Zeitschrift für
Gerontologie+Geriatrie

Themenschwerpunkt

Z Gerontol Geriat 2021 · 54:125–129
https://doi.org/10.1007/s00391-021-01844-4
Received: 13 November 2020
Accepted: 5 January 2021
Published online: 28 January 2021



**Abdullah Alshibani**[1,2] · **Boris Singler**[3,4] · **Simon Conroy**[1]

[1] Department of Health Sciences, College of Life Sciences, University of Leicester, Leicester, UK

[2] Emergency Medical Services Department, College of Applied Medical Sciences, King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia

[3] Zweckverband für Rettungsdienst und Feuerwehralarmierung, Nürnberg, Germany

[4] Klinik Hallerwiese/Cnopfsche Kinderklinik, Nürnberg, Germany

# Towards improving prehospital triage for older trauma patients

## Introduction

Major trauma has historically been conceived as a disease condition of younger populations, resulting from high-energy mechanisms of injury [19] and this thinking is reflected in education and training approaches [5]; however, the proportion of patients with major trauma aged ≥65 years has progressively increased in the last years [7]. In the United Kingdom (UK), the median age of trauma patients increased from 36.1 years in 1990 to 53.8 years in 2013 [19]. Therefore, more age-attuned prehospital triage is needed.

## Scope of the problem

Trauma triage tools are developed to assess the severity of a single event (i.e. injury) and determine transportation decisions [38]. This is not the case for older people who are at greater risk of 'silver trauma', which is major trauma consequent upon relatively minor injury mechanisms. Older trauma patients are significantly undertriaged in the prehospital care [3, 6, 9, 22, 26–28, 33, 39]. This might be due to the process of aging, comorbidities, and medication use which could affect the accuracy of prehospital triage [27]. This paper aimed to describe the evidence around these factors, their impact on the accuracy of prehospital triage, and the efforts in recent research to develop more accurate triage criteria.

## Age-related anatomical and physiological changes

Older adults undergo several anatomical and physiological changes with age. These changes in different body systems could affect their response to injury, which may result in inappropriate assessment of injury severity.

For the cardiovascular system, the heart is subjected to structural changes, such as hypertrophy and sigmoid septum of the left ventricle [10], and also physiological changes, such as reduced diastolic filling of the left ventricle [37] and prolonged contraction period [21]. Blood vessels also undergo structural changes including increased length of large vessels, enlarged lumen, and increased walls thickness [45]. This could impact their compliance and distensibility, which is the main functional change of blood vessels with age [43]. The aorta, for example, has decreased distensibility with age [43]. Such changes were shown to result in lower chance of older adults to present with low blood pressure (hypotension) or increased heart rate (tachycardia), the principal signs of shock [12].

Older adults are also at greater risk of impaired respiratory responses. They have significantly decreased response to hypoxia and hypercarbia [20], decreased pulmonary reserve [13], and decreased ability to effectively clear secretions and fluids from the lungs [13]. Therefore, older adults with chest trauma are at great risk of adverse events including pneumonia, respiratory failure, and death [24].

With respect to the nervous system, brain atrophy was shown to increase with age and accelerate after the age of 60 years [15] allowing more space between the brain and skull, which could accumulate a high volume of blood without presenting any sign of increased intracranial pressure [36]. This, as a result, could delay the diagnosis of intracranial bleeding among older people [36]. The structure and function of the blood vessels are also impaired with ageing including arterial stiffness and endothelial cells dysfunction [46]. These cerebrovascular changes could increase the vulnerability of intracranial hemorrhage for this population after injury.

Ageing is associated with progressive loss of skeletal muscle mass and strength (sarcopenia), which could negatively impact mobility and balance [16] and increase the risk of severe injury from falls [40]. Osteoporosis increases the risk of fractures [17] from even low energy mechanisms (i.e. low-level falls) in older people [11].

