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Geographical Variation in Use of Intensive Care in Denmark: A Nationwide Study

Research year report

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Preface

The current report is based on a study conducted during my research year at the Department of Clinical Epidemiology, Aarhus University Hospital.

First of all, I would like to express my profound gratitude to my supervisors and collaborators. During the research year, they have all helped me achieving competences and skills on everything from developing the concept and writing the protocol to securing funding, collecting data, conducting analyses, interpreting results, and working out the final scientific publication.
I am deeply thankful to my main-supervisor, Søren Paaske Johnsen, who introduced me to clinical epidemiology, shared scientific skills and visions with me, and placed great confidence in my ability to carry out this research year project and future studies as MD/PhD student.
Great thanks also go to my co-supervisor, Christian Fynbo Christiansen, for sharing his epidemiological knowledge and writing-skills with a remarkable patience and engagement.
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Moreover, thanks to Steffen Christensen for his clinical inputs on the paper included in the report as well as Henrik Nielsen for providing statistical analyses and relentlessly answering questions.
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Abbreviations

CI	Confidence intervals
DID	Danish Intensive Care Database
DRG	Diagnosis Related Groups
ICU	Intensive Care Unit
LOS	Length of ICU stays
NRP	Danish National Registry of Patients
SAPS II	Simplified Acute Physiology Score II
US	United States of America

Contents

Abstract

Objective: To examine whether there is geographical variation in the use of intensive care resources in Denmark concerning both intensive care unit (ICU) admission and use of specific interventions. Substantial variation in use of intensive care has been reported between countries and within the US, however, data on geographical variation in use within more homogenous tax-supported health care systems are sparse.

Methods: We conducted a population-based cross-sectional study based on linkage of national, medical registries including all Danish residents between 2008 and 2012 using population statistics from Statistics Denmark.

Data on ICU admission and interventions, including mechanical ventilation, non-invasive ventilation, acute renal replacement therapy, and treatment with inotropes/vasopressors, were obtained from the Danish Intensive Care Database. Data on patients' residence at the time of admission were obtained from the Danish National Registry of Patients.

Results: The overall age- and gender standardized number of ICU patients per 1,000 person-years for the 5-year period was 4.3 patients (95% CI, 4.2; 4.3) ranging from 3.7 (95% CI, 3.6; 3.7) to 5.1 patients per 1,000 person-years (95% CI, 5.0; 5.2) in the 5 regions of Denmark and from 2.8 (95% CI, 2.6; 3.0) to 23.1 patients per 1,000 person-years (95% CI, 13.0; 33.1) in the 98 municipalities.

The age-, gender- and comorbidity standardized proportion of use of interventions among ICU patients also differed across regions and municipalities.

Conclusions: There is geographical variation in the use of intensive care resources in Denmark both concerning ICU admissions and intensive care interventions.

Dansk resumé

Formål: At undersøge, om der er geografisk variation i brugen af intensivbehandling i Danmark vedrørende både indlæggelser på intensivafdelingerne og brugen af specifikke interventioner. I tidligere studier har man fundet geografisk variation mellem forskellige lande og mellem stater i USA, mens der kun er sparsom viden om potentiel geografisk variation i et mere homogent og skattefinansieret sundhedssystem som det danske.

Metode: Studiet er et nationalt tværsnitsstudie, som baserer sig på sammenkoblingen af nationale, medicinske registre og populationsdata fra Danmarks Statistik vedrørende alle danske indbyggere i perioden mellem 2008 og 2012. Data vedrørende indlæggelser på intensivafdelinger og de her udførte interventioner, herunder mekanisk ventilation, non-invasiv ventilation, akut dialyse og behandling med inotrope stoffer/vasopressorer, blev indhentet fra Dansk Intensiv Database. Ligeledes blev information om patienters bopæl på tidspunktet for indlæggelse optaget fra Landspatientregisteret.

Resultater: Det totale alders- og kønsstandardiserede antal af intensivpatienter per 1,000 personår for den femårige periode var 4,3 indlæggelser (95% CI, 4,2; 4,3) rangerende fra 3,7 (95% CI, 3,6; 3,7) til 5,1 patienter per 1,000 personår (95% CI, 5,0; 5,2) mellem de 5 regioner i Danmark og fra 2,8 (95% CI, 2,6; 3,0) til 23,1 patienter per 1,000 personår (95% CI, 13,0; 33,1) mellem de 98 kommuner.

Den alders-, køns- og komorbiditetsstandardiserede proportion af brugen af intensive interventioner var ligeledes varierende mellem de danske regioner og kommuner.

Konklusion: Der er geografisk variation i brugen af intensivbehandling i Danmark både hvad angår intensivindlæggelser og -interventioner.

Manuscript

Introduction

Intensive care is costly and constitutes a high proportion of healthcare costs [1]. Given the limited resources in the health care system, there has been continuous debate about the capacity and access to intensive care units (ICU) since studies show large variation between countries [2, 3]. This may be explained by lack of well-defined triage criteria in Europe. Beside the severity of illness and chronic diseases, differences in the available financial resources may have significant impact on triage decisions, as well as factors related to the organization of the health care system including number of nurses and thus level of monitoring and care of critically ill patients in the regular wards [4-6].

We hypothesize that the tax-supported health care system in Denmark shows limited variation in the use of intensive care compared to previous US studies with more diverse health care systems [7]. Knowledge about any geographical variation in use of intensive care in a homogenous health care system like Denmark may provide further insight into the extent and nature of variation in use of intensive care [8].

We examined geographical variation between regions and municipalities in Denmark with regard to the number of ICU patients per inhabitants and the proportion of ICU patients receiving specific types of interventions.

Methods

Study design and setting

We conducted a nationwide cross-sectional study among all patients who were residents in Denmark from 2008 through 2012 using population statistics from Statistics Denmark [9].

Denmark is divided into 98 municipalities, which are local administrative bodies responsible for home nursing, public health care, and rehabilitation. In addition, 5 regions are responsible for the hospitals and the practice sector. The hospitals are funded similarly according to Diagnosis Related Groups (DRG). It is possible for the regions to organize services within financial and national legal limits according to local needs, including hospital staff and equipment at the hospitals. The Ministry of Health and Prevention is the state's health authority, which is responsible for legislation on health care that covers the health care related tasks of the regions and the municipalities [10].

Tax-supported health care is provided to all Danish residents, including access to public hospitals, where all intensive care is provided.

Intensive care unit admission and interventions

We used the Danish Intensive Care Database (DID) to identify all patients admitted for intensive care as well as specific interventions (mechanical ventilation, non-invasive ventilation, acute renal replacement therapy, and treatment with inotropes/vasopressors) in the 2008-2012 period.

