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**Elderly adults with COVID-19 admitted to intensive care unit: A narrative review**

Gkoufa A *et al*. Critically ill elderly COVID-19 patients

Aikaterini Gkoufa, Eleni Maneta, Georgios N Ntoumas, Vasiliki E Georgakopoulou, Athina Mantelou, Stelios Kokkoris, Christina Routsi

**Aikaterini Gkoufa, Vasiliki E Georgakopoulou,** First Department of Internal Medicine, Laiko General Hospital, National and Kapodistrian University of Athens, Athens 11527, Greece

**Eleni Maneta, Georgios N Ntoumas, Athina Mantelou, Stelios Kokkoris, Christina Routsi,** First Department of Intensive Care, School of Medicine, National and Kapodistrian University of Athens, Athens 10676, Greece

**Author contributions:** All authors contributed to this work with literature review, drafting, critical revision and editing, and approved the final version.

**Corresponding author: Aikaterini Gkoufa, MD, Doctor,** First Department of Internal Medicine, Laiko General Hospital, National and Kapodistrian University of Athens, Agiou Thoma 17, Athens 11527, Greece. [katergouf@yahoo.gr](mailto:katergouf@yahoo.gr)

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**Abstract**

BACKGROUND

In the context of the Coronavirus disease 2019 (COVID-19) pandemic, it has been reported that elderly patients are particularly at risk of developing severe illness and exhibiting increased mortality. While many studies on hospitalized elderly patients with COVID-19 have been published, limited information is available on the characteristics and clinical outcomes of those elderly patients admitted to intensive care unit (ICU).

AIM

To review the available evidence of the clinical data of elderly patients admitted to the ICU due to COVID-19.

METHODS

We searched for published articles available in English literature to identify those studies conducted in critically ill patients admitted to the ICU due to COVID-19, either exclusively designed for the elderly or for the whole ICU population with COVID-19, provided that analyses according to the patients’ age had been conducted.

RESULTS

Only one study exclusively focusing on critically ill elderly patients admitted to the ICU due to COVID-19 was found. Eighteen additional studies involving 17011 ICU patients and providing information for elderly patients as a subset of the whole study population have also been included in the present review article. Among the whole patient population, included in these studies, 8310 patients were older than 65 years of age and 2630 patients were older than 70 years. Clinical manifestations were similar for all patients; however, compared to younger ones, they suffered from more comorbidities and showed a varied, albeit high mortality.

CONCLUSION

In summary, at present, although elderly patients constitute a considerable proportion of critically ill patients admitted to the ICU due to severe COVID-19, studies providing specific information are limited. The evidence so far suggests that advanced age and comorbidities are associated with worse clinical outcome. Future studies exclusively designed for this vulnerable group are needed.

**Key Words:** SARS-CoV-2; COVID-19; Elderly; Critically ill; Intensive care unit mortality; Respiratory failure

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**Core Tip:** Coronavirus disease 2019 (COVID-19) affects people of all ages; however, the risk for severe illness increases with age, with older adults being at highest risk. While many studies with regard to COVID-19 impact on elderly patients have been carried out, the information on characteristics and clinical outcome of critically ill elderly patients admitted to the intensive care unit (ICU) due to COVID-19 is scarce. Studies exclusively designed for these patients are limited. Data derived from these studies and additionally from studies analyzing critically ill elderly patients as a subset of the whole ICU population with COVID-19, support that advanced age along with comorbidities are associated with worse clinical outcome.

**INTRODUCTION**

December 2019 was marked by the emergence of coronavirus disease 2019 (COVID-19), caused by the novel severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2)[1]. First detected in Wuhan, China, this infectious disease has spread rapidly worldwide, and it was declared a global pandemic by the World Health Organization on March 11, 2020[2].

The major clinical complication in patients with COVID-19 is respiratory failure and acute respiratory distress syndrome (ARDS) followed by sepsis, septic shock and multi-organ failure. The disease affects people of all ages; however, the incidence and the severity of COVID-19 consistently rises with increasing age[3-12]. Even if a completely understood pathophysiological mechanism for the severity of COVID-19 infection in the elderly has not been described, two major axes play a cornerstone role, multimorbidity such as hypertension, cardiovascular disease, diabetes, chronic respiratory and chronic kidney disease[13,14] as well as changes and dysregulation affecting organ systems of older adults. Specifically, changes affecting the immune system, processes known as immunosenescence and inflammaging[15-17] and anatomical and functional decline of the respiratory system[18], have been proposed to contribute to a more severe course of infection at advanced age. Furthermore, Santesmasses *et al*[19], have recently indicated an age-related increased ACE2 gene expression, which encodes the cell entry receptor for SARS-CoV-2, with increased levels of ACE2 protein in older individuals, highlighting that advanced age represents a major risk factor for disease severity.

A consequence of the increased incidence and severity of COVID-19 infection among elderly populations compared with younger adultsis that the former will often need advanced medical care[20]. This fact, combined with the ongoing global population ageing[21], highlights the burden that this particular age group with severe COVID-19 infection puts on healthcare systems worldwide.

According to the available evidence, elderly patients are at an apparent increased risk of adverse outcome[22-27]. The mortality within older patient population could probably be further compounded by shortages of ICU beds and/or access to mechanical ventilatory support[28]. Indeed, in the context of COVID-19 pandemic, age and co-morbidities have been used as selection criteria to triage patients for ICU admission in order to prioritize the younger ones[29,30]. On the other hand, it could be suggested that in no overwhelmed ICU capacity, access to ICU for elderly patients with COVID-19 may be preserved and possibly could contribute to survival of severe forms of COVID-19.

Therefore, given the significant proportion of elderly patients putting pressure on health care systems, understanding the course of COVID-19 in this specific population is considered of major importance. The aim of this review is to present the existing literature and to provide a summary of the current evidence concerning characteristics and outcomes of elderly patients admitted to the ICU due to COVID-19, useful for the better management of this vulnerable population in the future.

**MATERIALS AND METHODS**

The search of the published medical literature was conducted across PubMed and Google Scholar databases using the keywords “COVID-19”, “SARS-CoV-2”, “critical care”, “intensive care”, “ICU”, “mechanical ventilation”, “elderly”, “older patients”, “death”, “mortality”, in order to find studies reporting characteristics and clinical outcome of critically ill elderly patients with laboratory- confirmed COVID-19 admitted to ICU, published in 2020 and in the early 2021. The last literature search was conducted on May 20, 2021. Only articles published in English were included; no limitations were applied to study design or country of origin. We also searched the reference lists of relevant articles to identify further articles. Studies were considered eligible if they included elderly patients with COVID-19 either exclusively or as a group among the whole study ICU population. Studies that did not analyse separately the subset of elderly patients were excluded.

