Abstract
Objective: To evaluate the differences in mortality and long-term outcome between young and elderly multitrauma patients.
Design: Retrospective and descriptive.
Materials and methods: Over a 5-year period (from January 1985 to January 1990) all the consecutive young (20-29 years, n=167) and elderly (≥ 60 years, n=121) patients with an AIS/ISS of ≥ 16 treated at the University Hospital Groningen (the Netherlands) were reviewed. Age, sex, mechanisms of injury, AIS, ISS, mortality, duration of artificial ventilation, hospitalization and intensive care treatment and discharge destination were analyzed. Long-term outcome was determined using the Glasgow Outcome Scale.
Measurements and Main Results: Motorized vehicles were the leading cause of injury in both groups. Mortality in the young was lower than in the elderly (19.6% versus 38.8%); all elderly with an ISS of ≥ 50 died. Nearly all deaths in young and elderly were caused by severe brain injuries (83.8% versus 74.4%). Deaths related to multiple organ failure were not observed in the young and were rare in the elderly. The surviving young and elderly could be discharged home in equal percentages and their functional outcome two years post-injury did not differ essentially.
Conclusion: We did not find any valid argument to treat severely injured elderly patients any differently from their younger counterparts, which implies that the increased trauma care cost is also justified for severely injured elderly.
4.1: Introduction

An increasingly large part of European and United States health care is being diverted towards care for the elderly. Elderly persons (65 years and older) constitute 12.9% of the Dutch population, while their medical consumption is proportionately more than any other group in the Netherlands, and accounts for one third of the total cost of medical care in the United States. The cost of trauma care for elderly patients will continue to rise with the proportional increase in the ageing population and this makes it a health care issue of growing importance. It is well-known that the number of elderly persons who sustain severe injuries is lower than the number of young persons and that they are more likely to die from these injuries. A useful parameter to measure the benefits of treatment in terms of quality of life is the long-term outcome. A few studies have addressed the functional outcome of the elderly, but the results are contradictory. As a consequence, it is not clear whether intensive treatments lead to comparable outcome results in young and elderly multitrauma patients. Such data might have consequences on therapeutic strategies, health care planning and the allocation of resources. In this study, we compared mortality and the long-term outcome of young (20-29 years) and elderly (≥ 60 years) multitrauma patients. The elderly were subdivided into three age groups (60-69, 70-79, 80-89 years old) to test the validity of the conclusion drawn by DeMaria and Osler that the outcome of patients aged 80 years and older is the worst.

4.2: Patients and methods

Over a 5-year period (from January 1985 to January 1990) 49,500 trauma patients were admitted to the Department of Traumatology of the University Hospital Groningen, a level I trauma centre in the Netherlands. In all these patients the severity of the injuries was assessed by hand using the ‘Injury Severity Score’ (ISS); the ISS was computed from the ‘Abbreviated Injury Scale’ (AIS). All the patients with an ISS of equal to or greater than 16 were considered to be severely injured. In the study period, 723 patients met this criterion. We reviewed all those of 20 to 29 years of age (group I, n=167) and all those 60 years of age and older (group II, n=121). The latter group was subdivided into three age groups, IIA, IIB and IIC, aged 60 to 69 years (n=52), 70 to 79 years (n=42) and 80 to 89 years (n=29), respectively.

Besides the AIS and ISS, we analysed the following items: age, sex, mechanisms of injury, mortality, duration of artificial ventilation, hospitalization and intensive care (IC) treatment and discharge destination. We determined the long-term outcome at two years post-injury using the Glasgow Outcome Scale (GOS). Data to establish the Glasgow Outcome Scale

* Glasgow Outcome Scale (GOS):
  1. Death.
  2. Persistent vegetative state.
  3. Severe disability (patient needs assistance for some activities of daily living every day. May range from continuous total dependency to the need for assistance with only one major activity. More often dependency is due to the combination of physical and mental disability).
  4. Moderate disability (independant but disabled; some previous activities, either at work or in social life are no
were obtained from the medical records of several departments of the University Hospital Groningen and of rehabilitation centres and nursing homes. When the information was insufficient specialists in attendance and general practitioners were approached to complete the data.

Statistical analysis was carried out with SPSS/PC+4.0 (Statistical Package for the Social Sciences/Personal Computer, version 4.0). Differences between the means of two continuous variables were determined with Student's t test and differences between discrete variables were analysed with the chi-square test for 2 x 2 contingency tables, using Yates's correction for continuity. The relation between ISS and GOS was calculated with Spearman's rank correlation. A p value of < 0.05 was considered to be significant.