The DID is a nationwide clinical quality database, which holds data on intensive care admissions from all ICUs (n=49 in 2011). The DID was established in 2007 by the Danish Society of Intensive Care Medicine and the Danish Society of Anaesthesiology and Intensive Care Medicine [11, 12]. The database is approved by Danish Health and Medicines Authority and by the Danish Data Protection Agency, and it is mandatory by law for ICU departments to report to the database. Data are collected through hospital information systems, electronically transferred to the Danish National Registry of Patients (NRP) and subsequently retrieved by the DID. The NRP was established in 1977 and holds data from all hospitals including dates of all admissions and discharges, discharge diagnoses, surgical procedures and patients' residences [13].

The positive predictive value of the coding of intensive care admissions in the NRP based on a sample of 150 intensive care admissions has been reported to be 97.3% [14].

In addition, Blichert-Hansen et al. have examined the accuracy of coding of 150 ICU admissions and the individual intensive care interventions and found it to be close to 100% [15]. The estimated completeness for DID is 95% based on comparison with local patient data management systems [16].
We identified the patients' residence at time of hospital admission using the NRP.

Patient characteristics

Covariates included age, gender, and comorbidity level according to the Charlson Comorbidity Index [17], comprising 19 conditions including myocardial infarction, diabetes, and chronic pulmonary disease, which are selected and weighted according to their potential influence on mortality. The Charlson Comorbidity Index was computed using all hospital diagnoses based on data from the NRP, including diagnoses from hospital admissions since 1977 and outpatient clinic and emergency room diagnoses since 1995. The weight of the 19 conditions were summed to a score and divided into three groups (1, 2, ≥3).

Statistical methods

First, we tabulated age, gender, Charlson Comorbidity Index Score, number of ICU beds (retrieved from the DID year report 2011 [15]), length of ICU stays (LOS), ICU bed-hours (LOS multiplied with ICU patients per 1,000 person-years), and 30-day mortality by region.
Secondly, we estimated the number of ICU patients per 1,000 person-years both annually and for the entire study period (2008-2012) as the number of patients' first admission within the 5-year period divided by the number of residents January 1st in the year of interest, as every person then counted one person-year. The denominator of the overall estimates was computed by the sum of the annually counted person-years for the 5-year study period.
The number of patients admitted to an ICU per 1,000 person-years was computed for the whole country as well as separately for the 5 regions and 98 municipalities. Additional analyses were conducted after excluding patients <15

years. We used direct standardization to account for differences in age and gender between geographical areas by an annual standard for each of the years 2008-2012, covering the entire Danish population. We did not consider comorbidity in this analysis, as this information is only available for ICU patients and not for the general population. As supplementary analysis, we also computed the total number of ICU admissions per 1,000 person-years and the number of ICU admissions with mechanical ventilation per 1,000 person-years.
Furthermore, we computed the proportion of ICU patients receiving mechanical ventilation, non-invasive ventilation, acute renal replacement therapy, or treatment with inotropes/vasopressors. We standardized this proportion to account for geographical differences in, age, gender, and Charlson Comorbidity Index [17] using an annual standard for each of the years 2008-2012.

Results

We identified 117,370 patients, who were admitted to ICUs within a population representing 26,009,602 person-years. As shown in Table 1, there was only small variation of age and gender of the ICU patients across the regions. In contrast, the distribution of the Charlson Comorbidity Index showed some variation between the regions with the North Denmark Region having the lowest proportion of patients with severe comorbidity (i.e., Charlson Comorbidity Index level 3+) with 21.3% and the Zealand Region the highest proportion of patients with 26.4% (Table 1).
Some variation was observed regarding the ICU bed capacity. The Zealand region had the lowest capacity by 5.9, whereas the Central Denmark Region had the highest number of ICU beds per 100,000 inhabitants by 7.8 [16] (Table 1).
The national median and mean LOS were 22.7 hours and 56.0 hours, respectively. The median LOS in the regions ranged from 19.4 hours in the Capital Region to 24.2 hours in the Region of Southern Denmark, whereas the mean ranged from 43.1 hours in the Zealand Region to 68.1 hours in the Region of Southern Denmark. Additionally, the ICU bed-hours per 1,000 person-years

ranged from 187.5 bed-hours in the Zealand Region to 311.8 bed-hours in the North Denmark Region (Table 1)

The overall mortality within 30 days after admission to an ICU was 14%. The mortality also varied among the regions from 10% in Central Denmark Region to 17% in the Capital Region.

Variation in number of patients admitted to ICU

The overall standardized number of ICU patients per 1,000 person-years in Denmark for the 5-year period between 2008 and 2012 was 4.3 patients per 1,000 person-years (95% CI, 4.2; 4.3) (Table 2). Among the regions, the population of the Capital Region had lowest standardized number of ICU patients with 3.7 per 1,000 person-years (95% CI, 3.6; 3.7), whereas North Denmark Region had the highest number with 5.1 patients per 1,000 person-years (95% CI, 5.0; 5.2) (Table 2).

The variation in the standardized number of ICU patients per 1,000 person-years among the municipalities for the 5-year period is illustrated in Figure 1 and ranged from 2.8 (95% CI, 2.6; 3.0) to 23.1 patients per 1,000 person-years (95% CI, 13.0; 33.1).

The annual standardized number of ICU patients per 1,000 person-years did not differ considerably within the 2008-2012 period, and did not show substantial annual variation among the regions (Appendix, Table 3).

Estimates of the number of ICU patients under the age of 15 years (Appendix, Table 4) as well as estimations based on number of ICU admissions rather than patients (Appendix, Table 5) did not differ substantially from the primary analyses.

Variation in use of intensive care interventions

For the 5-year period (2008-2012), the overall standardized proportions of ICU admissions, treated with mechanical ventilation, non-invasive ventilation, acute renal replacement therapy, or inotropes/vasopressors, were 41% (95% CI, 41;

41), 12% (95% CI, 12; 13), 6% (95% CI, 6; 6), and 33% (95% CI, 33; 33), respectively (Table 2).

For mechanical ventilation the standardized proportion among the regions ranged from 37% (95% CI, 37; 38) in Central Denmark Region to 45 % (95% CI, 45; 46) in Capital Region (Table 2).

The variation in use of mechanical ventilation across regions and municipalities is illustrated in Figure 2 (Appendix, Table 6).

The overall standardized proportion of admissions with mechanical ventilation per 1,000 person-years in the 5-year period was 1.9 (95% CI, 1.9, 1.9) ranging from 1.8 (95% CI, 1.8; 1.8) to 2.3 (2.2; 2.4) in the regions (Appendix, Table 7)

The use of non-invasive ventilation within the 5-year period ranged between 9% (95% CI, 8; 9) to 15% (95% CI, 14; 15) of all ICU patients among regions, whereas the corresponding numbers for acute renal replacement therapy were 5% (95% CI, 5; 5) to 8% (95% CI, 7; 8) (Table 2). Treatment with inotropes/vasopressors varied from 31% (95% CI, 30; 32) to 38% (95% CI, 37; 38) across regions (Table 2). As for mechanical ventilation, we also found variation across municipalities for use of non-invasive ventilation, acute renal replacement therapy, and treatment with inotropes/vasopressors (Appendix, Table 8, 9, 10).