The following data were extracted: first author, year of publication, country of origin, sample size of patients with COVID-19, mean or median age, number of elderly patients, number of deaths in each age group. Since there is no universally accepted age cut-off defining “elderly”[31], we followed each study’s definition as it was used by the authors.

Our initial search did not identify studies exclusively designed for critically ill elderly patients with COVID -19 admitted to the ICU. Thus, we included those studies that provided separate data for elderly patients, as a subgroup, in the analyses of the whole study ICU population with COVID-19. However, during the revision process of the present review article, two additional studies have been recently released; therefore they have been added to the present review[32,33].

**RESULTS**

***Description of the studies***

Finally, a total of 19 studies fulfilling the inclusion criteria were included involving 18210 critically ill patients admitted to the ICU due to COVID-19. The proportion of elderly patients included in the whole studies population was considerable: 10646 patients were older than 60, 8310 patients older than 65 and 2630 patients older than 70 years of age. Table 1 lists the summary characteristics of the included studies. Five studies were conducted in China, three studies in the United States, one in Canada, one in Australia, one in Kuwait and eight in Europe (Italy, Germany, Sweden, the United Kingdom and the Netherlands). As the duration of mechanical ventilation and recovery from COVID-19 are often quite prolonged procedures, several articles included a substantial number of patients who were still in the ICU at the end of data collection.

***Presence of comorbidities***

In the large cohort study by Grasselli *et al*[23], including 1591 patients with COVID-19 admitted to ICUs of the Lombardy Region, Italy, 363 patients (23%) were older than 71 years. All patients older than 80 and 76% older than 60 had at least one comorbidity. Hypertension was the most common, followed by diabetes, hypercholesterolemia, cardiovascular disease, chronic respiratory disease and obesity.

Similarly, in the large study of 5700 hospitalized patients with COVID-19 in the United States, including a subgroup of 373 ICU patients, older persons and those with pre-existing hypertension and/or diabetes were highly prevalent[24]. Other chronic conditions, such as smoking, malignancy, chronic kidney disease and chronic liver disease were less reported elsewhere[34-36]. In another study by Mitra *et al*[37] in critically ill patients with COVID-19 admitted to ICU, the majority were older than 65 and 73.5% of patients had at least one medical comorbidity. Seventeen (94.4%) out of the 18 patients who died (with a median age of 75 years), had at least one comorbid disease[37]. In addition, Burrell *et al*[35]*,* have shown that the number of comorbidities was associated with increased risk of ICU admission, need for mechanical ventilation or death. Similarly, older patients with comorbidities and ARDS were found at increased risk of death[8,38], though such an association was not observed elsewhere[36,39].

***Clinical features***

Based on the data collected from the selected studies, fever, cough, and shortness of breath were the most commonly developed symptoms among patients with COVID-19, including older adults[40]. Compared to younger patients, older ones more frequently presented shortness of breath; a factor related to dismal prognosis[41,42]. Other clinical manifestations in the elderly included fatigue, myalgia, nasal congestion, sore throat, diarrhea, nausea, anorexia, headache, and dizziness[43-45]. Other atypical presentations of the infection in elderly patients included absence or low-grade fever[36], abdominal pain and delirium[16,45]. Interestingly, in the cohort study of Kennedy *et al*[43], delirium symptoms, such as impaired consciousness, disorientation and inattention were found to be among the most common clinical manifestations in patients aged over 65. Additionally, 37% of patients presented delirium in the absence of fever or shortness of breath, while delirium was correlated with adverse clinical outcomes, including ICU admission or even death[43].

***Mechanical ventilation***

Among the 19 included studies, only seven report on mechanical ventilation use in older individuals. In the study by Grasselli *et al*[23], the majority (89%) of elderly patients admitted to the ICU received invasive mechanical ventilation with high levels of positive end expiratory pressure (PEEP). There was need for higher fraction of inspired oxygen (FiO2) in the group aged ≥ 64 years compared to the group aged ≤ 63 years (70% *vs* 60% respectively, *P* = 0.006); the ratio of the partial pressure of oxygen in arterial blood (Pao2) to Fio2 was higher in the younger patients compared to older ones (163 *vs* 156, *P* = 0.02). In addition, patients with hypertension were significantly older and had higher PEEP levels and lower PaO2/FiO2 compared with patients without hypertension[23].

In the studies by Auld *et al*[46], Yu *et al*[47] and Richardson *et al*[24], the proportion of elderly patients requiring mechanical ventilation was 52%, 89% and 91% respectively. In the large study by Richardson *et al*[24], which included 5700 patients hospitalized with COVID-19 in the New York City area, 373 patients (14.2%) were admitted to the ICU and 320 (12.2%) of them received invasive mechanical ventilation. An intriguing find was that older and frailer patients were less likely to receive ventilatory support compared to younger ones (< 65 years old); however, it could be attributed, at least in part, to incomplete outcome data, since 413 out of 613 patients were still hospitalized at the study end.

***Clinical outcome***

Usually, mortality rates were calculated based on the number of patients who had an outcome or had been discharged from the ICU, thus, excluding patients who were still in ICU. In all studies without exception, older patients with COVID-19 admitted to the ICU had a higher mortality rate compared to younger patients. In the study by Yang *et al*[8], 20 out of 27 (74.1%) patients ≥ 60 years old died. Similarly, in the study by Xu *et al*[48], among 112 critically ill patients ≥ 65 years old, mortality rate was 73.2 %. Alshukry *et al*[38], in their study included 82 patients admitted to the ICU; 17 out of 25 (68%) patients ≥ 60 years old died, while Bhatraju *et al*[49] reported similar mortality rates in patients ≥ 65 years (62%). Other studies, namely those by Auld *et al*[46], Yu *et al*[47], and Larsson *et al*[39], which included, 106, 149 and 110 elderly patients respectively, among the whole ICU study population, reported mortality rates of 44%, 44% and 45.7% respectively. Comparable mortality rates were reported by Shi *et al*[34], 36%, Burrell *et al*[35], 25.8%, Aleva *et al*[36], 33% and Mitra *et al*[37]*,* 23%, though, not all patients had reached an outcome at the study end. Finally, Thomson *et al*[50], in 89 patients ≥ 60 years old admitted to the ICU with COVID-19 reported a mortality rate of 31.3%.

In accordance with the aforementioned observational small-scale studies, large studies have reported similar findings. Indicatively, in the study by Richardson *et al*[24] mortality rates for those who received mechanical ventilation in the 18-to-65 and older-than-65 age groups were 76.4% and 97.2%, respectively. Mortality rate for those in the 18-to-65 and older-than-65 years age groups who did not receive mechanical ventilation was 1.98% and 26.6%, respectively.

