Incidence of cases of ocular trauma admitted to hospital and incidence of blinding outcome

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Abstract
Aims—To provide epidemiological data on the current burden of serious eye injuries utilising the hospital eye service, to inform the planning and provision of eye health care, and health and safety strategies for the prevention of ocular injuries.

Methods—A prospec tive observational study was carried out of all patients with ocular trauma admitted to hospitals in Scotland, under the care of a consultant ophthalmologist, during a 1 year period. The population of Scotland represented the population at risk of injury. Visual outcome (Snellen visual acuity in the injured eye) was measured at the time of final discharge from ophthalmic care and at follow up.

Results—All ophthalmic departments in Scotland participated and a total of 415 residents of Scotland were admitted. The 1 year cumulative incidence of ocular trauma necessitating admission to hospital is estimated to be 8.14 per 100 000 population (95% CI 7.38 to 8.97). Some 13.2% (n=56197) of patients discharged from follow up had a poor visual outcome with a visual acuity less than 6/12 in the injured eye. Some 10.7% (211197) patients at this time had a blinding outcome in the injured eye (visual acuity less than 6/60). No patient was registered blind or partially sighted during the study period. The home was the single most frequent place for blinding injuries to occur (52%, n=11121), followed by the workplace 24% (n=52316).

The 1 year cumulative incidence of blinding outcome from serious ocular trauma is estimated to be 0.41 per 100 000 population per year (95% CI 0.26 to 0.64).

Conclusion—The current burden of serious ocular trauma presenting to the hospital eye service has been quantified from this population based study, and for the first time, a direct estimate of the incidence of the subsequent blinding outcome from these injuries has been provided. Ocular trauma remains an important cause of avoidable and, predominantly, monocular visual morbidity (visual impairment and blindness), with over half of the blinding injuries now occurring in the home. Health education and safety strategies should now consider targeting the home for the prevention of serious eye injuries in addition to the traditional work, sports, and leisure environments and their related activities.

Ocular trauma is an important cause of preventable visual morbidity, particularly among the younger age groups.1 2 Although ocular trauma represents a significant burden of new cases presenting to ophthalmic services in the UK, many of these are minor injuries and are treated either in the accident and emergency department or as outpatients.3 4 Consequently, there are scant epidemiological data on moderate to severe injuries with potentially sight threatening sequelae that are available to inform not only planners and providers of eye health care, but also health and safety strategies for the prevention of ocular injuries. The data currently available for the UK relate to circumstances almost two decades ago.

This paper reports on the incidence of ocular trauma of sufficient severity to warrant admission to hospital under a consultant ophthalmologist, together with the incidence of blinding outcome within 1 year of injury.

Method
This was a prospective observational study of all admissions for ocular trauma under the care of a consultant ophthalmologist in Scotland, during the calendar period 1 November 1991 to 31 October 1992. All patients were followed up until 31 December 1992 or discharge from ophthalmic care, whichever came first. The study population was that of Scotland which was estimated to be about 5.1 million in 19917 and represented the population at risk of injury during the study period.

All ophthalmic departments in Scotland were invited to participate by providing clinical data on patients (children and adults) admitted under their care with an ocular injury sustained during the study period. Patients with an ocular injury referred from another specialty were also included provided that the injury had been sustained during the study period. A consultant ophthalmologist was identified at each ophthalmic department to act as a local coordinator to supervise and facilitate data collection at each participating centre. Regular feedback on identification, recruitment, and follow up of patients was provided to each centre at 3 monthly intervals throughout the study period.

All data were collected by ophthalmologists, in standardised proforma booklets developed specifically for the study. These contained separate proformas for each stage of patient care: reporting the event (admission of an ocu-
lar injury) and the process of care provided—
the history and clinical assessment of the
injury; clinical management on admission; fol-
low up in the outpatient department; at
discharge from ophthalmic care; and for
reporting a tertiary referral at any stage. Also
included in each booklet were instructions for
completion of the proforma together with the
definitions used in the study. An 'event' was
defined as the first time after injury that a
patient was admitted to hospital under the care
of a consultant ophthalmologist. Subsequent
referrals to another centre or readmissions
were therefore not counted as the index 'event'
but constituted details relevant to the overall
process of care that the patient received.