Discussion

We found geographical variation in intensive care admissions in Denmark, which could not be explained by differences in age and gender. Furthermore, we also found variation in use of intensive care interventions among ICU patients.

This study is to our knowledge the first nationwide study of geographical variation in a tax-supported health care system with universal coverage. Previous studies have reported variation in use of intensive care between countries and between US states [2, 3, 7].

A study of eight countries' use of intensive care showed major differences between the countries in the number of ICU beds and volume of admissions for adult patients, ranging from 2.16 ICU admissions per year per 1,000 inhabitants in United Kingdom to 23.53 ICU admissions per year per 1,000 inhabitants in Germany [3]. In comparison, we overall found 4.3 ICU patients per 1,000 person-years in Denmark.

Another study suggested that variation in use of intensive care between the US and United Kingdom, is caused by lower ICU bed availability in United Kingdom, which was associated with fewer direct admissions from the emergency room, longer hospital stays before ICU admission, and higher severity of illness scores when admitted compared to the US [2]. Such differences in care patterns and triage criteria may (although on a smaller scale) also be present between the regions of Denmark according to our study. However, ICU beds per inhabitant in Denmark did not vary as much as among European countries where it ranged from 4.2 to 29.2 ICU beds per 100,000 inhabitants [18].

Based on the available data we may only speculate on the reasons for the observed differences between regions in Denmark and it is beyond the scope of the current paper to disentangle the specific factors contributing to the variation. However, several factors could play a role including differences in capacity of ICUs and regular wards, differences in clinical practice and culture, differences in composition of the population and their morbidity patterns together with differences in registration and triage criteria for admission of an ICU patient.

Even within Denmark's uniform health care system, hospitals have different capacity both concerning ICUs and regular wards. It could be hypothesized that the number of patients admitted to ICUs and thereby admission decisions may vary depending on bed availability. However, the number of ICU beds per inhabitant in our study did not seem to be associated with admissions of patients to ICUs since the highest numbers of ICU beds per inhabitant were found in Central Denmark Region and Capital Region which did not correspond to the relatively low number of ICU patients per 1,000 person-years found particularly in the Capital Region. This pattern may be due to the fact that some highly specialized treatments including heart and lung transplantations, liver transplantations, advanced treatments of hematological cancers, and veno-venous extracorporeal membrane oxygenation are centered at hospitals and ICUs in these two regions, which may require a higher number of ICU beds than in other regions.

Only very few hospitals have step-down units, and there are limited options for close observation of patients outside the ICU at small hospitals. Therefore ICUs are often used for patients who do not require aggressive life-sustaining interventions but only close monitoring. This may partly explain why some geographical areas in our study had many ICU patients. However, it is unlikely to be the only explanation since we did not identify regions or municipalities with a combination of a high number of ICU patients per 1,000 person-years together with low use of mechanical ventilation. This would otherwise have supported the hypothesis that high number of ICU patients in some geographical areas was explained by admission of less severely ill patients. However, we identified the highest 30 days mortality in the Capital Region together with the lowest number of ICU patients and, additionally, the North Denmark Region had one of the lowest 30 days mortalities but the highest number of ICU patients. This could indicate case-mix differences of ICU patients, since patients who might have been admitted to an ICU in one region may be treated in a regular ward in other regions.

Furthermore, general morbidity patterns, e.g. of chronic diseases, may differ across the country. For instance, the age standardized incidence of heart failure varies substantially among the Danish regions [19]. However, our results on comorbidity only showed limited regional differences among patients admitted to an ICU (Table 1).

Socio-economic conditions may also influence some of the geographical variation since low socio-economic status may be associated with poor health and chronic illnesses and thereby more ICU admissions. However, regarding average yearly income, an overview from Statistics Denmark [9] did not show any correlations between the number of ICU patients and the average yearly income.

On almost every smaller island we found more ICU patients per 1,000 person-years than on the mainland. It is possible that these patients are more severely ill before they are transferred to the mainland, and therefore end up being admitted to an ICU. Additionally, there might be some statistical uncertainty, since population on these islands is small.

This issue might also be case when comparing municipalities since at least some of the variation may be explained by statistical imprecision due to fewer observations.

Concerning differences in registration and triage criteria for admission of an ICU patient, the triage criteria for being admitted to an ICU, may rely on clinical judgment rather than objective criteria. This is a possible mechanism, why some hospitals have higher or lower number of ICU patients per 1,000 person-years than others – decisions may be arbitrary and vary depending on the ICU physician and the capacity [6, 20].

The main strengths of our study include its nationwide population-based design within the setting of a homogeneous health care system. Results were based on data on the number of ICU patients and type of therapy from highly validated, almost complete registries although the validations of the NRP and DID were made on relatively small sample sizes [13, 14]. In addition, we found low proportions of patients treated with non-invasive mechanical ventilation in some municipalities. We therefore cannot rule out that an incomplete registration of non-invasive ventilation may have influenced our results, but without this being systematic.

In the DID only few patients were not registered (estimated completeness is 95%) [12], which indicates a low risk of selection bias.

However, in the calculations of LOS we assumed that LOS was similar for registered and non-registered patients although discharge date and time have separate codes implemented in 2009 and are therefore not complete throughout the study period.

Information concerning patients’ residence and admission to an ICU were obtained from the NRP and DID respectively. These data are registered prospectively without knowledge about the various outcomes. Of note, admissions were analyzed according to patient’s residency and not according to location of the ICU. Any bias from patients being transferred from regional hospitals to more specialized care at university hospitals is therefore unlikely. There may be confounding from unmeasured factors and residual confounding. We did not include comorbidity and other lifestyle associated conditions in the analysis of ICU patients per 1,000 person-years, and even in the analysis of interventions within ICU patients, residual confounding from severity of comorbidity may influence our findings. We lacked data on life-style factors, but this may at least partly be accounted for by including life-style associated comorbid conditions in the Charlson Index.

Conclusion

There was geographical variation in the use of intensive care in Denmark both for patients admitted to ICUs and for use of intensive care interventions. This finding might partly reflect underlying geographical differences in disease patterns, but may also indicate that a more need-based approach is required when allocating ICU resources in order to ensure balance between clinical need and capacity.

Supplementary information

In this supplementary part of the report, methodological considerations are discussed, including strengths and limitations of the current study.
Furthermore, results of additional analyses, that were not included in the final manuscript, are presented, displaying Simplified Acute Physiology Score II (SAPS II) and patient type.

