30-day mortality among very old patients admitted to European intensive care units for major trauma

Authors:

Chris F Duncan a, Dagan O Lonsdale a,b, Helen Farrah a, Sarah Farnell-Ward a, Christine Ryan a, Ximena Watson a, Maurizio Cecconi c,d, Jesper Fjølner e, Wojciech Szczeklik f, Rui Moreno g, Antonio Artigas h, Michael Joannidis i, Dylan W. de Lange j, Bertrand Guidet k, Hans Flaatten l, Christian Jung m , Susannah K Leaver a

Affiliations:

a Department of Critical Care, St George’s University Hospitals NHS Foundation Trust.

b Department of Clinical Pharmacology, St George's, University of London, UK.

c Department of Biomedical Sciences, Humanitas University, Via Rita Levi Montalcini

20090 Pieve Emanuele, Milan, Italy.

d Anesthesia and Intensive Care, IRCCS Humanitas Research Hospital, Via Manzoni 56, 20089 Rozzano, Milan, Italy.

e Department of Anaesthesia and Intensive Care, Viborg Regional Hospital, Vyborg, Denmark.

f Intensive Care and Perioperative Medicine Division, Jagiellonian University Medical College, Kraków, Poland.

g Hospital de São José, Centro Hospitalar Universitário de Lisboa Central, Faculdade de Ciências Médicas de Lisboa, Nova Médical School, Lisbon; Faculdade de Ciências da Saúde, Universidade da Beira Interior, Covilhã, Portugal.

h Department of Intensive Care Medicine, CIBER Enfermedades Respiratorias , Parc Tauli University Hospital, Institut d’Investigació I innovació Parc tauli ( I3PT), Autonomous University of Barcelona, Sabadell, Spain.

i Division of Intensive Care and Emergency Medicine, Department of Internal Medicine, Medical University Innsbruck, Innsbruck, Austria.

j Department of Intensive Care Medicine, Dutch Poisons Information Center (DPIC), University Medical Center, University Utrecht, Utrecht, The Netherlands.

k Sorbonne Université, INSERM, Institut Pierre Louis D’Epidémiologie Et de Santé Publique, Saint Antoine Hospital, AP-HP, Hôpital Saint-Antoine, Service de Réanimation, 75012, Paris, France.

l Department of Anaesthesia and Intensive Care, Dep of Clinical Medicine, Haukeland University Hospital Bergen, Dep. of Anaesthesia and Intensive Care and University of Bergen, 5019, Bergen, Norway.

m Division of Cardiology, Pulmonology and Vascular Medicine, University Hospital Düsseldorf, Heinrich Heine University, Düsseldorf, Germany.

Corresponding Author:

Dr Susannah Leaver

Department of Critical Care

St George’s University Hospitals NHS Foundation Trust

Blackshaw Road

Tooting

London

SW17 0QT

+44 20 8725 1307

susannahleaver@nhs.net

Running Title: Mortality among very old intensive care patients admitted with trauma

Number of Tables: 2

Number of Figures: 2

Word count: 3348

Key words: trauma, frailty, elderly, mortality, intensive care

Abstract

**Introduction**: Cases of major trauma in the very old (over 80 years) are increasingly common in the intensive care unit. Predicting outcome is challenging in this group of patients as chronological age is a poor marker of health and poor predictor of outcome. Increasingly, decisions are guided with the use of organ dysfunction scores of both the acute condition (e.g. Sequential Organ Failure Assessment (SOFA) score) and chronic health issues (e.g. clinical frailty scale, (CFS)). Recent work suggests that increased CFS is associated with a worse outcome in elderly major trauma patients. We aimed to test whether this association held true in the very old (over 80) or whether SOFA had a stronger association with 30-day outcome.

**Methods**: Data from the VIP-1 and VIP-2 studies for patients over 80 years old with major trauma admissions were merged. These participants were recruited from 20 countries across Europe. Baseline characteristics, level of care provided and outcome (ICU and 30-day mortality) were summarised. Uni- and multi- variable regression analysis were undertaken to determine associations between CFS and SOFA score in the first 24-hours, type of major trauma and outcomes.

