Reducing accident death rates in children and young adults: the contribution of hospital care

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Abstract

***Objective*—To assess the contribution of trauma care to the recent decline in accident death rates among children and young people.**

***Design*—Logistic regression modelling of temporal trends in the probability of death in patients admitted to hospital for the treatment of severe injury.**

***Setting*—Hospitals participating the United Kingdom major trauma outcome study.**

***Subjects*—3230 patients with an injury severity score of 16 or more, who were admitted for more than three days, transferred or admitted to intensive care, or died from their injuries.**

***Main outcome measures*—Death or survival in hospital within three months of injury.**

***Results*—Over the seven year period 1989-95 there was a substantial decline in the probability of death among children and young adults admitted to hospital after severe injury. The overall estimate of the reduction in the odds of death was 16% per year (odds ratio for the yearly trend 0.84; 95% confidence interval 0.79 to 0.89). This decline did not differ significantly between age groups. (0-4 years 0.79; 5-14 years 0.87; 15-24 years 0.83).**

***Conclusions*—Reductions in hospital case fatality have made an important contribution to reaching the Health of the Nation targets. The contribution of hospital care in the reduction of accident mortality should be taken into account in decisions about the allocation of resources to preventive and curative services.**

Introduction

The *Health of the Nation* established prevention of accidents in children as a government priority.[1] A national target has been set to reduce the death rate from accidents among children under 15 years by at least 33% by 2005, from a baseline of 6.7 deaths/100 000 in 1990. For people aged 15-24, the government aims to secure a 25% reduction in accident death rates. Progress towards these targets has been encouraging, and if present trends continue the targets might even be exceeded.[2] Although government publications have emphasised the importance of accident prevention, improvements in the hospital care of seriously injured children might also contribute to reductions in accident death rates. To assess the contribution of trauma care to the decline in accident death rates we used data from the major trauma outcome study to examine trends in the probability of death (case fatality) after severe injury.

Methods

The major trauma outcome study is a multicentre prospective cohort study designed to assess the effectiveness of the management of serious injury in the United Kingdom.[3] Information is collected on all injured patients who are admitted to participating hospitals for more than three days, die from their injuries, are transferred to or from another hospital, or are admitted to intensive care. For each patient a complete list of injuries is used to generate an injury severity score,[4 5] and recordings of the respiratory rate, systolic blood pressure, and Glasgow coma scale are used to calculate a revised trauma score.[6] The use of objective injury scoring allows an examination of trends in the probability of death unconfounded by severity of injury. In the absence of a measure of severity a decline in the proportion of injured patients who die may simply reflect a trend towards hospital admission of less severely injured patients.

Case fatality was defined as the proportion of patients with an injury severity score of 16 or more who died as a result of their injuries. A score of 16 or more is conventionally taken to represent major trauma. Trends in case fatality were examined over the seven year period 1989-95. Because the method of wounding (blunt or penetrating) has an independent effect on the probability of death and may have changed over time, analyses were restricted to patients with blunt trauma. Penetrating trauma accounts for a small proportion (5%) of severe trauma. Logistic regression modelling was used to examine temporal trends in the probability of death, with adjustment made for age, injury severity score, and revised trauma score. Expected mortality was calculated as the sum of the predicted probabilities of death for each patient. In a third of cases clinical data were incomplete, precluding calculation of revised trauma score. A dummy variable was therefore included in the model to account for differences between cases with complete data and cases with incomplete data. With this model, the odds ratio for the year variable is the odds of death in one year compared with that in the previous year, averaged over the observation period. During the seven year period the number of hospitals participating in the study increased from 30 to over 100. Analyses were carried out of all participating hospitals and also restricted to the original cohort of 30 hospitals.

Results

Over the study period 16 710 injured people aged 0-24 years fulfilled the inclusion criteria of the major trauma outcome study. Of these, 3394 (20%) had an injury severity score of 16 or more. The following analyses are based on the details of the 3230 (95%) patients from 122 centres who sustained blunt trauma. Of the patients with blunt trauma, 2290 (71%) had been involved in a road traffic accident and 531 (17%) had been injured in a fall. The distribution of these and other causes of injury were similar from year to year. There was no change in the median injury severity score over time, which was 25 in every year. Overall mortality throughout the study period for patients with a score less than 16 was 0.3%. There was an annual decline in the observed mortality of patients with a score of 16 or more (table 1). The log odds of death shows an almost linear decline across the seven year period in all three age groups (fig 1) When expected mortality was calculated by using logistic regression based on injury severity score and revised trauma score, the ratio of observed to expected deaths showed a similar decline (table 1).