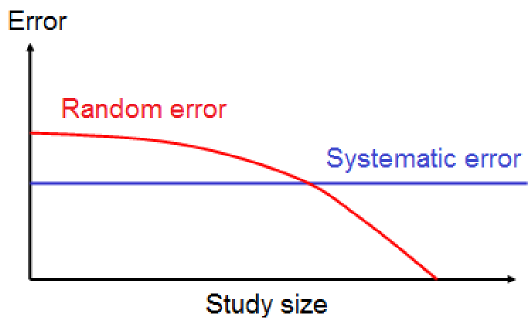
Methodological considerations

We designed a nationwide cross-sectional study among all patients who were residents in Denmark from 2008 through 2012 using data from national population-based registries.
Cross-sectional studies are used to estimate prevalence at a given point or period, here over the 5-year period. The cross-sectional design is not able to determine causation, since it cannot establish the direction of the effect. However, it can be used to identify associations, which can serve as a basis for further examinations of the causal pathways [21].
As described in the first part of the report, the aim of our study was to examine whether there was geographical variation in the use of intensive care resources in Denmark concerning both admission and use of specific interventions. The study was based on the hypothesis, that the uniform tax-supported health care system in Denmark would show limited variation in the use of intensive care compared to previous US studies with more diverse health care systems.
For the purpose of this study aim, we found the cross-sectional design most suitable. This is especially because of the available the registries, containing data collection from the universal tax-supported health care system provided to all Danish residents, including data from public hospitals where all intensive care is provided.

Strengths and limitations

The main strengths of the study include its nationwide population-based design within the setting of a homogeneous health care system. Results were based on data from highly validated, almost complete registries. For instance, the positive predictive value of the coding of intensive care admissions in the Danish National Registry of Patients based on a sample of 150 intensive care admissions has been reported to be 97.3% [14]. The accuracy of coding of ICU admissions and the individual intensive care interventions is found to be close to 100% accurate [15].
Furthermore, the estimated completeness of the DID is 95% based on reported differences between local patient data management systems and the DID included in the description of data quality in DID's annual reports [16].
Still, the study also entails some limitations. For instance, the above mentioned limitations of the cross-sectional design not being able to determine causation, but only determine whether an association is present.
Further limitations that typically afflict epidemiologic studies may be due to error – either random error or systematic error. Random error can be diminished by increasing the study size, whereas the systematic error, described as biases, would remain even when increasing the study size infinitely (Supplementary, Figure 3).

Fig. 3 The relation of systematic error and random error to study size



Selection bias

Selection bias is a systematic error that stems from the procedures used to select subjects and from factors that influence study participation. It arises when the association between exposure and outcome differs for those who participate and those who do not participate in the study [21, 22]. In our study, this could be the case if patients not registered in the DID had different association between living in a geographical area and being admitted to an intensive care unit than the patients actually registered. As described, only few patients were not registered in the DID (estimated completeness is 95%) [12], which indicates a low risk of selection bias.

Information bias

Systematic error in a study can arise, because the information collected is erroneus – information is misclassified. Misclassification is defined as either differential or nondifferential. Nondifferential misclassification occurrs when the misclassification of subjects on exposure is not associated with the outcome. Oppositely, nondifferential misclassification also occurs when the misclassification on outcome is not associated with the exposure [21].

In contrast, differential misclassification can occur when the exposure is misclassified differentially according to the outcome or when the outcome is misclassified differentially according to the person's exposure status [21, 22].

In our current study, information concerning patients' residence and admission to an ICU were obtained from the NRP and the DID, respectively. These data are registered prospectively without knowledge about the various outcomes, which makes differential misclassification unlikely.

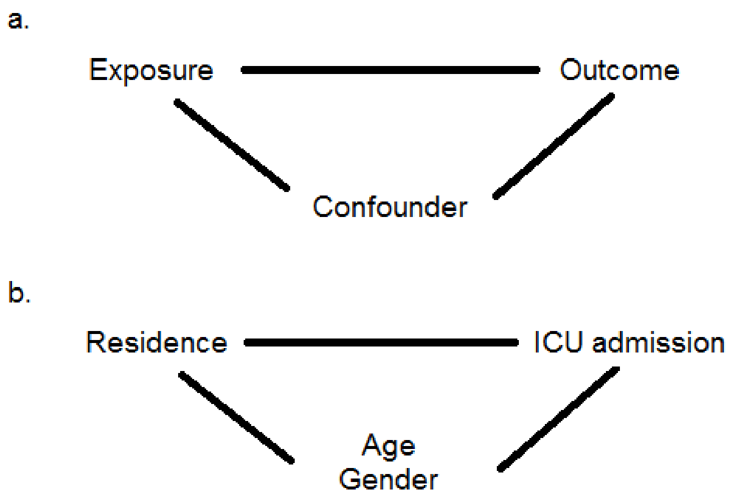
Of note, admissions were analyzed according to patient's residency and not according to location of the ICU. Any bias from patients being transferred from regional hospitals to more specialized care at university hospitals is therefore improbable.

Confounding

Confounding is thought of as mixing of effects and implies that the effect of the exposure is mixed with the effect of another variable. This will result in an imbalance between the exposure groups that are being compared. A confounding variable is one that is associated with exposure, associated with disease, but not an effect of the exposure [21, 22].

We incorporated relevant confounders in our analyses, including age, gender, and comorbidity, since they were all thought to have possible confounding correlations between exposure and outcome (Supplementary, Figure 4).

Fig. 4 Correlation between exposure, outcome, and confounder



a. General correlation between exposure, outcome, and the confounder
b. Correlation between exposure, outcome, and potential confounders in the current study

To account for differences in age and gender between the different geographical areas, we used direct standardization in our main analysis of standardized number of ICU patients. Direct standardization is a method of weighting information in strata, e.g. age strata, by a real or hypothetical distribution in a population [23]. In this way, the weights define the standard. In our study, we used annual standards for each of the years 2008-2012.

We did not consider comorbidity and other lifestyle associated conditions in the main analysis of standardized number of ICU patients, since this information is only available for ICU patients and not for the general population.
In the calculation of the standardized proportion of ICU patients receiving the specific types of intensive care intervention, we standardized the proportion to account for age, gender, and comorbidity level. However, even in this analysis, residual confounding, i.e. confounding still present after adjustment, from severity of comorbidity may influence our findings [21]. And there may also be confounding from unmeasured factors.

Random error

The error that remains after systematic error is eliminated is random error. But, by inclusion of a large number of patients as we did in this nationwide study of 117,370 patients within a population representing 26,009,602 person-years, it is possible to avoid substantial influence by random error [22].

