Amount of Care per Survivor in Young and Older Patients Hospitalized in Intensive Care Unit: A Retrospective Study*

Tarik Khouri,1 Anastasia Kabeshova,2,3,4 Cedric Annweiler,2,3,4,5,6 Alain Mercat,1 Olivier Beauchet,2,3,4 and Nicolas Lerolle1

1Department of Medical Intensive Care and Hyperbaric Medicine, Angers University Hospital, France.
2UPRES EA 4638, LUNAM, Angers University, France.
3Department of Neuroscience, Division of Geriatric Medicine, Angers University Hospital, France.
4Angers University Memory Clinic, France.
5Robarts Research Institute, London, Ontario, Canada.
6Department of Medical Biophysics, Schulich School of Medicine and Dentistry, University of Western Ontario, London, Canada.

*The study was performed at Department of Medical Intensive Care and Hyperbaric Medicine, Angers University Hospital, Angers, France.

Address correspondence to Nicolas Lerolle, MD, PhD, Department of Medical Intensive Care and Hyperbaric Medicine, Angers University Hospital, 4 rue Larrey, F-49 933 Angers Cedex 9, France. Email: nicolas.lerolle@univ-angers.fr

Background. It is unknown whether the amount of care deployed in the intensive care unit population divided by the number of survivors, that is, amount of care per survivor including the care performed for nonsurvivors, differs between patients older and younger than 75 years of age.

Methods. Data were extracted from the computerized files of all 2,220 patients admitted in a medical intensive care unit between January 2009 and December 2010. Patients ≥75 and <75 years old were compared. The Omega score per survivor (OMEGA/S) was calculated in both age groups by dividing the total amount of Omega points, a score of accumulated care load calculated over intensive care unit stay, by the number of survivors in each group.

Results. OMEGA/S was 26% higher in elderly versus younger patients when considering intensive care unit mortality and 40% higher when considering hospital mortality. The absence of difference in raw Omega values between the two groups implies that OMEGA/S differences were related to differences in mortality rate. Simplified Acute Physiology Score II (without age-related points) strata analysis (<20, 20–39, 40–59, 60–79, and ≥80) showed that OMEGA/S in the elderly patients was significantly higher in the first three Simplified Acute Physiology Score II strata only. When calculating by main diagnosis categories, a major increase in the difference of OMEGA/S between elderly and younger patients was observed in cardiac arrest patients due to a major difference in mortality rate.

Conclusions. Elderly patients required a significantly higher care load per survivor in comparison to younger patients. This excess was mainly due to patients with low initial severity.

Key Words: ICU—Outcome—Elderly—Mortality—Cost effectiveness.

Received November 29, 2013; Accepted March 11, 2014

Decision Editor: Stephen Kritchevsky, PhD

In many countries, a significant growth in the total elderly population is observed, with the biggest increase in the oldest age group (age > 80) (1). Older age is associated with a higher prevalence of chronic disease and functional defects but also acute diseases such as severe sepsis, acute lung injury, and acute kidney injury (2–4), which frequently require organ support such as mechanical ventilation (5–7). Multiple reports have also underlined the growth of the elderly population in intensive care units (ICUs) (3,8,9).

Using multivariable analyses, many studies have proven that age alone has only a modest impact on ICU survival. Nevertheless, the outcome of elderly patients admitted in the ICU remains less favorable than that observed for younger patients (6,10–15). Notwithstanding, at a same level of severity and comorbidity, it has been well described that compared with younger patients, elderly people benefit of less global care in the ICU, even if this particular aspect is rapidly evolving (16–22). As a result, whether caring for older patients in the ICU is associated with an increase in resource use is difficult to determine. When in a distributive justice perspective, the rationalization of care becomes a potential issue, the perception of futile care administration can undermine the functioning of an ICU (23). In this
context, assessing the relationship between amount of care and outcome appears all the more relevant.

In order to evaluate this relationship, this study compared the amount of care and the ICU survival rate between patients younger than 75 years and those 75 years and older, using a new concept of Omega score per survivor (OMEGA/S). The Omega score is an indicator of the quantity of care provided per patient during the entire ICU stay, combining both intensity of care and length of stay (see Supplementary Material) (24,25). The OMEGA/S is calculated by dividing the total Omega score in the studied population by the number of survivors of this same population. This indicator assesses the amount of care associated with a surviving ICU patient while also taking into account the effort provided for nonsurviving patients.

Patients and Methods

This retrospective study was performed on all 2,220 consecutive patients admitted between January 2009 and December 2010 in the medical ICU of the Angers University Hospital in Angers, France. The study was approved by the Institutional Ethics Committee.

