Age, injury severity and multi organ failure in elderly severe trauma patients - What influences mortality most and who is at risk? - An analysis of 34,469 severe trauma patients aged between 65 and 99 years

Tim Niklas Bewersdorf, Rolf Lefering, Stephan Rainer Stein, Sebastian Findeisen, Christian Schamberger, Gerhard Schmidmaier, Tobias Grossner

INTRODUCTION:

The number of elderly severely injured trauma patients has increased disproportionately in recent years. The high prevalence of comorbidities, organ dysfunctions and increased frailty is challenging trauma surgeons and shows the importance of specialized treatment protocols of this cohort. Elderly trauma patients stay longer at intensive care units (ICU), have an increased mortality and age is a well-known risk factor for organ failure (OF) and multi organ failure (MOF). However, exact risk and correlation analyses of age, OF, MOF, injury severity, and mortality rates were not performed with a big study population in the past. Therefore, we performed this retrospective register-based study, in which 34,469 severe trauma patients aged between 65-99 years were included, to analyze the effects of age, injury severity and OF/MOF on mortality.

METHODS:

For this study we used the German TraumaRegister DGU® database (project-ID: TR-DGU 2024-044) during the period of 2014 to 2023, in which 340,831 severely injured trauma patients were documented. Only severe trauma patients (injury severity score (ISS) >15) aged between 65 and 99 years, primarily admitted to the trauma center and treated on ICU were included. Injury severity was assessed by ISS and maximum abbreviated injury scale (MAIS). OF was defined as sequential organ failure assessment (SOFA) score of 3 or 4 points. MOF was defined as OF of at least 2 organs for ≥48 hours. Mortality was defined as inpatient mortality within 30 days after trauma. To answer the question of the impact of age, injury severity and OF/MOF on mortality, we performed a multivariate logistic regression of different ages grouped in 5-year-intervals, MAIS, ASA score, severe head injury, blood transfusion within 24 hours after admission, sepsis and specific OF and MOF. For further statistical analysis, data were examined using the Chi-squared-test and Spearman correlation. Statistical significance was set to $p \leq 0.05$. Evaluation and interpretation have not yet undergone the final review process of the TraumaRegister DGU®.

RESULTS:

OF and MOF were associated with higher injury severity (mean ISS: Non-OF: 15.5; OF: 25.7; MOF: 27.7) with a correlation of ISS with number of OFs ($\rho=0.44$, $p<0.001$). In general, elderly patients suffered more often from OF (37.0%) and MOF (21.0%) after severe trauma than patients aged between 18 and 64 years (OF: 22.7%, MOF: 12.8%, $p<0.001$). With rising numbers of OFs, mortality rose significantly (mean mortality: non-OF: 7.4%, OF: 45.3%, MOF: 59.0%; $p<0.001$). Distinct OFs showed significant differences in mortality ($p<0.001$), as lowest mortality was found in hemostasis (49.6%), followed by lung (51.6%), cardiovascular (52.6%) and renal OF (59.8%). Highest mortality rates showed cerebral (65.2%) and liver OF (77.3%). Age-specific risk rates of every individual OF revealed an increasing risk until risk rates peak between the age of 70 (liver OF) and 85 (cerebral OF) (**Figure 1**). Odds ratios (OR) of the multivariate logistic regression showed an increasing risk of death by all parameters, except sepsis and MOF (**Table 1**).

DISCUSSION AND CONCLUSION:

A possible reason for increasing OF with increasing age is the higher incidence of chronic organ dysfunctions in older patients. Like OF incidence, ISS rose in this study with an increasing age between 65 and 84 years, followed by an ISS decrease in patients aged 85 or older, which can partly explain the bell-shaped patterns of OF, as ISS is a relevant risk factor for OF. Another factor could be a shorter survival time after trauma in elderly patients and therefore these patients died before OF could be diagnosed.