## Comorbidities

Comorbidities can significantly change the physiological responses to trauma for older people. High blood pressure (hypertension) is a common comorbidity for older people and is a significant risk factor of cardiovascular and cerebrovascular diseases [23]. Its presence could impair the response to shock after trauma for this population. Older adults are at great risk of developing chronic obstructive pulmonary disease [8], which could

**Table 1** Prehospital physiological responses of older people post-injury

| Physiological variables | Findings |
|---|---|
| Systolic blood pressure (SBP) | Patients aged ≥ 55 years were less likely to present with shock than younger adults (i.e. SBP < 90mmHg) (SBP mean [SD] 144 mmHg [± 33 mmHg] vs. 131 mmHg [± 29 mmHg]) [9].<br>Patients aged > 55 years were less likely to have SBP < 90mmHg after major trauma than younger adults (234/3054, 7.7% vs. 565/4407, 12.8%, $p = 0.001$) [6]. |
| | There were decreasing rates of trauma patients presenting with hypotension (SBP < 90 mmHg) with age [22]. |
| Heart rate (HR) | Patients aged ≥ 55 years were less likely to have tachycardia than younger adults (HR mean [SD], 82.7 [± 20] beats per min vs. 91.7 [± 25] beats per min).<br>Patients aged > 55 years were less likely to have HR > 124 beats per min after major trauma than younger adults (163/3054, 5.3% vs. 609/4407, 13.8%, $p = 0.001$) [6]. |
| | There were decreasing rates of trauma patients presenting with tachycardia (HR > 100 beats per min) with age [22]. |
| Respiratory rate (RR) | Patients aged > 55 years with major trauma were less likely to have abnormal RR, i.e. < 12 per min or > 24 per min than younger adults (395/3054, 12.9% vs. 904/4407, 20.5%, $p = 0.001$) [6]. |
| Glasgow coma scale (GCS) | Patients aged ≥ 55 years, compared to younger adults, had higher GCS (GCS mean [SD], 14.2 [± 2.4] vs. 13.6 [± 3.5]) [9]. |
| | Patients aged > 55 years with major trauma were less likely to have GCS < 13 than younger adults (574/3054, 18.8% vs. 1125/4407, 25.5%, $p = 0.001$) [6]. |
| | These findings are consistent with the findings of other studies which showed higher GCS among patients aged ≥ 65 years with trauma brain injury compared to younger adults [18, 34]. |

*SBP* systolic blood pressure, *SD* standard deviation

adversely affect the response to hypoxia and hypercarbia after trauma. Chronic kidney disease is another common comorbidity among older people and could lead to decreased renal function and increased risk of adverse drug reactions (ADRs) [25].

## Medication use

The use of medications is more common in older people than younger populations, particularly for those with comorbidities. Older people more commonly use anticoagulants, which could significantly increase their risk of intracranial hemorrhage following head trauma [2]. As hypertension is also common in this population, they are also more likely to take antihypertensive drugs to control their blood pressure. Antihypertensive drugs were shown to increase the risk of serious fall injuries in older people [41]. Such important medications and others that are commonly used in this population could impact their response to injury and lead to inappropriate assessment of injury severity.

Apart from the medications themselves, the term 'polypharmacy', which is defined as using multiple medications and/or administering additional medications that are not clinically indicated which represents unnecessary medication use, is common among older people [14]. This issue continues to increase in this population and is a well-known risk factor for death and disability [14]. Polypharmacy is significantly associated with the incidence of ADRs in older people which adds a greater risk of poor outcomes [1]. Other issues with medication use for older people include disparity between the labeled dosage and the dosage actually used, drug interactions, and underuse of medications [31]. All these issues should be considered when assessing and managing older trauma patients.

## Impact on the accuracy of prehospital triage

Anatomical and physiological changes with age, comorbidities, and medication use were shown to affect physiological responses in prehospital care (**Table 1**). They also could affect mechanisms of injury, all of which may result in less accurate prehospital triage decisions. Even when older trauma patients met the physiological criteria, they had low chance of being transported to a trauma center (TC); 24% of hypotensive patients (systolic blood pressure [SBP] < 90 mm Hg), 23% of those with abnormal respiratory rate (RR) <10 per min or > 29 per min, and 26% of those with a Glasgow coma scale (GCS) < 13 were transported to a TC [26].