**Results**: Of the 8062 acute patients recruited to the two VIP studies, 498 patients were admitted to intensive care because of major trauma. Median age was 84 years; median SOFA score was 6 (IQR 3,9) and median CFS was 3 (IQR 2,5). Survival to 30-days was 54%. Median and inter-quartile range of CFS was the same in survivors and non-survivors. In the logistic regression analysis, CFS was not associated with increased mortality. SOFA score (p<0.001) and trauma with head injury (p<0.01) were associated with increased mortality.

**Conclusions**: Major trauma admissions in the very old are not uncommon and 30-day mortality is high. We found that CFS was not a helpful predictor of mortality. SOFA and trauma with head injury were associated with worse outcomes in this patient group.

Introduction

The incidence of trauma in the elderly population is increasing, with over half of major trauma patients in the UK being aged 65 and over [1]. Trauma in very old patients, defined as aged 80 years and above, requiring admission to critical care is also rising, reflecting the increased proportion of elderly population in most European countries [2, 3]. Benefits of intensive care unit (ICU) care in this age group are often questioned because of the reduced physiological reserve and post-illness life expectancy compared with younger people. Patients and their relatives or carers expect clinicians to provide information on the potential benefits and risks of therapies associated with an admission to critical care before making choices about the care they wish to receive. Chronological age is a poor predictor of physiological reserve due to variations in life expectancy in different countries, comorbidities and physical fitness [4]. A preferred descriptor is frailty which describes an age-related decline in physiological and psychological systems leading to increased vulnerability to even minor insults [5]. The degree of frailty has been demonstrated to correlate with outcomes following critical care admission and is unsurprisingly used to influence decisions regarding appropriateness of admission [6, 7]. Traditionally, frailty has been ascertained through detailed geriatric assessment, but this approach is often unrealistic in the setting of acute illness including major trauma. Increasingly, decisions around the probability of a successful outcome following a critical care admission are guided by the use of organ dysfunction scores of the acute condition (e.g. the sequential organ failure assessment (SOFA) score [8]) and functional baseline (e.g. the clinical frailty scale (CFS) [9]). Indeed, during the COVID-19 pandemic, the National Institute for Health and Care Excellence (NICE) initially recommended the use of the CFS to determine whether patients over 65 years were suitable for critical care admission [10] . Whilst this recommendation was later amended, the COVID-19 disease in Very Elderly Intensive care Patients (COVIP) study found CFS to be a better predictor of 30-day survival than chronological age in elderly (≥70 years) patients admitted to the ICU with COVID-19 [11]. Similarly, among elderly trauma patients (>65 years) presenting to accident and emergency, CFS was found to correlate best with a geriatric assessment of frailty when compared with other tools including the Trauma specific frailty index (TSFI) [12]. Recent data from a single UK trauma centre and two Australian intensive care units (ICUs) have found an increased score on the CFS to be associated with worse outcomes in major trauma patients aged over 65 and over 50 years respectively [13, 14] . As the majority of elderly trauma research has used a lower limit of between 50 and 65 years of age, no frailty score nor SOFA score have been validated to predict outcomes in the very old patient.

Two large prospective observational studies have recently investigated the characteristics, disease severity and predictors of outcome for patients admitted to the ICU aged 80 years or above (Very elderly Intensive Care Patient (VIP) 1 and VIP-2) [6, 7, 15]. Despite significant variation in the characteristics of patients admitted to the ICU, they reported frailty assessment using the CFS to be associated with increased short-term mortality in the very old.

We have undertaken an analysis of the combined VIP-1 and VIP-2 data to assess the baseline characteristics, level of care and 30-day mortality of very old patients admitted to European ICUs following major trauma. Our aim was to ascertain whether an association exists between CFS and 30-day mortality or whether conventional sequential organ failure scores, such as SOFA, had a stronger association.

Methods

Study participants and data collection

Participants included in this analysis were enrolled in the two prospective observational studies of very old intensive care patients (VIP-1 and VIP-2) [6, 7]. Over 300 ICUs from 20 European countries enrolled 8062 patients aged 80 years and above, admitted to ICU in a 7-month period in 2016-2017 (VIP-1) and a 6-month period in 2018-2019 (VIP-2). The study was coordinated through the Health Services Resource and Outcome (HSRO) section of the European Society of Intensive Care Medicine.