Data Extraction and Primary Diagnosis Rating

Medical data from the patient's computerized record were retrieved, including sex, age, Simplified Acute Physiology Score II (SAPS II) score at admission (26), ICU-stay cumulated OMEGA score (24), use of mechanical ventilation and its duration, use of renal replacement therapy, and duration of both ICU-and-hospital stay and ICU-and-hospital survival. The database has been collected prospectively by ICU physicians for monitoring ICU activity. The database is integral to patients’ medical files. As requested by French law, this database was declared to the French national commission for computerized files and liberty (CNIL, Commission Nationale de l’Informatique et des Libertés). In addition, by examining hospitalization reports, each patient was assigned a primary diagnosis within one of the following categories: resuscitated cardiac arrest, septic shock, nonseptic shock, acute respiratory failure in a patient suffering from chronic respiratory or cardiac disease, acute respiratory failure, drug overdose, neurological (excluding drug overdose), acute kidney injury and metabolic disorders, and other diagnosis. The first matching diagnosis quoted in the list was attributed to the patient: for example, septic shock on aspiration pneumonia following cardiac arrest was recorded as resuscitated cardiac arrest, whereas a nonseptic shock following cardiotoxic drug overdose was recorded as nonseptic shock. Interobserver reproducibility of this diagnosis rating was tested with two investigators of this study (N.L. and T.K.) on 200 hospitalization reports and was found to be excellent: 95% (95% confidence interval at 92%–98%, data not shown).

OMEGA/S Calculation and Statistical Analyses

OMEGA/S integrates the amount of care provided to the survivors as well as to the deceased patients. Two indices were calculated taking into account either ICU mortality or hospital mortality as follows:

\[
OMEGA/S-ICU = \frac{\Sigma OMEGA \text{ survivors} + \Sigma OMEGA \text{ deceased}}{\text{Number of ICU survivors}}
\]

\[
OMEGA/S-Hosp = \frac{\Sigma OMEGA \text{ survivors} + \Sigma OMEGA \text{ deceased}}{\text{Number of hospital survivors}}
\]

OMEGA/S is, therefore, a continuous variable integrating in a single parameter both mortality and amount of care (including amount of care per day and length of stay), allowing straightforward assessment and between-group comparisons.

Of note, because OMEGA is an indicator of the quantity of care administered per patient during the entire ICU stay only, the difference between OMEGA/S-ICU and OMEGA/S-Hosp is solely due to the difference in mortality between ICU and hospital discharge.

OMEGA/S in the age group <75 years and the age group 75 years and older was first compared on these two respective populations as a whole and, thereafter, upon stratification by SAPS II calculated without age-related points (SAPS II <20, 20–39, 40–59, 60–79, ≥80; these threshold being defined according to whole population quartiles) and upon stratification by main diagnosis.

Patient characteristics are expressed as mean ± standard deviation or n (%) as appropriate. Between-group comparisons were performed with Student’s t test for quantitative data or chi-square test for qualitative data. Comparisons of OMEGA/S between groups were performed using the independent two-sample exact z-test. A p value < .05 was considered significant. Statistical analyses were performed with SPSS Statistics (v 19.0.0.1).

Results

Population Description

The main characteristics of the studied 2,220 medical patients as well as between-group comparisons are described in Table 1. Twenty-six percent of the study population was aged 75 and older. These elderly patients were more frequently women and had a higher SAPS II score at admission (even in the absence of weighting for age) in comparison with patients younger than 75 years of age. These older patients required mechanical ventilation and renal replacement therapy more frequently. ICU stay was also longer along with higher ICU and in-hospital mortality in the ≥75 age group. Mortality rate was significantly increased in the elderly group between ICU discharge and hospital discharge than in the younger patients (increase in mortality rate: 18% vs. 12%, respectively, p < .001). The
ICU-stay cumulated load of care per patient, as estimated with the OMEGA score, was not different between the two groups.

Distribution of the two age groups was significantly different across SAPS II strata (defined as <20, 20–39, 40–59, 60–79, ≥80, calculated without age-related points): in particular, proportionally fewer elderly patients were admitted in the SAPS II <20 stratum (Table 2). Mortality rate was higher in elderly versus younger patients in the first three SAPS II strata, whereas no difference was observed in the two last strata. The distribution of the two age groups in the main diagnosis categories also differed. Specifically, more elderly patients were admitted for acute respiratory failure on chronic respiratory or cardiac disease and less for drug overdose (Table 3). A significantly higher mortality rate was observed for all diagnostic categories in elderly patients.

