



Polytrauma in the elderly: a review

Benedikt Johannes Braun
Jörg Holstein
Tobias Fritz
Nils Thomas Veith
Steven Herath
Philipp Mörsdorf
Tim Pohlemann

- Although the field of geriatric trauma is – ironically – young, care for the elderly trauma patient is increasingly recognised as an important challenge, considering the worldwide trend towards increasing longevity.
- Increasing age is associated with physiological changes and resulting comorbidities that present multiple challenges to the treating physician.
- Even though polytrauma is less likely with increasing age, lower-energy trauma can also result in life-threatening injuries due to the reduced physiological reserve.
- Mechanisms of injury and resulting injury patterns are markedly changed in the elderly population and new management strategies are needed. From initial triage to long-term rehabilitation, these patients require care that differs from the everyday standard.
- In the current review, the special requirements of this increasing patient population are reviewed and management options discussed. With the increase in orthogeriatrics as a speciality, the current status quo will almost certainly shift towards a more tailored treatment approach for the elderly patient. Further research expanding our current knowledge is needed to reduce the high morbidity and mortality rate.

Keywords: polytrauma; orthogeriatrics; elderly; comorbidities

Cite this article: Braun BJ, Holstein J, Fritz T, Veith NT, Herath S, Mörsdorf P, Pohlemann T. Polytrauma in the elderly: a review. *EFORT Open Rev* 2016;1:146-151. DOI: 10.1302/2058-5241.1.160002.

Introduction

The European population is forecast to become slightly smaller in the coming years, yet a significant increase in population age is expected.¹ Today one in four patients in

the United Kingdom is over 75 years of age.² Predictive studies expect this to rise to over 40%.^{3,4} Life expectancy is increasing at a continuous rate, due to higher living standards and medical treatment with early detection programmes for different diseases. In addition, the fertility rate in the European Union is expected to remain below the natural population replacement rate in the coming years, thus further increasing the problem.¹

Complicating this demographic development is the increased morbidity and mortality in elderly polytrauma patients. Estimations have shown mortality rates of more than double in this population, amounting to over 40%.⁵ Knowledge and careful consideration of existing comorbidities are important, as an overwhelming majority of patients over the age of 65 has at least one comorbidity,⁶ which is considered as an independent predictor of mortality.⁷

Most studies define the elderly patient as above the age of 65; however, different age cut-offs between 55 and 80 years are given⁸ and sometimes further differentiated between ‘old’ and ‘very old’. Unless otherwise stated, the definition of elderly used in our current work refers to patients over the age of 65.

Physiological changes in the elderly

Ageing is characterised by the inevitable decline of the organs’ individual, and the body’s overall, function. These physiological changes exist regardless of comorbidities. This leads to a decreased physical reserve that is unmasked during severe trauma.⁹ Thus mortality rates in the elderly are increased, even when controlling for existing comorbidities.

Illustrating this reduced physiological reserve most impressively is the fact that cardiac stroke volume is reduced by almost 50% in the 80-year-old patient, when compared to healthy 20-year-olds.¹⁰ This is associated with a reduced reserve of endogenous catecholamines, limiting the body’s ability to respond to shock and the challenge of blood loss. Further complicating volume response is the fact that the kidneys’ functional reserve decreases gradually with age. A 30-40% reduction of glomeruli has to be expected in patients over 65 years of age. Due to age-related changes in the collagen structure of the lung and atrophy of the intercostal muscles, compliance and physiological reserve of the lungs are also decreased.⁴ Furthermore, osteoporosis with its significant changes in bone architecture and mineralisation has to be

expected. This leads to an increased frequency of fractures around the proximal femur and spine.¹¹ Lastly, the immune response in the elderly is changed. A relative increase of memory cells is seen, while native T- and B-cell numbers are decreased. Consequently the immune response is slower and less intense, leading to increased infection and wound complication rates.¹²