Baseline characteristics including gender, age and reason for admission were collected. Reasons for admission were subdivided into multi-trauma with head injury, multi-trauma without head injury and isolated head injury. CFS was used to assess the frailty level prior to hospital. The CFS uses simple visual pictures and descriptions to divide patients into 9 categories from very fit to terminally ill. Pre-frail (vulnerable) patients have a CFS of 4, while frail patients have a CFS of 5 and above. CFS was assigned by either the treating healthcare professional or a member of the research team at each study site. Information to score CFS was provided by the patient, relative, carer or the clinical records. In VIP-2 patients baseline cognition was recorded using the short form of Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE), cognitive decline was taken as 3.5 or greater. Katz activities of daily living were recorded with ADL Score <4 defining disability. Comorbidity and polypharmacy score (CPS) was calculated, with a CPS above 15 considered high. The degree of organ dysfunction was estimated using the SOFA score within the first 24-hours of admission to the ICU. The SOFA score is a scoring system for assessing and monitoring organ dysfunction in critically ill patients [16]. It numerically quantifies the number and severity of failed organs (Brain, Blood, liver, kidney, heart and lungs). Provision of life-sustaining interventions including non-invasive ventilation, invasive ventilation, vasopressors and renal replacement therapy were recorded, including whether life-sustaining treatment was withheld (organ support not started) or withdrawn (organ support taken away). Outcome was measured as ICU length of stay, survival to ICU discharge and 30-day mortality (primary outcome).

Statistical analysis

Patient characteristics, reason for admission, interventions and outcome were compared with CFS and SOFA score using standard statistical tests (Chi-squared, Kruskal-Wallis, Fisher’s exact). Uni- and multi-variable logistic regression analysis were undertaken to determine associations between CFS and SOFA scores, type of major trauma and outcomes. Statistical analyses, tables and plots were undertaken and created using R: A language and environment for statistical computing (version 3.6.3) [17]

Results

Of the 8062 patients acutely recruited to the VIP studies, 498 patients (6.2%) were admitted to ICU because of major trauma. Table 1 shows the baseline characteristics and outcome at 30-days. 30-days survival was 54%. 33% of deaths occurred after discharge from ICU. 282 (57%) of patients were male. Median age was 84 years old (IQR 82, 87) and was not associated with 30-day mortality (p=0.13). The youngest participant was 80 and the oldest 100. Figure 1 shows a distribution of the age of participants. Multi-trauma accounted for 301 (60%) of participants of which 147 (49%) sustained a head injury as part of their polytrauma injury profile. The remainder of the patients (197, 40%) were admitted following an isolated head injury. Table 1 also demonstrates the resource utilisation by outcome. Median ICU length of stay was 4 days. The median SOFA score was 6 (IQR 3,9). The median CFS was 3 (IQR 2, 5, distribution shown in Figure 1). Median Katz score was 6 (IQR 5,6), median IQCODE was 3.14 (IQR 3,3.52) and median CPS score was 8 (IQR 5,13).

Median ICU length of stay was 4 days (IQR 2, 10) for survivors and 3 days (IQR 1, 8) for non-survivors. The median CFS was the same in survivors and non survivors. Uni- and multi-variable regression analyses are shown in Table 2. Median SOFA score was 6 (IQR 3, 9) and increasing SOFA was significantly associated with increased mortality (p<0.001). The median SOFA score was 5 (IQR 3, 8) for survivors and 8 (IQR 5, 11) for non-survivors. Figure 2 shows 30 day mortality by SOFA score. Illness severity was reflected by the greater provision of life support intervention in non-survivors compared with survivors including invasive ventilation (80% vs 48%), vasopressor therapy (65% vs 43%) and renal replacement therapy (8.7% vs 3.3%). Non-invasive ventilation was higher in survivors than non-survivors (14% vs 11%). Life-sustaining care was more likely to be withheld in non-survivors (45%) compared with survivors (12%).

