Economic implications of multiple births: inpatient hospital costs in the first 5 years of life

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Objective: To estimate long term health service costs for hospital stays associated with singleton, twin, and higher order multiple births up to 5 years of age.

Design: Costs from specialty based data from the English Department of Health’s NHS Trust Financial Returns were applied to admissions recorded in the Oxford record linkage study during 1970–1993.

Setting: Oxfordshire and West Berkshire, United Kingdom.

Subjects: A total of 276 897 children, of whom 270 428 were singletons, 6284 were twins, and 185 were higher order multiple births.

Main outcome measures: Duration of hospital admissions during the first 5 years of life. Costs, expressed in £ sterling and valued at 1998–1999 prices, of hospital inpatient services.

Results: The total duration of hospital admissions for twins and triplets were respectively twice and eight times that for singletons, once duration of life had been taken into account. Inpatient costs were significantly higher for multiple births than for singletons, with the cost differences concentrated in the first year of life. Over the first 5 years of life, the adjusted mean cost was estimated at £1532 (95% confidence interval (CI) £1516 to £1548) for singletons, £3826 (95%CI £3724 to £3929) for twins, and £8156 (95%CI £7559 to £8754) for higher order multiple births (p < 0.0001).

Conclusions: Multiple births contribute disproportionately to hospital inpatient costs, especially during the children’s first year of life.

Methods

Oxford record linkage study

This study used data from the ORLS. This is a collection of linked, anonymised records of birth registrations, death certificates, and statistical abstracts of NHS hospital inpatient and day case admissions for a region of southern England.£ Data collection began in 1966 in Oxfordshire and West Berkshire, and, from 1975, increased its population coverage to include six of the eight districts of the former Oxford Region and, from 1984, the whole of the former Oxford Region. The ORLS had its own data collection systems for maternity and perinatal data until 1989 which covered Oxfordshire and West Berkshire only. Thereafter, data were derived from maternity Hospital Episodes Statistics for the relevant geographical area. Hospital data collection ceased in 1999.

Study population

The study population included all children born to women who both lived and delivered in Oxfordshire or West Berkshire during the period 1 January 1970 to 31 December 1993. Before 1970, much of the relevant perinatal information was missing: a delivery cut off point of 31 December 1993 was required for follow up to cover the first five years of life. Between 1970 and 1993, about 6% of births to residents of Oxfordshire and West Berkshire took place outside of these two areas. These births were not included in the analyses. In addition, hospital admissions occurring outside the ORLS area were not available in the ORLS database and were therefore outside the scope of this study.

Use of hospital services

For each child, a record of inpatient service use between birth and 5 years of age was compiled. Data extracted from the ORLS included the number of babies delivered, date of each
hospital admission, the duration of hospital stay, specialty on admission, and number of babies in that delivery. Each day case admission was counted as a full 24 hour period for the purposes of this study. A readmission was defined as being any hospital admission after the birth admission. If a baby was admitted directly to neonatal care after birth, this was counted as part of the birth admission. Total time spent in hospital was calculated for each child by summing the lengths of stay of each child’s successive admissions. In addition, estimates of days in hospital were calculated for all children who were alive at the start of the period of life of interest (initial birth admission, consecutive years of life, first 5 years), with censoring for deaths. Children who were not readmitted to hospital at all during the first five years of life were included in the denominator in the calculation of means.

**Hospital service costs**

Inpatient costs were calculated for each hospital admission by multiplying the length of stay by the per diem cost of the respective specialty. The specialty based per diem costs were based on the English Department of Health’s NHS Trust Financial Returns (TFR2) for 1997–1998 and 1998–1999, which had been averaged over these two financial years to eliminate any random fluctuation in the data. These returns incorporate short run current average revenue costs, plus revenue and capital overheads, and are widely accepted as reliable indicators of hospital service costs. For hospital records with an unknown or incorrect specialty code, the per diem medical or surgical cost was applied, depending on the specialty costs. In the birth admission and first year readmissions, the cost of inpatient hospital care increased significantly.

**Statistical analysis**

The number of deaths over the first five years of life among live births was examined using Kaplan-Meier analysis. The log rank test was used to compare survival in singleton, twin, and higher order multiple births.

The total duration of hospital admissions, including the initial birth admission, during the first 5 years of life was compared in singletons, twins, and higher order multiple births using a multivariate negative binomial regression. Data on all children were incorporated into this analysis. Relative rates and 95% confidence intervals for the number of days in hospital were calculated after adjustment for duration of life.

Cost differences between singletons, twins, and higher order multiple births that occurred over the first five years, as well as in each of the first five years of life, were tested using multiple linear regression, including only children alive at the start of each period in cost estimates. Costs are reported per child rather than per “set” of twins or triplets. The size of the study sample (276 897) was sufficiently large to expect robust parameter estimates, and therefore, despite the skewed nature of the data, alternative methods such as bootstrapping techniques were not applied.

