



Intensive care of geriatric patients – a thin line between under- and overtreatment

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Summary Demographic developments are leading to an ever-increasing proportion of elderly and aged patients in hospitals at all levels of care, and even more patients from these age groups are to be expected in the future. Based on the projected population development, e.g., in Norway, an increase in intensive care beds of between 26 and 37% is expected by 2025. This poses special challenges for the treatment and management of geriatric intensive care patients. The acute illness is not the only decisive factor, but rather the existing multimorbidity and functional limitations of this vulnerable patient group must likewise be taken into account. Age per se is not the sole determinant of prognosis in critical patients, even though mortality increases with age.

Keywords Geriatric · Intensive care medicine · Frailty · Outcome · Older adults

Introduction

Intensive care had its inception around 1960 in provisionally converted hospital rooms with additional monitoring facilities, special treatment, and elaborate documentation. In recent decades, and especially in recent years, intensive care has continued to develop [1]. It is characterized by high to extreme disease

severity in the affected patients and high invasiveness in monitoring and therapy, with advanced levels of technology and increasing use of equipment but also high staff deployment. Intensive care is always a part of the comprehensive therapy, sometimes in a supportive function to enable the therapy of the underlying disease in the first place. Thus, intensive care defines the use of therapeutic options for the temporary replacement of disturbed or failed organ functions, while at the same time, the underlying condition must be treated. The goal is to restore the function of the disturbed organ system in order to enable further life under acceptable conditions [2]. Herein, we find the first differences in the assessment of quality of life in elderly patients compared to younger adults [3].

Geriatric patients

Persons are usually defined as “old adults” from the age of 65, and so far this has been linked to the retirement age in most European countries. Currently, about 25% of the European population are older than 60. This portion is expected to reach 35% in 2050. Compared to 2017, the number of people ≥60 years is expected to more than double by 2050 and more than triple by 2100. Thus, the proportion of very old patients in need of intensive care who are over 80 years old (octogenarians) will also increase. Their share is currently some 10–20% [4, 5] and is steadily increasing. Depending on the specialty of the Intensive Care Unit (ICU), it is between 15 and 30%. Based on the projected population development, e.g., in Norway, an increase in intensive care beds of between 26 and 37% is expected by 2025 [6]. Against this background of demographic change, geriatric medicine must increasingly be incorporated into the work on intensive care wards; modern intensive

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Table 1 Comprehensive definition of geriatric patients [9]

Geriatric patients are defined by
<ul style="list-style-type: none"> – Geriatrics-typical multimorbidity – Advanced age (predominantly 70 years or older)
<i>Wherein the geriatrics-typical multimorbidity must be given precedence over the age in years</i>
Or by
<ul style="list-style-type: none"> – Age 80+
Due to the increased vulnerability typical of old age, e.g., because of
<ul style="list-style-type: none"> – Occurrence of complications and sequelae – Risk of chronification – Increased risk of loss of autonomy with deterioration of independence

care without knowledge about the elderly is obsolete [7].

A functionally healthy person is physically and mentally intact, with an activity corresponding to that of a person without disorder, and active without impairment in all areas of life [8]. In geriatric patients, this no longer fully applies.

Although an ostensible association with age cannot be denied in the case of multimorbidity and the associated morbidity and mortality, chronological age alone is not decisive. The characteristics of geriatric patients are summarized in Table 1.

Multimorbidity and frailty

Critically ill geriatric patients are characterized by multimorbidity, i.e., simultaneous presence of several chronically existing diseases requiring treatment, coupled with physiological loss of organ function [10]. Organ-ageing processes lower the clinical threshold for organ dysfunction, resulting in atypical symptomatology, immunosenescence, and a steady decline in pulmonary function with age, as well as altered pharmacokinetics [11]. This constellation increases the risk of complications, and geriatric patients depend on rapid and effective treatment, as delayed

treatment presents the risk of swift deterioration and severe secondary complications. The additional frailty that exists in many cases makes the elderly patient and the old organism react more sensitively to external influences and acute disorders, entailing loss of functionality [12]. In the context of intensive care treatment of geriatric patients, frailty is associated with more complications in the course, more difficult convalescence, and, last but not least, higher mortality [13]. The Clinical Frailty Scale [14] is suitable as an additional assessment aid. The corresponding classification is shown in Table 2.