In the earlier study by Wang *et al*[42], which included 344 patients admitted to ICU due to COVID-19, older patients (> 60 years) with comorbidities were at dramatically increased risk of death, having a mortality of 75.9% (101/194), whereas a 24.1% mortality was observed in patients ≤ 60 years old. A lower mortality of 32% has been recently reported by Nachtigall *et al*[51],who analyzed 318 critically ill patients ≥ 60 years old with COVID-19 in German ICUs.

In the large retrospective analysis by Grasselli *et al*[23], older age was, among others, an independent risk factor associated with increased mortality. Specifically, 322 out of 436 (73.9%) ICU patients over 60 years of age died. Again, as commented above, a considerable number of patients (525 out of the 1521 study patients) were still in the ICU at the end of the study. Possibly for the same reason, the reported mortality of 91% among older patients in the study by Richardson *et al*[24], may have been overestimated, as it was calculated only for 413 out of 613 patients ≥ 65 years old who were either discharged alive or died by the end of the study.

The German nationwide cohort study by Karagiannidis *et al*[52] comprised 1727 mechanically ventilated patients, 75.5% of them aged ≥60 years. The mortality rate of 60.5% in this age group was remarkably higher compared to the observed mortality rate of 28% in the 18-to-59 age group. Further stratifying elderly patients (≥ 60 years) by age (60-69, 70-79, ≥ 80 years old), the risk for death increased with each successive age group (46%, 63%, 72% respectively). Moreover, comparison between mechanically ventilated patients and non-ventilated ones revealed that the latter presented significantly lower mortality rates regardless of age (1% and 22.5% in the 18-to-59 and ≥ 60-age group respectively).

Finally, two recently published large-scale studies by Guillon *et al*[32] and Dres *et al*[33], the latter focusing exclusively on elderly patients over 70 years old, demonstrated similar results with reported mortality rates 38.7% in patients ≥ 65 years and 45.8% in patients ≥ 70 years, respectively. Moreover, both studies showed that elderly patients over 80 years old were remarkably more susceptible to death (62.5% and 66.8%) compared to young- and middle-old patients.

**DISCUSSION**

Despite the large number of COVID-19- related publications, and despite the impact of COVID-19 on the elderly population, we found only a limited number of relevant studies being conducted in ICU, providing evidence on characteristics, clinical course and outcomes of critically ill elderly patients with COVID-19. In most of the studies, elderly patients comprised a substantial proportion of the study population, ranging approximately from 30.4% to 79.6%, indicating, thus, the high burden of advanced age on ICU beds capacity.

Although limited evidence on elderly patients in the ICU setting is available, accumulating observational data show a varied, albeit high mortality. This variability could partially be explained by management heterogeneity of these patients, the diversity in sample size and the incomplete outcome data due to rapid publication of results, while a substantial number of these patients were still in the ICU or the hospital at the time their outcome was evaluated. Another factor possibly influencing the reported mortality is a trend towards improvement of the disease clinical outcome. During the initial surge of the pandemic, reports of critically ill COVID-19 patients in China, Italy and the United States have reported a high mortality, whereas recent analyses are reassuring that ICU mortality is lower than earlier reports suggested[53]. Similarly, according to a systematic review and metanalysis of patients with severe COVID-19, the overall estimate for the reported case fatality rate was 45% (95% confidence interval, 38%-52%); nevertheless, significant variability was observed by age, among other parameters[54]. Specifically, the reported case fatality ratio was higher in older patients and in early pandemic epicenters, which may have been influenced by limited ICU resources.

Two recent studies confirm the evolution of clinical outcome over time in adults with COVID-19-related critical illness admitted to ICU. The first study shows that among patients with COVID-19–related critical illness admitted to ICUs in the United States, mortality seemed to decrease over time despite stable patient characteristics[55]. According to the second study, among more than 4000 critically ill patients with COVID-19 admitted to ICUs located at central Europe, 90 d mortality decreased from 42% to 25% over the study period. Although detailed information on elderly population is not provided in this study, mortality was higher in older patients as well as in those with diabetes, obesity and severe ARDS[56]. Probably, more studies are necessary to confirm these results and to investigate the causal mechanisms in the elderly subset of patients.

The impact of age on mortality of critically ill patients has been already demonstrated in earlier studies in the pre-COVID-19 era[57-60]. However, important factors, such as severity of acute illness, comorbidities, as well as functional status of very old patients before ICU admission might be of more importance for the prognosis than age alone[61]. Similarly, according to a recent metanalysis, in the context of COVID-19, age-related comorbidities seem to have a more important effect than age itself; though this metanalysis refers to the whole population of hospitalized elderly patients with COVID-19 and not exclusively to those admitted to the ICU[62]. A currently ongoing clinical trial (ClinicalTrials.gov identifier [NCT04321265)](https://clinicaltrials.gov/ct2/show/NCT04321265) has planned to study the outcome of elderly ICU patients (≥ 70 years) suffering from COVID-19 using a multi-centre and multi-national approach.

Clinical manifestation of the disease was common in all age groups, however, quite often, elderly patients seem to present insidious symptom onset, as low-grade fever or altered mental status with confusion or delirium, indicating the necessity for increased suspicion by clinicians for prompt diagnosis and appropriate interventions. Notably, dyspnea as presenting symptom in older individuals seemed to correlate with dismal prognosis, at least according to one study[42]. Regarding comorbidities, as they are more likely to occur in adults ≥ 60 years old, and as advanced age is associated with immune system dysfunction, a possible correlation between the particular high risk for severe disease of elderly population and the pre-existing diseases may be explained. Specifically, the majority of studies indicated hypertension, diabetes, COPD and obesity as the most commonly identified diseases, which could predict poor prognosis.

Although in some studies the type of ventilatory support, *i.e.*, invasive or non-invasive, in elderly patients is not clear, mechanical ventilation was associated with high mortality. As limited data is available on ventilation strategies used in elderly ICU patients with COVID-19, further research is needed as more comprehensive clinical insights concerning ICU treatment strategies in this population may be offered, in order to improve survival.

**CONCLUSION**

In this narrative review we summarize the current evidence for the characteristics and outcomes of elderly patients admitted to the ICU due to COVID-19. The cumulative data so far show that severe COVID-19 has a direct health impact on the elderly population, putting that at increased risk of mortality. Until effective treatments emerge, supportive care, including appropriate ventilator support for the acute respiratory failure along with co-morbidities clinical management, should be followed in the ICU so that survival of elderly patients with severe form of COVID-19 be improved. To this end, future studies exclusively designed for this vulnerable group are absolutely necessary.

**ARTICLE HIGHLIGHTS**

***Research background***

Coronavirus disease-2019 (COVID-19) affects people of all ages; however, in particular the elderly is at higher risk of severe illness.

***Research motivation***

Although many studies on elderly adults with COVID-19 admitted to hospital wards have been published, the information on characteristics and clinical outcome of critically ill elderly patients admitted to the intensive care unit (ICU) due to COVID-19 is limited.