But what influences mortality most and which patients are at risk? The performed multivariate logistic regression showed a detailed analysis about the influence of OF/MOF, age and injury severity on mortality. Due to good therapeutic options of OF of the cardiovascular system (catecholamines), lung (respirator, extracorporeal membrane oxygenation), hemostasis (blood product transfusion) and kidney (hemodialysis), OR and mortality of these OFs were lower than in patients suffering from cerebral or liver failure, in which limited therapeutic options exist. Our results revealed higher mortality risk in MOF patients than in patients suffering from a single OF, but mortality risk cannot simply be summed up, as OR of MOF is <1.

While only life-threatening injuries (MAIS 5-6) are accompanied with at least 5-times higher mortality risks, any MOF, liver, cerebral, kidney and cardiovascular OF showed ORs between 2.2 and 4.6. Comparing ORs of MAIS, OFs and age cohorts with each other points out the high impact of age on mortality, as patients older than 75 years showed at least a

2.3-12.7-times increased risk of death. Only MAIS 6 injuries have a higher OR (49.741) for mortality, than the age cohorts 85-89 (6.314), 90-94 (9.849) and 95-99 years (12.755), which reflects the limited capabilities to sustain higher ISS, OF and longer stays on ICU with increasing age. Besides MAIS 5-6 injuries and high ages, liver failure (5.815), cerebral failure (5.081) and an age of 80-84 (3.723) are the most important mortality risk factors.
As age is a non-treatable status and independent of trauma severity, clinicians should be aware that severely injured trauma patients older than 75 are as vulnerable as elderly patients suffering from OF and therefore admission to ICU should be executed liberally and screening for early signs of OF should be performed frequently.

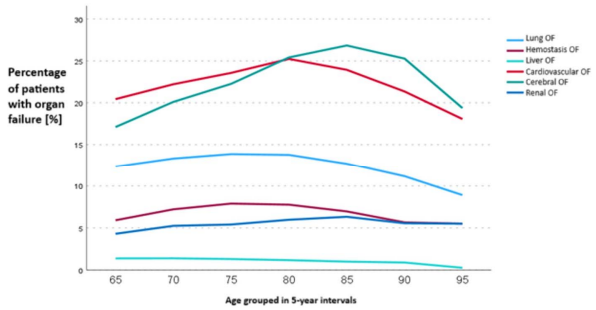

Figure 1: Incidence of a specific organ failure divided by age after severe trauma.

	Odds ratio	Significance [p]	95 % confidence interval
MAIS 3	1.720	<0.001	1.501 – 1.971
MAIS 4	1.471	<0.001	1.255 – 1.725
MAIS 5	5.154	<0.001	4.409 – 6.024
MAIS 6	49.741	<0.001	31.320 – 78.995
Hemostatic failure	1.297	<0.001	1.142 – 1.472
Lung failure	1.333	<0.001	1.192 – 1.491
Cardiovascular failure	2.481	<0.001	2.230 – 2.761
Renal failure	3.122	<0.001	2.714 – 3.592
Cerebral failure	5.081	<0.001	4.637 – 5.568
Liver failure	5.815	<0.001	4.306 – 7.852
Multi organ failure	0.866	0.061	0.745 – 1.007
Age 70-74	1.481	<0.001	1.294 – 1.696
Age 75-79	2.263	<0.001	1.995 – 2.566
Age 80-84	3.723	<0.001	3.293 – 4.210
Age 85-89	6.314	<0.001	5.534 – 7.203
Age 90-94	9.849	<0.001	8.398 – 11.549
Age 95-99	12.755	<0.001	9.710 – 16.754
ASA 3/4	1.629	<0.001	1.519 – 1.747
Sepsis	0.818	0.002	0.720 – 0.930
Blood transfusion within 24 hours after admission	1.261	<0.001	1.123 – 1.417
MAIS head ≥3	2.827	<0.001	2.548 – 3.136

Table 1: Multivariate logistic regression of injury severity according to MAIS, organ failure and multi organ failure, different ages grouped in 5-year-intervals, ASA, severe head injury, blood transfusion and sepsis after severe trauma.