The objective of the Clinical Frailty Scale (CFS) is to identify patients who are at increased risk of failing treatment and unlikely to benefit from intensive care intervention. The Clinical Frailty Scale has a high diagnostic value with regard to the short- and long-term prognosis of very old patients in intensive care and can be applied prospectively [15]. In intensive care patients, frailty is associated with increased in-hospital mortality, increased long-term mortality, and fewer patient discharges into the domestic environment [16]. Application of the scale is easy to learn, the scale is validated for daily intensive care clinical practice in Germany, and interrater reliability is high [17]. Despite primarily successful intensive care, survivors suffering from frailty have twice the risk of not being discharged home into their previous living environment [18].

Sepsis

Sepsis is a systemic inflammatory response of the organism to a bacterial infection and still associated with high mortality. The incidence of sepsis increases sharply with age, lethality moderately. The mortality of sepsis, on the other hand, increases significantly [19]. However, functionality is also significantly reduced, e.g., after septic pneumonia [29].

Table 2 Clinical Frailty Scale [14]

Category	Description
Very fit	People in this category are robust, active, full of energy, and motivated. They usually train regularly and are among the fittest within their age cohort
Averagely active	People in this category do not show active symptoms of disease but are not as fit as people in the first category are. They are moderately active or very active at times, e.g., seasonally
Doing well	The disease symptoms of this group of people are well controlled, but apart from walking in the course of their everyday activities, they do not exercise regularly
Vulnerable	Even if they are not dependent on external assistance in everyday life, people in this category are often restricted in their activities due to their disease symptoms. They often complain of daytime fatigue and/or report that everyday activities take more time
Slightly frail	People in this category appear slowed down in their activities and need help with demanding daily activities, such as financial matters, transport, heavy housework, and dealing with medication. Low-grade frailty affects independent shopping, walking, meal preparation, and household activities
Moderately frail	People in this category need help with all activities outside the home and with household management. In the home, they often have difficulty with stairs, need help with bathing/showering, and may need guidance or minimal assistance with dressing
Markedly frail	People in this category are completely dependent on external help for personal care due to physical or cognitive limitations. Nevertheless, their health is stable. The probability that they will die within the next 6 months is low
Extremely frail	Completely dependent on support and approaching the end of his or her life. In many cases, people in this category do not recover even from minor illnesses
Terminally ill	People in this category have a life expectancy <6 months. The category refers to people who otherwise show no signs of frailty

Table 3 Functional lung organ changes in the elderly (modified from [37])

Structure	Changes	Significance
Airways and lung parenchyma	Loss of muscular support in the pharynx	Risk of aspiration
	Reduced effectiveness of the protective reflexes	Reduced self-cleaning of the lungs
	Reduced ciliary function	
	Extension of the dead space	
Pulmonary mechanics	Reduced respiratory muscles	Hampering of the respiratory pump
	Osteoporosis/kyphosis	Reduced thoracal excursions
	Calcification of the rib cartilage	More difficult ventilation conditions
Lung volumes	Reduced vital capacity	Less breathing reserve
	Reduced FEV ₁ (30 ml/year)	Lower endurance
	Increase in FRC	Adjustment of the ventilation volumes
Pulmonary comorbidities	Chronic obstructive bronchitis	Difficult weaning
	Pulmonary hypertension	Restricted oxygenation
	Pulmonary fibrosis	Prolonged convalescence

FEV forced expiratory volume, *FRC* functional residual capacity

In the acute emergency, assessment of the critical illness is difficult, and the symptoms are often not pathognomonic [21]. In the elderly, sepsis is often asymptomatic or atypical in its presentation. Laboratory parameters such as leukocyte count or C-reactive protein levels are not always pathognomonic either [22]. In this context, inflammatory biomarkers such as procalcitonin have proven reliable for detection of bacterial infections of the lower respiratory tract even in elderly patients [23].