***Research objectives***

To provide information about clinical features and outcomes of elderly critically ill patients admitted to the ICU due to COVID-19, by carrying out a review of the existing literature.

***Research methods***

PubMed and Google Scholar databases were searched up to May 20, 2021, while reference lists were explored for relevant articles, to identify studies either focusing on this patient population or studies in which age-stratified results were reported.

***Research results***

A total of 19 studies, involving 10646 patients older than 60, 8310 patients older than 65 and 2630 patients older than 70 years of age, were included. Only one study exclusively focusing on critically ill elderly patients admitted to the ICU due to COVID-19 was found. Although clinical manifestations were similar for all ICU patients, compared to younger ones, elderly patients suffered from more comorbidities and showed a varied, albeit high mortality, up to 91%.

***Research conclusions***

Studies exclusively designed for elderly ICU population with COVID-19 are currently limited. The current evidence suggests that elderly patients admitted to the ICU with COVID-19 are at increased risk of death.

***Research perspectives***

Future studies focused on elderly patients admitted to the ICU due to COVID-19 are worthwhile.

**REFERENCES**

1 **Guan WJ**, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, Liu L, Shan H, Lei CL, Hui DSC, Du B, Li LJ, Zeng G, Yuen KY, Chen RC, Tang CL, Wang T, Chen PY, Xiang J, Li SY, Wang JL, Liang ZJ, Peng YX, Wei L, Liu Y, Hu YH, Peng P, Wang JM, Liu JY, Chen Z, Li G, Zheng ZJ, Qiu SQ, Luo J, Ye CJ, Zhu SY, Zhong NS; China Medical Treatment Expert Group for Covid-19. Clinical Characteristics of Coronavirus Disease 2019 in China. *N Engl J Med* 2020; **382**: 1708-1720 [PMID: 32109013 DOI: 10.1056/NEJMoa2002032]

2 **Cucinotta D**, Vanelli M. WHO Declares COVID-19 a Pandemic. *Acta Biomed* 2020; **91**: 157-160 [PMID: 32191675 DOI: 10.23750/abm.v91i1.9397]

3 **COVIDView Summary ending on June 13, 2020**. [cited 20 February 2021]. Available from: https://www.cdc.gov/coronavirus/2019-ncov/covid-data/covidview/past-reports/06192020.html

4 **Davies NG**, Klepac P, Liu Y, Prem K, Jit M; CMMID COVID-19 working group, Eggo RM. Age-dependent effects in the transmission and control of COVID-19 epidemics. *Nat Med* 2020; **26**: 1205-1211 [PMID: 32546824 DOI: 10.1038/s41591-020-0962-9]

5 **Wang D**, Hu B, Hu C, Zhu F, Liu X, Zhang J, Wang B, Xiang H, Cheng Z, Xiong Y, Zhao Y, Li Y, Wang X, Peng Z. Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China. *JAMA* 2020; **323**: 1061-1069 [PMID: 32031570 DOI: 10.1001/jama.2020.1585]

6 **Vanhems P**, Gustin MP, Elias C, Henaff L, Dananché C, Grisi B, Marion E, Khanafer N, Hilliquin D, Gardes S, Gerbier-Colomban S, Amour S, Kuczewski E, Escuret V, Lina B, Saadatian-Elahi M; COVID-Outcomes-HCL Consortium. Factors associated with admission to intensive care units in COVID-19 patients in Lyon-France. *PLoS One* 2021; **16**: e0243709 [PMID: 33503018 DOI: 10.1371/journal.pone.0243709]

7 **Li G**, Liu Y, Jing X, Wang Y, Miao M, Tao L, Zhou Z, Xie Y, Huang Y, Lei J, Gong G, Jin P, Hao Y, Faria NR, Clercq E, Zhang M. Mortality risk of COVID-19 in elderly males with comorbidities: a multi-country study. *Aging (Albany NY)* 2020; **13**: 27-60 [PMID: 33472167 DOI: 10.18632/aging.202456]

8 **Yang X**, Yu Y, Xu J, Shu H, Xia J, Liu H, Wu Y, Zhang L, Yu Z, Fang M, Yu T, Wang Y, Pan S, Zou X, Yuan S, Shang Y. Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study. *Lancet Respir Med* 2020; **8**: 475-481 [PMID: 32105632 DOI: 10.1016/S2213-2600(20)30079-5]

9 **Mueller AL**, McNamara MS, Sinclair DA. Why does COVID-19 disproportionately affect older people? *Aging (Albany NY)* 2020; **12**: 9959-9981 [PMID: 32470948 DOI: 10.18632/aging.103344]

10 **Chen N**, Zhou M, Dong X, Qu J, Gong F, Han Y, Qiu Y, Wang J, Liu Y, Wei Y, Xia J, Yu T, Zhang X, Zhang L. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *Lancet* 2020; **395**: 507-513 [PMID: 32007143 DOI: 10.1016/S0140-6736(20)30211-7]

11 **Wu C**, Chen X, Cai Y, Xia J, Zhou X, Xu S, Huang H, Zhang L, Zhou X, Du C, Zhang Y, Song J, Wang S, Chao Y, Yang Z, Xu J, Zhou X, Chen D, Xiong W, Xu L, Zhou F, Jiang J, Bai C, Zheng J, Song Y. Risk Factors Associated With Acute Respiratory Distress Syndrome and Death in Patients With Coronavirus Disease 2019 Pneumonia in Wuhan, China. *JAMA Intern Med* 2020; **180**: 934-943 [PMID: 32167524 DOI: 10.1001/jamainternmed.2020.0994]

12 **Brown R**, McKelvey MC, Ryan S, Creane S, Linden D, Kidney JC, McAuley DF, Taggart CC, Weldon S. The Impact of Aging in Acute Respiratory Distress Syndrome: A Clinical and Mechanistic Overview. *Front Med (Lausanne)* 2020; **7**: 589553 [PMID: 33195353 DOI: 10.3389/fmed.2020.589553]

13 **Nandy K**, Salunke A, Pathak SK, Pandey A, Doctor C, Puj K, Sharma M, Jain A, Warikoo V. Coronavirus disease (COVID-19): A systematic review and meta-analysis to evaluate the impact of various comorbidities on serious events. *Diabetes Metab Syndr* 2020; **14**: 1017-1025 [PMID: 32634716 DOI: 10.1016/j.dsx.2020.06.064]

14 **Shahid Z**, Kalayanamitra R, McClafferty B, Kepko D, Ramgobin D, Patel R, Aggarwal CS, Vunnam R, Sahu N, Bhatt D, Jones K, Golamari R, Jain R. COVID-19 and Older Adults: What We Know. *J Am Geriatr Soc* 2020; **68**: 926-929 [PMID: 32255507 DOI: 10.1111/jgs.16472]

