MOTORCYCLE INJURY AND SURVIVAL : IMPROVING OUTCOMES

N. COLLIGHAN, P. V. GIANNOUDIS, I. BARLOW, E. KOUREAKI, M. C. BELLAMY

The aim of this study was to examine all motorcycle accident injuries presenting in Yorkshire, United Kingdom, and to assess the impact of the introduction of a consultant-led trauma team on mortality, 1993-2000.

Data were collected on 1239 patients.

Factors independently associated with survival by logistic regression were : the presence of abdominal trauma (odds ratio 0.46, 95% confidence interval 0.31 to 0.68), the presence of chest trauma (OR 0.41, 0.29 to 0.6), the presence of head trauma (OR 0.36, 0.30 to 0.45), requirement of a blood transfusion in the emergency room (OR 0.88/unit of blood, 0.72 to 1.07), presence of the trauma team (OR 0.43, 0.16 to 1.03) and the number of years into the program (OR 1.34/ year, 1.07 to 1.67).

The single factor determining improved survival was the time into the study. This shows that treatment of motorcycle trauma has improved overall with time. We propose that the introduction of uniform treatment protocols and improvements in the general standard of care have had a great effect.

Keywords : motorcyclists ; trauma ; outcomes ; results ; survival.

Mots-clés : motocyclistes ; traumatisme ; résultats ; survie.

INTRODUCTION

In 1988 there were 322,305 traffic accident casualties in the United Kingdom, of whom 68,543 (21.3%) sustained severe injuries and 5,052 (1.6%) were killed. By 1998 there were still 325,212 traffic accident casualties but the number of severe injuries had dropped to 44,255 (13.6%) and only 3,421 (1.05%) were killed (2).

Traffic accidents involving motorcyclists and their passengers (including mopeds and scooters) have not followed this trend. In 1988 there were 42,836 casualties, of whom 12,654 (29.5%) sustained severe injuries and 670 (1.56%) were killed. By 1998 the number of casualties had dropped to 24,610, but the number of serious injuries was still 6,442 (26.2%) with 498 (2.02%) deaths. National data suggest that in motorcyclists, there has been a small reduction in severe injuries sustained but the mortality rate appears to have risen (2).

Over the last ten years there have been many improvements in the treatment of trauma, including nationwide implementation of advanced trauma life support (ATLS) protocols and the introduction of the concept of a 'trauma team' with multidisciplinary involvement. There have also been advances in the understanding of the pathophysiology and mechanism of injury and its associated problems. In the Yorkshire region trauma protocols have been in place for some time, and in 1998 the consultant-led trauma team was introduced in St. James's University Hospital.

Trauma admissions in Yorkshire have been monitored by the introduction of the Yorkshire

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Trauma Audit Research Network (YTARN) (established in 1993), which has accumulated data from all accident and orthopedic units in the Yorkshire region. In the Yorkshire region, UK, there are 14 trauma units consisting of 12 district general hospitals and two teaching hospitals. All trauma admissions to these units have their data entered in the YTARN database. With the introduction of a consultant-led team and established protocols we wished to examine, using the available YTARN data, whether motorcycle casualties in our region reflected the national trends, whether newly introduced initiatives affected outcome, and whether there were any clear outcome predictors likely to allow better targeting of resources to improve overall performance.

MATERIALS AND METHODS

A standard form was used for data collection (fig. 1). Data were abstracted from the YTARN database for trauma admissions involving motorcyclists and their pillion passengers from 1993 to 2000. This produced data on 1239 patients.

Data included demographic details, prehospital care and trauma history. Primary survey details were recorded along with grade and time of arrival of medical staff. All interventions were recorded, including radiological investigations, blood results, fluids and drugs given. The form also records the secondary survey in writing and pictorially.

An Injury Severity Score was compiled. Information on further treatment including operative surgery, by whom the surgery was undertaken and the level of all doctors in the operating room were recorded. Finally, we noted follow-up data, length of hospital stay, morbidity and late deaths.

