Trauma Care in Germany: A European Perspective

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By the year 2020, the incidence of trauma has been predicted to rise worldwide and the death rate is expected to increase from 5.1 million to 8.4 million.[11] The most important cause of death and severe morbidity up to the age of 45 years is traumatic brain injury (TBI), with or without polytrauma, which carries an equal burden to patients as cerebrovascular and depressive illness disorders.[13] Thus, TBI is and will remain both a major individual as well as a vast public health problem in the Western world and globally. In the United States, the incidence of closed head injuries admitted to hospitals is estimated to be 200 per 100,000. This rate yields an approximate number of 500,000 new cases each year, a sizeable proportion of which demonstrate significant long-term disabilities. In a meta-analysis from Tagliaferri et al.[15] regarding head injury in Europe, TBI had an incidence rate of approximately 235 per 100,000 and a mortality rate of 15 per 100,000. However, epidemiology as well as acute treatment modalities of TBI show a wide heterogeneity across European countries.[12] For instance, the frequency of secondary transfer to a hospital with a neurointensive care unit ranged from 35 to 75%, the frequency of use of ventilation varied from 53 to 88%, and intracranial operation frequency within 24 hours stretched from 18 to 53%.[12] In Germany, reliable numbers on TBI were not available until recently, when two national studies (the Hannover-Munster study[16] and the Bavarian study[17]) presented prospectively obtained data on both the epidemiology and the practices in acute treatment.[1,2,16,17]

TBI IN GERMANY: EPIDEMIOLOGICAL NUMBERS

The current population of Germany is 82 million. Whereas, in the Hannover-Munster study all grades of TBI (n = 6783) were analyzed within a population of 2.1 million, the Bavarian study focused on severe TBI only (n = 524), covering a catchment area of 5.6 million residents.[1,2,16,17] The incidence of all TBI severity grades was 332/100,000/year, and the incidence of severe TBI was as high as 17/100,000/year and 13/100,000/year, respectively (*Table 33.1*).[2,16,17] These differences in incidence can be explained by specific distinctions in the investigated areas (e.g., urban region in the Hannover-Munster study versus rural region in the Bavarian study). When one extrapolates these numbers, Germany faces 272,240 new TBI cases/year admitted to hospitals, most of them are minor-grade TBI (n = 247,640), but severe TBI would occur in 13,940 or 10,660 individuals, respectively (*Table 33.1*). Overall, approximately 200,000 patients per year are treated acutely on an inpatient basis, generating costs as high as approximately 300 million Euros per year (Hannover-Munster study, personal communication).

TRAFFIC-RELATED INJURIES

Since the early 1970s, traffic-related deaths in Germany have dropped continuously—with the exception of the early 1990s because of the German reunification—from approximately 20,000 to approximately 5300 in 2005, despite an enormously increased traffic volume. Compared with 2004, the death rate declined by 8.2% in 2005.[14] Undoubtedly, this success results mainly from powerful prevention strategies, such as airbags, seat belts, helmets, etc. In 2006, national economic costs for traffic-related injuries were reduced to 32 billion Euros, and expenses for material damages (15.7 billion Euros) surpassed those of personal damages (15.2 billion Euros) for the first time in German history.[3] Despite how promising these data are, it should not be overlooked that specific injury mechanisms, contrary to the general positive trend, are escalating. For example, cyclists without helmets account for 8% of all TBI causes in Germany, a rather high number compared with the 12% associated with car crashes.[16] Compared with restrained car occupants, the odds ratio for having a severe TBI for unhelmeted cyclists is as high as 3.9.[5] Thus, prevention programs aiming at improving the head protection in cyclists are needed urgently as well as legislation initiatives. As the Bavarian study demonstrated, traffic-related injuries were the cause for severe TBI in 48.7% of cases, which is close to the rate caused by falls (42.8%). These data show that traffic is still responsible for a high number of severe lesions, predominantly to the brain, although the risk population has changed.

FROM INJURY SITE TO HOSPITAL: WHO, HOW, WHEREBY, AND HOW FAST

The treatment of patients with severe TBI, initially consisting of adequate preclinical resuscitation and manage-

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TABLE 33.1. Incidence and new cases/year of traumatic brain injury (TBI) in Germany as demonstrated by two population-based studies

		Hannover-Munster[a]	Bavaria[b]
Incidence	TBI (all grades)	332	—
	Minor TBI	302	—
	Moderate TBI	13	—
	Severe TBI	17	13
New cases/year	TBI (all grades)	272,240	—
	Minor TBI	247,640	—
	Moderate TBI	10,660	—
	Severe TBI	13,940	10,660

[a]Inclusion criteria: S02, S04; S06, S07, S09 (International Classification of Diseases 10) in combination with dizziness or vomiting, retrograde or anterograde amnesia, impaired consciousness, cranial fracture, and/or focal neurological impairment. *From,* von Wild KR, Wenzlaff P: Quality management in traumatic brain injury (TBI) lessons from the prospective study in 6.800 patients after acute TBI in respect of neurorehabilitation. **Acta Neurochir Suppl** 93:15–25, 2005 (16).

