Consumption of ICU resources by long-stay patients does not change over time: 9-year observation in a teaching hospital in the Netherlands

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Abstract - Background The steady increase of expected lifetime and mean age of people in the western world can only be accompanied by an increase in medical care and inherent use of Intensive Care (ICU) resources. We explored whether the use of ICU resources by long-stay patients has increased over time. Methods Data from all patients admitted to a 10-bed medical-surgical ICU between 1999-2007 were analyzed. In the study period, organizational aspects remained stable in the unit. In the first 24 hours, type of admission and medical history were recorded and APACHE-II scores were calculated. After discharge, patients were divided into four groups with ICU length of stay (LOS) <2, 3-6, 7-13 and >13 days. Data are shown as median [interquartile range]. Results Over the years, the number of patients admitted per year was stable at median 578 [IQR 535-588] with stable age (69 [56-77]) and APACHE-II scores (14 [10-20]). The average proportion of patients per year per LOS group remained stable. Long-stay patients (>13 days; N=42 [38-47] per year) comprised predominantly medical admissions (63.7%) and consumed 52.0 % of yearly ICU treatment days. Mortality in this group (30.2%) was higher than in the groups with shorter LOS (14.8% in LOS <2, 18.3% in LOS 3-6 and 25.9% in LOS 7-13; P<0.001). Conclusion Consumption of ICU resources by long-stay patients was considerable, but did not change over time in our setting. Long-stay patients comprised predominantly medical admissions and showed highest mortality. These findings are important in view of futility and costs.

Keywords - long-stay, ICU, consumption

Introduction
The expected lifetime and mean age of people in the western world is steadily increasing. The total population of the world will have grown by 30% by the year 2035 [1]. Meanwhile, the number of people over 65 will increase by 7.5% to 13.5% of the total population [1]. In the Netherlands in 2035, 25% of the population will be over 65 years of age, in contrast with 15% of the population this year [2]. Consequently, these projections imply a rise in the consumption of ICU resources by the elderly, since older critically ill patients take more time to recover [3,4].

The care delivered in hospitals has changed markedly over the past decades. Indeed, as a result of clinical innovations, the use of practice guidelines, care protocols and early inpatient rehabilitation length of hospital stay has shortened during this period [5-7]. Although a similar decrease in the length of stay in ICUs might be expected, conflicting results have been reported [3,8,9]. In particular, long-stay patients may consume a disproportionate amount of ICU resources [10,11]. It is hypothesized that the increasing age of the population could lead to older patients in ICUs and to a rise in the number of long-stay patients. This would thereby inevitably cause a disproportional rise in use of ICU resources.

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The aim of this study was to analyze the temporal changes over time in the consumption of ICU days in a Dutch medical-surgical ICU, and to explore whether the use of ICU resources by long-stay patients has increased over the years.

Patients and methods
Study setting
The study was performed in the mixed medical-surgical ICU of a university-affiliated 750-bed teaching hospital, part of the Gelre hospital group in Apeldoorn, the Netherlands. The ICU is a 10-bed “closed format” department with both medical and surgical patients. The ICU team comprises 2 full-time ICU physicians, 5 physicians who participate in evening and night shifts, and 1 resident. During the study period staffing did not change. The ethics review board waived the necessity to obtain informed consent.

Patients
From 1999 to 2007, all patients admitted to the ICU were enrolled in the study. For each ICU admission, in the first 24 hours, type of admission and medical history were recorded in a database. Acute Physiology Age and Chronic Health Evaluation (APACHE) II-scores and predicted mortality risks were calculated. Each admission was classified as either medical, elective surgical or acute surgical. Length of stay in the ICU (LOS) was stratified into four groups, i.e. ≤2, 3-6, 7-13 and ≥14 days.
Statistics
All statistical analyses were performed using SPSS version 13. Changes over the years were analyzed by calculating the various data per year. Mann-Whitney-U non-parametric test was used to compare different subgroups. Chi-square analysis was applied to compare frequencies between subgroups. All data are expressed as medians with interquartile range (IQR; [P25-P75]). P<0.05 was considered to indicate significant difference.

Results
Patients
A total of 5310 admissions were evaluated. Over the years, the number of patients admitted per year remained stable at median 578 [IQR 535-588]. Characteristics of patients per year are depicted in Table 1. Median hospital mortality was 18.5% (range 16.2-19.3%).