Visual outcome was only considered at final
discharge (from follow up and ophthalmic
care). This time was taken as it represented a
definite stage in the patient’s recovery where
stability was likely to have been achieved and
no further medical care was required, irrespec-
tive of type or severity of injury. Visual outcome
was defined in terms of the best corrected
Snellen visual acuity in the injured eye (or in
the case of bilateral injuries the worse affected
eye was taken) at time of final discharge. A
good visual outcome was defined as a Snellen
visual acuity of 6/12 or better. Blindness was
taken to be a visual acuity of less than 6/60 and
visual impairment was taken as an acuity of
6/18 to 6/60 (inclusive). Definitions used by
the World Health Organisation for blindness
(less than 3/60) and visual impairment (6/24 to
3/60 inclusive) are also presented.

At the end of the study period, routine hos-
pital activity returns for inpatients and day
cases (Standard Morbidity Record—SMR1)
to the Department of Health in Scotland were
obtained to assess the completeness of report-
ing of admissions for eye injuries by ophthal-
mologists for the purposes of the study. The
SMR1 data were provided for patients admit-
ted as emergencies, by specialty, principal
diagnosis on discharge, age, and sex for the
study period. Table 1 presents the ICD 9
diagnostic codes (International Classification
of Diseases version 9) that were used. Where
discrepancies occurred, a list of pertinent
details of study patients (date of birth, sex, and
hospital number), was sent to the Scottish
Office of the Department of Health for
comparison and validation.

The cumulative incidence for cases with
ocular trauma admitted to hospital during one
calendar year is presented. This is a propor-
tion given by the ratio of the number of patients
admitted during the study period (1 year), to
the number of persons at risk at the beginning
of that period. It indicates the average risk that
an individual has of sustaining an eye injury
requiring admission to hospital under the care
of an ophthalmologist in the specified period
of time. Similarly the cumulative incidence for
permanent blindness from injury is also
presented. The population estimates for Scot-
land for 1991 were used and are presented in
Table 2.

The Fleiss quadratic approximation
method was used to calculate 95% confi-
dence intervals (CI) for the estimated cumula-
tive incidence proportions. In comparing males
with females, incidence ratios (relative risks
RR) were estimated using the EPI-INFo soft-
ware.11

Results
There were 18 eligible ophthalmic depart-
ments in Scotland at the time of the study pro-
viding regular inpatient and outpatient services
and all of these participated.
A total of 428 admissions were reported
during the study period. Thirteen patients
were identified as not being residents of
Scotland and were not included in this
analysis. One hundred and ninety seven
patients were discharged from ophthalmic care
and follow up during the study period. All of
these patients were discharged by 12 months
after injury (range for time to discharge: 1 day
to 1 year; median 1 month). Losses to follow
up accounted for a third of all cases, with most
of these occurring within 3 months of injury by
failure to reattend for outpatient assessment.
Analysis of routine SMR1 returns during the
study period (1 November 1991 to 31 October
1992) gave a count of 637 patients who had
emergency admissions under an ophthalmic
service and were discharged with a principal
diagnosis of discharge of ocular trauma. How-
ever, 113 (27%) patients entered and followed
up in the study were not identified on the rou-
tine SMR1 returns.

The 1 year cumulative incidence for moder-
ate to severe ocular trauma requiring admis-
sion to hospital under the care of a consultant
ophthalmologist is presented in Table 3. The
overall incidence for hospitalised ocular
trauma is 8.14 per 100,000 of the population in
1 year, with incidence peaking at the age
groups 15–24 years and 25–34 years for males, and falling thereafter. For females the peak incidence occurs at the 5–14 year age group (Table 3 and Fig 1).

Controlling for age, males were at a higher risk of eye injury than females. The overall crude incidence ratio (relative risk, RR) was 5.4 (95% CI 4.04 to 6.88). Stratum specific age adjusted incidence ratios are also presented, demonstrating an effect modification by age. The risk of having an eye injury necessitating an admission to hospital is over nine times higher for males than females between the ages of 15–64 years (RR=9.73; 95% CI 6.49 to 14.14). The size of this relative risk is reduced at the younger age group 0–14 years (RR=2.16; 95% CI 1.36 to 3.43). Similarly, for the older age group of 65 years and older, the excess risk is still demonstrated but without reaching statistical significance (RR=1.33; 95% CI 0.61 to 3.11) (Table 3).

