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Impact of the post-World War II generation on intensive care needs in Norway

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Background: A high birth rate during the first two decades following World War II has increased the proportion of elderly people in present-day society and, consequently, the demand for health-care services. The impact on intensive care services may become dramatic because the age distribution of critically ill patients is skewed towards the elderly. We have used registry data and population statistics to forecast the demand for intensive care services in Norway up until the year 2025.
Methods: Data collected by the Norwegian intensive care registry (NIR), showing the age distribution in Norwegian intensive care units (ICU) during the years 2006 and 2007, were used with three different Norwegian prognostic models of population growth for the years 2008–2025 to compute the expected increase in intensive care unit bed-days (ICU bed-days).
Results: The elderly were overrepresented in Norwegian ICUs in 2006–2007, with patients from 60 to 79 years of age occupying 44% of ICU bed-days. Population growth from 2008 to 2025 was estimated to be from 11.1 to 26.4%, depending on the model used. Growth will be much larger in the age group 60–79 years. Other factors kept unchanged, this will result in an increase in the need for intensive care (ICU bed-days) of between 26.1 and 36.9%.
Conclusion: The demand for intensive care beds will increase markedly in Norwegian hospitals in the near future. This will have serious implications for the planning of infrastructure, education of health care personnel, as well as financing of our health care system.

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DURING the last two decades, the number of hospital beds in Norway has decreased, as more patients are cared for on an ambulatory basis.* Those who require intensive care must obviously remain within the hospital, however. These are critically ill patients with acute and often life-threatening organ dysfunction. Most patients in Norwegian intensive care units (ICUs) require mechanical ventilation, are invasively monitored and receive intravenous medications at some time during their sojourn in the ICU.† In addition, many critically ill patients cannot be managed at a lower level even if mechanical ventilation is discontinued, because many Norwegian hospitals lack high-dependency units with trained staff who may care for closely monitored patients. This absence of 'intermediate' services often limits the availability of full ICU services.

Elderly patients are overrepresented among the critically ill.[1–3] It is therefore pertinent to ask how changing demographics due to alterations in birth rate and life expectancy may impact on the capacity of critical care services. Specifically, what effect on ICU demand will the 'baby-boomers', i.e. people born during the first decades following World War II, have in the near future? The aim of this study was to estimate the future demand for ICU beds in Norway based on present data from the Norwegian Intensive Care Registry (NIR) and prognoses for population growth from 2008 to 2025 provided by Statistics Norway.

Methods

The NIR was established in 1998 following an initiative from the Norwegian Board of Health

*Statistics Norway: Statistikkbanken 2009. Available at http://statbank.ssb.no/statistikkbanken/ (accessed on 9 May 2009)
†Norwegian intensive care registry 2009. Available at http://www.intensivregister.no (accessed on 9 May 2009)

Supervision. It is one of several national medical registries in Norway.† The critically ill are normally unable to give any kind of informed consent and the NIR has not been granted permission to record identifiable data. Thus, all records in the registry are anonymous. This study involved no interventions and ethics approval was not sought.

Before 2006, NIR consisted partly of aggregate reports from participating ICUs and partly data on individual admissions. Submission of data was inconsistent from year to year. This precluded inclusion of these data in our analysis. From 2006, the registry has received data on individual admissions from 31 surgical and mixed ICUs, i.e. five in tertiary hospitals (all university hospitals with comprehensive medical services including neurosurgery and heart surgery), 15 in secondary hospitals (comprehensive medical services, except neurosurgery and heart surgery) and 11 primary hospitals (basic medical and surgical services). Cardiothoracic post-operative departments, neonatal units and ICUs at paediatric and the facilities at two internal medicine departments have so far not contributed to the registry. Excluding neonatal units, the registry thus comprises all public hospitals in every region, and our best estimate is that more than 90% of all ICU admissions in Norway are included. Regarding the capacity of these units, uncertainties exist because of inconsistent reporting of physical capacity vs. manned beds. All admissions lasting ≥ 24 h are registered, as well as admissions that include mechanical ventilation or result in death within 24 h. The following variables are registered: hospital name, age of the patient, sex, length of stay (LOS) in ICU, time on mechanical ventilatory support, risk score using Simplified Acute Physiology Score 2 (SAPS II),[4] resource use by Nine Equivalent of Nursing Manpower Score (NEMS),[5] surgical or medical status, elective or acute admission and whether the patient was transferred from another ICU and vital status upon discharge from the ICU and the hospital.