Comorbidities

Cardiovascular

The prevalence of often multiple comorbidities increases with age. Data from Nikkel et al of over 30 000 geriatric patients with proximal femur fractures gives a good indication of the comorbidities to be expected in the elderly trauma population.⁶ In patients over the age of 55 years, at least two (23.3%) or three (22.8%) comorbidities of any kind have to be expected. The leading cause of comorbidity in this population at 67% is hypertension, hence blood pressure averages are higher, and levels considered normal in younger populations should be viewed with suspicion.¹³ The systemic vascular resistance can be increased despite relative hypovolemia, and cardiac output is decreased due to the reduced ability to increase heart rate and contractility. Early invasive blood pressure measurements should be considered especially in haemodynamic shock, as mean arterial pressure is more reliable invasively and less affected by small vessel vasoconstriction.¹⁴ To adjust to the lower contractility reserve, smaller doses of volume replacement should be used than in younger patients (Table 1).

Anaemia and fluid balance

The next most common comorbidities are deficiency anaemia, as well as fluid and electrolyte imbalances. Concerning anaemia, especially in patients with severe comorbidities, no difference was shown between liberal blood transfusion regimes (trigger at 10 g haemoglobin per decilitre) and restrictive transfusion regimes (trigger at 8 g haemoglobin per decilitre) in elderly patients with proximal femur fractures. The studies conclude that it is safe to withhold blood transfusions, even below a threshold of 8 g haemoglobin per decilitre, as long as no physiological

symptoms of anaemia are present.¹⁵ However, these physiological symptoms of volume depletion are not always present in the polytraumatised patient and careful consideration of the accompanying risk factors (such as low cardiopulmonary reserve) is necessary. Volume management is further complicated by renal failure, another common comorbidity. With a decreased overall glomerular filtration rate in the geriatric population, the risk of electrolyte imbalance and fluid overload is increased. Ringer solution and small volume resuscitation have been identified as beneficial to prevent hyperchloraemic acidosis, which is associated with the use of normal saline.¹⁶

Chronic pulmonary disease

Chronic pulmonary disease was identified as the fourth most common comorbidity, with over 20% prevalence. This leads to reduced vital capacity and lung compliance. Increasing the risk for pulmonary complications are congestive heart failure, prolonged surgery, advanced age and low serum albumin (< 30 g per litre).¹⁷ Chest radiographs and spirometry have limited value as risk stratification tools. Careful post-operative management is needed if pulmonary complication risks are identified. Serum albumin levels should be corrected in the immediate care phase.

Diabetes mellitus

Diabetes is an important comorbidity as an independent risk factor for cardiac complications, heart failure, renal failure, infections and overall mortality. To adequately reduce the peri- and post-operative complication risk, the American College of Endocrinologists recommends a glucose level below 110 mg per decilitre.¹⁸

Anticoagulant therapy

Another often-underestimated risk factor in the geriatric population is treatment with anticoagulants. For the most commonly-used anticoagulant, aspirin, the risk of perioperatively increased bleeding was shown to be clinically irrelevant. However, clopidogrel was shown to have no significant effect on bleeding, transfusions, length of surgery or hospital stay.¹⁹ Vitamin K antagonists, however, need to be interrupted and replaced by either unfractionated heparin or low molecular weight heparin, as soon as

Table 1. Common comorbidities, physiological changes and consequences in the elderly

Comorbidity	Physiological change	Consequences
Hypertension	↑ Vascular resistance	Hypovolemic state masked
Coronary artery disease/congestive heart failure	↓ Chronotropic reserve ↓ Contractility	Dysrhythmia ↓ Heart rate response ↓ Cardiac output
Renal insufficiency	↓ Glomerular filtration rate ↓ Drug metabolism	↑ Risk electrolyte imbalance ↑ Risk fluid overload
Chronic pulmonary disease	↓ Compliance/vital capacity	↑ Risk ARDS ↓ O ₂ levels ↓ Response to hypoxia
Diabetes mellitus	Impaired glucose tolerance ↑ Blood-glucose	↑ Risk infection ↑ Risk cardiac/renal complications

the Vitamin K antagonist is outside its therapeutic range. The administration of prothrombin complex concentrates allows an immediate INR correction without delaying surgery.²⁰ Newer oral anticoagulants such as dabigatran, apixaban and rivaroxaban might delay surgery, as there is still no antidote available.