15 **Jaul E**, Barron J. Age-Related Diseases and Clinical and Public Health Implications for the 85 Years Old and Over Population. *Front Public Health* 2017; **5**: 335 [PMID: 29312916 DOI: 10.3389/fpubh.2017.00335]

16 **Kang SJ**, Jung SI. Age-Related Morbidity and Mortality among Patients with COVID-19. *Infect Chemother* 2020; **52**: 154-164 [PMID: 32537961 DOI: 10.3947/ic.2020.52.2.154]

17 **Akbar AN**, Gilroy DW. Aging immunity may exacerbate COVID-19. *Science* 2020; **369**: 256-257 [PMID: 32675364 DOI: 10.1126/science.abb0762]

18 **Perrotta F**, Corbi G, Mazzeo G, Boccia M, Aronne L, D'Agnano V, Komici K, Mazzarella G, Parrella R, Bianco A. COVID-19 and the elderly: insights into pathogenesis and clinical decision-making. *Aging Clin Exp Res* 2020; **32**: 1599-1608 [PMID: 32557332 DOI: 10.1007/s40520-020-01631-y]

19 **Santesmasses D**, Castro JP, Zenin AA, Shindyapina AV, Gerashchenko MV, Zhang B, Kerepesi C, Yim SH, Fedichev PO, Gladyshev VN. COVID-19 is an emergent disease of aging. *Aging Cell* 2020; **19**: e13230 [PMID: 33006233 DOI: 10.1111/acel.13230]

20 **Ferguson NM,** Laydon D, Nedjati-Gilani G, Imai N, Ainslie K, Baguelin M, Bhatia S, Boonyasiri A, Cucunubá Z, Cuomo-Dannenburg G, Dighe A (2020) Impact of non-pharmaceutical interventions (NPIs) to reduce COVID-19 mortality and healthcare demand. Imperial College COVID-19 Response Team, London, March, 16. https://www.imperial.ac.uk/media/imperial-college/medicine/sph/ide/gida-fellowships/Imperial-College-COVID19-NPI-modelling-16-03-2020.pdf

21 United Nations Department of Economic Affairs. World Population Ageing 2019: Highlights (2019). [cited 20 February 2021]. Available from: https://www.un.org/en/development/desa/population/publications/pdf/ageing/WorldPopulationAgeing2019-Highlights.pdf

22 **Arentz M**, Yim E, Klaff L, Lokhandwala S, Riedo FX, Chong M, Lee M. Characteristics and Outcomes of 21 Critically Ill Patients With COVID-19 in Washington State. *JAMA* 2020; **323**: 1612-1614 [PMID: 32191259 DOI: 10.1001/jama.2020.4326]

23 **Grasselli G**, Zangrillo A, Zanella A, Antonelli M, Cabrini L, Castelli A, Cereda D, Coluccello A, Foti G, Fumagalli R, Iotti G, Latronico N, Lorini L, Merler S, Natalini G, Piatti A, Ranieri MV, Scandroglio AM, Storti E, Cecconi M, Pesenti A; COVID-19 Lombardy ICU Network. Baseline Characteristics and Outcomes of 1591 Patients Infected With SARS-CoV-2 Admitted to ICUs of the Lombardy Region, Italy. *JAMA* 2020; **323**: 1574-1581 [PMID: 32250385 DOI: 10.1001/jama.2020.5394]

24 **Richardson S**, Hirsch JS, Narasimhan M, Crawford JM, McGinn T, Davidson KW; the Northwell COVID-19 Research Consortium, Barnaby DP, Becker LB, Chelico JD, Cohen SL, Cookingham J, Coppa K, Diefenbach MA, Dominello AJ, Duer-Hefele J, Falzon L, Gitlin J, Hajizadeh N, Harvin TG, Hirschwerk DA, Kim EJ, Kozel ZM, Marrast LM, Mogavero JN, Osorio GA, Qiu M, Zanos TP. Presenting Characteristics, Comorbidities, and Outcomes Among 5700 Patients Hospitalized With COVID-19 in the New York City Area. *JAMA* 2020; **323**: 2052-2059 [PMID: 32320003 DOI: 10.1001/jama.2020.6775]

25 **Williamson EJ**, Walker AJ, Bhaskaran K, Bacon S, Bates C, Morton CE, Curtis HJ, Mehrkar A, Evans D, Inglesby P, Cockburn J, McDonald HI, MacKenna B, Tomlinson L, Douglas IJ, Rentsch CT, Mathur R, Wong AYS, Grieve R, Harrison D, Forbes H, Schultze A, Croker R, Parry J, Hester F, Harper S, Perera R, Evans SJW, Smeeth L, Goldacre B. Factors associated with COVID-19-related death using OpenSAFELY. *Nature* 2020; **584**: 430-436 [PMID: 32640463 DOI: 10.1038/s41586-020-2521-4]

26 **Zhou F**, Yu T, Du R, Fan G, Liu Y, Liu Z, Xiang J, Wang Y, Song B, Gu X, Guan L, Wei Y, Li H, Wu X, Xu J, Tu S, Zhang Y, Chen H, Cao B. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *Lancet* 2020; **395**: 1054-1062 [PMID: 32171076 DOI: 10.1016/S0140-6736(20)30566-3]

27 **Du RH**, Liang LR, Yang CQ, Wang W, Cao TZ, Li M, Guo GY, Du J, Zheng CL, Zhu Q, Hu M, Li XY, Peng P, Shi HZ. Predictors of mortality for patients with COVID-19 pneumonia caused by SARS-CoV-2: a prospective cohort study. *Eur Respir J* 2020; **55** [PMID: 32269088 DOI: 10.1183/13993003.00524-2020]

28 **Haas LEM**, de Lange DW, van Dijk D, van Delden JJM. Should we deny ICU admission to the elderly? Ethical considerations in times of COVID-19. *Crit Care* 2020; **24**: 321 [PMID: 32517776 DOI: 10.1186/s13054-020-03050-x]

29 **Herreros B**, Gella P, Real de Asua D. Triage during the COVID-19 epidemic in Spain: better and worse ethical arguments. *J Med Ethics* 2020; **46**: 455-458 [PMID: 32424063 DOI: 10.1136/medethics-2020-106352]

30 **Tonetti T**, Grasselli G, Zanella A, Pizzilli G, Fumagalli R, Piva S, Lorini L, Iotti G, Foti G, Colombo S, Vivona L, Rossi S, Girardis M, Agnoletti V, Campagna A, Gordini G, Navalesi P, Boscolo A, Graziano A, Valeri I, Vianello A, Cereda D, Filippini C, Cecconi M, Locatelli F, Bartoletti M, Giannella M, Viale P, Antonelli M, Nava S, Pesenti A, Ranieri VM; COVID-19 Northern Italian ICU Network. Use of critical care resources during the first 2 wk (February 24-March 8, 2020) of the Covid-19 outbreak in Italy. *Ann Intensive Care* 2020; **10**: 133 [PMID: 33044646 DOI: 10.1186/s13613-020-00750-z]