Additional results

Since 2010, the DID has included information on patient type (medical, acute surgical, and elective surgical) and SAPS II [24]. The SAPS II is a severity of illness score comprising 17 variables such as age, physiological variables including Glasgow Coma Score, and severe chronic diseases. The point score ranges from 0 to 163 and a corresponding predicted mortality between 0% and 100%.
Information on patient type was available from 2010 and onwards on 79.3% of the patients. The proportion of patients with missing information on this variable was highest in the Capital Region with 44.5%. For the rest of the regions, the distribution of medical patients ranged from 39.1% to 44.1%, acute surgical patients from 22.6% to 31.5%, and elective surgical patients from 9.2 to 26.0% (Appendix, Table 11). Information on the SAPS II was also available from 2010

and onwards. The median score ranged 36.0 to 45.0 across the regions (Appendix, Table 11). For 65.7% of all patients, SAPS II scoring was irrelevant (patients were under the age of 15 or had admissions of less than 24 hours), and of the remaining patients, 47.2% were not scored.

We did not include information on patient type and SAPS II in the neither the formal statistical analyses on use of intensive care nor in the first part of the study report due to the relatively high proportion of patients with missing information. However, the SAPS II scores did suggest that there were no apparent similarities in the regional variation of number of ICU patients and SAPS II score – for instance, the SAPS II score median in Capital Region was highest of all, but standardized number of ICU patients per 1,000 person-years was lowest, which may be explained by the capacity being lower than, for example, in Central Denmark Region which had the lowest SAPS II score median.

Additional perspectives

The present population-based nationwide study demonstrated that there is substantial geographical variation in use of intensive care, including both intensive care unit admission and specific intensive care interventions, in Denmark.

This finding might partly reflect underlying geographical differences in disease patterns, but also adds further evidence in support for the hypothesis that a more need-based approach is required when allocating intensive care unit resources across hospitals in order to ensure balance between clinical need and capacity.

In this way, the continuous debate about the capacity and access to ICUs, including how ICU beds should be allocated is increasingly relevant as the population simultaneously grows bigger and older, thus increasing the need for intensive care [2, 3, 25]. But at the present moment, triage criteria for admitting patients to ICUs are not widely implemented neither in Europe nor Denmark and may rely on clinical judgement rather than being based solely on objective criteria [4-6].

Moreover, the perception of more care always being better may not result in better quality of care. When trying to understand the nature of the variation in intensive care, the categorization of care proposed by John E. Wennberg and colleagues may be useful. Wennberg et al. describes three categories of care – effective care, preference-sensitive care, and supply-sensitive care [26].

Effective care refers to services that are of proven value and have no significant tradeoffs – i.e. therapy viewed as medically necessary on the basis of clinical outcome evidence. Variation in this category of care often reflects underuse of treatments known to be effective [26, 27].

Preference-sensitive care encompasses treatment decisions. Decisions about whether to have interventions or not, as well as which ones to have, should reflect patients' preferences but may also reflect physician preferences. Options with different risks and benefits ought to be discussed in partnership with the physician, and patients' personal values and preferences should lead to a decision about the treatment. Failure to include individual preferences can lead to over- as well as under-treatment [26, 28].

Supply-sensitive care refers to services where the supply of the resources has major influence on the likelihood of actual use. Excess supply has clearly correlations to excessive use. Intensive care is an example of a type of care that is clearly supply-sensitive, e.g. in regions where there are more ICU beds, more patients may be admitted to an ICU – that is, the number of patients admitted to ICUs and thereby admission decisions may vary depending on bed availability [8, 26, 29].

The way of categorizing health care services into the three categories may be a useful way to view unwarranted practice variations and to help establishing initiatives to address them. However, the use of intensive care resources that we examined in the current study does not unambiguously fit into a single one of these categories. The variation in use of intensive are may to some extent contribute to the variation within all three categories rather than a specific.

Several factors could play a role for the observed differences between regions in Denmark in our study, including differences in capacity of ICUs and regular wards, differences in clinical practice and culture, and differences in composition of the population, which have already been discussed in the first part of the report. To disclose the underlying factors contributing to the variation in use of intensive care in Denmark is beyond the scope of this study, but other studies may be aimed at examining these specific factors.

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Tables

Table 1 Characteristics of patients, who were admitted to intensive care units in Denmark between 2008 and 2012

Patient characteristics	**Denmark**	**Regions**				
		North Denmark Region	*Central Denmark Region*	*Region of Southern Denmark*	*Capital Region*	*Zealand Region*
Age						
25th percentile	48.0	44.0	44.0	51.0	49.0	50.0
Median	64.0	63.0	63.0	65.0	64.0	64.0
75th percentile	74.0	74.0	74.0	75.0	74.0	74.0
Gender, n (%)						
Female	50,563 (43.1)	6,758 (43.9)	12,322 (43.8)	10,903 (42.0)	12,673 (43.3)	7,980 (42.8)
Male	66,807 (56.9)	8,648 (56.1)	15,824 (56.2)	15,044 (58.0)	16,618 (56.7)	10,678 (57.2)
Charlson Comorbidity Index Score Level, n (%)						
0	46,062 (39.2)	6,640 (43.1)	11,644 (41.4)	9,441 (36.4)	11,394 (38.9)	6,943 (37.2)
1	22,480 (19.1)	2,918 (19.0)	5,319 (18.9)	5,095 (19.6)	5,591 (19.1)	3,557 (19.1)
2	19,724 (16.8)	2,562 (16.6)	4,400 (15.6)	4,686 (18.1)	4,839 (16.5)	3,237 (17.4)
3+	29,177 (24.8)	3,281 (21.3)	6,783 (24.1)	6,725 (25.9)	7,467 (25.5)	4,921 (26.4)
ICU beds per 100,000 inhabitants (2011)	7.2	7.2	7.8	7.1	7.5	5.9
Length of stay, hours						
25th percentile	10.5	11.8	9.9	14.9	2.6	11.7
Median	22.7	22.2	21.9	24.2	19.4	23.3
75th percentile	53.5	47.6	48.2	58.3	52.8	65.9
Length of stay, hours						
Mean	56.0	60.9	47.9	68.1	53.2	43.1
ICU bed-hours per person-years	238.0	311.8	220.8	284.7	195.8	187.5
30 days mortality, n (%)	4,991 (14)	1,761 (12)	2,811 (10)	2,964 (12)	4,757 (17)	2,698 (16)

Table 2 Standardized number of ICU patients per 1,000 person-years and standardized percentages of interventions in ICUs for the 5-year period between 2008 and 2012