In many cases, delirium is the only reliable diagnostic criterion in this situation, which can be decisive. This is also defined in the Quick-SOFA Score (qSOFA) for altered vigilance [24]. Falls, functional deterioration, and cognitive change often manifest the initial phase of sepsis or general weakness that cannot be defined specifically [25]. In the course of initial assessment, this can then lead to a high risk of undertriage in the elderly, failure to ascertain high-risk constellations, or misinterpretation of vital signs [26, 27]. This problem was also found to be typical of COVID-19 infections in the elderly [28]. In addition, the circadian rhythm is significantly more disturbed in elderly patients with sepsis [29], often leading to a complicated course of treatment.

Delirium

Delirium is defined as an acute deterioration of cognitive functions and attention and is a common mental disturbance in the elderly.

The particular susceptibility of old people to a variety of triggering disturbances makes delirium a geriatric condition. Delirium is the most common complication in hospitalized elderly patients, with a prevalence in conservative medical fields reported at 11–42% [30]. Delirious agitation is reported in up to 85% of intensive care patients [31]. Acutely ill and cerebrally damaged patients are particularly affected [32]. The care of delirious patients is part of every-

day life in ICUs, whereby the acute disorder itself underlying the admission or, alternatively, the intensive care treatments and environmental conditions may be what triggers the delirium. According to the current German S3 guideline, over 80% of patients in analgo-sedation are affected. Purely hyperactive delirium is found rather infrequently in intensive care units—about two thirds of patients suffer from hypoactive delirium [33]. In acute situations, only 30% of delirious patients are recognized accordingly [32]. The risk of delirium must be assessed early [34], and preventive measures must be initiated and treatment options utilized. If left untreated, the mortality rate is similar to that of acute myocardial infarction [35], and morbidity with resulting permanent dependence on institutional care is increased [36].

Mechanical ventilation

Ventilation is an essential part of intensive care and increasingly used in advanced age. Although performance and prognosis depend largely on knowledge of the underlying respiratory disorder, functional changes in the lung parenchyma and airways in the elderly may complicate ventilation therapy. The changes associated with physiological ageing are summarized in Table 3.

Although there is an initial association between advanced age and mortality, age does not play a role in the success of respiratory weaning after invasive ventilation [38]. Non-invasive ventilation (NIV) for respiratory insufficiency is becoming increasingly important in advanced age [39]. In the meantime, decreasing mortality among the elderly has been observed [40].

Cardiopulmonary resuscitation

Globally, sudden cardiac death affects around 350,000 to 700,000 people each year [41], making it still one of the leading causes of death in the western industrial-

ized world [42]. Here, too, increasing life expectancy is leading to growing numbers of elderly and old (<80 years) patients being admitted to intensive care units after primarily successful resuscitation [43]. In all age groups, the success of cardiopulmonary resuscitation depends on a variety of factors. In the few studies that address resuscitation of elderly patients, it has been shown that age per se has no independent effect on mortality or survival. The rate of primary successful resuscitation in patients over 70 years of age is about 20% [44]. Extensive acute myocardial infarction, hypoxia-induced asystole, or pre-existing severe heart failure have a poor prognosis for successful resuscitation, and a long duration of resuscitation or failure to detect cardiovascular arrest is deemed almost invariably fatal. Elderly patients benefit from a short resuscitation time or treatment of causative arrhythmias such as ventricular tachycardia or ventricular fibrillation [45]. Also, as expected, the outcome is worse for functionally impaired patients and residents of long-term care facilities [46]. Discharge alive after resuscitation in nursing home residents is around 2% [47], but this should by no means lead to refraining from resuscitation attempts in nursing home residents at all. About one in two of this total group can be discharged back into the domestic environment. It has been shown that of patients over 90 years of age with cardiovascular arrest, around 46% survived their stay in the ICU, and the 1-year survival rate was 23% [48]. Overall, due to the often-small number of cases, the studies on resuscitation in elderly and old patients allow only limited conclusions. Thus, despite the generally less favorable course in elderly patients, resuscitation is, as a matter of principle, indicated and expedient, since survivors also report a thoroughly satisfactory quality of life, although the rate of transfers to institutional facilities is slightly increasing.