31 **Orimo H**. [Reviewing the definition of elderly]. *Nihon Ronen Igakkai Zasshi* 2006; **43**: 27-34 [PMID: 16521795 DOI: 10.3143/geriatrics.43.27]

32 **Guillon A**, Laurent E, Godillon L, Kimmoun A, Grammatico-Guillon L. Long-term mortality of elderly patients after intensive care unit admission for COVID-19. *Intensive Care Med* 2021; **47**: 710-712 [PMID: 33844045 DOI: 10.1007/s00134-021-06399-x]

33 **Dres M**, Hajage D, Lebbah S, Kimmoun A, Pham T, Béduneau G, Combes A, Mercat A, Guidet B, Demoule A, Schmidt M; COVID-ICU investigators. Characteristics, management, and prognosis of elderly patients with COVID-19 admitted in the ICU during the first wave: insights from the COVID-ICU study : Prognosis of COVID-19 elderly critically ill patients in the ICU. *Ann Intensive Care* 2021; **11**: 77 [PMID: 33988767 DOI: 10.1186/s13613-021-00861-1]

34 **Shi M**, Chen L, Yang Y, Zhang J, Xu J, Xu G, Li B, Yin Y. Analysis of clinical features and outcomes of 161 patients with severe and critical COVID-19: A multicenter descriptive study. *J Clin Lab Anal* 2020; **34**: e23415 [PMID: 32488958 DOI: 10.1002/jcla.23415]

35 **Burrell AJ**, Pellegrini B, Salimi F, Begum H, Broadley T, Campbell LT, Cheng AC, Cheung W, Cooper DJ, Earnest A, Erickson SJ, French CJ, Kaldor JM, Litton E, Murthy S, McAllister RE, Nichol AD, Palermo A, Plummer MP, Ramanan M, Reddi BA, Reynolds C, Trapani T, Webb SA, Udy AA. Outcomes for patients with COVID-19 admitted to Australian intensive care units during the first four months of the pandemic. *Med J Aust* 2021; **214**: 23-30 [PMID: 33325070 DOI: 10.5694/mja2.50883]

36 **Aleva FE**, van Mourik L, Broeders MEAC, Paling AJ, de Jager CPC. COVID-19 in critically ill patients in North Brabant, the Netherlands: Patient characteristics and outcomes. *J Crit Care* 2020; **60**: 111-115 [PMID: 32799179 DOI: 10.1016/j.jcrc.2020.08.001]

37 **Mitra AR**, Fergusson NA, Lloyd-Smith E, Wormsbecker A, Foster D, Karpov A, Crowe S, Haljan G, Chittock DR, Kanji HD, Sekhon MS, Griesdale DEG. Baseline characteristics and outcomes of patients with COVID-19 admitted to intensive care units in Vancouver, Canada: a case series. *CMAJ* 2020; **192**: E694-E701 [PMID: 32461326 DOI: 10.1503/cmaj.200794]

38 **Alshukry A**, Ali H, Ali Y, Al-Taweel T, Abu-Farha M, AbuBaker J, Devarajan S, Dashti AA, Bandar A, Taleb H, Al Bader A, Aly NY, Al-Ozairi E, Al-Mulla F, Bu Abbas M. Clinical characteristics of coronavirus disease 2019 (COVID-19) patients in Kuwait. *PLoS One* 2020; **15**: e0242768 [PMID: 33216801 DOI: 10.1371/journal.pone.0242768]

39 **Larsson E**, Brattström O, Agvald-Öhman C, Grip J, Campoccia Jalde F, Strålin K, Nauclér P, Oldner A, Konrad D, Persson BP, Eriksson LI, Mårtensson J; Karolinska Intensive Care COVID-19 Study Group. Characteristics and outcomes of patients with COVID-19 admitted to ICU in a tertiary hospital in Stockholm, Sweden. *Acta Anaesthesiol Scand* 2021; **65**: 76-81 [PMID: 32892337 DOI: 10.1111/aas.13694]

40 **Niu S**, Tian S, Lou J, Kang X, Zhang L, Lian H, Zhang J. Clinical characteristics of older patients infected with COVID-19: A descriptive study. *Arch Gerontol Geriatr* 2020; **89**: 104058 [PMID: 32339960 DOI: 10.1016/j.archger.2020.104058]

41 **Chen T**, Dai Z, Mo P, Li X, Ma Z, Song S, Chen X, Luo M, Liang K, Gao S, Zhang Y, Deng L, Xiong Y. Clinical Characteristics and Outcomes of Older Patients with Coronavirus Disease 2019 (COVID-19) in Wuhan, China: A Single-Centered, Retrospective Study. *J Gerontol A Biol Sci Med Sci* 2020; **75**: 1788-1795 [PMID: 32279081 DOI: 10.1093/gerona/glaa089]

42 **Wang Y**, Lu X, Li Y, Chen H, Chen T, Su N, Huang F, Zhou J, Zhang B, Yan F, Wang J. Clinical Course and Outcomes of 344 Intensive Care Patients with COVID-19. *Am J Respir Crit Care Med* 2020; **201**: 1430-1434 [PMID: 32267160 DOI: 10.1164/rccm.202003-0736LE]

43 **Kennedy M**, Helfand BKI, Gou RY, Gartaganis SL, Webb M, Moccia JM, Bruursema SN, Dokic B, McCulloch B, Ring H, Margolin JD, Zhang E, Anderson R, Babine RL, Hshieh T, Wong AH, Taylor RA, Davenport K, Teresi B, Fong TG, Inouye SK. Delirium in Older Patients With COVID-19 Presenting to the Emergency Department. *JAMA Netw Open* 2020; **3**: e2029540 [PMID: 33211114 DOI: 10.1001/jamanetworkopen.2020.29540]

44 **Neumann-Podczaska A**, Al-Saad SR, Karbowski LM, Chojnicki M, Tobis S, Wieczorowska-Tobis K. COVID 19 - Clinical Picture in the Elderly Population: A Qualitative Systematic Review. *Aging Dis* 2020; **11**: 988-1008 [PMID: 32765959 DOI: 10.14336/AD.2020.0620]

45 **Liu K**, Chen Y, Lin R, Han K. Clinical features of COVID-19 in elderly patients: A comparison with young and middle-aged patients. *J Infect* 2020; **80**: e14-e18 [PMID: 32171866 DOI: 10.1016/j.jinf.2020.03.005]