Age was stable over the years (69 [56-77]). There were no signs of a growing number of older patients over the years. APACHE-II scores (14 [10-20]) were stable over the years as well.

Length of ICU stay
Patients were stratified into four groups depending on ICU-LOS: LOS of ≤2, 3-6, 7-13 and ≥14 days until discharge. The proportion of patients per year in the different LOS groups did not change over the years, i.e. LOS ≤2: 63.5% (range 62.5-64.3%), LOS 3-6: 19.1% (range 18.7-19.7%), LOS 7-13: 9.8% (range 9.7-10.7%), and LOS ≥14: 7.4% (range 6.0-8.2%). Most admissions concerned short-stay patients. The relatively small group of long-stay patients (≥14 days; N=42 [38-47] per year) comprised 7.3% of the total number ICU admissions, but consumed 52.0% of yearly ICU treatment days. Age did not change over time between the different LOS-groups (Table 2). In addition, age itself was not a predictor for length of stay in the ICU. APACHE-II scores differed between the LOS groups, from 12 [9-17] in LOS ≤2 to 19 [16-24] in LOS ≥14. No changes were observed in the types of admission within the groups over the years. Of the total number of admissions, 51.7% were medical. In the group of long-stay patients (≥14 days), almost two-thirds comprised medical admissions (63.7%). In the short-stay patients (LOS<2 days), elective surgery accounted for 34.1% of admissions, whereas in the long-stay patients, elective surgical admissions occurred least frequently (9.5%).

Change in mortality over time
Mortality of the total cohort was stable over the years. However, mortality in the long-stay patients seemed to decrease, although this was not significant (P=0.13). The number of non-survivors who died after ≥14 days in the ICU also showed a decreasing trend. In 1999 14.0% of the total non-survivors in ICU died after ≥14 days in ICU, compared with 7.1% in 2007 (P=0.09). Mortality in the group of long-stay patients (≥14 days) (30.2%) was higher than in the groups with shorter length of ICU stay (14.8% in LOS ≤2, 18.3% in LOS 3-6 and 25.9% in LOS 7-13; P<0.001). The highest mortality was seen in the group of medical admissions. In this group, 23.6% of the patients died during ICU admission. Most of these patients died during the first 2 days of admission (54.2%), which represents failed treatment on ICU after admission. The lowest mortality of 6.5% was seen in the elective surgery group.

Discussion
We demonstrated in an ICU environment with a stable number of beds and staffing that the number of ICU admissions, age, predicted mortality and actual hospital mortality has not changed...
over the past decade. Moreover, the proportion of long-stay patients remained stable, although mortality in this group has decreased over the years.

The stable number of ICU admissions over the years contrasts with an earlier study by Kvale et al. [8] who described an increase in the number of ICU admissions and patients from 1987 to 1997. They compared the ICU populations in 1987 and 1997 in a university hospital. In their study, the primary reason for admission to ICU changed significantly in only two diagnostic categories, i.e. an increase in neurological and in cardiovascular admissions. Data from Jakob also show an increase in number of admissions from 1980 to 1995 to a medical-surgical ICU. In their study, the hospital as a whole as well as the ICU treated approximately 33% more patients than in 1980, and the percentage of patients admitted to the ICU compared with the total number of hospitalized patients did not substantially increase over the years [3]. The difference with these findings may be related to the fact that our data were derived from a mixed medical-surgical ICU population, without cardiac surgical, neurosurgical and coronary care patients. In addition, the occupancy rate remained between 95-105%, indicating a lack of ICU beds. This may suggest selection of patients before actual admission. Nevertheless, medical staffing remained stable during the study period and the stable patient characteristics over the years argue against a change in admission criteria over the years, although transerrals to other hospitals may partly account for a rise in ICU requirements. These referrals were carried out without involvement of ICU physicians, so no data on these are available.

In our data, median age did not change over the years, in spite of the increasing age of the Dutch population. Similar results were seen in a comparison of two different institutions’ ICUs in 1988 and 1993, in which no changes in age over the years were found between the patients who died in both ICUs [12]. In a large study, Rosenberg et al. compared admissions to ICUs in the United States during 1988-1990 and 1993-1996 and found the same age in these two cohorts [9]. In addition, besides an increase in number of ICU admissions, the aforementioned studies from Kvale and Jakob show an increase in mean age, due to a growing proportion of patients aged above 70 over the years.

