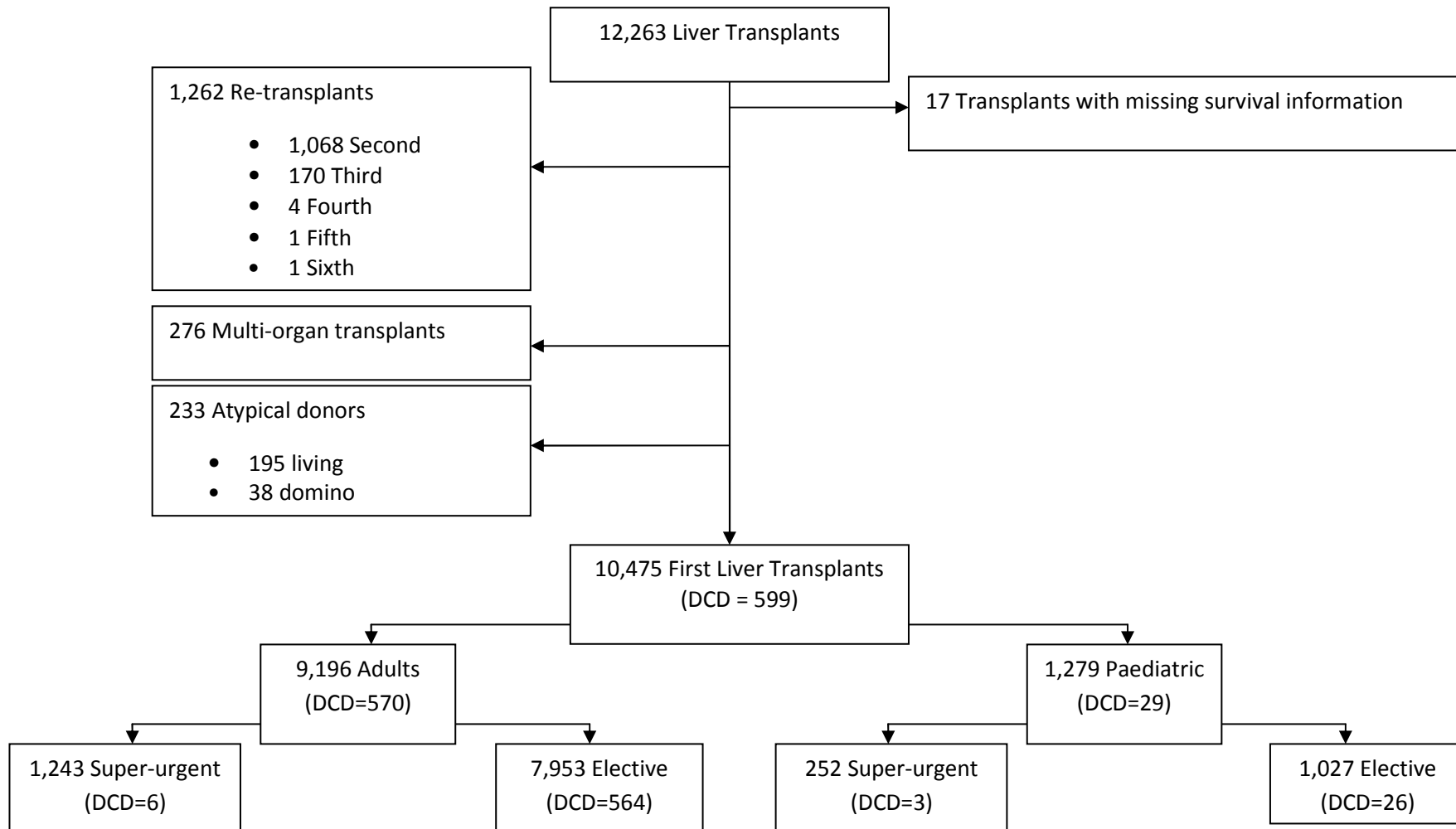
Table 29 - Patient mortality (%) and graft loss (%) by transplant centre post liver transplantation for paediatric patients who received a second liver transplant between 1st March 1994 and 31st March 2012 in the UK.