Table 2 gives the odds ratios for average yearly trend in each age group adjusted for the two scores. For all age groups there was a significant decline in the probability of death, and the magnitude of the decline did not differ

Table 1—*Trends in case fatality and comparison with expected mortality for children and young people, 1989-95 (injury severity score ≥16)*

Year	Total No of cases	Mortality (%) Observed	Expected	Observed: expected
0 to 4 Years				
1989	6	50	36.5	1.37
1990	16	25	21.3	1.17
1991	70	20	18.3	1.09
1992	52	15.4	13.8	1.11
1993	41	22	14	1.56
1994	84	13.1	18.2	0.72
1995	34	8.8	15.7	0.56
5 to 14 Years				
1989	44	29.5	20.4	1.45
1990	58	24.1	22.6	1.07
1991	129	27.1	24.4	1.11
1992	135	22.2	22	1.01
1993	128	20.3	18.6	1.09
1994	240	19.2	22	0.87
199 5	154	16.2	19	0.85
15 to 24 Years				
1989	155	29.7	20.4	1.46
1990	145	33.1	24.9	1.33
1991	284	25	23.7	1.05
1992	356	25.2	24.1	1
1993	310	24.5	26.8	0.92
1994	500	23.8	27.5	0.87
1995	289	20.4	22.2	0.92

Table 2—*Odds ratios (95% confidence intervals) for average yearly trend in each age group adjusted for injury severity score and revised trauma score*

Age (years)	All hospitals	Original cohort of hospitals
0-4	0.79 (0.63 to 0.99)	0.88 (0.65 to 1.20)
5-14	0.87 (0.78 to 0.97)	0.88 (0.76 to 1.01)
15-24	0.83 (0.77 to 0.90)	0.80 (0.72 to 0.87)

significantly between age groups. Modelling the trend by using age group as a confounding variable and by controlling for the two scores, the overall odds ratio for the yearly trend was 0.84 (95% confidence interval 0.79 to 0.89). Separate analyses were carried out on data from the 30 hospitals participating in the major trauma outcome study at the start of the observation period. The results were essentially unchanged.

Figure 2 shows the decline in the estimated odds of death in each year calculated relative to the baseline year of 1989, adjusted for injury severity score, revised trauma score, and age. Since 1989 there has been a clear downward trend in the odds of death that can not be explained by differences in severity of injury or age. The data for 1995 admissions is still incomplete. Some other potential risk factors that may have affected the above results were considered. The percentage of patients with a serious head injury did not change significantly over the study period, ranging from 72% to 77% of patients having at least a moderate head injury (≥3 abbreviated injury scale). In 1989, 83% of the study subjects were male. Between 1990 and 1995, this percentage was between 71% and 76% with no clear trend.

Discussion

Examination of the database from the major trauma outcome study revealed a substantial decline in the probability of death among children and young adults admitted to hospital for severe injury over the seven year period 1989-95. After we controlled for injury severity, we found an annual decline in the odds of death in hospital of 21% for children under the age of 5 years, 13% for children aged 5-14, and 17% for people aged 15-24.

These results suggest that reductions in hospital case fatality have made an important contribution to reaching the Health of the Nation targets. Because many severely injured children die before they reach hospital, the impact of hospital care on total child injury death rates is limited. A study of children who died with head injuries in the Northern region found that half of the children died before hospital admission.[7] If we assume that deaths from head injury are representative of all deaths from injury, and an overall annual decline in case fatality of 16%, then the proportion of deaths from injury in childhood that have been averted by improved hospital care is about 8%.

The validity of this conclusion, based on the methodology of the major trauma outcome study, merits careful examination. The severity of injury is a major determinant of outcome so the ability to control adequately for severity is essential. This in turn depends on the accuracy of the measurement of severity. Misclassification may result from deficiencies in the scoring systems themselves or from substantial variation between assessors in the scoring of individual patients. Severity scoring for the major trauma outcome study is carried out only by trained staff at the North Western Injury Research Centre, but misclassification may have arisen because of variability in the accuracy of recording of injury from the case notes.[8] Bias might also have arisen if there has been a change in recruitment criteria during the study period. While the use of unambiguous inclusion criteria would be expected to minimise this, the extent to which subjective bias accounts for the decline in case fatality remains a matter for judgment.

Is there the potential for such a reduction in the hospital case fatality? Sharples *et al* examined the prevalence of avoidable complications contributing to