Mechanisms of injury

The mechanisms of injury are markedly changed in the elderly patient, and are in themselves changing with further increasing age. The most common mechanism of injury in seriously injured geriatric patients is a fall (over 60%), motor vehicle accidents (over 20%), or pedestrian injuries (around 5%).²¹ Low-energy falls account for over 50% of the traumatic deaths in patients over 65 years of age.²² The likelihood of an injury sustained from a fall further increases with age, from 49.2% between 65 and 74 years, to over 80% in patients over 85 years of age. The increased risk is commonly attributed to physiological changes such as decreased peripheral sensory function, increased reaction time and cardiac comorbidities. The higher risk of fractures from these low-energy falls is associated with increased rates of osteoporosis in this population. The osteoporosis rate is predicted to rise in future

even further, increasing the risk for low-energy fracture types.²³

Higher-energy trauma is sustained from motor vehicle accidents. Almost 15% of fatal traffic accidents involve an elderly driver.¹⁶ As in low-energy falls, changes in patient sensory function are associated with the accident rate. Visual and musculoskeletal impairments lead to an increased reaction time and decreased ability to avoid traffic hazards. Despite travelling at slower speeds, the automobile accident risk has been shown to increase with advancing age.²² The incidence for elderly pedestrian trauma is lower, but mortality rates increase, especially in pedestrian–vehicle collisions²⁴ (Fig. 1).

Even though other causes of injury are rare, special consideration has to be given to abuse and assault of the elderly. The few existing studies show incidence rates around one per cent,²¹ with possibly a higher number of undetected cases. A high level of suspicion is required for patients where the resulting injuries are inconsistent with trauma history and signs of neglect are seen.

Injury patterns

A knowledge of the typical injuries in elderly trauma patients is of great importance, since the severity and