Outcome

With increasing age, all organs and organ systems are subject to a physiological ageing process. Due to the limitation of the physiological reserves, this means that even minimal deviations or noxae can lead to organ dysfunction and even multiorgan failure [11]. With regard to the outcome after intensive care treatment, even though the patients showed concentration deficits, states of exhaustion, and depressive moods, the majority were able to carry out their usual everyday activities to the same extent as before the treatment. Even if functional limitations are temporarily greater immediately after discharge from the intensive care unit, the independence of geriatric patients indeed returns to normalcy in the following months [49]. This is also the reason for the geriatricians' task to get involved as early as possible, in order to coordinate early rehabilitation and discharge management in interdisciplinary communication after identifying geri-

atric risk patients [50]. With regard to outcome, one should therefore not presume age-related mortality, but rather functional limitations, comorbidities, living in a nursing home, chronic need for dialysis, and similar risk factors must be taken into account [51]. Furthermore, delayed admission to the intensive care unit in case of an existing indication is a significant limiting factor for treatment success [52]. Long-term survival of elderly patients after intensive care treatment varies and is essentially dependent on the existing limitations of functionality before and after hospitalization [53]. However, the impairment of functionality for coping with everyday life and the associated reduced self-assessment of quality of life can be significant [54]. Impairment can persist for years [55]. This is even more pronounced if the patients were already severely restricted before or used to live in long-term care facilities [56]. According to the current state of studies, age per se contributes only a small part to the description of the mortality risk [57]. Some studies even show a pronounced survival benefit from ICU admission in elderly patients. For example, an absolute mortality reduction of 20% was found in patients over 84 years of age [58].

Treatment goal setting and treatment goal modification

The important aspect of changing treatment goals must not be absent from the discussion on intensive care treatment of geriatric patients. The perspective of possible survival of the life-threatening disease is the most important endpoint and goes far beyond the question of mere survival. For intensive care, it is still unsatisfactory to have a situation where patients survive the acute phase, but it is unsure whether they will be able to cope in everyday life later on with a persisting restriction of functionality or a severe handicap. Often, too much is expected and too little attention paid to prognosis assessment for any clinical pattern, at any age. It is important to recognize in due time when a medical therapy is not, or no longer, indicated, so that it can then no longer be prescribed or can be terminated. Thus, quality of life and independence will certainly represent a benchmark for the assessment of intensive care treatment in the future [59]. Intensive care of elderly patients has become part of everyday clinical practice and is no longer a rarity. Due to the limitations of financial and human resources and the increasing numbers of elderly patients requiring intensive care, there is a risk of incorrect treatment, overtreatment, and undertreatment of geriatric intensive care patients [60]. Hence inevitably, the question keeps being asked as to how to define the patient-centered indication for intensive care treatment correctly and to the benefit of the patient. Accurate prognosis by physicians likewise takes place less frequently, and physicians moreover tend to underestimate the quality of life and life expectancy

of elderly patients, so that overall, elderly patients not infrequently receive less aggressive treatment [61, 62]. “It is the task and goal of intensive care to preserve life and not to protract dying” states the consensus paper of the Austrian intensive care societies on the topic of changing treatment goals [63]. This makes it clear that treatments that have become futile cannot be justified either medically or ethically. Decisions in intensive care must follow basic ethical principles, without limitations or reservations [64].

Of course, the individual patient’s wishes are of the utmost importance in the decision for or against intensive care therapy.

Conclusion

- Persons of advanced age show multimorbidity.
- In many cases, the elderly present with atypical symptoms.
- Age per se is not the sole determinant of prognosis in critical patients, even though mortality increases with age.
- Comorbidity burden and functionality are crucial for outcome in geriatric intensive care patients.
- Early identification of patients at risk for morbidity and mortality is important.
- In critically ill geriatric patients, indicated intensive therapy should be started as soon as possible, since the organ reserves are reduced.
- There is a need for standardized treatment protocols in invasive procedures for elderly patients.
- Participation of geriatrics in the care of critically ill patients already in the intensive care setting.
- Early rehabilitation and discharge planning should be achieved.
- Acute geriatric follow-up after intensive care treatment improves prognosis.
- The question is not whether or not intensive care is expedient for geriatric patients. The question must be: Does intensive care make sense without a basic understanding of geriatrics?

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Ethical standards For this article no studies with human participants or animals were performed by any of the authors. All studies performed were in accordance with the ethical standards indicated in each case.