Twenty six (13.2%) patients had a poor visual outcome at final discharge from follow up. Of these, five (2.5%) had visual impairment achieving a visual acuity between 6/18 and 6/60 (inclusive) and 21 (10.7%) patients were blind with a visual acuity of less than 6/60 in the injured eye. Applying the WHO definitions, six (3.05%) patients had low vision and 18 (9.14%) patients had a visual impairment as a consequence of injury (Table 4).

Two of the patients with visual impairment in the injured eye at final discharge (acuities of 6/18 and 6/36) had pre-existing amblyopia in that eye. Twelve of the patients with blinding outcome had no perception of light (NPL). There were a further seven patients with a last recorded visual acuity of NPL as a result of the injury, but as they were all still under follow up, they were not included in the analysis for blinding outcome at final discharge (Table 4). Twenty five patients sustained a bilateral injury. Of these 17 were discharged with good visual outcome and of those still under follow up, only one patient had visual impairment.

The overall 1 year cumulative incidence of blinding outcome by 1 year after injury was 0.41 per 100 000 population. (Using the WHO definitions, the overall incidence of blinding outcome was 0.36 per 100 000 population per year.) No patient was bilaterally blind following injury. No patient was registered blind or partially sighted during the study period. The single most frequent place for blinding injuries

### Table 3  One year cumulative incidence of cases of ocular trauma admitted to hospital in Scotland

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Residents cases admitted without ocular trauma (n)</th>
<th>Cumulative incidence (per 100 000 population per year)</th>
<th>Incidence ratios (relative risk)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–4</td>
<td>Males 10 Females 5 All 15</td>
<td>Males Females All (95% CI)</td>
<td>Males/females (95% CI)</td>
</tr>
<tr>
<td>0–14</td>
<td>59 26 85</td>
<td>11.99 5.56 8.85 (7.11 to 11.0)</td>
<td>1.9 (0.65 to 5.55)</td>
</tr>
<tr>
<td>15–24</td>
<td>88 10 98</td>
<td>23.17 2.71 13.08</td>
<td>8.55 (4.45 to 16.45)</td>
</tr>
<tr>
<td>25–34</td>
<td>75 10 85</td>
<td>18.63 2.49 10.57</td>
<td>7.48 (3.87 to 14.47)</td>
</tr>
<tr>
<td>35–44</td>
<td>55 3 58</td>
<td>15.69 0.86 8.27</td>
<td>18.34 (5.74 to 58.62)</td>
</tr>
<tr>
<td>45–54</td>
<td>33 3 36</td>
<td>11.62 1.01 6.21</td>
<td>11.44 (3.51 to 37.29)</td>
</tr>
<tr>
<td>55–64</td>
<td>17 2 19</td>
<td>6.69 0.71 3.54</td>
<td>9.45 (2.18 to 40.89)</td>
</tr>
<tr>
<td>Stratum summary 15–64</td>
<td>268 28 296</td>
<td>16.03 1.65 8.78 (7.82 to 9.85)</td>
<td>7.93† (6.49 to 14.14)</td>
</tr>
<tr>
<td>65–74</td>
<td>7 6 13</td>
<td>3.65 2.41 2.95</td>
<td>1.51 (0.51 to 4.51)</td>
</tr>
<tr>
<td>75–84</td>
<td>3 5 8</td>
<td>3.28 2.98 3.09</td>
<td>1.1 (0.26 to 4.61)</td>
</tr>
<tr>
<td>85+</td>
<td>1 2 3</td>
<td>6.35 3.78 4.37</td>
<td>1.08 (0.15 to 18.55)</td>
</tr>
<tr>
<td>Stratum summary ≥65</td>
<td>11 13 24</td>
<td>3.68 2.77 3.12 (2.04 to 4.72)</td>
<td>1.33† (0.61 to 3.11)</td>
</tr>
<tr>
<td>Missing</td>
<td>7 10</td>
<td>13.73 2.54 8.14 (7.38 to 8.97)</td>
<td>5.4 (4.04 to 6.68)</td>
</tr>
<tr>
<td>All strata</td>
<td>338 67 415*</td>
<td>13.73 2.54 8.14 (7.38 to 8.97)</td>
<td>5.4 (4.04 to 6.68)</td>
</tr>
</tbody>
</table>

* Visual acuity in the injured eye
† Two of these patients had pre-existing amblyopia in the injured eye.