Centre	Number of transplants	90-day mortality % (95% CI)	90-day graft loss (95% CI)	1-year mortality % (95% CI)	1-year graft loss % (95% CI)
Leeds	18	11.1 (2.9, 37.6)	16.7 (5.7, 43.2)	11.1 (2.9, 37.6)	16.7 (5.7, 43.2)
King's	78	12.8 (7.1, 22.5)	18.0 (11.1, 28.4)	20.9 (13.3, 31.8)	24.7 (16.5, 35.9)
Birmingham	60	21.7 (13.2, 34.4)	21.7 (13.2, 34.4)	26.8 (17.3, 39.9)	33.6 (23.1, 47.1)
Others	16	18.8 (6.5, 47.5)	25.0 (10.2, 53.7)	32.3 (14.9, 61.2)	38.6 (19.5, 66.8)
All	172	16.3 (11.6, 22.7)	19.8 (14.6, 26.6)	22.9 (17.3, 30.0)	28.2 (22.1, 35.7)

Table 30 - Patient mortality (%) and graft loss (%) post liver transplantation for patients who received a liver transplant between 1st March 1994 and 31st March 2012 in the UK.

Category	Number	90-day mortality (95% CI)	90-day graft loss (95% CI)	1-year mortality (95% CI)	1-year graft loss (95% CI)
Organ Type					
Whole	8,334	9.1 (8.5, 9.7)	12.0 (11.3, 12.7)	13.5 (12.8, 14.3)	17.3 (16.5, 18.1)
Reduced	426	17.4 (14.1, 21.3)	21.1 (17.6, 25.3)	21.2 (17.6, 25.4)	27.2 (23.2, 31.7)
Split	1,038	6.8 (5.4, 8.5)	12.7 (10.8, 14.9)	10.1 (8.4, 12.1)	17.1 (14.9, 19.6)
Missing	75	20.0 (12.6, 31.0)	24.0 (15.9, 35.4)	21.6 (13.8, 32.8)	28.6 (19.6, 40.5)
Type of Transplantation					
First transplants	9,876	9.3 (8.7, 9.8)	12.6 (11.9, 13.2)	13.6 (12.9, 14.3)	17.8 (17.0, 18.6)
Second transplants	1,068	19.7 (17.4, 22.2)	23.0 (20.6, 25.7)	26.0 (23.5, 28.8)	30.7 (28.0, 33.6)
Third transplants	170	35.9 (29.2, 43.6)	38.8 (32.0, 46.6)	44.3 (37.2, 52.1)	48.0 (40.7, 55.8)
Fourth or higher transplants	24	37.5 (21.6, 59.7)	37.5 (21.6, 59.7)	70.8 (52.4, 87.1)	70.8 (52.4, 87.1)
Multi- organ transplants	276	14.5 (10.9, 19.3)	16.3 (12.5, 21.3)	21.9 (17.4, 27.4)	24.9 (20.2, 30.5)
Donors after cardiac death	599	6.7 (4.9, 9.0)	10.4 (8.2, 13.1)	12.2 (9.7, 15.3)	16.8 (13.9, 20.2)
Living Donor	233	6.9 (4.3, 11.0)	8.2 (5.3, 12.5)	11.8 (8.1, 17.0)	13.6 (9.6, 19.0)
All transplants	12,246	10.5 (10.0, 11.1)	13.8 (13.2, 14.4)	15.3 (14.7, 15.9)	19.5 (18.8, 20.2)

Figure 1 - Count of exclusions and unusable cases from the main analysis of first liver transplants to 31st March 2012



DCD = donor after cardiac death

Figure 2 - Unadjusted and risk-adjusted observed – expected plots for 90-day mortality in adult super-urgent liver transplantation performed between 1st January 2006 and 31st March 2012 in the UK