References

1. Bartels O. Intensivtherapie aus internistischer Sicht. In: Lang K, editor. *Intensivtherapie im Alter*. Berlin, Heidelberg, New York: Springer; 1974. pp. 86–99.
2. Lawin P, editor. *Praxis der Intensivbehandlung*. 3rd ed. Stuttgart: Thieme; 1975.
3. Vosylius S, Sipylaite J, Ivaskevicius J. Determinants of outcome in elderly patients admitted to the intensive care unit. *AgeAgeing*. 2005;35:157–62.
4. Leblanc G, Boumendil A, Guidet B. Ten things to know about critically ill elderly patients. *Intensive Care Med*. 2017;43:217–9.
5. Bagshaw SM, Webb SA, Delaney A, et al. Very old patients admitted to intensive care in Australia and New Zealand: a multi-centre cohort analysis. *Crit Care*. 2009;13:R453.
6. Laake JH, Dybwik K, Flaatten HK, et al. Impact of the post-World War II generation on intensiv care needs in Norway. *Acta Anaesthesiol Scand*. 2010;54:479–84.
7. Heppner HJ. Intensivstationen: Geriater wollen Altersmedizin stärken. 2017. <https://www.aerzteblatt.de/nachrichten/73872/Intensivstationen-Geriater-wollen-Altersmedizin->. Accessed 27 Sept 2021.
8. Grenness C, Meyer C, Scarinci N, et al. The international classification of functioning, disability and health as a framework for providing patient- and family-centered audiological care for older adults and their significant others. *Semin Hear*. 2016;37:187–99.
9. Heppner HJ, Sieber C, Walger P, et al. Infections in the elderly. *Crit Care Clin*. 2013;46:361–71.
10. Steinman MA, Lee SJ, Boscardin WJ, et al. Patterns of multimorbidity in elderly veterans. *J Am Geriatr Soc*. 2012;60:1872–80.
11. Müller-Werdan U, Heppner HJ, Michels G geriatric intensive care patients: perspectives and limits of geriatric intensive care medicine. *Med Klin Intensivmed Notfmed*. 2018;113:256–9.
12. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, et al. Sarcopenia: European consensus on definition and diagnosis: report of the European working group on sarcopenia in older people. *AgeAgeing*. 2010;39:412–23.
13. Heppner HJ, Bauer JM, Sieber CC, et al. Laboratory aspects relating to the detection and prevention of frailty. *Int J Prev Med*. 2010;1:149–57.
14. Singler K, Antwerpen L. Klinische Frailty Skala. 2020. <https://www.dggeriatrie.de/ueber-uns/aktuelle-meldung/en/1682-covid-19-dgg-veroeffentlicht-poster-zur-klinische-n-frailty-skala-cfs>. Accessed 30 Sept 2021.
15. Jung C, Bruno RR, Wernly B, et al. Frailty as a prognostic indicator in intensive care. *Dtsch Arztebl Int*. 2020;117:668–73.
16. Muscedere J, Waters B, Varambally A, et al. The impact of frailty on intensive care unit outcomes. *Intensive Care Med*. 2017;43:1105–22.
17. Romero-Ortuno R, Walölis S, Biram R, et al. Clinical frailty adds to acute illness severity in predicting mortality in hospitalized older adults: an observational study. *Eur J Intern Med*. 2016;35:24–34.
18. Shears M, Takaoka A, Rochweg B, et al. Assessing frailty in the intensive care unit: a reliability and validity study. *J Crit Care*. 2018;45:197–203.
19. Nau R, Djukic M, Seele J, et al. Warum sind Infektionen bei Senioren so gefährlich? *Neurotransmitter*. 2021;32:1–2.
20. Welte T. Community-acquired pneumonia: a disease of the elderly. *Z Gerontol Geriatr*. 2011;44:221–8.
21. LaMantia MA, Platts-Mills TF, Biese K, et al. Predicting hospital admission and returns to the emergency department for elderly patients. *Acad Emerg Med*. 2010;17:252–9.
22. Thiem U, Niklaus D, Sehlhoff B, et al. C-reactive protein, severity of pneumonia and mortality in elderly, hospitalised patients with community-acquired pneumonia. *Age Ageing*. 2009;38:693–7.