**OMEGA/S in the Whole Study Population**

When considering the whole population, ICU-calculated Omega/S was 138 (OMEGA/S-ICU) and 145 when considering hospital survivors (OMEGA/S-Hosp). OMEGA/S-ICU was 26% higher in the elderly patient group in comparison to the younger patient group (165 vs. 129, p < .001) and rose to 40% when considering OMEGA/S-Hosp (186 vs. 133, p < .001). The absence of difference in OMEGA raw values between the two age groups indicated that these OMEGA/S differences were mainly due to differences in mortality.

**OMEGA/S and SAPS II Strata**

For the study population as a whole and independently of age group, the higher the SAPS II strata, the higher the OMEGA/S score (p < .001 for global comparison of OMEGA/S-ICU between SAPS II strata, Figure 1). Due to a poor survival rate, a major increase in the OMEGA/S level was observed in the SAPS II > 80 stratum. OMEGA/S was significantly different between the two age groups in the first three SAPS II strata. Due to the absence of any survivors, the OMEGA/S value could not be calculated for the elderly patient group in the SAPS II > 80 stratum. Percentagewise, the OMEGA/S value was 87% higher in the elderly group compared to the younger group (335 vs. 180, p < .001). Due to the absence of any survivors, the OMEGA/S value could not be calculated for the elderly patient group in the SAPS II > 80 stratum.

For every SAPS II stratum, comparison of intergroup raw OMEGA values did not show any differences except for the <20 SAPS II stratum where raw OMEGA values were higher in the elderly patient group (76 ± 52 vs. 62 ± 50, (186 vs. 133, p < .001). The absence of difference in OMEGA raw values between the two age groups indicated that these OMEGA/S differences were mainly due to differences in mortality.

**Table 1. Patient Characteristics According to Age**

<table>
<thead>
<tr>
<th>Age (y)</th>
<th>Total, n = 2,220</th>
<th>&lt;75 years old, n = 1,636 (74%)</th>
<th>≥75 years old, n = 584 (26%)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (y)</td>
<td>59.6 ± 18</td>
<td>51.9 ± 15</td>
<td>80.9 ± 4</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Female gender</td>
<td>894 (40%)</td>
<td>625 (38%)</td>
<td>269 (46%)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>SAPS II</td>
<td>40.6 ± 12</td>
<td>37.2 ± 20</td>
<td>50.2 ± 12</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>SAPS II without age-related points</td>
<td>30.6 ± 19</td>
<td>29.6 ± 19</td>
<td>33.1 ± 18</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Mechanical ventilation requirement</td>
<td>1,521 (68)</td>
<td>1,084 (66%)</td>
<td>437 (75%)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Mechanical ventilation duration (d)</td>
<td>7.3 ± 9.0</td>
<td>7.2 ± 9.1</td>
<td>7.6 ± 8.8</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Renal replacement therapy</td>
<td>248 (11)</td>
<td>165 (10)</td>
<td>83 (14)</td>
<td>.006</td>
</tr>
<tr>
<td>ICU length of stay (d)</td>
<td>6.4 ± 8.9</td>
<td>6.2 ± 9.1</td>
<td>7 ± 8.2</td>
<td>.04</td>
</tr>
<tr>
<td>Hospital length of stay (d)</td>
<td>17.9 ± 20.7</td>
<td>17.6 ± 21.6</td>
<td>18.7 ± 17.6</td>
<td>.26</td>
</tr>
<tr>
<td>OMEGA score</td>
<td>108 ± 161</td>
<td>106 ± 168</td>
<td>115 ± 141</td>
<td>.23</td>
</tr>
<tr>
<td>ICU mortality</td>
<td>474 (21.4%)</td>
<td>299 (18.3%)</td>
<td>175 (30%)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Hospital mortality</td>
<td>556 (25%)</td>
<td>335 (20%)</td>
<td>221 (37.8%)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