For all statistical analyses, differences were considered significant if p values were 0.001 or less. This cut off was selected both because multiple comparisons were being made and because in such a large dataset even a small difference tends to be significant. Analyses were performed with a microcomputer using SAS software (version 8.2; SAS Institute Inc, Cary, North Carolina, USA) and SPSS for Windows (release 11.5; SPSS Inc, Chicago, Illinois, USA).

**RESULTS**

The number of babies born as singletons, twins, and higher order multiples in Oxfordshire and West Berkshire between 1970 and 1993 was 270 428, 6284, and 185 respectively. Of the 185 triplet and higher order multiple births, 20 were quadruplets. The rate of multiple births increased slightly over the time period in line with national trends.

Figure 1 illustrates the differential survival of babies born in multiple births. This shows Kaplan-Meier survival up to one year for singletons, twins, and higher order multiple births. Mortality was higher for twins and even greater for higher order multiple births, compared with singleton babies (log rank test $\chi^2 = 551.4, df = 2, p < 0.0001$). Nevertheless, even among higher order multiple births, more than 90% of liveborn infants survived their first year.

As expected, most deaths occurred within the first month of life. Differences in survival decreased over time, and after about six months there were very few deaths.

Babies born in multiple births were at increased risk of both mortality and morbidity. The mean number of days in hospital up to age 5 for singletons, twins, and higher order multiple births respectively were seven, 15, and 30 (table 1). Relative rates, taking account of duration of life, show that twins experienced twice the number of days in hospital as singletons (relative rate 2.40, 95% confidence interval 2.35 to 2.46), and triplets almost eight times as many days in hospital during the first five years of their lives (relative rate 7.58, 95% confidence interval 6.60 to 8.69).

The lengthier periods of inpatient hospital care experienced by babies born in multiple births clearly have financial implications. Table 2 shows estimates based on mean specialty costs. In the birth admission and first year readmissions, the cost of inpatient hospital care increased significantly ($p < 0.0001$) with the multiplicity of birth. Relative to the cost of a singleton baby, the additional cost for

![Figure 1](http://fn.bmj.com/ArchDisChildFetalNeonatalEd/Y04-043851/01f01.jpg)
a twin was £2294 over the first five years. For a baby born in a higher order multiple birth, the additional cost was £6624. Annual costs decreased as the children got older, and cost differences between singletons and multiples tended to decrease. At ages 2–5 years, there was no significant variation by multiplicity except during the third year of life when higher order multiple births had significantly higher inpatient hospital costs. This was largely explained by the admission to hospital of one set of triplets who required considerable inpatient support.

**DISCUSSION**

This study shows the increased hospital inpatient costs associated with twins and higher order multiple births during the first five years of life. This is in line with work by others, including Keith et al. and Callahan and Greene, who also reported increased costs associated with multiple births. Keith et al. reported that costs associated with neonatal care were $3600, $8336, and $60,045 per baby (price date not reported) for singletons, twins, and triplets respectively. Callahan and Greene reported that the proportion of babies requiring treatment in neonatal intensive care were 15%, 48%, and 78% for singletons, twins, and triplets respectively, but that mean lengths of stay in neonatal intensive care were not significantly different.

The strength of this study is that it is based on a very large, geographically determined, dataset, which included data on all inpatient and day case admissions to NHS hospitals within the former Oxford Region over a 24 year period. However, it does not include data on outpatient or community health service costs or non-health related costs, such as social service or education related costs. The Mersey study of low birthweight babies found that costs in all these sectors were also increased when compared with normal weight babies, and this is also likely to be the case with low birthweight multiples. The use of health service resources is also greater in mothers of multiples both antenatally and postnatally, although these figures are dwarfed by the costs of neonatal care.

None of these data give any measure of the intangible costs associated with multiple gestation pregnancies and births.

Although the current study is unusual in covering a five year time frame, the corollary of this is that the data on births are not current; the most recent year of hospital data available from ORLS was 1998, the latest births therefore were in 1993. Practice may have changed in the intervening decade.

The ORLS included all admissions to NHS hospitals in the area covered by the former Oxford Region. Migration out of the area covered by the former Oxford Region over a 24 year period. The greatest component of total costs, and the greatest difference in costs, occurs in the first year of life.
There is scope for more in-depth research into the costs borne by families, including intangible costs, associated with multiple births. Policy implications of increasing provision of assisted reproductive techniques, and in vitro fertilisation in particular, need to be assessed. Draft guidelines from the National Institute for Clinical Excellence (NICE) propose recommending that, for couples meeting certain criteria, up to three cycles of in vitro fertilisation be paid for by the NHS. This would address some of the problems of the “postcode lottery” but would work against local decision making. If the draft guidelines are agreed, it would be important to evaluate outcomes from clinical, psychological, and health economic perspectives.

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