The presence of head injury was associated with an increased risk of 30-day mortality whether isolated (OR 1.92; p<0.01) or in the context of multi-trauma (OR 1.90; p<0.01, Table 2).

30-day survival was missing for 45 (9%) participants and CFS data missing for 4 participants. Missing data was not imputed in these analyses. In the logistic regression analysis, neither age nor CFS were associated with increased mortality.

Discussion

In this study of 498 elderly patients (age >80) we found that 30-day mortality was high among patients admitted to the ICU following major trauma. Survival to ICU discharge was 68% and 30-day survival just 54%. There was no association between the Clinical Frailty Scale or age with mortality in this cohort. However, SOFA score and the presence of a head injury were both significantly associated with increased mortality. To our knowledge, this is the largest study showing the associations between outcome and frailty in major trauma cases dedicated to the very old intensive care patient.

The incidence of trauma in the very old is increasing in parallel with the ageing population and clinicians are frequently required to provide information about the potential benefits and risks of invasive therapies associated with critical care [18]. We sought to identify associations that might provide useful indicators for future work in risk stratification or outcome prediction including using CFS as a measure of functional baseline.

Our analysis did not suggest a correlation between frailty, assessed using the CFS, and 30-day mortality which conflicts with recent studies investigating major trauma admissions in patients aged over 50 and over 65 years [13, 14, 19] . In a single centre, prospective, observational cohort study in patients 65 years and above, Rickard *et al* reported increased frailty to be an independent risk factor for 30-day mortality (CFS odds ratio (OR) 5.68; p<0.01; CFS 7-9 OR 10.38; p<0.01) [13]. These findings from Rickard *et al* corroborated earlier work by Tipping *et al* in a prospective observational study of 138 patients admitted to two Australian ICUs [14]. More recently, Cole et al. found in adult trauma patients admitted to critical care that frailty, rather than chronological age, was associated with developing multi-organ dysfunction syndrome (defined as a SOFA score >6 within a 24-hour period), which subsequently had an impact on survival [20][19] In a non-ICU study assessing 819 patients aged 60 and over admitted to a UK hospital with major trauma, defined as an injury severity score >15, Pecheva *et al* found frailty (assessed using the modified frailty index) to be associated with increased risk of mortality at one-year post-discharge (26.2%, 35.2% and 51% for low, medium and high frailty groups respectively) [21]. This was supported by Carter et al. who using records, from the Trauma Audit and Research Network (TARN) database, for over 16,000 patients >65 years old found a dose-response association between increasing severity of frailty and increased risk of inpatient mortality, longer duration of hospital stay and higher risks of complications after severe injuries [22].

The apparent lack of association between frailty and 30-day mortality in our population is unclear and may be due to a number of reasons. First, the association may be underestimated due to patient follow-up being limited to 30-days rather than 90-days or longer. Second, our patient population focused on the very elderly (80 years and older), it is therefore plausible that trauma patients admitted to the ICU may have been preferentially selected due to lower CFS scores, which potentially limits the utility of CFS to predict outcome in this cohort. Indeed, in a study of 372 patients admitted with trauma aged 65 or older (median age 80), 40 (10.7%) were admitted to critical and of these 92.5% were not frail (CFS<4). This was corrobated by Rikard et al. who reported 27% of non frail patients (CFS <4) were admitted to ICU compared to 9.3% of those with mild to moderate frailty (CFS 5-7) and 0% of those with severe frailty (7-9). The median CFS was 3 in our patient population, indicating that a number of patients may have been excluded from ICU , being triaged prior to ICU. This was supported by the low level of disability as shown by median Katz of 6, relatively good cognition with a median IQCODE 3.1 and low CPS score, median score of 8, seen among the patients admitted to ICU. Third, it is possible that frailty is a reliable assessment of trauma survival in the population between 50 and 80, but perhaps beyond 80 years the impact of advanced age on physiological reserve lessens the significance of quantitative screening methods for frailty. This study differs from others as all the patients were 80 or older.