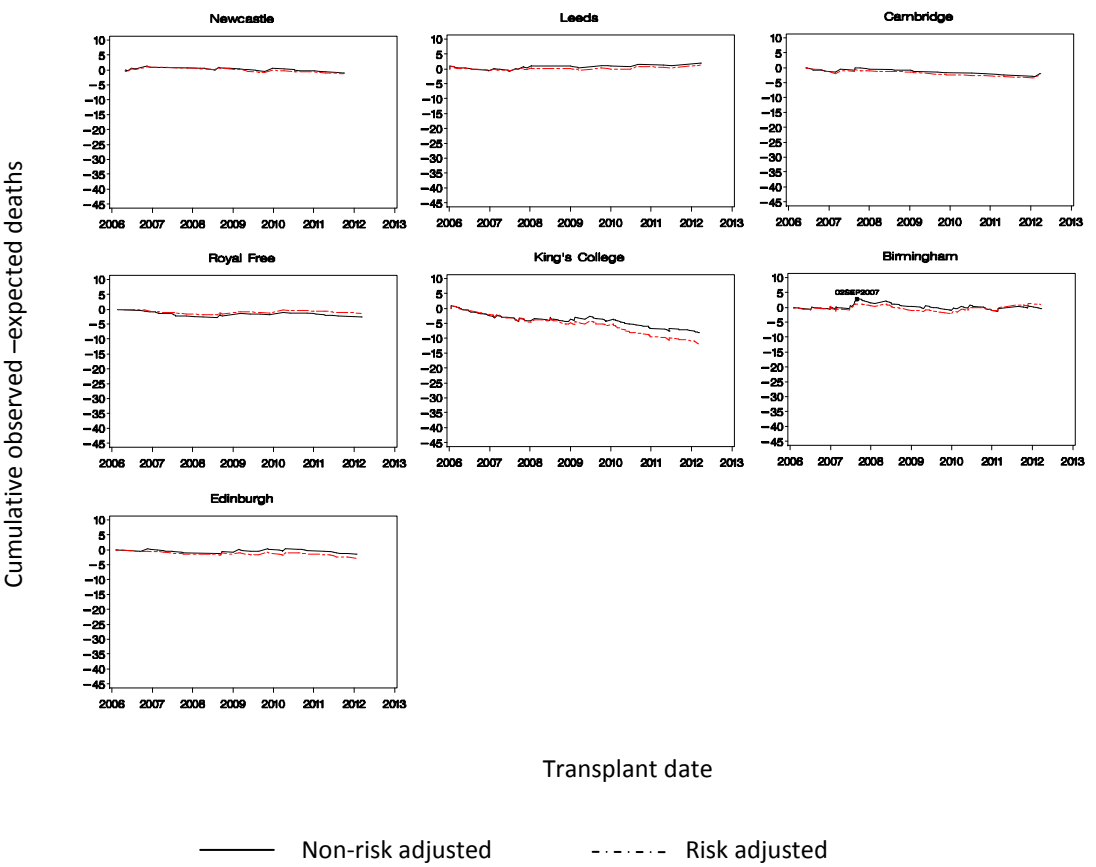


Figure 3 - Tabular CUSUM plots for 90-day mortality in adult super-urgent liver transplantation performed between 1st January 2006 and 31st March 2012 in the UK