Following univariate analysis, significant variables were used in a backward stepwise logistic regression multivariate analysis to determine relationship with outcome. Results are expressed as a median (interquartile range) or mean (95% confidence intervals) as appropriate. The assumption of normality was tested using the Kolmogorov-Smirnov test. Statistical analysis was performed using SPSS for Windows version 6.

RESULTS

There were 1239 admissions to trauma units in the Yorkshire region involving motorcyclists and their pillion passengers. Of these 1120 (90.4%) were male and 119 (9.6%) were female .The mean age for all patients was 30.7 years (interquartile range 22 to 36 years).

Mean ISS was 13.2 (interquartile range 9 to14) and this was found to be fairly constant throughout all the years of the study.

In the resuscitation room the mean fluid requirement was 688 ml (interquartile range 0 to 1000 ml), and if a blood transfusion was needed, then the mean amount of blood given was 0.26 units (0.18 to 0.34, 95% confidence interval). From here 649 (52.4%) patients required surgery.

There were 74 deaths over the study period, giving an overall mortality rate of 6% (4.7 to 7.3%, 95% confidence interval).

One hundred twenty four patients did not wear a crash helmet. Those without helmets had a mean Glasgow Coma Score (GCS) of 11.6 (interquartile range 9.9 to 13.3), as opposed to those who did wear helmets with mean GCS of 13.9 (interquartile range 13.6 to 14.2). Reduced GCS was more frequently present in those without helmets, $p = 0.0007$ (Chi-square). Of those without a helmet, 37% sustained a head injury, as opposed to 10% of those with helmets, $p < 0.00001$. Lack of a helmet was not independently associated with survival.

Variables included in the multivariate analysis were : presence of a trauma team ($p = 0.008$) ; presence of tibial ($p = 0.028$), spinal ($p = 0.042$), pelvic ($p = 0.045$), head ($p = 0.001$), facial ($p = 0.001$), abdominal ($p = 0.001$) or chest ($p = 0.001$) injuries ; number of years from inception of the YTARN database ($p = 0.008$) ; amount of fluid ($p = 0.001$) or blood ($p = 0.001$) given in the emergency room.

Of these, six factors were found to have a significant effect on survival. Odds ratios for independent predictors of survival are summarized in table I. Abdominal trauma had a major impact on survival (OR 0.46, 0.31to 0.68, 95%confidence interval), as did the presence of significant chest injuries (OR 0.42, 0.29 to 0.60, 95% confidence interval) ; along with the presence of head trauma (OR 0.37, 0.30-0.45, 95%CI). The attendance of the trauma team had a negative effect on survival (OR 0.43,0.16 to 1.03), while the requirement for a