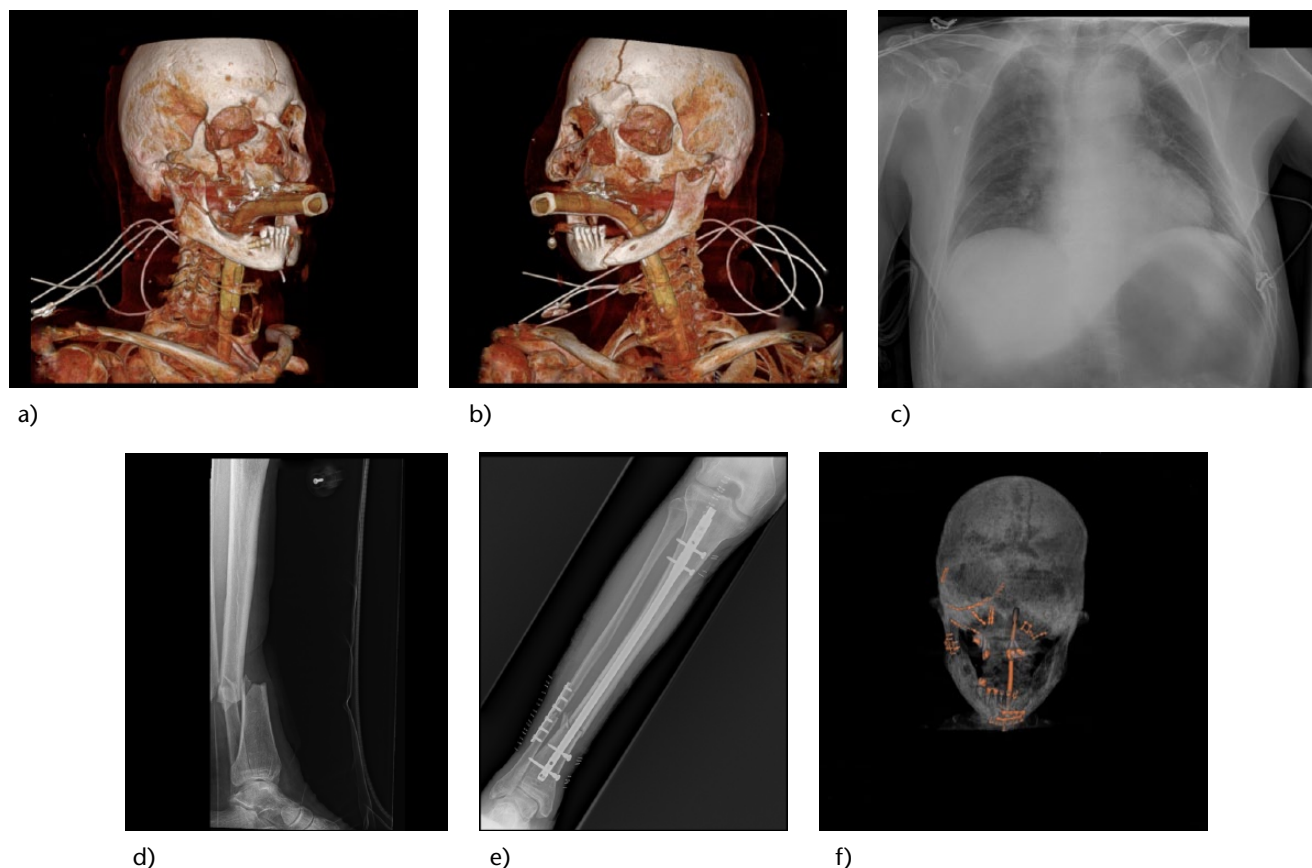


Fig. 1 Seventy-six year old male polytrauma patient with Le Fort III fracture (a, b), severe lung contusion (c) and tibia shaft fracture (d). Treatment was performed with nail (e) and plate osteosyntheses (f).

number of injuries can often be underappreciated in these patients.²⁵ Bony injuries to the extremities and pelvic girdle are common (Fig. 2). Fractures of the pelvic ring are associated with severe blood loss and high mortality rates.²⁶

Head and neck trauma is the second most common type of injury often associated with fractures and dislocations in the polytraumatised elderly.^{21,27} Fractures of the C1-C2 level including the odontoid are the most common cervical spine fractures, and often result from simple falls.²⁸ Intracranial injury patterns also change with age. In the elderly, the dura mater adheres tightly to the skull, virtually eliminating the epidural space. The risk for epidural bleeding is thus decreased, while the risk for subdural hematoma is increased.¹⁶ Caution is required, as subdural haematoma can present with relatively few symptoms in the elderly.

Chest injuries are common, with rib fractures often resulting from decreased bone quality due to osteoporosis and increased chest wall stiffness. These injuries need to be detected and corrected at an early stage, as pulmonary complications significantly increase mortality due to the limited functional reserve of the lungs.¹⁶ Intra-abdominal injuries, especially to the great vessels, are common in the elderly and result in significantly higher mortality than in younger patients. Due to reduced elasticity and atherosclerosis, the ageing vascular system is more susceptible to acceleration and deceleration, increasing the overall risk for major bleeding.²²

Initial management

In principle, management of the elderly should follow the guidelines of the Advanced Trauma and Life Support (ATLS) system. Several authors have noted however that the severity of injuries in elderly patients is often underestimated and under-triaged. The assessment of elderly patients in common trauma scores often results in unacceptable levels of under-triage, even in patients with potentially life-threatening injuries.²⁷ The rate of under-triaged elderly in multiple studies ranged between 15% and 49%, and resulted in inadequate care,²⁵ increasing overall mortality.²⁹ Unlike in younger patients, vital signs within normal limits are not reassuring in elderly patients. Heffernan et al. showed that the mortality rate increased significantly from 12% to 70% if an increased heart rate and decreased systolic blood pressure is noticed.³⁰ The threshold for early invasive cardiac monitoring in the emergency room should thus be low, to help identify and treat occult shock. Early aggressive treatment can limit organ hypoperfusion, preventing multiple organ failure and increasing survival.²⁷ The assessment of base deficit and serum lactate has been shown to have predictive value in the outcome after polytrauma, as increases in both are associated with significantly increased mortality in elderly patients.³¹ Therefore, new triage criteria and scoring systems for the elderly need to be developed.