23. Heppner HJ, Bertsch T, Alber B, et al. Procalcitonin: inflammatory biomarker for assessing the severity of community-acquired pneumonia—a clinical observation in geriatric patients. *Gerontology*. 2010;56:385–9.
24. Singer M, Deutschmann CS, Seymour CW, et al. The third international consensus definitions for sepsis and septic shock (sepsis-3). *JAMA*. 2016;315:788–800.
25. Kellett J, Nickel CH. What are nonspecific complaints and what are their causes and outcomes? The common unknown unknowns of medicine. *Eur J Intern Med*. 2018;47:e12–e3.
26. Grossmann F, Zumbunn T, Fauchinger A, et al. At risk of undertriage? Testing the performance and accuracy of the emergency severity index in older emergency department patients. *Ann Emerg Med*. 2012;60(3):317–325.e3. <https://doi.org/10.1016/j.annemergmed.2011.12.013>.
27. Platts-Mills TF, Travers D, Biese K, et al. Accuracy of the emergency severity index triage instrument for identifying elder emergency department patients receiving an immediate life-saving intervention. *Emerg Med*. 2010;17:238–43.
28. Mandal AKJ, Gan J, Chauhan R, et al. COVID-19 in older adults: typically atypical. *Geriatr Gerontol Int*. 2021;21:119–20.
29. Davoudi A, Corbett DB, Ozrazgat-Baslanti T, et al. Activity and circadian rhythm of sepsis patients in the intensive care unit. *IEEE EMBS Int Conf Biomed Health Inform*. 2018;16:17–20.
30. Siddiqi N, House AO, Holmes JD. Occurrence and outcome of delirium in medical in-patients: a systematic literature review. *Age Ageing*. 2006;35:350–64.
31. Inouye SK, Westendorp RG, Saczynski JS. Delirium in elderly people. *Lancet*. 2014;383:911–22.
32. Singler K, Thiem U, Christ M, et al. Aspects and assessment of delirium in old age. First data from a German interdisciplinary emergency department. *Z Gerontol Geriatr*. 2014;47:680–5.
33. Müller A, Weiß B, Spies CD, et al. Symptomatic treatment of delirium, anxiety and stress, and protocol based analgesia, sedation and management of sleep in intensive care patients. *Anesthesiol Intensivmed Notfallmed Schmerzther*. 2015;50:698–703.
34. Heriot NR, Levinson MR, Mills AC, et al. Diagnosing delirium in very elderly intensive care patients. *Intensive Crit Care Nurs*. 2017;38:10–7. <https://doi.org/10.1016/j.iccn.2016.07.002>.
35. National Institute for Health and Clinical Excellence. NICE guideline. 2021. <http://www.nice.org.uk/guidance/CG103>. Accessed 25 Sept 2021.
36. Gurlit S, Möllmann M. How to prevent perioperative delirium in the elderly? *Z Gerontol Geriatr*. 2008;41:447–52.
37. Singler K, Christ M, Sieber C, et al. Geriatric patients in emergency and intensive care medicine. *Internist (Berl)*. 2011;52:934–8.
38. Hifumi T, Jinbo I, Okada I, et al. The impact of age on outcomes of elderly ED patients ventilated due to community acquired pneumonia. *Am J Emerg Med*. 2015;33:277–81. <https://doi.org/10.1016/j.ajem.2014.10.046>.
39. Heppner HJ, Singler K, Sieber CC, et al. Evidence-based medicine: implications from the guideline “non-invasive ventilation” in critically ill elderly patients. *Z Gerontol Geriatr*. 2011;44:103–8.
40. Lerolle N, Trinquart L, Bornstain C, et al. Increased intensity of treatment and decreased mortality in elderly patients in an intensive care unit over a decade. *Crit Care Med*. 2010;38:59–64.
41. Berdowski J, Berg RA, Tijssen JG, et al. Global incidences of out-of-hospital cardiac arrest and survival rates: systematic review of 67 prospective studies. *Resuscitation*. 2010;81:1479–87.
42. Benjamin EJ, Virani SS, Callaway CW, et al. Heart disease and stroke statistics-2018 update: a report from the American heart association. *Circulation*. 2018;137:e67–e492.
43. Nielsson MS, Christiansen CE, Johansen MB, et al. Mortality in elderly ICU patients: a cohort study. *Acta Anaesthesiol Scand*. 2014;58:19–26.