### Table 4  Visual impairment and blindness from ocular trauma at final discharge from follow up (n=197)

<table>
<thead>
<tr>
<th>Visual acuity *</th>
<th>No</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good visual outcome: Vision 6/12 or better</td>
<td>171</td>
<td>86.8</td>
</tr>
<tr>
<td>Poor visual outcome: Poor vision (less than 6/12)</td>
<td>26</td>
<td>13.2</td>
</tr>
<tr>
<td>Visual impairment (6/18 to 6/60)†</td>
<td>5</td>
<td>2.5</td>
</tr>
<tr>
<td>Blind (less than 6/60) (NPL)</td>
<td>21</td>
<td>10.7</td>
</tr>
<tr>
<td>Total</td>
<td>197</td>
<td>100</td>
</tr>
<tr>
<td>WHO definitions: Low vision (6/24 to 3/60)</td>
<td>6</td>
<td>3.0</td>
</tr>
<tr>
<td>Blind (less than 3/60)</td>
<td>18</td>
<td>9.1</td>
</tr>
</tbody>
</table>

* Visual acuity in the injured eye
† Two of these patients had pre-existing amblyopia in the injured eye.

NB: In addition to the 12 NPL (no perception of light) cases above, there were a further seven patients still being followed up, with last recorded vision as NPL, all directly due to the injury, making a total of 19 NPL outcomes out of 415 cases (4.58%) by the end of the study period.
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Table 5 Incidence of binding outcome in the injured eye at final discharge* by place of injury

<table>
<thead>
<tr>
<th>Place of injury</th>
<th>Blinding outcome (n)</th>
<th>Cumulative incidence (95% CI) (per 100 000 population per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home</td>
<td>11</td>
<td>0.22</td>
</tr>
<tr>
<td>Workplace</td>
<td>5</td>
<td>0.10</td>
</tr>
<tr>
<td>Pavement</td>
<td>2</td>
<td>0.04</td>
</tr>
<tr>
<td>Road traffic accident</td>
<td>1</td>
<td>0.02</td>
</tr>
<tr>
<td>Other places</td>
<td>2</td>
<td>0.04</td>
</tr>
<tr>
<td>All places</td>
<td>21</td>
<td>0.41 (0.26 to 0.64)</td>
</tr>
</tbody>
</table>

* All of these patients were discharged within 1 year of injury.
‡ The denominator was the 1991 estimate for the population of Scotland.

Discussion

A wide discrepancy was clearly observed between the events reported directly by ophthalmologists for the study and routinely collected SMR1 data. Despite frequent feedback regarding recruitment and follow up, it is possible that some admissions were missed and not included in the study, compromising completeness of data collection. However, since the data for the study were collected by ophthalmologists, their quality regarding accuracy (diagnosis of ocular injury and other relevant details) may be considered to be of a high standard.

The routine SMR1 returns are not confined to the first admission following injury and include repeat episodes of admission for the same injury and admissions for injuries that may have occurred outside the study period. They are also likely to include patients who may not have been residents of Scotland. All of these, together with the possibility of coding errors occurring, may partially explain the larger number of admissions recorded in this manner. It is also notable that a considerable proportion (27%, n=113) of study patients were not identified within the SMR1 data set. These patients are known to have been treated for an eye injury and considerable amounts of data regarding details of their injuries, their admission, and process of care received have been collected and returned to the study centre by the attending ophthalmologists. Similar discrepancies between routinely and specifically collected data with respect to their completeness and accuracy, are well recognised within the National Health Service and have been widely reported.12-15

A third of all cases were lost to follow up (mostly within 3 months of injury). All of the patients in this analysis were residents of Scotland, with most patients travelling 15 miles or less to the hospital from the location where the injury was sustained (40% travelled less than 8 miles, 32% travelled 8–15 miles). It is possible that these patients did not return for follow up because they were satisfied with their recovery and visual status following injury. Although it is unlikely that the seven patients with a last recorded visual acuity of NPL would significantly improve on this status, this could not have been assumed to be the case until final discharge. As they were still under follow up, they were not included in the analysis for blinding outcome at final discharge.