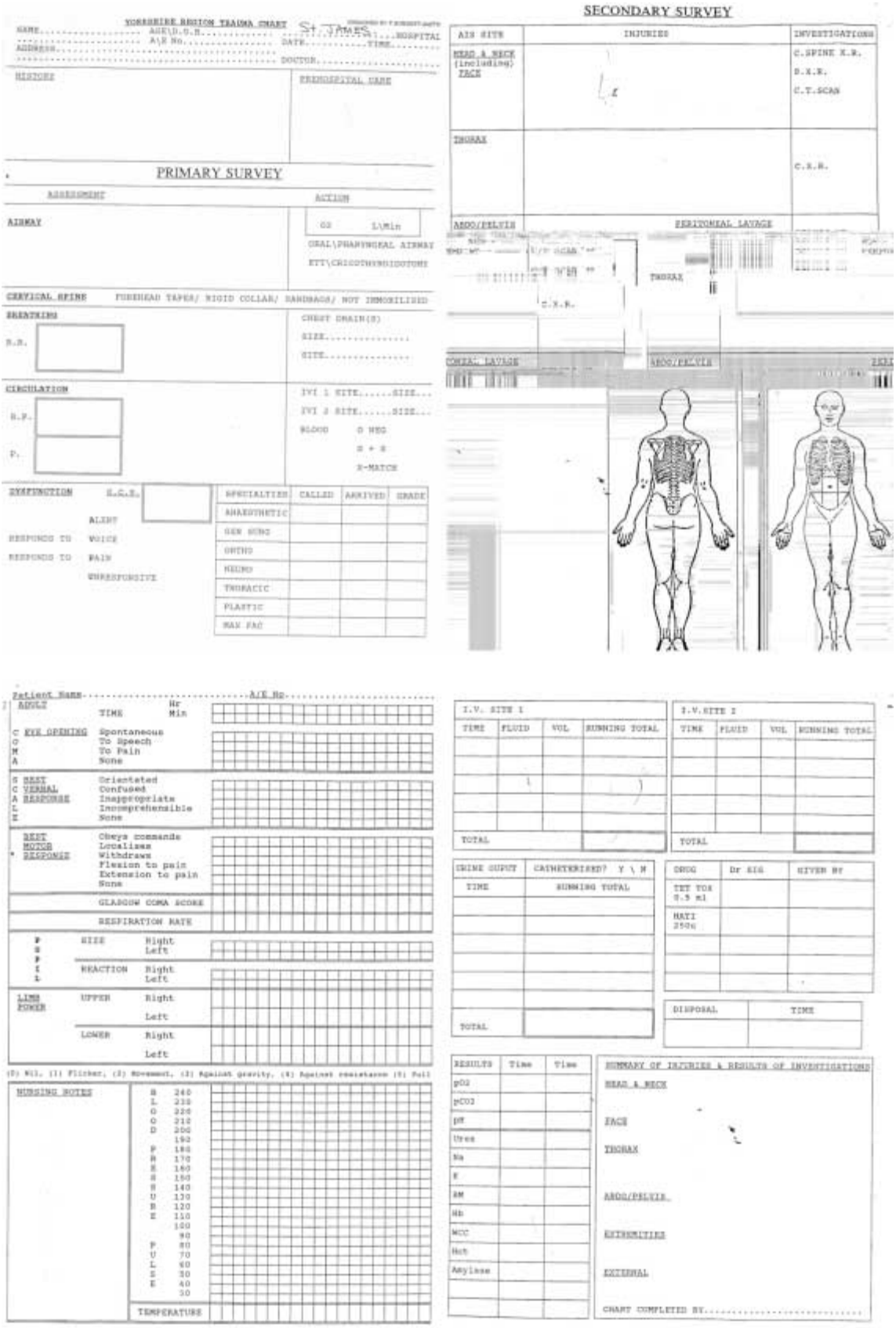

Fig. 1. — Yorkshire Region, U.K. YTARN form

Table I. — Odds ratios for independent predictors of survival

Variable	odds ratio	95% Confidence interval
Years into program	1.34/ year	1.07-1.67
Trauma team involvement	0.43	0.16-1.03
Blood transfusion in A+E	0.88/unit of blood	0.72-1.07
Head trauma	0.37	0.3-0.45
Chest trauma	0.42	0.29-0.6
Abdominal trauma	0.46	0.31-0.68

Table II. — Trends of percentage (%) Trauma deaths and injury severity scores (ISS) over time

Year	total trauma admissions	total trauma deaths	% deaths	ISS median	5TH percentile	95TH percentile
1993	96	10	10.4	9	4	45
1994	168	8	4.8	9	4	36
1995	218	17	7.8	9	4	38
1996	220	11	5	9	4	34
1997	181	8	4.4	9	4	37
1998	213	6	2.8	9	4	41
1999	143	5	3.5	9	4	41

blood transfusion in the emergency room was harmful (OR 0.88/ unit of blood, 0.72 to1.07). The more years into the program (i.e. the more recent the admission) the better the chance of survival (OR 1.6 per year, 1.06 to 2.4, 95%confidence interval). Severity of injury remained constant over time but survival improved.

Nonpredictive factors included the age of the patient, the gender of the patient and the level of the surgeon involved in the operating room. While not being significant there appeared a trend for improved survival in the presence of a senior anesthetist (consultant or senior Registrar), ($p = 0.09$).