44. Dumont JA, Burval DJ, Sprung J, et al. Outcome of adult cardiopulmonary resuscitations at a tertiary referral center including results of “limited” resuscitation. *Arch Intern Med*. 2001;161:1751–8.
45. Elshove-Bolk J, Guttormsen AB, Austlid I. In-hospital resuscitation of the elderly: characteristics and outcome. *Resuscitation*. 2007;74:372–3376.
46. Günther A, Schildmann J, in der Schmitten J, et al. Opportunities and risks of resuscitation attempts in nursing homes—facts for nursing home residents and caregivers. *Dtsch Arztebl Int*. 2020;117:757–63.
47. Vaux J, Lecarpentier E, Heidet M, et al. Management and outcomes of cardiac arrests at nursing homes: a French nationwide cohort study. *Resuscitation*. 2019;140:86–92.
48. Roedel K, Jarcezak D, Becker S, et al. Long-term neurological outcomes in patients aged over 90 years who are admitted to the intensive care unit following cardiac arrest. *Resuscitation*. 2018;132:6–12.
49. Sacanella E, Pérez-Castejón JM, Nicolás JM, et al. Functional status and quality of life 12 months after discharge from a medical ICU in healthy elderly patients: a prospective observational study. *Crit Care*. 2011;5:R105.
50. Stricker KH, Sailer S, Uehlinger DE, et al. Quality of life 9 years after an intensive care unit stay: a long-term outcome study. *J Crit Care*. 2011;26:379–87.
51. Sligl WI, Eurich DT, Marrie TJ, et al. Age still matters: prognosticating short- and long-term mortality for critically ill patients with pneumonia. *Crit Care Med*. 2010;38:2126–32.
52. Qiang XH, Yu TO, Li YN, et al. Prognosis risk of urosepsis in critical care medicine. *Biomed Res Int*. 2016;2016:9028924.
53. Wehler M. Langzeitprognose alter Intensivpatienten nach intensiv-medizinischer Behandlung. *Med Klin Intensivmed Notfmed*. 2011;106:29–33.
54. Anica C, Turnbull AE. Patient-centered outcomes after sepsis. *Chest*. 2020;158:1808–9.
55. Mankowski RT, Anto SD, Ghita SL, et al. Older sepsis survivors suffer persistent disability burden and poor long-term survival. *J Am Geriatr Soc*. 2020;68:1962–9.
56. Meurer WJ, Losmann ED, Smith BL, et al. Short-term functional decline of older adults admitted for suspected sepsis. *Am J Emerg Med*. 2011;29:936–42.
57. Brunner-Ziegler S, Heinze G, Ryffel M, et al. “Oldest old” patients in intensive care: prognosis and therapeutic activity. *Wien Klin Wochenschr*. 2007;119:14–9.
58. Sprung CL, Baras M, Iapichino G, et al. The eldicus prospective, observational study of triage decisionmaking in European intensive care units: part I—European intensive care admission triage scores. *Crit Care Med*. 2012;40:125–31.
59. Tabah A, Philippart F, Timsit JF, et al. Quality of life in patients aged 80 or over after ICU discharge. *Crit Care*. 2010;14:R2.
60. Boumendil A, Aegerter P, Guidet B, CUB-Rea Network. Treatment intensity and outcome of patients aged 80 and older in intensive care units: a multicenter matched-cohort study. *J Am Geriatr Soc*. 2005;53:1:88–93.
61. Sprung CL, Artigas A, Kesecioglu J, et al. The eldicus prospective, observational study of triage decision making in European intensive care units. Part II: intensive care benefit for the elderly. *Crit Care Med*. 2012;40:132–8.

62. Wirth R, Sieber CC. Health care professionals underestimate the mean life expectancy of older people. *Gerontology*. 2012;581:56–9.
63. Anonymous Konsensuspapier der Intensivmedizinischen Gesellschaften Österreichs. Empfehlungen zum Thema Therapiebegrenzung und -beendigung an Intensivstationen. *Wien Klin Wochenschr*. 2004;116:763–7.
64. Valentin A. Intensivmedizin im Alter. *Med Klin Intensivmed Notfmed*. 2017;112:303–7.

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