[b]Inclusion criteria: Glasgow Coma Score ≤ 8. —, data not available. *From,* Wirth A, Baethmann A, Schlesinger-Raab A, Assal J, Aydemir S, Bayeff-Filloff M, Beck J, Belg A, Boscher A, Chapuis D, Dietz HG, Doffinger J, Eisenmenger W, Gerstner W, Gobel WE, Grosse P, Grumme T, Gutermuth L, Holzel D, Hopner F, Huf R, Jaksche H, Jensen U, Kettemann M, Ketterl R, Kirmayer U, Kolodziejcyk D, Kostler W, Kuznik J, Lackner C, Lenz G, Lochbihler H, Lumenta C, Martin S, Preisz A, Proksch G, Regel G, Reischl H, Reulen HJ, Rothmeier F, Sackerer D, Schneck S, Schweiberer L, Sommer F, Steiger HJ, Stolpe E, Stummer W, Tanner P, Trappe A, Twickel J, Ueblacker P, Wambach W, Wengert P, Zimmerer S: Prospective documentation and analysis of the pre- and early clinical management in severe head injury in southern Bavaria at a population based level. **Acta Neurochir Suppl** 89:119–123, 2004 (17).

ment, encompasses a comprehensive package of measures. Their effective administration requires great competence and skill as well as a high level of organization and logistics among emergency physicians and preclinical rescue personnel. In particular, endotracheal intubation, usually regarded as necessary to counteract hypoxia, has been challenged by Davis et al.,[4] who report a low intubation rate of only 20%, but a worse outcome in those who were intubated on the scene, a fact that might be caused by a lack of training and experience in Emergency Medical System personal in the United States. On the contrary, a TBI study from Slovenia demonstrated a decrease in the number of deaths on hospital admission, a reduction in hospital mortality, an improvement in functional neurological outcome, and shortened hospitalization time after starting a trauma system with emergency physicians and early intubation.[7] The Bavarian study provides the first data describing the efficacy and quality of German emergency squads in severe TBI. In 98.1% of cases, an emergency physician was present on the scene, had reached the injury site after a mean of only 12.5 (±7.6) minutes and had performed rapid sequence intubation in 62% of all patients. The transfer to the first hospital was performed by ground transportation in 63% of cases and by aeromedical service in 32% of cases. In 75% of patients, preclinical rescue (e.g., intubation, lines, etc.) was finished within 49 minutes, the first hospital was reached within 75 minutes, and neurosurgical surgery or intensive care unit treatment started within 200 minutes after trauma (personal communication). In contrast to the situation in the United States, early intubation was not an independent predictor of a worse outcome, substantiating the quality of the professional performance in emergency staff in Germany.[4] This finding is also underlined by the fact that polytrauma (present in one-third of cases) was managed properly and, thus, not a risk factor for worse prognosis, as was advanced age, abnormal pupillary response, lesion severity (computed tomographic scan), and a low Glasgow Coma Score on the scene (personal communication).

OUTCOME FROM SEVERE TBI OR DID THE MORTALITY RATE REALLY IMPROVE WITHIN THE LAST DECADES?

Recent international pharmaceutical trials on severe TBI claimed that mortality has been reduced markedly from 52% in the 1960s to approximately 22 to 25% (6, 8–10). In the course of these trials, it became obvious that the outcome findings published in the past are very often influenced by the purpose of a given study and, consequently, the inclusion and exclusion criteria are adjusted to the specific objectives of a given trial. With such a procedure, a major number of patients may be eliminated and ignored, often those who are dead on arrival or who die within 24 hours after TBI. Moreover, in most studies, no figures on patients dying at the scene are available. The Bavarian study followed not only the treated 524 patients but also those 291 patients who were dead on the scene. From those 291 patients, 221 underwent postmortem examination, confirming severe TBI in 214 cases as the primary cause of death. Thus, severe TBI is, in 96.8%, the major cause of death in patients dying at the scene, and it has become clear that the overall mortality associated with severe

TABLE 33.2. Glasgow outcome scale 12 months after severe traumatic brain injury (TBI) in Germany based on an incidence of 13/100,000/year (10,660)[a]

Glasgow Outcome Scale	%	New cases/year
Good recovery	15.4	1641
Moderate disability	8.3	885
Severe disability	7.9	842
Vegetative state	1.3	139
Dead	67.1	7153[b]

[a]*From,* Wirth A, Baethmann A, Schlesinger-Raab A, Assal J, Aydemir S, Bayeff-Filloff M, Beck J, Belg A, Boscher A, Chapuis D, Dietz HG, Doffinger J, Eisenmenger W, Gerstner W, Gobel WE, Grosse P, Grumme T, Gutermuth L, Holzel D, Hopner F, Huf R, Jaksche H, Jensen U, Kettemann M, Ketterl R, Kirmayer U, Kolodziejcyk D, Kostler W, Kuznik J, Lackner C, Lenz G, Lochbihler H, Lumenta C, Martin S, Preisz A, Prokscha G, Regel G, Reischl H, Reulen HJ, Rothmeier F, Sackerer D, Schneck S, Schweiberer L, Sommer F, Steiger HJ, Stolpe E, Stummer W, Tanner P, Trappe A, Twickel J, Ueblacker P, Wambach W, Wengert P, Zimmerer S: Prospective documentation and analysis of the pre- and early clinical management in severe head injury in southern Bavaria at a population based level. **Acta Neurochir Suppl** 89:119–123, 2004 (17).

[b]36.1% dead on the scene.

TBI is still as high as 67.1%, with 36.1% dying before arrival of the emergency staff (*Table 33.2*).[17] By dichotomizing the 12-month Glasgow Outcome Scale scores (good recovery, moderate disability versus severe disability, vegetative state, dead), the chance for a good outcome was only as low as 23.7% (*Table 33.2*). These frustrating numbers raise questions not only regarding improvement potentials of prevention but also regarding the real impact of optimized treatment and increasing use of expensive advanced neuromonitoring techniques. Here, a better understanding and, clearly, well-designed prospective clinical trials are necessary.

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