**Table 2. Patient Distribution and Mortality According to Age and SAPS II (without age-related points)**

<table>
<thead>
<tr>
<th>SAPS II (without age-related points)</th>
<th>Patient Distribution</th>
<th>ICU Mortality</th>
<th>Hospital Mortality</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;75 years old</td>
<td>≥75 years old</td>
<td>&lt;75 years old</td>
<td>≥75 years old</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;20</td>
<td>623 (38%)</td>
<td>157 (27%)</td>
<td>22 (4%)</td>
<td>20 (13%)</td>
</tr>
<tr>
<td>20–39</td>
<td>606 (37%)</td>
<td>263 (45%)</td>
<td>72 (12%)</td>
<td>60 (23%)</td>
</tr>
<tr>
<td>40–59</td>
<td>289 (18%)</td>
<td>117 (20%)</td>
<td>115 (40%)</td>
<td>58 (50%)</td>
</tr>
<tr>
<td>60–79</td>
<td>89 (5%)</td>
<td>38 (6%)</td>
<td>65 (73%)</td>
<td>27 (71%)</td>
</tr>
<tr>
<td>≥80</td>
<td>26 (2%)</td>
<td>11 (2%)</td>
<td>25 (96%)</td>
<td>11 (100%)</td>
</tr>
</tbody>
</table>

**Notes:** Data are n (%). Sum of percentages may exceed 100% due to rounding. ICU = intensive care unit; SAPS II = Simplified Acute Physiology Score II.

*Comparison between age groups for SAPS II strata distribution.

†Comparison of mortality between age groups within the stratum.
This higher OMEGA score could be related to both longer ICU stay (5.5 ± 6.0 vs. 4.4 ± 7.2, p = .07) and higher raw OMEGA score per day (13.1 ± 7.7 vs. 11.5 ± 9.0, p = .04) although the former was at the limit of statistical significance. Accordingly, older patients in this stratum had a higher frequency of mechanical ventilation (101/157 vs. 252/620, p < .001) and renal replacement therapy (8/157 vs. 11/609, p = .02) than younger patients. Thus, in the elderly patient group, the increase in OMEGA/S-ICU scores in the SAPS II < 20 stratum can be interpreted by a greater
amount of care combined with an increased mortality rate (Table 2), whereas in the 20–39 and 40–69 SAPS II strata, differences in OMEGA/S were only related to an increased mortality rate.

Analyses for OMEGA/S-Hosp showed similar results (data not shown).

**OMEGA/S and Main Diagnosis**

Independently of age, OMEGA/S-ICU and OMEGA/S-Hosp were significantly different between each main diagnosis (Figure 3, p < .001 for global comparison of OMEGA/S-ICU and OMEGA/S-Hosp between diagnosis categories). Acute respiratory failure, kidney injury, and metabolic disorders were associated with significantly lower OMEGA/S-ICU in elderly patients in comparison with younger patients. In these categories, a significant lower raw OMEGA value in the elderly patients (data not shown) explained the differences in OMEGA/S. There was no difference in duration of stay (data not shown); thus, these OMEGA/S differences were explained by a lower amount of care per day in the elderly patients. In contrast, elderly patients suffering from acute-on-chronic respiratory failure, neurological failure, nonseptic shock, and other diagnoses had a higher OMEGA/S. In the absence of differences in crude OMEGA (data not shown), these differences were explained by higher mortality (Table 3).

When considering hospital stay, similar results were also observed, with the exception of the kidney injury and metabolic disorders categories, in which no difference was observed; in addition, in the resuscitated cardiac arrest category, a 50% excess in OMEGA/S was observed in the elderly patients. Because OMEGA score calculation integrates only the amount of care in the ICU, only an out-of-ICU higher mortality rate explains these differences between OMEGA/S-ICU and OMEGA/S-Hosp.

**DISCUSSION**

In this retrospective and observational study conducted on 2,220 medical ICU patients, we aimed to assess the impact of age on care load in the ICU. The novelty of the study lies in the methodological approach used whereby the amount of care spent for the population as a whole (survivors and nonsurvivors) is divided by the number of survivors, in order to infer the global amount of care per survivor, taking into account the amount of care provided in both surviving and deceased patients. The resulting OMEGA/S showed that elderly patients ≥75 years old required 26% more ICU care in order to survive in comparison to younger patients (<75 years old); this percentage grew to a further 40% when hospital stay was considered. Interestingly, when considering SAPS II stratum, the differences in OMEGA/S between the two age groups grew increasingly smaller as SAPS II
increased (without age-related points). Indeed, a 34% difference in OMEGA/S-ICU was observed in the first SAPS II stratum (0–20), whereas this difference fell to 10% in the third SAPS II grade (40–59) and was no longer significant for patients with higher SAPS II. When analyzed according to main diagnostic categories, differences in OMEGA/S between elderly and younger patients were uneven although without major differences. However, when considering hospital mortality, resuscitated cardiac arrest was observed to cause a major increase in OMEGA/S in the elderly patients due to both high ICU and post-ICU mortality in these patients.