	Denmark	**Regions**				
		North Denmark Region	*Central Denmark Region*	*Region of Southern Denmark*	*Capital Region*	*Zealand Region*
ICU patients per 1,000 person-years[a] (95% CI)	4.3 (4.2; 4.3)	5.1 (5.0; 5.2)	4.6 (4.6; 4.7)	4.2 (4.1; 4.2)	3.7 (3.6; 3.7)	4.4 (4.3; 4.4)
Mechanical ventilation[b], % (95% CI)	41 (41; 41)	43 (42; 44)	37 (37; 38)	41 (40; 42)	45 (44; 46)	39 (38; 39)
Non-invasive ventilation[b], % (95% CI)	12 (12; 13)	9 (8; 9)	12 (12; 13)	15 (14; 15)	12 (12; 12)	14 (14; 15)
Acute renal replacement therapy[b], % (95% CI)	6 (6; 6)	5 (4; 5)	5 (5; 6)	6 (6; 6)	8 (7; 8)	6 (6; 7)
Inotropes /vasopressors[b], % (95% CI)	33 (33; 33)	34 (33; 35)	31 (31; 32)	38 (37; 38)	31 (30; 32)	33 (32; 33)

[a] Age- and gender standardized
[b] Age-, gender-, and comorbidity standardized

Figures

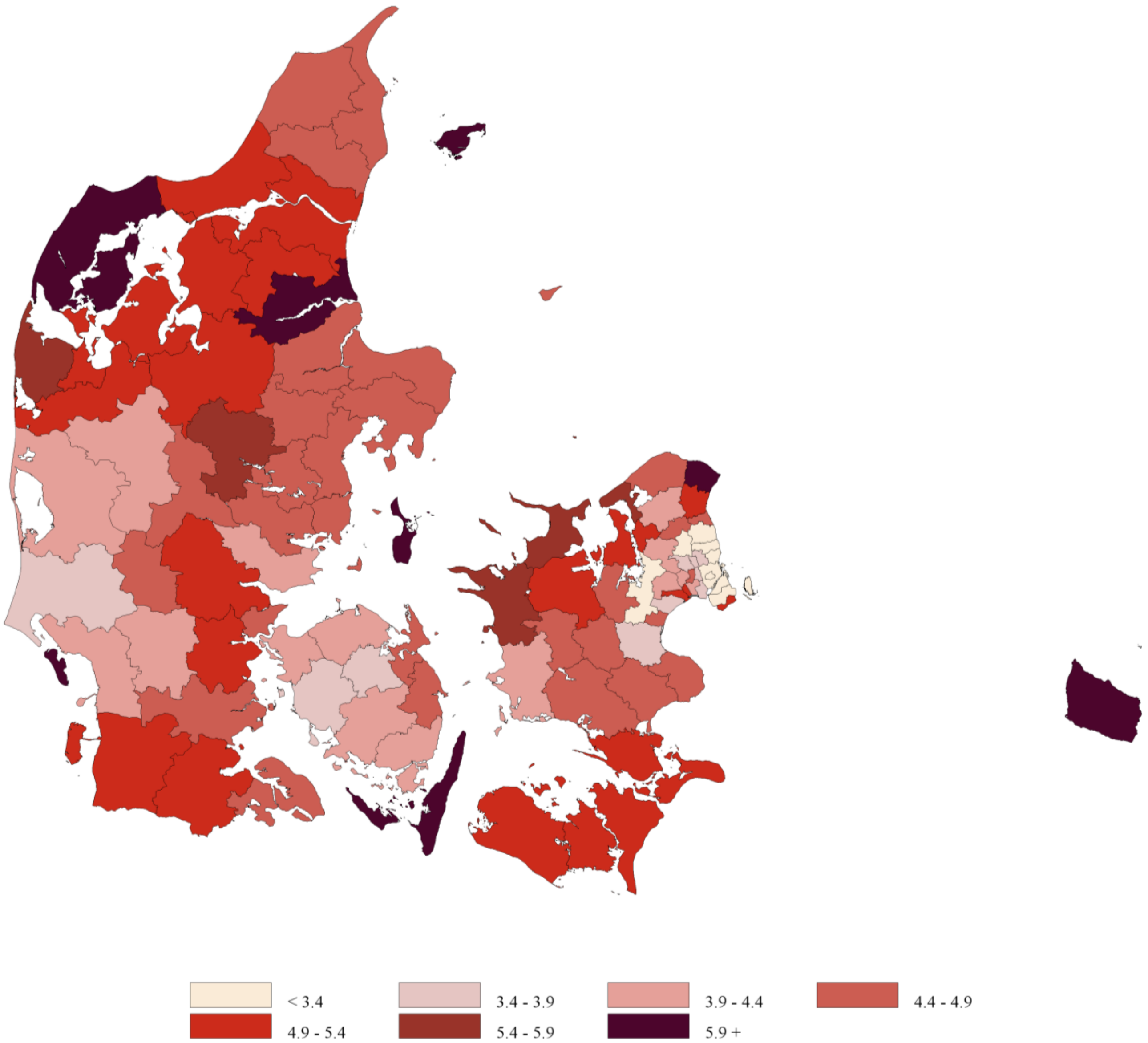

Fig. 1 Standardized number of ICU patients per 1,000 person-years for the various municipalities of Denmark in the 5-year period between 2008 and 2012