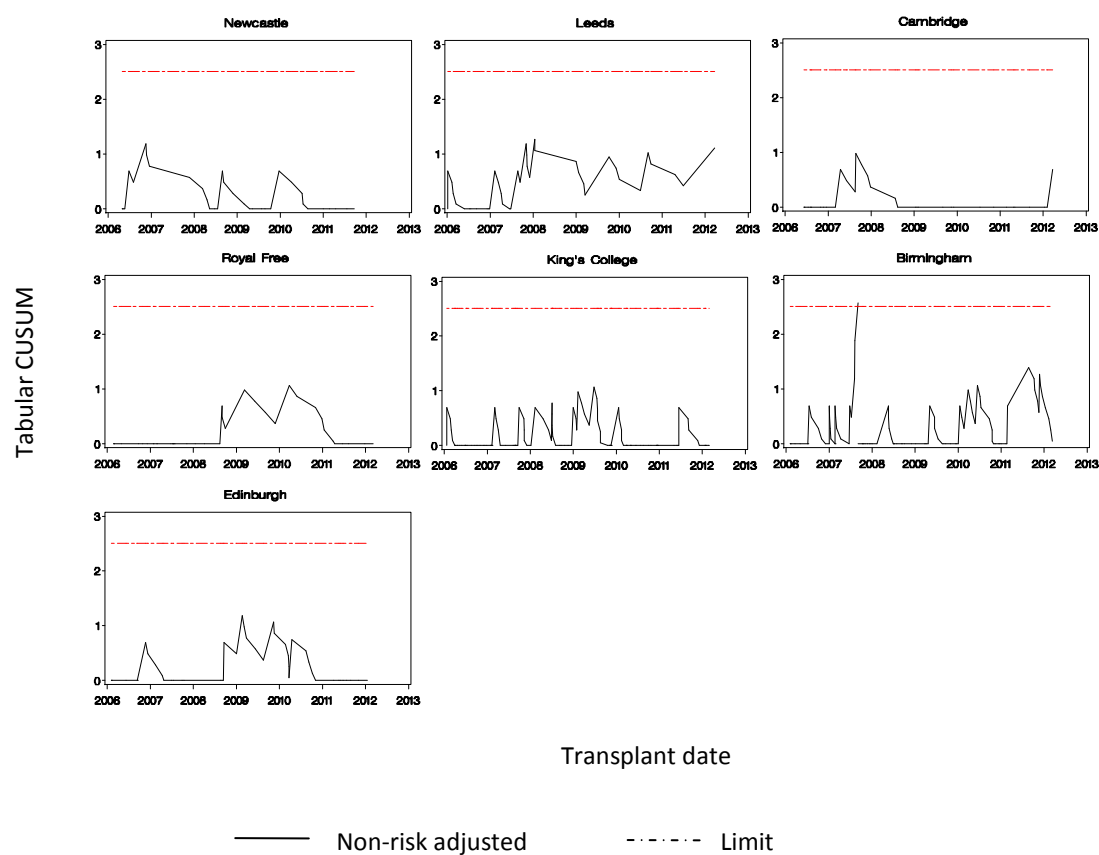


Figure 4 - Unadjusted and risk-adjusted observed – expected plots for 90-day mortality in adult elective liver transplantation performed between 1st January 2006 and 31st March 2012 in the UK