Researchers including younger patient populations have found chronological age to be independently associated with poor short- and long-term outcomes following major trauma [21, 23] . In our analysis, we found age to not correlate with 30-day mortality which is consistent with previous data by Mock *et al* where they assessed predictors of mortality in 193 critically unwell trauma patients aged 80 and above [24] . Whilst unsurprising that advancing age lessens an individual’s ability to overcome a major traumatic insult, the impact of age may peak once a threshold of 80 years and above has been reached. However, this hypothesis differs from the VIP-2 dataset for all causes of acute admissions to ICU where the authors found an increased risk of death per 1-year increase in age [7] . Furthermore, our data had a narrow range of ages (mean 84, IQR 82 to 87) which potentially limits the ability to detect an age effect.

The degree of organ dysfunction , as measured by the SOFA score during the first 24 hours of ICU admission, was independently associated with an increased 30-day mortality (p<0.001). This is perhaps unsurprising given that SOFA has been demonstrated to be associated with outcome in younger patients admitted to the ICU following trauma [25][26, 27] . Although we do not propose a cut off value, SOFA may aid in the prognostication of major trauma patients after 24 hours in the ICU and help to inform multidisciplinary and family discussions regarding appropriateness of potential therapies. Figure 2 shows a graph of mortality against SOFA score.

Increased illness severity was mirrored by the greater provision of life support interventions in non-survivors. Invasive ventilation (80% vs 48%), vasopressor use (65% vs 43%) and renal replacement therapy (8.7% vs 3.3%) were all higher in non-survivors compared with survivors. The high proportion of patients receiving advanced critical care support may be surprising to readers given that refusal rates for invasive ventilation and renal replacement therapy may be as high as 43% and 63% respectively for independent individuals aged 80 years and above [28] . This may be explained by clinicians being unable to investigate preferences for life-sustaining treatment in the context of an acute major trauma presentation. Life sustaining care was withheld in 45% of non-survivors as opposed to only 12% in survivors. A shorter ICU length of stay (3 vs 4 days) was seen in non-survivors which may indicate mortality early in the ICU admission or reflect a short time-limited trial of therapy prior to withdrawal of care in those that did not respond to treatment .

SOFA score was higher in patients where life sustaining treatment was withdrawn (8.0 vs 5.0), but there was no difference in frailty (CFS=3) or ICU length of stay (4 days). The provision of invasive ventilation and vasopressors were higher in the treatment withdrawn group (93% vs 55% and 73% vs 47% respectively) suggesting that severe cases of elderly trauma accepted to the ICU were given a time limited trial of full therapy. The treatment withheld group featured similar trends with a greater provision of non-invasive ventilation (14% vs 11%), invasive ventilation (66% vs 61%) and vasopressors (57% vs 50%), with little difference in frailty (CFS=4 vs 3). A recent study of octogenarians in German ICUs identified that 51% of all admissions were classified as ‘frail’ (CFS=5-9) and that higher frailty was significantly associated with the implementation of life-sustaining treatment limitations (p=0.003) [29] . The low frailty of treatment limitation groups in this study may indicate that frail elderly patients either sustain fewer traumas or may be more consistently denied ICU care in the context of trauma than the general population. Frailty scoring *after* arrival to the ICU would therefore be less applicable and explain the superiority of illness severity in predicting outcome. Applying limitations of life-sustaining treatment was strongly associated with reduced survival to ICU discharge and 30-day mortality which supports recent data by Flaatten *et al.* and Bruno *et al.* [29, 30].

In this study, the presence of head injury, whether isolated or associated with multi-trauma, correlated with poor outcome (p<0.01). This finding is consistent with previous studies which have identified head injury and initial GCS to be associated with increased mortality [2, 20, 24, 31]. We found that less than half of patients who sustained a head injury survived at 30-days. This information may aid the intensivist with setting reasonable long-term expectations with the patient, their family, and the multidisciplinary team.