We did not find a change in mean LOS over the years. The same was found in the Norwegian study from Kvale, which showed a similar mean ICU-LOS in 1997 compared with 1987 with similar consumption of short (<24h) and long (>40 days) ICU stay periods in both periods. Another study showed similar results, i.e. the mean observed ICU length of stay remained similar over the years from 1988-1990 to1993-1996, and after adjusting for patient and institutional differences, the mean-adj usted ICU stay decreased by only 0.11 days during this 5-year interval. This latter finding seemed not to be of clinical importance [9].

In contrast to these observations, a decrease in ICU length of stay was described in a Swiss study analyzing the period from 1980 to 1995 from 4.1 to 3.8 days [3]. They showed that the ICU occupancy rate increased from 85% in 1980 to 100% in 1995. It could be hypothesized that this may be explained because patients remained in the ICU for a longer time in earlier years, because of a lower need for ICU beds, whereas LOS shortened over the years due to an increased occupancy rate. However, other changes in ICU logistics may account for this finding, e.g. starting a medium care unit in that hospital.

The stratification of LOS into 4 groups was chosen because of the rightward skewed distribution patterns seen in these data in earlier studies [13]. The cut-offs used were comparable with those used by the group of Wong et al. [10].

We observed that long-stay patients (≥14 days) comprise only a small proportion of the total number of patients, but account for 52.0% of total ICU days. These results are comparable with a prospective descriptive Canadian study showing that on a medical-surgical ICU, 60.3% of admissions had a length-of-stay

### Table 2. Patient characteristics and LOS groups

<table>
<thead>
<tr>
<th></th>
<th>ALL PATIENTS</th>
<th>LOS 0-2 DAYS</th>
<th>LOS 3-6 DAYS</th>
<th>LOS 7-13 DAYS</th>
<th>LOS ≥14 DAYS</th>
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<tbody>
<tr>
<td>N (%)</td>
<td>5310</td>
<td>3368 (63.4)</td>
<td>1025 (19.3)</td>
<td>529 (10.0)</td>
<td>388 (7.3)</td>
</tr>
<tr>
<td>age</td>
<td>69 [56-77]</td>
<td>69 [54-77]</td>
<td>71 [58-78]</td>
<td>70 [60-77]</td>
<td>70 [60-76]</td>
</tr>
<tr>
<td>Type 1 (N(%)%)</td>
<td>2747 (51.7)</td>
<td>1554 (56.6)</td>
<td>615 (22.4)</td>
<td>331 (12.0)</td>
<td>247 (9.0)</td>
</tr>
<tr>
<td>Type 2 (N(%)%)</td>
<td>1237 (23.3)</td>
<td>666 (53.8)</td>
<td>311 (25.1)</td>
<td>156 (12.6)</td>
<td>104 (8.4)</td>
</tr>
<tr>
<td>Type 3 (N(%)%)</td>
<td>1326 (25.0)</td>
<td>1148 (86.6)</td>
<td>99 (7.5)</td>
<td>42 (3.2)</td>
<td>37 (2.8)</td>
</tr>
<tr>
<td>PM</td>
<td>16.6 [6.9-34.1]</td>
<td>10.9 [4.7-23.3]</td>
<td>25.6 [14.6-42.6]</td>
<td>30.4 [17.4-49.2]</td>
<td>34.8 [21.3-53.3]</td>
</tr>
<tr>
<td>Hospital mortality N (%)</td>
<td>940 (17.7)</td>
<td>498 (14.8)</td>
<td>188 (18.3)</td>
<td>137 (25.9)</td>
<td>117 (30.2)</td>
</tr>
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</table>

LOS: Length of stay; Admission type 1: medical admissions. 2: acute surgical. 3: elective surgical; APACHE II: Acute physiological, age and chronic health evaluation; PM: predicted mortality (%). Values are depicted as median [interquartile range]
shorter than 2 days, while consuming 16.4% of total ICU-days. In contrast, 7.3% of admissions had a long-stay on the ICU (>14 days) and consumed 43.5% of total ICU days [10]. Arabi et al. showed similar results, i.e. that a group of patients with prolonged stay (>14 days) on a medical-surgical ICU formed only 11% of patients, but utilized 45.1% of ICU days and 55.5% of mechanical ventilation days [11]. These data corroborate the concept that long-stay patients comprised a disproportionate amount of ICU resources. This is important, because ICUs utilize a substantial proportion of hospital budgets, up to 30%. It is important that ICU resources are optimized. Also, more effective advanced care planning may be required. Futile treatment should be prevented, which implies that we would have to know before deciding to admit a patient to the ICU who will benefit from ICU treatment and who will ultimately die. Obviously, this is not possible for every individual critically ill patient. Nevertheless, a small reduction in the number of long-stay patients could result in considerable cost savings. This could be achieved by the early recognition of high-risk patients, i.e. those patients who will not benefit from ICU treatment [4,14]. Further studies should address the question of whether indeed identification of patients with a low chance of ICU and hospital survival is feasible.