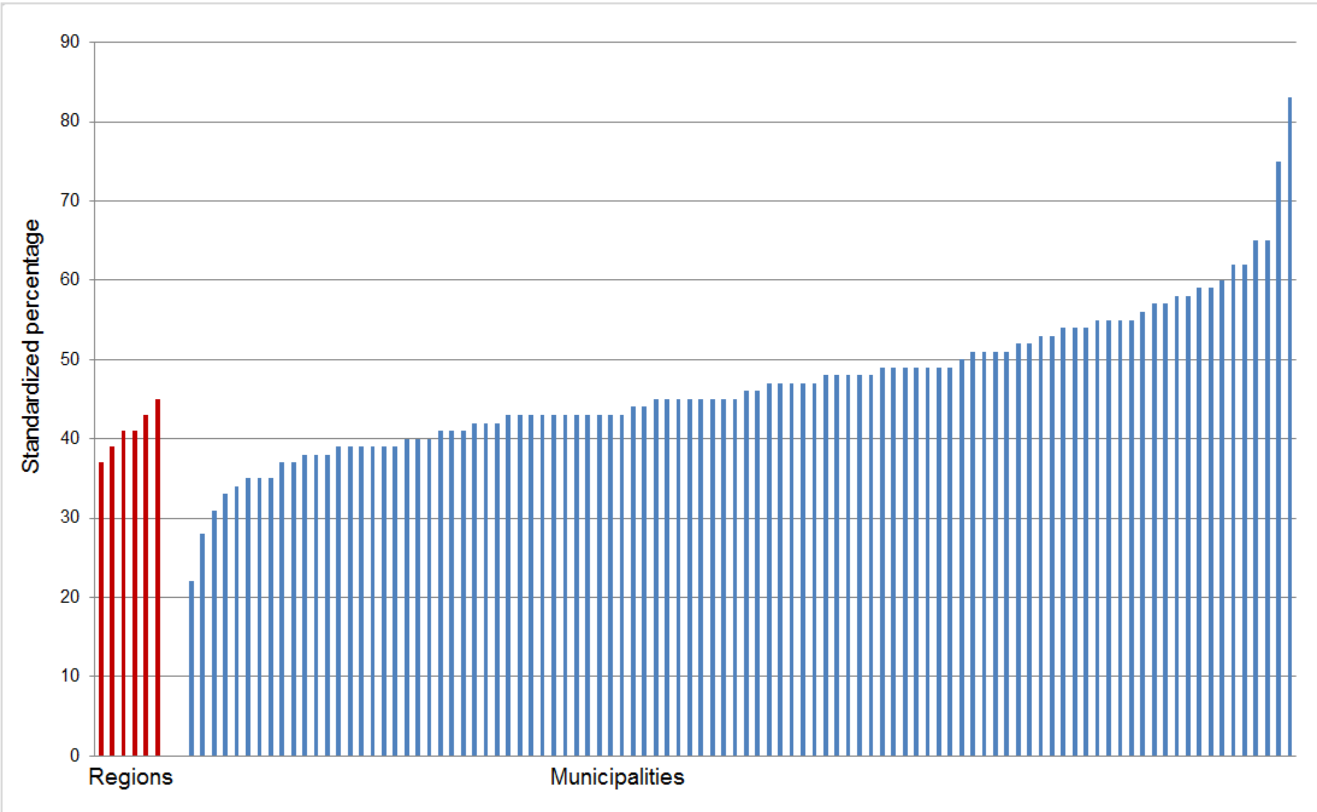

Fig. 2 Standardized percentages of ICU admissions treated with mechanical ventilation for the 5-year period between 2008 and 2012