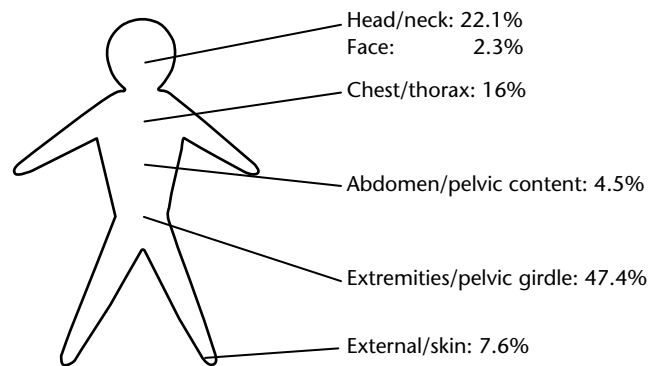


Fig. 2 Body regions with the most severe injuries, as reported by Richmond et al in over 35 000 injured elderly persons.²¹

When treating a polytraumatised patient over 65 years of age, the patient's age and comorbidities should always be accounted for and the relevant diagnostic studies initiated. By applying these simple triage considerations, studies have shown that the rate of under-triage can be significantly reduced.³²

Interdisciplinary care

As studies have highlighted the benefits of early aggressive treatment, the threshold to admit elderly trauma patients to the intensive care unit should be low. This setting allows for thoughtful, continued management with invasive monitoring. For the post-acute care of elderly trauma patients, interdisciplinary treatment is indispensable in addressing the associated comorbidities.³³ Geriatric consultation can help to identify additional diagnoses unrelated to the trauma, further improving outcome. Kristensen et al showed that admission to an orthogeriatric unit in which a geriatrician assesses all patients in orthogeriatric units for relevant comorbidities³³ results in a better outcome, with a lower 30-day mortality among patients with hip fractures.³⁴ It is recommended that the leadership of the interdisciplinary team should remain with the trauma surgeon.

Long-term care

The outcome in elderly trauma patients also depends on further nursing after discharge from hospital. Often elderly trauma patients require admission to a nursing home after their initial care. Kozar et al observed that geriatric nursing, using an acute care elderly unit model, may improve the outcome of the patient.³³ A home-like environment, including plans to prevent further disability and iatrogenic illnesses, as well as providing early discharge planning, may help in the treatment of elderly trauma patients after discharge. Appropriate rehabilitation programmes and orthogeriatric consultations can help to decide whether a patient can return home and continue independent living, or whether he/she will require permanent nursing.

Predicting outcome

Predicting the outcome in elderly trauma patients can be a difficult and imprecise challenge. Most authors found the Injury Severity Score (ISS) to be the only significant predictor of outcome. Ferrera et al showed that an ISS >25 is associated with significantly increased mortality rates.³⁵ The authors were also able to show that indicators of poor outcome were the presence of shock on admission, head injury, sepsis, GCS ≤7 and comorbidities such as prior myocardial infarction and renal insufficiency. Medical complications, including cardiac events and pneumonia, as well as suffering from more severe head and neck injuries, seemed to have a higher rate of mortality.⁵ Although age was again shown to be associated with a poorer outcome, no further outcome prediction was possible in patients over the age of 75 years.⁵ This demonstrates that, along with all of the general considerations, it should always be remembered that each patient needs to be treated individually. Chronological age should merely be regarded as guidance, as it may not reliably represent the patient's biological age or extent of medical comorbidities.

Conclusions

It is often taught that paediatric patients are not 'little adults', and perhaps equally as important is the fact that elderly patients are not merely 'older adults'. Orthogeriatric treatment concepts are developed worldwide, and research regarding this patient population has accelerated over the last few years. A simple PubMed search reveals that almost one-third of all publications concerned with orthogeriatric treatment were published during the last two years. Limited evidence already exists that demonstrates the effectiveness of tailored treatment regimens, improving outcomes in the elderly fracture population.³⁴ Literature on the polytraumatised elderly also suggests that outcome can be improved if rapid, tailored treatment is provided in specialised institutions.³⁶

Until further research establishes new management strategies, treating physicians should bear in mind current existing management guidelines, along with the special considerations required for the elderly patient.