46 **Auld SC**, Caridi-Scheible M, Blum JM, Robichaux C, Kraft C, Jacob JT, Jabaley CS, Carpenter D, Kaplow R, Hernandez-Romieu AC, Adelman MW, Martin GS, Coopersmith CM, Murphy DJ; and the Emory COVID-19 Quality and Clinical Research Collaborative. ICU and Ventilator Mortality Among Critically Ill Adults With Coronavirus Disease 2019. *Crit Care Med* 2020; **48**: e799-e804 [PMID: 32452888 DOI: 10.1097/CCM.0000000000004457]

47 **Yu Y**, Xu D, Fu S, Zhang J, Yang X, Xu L, Xu J, Wu Y, Huang C, Ouyang Y, Yang L, Fang M, Xiao H, Ma J, Zhu W, Hu S, Hu Q, Ding D, Hu M, Zhu G, Xu W, Guo J, Xu J, Yuan H, Zhang B, Yu Z, Chen D, Yuan S, Shang Y. Patients with COVID-19 in 19 ICUs in Wuhan, China: a cross-sectional study. *Crit Care* 2020; **24**: 219 [PMID: 32410714 DOI: 10.1186/s13054-020-02939-x]

48 **Xu J**, Yang X, Yang L, Zou X, Wang Y, Wu Y, Zhou T, Yuan Y, Qi H, Fu S, Liu H, Xia J, Xu Z, Yu Y, Li R, Ouyang Y, Wang R, Ren L, Hu Y, Xu D, Zhao X, Yuan S, Zhang D, Shang Y. Clinical course and predictors of 60-day mortality in 239 critically ill patients with COVID-19: a multicenter retrospective study from Wuhan, China. *Crit Care* 2020; **24**: 394 [PMID: 32631393 DOI: 10.1186/s13054-020-03098-9]

49 **Bhatraju PK**, Ghassemieh BJ, Nichols M, Kim R, Jerome KR, Nalla AK, Greninger AL, Pipavath S, Wurfel MM, Evans L, Kritek PA, West TE, Luks A, Gerbino A, Dale CR, Goldman JD, O'Mahony S, Mikacenic C. Covid-19 in Critically Ill Patients in the Seattle Region - Case Series. *N Engl J Med* 2020; **382**: 2012-2022 [PMID: 32227758 DOI: 10.1056/NEJMoa2004500]

50 **Thomson RJ**, Hunter J, Dutton J, Schneider J, Khosravi M, Casement A, Dhadwal K, Martin D. Clinical characteristics and outcomes of critically ill patients with COVID-19 admitted to an intensive care unit in London: A prospective observational cohort study. *PLoS One* 2020; **15**: e0243710 [PMID: 33320904 DOI: 10.1371/journal.pone.0243710]

51 **Nachtigall I**, Lenga P, Jóźwiak K, Thürmann P, Meier-Hellmann A, Kuhlen R, Brederlau J, Bauer T, Tebbenjohanns J, Schwegmann K, Hauptmann M, Dengler J. Clinical course and factors associated with outcomes among 1904 patients hospitalized with COVID-19 in Germany: an observational study. *Clin Microbiol Infect* 2020; **26**: 1663-1669 [PMID: 32822883 DOI: 10.1016/j.cmi.2020.08.011]

52 **Karagiannidis C**, Mostert C, Hentschker C, Voshaar T, Malzahn J, Schillinger G, Klauber J, Janssens U, Marx G, Weber-Carstens S, Kluge S, Pfeifer M, Grabenhenrich L, Welte T, Busse R. Case characteristics, resource use, and outcomes of 10 021 patients with COVID-19 admitted to 920 German hospitals: an observational study. *Lancet Respir Med* 2020; **8**: 853-862 [PMID: 32735842 DOI: 10.1016/S2213-2600(20)30316-7]

53 **Armstrong RA**, Kane AD, Cook TM. Outcomes from intensive care in patients with COVID-19: a systematic review and meta-analysis of observational studies. *Anaesthesia* 2020; **75**: 1340-1349 [PMID: 32602561 DOI: 10.1111/anae.15201]

54 **Lim ZJ**, Subramaniam A, Ponnapa Reddy M, Blecher G, Kadam U, Afroz A, Billah B, Ashwin S, Kubicki M, Bilotta F, Curtis JR, Rubulotta F. Case Fatality Rates for Patients with COVID-19 Requiring Invasive Mechanical Ventilation. A Meta-analysis. *Am J Respir Crit Care Med* 2021; **203**: 54-66 [PMID: 33119402 DOI: 10.1164/rccm.202006-2405OC]

55 **Anesi GL**, Jablonski J, Harhay MO, Atkins JH, Bajaj J, Baston C, Brennan PJ, Candeloro CL, Catalano LM, Cereda MF, Chandler JM, Christie JD, Collins T, Courtright KR, Fuchs BD, Gordon E, Greenwood JC, Gudowski S, Hanish A, Hanson CW 3rd, Heuer M, Kinniry P, Kornfield ZN, Kruse GB, Lane-Fall M, Martin ND, Mikkelsen ME, Negoianu D, Pascual JL, Patel MB, Pugliese SC, Qasim ZA, Reilly JP, Salmon J, Schweickert WD, Scott MJ, Shashaty MGS, Sicoutris CP, Wang JK, Wang W, Wani AA, Anderson BJ, Gutsche JT. Characteristics, Outcomes, and Trends of Patients With COVID-19-Related Critical Illness at a Learning Health System in the United States. *Ann Intern Med* 2021; **174**: 613-621 [PMID: 33460330 DOI: 10.7326/M20-5327]

56 **COVID-ICU Group on behalf of the REVA Network and the COVID-ICU Investigators**. Clinical characteristics and day-90 outcomes of 4244 critically ill adults with COVID-19: a prospective cohort study. *Intensive Care Med* 2021; **47**: 60-73 [PMID: 33211135 DOI: 10.1007/s00134-020-06294-x]

57 **Demiselle J**, Duval G, Hamel JF, Renault A, Bodet-Contentin L, Martin-Lefèvre L, Vivier D, Villers D, Lefèvre M, Robert R, Markowicz P, Lavoué S, Courte A, Lebas E, Chevalier S, Annweiler C, Lerolle N. Determinants of hospital and one-year mortality among older patients admitted to intensive care units: results from the multicentric SENIOREA cohort. *Ann Intensive Care* 2021; **11**: 35 [PMID: 33595733 DOI: 10.1186/s13613-021-00804-w]

58 **Ihra GC**, Lehberger J, Hochrieser H, Bauer P, Schmutz R, Metnitz B, Metnitz PG. Development of demographics and outcome of very old critically ill patients admitted to intensive care units. *Intensive Care Med* 2012; **38**: 620-626 [PMID: 22354500 DOI: 10.1007/s00134-012-2474-7]

59 **Nicolas F**, Le Gall JR, Alperovitch A, Loirat P, Villers D. Influence of patients' age on survival, level of therapy and length of stay in intensive care units. *Intensive Care Med* 1987; **13**: 9-13 [PMID: 3558942 DOI: 10.1007/BF00263549]