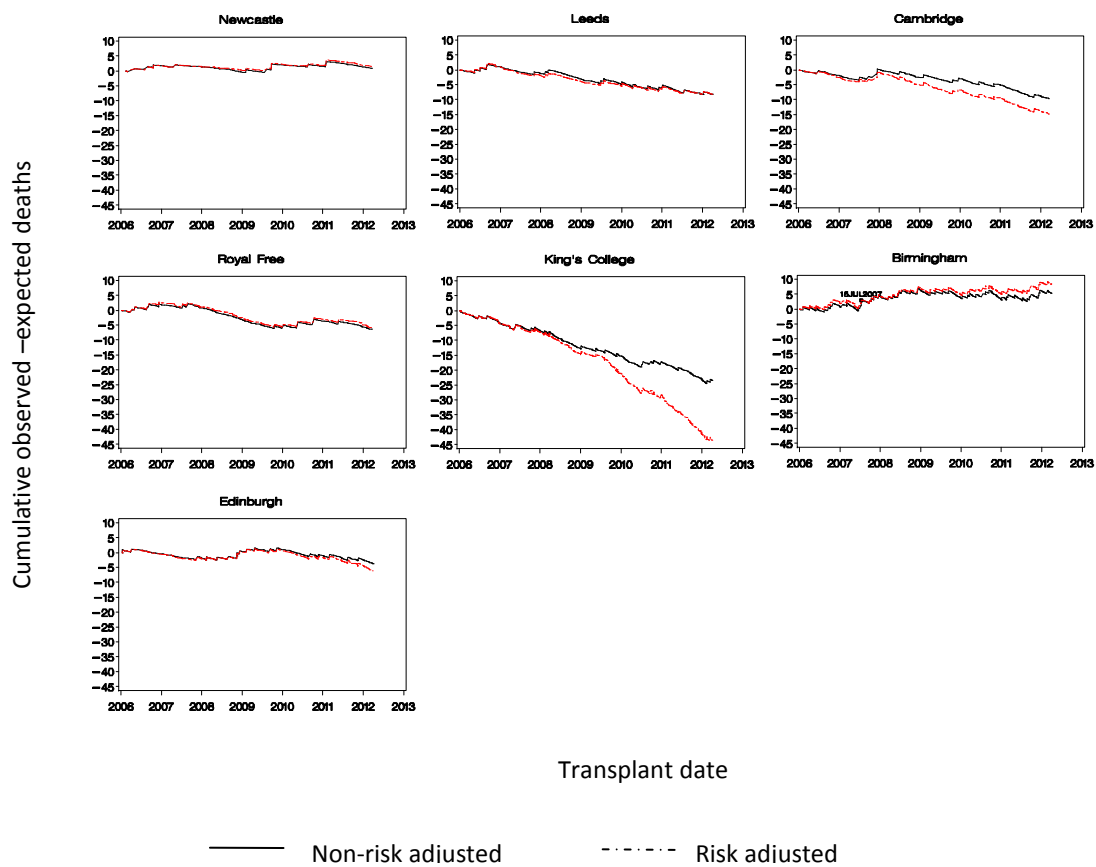


Figure 5 - Tabular CUSUM plots for 90-day mortality in adult elective liver transplantation performed between 1st January 2006 and 31st March 2012 in the UK