Admissions recorded during 2006–2007 were divided into age cohorts of 10 years each. LOS was aggregated for each group and the average from 2006 and 2007 was calculated. This average sum of ICU bed-days per year and age cohort was used for further calculations.

Statistics Norway has prognosticated the development of the Norwegian population from 2008 to 2030 according to several different models.* We used data from models termed 'low', 'moderate' and 'high' national growth rate. These indicate that the population of Norway will increase from 4,737,171 in 2008 to between 5,263,680 and 5,986,789 in 2025. Relative growth from 2008 to 2025 was calculated for each 10-year cohort and was multiplied with the sum of ICU bed-days per year and age cohort in 2006–2007 to obtain expected ICU bed-days per year and age cohort in 2025. We have assumed that bed occupancy will change little from 2006–2007 to 2008.

We also analysed LOS in relation to SAPS II and age cohorts.

Calculations were performed in Excel (Microsoft corporation, Seattle, WA) and SPSS version 16 (SPSS Inc., Chicago, IL). Descriptive statistics was used for the main analysis. Cox regression and Kaplan–Meier estimation were used for LOS analysis.

Results

Statistics Norway estimates that the Norwegian population will increase by 11.1–26.4% from 2008 to 2025. Growth will be most pronounced in age groups 60–69 and 70–79 years in all models (Table 1). Compared with the other age groups, choice of model has only a limited effect on growth estimates for the elderly. In the two groups combined, growth will be from 43.7% (low national growth rate) to 49.8% (high national growth rate) from 2008 to 2025.

In 2006 and 2007, the NIR recorded 10,959 and 10,983 admissions, respectively. The total number of ICU bed-days were 54,468 in 2006 and 55,575 in 2007. In 2006, the median and mean LOS were 2.1 and 4.8 days, and in 2007, the median and mean LOS were 2.1 and 5.1 days. Individual LOS was significantly related to SAPS II score and age group (Figs 1a and b). Patients with SAPS II scores from 50 to 74 had significantly longer LOS and those with scores below 25 had significantly shorter LOS compared with other cohorts. Similarly, patients aged 40–79 years had significantly longer LOS and those aged 80 years and above had significantly shorter LOS compared with other age cohorts. Also, patients with SAPS II scores in the medium-range occupied most ICU bed-days in both 2006 and 2007 (Fig. 1c).

†*Norwegian intensive care registry 2009. Available at http://www.intensivregister.no (accessed on 9 May 2009)*

**Statistics Norway: Statistikkbanken 2009. http://statbank.ssb.no/statistikkbanken/ (accessed on 9 May 2009)*

Table 1

Population growth 2008–2025*.

Age group (years)	2008	2025					
		Low national growth rate	%	Medium national growth rate	%	High national growth rate	%
0–9	592,764	536,703	−9.5	685,446	15.6	799,046	34.8
10–19	630,182	614,772	−2.4	664,768	5.5	718,099	14.0
20–29	580,932	672,092	15.7	703,623	21.1	742,508	27.8
30–39	683,936	716,414	4.7	762,347	11.5	818,629	19.7
40–49	674,780	681,262	1.0	710,879	5.3	747,771	10.8
50–59	603,915	724,095	19.9	740,165	22.6	759,336	25.7
60–69	465,854	605,896	30.1	616,366	32.3	628,139	34.8
70–79	286,214	474,890	65.9	486,429	70.0	498,774	74.3
80–89	185,322	201,491	8.7	213,647	15.3	226,861	22.4
90+	33,272	36,065	8.4	41,441	24.6	47,626	43.1
Total	4,737,171	5,263,680	11.1	5,625,111	18.7	5,986,789	26.4

**Source*: Statistics Norway: Statistikkbanken 2009. Available at http://statbank.ssb.no/statistikkbanken/ (accessed 9 May 2009).