These factors were also found to affect the mechanism of injury (i.e. increase the risk of low-level falls) which is now the most common mechanism of injury in the UK (falls < 2m) [42]. The assessment of triage patterns for injured adults showed increasing rates of patients who had falls with age (from 12% of patients aged 16–25 years to 77% of patients aged > 65 years, $p < 0.05$) and decreasing rates of motor vehicle accidents (from 52% of patients aged 16–25 years to 16% of patients aged > 65 years, $p < 0.05$) [22]. Indeed, most injuries among patients aged ≥ 65 years occurred at home usually due to falls from standing height (62%) [3]. An earlier study showed that trauma triage tools failed to identify major trauma resulting from falls (94% undertriaged) [33]. Falls were related to 70% of the hospitalizations of these patients and 45% of those with major trauma had falls [33]. Most injured patients aged ≥ 55 years due to falls were transported to non-TC (63.4% vs. 33.9%, $p < 0.001$) [39].

## Adjusting prehospital trauma triage

Recent literature has investigated modifying and developing specific prehospital

Z Gerontol Geriat 2021 · 54:125–129 https://doi.org/10.1007/s00391-021-01844-4


A. Alshibani · B. Singler · S. Conroy

## Towards improving prehospital triage for older trauma patients

### Abstract

**Background.** The proportion of older adults with major trauma is increasing. High-quality care for this population requires accurate and effective prehospital trauma triage decisions.
**Objective.** Anatomical and physiological changes with age, comorbidities, and medication use for older adults may affect the accuracy of prehospital trauma triage.
**Material and methods.** This narrative review focusses on age-related anatomical and physiological changes, comorbidities, and medication use for older adults with an emphasis on their impact on the accuracy of prehospital trauma triage tools. It also addresses the efforts to develop alternative triage criteria to reduce undertriage.
**Results.** Age-related anatomical and physiological changes, comorbidities, and medication use were shown to affect physiological responses to injury and mechanism of injury for older people. Current triage tools poorly predicted injury severity. Geriatric-specific physiological measures and comorbidities significantly improved sensitivity with much lower specificity. Assessing anticoagulant or antiplatelet use in head injury notably improved sensitivity to identify traumatic intracranial hemorrhage, neurosurgery or death with modest decrease in specificity.
**Conclusion.** Improving prehospital providers' knowledge about the challenges of assessing older people with trauma may reduce undertriage. Assessing frailty could help in improving prehospital providers' judgments. Future research is needed to improve triage decisions for this population.

### Keywords

Injury · Geriatrics · Paramedics · Emergency · Preclinical

## Verbesserung der präklinischen Triage-Entscheidungen bei älteren Traumapatienten

### Zusammenfassung

**Hintergrund.** Der Anteil älterer Personen mit schweren traumatischen Verletzungen nimmt zu. Eine qualitativ hochwertige Versorgung dieser Population erfordert präzise und effektive präklinische Triage-Entscheidungen.
**Fragestellung/Zielsetzung.** Anatomische und physiologische Altersveränderungen, Komorbiditäten und die Medikation älterer Personen könnten die Genauigkeit präklinischer Triage-Entscheidungen im Fall schwerer Verletzungen beeinflussen.
**Material und Methoden.** Diese narrative Übersichtsarbeit fokussiert sich auf altersassoziierte anatomische und physiologische Veränderungen, Komorbiditäten und die Medikation älterer Menschen in Hinblick auf deren Einfluss auf die Genauigkeit präklinisch angewandter Triage-Instrumente bei Traumapatienten. Zudem wird über die Bemühungen berichtet, alternative Triage-Kriterien zu entwickeln, um die Unter-Triagierung der betroffenen Patienten zu reduzieren.
**Ergebnisse.** Altersassoziierte anatomische und physiologische Veränderungen, Komorbiditäten und die Einnahme von Medikamenten beeinflussen Traumamechanismen und die physiologischen Reaktionen auf stattgehabte Traumata bei alten Menschen. Aktuell angewandte Triage-Instrumente können bei diesen Personen die Schwere einer Verletzung nur schlecht prognostizieren. Der Einbezug geriatrischer Messparameter und Komorbiditäten verbesserten die Sensitivität signifikant bei deutlich verminderter Spezifität. Die Erhebung der Einnahme von Antikoagulanzien oder Thrombozyten-hemmenden Substanzen bei Kopfverletzungen verbesserte insbesondere die Sensitivität hinsichtlich der Identifizierung traumatisch bedingter intrakranieller Blutungen, der Notwendigkeit einer neurochirurgischen Intervention und Versterben bei nur moderater Minderung der Spezifität.
**Schlussfolgerung.** Eine Optimierung des Wissensstands in der prähospitalen Notfallversorgung hinsichtlich spezifischer Herausforderungen in der Beurteilung von älteren Traumapatienten kann eine Unter-Triagierung vermindern. Die Erhebung von Frailty könnte bei Entscheidungen in der prähospitalen Versorgung helfen. Allerdings wird weitere Forschung benötigt, um Triage-Entscheidungen für diese Patientengruppe zu verbessern.