Of 649 cases who required immediate surgery, 279 (43%) involved a senior anesthetist while 370 (57%) involved a junior anesthetist or staff grade.

DISCUSSION

To our knowledge this is the largest series of motorcycle accidents and trauma to date. Several studies have looked at isolated periods of time, but we were able to look at a longer seven-year period.

We noted that the mortality rate in this series ranged from 10.4% to 3.5% (1993-2000) with a mean value of 5.5%. This is higher than the national average, 1.6% (2) (this includes all motorcycle road accidents in Great Britain), but slightly lower than at the Tourist Trophy (TT) races on the Isle of Man, U.K (9.1%) (5). The reasons for this are unclear, but reasons could include the geography of the Yorkshire Dales with its narrow and circuitous roads, and many small trauma units ; patterns of injuries sustained may differ as well as Injury Severity Scores. In other studies the mortality rate varied from 3.8% (3) in Quebec, Canada, to 3% (1) in Newcastle, UK.

In the Yorkshire region there appears to be a more mature, but not safer, motorcyclist with an average age of 30.7 years. Previous studies have shown a younger average age tending to be in the region of 20 to 24 years of age. The average for a participant in the TT races was 34.3 years of age. It is interesting to speculate that older motorcyclists can afford more powerful machines, largely for leisure purposes. This might account for the reduced survival. No such association could be found using the Yorkshire data. The motorcyclists involved in trauma in Yorkshire may be of the same generation as those in previous studies, and the

average age of those involved in the sport may be increasing.

Offner *et al*. (4) in 1992 looked at the impact of motorcycle use in the United States. In a series of 425 patients they concluded, "helmet use decreased the need for and duration of mechanical ventilation, the length of ICU stay, the need for rehabilitation, and prevented head injury". Their study showed no significant difference in mortality (9.1% and 7.7%) but an increase in frequency in head injury in the unhelmeted patients. They also showed an increase in injuries below the neck in those who wore a helmet, but despite this they had a shorter hospital stay. These findings have been confirmed by our results. We also noted the increase in morbidity among unhelmeted motorcyclists while there was no significant difference in mortality between the two groups. In our series, 37% of patients who did not wear a helmet incurred a head injury, while significantly ($p < 0.00001$) only 10% of those who wore a helmet had a head injury. Helmet use could not be shown to be independently indicative of survival but head injury is an independent factor for survival. Of note in Offner's *et al*. (4) study helmet use was only 39%, while in our more recent study helmet use was at 90%. The differences in helmet use may imply different attitudes to helmet wearing between the two countries, or it could have been a notable increase in helmet use over time.

One factor not noted in the YTARN database was the clothing being worn by motorcyclists and their pillion passengers at the time of the accident. We have shown that injuries to the abdomen and to the chest have as great an effect on mortality rates as head injuries ; it may be prudent to look at protective clothing in future studies. Compulsory helmet use is known to have reduced the incidence of head injury (4). Can appropriate clothing, e.g. 'leathers' or body armor, have a similar effect on chest and abdominal injuries ?

The presence of a senior anesthetist did not have a statistically significant effect on outcome, although there was a trend, which may be clinically important. This was greater than the effect of the presence of a senior surgeon (although the presence of a senior surgeon increased the chances of there being a senior anesthetist present). We believe that the trauma team should always include a senior anesthetist. This is an important area for further study.

The presence of a trauma team appeared to have a negative impact on survival. Of the fourteen units involved in the YTARN database only St. James's University Hospital and one district hospital had a trauma team during the study period. While it may be that the trauma teams are decreasing survival, it is more likely that these teams have to treat patients with more extensive injuries and already reduced chances of survival. The involvement of a trauma team may act as a surrogate marker for severity of injury not otherwise well described by this model. It may be that the transfer of patients to the hospital with a dedicated trauma team may prolong time prior to definitive treatment, missing the 'golden hour'. There may be an over-representation of transferred patients in the data creating a lead-time bias. The recent introduction of an air ambulance service in the Yorkshire region may have a positive effect on survival, and this will require further study over the next few years.