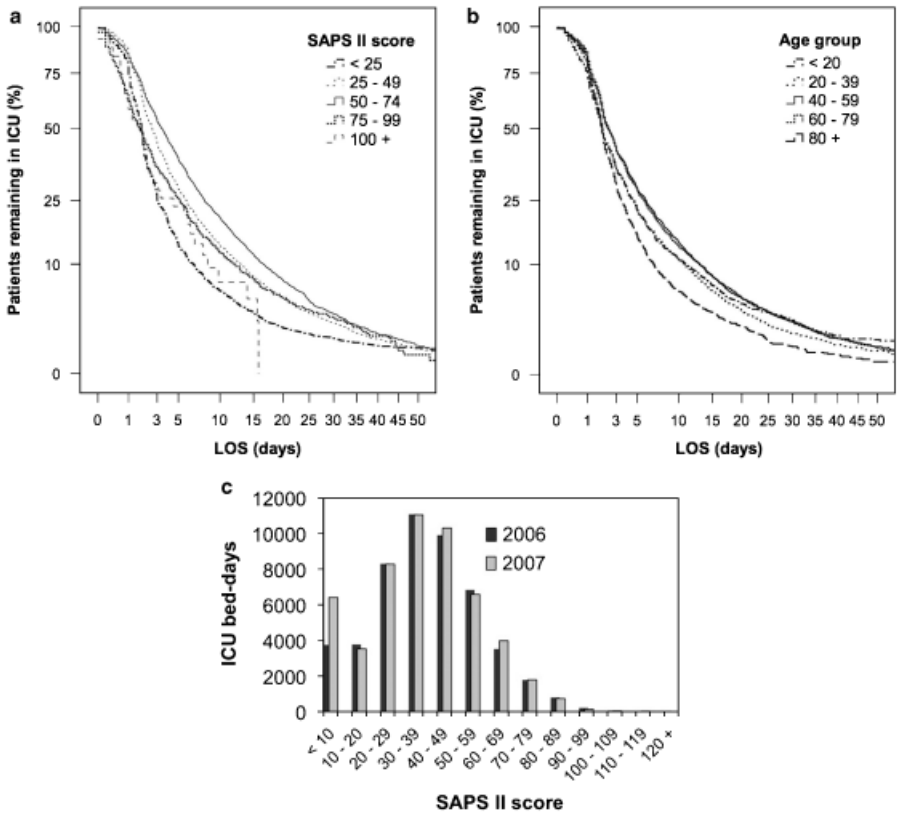

Fig. 1. Length of stay (LOS) related to (a) Simplified Acute Physiology Score 2 (SAPS II) score (n = *21,937) and (b) age group* (n = *21,942) (Kaplan–Meier estimate; data from 2006 and 2007); (c) ICU-bed occupancy by SAPS II cohort* (n = *21,942).*

The median age was 63.7 years in 2006 and 64.0 years in 2007. In 2006 and 2007, 42.7% and 43.8% of the patients were female. There was a close correlation between the number of admissions and the total ICU bed-days for most age groups. However, patients aged 80–89 years had disproportionally fewer ICU bed-days (Fig. 2, Table 2). During 2006–2007, an average of 40.6% of all registered admissions were patients aged 60–79 years and these occupied 44.0% of all ICU bed-days (Table 2). Depending on the choice of growth rate model, and given that all other factors are kept unchanged, the alteration in age distribution in the Norwegian population will cause an increase in the total number of ICU bed-days from 26.1 to 36.9%. (Fig. 3, Table 2).