### Schlüsselwörter

Verletzungen · Geriatrie · Rettungsdienst · Notfallmedizin · Prähospital

trauma triage criteria for older people. Applying the criterion SBP < 110 mmHg instead of SBP < 90 mmHg for patients aged > 65 years was shown to reduce the rate of undertriage by 4% and increase the rate of overtriage by 4% [4]. The risk of death for patients who had a SBP < 110 mmHg was similar to those with a SBP < 90 mmHg; highlighting the importance of applying this criterion for direct transport of these patients to TCs [4].

A recent study developed specific criteria for prehospital trauma triage of patients aged ≥ 55 years [28]. It showed that HR was not associated with major trauma (injury severity score, ISS > 15) in adjusted models ($p = 0.48$) and was excluded from further analysis [28]. In the revised triage tool, the study showed that GCS ≤ 14 was the most predictive variable of ISS > 15 [28]. Replacing the current criterion (GCS ≤ 13) with GCS ≤ 14 in the trauma triage tool could decrease the rate of undertriage (increased sensitivity from 78.6% to 84.1%) with similar increase in the rate of overtriage (decreased specificity from 75.5% to 68.4%) [28]. Adding RR < 10 per min or > 24 per min (including the need for assisted ventilation) was the second most predictive physiological measure as it improved sensitivity from 78.6% to 84.5% but had lower specificity from 75.5% to 66.9% [28]; however, the change of undertriage for respiratory status compared to GCS was small (sensitivity 84.5% and 84.1%, respectively); indicating that many patients with ab-

normal RR were already identified with abnormal GCS [28]. Shock index > 1.0 and SBP < 110 mmHg or > 200 mmHg improved sensitivity by a similar change (from 78.6% to 86.4% and 86.3%, respectively) with also similarly a much lower decrease in the specificity (from 75.5% to 60.4% and 60.7%, respectively); resulting in a lower predictive value than GCS and RR [28].

Adding the count of comorbidities was assessed in a trauma triage tool developed for patients aged ≥ 65 years [27]. The predictors were identified in order: any current criterion in the triage tool, GCS ≤ 14, abnormal geriatric specific physiological criteria (RR < 10 per min or > 24 per min, SBP < 110 mmHg or > 200 mmHg , and HR ≤ 60 or ≥ 110 beats per min), and comorbidity count ≥ 2 [27]. This triage tool had 90.3% sensitivity (95% confidence interval, CI 86.8–93.7%) and 17.0% specificity (95% CI 15.8–18.1%) to identify patients with ISS > 15 or require major nonorthopedic surgery compared to the current triage tool which had 36.6% sensitivity (95% CI 31.2–42.0%) and 90.1% specificity (95% CI 89.2–91.0%) [27]. Anticoagulant use was also assessed and found not to be a primary predictor [27]. Adding this criterion to the developed triage tool showed 94.1% sensitivity (95% CI 90.1–98.1%) and 14.0% specificity (95% CI 12.6–15.4%) [27]. When comorbidity count was replaced by medication use, the triage tool showed 78.9% sensitivity (95% CI 71.5–86.2%) and 40.8% specificity (95% CI 38.7–42.9%) [27].