LIMITATIONS

Several limitations exist for this study. First, the original studies described regional variations in the characteristics of patients admitted to the ICU in view of known heterogeneity in healthcare provision across the continent [6, 7]. This may limit the applicability of these results to specific healthcare settings. Second, the data did not capture information regarding the discharge disposition, long-term functional status, cognitive decline, health related quality of life and long-term mortality. Pecheva *et al* found the risk of death to almost double from 30 days to 1 year in non-ICU trauma patients aged over 60 years with a high frailty score [21]. Other work has identified that patients aged above 80 are more likely to be discharged to a location other than their home following an ICU stay, adding weight to the argument that mortality is not always a useful standalone outcome measure [2, 21, 23] . Third, no trauma severity scores were available and we were therefore unable to adjust for the severity of trauma, although the SOFA score is a measure of sickness severity and a composite marker of organ failure so mitigates this limitation to some degree. In addition, subdividing the population into those with and without head injury has provided additional prognostic information. Lastly, information regarding patients admitted to hospital with major trauma who were not admitted to critical care was not unavailable. Given that as many as two thirds of patients referred to critical care aged 80 and above may be denied admission or have limitations of care in place, this may represent a significant proportion of major trauma admissions [32-34]. We are therefore unable to assess the incremental gain from ICU admission versus ward-based care in patients presenting after sustaining major trauma. In view of the physiological and psychological trauma associated with critical care intervention, the comparison between the outcomes of ICU and non-ICU major trauma patients may provide valuable information that clinicians may use to counsel patients, family and carers of the potential risks or benefits of ICU admission and should be a focus of future work.

Despite these limitations, we have presented detailed data from a large cohort describing the baseline characteristics, interventions and outcomes in very old trauma patients requiring ICU admission across Europe. These clinical outcomes are valuable for patients and clinicians when considering and communicating the risk of a critical care admission.

Conclusions

Admissions for major trauma in the very old are common and the mortality rate is high. In this study, frailty was not associated with increased mortality at 30 days in very old patients admitted to critical care following major trauma. Increased illness severity, measured using SOFA, and trauma with head injury was independently associated with worse outcomes. Further prospective studies are required, in this important population, to validate these scores as risk prediction methods to help determine who will benefit from ICU care.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Funding Sources

The ESICM supported VIP-1 with a research award. Free support for running the electronic database was granted from Aarhus University, Denmark. Financial support for creation of the e-CRF and maintenance of the database was possible from a grant (open project support) by the Western Health Region in Norway in 2018.

Ethical Statement

The study protocol was reviewed and approved by the ethics committees of all 22 participating countries in accordance with national guidelines. Consent to participate varied. In 15 countries written informed consent was required from the patient or their next of kin for vulnerable patients, whereas in 7 countries deferred consent was accepted [35]. In some countries for deceased patient consent was not required in accordance with local or national guidelines Each participating centre received a copy of the study protocol and institutional research ethic board approval was obtained from each study site and was mandatory for study participation. The study was planned in adherence with the European Union General Data Privacy Regulation (GDPR) directive, which is implemented in most participating countries.

For VIP-1, in Norway where the chief investigator (HF) works, the study protocol was reviewed and approved by the National Board in Helse Sør-Øst, approval number 2016/806/REK, the date of the decision was 05/09/16. For VIP-2, in France where the chief investigator for VIP-2 (BG) works, the study protocol was reviewed and approved by Comite de Protection des Personnes (CPP), approval number ID-RCB:2018-A01664-51, the date of the decision was 18/09/18. These studies were registered on ClinicalTrials.gov (IDs: NCT03134807 and NCT03370692).

Author Contributions

All authors were involved in the design of this work; Chris F Duncan, Susannah K Leaver and Dagan O Lonsdale drafted the manuscript. All authors (Helen Farrah, Sarah Farnell-Ward, Christine Ryan, Ximena Watson, Maurizio Cecconi, Jesper Fjølner, Wojciech Szczeklik, Rui Moreno, Antonio Artigas, Michael Joannidis, Dylan W. de Lange, Bertrand Guidet, Hans Flaatten and Christian Jung reviewed and contributed to the final version.

Data Availability Statement

All data generated or analysed during this study are included in this article. Further inquiries can be directed to the corresponding author.

References

1. The Trauma Audit and Research Network. Major Trauma in Older People (England & Wales). 2017.

2. Hwabejire JO, Kaafarani HM, Lee J, Yeh DD, Fagenholz P, King DR, et al. Patterns of injury, outcomes, and predictors of in-hospital and 1-year mortality in nonagenarian and centenarian trauma patients. JAMA Surg. 2014 Oct;149(10):1054-9.