The YTARN database is an audit tool to allow us to compare outcomes and assess our abilities. We were pleased that outcomes have improved over time. Presumably performance of all hospital staff involved in trauma in Yorkshire has improved over time, and this improvement has made a significant difference. It was not obviously important which member of the trauma team was present and this tends towards the perception of good training through all specialities and grades. The ATLS guidelines are now widely accepted, and training schemes are being attended by all specialities at an early stage of their training. This has led to a broader learning base and uniformity in the treatment of trauma casualties.

CONCLUSIONS

These data have major implications. Helmet wearing is known to reduce the incidence of serious head injury, and while we have confirmed this we have not been able to associate it with survival, unlike head injury. It would be interesting to further

study the effect of protective clothing in reducing abdominal, chest and head injuries.

While the presence of the trauma team had an apparent negative effect on survival, the overall performance of those involved in trauma in Yorkshire has improved over the years 1993-2000. This appears to be a result of acceptance and implementation of ATLS guidelines throughout all specialties providing a uniform and increasingly efficient service.

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SAMENVATTING

N. COLLIGHAN, P. V. GIANNOUDIS, I. BARLOW, E. KOUREAKI, M. C. BELLAMY. Verbeteren van de overlevingskansen na motoraccidenten.

Om de invloed op de mortaliteit van de invoering van een trauma team onder leiding van een "consultant" te evalueren, werden alle motoraccidenten in de regio Yorkshire, gebeurd tussen 1993 en 2000, onderzocht. Gegevens werden verzameld over 1239 patiënten. Factoren die onafhankelijk van elkaar statistisch verbonden zijn met de overlevingskans waren de aanwezigheid van abdominaal trauma (Odds Ratio 0.46, 95% confidence interval 0.29 tot 0.68), de aanwezigheid van thorax trauma (OR 0.41, 0.29 tot 0.6), de aanwezigheid van een hoofd trauma (OR 0.36, 0.30 tot 0.45), de nood aan bloedtransfusie in de spoeddienst (OR 0.43, 0.16 tot 1.03) en het aantal jaar dienst in het programma (OR, 1.34/jaar, 1.07 tot 1.67).
De determinerende factor in verbeteren van de overlevingskansen was de tijdsduur in de studie. In het algemeen is de behandeling van moto accidenten verbeterd mettertijd. De invoering van eensluidende behandelingsrichtlijnen en verbetering van het peil van de zorgen hadden een grote invloed.

RÉSUMÉ

N. COLLIGHAN, P. V. GIANNOUDIS, I. BARLOW, E. KOUREAKI, M. C. BELLAMY. Comment améliorer la survie après accident de moto ?

Ce travail avait pour but de passer en revue tous les traumatismes résultant d'un accident de moto qui se sont présentés dans le Yorkshire (Grande-Bretagne) et d'évaluer l'impact sur la mortalité de l'introduction d'une équipe dirigée par des consultants, sur la période 1993-2000. Cette étude a rassemblé les données concernant 1239 patients. On a montré par régression logistique que les facteurs suivants étaient indépendamment associés à la survie : existence d'un traumatisme abdominal (facteur 0,46 ; intervalle de confiance à 95% : 0,31 à 0,68), existence d'un traumatisme thoracique (facteur 0,41 ; 0,29 à 0,60), existence d'un traumatisme céphalique (facteur 0,36 ; 0130 à 0,45), nécessité d'une transfusion sanguine en salle d'urgence (facteur 0.88/unité de sang ; 0,72 à 1,07), intervention de l'équipe spécialisée (facteur 0,43 ; 0,16 à 1,03) ainsi que le nombre d'années écoulées depuis le début du programme (facteur 1.34/année ; 1,07 à 1,67).
Le seul facteur associé à une amélioration de la survie était le temps écoulé depuis le début de l'étude. Ceci montre que le traitement des motocyclistes accidentés s'est amélioré dans l'ensemble au fil du temps. Pour les auteurs, cela suggère que l'introduction de protocoles de traitement uniformes et l'amélioration de la qualité des soins ont eu un effet important.