Traffic accident victims and polytrauma patients: injury patterns, outcome and their influencing factors

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DISCUSSION

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General discussion

The number of road traffic accident (RTA) fatalities continues to increase worldwide. According to the World Health Organisation's "Global Status Report on Road Safety", it reached 1.35 million in 2016 alone. This means that around the world more people die as a result of road traffic injuries than from infectious diseases like HIV/AIDS, tuberculosis or diarrhoeal diseases[1]. Like with many causes of mortality the key to reduction of mortality due to traffic accidents lies mostly in prevention, which in the case of traffic accidents implies road safety. Road (un)safety affects all people in both high-income and low-income countries, every day. Almost everyone participates in daily traffic, wants to travel safely and expects to return home unharmed. Road safety is therefore an important social issue.

In a densely populated country like the Netherlands, it is quite a challenge to ensure that all road users, whether travelling by car, bicycle, motorcycle or on foot, can safely participate in traffic. Nevertheless, the importance of road safety is often underestimated by these participants.

It is only when things go wrong in traffic that people face the consequences of hazardous behaviour and experience both the physical and mental impact on their lives as a result of traffic unsafety. Not to mention the medical costs, loss of production, handling costs and congestion costs because of traffic accidents, which result in substantial social and economic burden. Traffic accident-related social and economic costs are estimated to exceed € 14 billion per year, equalling 2% of the Dutch gross domestic product (GDP)[2]. In this context, the importance of safe traffic for society is also high[3]. The Dutch government together with road safety institutes and pre- and in-hospital care institutions should adopt a new approach to structurally improve road safety and traffic accident outcome. Only by working together, safety and outcome can both be improved.

The primary aim of this thesis was to analyse injury patterns, injury severity and mortality for different types of road traffic participants involved in accidents in the Netherlands.

Policies and measures taken in the past have led to many successes and greatly reduced the number of road traffic accident victims. Unfortunately, it became apparent that the number of seriously injured road accident victims is increasing and the decline in the number of road deaths has stagnated over recent years. Increased numbers of elderly victims in general and both bicycle and motorized mobility scooter victims seem to have contributed substantially to this development[3,4]. This is consistent with the findings described in this thesis (**Chapter 2)**, that bicyclists were the largest and eldest group of in-hospital deceased traffic accident victims. Although 88% of all deceased RTA victims

with severe trauma (ISS≥ 16) in **Chapter 2** were transported to a level-I trauma centre, this percentage decreased with advancing age from 93% in the youngest age group (18-24 years) to 78% in the elderly (75 years and older). According to national guidelines set up by the Dutch Trauma Association, patients with severe trauma should directly be transported to a level-I trauma centre, but the above presented findings may reflect the fact that injury severity often is difficult to determine in the prehospital phase, especially in elderly victims. To prevent under-triage in the elderly, one may consider referring all acute elderly trauma patients (>65 years), with at least one AIS>3 injury, to a level-I trauma center[5]. As RTA victims aged over 75 years in this study were the largest group, with the lowest mean ISS and the most favourable clinical parameters, more awareness of the vulnerability of elderly RTA victims in prehospital triage is needed. This is even more important as the proportion of elderly RTA victims in both the Netherlands and in the Europe Union has risen during the past decade and will probably continue to rise in the future [6,7]. Also, the majority of the victims described in **Chapter 2** sustained severe head trauma and showed an almost three times higher frequency of severe head trauma than all RTA victims together in the Netherlands[8]. Thus, it can be assumed that the prevention of head trauma may substantially reduce the number of RTA fatalities. In the Netherlands, helmet use is mandatory for motorcyclists and some types of moped vehicles, but not for light-mopeds and bicycles, even though bicycling is the most common form of transportation[9]. Because of increasing road congestion in the Netherlands, however, the motorized two-wheeled vehicle (MTV) is becoming a more important method of transportation. In the 1970s extensive helmet laws for both motorcyclists and moped riders were introduced. Light-moped riders, on the other hand, are not obliged to wear a helmet, which makes this a popular way of transportation for both young and elderly people in the Netherlands. The three categories of MTVs offered a unique possibility to compare and analyse the effects of accidents with different types of MTV and their specific drivers on injury severity and mortality (**Chapter 3)**. It was found that driving a light-moped is associated with a high risk to sustain severe trauma and dying when admitted to a hospital after a crash, compared to the better-protected motorcyclist and moped rider. Severe head injury was most common in light-moped riders, both fatally and nonfatally injured, and lowest in motorcyclists. This may imply that a large proportion of head injuries in light-moped riders is related to their heads being unprotected; the head injuries are likely to have been prevented or to be less severe with the usage of protective helmets. The protective effect of helmets in MTVs has been confirmed in many studies[10-15] This underscores the importance of implementation of strict legislation concerning helmet usage for all types of motorized two-wheelers in the Netherlands.