4.3 : Results

4.3.1 : Demographics

Motorized vehicles were the leading cause of injury in both groups (76.6% in group I versus 79.3% in group II, NS, Table 4.1). In the young this predominantly comprised collisions in cars (47.3%) and on motorcycles (13.8%), whereas in the elderly, injuries not only occurred as car occupants (25.5%), but also particularly as cyclists (27.3%) or pedestrians (22.3%). The mean age of the elderly was 71.9 years (range 60-89). More males than females were involved, especially in the younger age group (84.4% versus 64.5% males). The injury distribution per body region (AIS ≥ 3) was comparable in the two groups (NS, Figure 4.1). The head and neck area and thorax were the most frequently severely injured sites in the young and elderly.

Table 4.1 Mechanisms of injury in 167 young (group I, 20-29 years) and 121 elderly (group II, ≥ 60 years) multitrauma patients with an AIS/ISS of ≥ 16

<table>
<thead>
<tr>
<th></th>
<th>Group I</th>
<th></th>
<th></th>
<th>Group II</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td></td>
<td>n</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Traffic</td>
<td>128</td>
<td>76.6</td>
<td></td>
<td>96</td>
<td>79.3</td>
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<tr>
<td>Work</td>
<td>12</td>
<td>7.2</td>
<td></td>
<td>5</td>
<td>4.1</td>
<td></td>
</tr>
<tr>
<td>Home</td>
<td>7</td>
<td>4.2</td>
<td></td>
<td>18</td>
<td>14.9</td>
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</tr>
<tr>
<td>Sports</td>
<td>5</td>
<td>3.0</td>
<td></td>
<td>0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>15</td>
<td>9.0</td>
<td></td>
<td>2</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>167</td>
<td>100.0</td>
<td></td>
<td>121</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>
4.3.2: Severity of the injury in relation to mortality

Differences in injury severity between the younger group and the elderly could not be demonstrated (mean ISS 29.6 versus 23.9 in the survivors and 37.7 versus 34.3 in the nonsurvivors, NS). Fewer youngsters died than elderly persons (19.6% versus 38.8%, p<0.05). In the elderly group, the mortality rate was highest in the patients of 80 years and older: the percentages in the subgroups were 33%, 29% and 67%, respectively (Figure 4.2).
Cerebral damage was the main cause of death in both groups (83.8% in the young and 74.4% in the elderly). Mortality in the elderly was also caused by severe bleeding or cardiac/pulmonary complications. None of the youngsters died of multiple organ failure or sepsis, whereas this was the case in 6.3% of the elderly.

The young nonsurvivors died very shortly after admission to hospital: mean length of hospitalization 2.6 days, compared to 14.4 days in the elderly (p<0.05, Figure 4.3).
In general, mortality increased with an increasing ISS (Figure 4.4). Both groups showed a 'camel hump' mortality curve. The characteristic increase in mortality with a relatively low ISS value, the first 'hump', was related to patients with more or less isolated severe brain injuries (AIS 4 or 5). This "hump" symbolizes the higher risk to die from (isolated) severe brain injuries compared with the risk to die from (isolated) severe injuries in other body regions. The second 'hump' was connected to the high ISS values: an ISS of ≥ 50 appeared to be fatal for all the elderly patients, which means that an AIS 4 or 5 in 2 or more body regions was incompatible with life in the elderly.

4.3.3 : Duration of hospitalization, intensive care and artificial ventilation

Equal percentages of young and elderly patients were treated at the Intensive Care Unit (ICU) (76.6% versus 73.6%, NS); all these patients needed artificial ventilation. The young were ventilated for fewer days than the elderly (p<0.05) and had shorter stays in the ICU and hospital (p<0.05, Table 4.2). In the elderly group, the number of ventilation days and the duration of hospitalization increased with age.
Figure 1.4  Mortality (%) in relation to the Injury Severity Score of young (20-29 years) and elderly (> 60 years) multitrauma patients

Table 1.2  Mean number of days of artificial ventilation, mean length of intensive care treatment and hospital stay (in days) for survivors (Surv) and nonsurvivors (Nsurv). Data are presented for the young (group I, 20-29 years) and the elderly (group II, > 60 years). Group II was subdivided into IIA, IIB and IIC (60-69 years; 70-79 years; 80-89 years)