3. Union ECSOotE, Amt EKS. Ageing Europe: Looking at the Lives of Older People in the EU : 2019 Edition. Publications Office of the European Union; 2019.

4. Flaatten H, de Lange DW, Artigas A, Bin D, Moreno R, Christensen S, et al. The status of intensive care medicine research and a future agenda for very old patients in the ICU. Intensive Care Med. 2017 Sep;43(9):1319-28.

5. Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. The Lancet. 2013 2013/03/02/;381(9868):752-62.

6. Flaatten H, De Lange DW, Morandi A, Andersen FH, Artigas A, Bertolini G, et al. The impact of frailty on ICU and 30-day mortality and the level of care in very elderly patients (≥ 80 years). Intensive Care Medicine. 2017 2017/12/01;43(12):1820-28.

7. Guidet B, de Lange DW, Boumendil A, Leaver S, Watson X, Boulanger C, et al. The contribution of frailty, cognition, activity of daily life and comorbidities on outcome in acutely admitted patients over 80 years in European ICUs: the VIP2 study. Intensive care medicine. 2020;46(1):57-69.

8. Vincent JL, Moreno R, Takala J, Willatts S, De Mendonça A, Bruining H, et al. The SOFA (Sepsis-related Organ Failure Assessment) score to describe organ dysfunction/failure. On behalf of the Working Group on Sepsis-Related Problems of the European Society of Intensive Care Medicine. Intensive Care Med. 1996 Jul;22(7):707-10.

9. Rockwood K, Song X, MacKnight C, Bergman H, Hogan DB, McDowell I, et al. A global clinical measure of fitness and frailty in elderly people. Cmaj. 2005 Aug 30;173(5):489-95.

10. Health NIf, Excellence C. COVID-19 rapid guideline: critical care in adults NICE guideline [NG159].

11. Jung C, Flaatten H, Fjølner J, Bruno RR, Wernly B, Artigas A, et al. The impact of frailty on survival in elderly intensive care patients with COVID-19: the COVIP study. Crit Care. 2021 Apr 19;25(1):149.

12. Jarman H, Crouch R, Baxter M, Wang C, Peck G, Sivapathasuntharam D, et al. Feasibility and accuracy of ED frailty identification in older trauma patients: a prospective multi-centre study. Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine. 2021 2021/03/30;29(1):54.

13. Rickard F, Ibitoye S, Deakin H, Walton B, Thompson J, Shipway D, et al. The Clinical Frailty Scale predicts adverse outcome in older people admitted to a UK major trauma centre. Age and Ageing. 2020;50(3):891-97.

14. Tipping CJ, Bilish E, Harrold M, Holland AE, Chan T, Hodgson CL. The impact of frailty in critically ill patients after trauma: A prospective observational study. Aust Crit Care. 2020 May;33(3):228-35.

15. Van Heerden PV, Beil M, Guidet B, Sviri S, Jung C, de Lange D, et al. A new multi-national network studying Very old Intensive care Patients (VIPs). Anaesthesiology intensive therapy. 2021;53(4):290-95.

16. Antonucci E, Donadello K, Cristallini S, Beumier M, Jacobs F, Cotton F, et al. Meropenem and piperacillin pharmacokinetics during extracorporeal membrane oxygenation: A case-control study. Intensive Care Medicine. 2013 October;39:S305.

17. Team RC. R: A language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing; 2016.

18. Kehoe A, Smith JE, Edwards A, Yates D, Lecky F. The changing face of major trauma in the UK. Emerg Med J. 2015 Dec;32(12):911-5.

19. Hamidi M, Zeeshan M, Leon-Risemberg V, Nikolich-Zugich J, Hanna K, Kulvatunyou N, et al. Frailty as a prognostic factor for the critically ill older adult trauma patients. Am J Surg. 2019 Sep;218(3):484-89.

20. Cole E, Aylwin C, Christie R, Dillane B, Farrah H, Hopkins P, et al. Multiple Organ Dysfunction in Older Major Trauma Critical Care Patients: A Multicenter Prospective Observational Study. Annals of Surgery Open. 2022;3(2):e174.