This thesis also clearly presents that injury patterns differ between different road user groups. In **Chapter 5** it was determined that pedestrians were the most vulnerable group of road traffic accident victims. They had the highest risk to sustain severe traumatic brain injury (TBI), resulting in the longest hospitalization compared to other groups. These findings are in accordance with other European epidemiological studies, which also demonstrated that pedestrians are vulnerable participants in daily traffic, having the most severe TBI with the worst outcome[16-19]. Both the high incidence of specific types of severe TBI and the frequent combination of multiple severe injuries in pedestrians may be due to their unprotected traffic participation and relatively high age. Possible measures to increase pedestrian safety are pedestrian-friendly car fronts and truck side shields, supplying more pedestrian crossings with traffic lights and the forced reduction of speed of other traffic in crowded pedestrian areas by installing elevations (raised junctions) or by completely excluding motorised traffic[20].

Our analysis showed that the overall injury severity in fatally injured road traffic accident victims is inversely related to age and that younger victims had a higher prevalence of severe (AIS≥3) injuries to the head and thorax. On the other hand, in-hospital deceased elderly trauma patients showed lower overall injury severity compared to younger deceased trauma patients. This underlines that the elderly are very vulnerable road users, mostly due to pre-existing comorbidities and functional decline in daily life[21,22]. The vulnerability of these patients aged over 75 years in combination with better vital signs at initial presentation than in younger accident victims **(Chapter 2)** can easily obscure severe injuries. It may bias the clinicians' interpretation of injury severity during admission and the impact of the injury severity on the chance of survival. In elderly pedestrians and cyclists, clinicians should therefore be extra suspicious of (combinations of) potentially lethal injuries to the head and thorax, that do not seem life-threatening at the time of admission.

Another vulnerable group of road users prone to under-triage after road traffic accidents are motorized mobility scooter (MMS) victims **(chapter 4)**. With its low speed, the mobility scooter may seem a relatively safe mode of transport, but safe use can be affected negatively by chronic illnesses and polypharmacy, especially among older users, and by changes in physical and cognitive skills. As a consequence, accidents involving these road users often result in unpredictable injury patterns and therefore it can be difficult for both ambulance and hospital staff to adequately assess the severity of these injuries after such an accident.[5,23,24] More and more accidents involving mobility scooters occur in our country and there are several specific reasons why these accidents may occur; the driver loses balance after contact with an obstacle or on an uneven surface and falls over, the driver makes a mistake when operating the mobility

scooter, or the mobility scooter is hit by another road user. [25] In 2010, 3% of all people who died in a traffic accident were driving a mobility scooter. In 2018, 44 mobility scooter users died after traffic accidents, which is more than 6% of all traffic accident victims. Also, approximately 1200 mobility scooter drivers ended up in hospital with an injury[26]. It was striking that in the study described in **chapter 4**, five MMS accident victims who died after a low-energy trauma were all older than 75 years and four out of these five had not suffered severe injuries (ISS < 16). This emphasises that age and related factors, such as the presence of chronic diseases and polypharmacy, influence the risk of death in victims of mobility scooter accidents [27-29]. Therefore, it is important to involve various medical disciplines (trauma surgeon, neurologist and geriatrician) during the early phase of in-hospital care and treatment of this group of patients, especially to prevent underestimation of injuries. Regarding injury prevention, multiple measures should be taken to reduce the number of serious and fatal accidents involving these vulnerable traffic participants. One might consider regulations to equip mobility scooters with steering angle protection and to improve the stability of the mobility scooter.[25] Also, in spatial planning one might consider widening narrow bike paths and rearranging tight curves or removing, flattening or marking kerbstones along cycle paths to prevent mobility scooters from falling over and the introduction of driving skills training for mobility scooter users.