Adding anticoagulant or antiplatelet use to current prehospital triage for patients aged ≥ 55 years with head injury was assessed [29]. Applying physiological, anatomical, and mechanism of injury criteria in the triage tool had poor sensitivity in identifying traumatic intracranial hemorrhage (26/131, 19.8%, 95% CI 5.5–51.2%) and inhospital death or neurosurgery (14/41, 34.1%, 95% CI 21.6–49.5%) [29]. Adding the criterion of anticoagulant or antiplatelet use in the triage tool improved its sensitivity to identify traumatic intracranial hemorrhage (78/131, 59.5%, 95% CI 51.0–67.6%) and death or neurosurgery (29/41, 70.7%, 95% CI 55.5–82.4%) with a modest decrease in specificity from 1843/1979 (93.1%, 95% CI 91.2–94.7%) to 1329/1979 (67.2%, 95% CI 61.1–72.7%) [29].

## Recommendations for practice and future research

This review is the first paper to discuss distinct factors with older people and how they could affect prehospital trauma triage; however, the review is narrative which may introduce a risk of bias and future systematic reviews assessing each factor are, therefore, needed when more studies are available.

The review has significant implications for practice and future research. Older adults were shown to have unique factors that could reduce their chance to meet current triage criteria. Therefore, prehospital providers should focus on improving their knowledge about the changes in anatomy and physiology with age, the impact of comorbidities and medication use on physiological responses and mechanism of injury in this population. This will aid prehospital providers to improve their judgments and triage decisions. A recent systematic review showed that prehospital provider judgment could decrease the rate of undertriage for trauma patients especially for those who did not meet the triage criteria [44].

The assessment of frailty could improve prehospital providers' judgments as it was shown to be an independent predictor of adverse outcomes for older trauma patients [32, 35]. Applying simple frailty assessment tools, such as the clinical frailty scale (CFS), which was determined to be feasible, reliable, and accurate to apply in emergency care [30], could be useful in prehospital care. The CFS was recently shown to independently predict 30-day mortality, inpatient delirium, and increased care level at discharge in trauma patients aged ≥ 65 years [35]; however, the compliance rate of prehospital providers to trauma triage tools varied from a rate of 21% to 93% [44], which may impact the role of frailty attuned scores in prehospital care.

In Germany, ambulance response might include doctors with paramedics or only paramedics. The paramedic profession is new in Germany as it was developed in 2014. Paramedics are only allowed to undertake responsibility if no doctor is available, if a special task is delegated or if the emergency call has not triggered the presence of a doctor especially in rural areas. Germany also has different levels of trauma centers where patients are transported to according to their physiological criteria and mechanism of injury with no assessment of frailty or anticoagulant use. Developing more accurate and standardized prehospital triage criteria for older trauma patients could improve both doctors' and paramedics' triage decisions for this population.

Future research is needed to assess: 1) the accuracy of several trauma triage tools from different countries, 2) the development and application of more accurate geriatric-specific trauma triage criteria and 3) the destination compliance for positively triaged older trauma patients.

## Conclusion

Age-related anatomical and physiological changes, comorbidities and medication use were shown to affect the physiological responses and mechanism of injury for older people. Current triage tools had poor sensitivity to detect severe trauma in older patients. Geriatric-specific physiological measures and comorbidity count significantly improved the sensitivity of prehospital triage with much lower specificity. Adding anticoagulant or antiplatelet use for patients with head injury notably improved the sensitivity for predicting traumatic intracranial hemorrhage, neurosurgery or death with a modest decrease in specificity. Prehospital providers' knowledge about the challenges when assessing these patients could improve their judgments. Assessing frailty using, for example, the CFS could improve prehospital providers' judgments. More research is needed to improve prehospital triage for this population.

## Corresponding address

**Abdullah Alshibani**
Department of Health Sciences, College of Life Sciences, University of Leicester
LE1 7HA Leicester, UK
anaa3@le.ac.uk


**Author contribution.** A. Alshibani developed the structure of the article and drafted the manuscript. B. Singler reviewed and edited the manuscript to fit with the German context. S. Conroy reviewed and edited the structure of the study, discussed the available literature around the main heading with A. Alshibani and B. Singler, monitored the progress of the article, and critically reviewed and edited the manuscript. All authors read and approved the final manuscript.