Discussion

The purpose of this study was to investigate how an altered age distribution will impact on

Norwegian intensive care services in the near future. We found that the expected increase in the proportion of elderly people will increase the demand for ICU bed-days by around one third. However, the premise that other factors remain unchanged is problematic. Many factors may contribute to an even greater increase in demand: the elderly of today receive more extensive therapy when seriously ill than only a decade ago. Higher age is an independent risk factor for serious complications and need for intensive care services.[6] It is expected that patients with common disorders, such as cancer[7] and stroke,[8] to an increasing degree will require intensive care following treatment. Also, those with organ transplants and an increasing population of adults treated for congenital disease represent new groups of patients who require life-long follow-up and repeated interventions, again with a high risk of complications.[9,10]

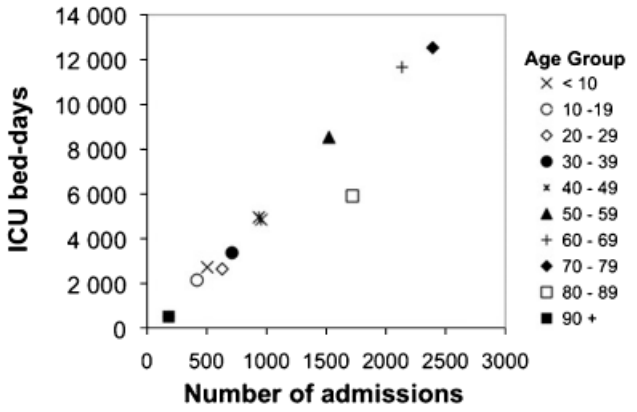

Fig. 2. Number of admissions vs. intensive care unit (ICU)-bed occupancy by age cohort in Norwegian ICUs.

Our LOS data confirm that the severely ill, i.e. with a high SAPS II score, occupy a large fraction of ICU bed-days.

On the other hand, a change in the spectrum of injury and disease may also reduce the demand for intensive care services. Thus, in western countries, the incidence rate of cardiogenic shock following myocardial infarction is decreasing,[11] and in most Nordic countries, the incidence rate of fatal head injuries has been drastically reduced.[12] In Sweden, Walther and Jonasson[13] found that ICU LOS for elderly patients was significantly reduced from 1993 to 1999 without any increase in mortality.

Half of all admissions during 2006–2007 were 2.1 days or shorter (median LOS). Many of these admissions may represent post-operative patients who might have been cared for at a lower level (e.g.

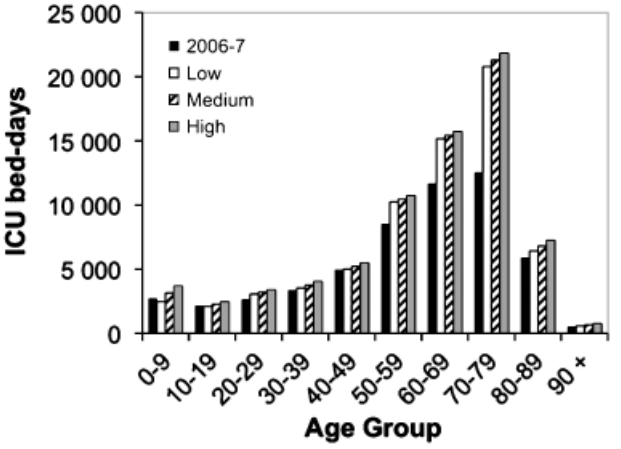

Fig. 3. Intensive care unit (ICU) bed-days 2006/2007–2025, according to a high, a medium and a low national population growth rate.

Table 2

ICU bed-days 2008–2025.