AUTHOR INFORMATION

Department of Trauma, Hand and Reconstructive Surgery, Saarland University Hospital, Homburg, Germany.

Correspondence should be sent to T. Pohlemann, Director, Department of Trauma, Hand and Reconstructive Surgery, Saarland University Hospital, Building 57, Kirrbergerstr. 1, 66421 Homburg, Germany.

Email: tim.pohlemann@uks.eu

CONFLICT OF INTEREST

None declared.

FUNDING

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

LICENCE

© 2016 The author(s)

This article is distributed under the terms of the Creative Commons Attribution-Non-Commercial 4.0 License (<http://www.creativecommons.org/licenses/by-nc/4.0/>) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed.

REFERENCES

1. Costello D, Carone G. Can Europe afford to grow old. *Finance and Development* 2006;43:8-31.
2. Clement ND, Aitken S, Duckworth AD, McQueen MM, Court-Brown CM. Multiple fractures in the elderly. *J Bone Joint Surg [Br]* 2012;94-B:231-6.
3. Søreide K, Krüger AJ, Vårdal AL, Ellingsen CL, Søreide E, Lossius HM. Epidemiology and contemporary patterns of trauma deaths: changing place, similar pace, older face. *World journal of surgery* 2007;31:2092-2103.
4. Schwab CW, Kauder DR. Trauma in the geriatric patient. *Archives of surgery* 1992;127:701-6.
5. Giannoudis PV, Harwood PJ, Court-Brown C, Pape HC. Severe and multiple trauma in older patients; incidence and mortality. *Injury* 2009;40:362-7.
6. Nikkel LE, Fox EJ, Black KP, et al. Impact of comorbidities on hospitalization costs following hip fracture. *J Bone Joint Surg [Am]* 2012;94-A:9-17.
7. Rixen D, Raum M, Bouillon B, Schlosser LE, Neugebauer E. Arbeitsgemeinschaft Polytrauma der Deutschen Gesellschaft für Unfallchirurgie. [Predicting the outcome in severe injuries: an analysis of 2069 patients from the trauma register of the German Society of Traumatology (DGU)]. *Unfallchirurg* 2001;104:230-9. [Article in German]
8. Jacobs DG, Plaisier BR, Barie PS, et al; EAST Practice Management Guidelines Work Group. Practice management guidelines for geriatric trauma: the EAST Practice Management Guidelines Work Group. *J Trauma* 2003;54:391-416.
9. McMahon DJ, Shapiro MB, Kauder DR. The injured elderly in the trauma intensive care unit. *Surg Clin North Am* 2000;80:1005-19.
10. Frankenfield D, Cooney RN, Smith JS, Rowe WA. Age-related differences in the metabolic response to injury. *J Trauma* 2000;48:49-56; discussion 56-57.
11. Warriner AH, Patkar NM, Curtis JR, et al. Which fractures are most attributable to osteoporosis? *J Clin Epidemiol* 2011;64:46-53.
12. Plackett TP, Boehmer ED, Faunce DE, Kovacs EJ. Aging and innate immune cells. *J Leukoc Biol* 2004;76:291-9.
13. Stevenson J. When the trauma patient is elderly. *J Perianesth Nurs* 2004;19:392-400.
14. Wilson M, Davis DP, Coimbra R. Diagnosis and monitoring of hemorrhagic shock during the initial resuscitation of multiple trauma patients: a review. *J Emerg Med* 2003;24:413-22.
15. Carson JL, Terrin ML, Noveck H, et al; FOCUS Investigators. Liberal or restrictive transfusion in high-risk patients after hip surgery. *N Engl J Med* 2011;365:2453-62.
16. Pudelek B. Geriatric trauma: special needs for a special population. *AACN Clin Issues* 2002;13:61-72.
17. Smetana GW, Lawrence VA, Cornell JE; American College of Physicians. Preoperative pulmonary risk stratification for noncardiothoracic surgery: systematic review for the American College of Physicians. *Ann Intern Med* 2006;144:581-95.