60 **Friesen RH**. Building an International Community of Paediatric Anaesthesiologists: An interview with Dr Edward Sumner. *Paediatr Anaesth* 2019; **29**: 1158-1162 [PMID: 31621981 DOI: 10.1111/pan.13753]

61 **Boumendil A**, Somme D, Garrouste-Orgeas M, Guidet B. Should elderly patients be admitted to the intensive care unit? *Intensive Care Med* 2007; **33**: 1252 [PMID: 17404703 DOI: 10.1007/s00134-007-0621-3]

62 **Romero Starke K**, Petereit-Haack G, Schubert M, Kämpf D, Schliebner A, Hegewald J, Seidler A. The Age-Related Risk of Severe Outcomes Due to COVID-19 Infection: A Rapid Review, Meta-Analysis, and Meta-Regression. *Int J Environ Res Public Health* 2020; **17** [PMID: 32824596 DOI: 10.3390/ijerph17165974]

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**Table 1 Critically ill coronavirus disease-2019 elderly patients, included in observational clinical studies conducted in intensive care units**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Ref.** | **Country** | **Median age, yr** | **Sample size / No. of the elderly admitted to the ICU (proportion, %)** | **ICU mortality, No. of deaths (%), all ages** | **ICU mortality of the elderly, No. of deaths and proportion (%)** | **Comments** |
| Yang *et al*[8], *Lancet Respir Med* | China | 59.71 | 52 / 27 ≥ 60 yr (52) | 32 (61.5) | 20/27 (74.1) (≥ 60 yr) | - |
| Grasselli *et al*[23], *JAMA* | Italy | 63 | 1591 / 961 ≥ 61 yr (60.4) | 405 (60.3) | 322/436 (73.9) (≥ 61 yr) | 525/961 elderly patients still in ICU; 920/1591 patients (all ages) still in ICU |
| Richardson *et al*[24], *JAMA* | United States | N/A | 1281 / 613 ≥ 65 yr (47.8) | 291 (78) | 182/200 (91) (≥ 65 yr) | 413/613 patients ≥ 65 yr old still in hospital; 908/1281 patients (all ages) still in hospital |
| Bhatraju *et al*[49], *NEJM* | United States | 641 | 24 / N/A | 12 (57.1) | 62 (≥ 65 yr) | 3 patients remained intubated at the end of the study |
| Karagiannidis *et al*[52], *Lancet Respir Med* | Germany | 71 | 1727 / 1305 ≥ 60 yr (75.5)  535, 70-79 yr; 388, ≥ 80 yr | 906 (53) | 174/382 (46), 60-69 yr; 335/535 (63), 70-79 yr; 280/388 (72), ≥ 80 yr | ICU deaths in elderly with invasive and non-invasive mechanical ventilation are reported |
| Yu *et al*[47], *Crit Care* | China | 64 | 226 / 149 ≥61 yr (65.9) | 87 (41.2) | 62/140 (44) (≥ 61 yr) | 9/149 elderly patients still in hospital; 15/226 patients (all ages) still in hospital |
| Shi *et al*[34], *Clin Lab Anal* | China | 59.41 | 161 / 83 ≥ 60 yr (51.5) | 50 (39) | 36 (60-74 yr)  24.24 (> 74 yr) | Further comparison analysis revealed that no difference was found among the following age group patients: ≤ 44, 45-59, 60-74, and ≥ 75 yr; 33/161 still in hospital- N/A if they were in ICU or in hospital’s ward |
| Burrell *et al*[35], *MJA* | Australia | 63.5 | 200 / 123 ≥ 60 yr (61.5); 97 ≥ 65 yr (48.5) | 30 (15) | 28/123 (22.8) (≥60 yr); 25/97 (25.8) (≥ 65 yr) | 6/200 patients still in hospital wards |
| Aleva *et al*[36], *J Crit Care* | The Netherlands | 651 | 50 / 30 ≥ 65 yr (60) | 13 (32) | 10/30 (33) (≥ 65 yr) | All survivors successfully discharged from the hospital |
| Mitra *et al*[37], *CMAJ* | Canada | 69 | 117 / 76 ≥ 65 yr (64.9) | 18 (17.1) | 16/69 (23) (≥ 65 yr) | 7/76 elderly patients still in ICU; 12/69 elderly patients still hospitalized; 12/117 patients (all ages) still in ICU |
| Alshukry *et al*[38], *PLoS One* | Kuwait | 47 | 82 / 25 > 60 yr (30.4) | 60 (73.1) | 17/25 (68) (> 60 yr) | - |
| Larsson *et al*[39], *Acta Anesthesiol Scand* | Sweden | 59 | 260 / 110 ≥ 60 yr (42.3); 28 ≥ 70 yr (10.7) | 60 (30.3) | 37/81 (45.7) (≥ 60 yr) | 29/110 elderly patients still in ICU; 62/260 patients (all ages) still in ICU |
| Wang *et al*[42], *AJRCCM* | China | 60 | 344 / 194 ≥ 60 yr (56.4) | 133 (38.7) | 101/194 (52.1) (≥ 60 yr) | - |
| Auld *et al*[46], *Crit Care Med* | United States | 64 | 217 / 106 ≥ 65 yr (48.8) | 62 (29.7) | 45/103 (44) (≥ 65 yr) | 3/106 elderly patients still in ICU; 8/217 patients (all ages) still in ICU |
| Xu *et al*[48], *Crit Care* | China |  | 239 / 112 ≥ 65 yr (46.9) | 147 (61.5) | 82/112 (73.2) (≥ 65 yr) | - |
| Thomson *et al*[50], *PLoS One* | United Kingdom | 62 | 156 / 89 ≥ 60 yr (57) | 38 (24.3) | 31/89 (34.8) (≥ 60 yr) | - |
| Nachtigall *et al*[51], *Clin Microbiol Infect* | Germany | 73 | 399 / 318 ≥ 60 yr (79.6) | 109 (27.3) | 102/318 (32) (≥ 60 yr) | - |
| Guillon *et al*[32], *Intensive Care Med* | France | N/A | 9885 / 5126 ≥ 65 yr (51.9); 480 ≥ 80 yr (4.9) | 2914 (29.5) | 1986/5126 (38.7) (≥ 65 yr); 300/480 (62.5) (≥ 80 yr) | - |
| Dres *et al*[33], *Ann Intensive Care* | France, Switzerland, Belgium | 74 | 1199 / 639 70-74 yr (53.3); 367 75-79 yr (30.6); 193 > 80 yr (16.1) | 549 (45.8) | 247/639 (38.7) (70-74 yr); 173/367 (47.1) (75-79 yr); 129/193 (66.8) (> 80 yr) | All patients were ≥ 70 yr old |

1Mean value. ICU: Intensive care unit; N/A: Not available.