<table>
<thead>
<tr>
<th>Group</th>
<th>Ventilation (days) Surv</th>
<th>Nsurv</th>
<th>ICU stay (days) Surv</th>
<th>Nsurv</th>
<th>Hospital stay (days) Surv</th>
<th>Nsurv</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>8.1</td>
<td>2.6</td>
<td>9.1</td>
<td>3.4</td>
<td>28.6</td>
<td>2.6</td>
</tr>
<tr>
<td>Group II</td>
<td>12.2</td>
<td>10.6</td>
<td>13.5</td>
<td>14.6</td>
<td>32.2</td>
<td>14.4</td>
</tr>
<tr>
<td>II A</td>
<td>11.2</td>
<td>7.1</td>
<td>12.0</td>
<td>9.4</td>
<td>30.5</td>
<td>8.6</td>
</tr>
<tr>
<td>II B</td>
<td>11.7</td>
<td>13.0</td>
<td>13.5</td>
<td>15.6</td>
<td>32.1</td>
<td>12.9</td>
</tr>
<tr>
<td>II C</td>
<td>19.8</td>
<td>13.5</td>
<td>20.3</td>
<td>22.1</td>
<td>39.0</td>
<td>20.9</td>
</tr>
</tbody>
</table>

4.3.4 : Discharge destination

Discharge home was possible in 38.2% of the young patients and 33.8% of the elderly (NS). Forty-four per cent of the young were admitted to a rehabilitation centre, whereas this was the case in only 13.5% of the elderly (p<0.05). A substantial proportion of the latter group was discharged to a nursing home (33.8%), in contrast with 2.9% of the
youngsters (p<0.05). The remaining survivors went to another hospital (17.6% group I and 11.0% group II, NS) or to a psychiatric care centre (1.4% group I and 3.7% group II, NS).

The situation of the survivors two years post-injury was that 3.7% of the young and 6.8% of the elderly needed custodial care and were permanently institutionalized. All the others could ultimately be discharged home.

4.3.5: Long-term outcome

Two years post-injury there was no difference between the two groups regarding the proportion of patients who recovered completely or had only mild disabilities (GOS 5) (65.4% young and 73.8% elderly, NS, Figure 4.5).

The elderly group had fewer moderate (GOS 4, 14.8%) and equal severe (GOS 3, 1.6%) disabilities than the young patients (24.3% GOS 4, p<0.05 and 6.6% GOS 3, NS). In the two years following discharge from hospital, seven patients died; they all belonged to the elderly group. Four died as a consequence of their injuries, the remaining three died of natural causes. Two years post-injury, nobody was in a persistent vegetative state. It was not able to be proved that the functional outcome two years after injury was influenced by the mechanism of injury ($\chi^2 = 24.5$, 20 DF, NS), but was related to the Injury Severity Score at hospital admission (Spearman’s rank correlation coefficient -0.42, p<0.001).
4.4 : Discussion

Trauma is considered to be a ‘disease’ of the young. If a young person is seriously injured, this will have major consequences on his/her employment and career planning. Any subsequent residual disability often results in a long-term appeal for social security. The financial cost is enormous.

Disproportionate growth in the consumption of medical and social resources in the western countries caused by increasing ageing of the population also applies to elderly people with serious injuries. Their decreased ability to cope with severe injuries and their susceptibility to complications result in more days of intensive care treatment, longer hospitalization and involve a higher risk of dying from the injuries. Doctors who are aware of the high mortality rate in relation to the huge efforts to keep these patients alive, might be influenced by this when planning their initial treatment strategy. However, in this respect one should realize that the benefits of a patient’s treatment should not only be assessed by the mortality rate, but also by its impact on the long-term functional outcome. This study revealed differences in the mortality rate and functional outcome between elderly multitrauma patients and their younger counterparts.

The injury profile and injury severity were highly comparable in young and elderly multitrauma patients, which enabled us to make a reliable general analysis of differences in mortality and functional outcome. As was expected in the light of the results of studies performed by Rhodes, Hershman, Siegel and Mock, the mortality rate in our young group was considerably lower (20%) than in the elderly group (39%). In our series the main cause of death was severe brain injuries in both the young and the elderly. This means that severe injuries to other body regions did not make any major contribution to the overall mortality. This is remarkable because serious skeletal and thoracic injuries, as were present in our series, are generally related with a high incidence of ‘distant’ organ failure and late deaths. However, the low percentages of sepsis and multiple-organ-failure-related deaths found in this study (0% and 6.3%), illustrate that although it is still not possible to totally prevent distant organ failure, it only results in a fatal outcome in a minority of the patients.