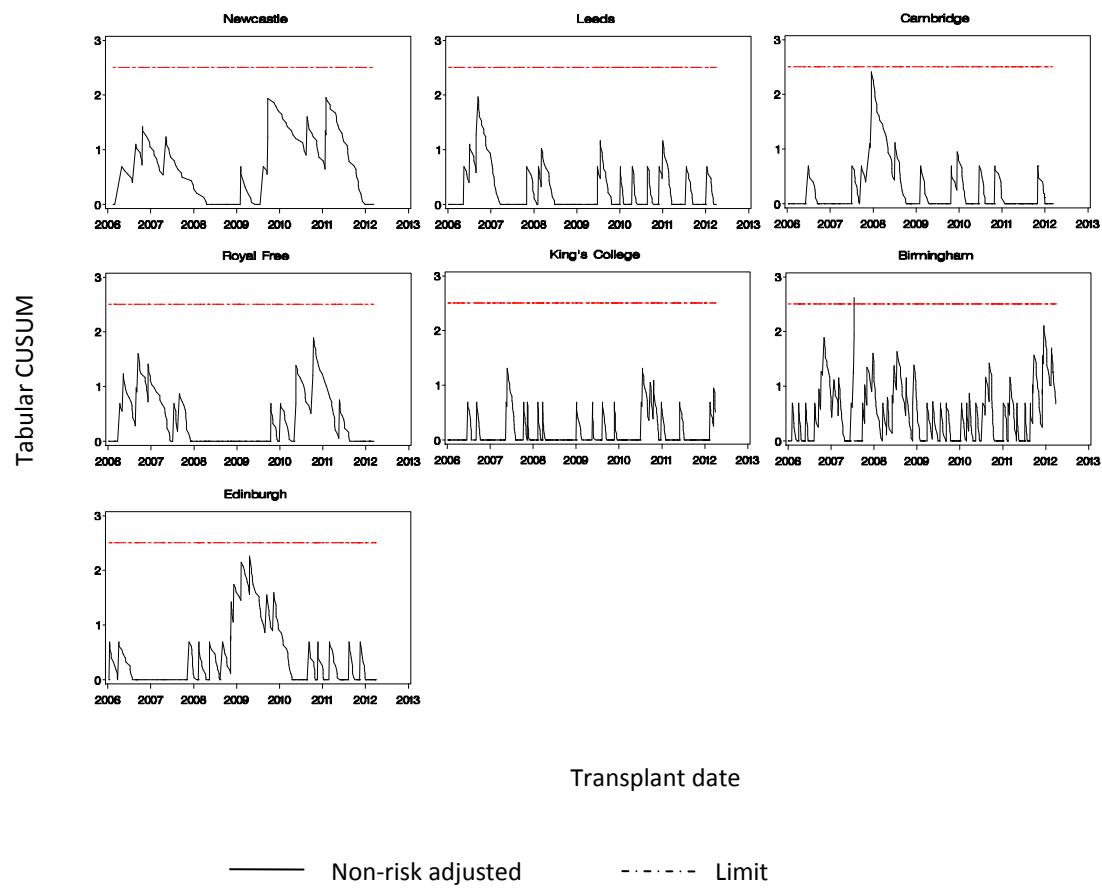


Figure 6 - Unadjusted observed – expected, and tabular CUSUM plots for 90-day mortality in paediatric super-urgent liver transplantation performed between 1st January 2006 and 31st March 2012 in the UK

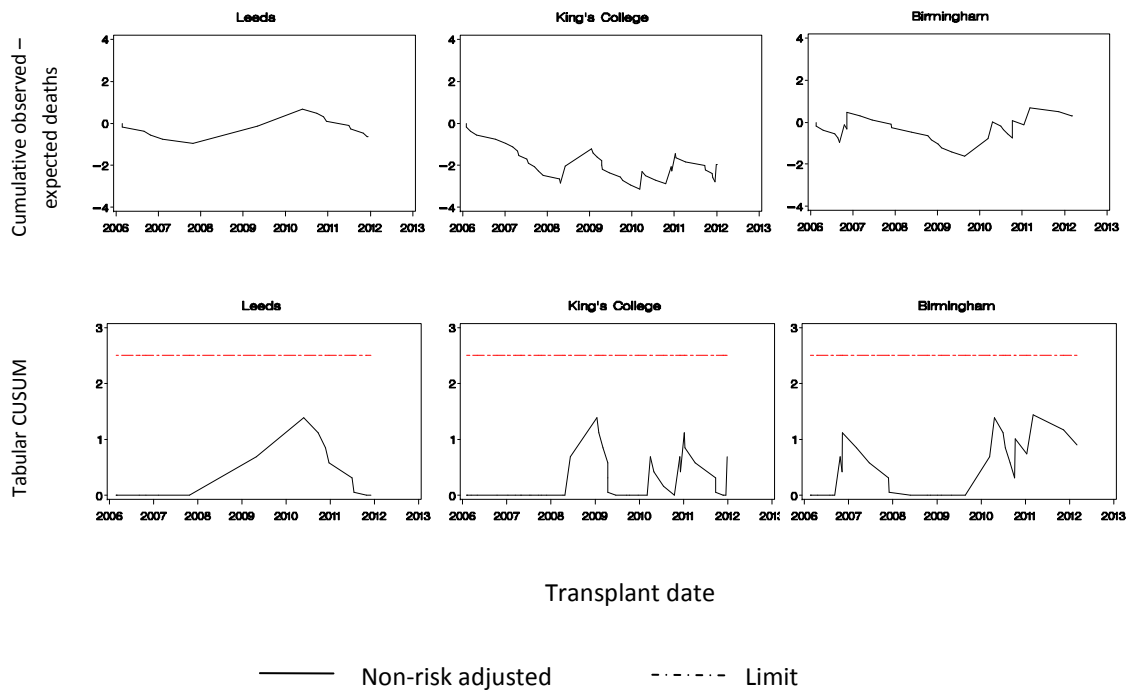


Figure 7 - Unadjusted observed – expected, and tabular CUSUM plots for 90-day mortality in paediatric elective liver transplantation performed between 1st January 2006 and 31st March 2012 in the UK