In this thesis associations between blood alcohol concentrations, TBI patterns and patient outcome, and between patient and injury characteristics and HRQoL, fatigue and societal participation in polytrauma patients were also studied. In these two separate areas of research, traumatic brain injury (TBI) in particular constitutes a significant public health problem[30-32]. A considerable number of patients with TBI is also diagnosed with alcohol intoxication[32]. The influence of different levels of blood alcohol concentrations (BAC) on the outcome of this patient population remains to be clarified. The study described in **chapter 6** examined this controversial issue of alcohol intoxication at the time of injury and its assumed protective effect on short-term outcome in TBI patients. The findings of this study are in line with some previous studies on this issue and suggest that in trauma patients with TBI, higher blood alcohol concentrations are associated with less severe TBI, fewer ICU admissions and a higher survival rate[33-38]. However, other studies did not find these effects of alcohol intoxication. Some even found an increased effect on in-hospital mortality for patients with TBI after correction for confounding variables such as cause of TBI and injury severity[38,39]. Unfortunately, all of these studies are not completely comparable with our study because of heterogeneous outcomes, the retrospective nature of our study and our failure to distinguish between acute alcohol intoxication and chronic alcohol consumption[40]. Obviously, the exact pathophysiological mechanism by which alcohol may or may not enhance survival is not yet fully under-

stood at this time and further clinical studies and basic research is needed to provide insights into these mechanisms.

This thesis points out that road traffic accidents related to trauma contribute significantly to the global burden of disease. The trauma mechanisms and injury affect people of all ages, resulting in considerable numbers of life years lost due to premature death and large numbers of years lived with disability[41]. As a result of the introduction of an all-inclusive trauma system and centralization of trauma care in the Netherlands, an increasing number of trauma patients survive with long-term morbidity and often face severe and prolonged deficits in health-related quality of life (HRQoL), fatigue and societal participation[42]. These aspects, therefore, have become increasingly important outcome measures to evaluate further enhancement of trauma care. The study in **chapter 7** showed that one to two years after the trauma, polytrauma patients still report reduced HRQoL, associated with more fatigue and reduced societal participation. Although persistent fatigue is a frequent complaint after TBI[43-45], determinants of fatigue in the general polytrauma population have not been described well previously. We found that scores for fatigue on all subscales on the multidimensional fatigue inventory (MFI-20) were equally high for polytrauma patients with severe injuries to the head, trunk or extremities. Also, patients with pre-existing comorbidities and female patients experienced more restrictions in social participation compared with other polytrauma patients. However, because more than half of the patients in our study did not report any reduced HRQoL, it seems that many polytrauma patients in contrast to other studies[46-50] recover fully from their injuries. Nevertheless, trauma rehabilitation strategies should focus on early recognition of reduced HRQoL, fatigue and societal participation and facilitate early intervention to improve these outcomes.

Final Consideration

All road users should reach their destination safely. After decades of declining figures, the number of road traffic accident (RTA) fatalities is stagnating in the Netherlands, whilst the number of road traffic-related injuries has been increasing for years. But traffic is changing. Especially in the cities, it is getting busier and busier on both the roads and bicycle paths. Also, there are new (quieter) vehicles, such as electric bicycles and cars. Also, people increasingly participate in traffic at an older age. Thus, changing circumstances call for new measures. The introduction and implementation of new road traffic accident prevention measures as well as improving existing governmental protective and preventive measures, such as further prevention of head trauma, traffic education, alcohol education, improved infrastructure, improved vehicle safety standards and better enforcement of traffic rules, are essential to promote traffic safety in

the Netherlands. Ultimately, the aim is to decrease the number of RTA fatalities in all road user groups.

If pre-hospital and hospital care providers are aware of the specific crash and patient characteristics, this will improve the vigilance for specific types of injury after RTA's, stimulate the development of focused diagnostic strategies in the early phases of trauma care and, consequently, help to achieve better outcomes for these specific trauma patients.

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