Age group (years)	2006–2007*		ICU bed-days 2025†		
	Admissions (%)	ICU bed-days (%)	Low national growth rate	Medium national growth rate	High national growth rate
0–9	504 (4.5)	2725.5 (4.9)	2467.7 (0.91)	3151.6 (1.16)	3673.9 (1.35)
10–19	418 (3.7)	2151.4 (3.9)	2098.8 (0.98)	2269.5 (1.06)	2451.5 (1.14)
20–29	629 (5.6)	2649.3 (4.8)	3065.0 (1.16)	3208.8 (1.21)	3386.2 (1.28)
30–39	711 (6.4)	3372.2 (6.1)	3532.3 (1.05)	3758.8 (1.11)	4036.3 (1.20)
40–49	936 (8.4)	4956.3 (3.6)	5003.9 (1.01)	5221.4 (1.05)	5492.4 (1.11)
50–59	1523 (13.7)	8533.7 (15.5)	10,231.9 (1.20)	10,458.9 (1.23)	10,729.8 (1.26)
60–69	2135 (19.2)	11,665.0 (21.2)	15,171.7 (1.30)	15,433.8 (1.32)	15,728.6 (1.35)
70–79	2392 (21.5)	12,533.7 (22.8)	20,796.0 (1.66)	21,301.3 (1.70)	21,841.9 (1.74)
80–89	1720 (15.4)	5911.4 (10.7)	6427.2 (1.09)	6814.9 (1.15)	7236.4 (1.22)
90+	185 (1.7)	523.6 (0.9)	567.6 (1.08)	652.2 (1.25)	749.5 (1.43)
Total	11,150	55,021.9	69,361.9 (1.26)	72,271.2 (1.31)	75,326.5 (1.37)

*Mean of 2006 and 2007.
†Total intensive care unit (ICU) bed-days per year and age group. Relative growth rate in parentheses.

a high dependency unit if these were available).[14] To further reduce demand for intensive care services, it will be necessary to restrict admissions based on some predictive rule (risk score, age, etc.). Such rationing of care is implicit in today's selection of patients for intensive care, but is probably politically problematic if made explicit.

This study has several weaknesses: the NIR does not record data that allow us to reliably calculate the full capacity of Norwegian ICUs. Therefore, it is difficult to estimate precisely what increase in ICU bed-days can be absorbed with present-day resources. However, based on the number of admissions with a short LOS, the number of transfers to other ICUs (about 10%) and readmissions (10%), we assume that there is little available bed-capacity in Norwegian ICUs.† Thus, an increase in the number of ICU bed-days due to demographic or other changes will necessitate an expansion of intensive care facilities.

Another weakness of this study is that we have used registry data from 2006 to 2007 to calculate changes in ICU bed-days although the demographic data from Statistics Norway are concerned with population changes starting in 2008. This is for pragmatic reasons. Data from Norwegian ICUs for 2008 will not be available until autumn 2009 and our assumption is that the admission data will change little over such a short period. Thus, the total number of ICU bed-days increased by 1107 (2.0%) from 2006 to 2007 and the age distribution was similar. However, instead of extrapolating from these data, we rather assumed that the average number of ICU bed-days per age group in 2006–2007 would be a more robust starting point. Inconsistent reporting from previous years precludes inclusion of such data in our analysis.

Analyses similar to ours have been performed in both Finland and Canada.[3,15] In Finland, it was found that a change in demographics would cause an increase in the demand for ICU bed-days of 19% by 2020 and 25% by 2030, i.e. a somewhat lower estimate than ours. However, in Ontario, Canada, the need for mechanical ventilation is expected to increase by as much as 80% by 2026. The elderly part of the population is expected to grow even more rapidly in Canada than in Norway. Also, in North America, ICUs care for more terminal patients than in Scandinavia.[16] We found that the age group of 80–89 years occupied disproportionally few ICU bed-days per admission compared with other age groups. This may indicate that Norwegian doctors at present are reluctant to provide extended intensive care for the very old. This may change, however, as it is becoming apparent that age alone is a poor criterion for restricting care.[17,18]

†*Norwegian intensive care registry 2009. Available at http://www.intensivregister.no (accessed on 9 May 2009)*

Conclusion

In Norway, altered age distribution alone will probably increase the number of ICU bed-days from 26.1 to 36.9% by the year 2025. This will challenge the capacity of present-day intensive care services and calls for an expansion of ICU-facilities and high-dependency units, education of health care personnel and financing in the near future. The alternative, strict rationing of intensive care services based on cost-effectiveness and explicit criteria (risk estimates or age) seems improbable at present.

Acknowledgements

Conflict of interests: All authors declare that there are no conflicts of interest.

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