Acute Kidney Injury (AKI) in Elderly Severely Injured Trauma Patients – AKI Correlates with Prolonged Stay at Intensive Care Unit (ICU) and Multi Organ Failure (MOF)

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INTRODUCTION:

Acute kidney injury (AKI) is a severe complication in elderly severely injured trauma patients resulting in high morbidity and mortality rates. Trauma related factors like direct renal trauma, hemorrhage, hypoperfusion, acid-base and electrolyte imbalances, as well as rhabdomyolysis and systemic inflammation can cause serious damage to the kidneys and can result in AKI or renal failure. Age-related factors like physiological nephron-loss, reduced renal perfusion and reduced glomerular filtration make elderly patients more vulnerable for AKI. Furthermore, CT-contrast agents and high prevalence of nephrotoxic medications in elderly patients increase AKI risk after trauma.

To determine AKI risk after severe trauma in the specific group of vulnerable elderly patients we conducted this study and analyzed effects of AKI on several outcome parameters like, length of stay at Intensive Care Unit (ICU), other organ failure (OF), multi organ failure (MOF) and mortality to improve patient care.

METHODS:

In this monocentric, retrospective study we analyzed data from severely injured trauma patients ((Injury Severity Scores (ISS) >15) or need of ICU-treatment for ≥24h), who were admitted to a German level-I-trauma center during the period of 2021 to 2024. Out of 2,636 trauma patients, 209 patients aged ≥70 years were included in this study. AKI was defined based on KDIGO (Kidney Disease Improving Global Outcome) criteria and were divided into 3 stages. 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 or longer. Mortality was defined as inpatient mortality within 30 days after trauma. Among AKI stage, OF, MOF, age, sex, ISS, hospital and ICU stay, and mortality were considered for this study. Subgroup analyses were performed for non-AKI, AKI I°, II° and III° patients. For statistical analysis, data were examined using the Mann-Whitney-U-Test and Spearman correlation. Statistical significance was set to $p \leq 0.05$.

RESULTS:

Out of 209 patients 69 patients suffered from an AKI (33.0 %), with significantly higher percentage of males ($p=0.019$) (**Table 1**). Although the mean ISS ($p=0.910$) and mean age ($p=0.863$) did not differ significantly, ICU duration was significantly longer in patients with AKI (12.39 days (d)) than in patients without AKI (4.45 d, $p<0.001$). Detailed analysis of AKI subgroups revealed longer stay on ICU (AKI I° vs. III°: $p=0.015$) with a more serious AKI stage (**Figure 1**). Performed Spearman correlation showed significant correlations of AKI stage with ICU-duration ($\rho=0.425$, $p<0.001$) and MOF ($\rho=0.214$, $p=0.002$). Although patients with AKI had a significantly higher prevalence of developing MOF ($p=0.006$), we detected no significant differences in mortality between AKI and non-AKI patients ($p=0.224$) due to high mortality rates in non-AKI OF patients. While AKI patients had a mortality of 24.64 %, we detected a higher mortality in patients suffering from non-renal OF (76.27 %). Nevertheless, mortality in AKI patients was significantly higher than in patients without AKI and any OF ($p<0.001$). The serum creatinine concentration at time of admission in AKI patients was significantly higher than in patients without AKI ($p=0.011$).

DISCUSSION AND CONCLUSION:

The study found a high AKI incidence in elderly severe injured trauma patients with no differences in mean age between AKI and non-AKI patients. While mean ISS in AKI and non-AKI patients were comparable, we detected higher mean ISS in patients suffering from a more serious stage of AKI, as higher ISS is associated with well-known AKI-risk factors, like elevated incidences of hemorrhage, rhabdomyolysis, renal hypoperfusion and overshooting systemic inflammation. Moreover, higher serum creatinine levels at time of admission are linked to a higher risk of AKI development, as higher serum creatinine indicates patients with chronic renal insufficiency.

Our study revealed a significantly higher mortality in patients suffering from AKI in comparison to non-AKI patients without OF, but no significant differences in comparison to all non-AKI patients. This can be explained by high number of deaths within 24 hours after trauma in non-AKI OF patients and therefore these patients died before a relevant creatinine increase was detectable.

It is remarkable that even patients suffering from AKI I° or II° stayed significantly longer at ICU than patients without AKI ($p<0.001$). This and the significant correlation of AKI stage and ICU-duration reflect the high impact of any AKI on duration of stay at ICU. Moreover, this study highlights that AKI is a relevant risk factor for MOF, which is a consequence of the essential role of renal function in the human body. Therefore, monitoring renal function can help to identify elderly patients at risk of MOF after severe trauma.

As this study showed prolonged ICU stay, high mortality and MOF rates in all AKI stages, nephroprotective therapies and avoidance of nephrotoxic agents are essential in elderly severely injured trauma patients to prevent AKI and consequently to reduce ICU duration, mortality and health care costs. Moreover, clinicians should consider intensive monitoring and screening for other organ dysfunctions in patients suffering from any AKI stage to prevent further complications like MOF. Our findings support the development of age-specific protocols in polytrauma care and underline the need for further research to lower AKI-related mortality in this high-risk group.

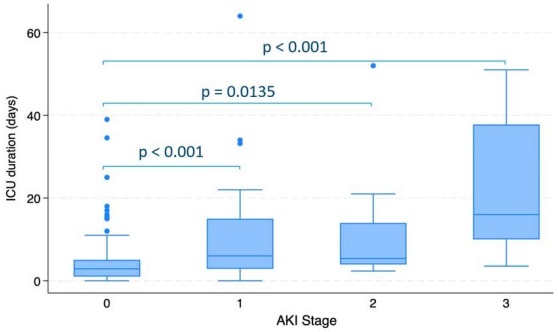

Figure 1: Mean ICU duration of patients suffering from different AKI stages. Boxes: interquartile range, whiskers: 1.5x interquartile range, horizontal line: median, x: mean, dot: outliers. Significances are indicated by stars; bars under the stars indicate the compared group of each significance.

		Gender	Mean age	ISS	ICU duration	Mortality	MOF
AKI	Total AKI (n=69)	45 males (65,2%), 24 females (34,8%) (p=0.018*)	81,08 (p=0.863)	20,09 (p=0.910)	12,39d (p<0.001***)	24,64% (p=0.224)	11 (15.94%) (p=0.006***)
	AKI I° (n=44)	31 males (70,5%), 13 females (29,5%)	82,05	18,05	10,59d (p<0,001***)	20,45%	6 (13.64 %)
	AKI II° (n=16)	9 males (56,2%), 7 females (43,8%)	80,31	20,38	10,82d (p<0,001***)	31,25%	2 (12.5%)
	AKI III° (n=9)	5 males (55,6%), 4 females (44,4%)	77,78	29,56	23,96d (p<0,001***)	33,33%	3 (33,33%)
Non-AKI	Total Non-AKI (n=140)	67 males (47,9%), 73 females (52,1%)	81,34	19,26	4,45d	32,86%	9 (6.42%)
	Without organ failure (n=81)	34 males (42,0%), 47 females (58,0%)	80,38	16,20	4,84d	1,23%	0
	With organ failure (n=59)	33 males (55,9%), 26 females (44,1%)	82,64	23,46	3,91d	76,27%	9 (15.25%)

Table 1: Specifications of elderly severely injured trauma patients with and without AKI. Patients with AKI were divided in subgroups AKI I°, II° and III°.