21. Pecheva M, Phillips M, Hull P, Carrothers A OLR, Queally JM. The impact of frailty in major trauma in older patients. Injury. 2020 2020/07/01/;51(7):1536-42.

22. Carter B, Short R, Bouamra O, Parry F, Shipway D, Thompson J, et al. A national study of 23 major trauma centres to investigate the effect of frailty on clinical outcomes in older people admitted with serious injury in England (FiTR 1): a multicentre observational study. The Lancet Healthy Longevity. 2022;3(8):e540-e48.

23. Bagshaw SM, Webb SA, Delaney A, George C, Pilcher D, Hart GK, et al. Very old patients admitted to intensive care in Australia and New Zealand: a multi-centre cohort analysis. Crit Care. 2009;13(2):R45.

24. Mock K, Keeley J, Moazzez A, Plurad DS, Putnam B, Kim DY. Predictors of Mortality in Trauma Patients Aged 80 years or Older. Am Surg. 2016 Oct;82(10):926-29.

25. Fröhlich M, Wafaisade A, Mansuri A, Koenen P, Probst C, Maegele M, et al. Which score should be used for posttraumatic multiple organ failure? - Comparison of the MODS, Denver- and SOFA- Scores. Scand J Trauma Resusc Emerg Med. 2016 Nov 3;24(1):130.

26. Kumar M, S CC. SOFA scoring system in assessing prognosis of critically ill surgical and trauma patients: a prospective study. International Surgery Journal. 2018;5(7).

27. Antonelli M, Moreno R, Vincent JL, Sprung CL, Mendoça A, Passariello M, et al. Application of SOFA score to trauma patients. Sequential Organ Failure Assessment. Intensive Care Med. 1999 Apr;25(4):389-94.

28. Philippart F, Vesin A, Bruel C, Kpodji A, Durand-Gasselin B, Garçon P, et al. The ETHICA study (part I): elderly's thoughts about intensive care unit admission for life-sustaining treatments. Intensive Care Med. 2013 Sep;39(9):1565-73.

29. Bruno RR, Wernly B, Beil M, Muessig JM, Rahmel T, Graf T, et al. Therapy limitation in octogenarians in German intensive care units is associated with a longer length of stay and increased 30 days mortality: A prospective multicenter study. J Crit Care. 2020 Dec;60:58-63.

30. Flaatten H, Guidet B, de Lange DW, Beil M, Leaver SK, Fjølner J, et al. The importance of revealing data on limitation of life sustaining therapy in critical ill elderly Covid-19 patients. J Crit Care. 2022 Feb;67:147-48.

31. Bolandparvaz S, Yadollahi M, Abbasi HR, Anvar M. Injury patterns among various age and gender groups of trauma patients in southern Iran: A cross-sectional study. Medicine (Baltimore). 2017 Oct;96(41):e7812.

32. Ihra GC, Lehberger J, Hochrieser H, Bauer P, Schmutz R, Metnitz B, et al. Development of demographics and outcome of very old critically ill patients admitted to intensive care units. Intensive Care Med. 2012 Apr;38(4):620-6.

33. Garrouste-Orgeas M, Timsit JF, Montuclard L, Colvez A, Gattolliat O, Philippart F, et al. Decision-making process, outcome, and 1-year quality of life of octogenarians referred for intensive care unit admission. Intensive Care Med. 2006 Jul;32(7):1045-51.

34. Boumendil A, Aegerter P, Guidet B. Treatment intensity and outcome of patients aged 80 and older in intensive care units: a multicenter matched-cohort study. J Am Geriatr Soc. 2005 Jan;53(1):88-93.

35. Flaatten H, Guidet B, Jung C, Boumendil A, Leaver S, Szczeklik W, et al. Consent is a confounding factor in a prospective observational study of critically ill elderly patients. PloS one. 2022;17(10):e0276386.

Figure 1: Distribution of age and clinical frailty scale of participants in VIP-1 & VIP-2 admitted with major trauma.

Figure 2: 30-day mortality by SOFA score. Numbers on plot indicate number of deaths.