To our knowledge, this is the first study to utilize the notion of per survivor amount of care. In order to improve the management and allocation of resources, Sznajder and coworkers (25) used the OMEGA score to describe the relationship between this score and medical and paramedical costs; however, survival and age group were not studied in their analysis.

A particularly noteworthy finding in this study is that the biggest differences in OMEGA/S between both age groups were observed in the first SAPS II strata. This difference was primarily due to a two- to threefold higher mortality rate in elderly patients presenting this initial severity in comparison with younger patients and due to an increased amount of care in the less-severe patients. First and foremost, it is important to emphasize that, in absolute values, this mortality rate remained moderate (13%), thus leading to the belief that this overinvestment should not be confounded with futility. Second, it has been recently demonstrated that elderly patients with low SAPS II stand to benefit the most from an admission in an ICU when compared with a conventional ward. Indeed, the Eldicus II trial revealed that admitting elderly patients in an ICU was associated with a dramatic improvement in mortality, superior to the benefit observed in younger patients, and that this improvement was accentuated in the less-severe patients, often in those deemed “too well to be admitted” (20). Altogether, the present results and those of the Eldicus trial indicate that admission of elderly patients in the ICU undoubtedly increases the amount of care needed, yet this overinvestment is made for patients who indisputably benefit significantly from ICU admission. This observation is important because interrogations within the medical and paramedical staff are frequently raised regarding the futility of care for elderly patients. This particular point is of major concern given that perceived inappropriateness of care is positively associated with factors indicating poor team performance (23). We believe that the present data may comfort ICU teams in accepting elderly patients by first acknowledging that such patients are indeed associated with increased work-load for a similar result and, secondly, by showing that this increase is all but futile.

Conversely, the absence of difference in OMEGA/S between the two groups in the highest SAPS II stratum is likely linked to the weight of acute multiple organ failure rather than the overwhelming role played by age on patient outcome. Of particular interest is the resuscitated cardiac arrest category, which was the only category to display a very significant difference in OMEGA/S between the two age groups. However, even without considering age, patients of this specific category required a significantly greater amount of care for their survival compared with the other categories. Comparing the two age groups only amplifies this phenomenon.

Certain limitations of this study should be acknowledged. First, this being a retrospective study, the accuracy of the OMEGA score and SAPS II scoring, especially over time, could come into question. Nonetheless, the medical staff as well as the admission policy for elderly patients remained unchanged throughout the study period; in particular, this policy was to never deny admission of a patient or initiation of any treatment including organ support on
the single criterion of age. Moreover, the coding of the data used herein was always performed by the very same staff that worked at the patient’s bedside, which reinforces the reliability and reproducibility of our data. Second, this is a monocentric study, which can undermine the extensibility of our data and results to other centers. However, our findings, including the proportion of elderly patients, organ support, and mortality rate are perfectly in keeping with the existing literature (3,7,8,27), which bodes in favor of the relevance of our results. Third, differences in OMEGA/s between elderly and younger patients, as well as the fact that they are largely driven by differences in mortality rates, may appear obvious. However, in our opinion, this aspect deserved to be clearly demonstrated when considering a priori the potential weight of care limitations frequently encountered in elderly patients. Fourth, testing the role played by comorbidities (vs. age alone) would have been interesting; unfortunately, our database did not allow such analysis. Fifth, the absence of mid- and long-term data is an important limitation in the interpretation of our study. Long-term follow-up is assuredly a major concern for future studies on elderly patients in the ICU. Finally, we acknowledge that this study is based on multiple computations of different scorings, such that these computations may potentially amplify the limitations inherent to each score (such as linearity or homogeneity), all the more given that a modified SAPS II score was used without age-related points. In addition, although representing “true life” and an important aspect of our analysis, the variety of diagnoses and severity of diseases prevented an in-depth analysis of the relationship between intensity of care and survival due to the interaction of too many parameters to be entered in a multiconrolled analysis. Therefore, this study could be considered as a preliminary observation in a field that deserves much further investigation.

**CONCLUSION**

In conclusion, in this retrospective monocentric study, the amount of care required to achieve patient survival after ICU admission was higher in elderly patients in comparison to younger patients. This increase reached as high as 40% to achieve hospital survival. More importantly, this increase varied with initial severity and was mostly due to patients with low severity.

**Supplementary Material**

Supplementary material can be found at: http://biomedgerontology.oxfordjournals.org/

**Funding**

This work was financially supported by Angers University, Angers and Angers University Hospital, Angers, France.

**Conflict of Interest**

All authors declare no conflict of interest.

**References**