Factors associated with longer ICU stay may include age and type of admission. Age itself was not a predictor for length of stay, and a higher age was not associated with a longer stay on the ICU. The assumption that older age might correlate with a longer stay in hospital or on the ICU has been researched before. Analysis of a cohort of about 10 000 ICU patients in 1998 showed that age was less important as a predictor of high-weighted hospital days, a proxy of high cost of care, than presence of infection or ventilator dependency at 24 hrs. Besides this, long ward stays before ICU admission and lack of full-time ICU physician involvement in care increased the probability of long ICU stays [15]. Another factor associated with prolonged ICU stay was the type of admission. The largest proportion of long-stay patients comprised non-elective admissions, especially medical admissions. Similar results were observed in a prospective study in Saudi Arabia. They analyzed various potential predictors for associations with prolonged ICU stay (14 days) in a medical-surgical ICU and found that as well as non-elective admissions, readmissions, respiratory or trauma-related reasons for admission, and first 24-hour evidence of infection, oliguria, coagulopathy, and the need for mechanical ventilation or vasopressor therapy had a significant association with long stay. They also showed that the group with a LOS of > 14 days had a significantly higher mean APACHE II score, which is in line with our data [11].

Mortality in ICUs remains high. One in five Americans dies using intensive care services [16]. There is little evidence indicating that mortality among ICU patients is decreasing despite advances in therapy, technology, training and resources. A retrospective cohort study in Australia and New Zealand ICUs showed a decline in overall adjusted mortality from 0.19 in 1993 to 0.15 in 2003. However, the data were not consistent in all participating centres, i.e. a decline in private and tertiary ICUs was observed, whereas no changes had occurred in metropolitan ICUs, and mortality had significantly increased in rural ICUs [17]. This may suggest a change in the number of patients in comparison with local capacity and logistics. In our results, mortality of the total group of patients remained stable over the years. In the first few years of our study hospital mortality was above the predicted mortality, which seems to have improved over time. Besides this, we observed a mild gradual decrease in mortality of patients staying ≥ 14 days in the ICU. This development might be the result of several changes in the standard of ICU care since 1999, such as low tidal volume ventilation [18], strict glucose regulation [19] and application of surviving sepsis guidelines [20]. It could be expected that these effects emerge more clearly in the long-stay patients, compared with the shorter stay patients.

Our study has several limitations. Firstly, our data were retrospectively collected from a mixed medical-surgical ICU, without any cardiac surgical, coronary care or neurosurgical patients. ICUs that also treat the latter group of patients may show different patterns of ICU consumption throughout the years. Secondly, the study was conducted in a single centre. It might be expected that a larger, multi-centre study, involving ICUs of various hospitals (including secondary as well as tertiary referral centres) would show different results. Also, differences in criteria for ICU admission and discharge may differ markedly between hospitals, but particularly between countries due to local law, policy, and implemented guidelines. Yet, we believe that our observations are applicable to most ICUs of secondary referral community hospitals, at least in the Netherlands.

In conclusion, consumption of ICU resources by long-stay patients was considerable, but did not change over time in our setting. Long-stay patients were predominantly medical admissions and showed highest mortality. Mortality in this group decreased over the years. These findings are important in view of futility and costs.

List of abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>APACHE II-score</td>
<td>Acute Physiology Age and Chronic Health Evaluation II-score</td>
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<tr>
<td>ICU</td>
<td>Intensive Care Unit</td>
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<tr>
<td>IQR</td>
<td>Interquartile range</td>
</tr>
<tr>
<td>LOS</td>
<td>Length of stay</td>
</tr>
<tr>
<td>N</td>
<td>Number</td>
</tr>
<tr>
<td>PM</td>
<td>Predicted mortality</td>
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References