## Compliance with ethical guidelines

**Conflict of interest.** A. Alshibani, B. Singler and S. Conroy declare that they have no competing interests.

**Ethical standards.** This article does not contain any studies with human or animal subjects.

## References


1. Ahmed B, Nanji K, Mujeeb R et al (2014) Effects of polypharmacy on adverse drug reactions among geriatric outpatients at a tertiary care hospital in Karachi: a prospective cohort study. Plos One 9:e112133
2. Batchelor JS, Grayson A (2012) A meta-analysis to determine the effect of anticoagulation on mortality in patients with blunt head trauma. Br J Neurosurg 26:525–530
3. Brown E, Tohira H, Bailey P et al (2019) Older age is associated with a reduced likelihood of ambulance transport to a trauma centre after major trauma in Perth. Emerg Med Australas 31:763–771
4. Brown JB, Gestring ML, Forsythe RM et al (2015) Systolic blood pressure criteria in the national trauma triage protocol for geriatric trauma: 110 is the new 90. J Trauma Acute Care Surg 78:352–359
5. Collicott PE, Hughes I (1980) Training in advanced trauma life support. JAMA 243:1156–1159
6. Cox S, Morrison C, Cameron P et al (2014) Advancing age and trauma: triage destination compliance and mortality in Victoria, Australia. Injury 45:1312–1319
7. Dinh MM, Roncal S, Byrne CM et al (2013) Growing trend in older patients with severe injuries: mortality and mechanisms of injury between 1991 and 2010 at an inner city major trauma centre. ANZ J Surg 83:65–69
8. Divo MJ, Martinez CH, Mannino DM (2014) Ageing and the epidemiology of multimorbidity. Eur Respir J 44:1055–1068
9. Garwe T, Stewart K, Stoner J et al (2017) Out-of-hospital and inter-hospital under-triage to designated tertiary trauma centers among injured older adults: a 10-year statewide geospatial-adjusted analysis. Prehop Emerg Care 21:734–743
10. Gentille-Lorente D, Salvado-Usach T (2016) Sigmoid septum: A variant of the ventricular hypertrophy or of the hypertrophic cardiomyopathy? Arch Cardiol Mex 86:110–122
11. Greenspan SL, Myers ER, Maitland LA et al (1994) Fall severity and bone mineral density as risk factors for hip fracture in ambulatory elderly. JAMA 271:128–133
12. Gribbin B, Pickering TG, Sleight P et al (1971) Effect of age and high blood pressure on barorefiex sensitivity in man. Circ Res 29:424–431
13. Haas CF, Loik PS, Gay SE (2007) Airway clearance applications in the elderly and in patients with neurologic or neuromuscular compromise. Respir Care 52:1362–1381
14. Hajjar ER, Cafiero AC, Hanlon JT (2007) Polypharmacy in elderly patients. Am J Geriatr Pharmacother 5:345–351
15. Hedman AM, Van Haren NE, Schnack HG et al (2012) Human brain changes across the life span: a review of 56 longitudinal magnetic resonance imaging studies. Hum Brain Mapp 33:1987–2002
16. Janssen I, Heymsfield SB, Ross R (2002) Low relative skeletal muscle mass (sarcopenia) in older persons is associated with functional impairment and physical disability. J Am Geriatr Soc 50:889–896
17. Kannus P, Palvanen M, Niemi S et al (1996) Increasing number and incidence of osteoporotic fractures of the proximal humerus in elderly people. BMJ 313:1051–1052
18. Kehoe A, Smith J, Bouamra O et al (2016) Older patients with traumatic brain injury present with a higher GCS score than younger patients for a given severity of injury. Emerg Med J 33:381–385
19. Kehoe A, Smith J, Edwards A et al (2015) The changing face of major trauma in the UK. Emerg Med J 32:911–915
20. Kronenberg RS, Drage CW (1973) Attenuation of the ventilatory and heart rate responses to hypoxia and hypercapnia with aging in normal men. J Clin Invest 52:1812–1819
21. Lakatta E, Gerstenblith G, Angell CS et al (1975) Prolonged contraction duration in aged myocardium. J Clin Invest 55:61–68
22. Lehmann R, Beekley A, Casey L et al (2009) The impact of advanced age on trauma triage decisions and outcomes: a statewide analysis. Am J Surg 197:571–575