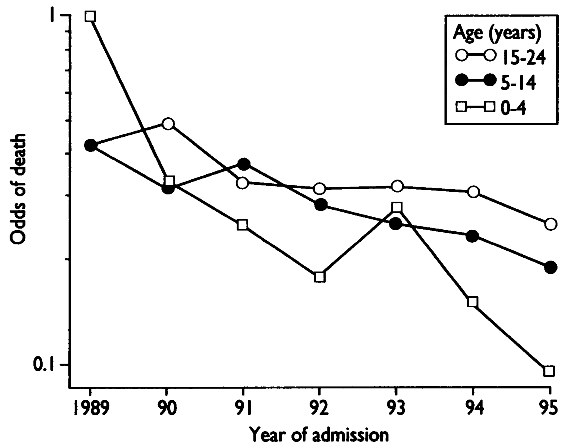

Fig 1—*Log odds of death in each year of admission for three age groups*

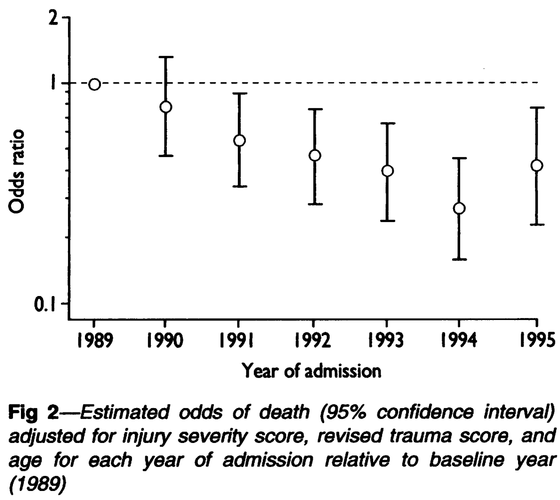

Fig 2—*Estimated odds of death (95% confidence interval) adjusted for injury severity score, revised trauma score, and age for each year of admission relative to baseline year (1989)*

Key messages

- There has been considerable progress towards the Health of the Nation target for reducing child accident death rates
- Government publications emphasise the role of accident prevention in reaching the targets, but the hospital care of seriously injured children might also make an important contribution
- Analyses of data from the major trauma outcome study show that, after severity of injury is controlled for, there has been a substantial decline in hospital case fatality for severe injury
- Over the seven year period 1989-95 the odds of death after severe injury declined by 16% a year
- The contribution of hospital care to the reduction of child accident mortality should be taken into account in decisions about the allocation of resources to preventive and curative services

the death of children with head injuries.[7] For children who died in hospital there was a high prevalence of potentially avoidable factors, including delayed diagnosis of intracranial haemorrhage and intra-abdominal injury, inadequate airway management, and poor management of transfers between hospitals.

The observed improvements in survival over the past seven years may be due to better initial assessment and resuscitation in hospital and the provision of integrated management from the scene of the incident through to intensive care and definitive surgery.

Although these results suggest that the care of patients with multiple injuries is improving in the United Kingdom, case fatality is a relatively crude measure of the outcome of trauma care. A measure of the extent of disability among those who survive is also required.[9] Nevertheless, the effectiveness of improvements in hospital care in the reduction of accident mortality should be taken into account when the allocation of resources to preventive and curative services is determined.

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Incidence and recall of influenza in a cohort of Glasgow healthcare workers during the 1993-4 epidemic: results of serum testing and questionnaire

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The United States Centers for Disease Control and Prevention advocate annual influenza immunisation for all healthcare workers in contact with vulnerable patients.[1] The health departments in the United Kingdom, however, advise immunising only people with risk factors.[2] Little evidence exists to support or refute a policy of immunisation for such healthcare workers, and, although influenza outbreaks have been documented, epidemiological data concerning influenza in healthcare workers are lacking. We aimed principally to determine the incidence of influenza in a cohort of healthcare workers. As prevention of cross infection is one of the main arguments in favour of immunisation of healthcare workers, we also estimated the proportion of asymptomatic infection by linking recall of illness with serological results.

Subjects, methods, and results

The study population consisted of all 970 healthcare workers at four acute hospitals in Glasgow who had serum stored for a routine post-vaccination test for antibody to hepatitis B between 1 February and 26 October 1993. This group was likely to be representative of healthcare workers in contact with patients as internal audits have shown that over 80% of targeted staff complete the hepatitis B vaccination programme. After the influenza epidemic (late October 1993 to end of January 1994) we invited these healthcare workers to provide a further blood sample and complete a questionnaire on their history of influenza and respiratory infection between the end of October 1993 and 1 February 1994. In all, 163 subjects were excluded as they had resigned or were on long term sick leave or maternity leave. Of the remaining 807 subjects, 602 (75%) agreed to enter the study and provided the blood sample during six weeks beginning 1 February 1994.

Analysis of the 602 subjects showed that their age, sex, and occupation were consistent with those of staff offered hepatitis B vaccination, and over 90% of the subjects had regular contact with patients. Further exclusions from analysis were due to influenza vaccination (20 subjects), insufficient serum (25), and inability to trace first serum sample (39).

We matched the remaining 518 samples with baseline stored serum samples and tested for antibodies to influenza A and B by single radial haemolysis using the method of the National Institute for Biological Standards and Control, with antigens derived from the 1993-4 season. This test is known to compare favourably with the standard haemagglutination inhibition test[3]; a 50% increase in reactivity between two samples is diagnostic of infection. Questionnaire responses and serological findings were analysed with the χ^2 test.

Overall, 120 samples (23.2% (95% confidence interval 19.6% to 26.8%)) had a significant rise in titre due to influenza. Type A influenza occurred in 107 samples (20.7% (17.2% to 24.2%)) and type B in 18 samples