Given these circumstances, the estimates reported in this paper for incidence of hospitalised ocular trauma of 8.14 per 100 000 population per year (95% CI 7.38 to 8.97), and the incidence of blinding outcome of 0.41 per 100 000 population per year (95% CI 0.26 to 0.64), must be considered to be minimum estimates.

Estimates from previous retrospective studies for hospitalised ocular trauma from the USA range from 4.1 to 13.2 per 100 000 population.2-4 The lower estimate is from a defined locality with a given number of hospitals serving its residents for all outpatient and inpatient care, with information about eye injuries being obtained from the hospital records of patients sustaining a facial injury within a 1 year period (the ocular injuries representing a subset of these cases). The higher estimates are from hospital discharge data collated either by a statewide institution in Maryland5 or from sources of nationally aggregated discharge data.

Our direct estimates from this prospective study lie between these extremes and are derived from data from individual patients, not aggregated episodes. Estimates from the routine SMR1 suggest an overall incidence of 13.2 per 100 000 population per year and are consistent with the estimates derived from other routine sources of aggregated discharge data.

The age specific patterns reflect those previously reported for the younger age groups.2-3 There was some suggestion for the presence of a bimodal peak occurring at older age groups.6,7 The relative risk has been previously reported.2-3 Controling for age, males were observed to be at increased risk for an eye injury necessitating admission to hospital. The greatest relative risk was between the ages of 15 and 64 years (RR=9.73). The relative risk was lower for both the 0–14 year age group (RR=2.16) and the 65 years and over age group (RR=1.33). The effect modification by age may reflect differences between males and females not only with respect to their daily activities that may be risk factors for injury, but also duration of exposure to these risk factors. In the 15–64 year age group males and females are more likely to have differences in their daily work, leisure, and domestic activities and the amount of time spent on these, with each of the related environments having their own inherent risk factors for injury. At the 0–14 years and 65 years and older age groups, it is possible that males and females are more likely to share similar environments throughout the day, sharing similar exposures to risk of an injury. The home (and activities related to this location) has been identified as being the most important environment for a serious eye injury to take place at all ages. It is the single most frequent place of injury in the 0–14 years and
65 years and over age groups, showing increasing frequency with age in the intermediate age groups.  

It has been difficult to quantify the burden of visual morbidity resulting from ocular trauma in the UK, particularly as routine discharge returns to the Department of Health do not contain outcome information and monocular blindness or partial sight are not eligible for registration. In addition, registration data that are available from the blind and partially sighted registers have been identified as having some fundamental problems that compromise their use for epidemiological purposes. These include incomplete coverage, inconsistent interpretations of the definitions of blindness and partial sight, and misclassification of disease for the main cause of visual disability for registration. Consequently, direct population based estimates of the incidence of blinding outcome from ocular trauma as reported in this paper have previously been unavailable.

Although our estimates for the incidence of eye injuries admitted to hospital and the incidence of blinding outcome from these injuries are minimum estimates, when applied to the population of the UK as a whole, they may serve to indicate the national burden of visual morbidity from ocular trauma. The 1991 population estimates for the UK do not demonstrate any important differences in the age structure of the populations of England and Wales, Northern Ireland, or Scotland. It is thus estimated that annually about 4688 patients (95% CI 4250 to 5166) with ocular injuries are expected to be admitted to hospital under the care of a consultant ophthalmologist. Similarly, 236 (95% CI 150 to 369) patients a year may be expected to be permanently blinded in the eye sustaining such an injury, with over half of these blinding injuries occurring in the home.

Ocular trauma remains an important cause of preventable and predominantly monocular visual morbidity and blindness. With the home now being identified as the single most frequent place for a blinding injury to take place, health education and safety strategies should now be directed towards this previously unrecognised location for the prevention of serious eye injuries.

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