23. Lionakis N, Mendrinos D, Sanidas E et al (2012) Hypertension in the elderly. WJC 4:135–147
24. Lotfipour S, Kaku SK, Vaca FE et al (2009) Factors associated with complications in older adults with isolated blunt chest trauma. West J Emerg Med 10:79–84
25. Mallappallil M, Friedman EA, Delano BG et al (2014) Chronic kidney disease in the elderly: evaluation and management. Clin Pract 11:525–535
26. Meyers MH, Wei TL, Cyr JM et al (2019) The triage of older adults with physiologic markers of serious injury using a state-wide prehospital plan. Prehosp Disaster med 34:497–505
27. Newgard CD, Lin A, Eckstrom E et al (2019) Comorbidities, anticoagulants, and geriatric-specific physiology for the field triage of injured older adults. J Trauma Acute Care Surg 86:829–837
28. Newgard CD, Richardson D, Holmes JF et al (2014) Physiologic field triage criteria for identifying seriously injured older adults. Prehop Emerg Care 18:461–470
29. Nishijima DK, Gaona SD, Waechter T et al (2017) Out-of-hospital triage of older adults with head injury: a retrospective study of the effect of adding "anticoagulation or antiplatelet medication use" as a criterion. Ann Emerg Med 70:127–138.e6
30. O'caoimh R, Costello M, Small C et al (2019) Comparison of frailty screening instruments in the emergency department. IJERPH 16:3626
31. Ostrom JR, Hammarlund ER, Christensen DB et al (1985) Medication usage in an elderly population. Med Care 23:157–164
32. Pecheva M, Phillips M, Hull P et al (2020) The impact of frailty in major trauma in older patients. Injury 51:1536–1542
33. Phillips S, Rond Iii PC, Kelly SM et al (1996) The failure of triage criteria to identify geriatric patients with trauma: results from the Florida trauma triage study. J Trauma 40:278–283
34. Rau C-S, Wu S-C, Chen Y-C et al (2017) Effect of age on Glasgow Coma Scale in patients with moderate and severe traumatic brain injury: an approach with propensity score-matched population. IJERPH 14:1378
35. Rickard F, Ibitoye S, Deakin H et al (2020) The Clinical Frailty Scale predicts adverse outcome in older people admitted to a UK major trauma centre. Age Ageing 2020:1–7
36. Rose J, Valtonen S, Jennett B (1977) Avoidable factors contributing to death after head injury. BMJ 2:615–618
37. Salmasi A-M, Alimo A, Jepson E et al (2003) Age-associated changes in left ventricular diastolic function are related to increasing left ventricular mass. Am J Hypertens 16:473–477
38. Sasser SM, Hunt RC, Faul M et al (2012) Guidelines for field triage of injured patients: recommendations of the National Expert Panel on Field Triage, 2011. MMWR Recomm Reports 61:1–20
39. Staudenmayer KL, Hsia RY, Mann NC et al (2013) Triage of elderly trauma patients: a population-based perspective. J Am Coll Surg 217:569–576
40. Sterling DA, O'connor JA, Bonadies J (2001) Geriatric falls: injury severity is high and disproportionate to mechanism. J Trauma Acute Care Surg 50:116–119
41. Tinetti ME, Han L, Lee DS et al (2014) Antihypertensive medications and serious fall injuries in a nationally representative sample of older adults. JAMA Intern Med 174:588–595
42. Trauma Audit and Research Network (Tarn) (2017) Major trauma in older people. Trauma Audit and Research Network (Tarn), Salford
43. Van Der Heijden-Spek JJ, Staessen JA, Fagard RH et al (2000) Effect of age on brachial artery wall properties differs from the aorta and is gender dependent: a population study. Hypertension 35:637–642
44. Van Rein EA, Van Der Sluijs R, Raaijmaakers AM et al (2018) Compliance to prehospital trauma triage protocols worldwide: a systematic review. Injury 49:1373–1380
45. Virmani R, Avolio A, Mergner W et al (1991) Effect of aging on aortic morphology in populations with high and low prevalence of hypertension and atherosclerosis. Comparison between occidental and Chinese communities. Am J Pathol 139:1119–1129
46. Xu X, Wang B, Ren C et al (2017) Age-related impairment of vascular structure and functions. A&D 8:590–610