The low mortality rate from sepsis or distant organ failure in our series is not easy to explain. Most of our patients died early from severe brain damage; this category of patients possibly might have developed sepsis or distant organ failure otherwise. Some treatment policies at the UHG might have been advantageous in preventing deaths from sepsis or distant organ failure. Of these we can mention early intubation and artificial ventilation following the Multiple Organ Failure (MOF) Score, primary open reduction and stabilisation of major fractures of the long bones, selective decontamination of the gut, and a very restrictive policy concerning blood transfusions (red cell transfusions in severely injured patients at hemoglobin levels between 8-9 g%).

Ninety per cent of the patients died within one week as a direct consequence of cerebral damage. In all the young patients, it became apparent within three days after admission whether the result of brain injury would be fatal, whereas this was the case in seventy per cent of the elderly. The remaining 30 per cent of the elderly patients died at a later stage of hospitalization as a result of cerebral damage, multiple organ failure, sepsis, or a combination. These differences in incidence of early cerebral death and single and multiple-organ-failure-related deaths, reflect impairment of the compensatory mechanisms
or physiological reserves of elderly patients to overcome the invariably locally-induced and systemic pathophysiological disturbances; a process which is probably intensified by pre-existing diseases. It explains why all elderly with an ISS of ≥ 50 died. This finding might be of influence in the discussion if resources are insufficient to meet the needs. From our results it becomes apparent that an increasing ISS is related to an increase in mortality, which was also confirmed by others. It is known that the ISS should not be used to predict the outcome of individual patients. In our series the correlation between the ISS and the functional outcome two years after the injury indicated that the ISS is one of the factors contributing to long-term outcome. This means that doctors should not base the decision whether an elderly patient should receive full medical treatment solely on the ISS rating, but other factors contributing to the long-term outcome should also be taken into account.

Fatality in our series was highest in the oldest subgroup of patients (80-89 years); their mortality was twice as high as that in the 60-69 year olds and the 70-79 year olds. Consequently, the durations of IC treatment, hospitalization and ventilation were longest in the oldest subgroup. This ‘over 80 phenomenon’ was also described by DeMaria in his trauma series. He found that the mortality rate in patients of over 80 years was four times higher than that in the 65 to 79-years-old patients.

A rapid increase in mortality has also been found in demographic population statistics; in the Netherlands, the mortality rates in various age groups are: 60-69 years 1.6%, 70-79 years 4.1% and 80-89 years 12.4%. It was interesting to observe that despite the higher mortality rate in the elderly, their functional outcome was similar to that in the young. Equal proportions of young and elderly patients could be discharged home after hospitalization. This implies that once the elderly have survived the first weeks post-injury, they do not differ essentially from the youngsters concerning their functional status. The functional outcome two years after the accident confirmed this. It appeared that comparable percentages of young and elderly patients had recovered completely (GOS 5), while even fewer elderly were classified as moderately or severely disabled than young patients (GOS 4 and 3). It was difficult to compare our outcome data to those presented in the literature, because the studies suitable for comparison dealt with less severely injured trauma populations. As a consequence, the rates of discharge home were equal to or higher than ours. On the other hand, there was also a study in which only 8% of the patients of over 70 years of age could live independently and 72% of them needed full nursing care after one year.

The overall functional result in our series was good, which implies a good quality of life in the survivors, especially in those with no or mild disabilities. To measure the quality of life a more refined measurement instrument than the Glasgow Outcome Scale should be used in future research, for example the Quality of Well-being Scale, the Life Satisfaction Index or the Sickness Impact Profile. These outcome measurements will gain importance, when decisions have to be made regarding it is justified to apply expensive treatments to severely injured patients.

4.5 : Epilogue
The decrease in the mortality rate of trauma victims in recent years may lead to (future) increases in the disability rates. This is a matter of great importance in view of the increasing cost of health care and the allocation of resources. Disabled youngsters form a long-term burden on society because of loss of productive years and their dependency on social security. To reduce this social burden we believe that it will become necessary to pay more and more attention to the prevention of permanent disablement. Our results make clear that this should not only be done in favour of young trauma patients, but also in favour of elderly patients. The elderly are more expensive initially (longer durations of IC treatment and hospitalization), but their ultimate disability rate is low. We can conclude that our results do not provide any valid argument for treating elderly trauma patients differently from young trauma patients.

4.6: References