- 18. Clement S, Braithwaite SS, Magee MF, et al; American Diabetes Association Diabetes in Hospitals Writing Committee.** Management of diabetes and hyperglycemia in hospitals. *Diabetes Care* 2004;27:553-91.
- 19. Chechik O, Thein R, Fichman G, et al.** The effect of clopidogrel and aspirin on blood loss in hip fracture surgery. *Injury* 2011;42:1277-82.
- 20. Tazarourte K, Riou B, Tremey B, et al; EPAHK study group.** Guideline-concordant administration of prothrombin complex concentrate and vitamin K is associated with decreased mortality in patients with severe bleeding under vitamin K antagonist treatment (EPAHK study). *Crit Care* 2014;18:R81.
- 21. Richmond TS, Kauder D, Strumpf N, Meredith T.** Characteristics and outcomes of serious traumatic injury in older adults. *J Am Geriatr Soc* 2002;50:215-22.
- 22. Dimitriou R, Calori GM, Giannoudis PV.** Polytrauma in the elderly: specific considerations and current concepts of management. *Eur J Trauma Emerg Surg* 2011;37:539-48.
- 23. U S Department of Health and Human Services Task Force on Health Risk Assessment and Us Public Health.** *Bone health and osteoporosis: A report of the surgeon general.* US Dep Health Hum Serv; 2004:69-87.
- 24. Akköse Aydin S, Bulut M, Fedakar R, Özgürer A, Özdemir F.** Trauma in the elderly patients in Bursa. *Ulus Travma Acil Cerrahi Derg* 2006;12:230-4.
- 25. Meldon SW, Reilly M, Drew BL, Mancuso C, Fallon W Jr.** Trauma in the very elderly: a community-based study of outcomes at trauma and nontrauma centers. *J Trauma* 2002;52:79-84.
- 26. Ojodu I, Pohlemann T, Hopp S, et al.** Predictors of mortality for complex fractures of the pelvic ring in the elderly: a twelve-year review from a German level I trauma center. *Injury* 2015;46:1996-8.
- 27. Soles GL, Tornetta P III.** Multiple trauma in the elderly: new management perspectives. *J Orthop Trauma* 2011;25:S61-S65.
- 28. Lomoschitz FM, Blackmore CC, Mirza SK, Mann FA.** Cervical spine injuries in patients 65 years old and older: epidemiologic analysis regarding the effects of age and injury mechanism on distribution, type, and stability of injuries. *AJR Am J Roentgenol* 2002;178:573-7.
- 29. Chang DC, Bass RR, Cornwell EE, Mackenzie EJ.** Undertriage of elderly trauma patients to state-designated trauma centers. *Arch Surg* 2008;143:776-81.
- 30. Heffernan DS, Thakkar RK, Monaghan SF, et al.** Normal presenting vital signs are unreliable in geriatric blunt trauma victims. *J Trauma* 2010;69:813-20.
- 31. Callaway DW, Shapiro NI, Donnino MW, Baker C, Rosen CL.** Serum lactate and base deficit as predictors of mortality in normotensive elderly blunt trauma patients. *J Trauma* 2009;66:1040-4.
- 32. Scheetz LJ.** Trends in the accuracy of older person trauma triage from 2004 to 2008. *Prehosp Emerg Care* 2011;15:83-7.
- 33. Kozar RA, Arbabi S, Stein DM, et al.** Injury in the aged: geriatric trauma care at the crossroads. *J Trauma Acute Care Surg* 2015;78:1197-1209.
- 34. Kristensen PK, Thillemann TM, Søballe K, Johnsen SP.** Can improved quality of care explain the success of orthogeriatric units? A population-based cohort study. *Age Ageing* 2016;45:66-71.
- 35. Ferrera PC, Bartfield JM, D'Andrea CC.** Outcomes of admitted geriatric trauma victims. *Am J Emerg Med* 2000;18:575-80.
- 36. Jacobs DG.** Special considerations in geriatric injury. *Curr Opin Crit Care* 2003;9:535-9.