Appendix

Table 3 Yearly standardized number of ICU patients per 1,000 person-years

	Standardized number of ICU patients per 1,000 person-years (95% CI)				
	2008	*2009*	*2010*	*2011*	*2012*
Denmark	4.61 (4.55; 4.66)	4.44 (4.39; 4.50)	4.32 (4.26; 4.37)	4.02 (3.97; 4.08)	3.85 (3.80; 3.90)
Capital Region	4.01 (3.91; 4.11)	4.09 (3.99; 4.19)	3.58 (3.49; 3.68)	3.34 (3.25; 3.43)	3.39 (3.30; 3.48)
Zealand Region	4.75 (4.61; 4.90)	4.33 (4.19; 4.47)	4.27 (4.13; 4.41)	4.19 (4.05; 4.33)	4.18 (4.05; 4.32)
Region of Southern Denmark	3.94 (3.83; 4.05)	4.02 (3.91; 4.13)	4.33 (4.21; 4.44)	4.32 (4.20; 4.44)	4.28 (4.17; 4.40)
Central Denmark Region	5.34 (5.21; 5.47)	5.09 (4.97; 5.22)	4.97 (4.85; 5.10)	4.29 (4.18; 4.41)	3.38 (3.27; 3.48)
North Denmark Region	5.98 (5.78; 6.17)	5.18 (5.00; 5.36)	5.13 (4.95; 5.31)	4.59 (4.41; 4.76)	4.73 (4.56; 4.91)
Capital Region	4.01 (3.91; 4.11)	4.09 (3.99; 4.19)	3.58 (3.49; 3.68)	3.34 (3.25; 3.43)	3.39 (3.30; 3.48)
Albertslund	4.22 (3.22; 5.22)	5.08 (4.06; 6.11)	5.26 (4.13; 6.39)	5.17 (4.03; 6.31)	3.72 (2.85; 4.59)
Allerød	5.04 (3.89; 6.19)	5.15 (4.10; 6.19)	6.07 (4.76; 7.38)	6.20 (4.76; 7.64)	4.87 (3.63; 6.11)
Ballerup	4.38 (3.72; 5.04)	4.98 (4.24; 5.72)	4.21 (3.55; 4.88)	4.08 (3.45; 4.71)	3.59 (3.02; 4.15)
Bornholm	17.34 16.02; 18.67)	16.93 (15.63; 18.23)	7.03 (6.17; 7.90)	6.56 (5.73; 7.38)	7.16 (6.34; 7.98)
Brøndby	4.85 (4.11; 5.59)	5.44 (4.61; 6.28)	4.76 (3.92; 5.60)	4.31 (3.52; 5.10)	4.46 (3.70; 5.22)
Dragør	4.93 (2.85; 7.01)	5.68 (4.09; 7.27)	6.21 (4.30; 8.12)	5.15 (3.54; 6.76)	6.34 (4.61; 8.07)
Egedal	5.29 (4.38; 6.21)	4.94 (4.12; 5.75)	4.79 (3.93; 5.65)	4.00 (3.27; 4.73)	2.69 (2.11; 3.27)
Fredensborg	6.22 (5.36; 7.08)	6.00 (5.18; 6.82)	6.25 (5.38; 7.12)	4.31 (3.60; 5.03)	4.35 (3.64; 5.06)
Frederiksberg	3.30 (2.89; 3.71)	2.84 (2.47; 3.22)	2.84 (2.47; 3.22)	2.89 (2.50; 3.27)	2.89 (2.53; 3.25)
Frederikssund	5.51 (4.81; 6.22)	6.22 (5.46; 6.98)	5.03 (4.34; 5.72)	4.53 (3.89; 5.17)	4.20 (3.52; 4.88)
Furesø	3.96 (3.28; 4.64)	3.89 (3.19; 4.59)	3.73 (3.05; 4.41)	3.16 (2.49; 3.83)	3.42 (2.74; 4.09)
Gentofte	3.14 (2.70; 3.57)	4.00 (3.47; 4.53)	3.07 (2.61; 3.52)	2.99 (2.56; 3.42)	3.31 (2.83; 3.78)
Gladsaxe	4.40 (3.83; 4.98)	3.66 (3.15; 4.17)	3.45 (2.96; 3.94)	3.80 (3.27; 4.33)	3.92 (3.40; 4.44)
Glostrup	6.47 (5.19; 7.74)	7.45 (6.01; 8.90)	6.07 (4.82; 7.32)	4.95 (3.76; 6.15)	5.02 (3.91; 6.12)
Gribskov	5.97 (5.14; 6.81)	6.21 (5.33; 7.09)	5.39 (4.63; 6.15)	4.23 (3.55; 4.91)	4.26 (3.58; 4.95)
Halsnæs	6.90 (5.92; 7.87)	6.51 (5.60; 7.43)	5.25 (4.44; 6.06)	5.44 (4.55; 6.34)	5.71 (4.69; 6.73)
Helsingør	6.85 (6.18; 7.52)	8.10 (7.35; 8.85)	7.40 (6.70; 8.10)	4.96 (4.39; 5.53)	4.18 (3.64; 4.72)
Herlev	5.36 (4.26; 6.46)	4.64 (3.69; 5.60)	4.25 (3.33; 5.17)	5.32 (4.24; 6.39)	3.91 (3.05; 4.76)
Hillerød	4.69 (4.04; 5.34)	4.58 (3.94; 5.23)	4.52 (3.88; 5.16)	4.39 (3.73; 5.06)	4.05 (3.38; 4.72)
Hvidovre	4.37 (3.74; 5.00)	4.84 (4.16; 5.53)	4.33 (3.67; 4.99)	3.58 (3.01; 4.15)	3.39 (2.85; 3.93)
Høje-Taastrup	4.14 (3.48; 4.79)	5.07 (4.37; 5.77)	5.29 (4.55; 6.03)	4.45 (3.79; 5.11)	3.99 (3.39; 4.59)
Hørsholm	6.58 (5.41; 7.76)	5.31 (4.34; 6.28)	6.01 (4.88; 7.13)	4.58 (3.60; 5.56)	5.86 (4.63; 7.09)
Ishøj	6.28 (4.87; 7.69)	6.29 (4.88; 7.71)	6.16 (4.69; 7.62)	5.23 (3.95; 6.51)	6.08 (4.68; 7.48)
København	3.25 (3.07; 3.44)	3.16 (2.98; 3.35)	3.22 (3.03; 3.40)	3.52 (3.32; 3.71)	3.81 (3.61; 4.02)
Lyngby-Taarbæk	3.62 (3.06; 4.18)	3.59 (3.02; 4.17)	3.66 (3.06; 4.26)	3.41 (2.86; 3.96)	3.35 (2.80; 3.90)
Rudersdal	3.02 (2.54; 3.49)	3.71 (3.17; 4.26)	2.87 (2.41; 3.33)	3.45 (2.89; 4.01)	3.17 (2.68; 3.66)
Rødovre	3.79 (3.12; 4.46)	4.03 (3.32; 4.74)	3.81 (3.12; 4.51)	3.42 (2.75; 4.08)	3.73 (3.06; 4.41)
Tårnby	3.48 (2.77; 4.19)	3.60 (2.94; 4.25)	3.32 (2.74; 3.90)	4.13 (3.39; 4.87)	4.10 (3.44; 4.76)
Vallensbæk	5.49 (3.66; 7.33)	6.42 (4.33; 8.50)	6.32 (4.48; 8.16)	6.49 (4.65; 8.33)	6.60 (4.52; 8.69)
Zealand Region	4.75 (4.61; 4.90)	4.33 (4.19; 4.47)	4.27 (4.13; 4.41)	4.19 (4.05; 4.33)	4.18 (4.05; 4.32)
Faxe	4.71 (3.96; 5.45)	4.63 (3.84; 5.42)	5.12 (4.31; 5.94)	4.53 (3.78; 5.29)	5.37 (4.52; 6.22)
Greve	3.75 (3.14; 4.37)	4.07 (3.40; 4.73)	3.58 (2.97; 4.19)	3.39 (2.82; 3.95)	3.58 (2.96; 4.19)
Guldborgsund	5.61 (5.06; 6.17)	5.80 (5.23; 6.38)	5.21 (4.67; 5.76)	5.41 (4.85; 5.97)	5.29 (4.73; 5.84)
Holbæk	5.83 (5.25; 6.41)	4.82 (4.29; 5.35)	5.41 (4.83; 5.98)	5.05 (4.52; 5.59)	5.19 (4.65; 5.73)
Kalundborg	7.36 (6.60; 8.11)	6.31 (5.58; 7.05)	5.78 (5.10; 6.46)	4.63 (4.01; 5.25)	4.94 (4.31; 5.56)
Køge	4.73 (4.12; 5.33)	4.45 (3.85; 5.06)	3.79 (3.25; 4.34)	3.49 (2.98; 4.01)	4.21 (3.62; 4.79)
Lejre	4.18 (3.22; 5.15)	4.56 (3.51; 5.62)	4.55 (3.52; 5.58)	5.18 (4.10; 6.27)	5.31 (4.30; 6.32)
Lolland	5.64 (4.98; 6.31)	5.27 (4.62; 5.92)	5.33 (4.69; 5.97)	5.72 (5.06; 6.37)	5.67 (5.01; 6.34)
Næstved	4.61 (4.14; 5.07)	4.28 (3.83; 4.73)	4.87 (4.40; 5.35)	4.48 (4.01; 4.94)	4.62 (4.14; 5.11)
Odsherred	5.91 (5.09; 6.73)	6.59 (5.64; 7.54)	6.17 (5.26; 7.07)	6.42 (5.54; 7.31)	5.55 (4.74; 6.36)
Ringsted	5.35 (4.43; 6.27)	5.16 (4.28; 6.03)	4.18 (3.41; 4.94)	4.51 (3.70; 5.33)	4.93 (4.08; 5.77)
Roskilde	3.47 (3.05; 3.88)	3.49 (3.08; 3.91)	3.25 (2.85; 3.65)	3.44 (3.02; 3.86)	3.52 (3.10; 3.93)
Slagelse	4.61 (4.14; 5.08)	4.26 (3.81; 4.71)	4.14 (3.70; 4.59)	4.33 (3.87; 4.80)	3.75 (3.32; 4.19)
Solrød	6.74 (5.21; 8.27)	6.04 (4.57; 7.51)	5.77 (4.33; 7.21)	4.92 (3.66; 6.17)	5.14 (3.79; 6.49)
Sorø	6.29 (5.28; 7.31)	5.65 (4.75; 6.56)	4.86 (3.97; 5.76)	4.75 (3.84; 5.67)	4.50 (3.62; 5.39)
Stevns	5.46 (4.30; 6.62)	4.98 (3.91; 6.05)	4.92 (3.83; 6.02)	6.05 (4.78; 7.32)	5.33 (4.19; 6.47)
Vordingborg	5.58 (4.89; 6.27)	4.69 (4.06; 5.32)	5.29 (4.65; 5.94)	5.31 (4.64; 5.99)	5.16 (4.50; 5.81)

Region of Southern Denmark	3.94 (3.83; 4.05)	4.02 (3.91; 4.13)	4.33 (4.21; 4.44)	4.32 (4.20; 4.44)	4.28 (4.17; 4.40)
Aabenraa	4.85 (4.30; 5.40)	5.41 (4.83; 5.99)	5.27 (4.69; 5.85)	5.02 (4.43; 5.62)	5.38 (4.79; 5.97)
Assens	4.55 (3.79; 5.31)	3.70 (3.07; 4.33)	4.02 (3.37; 4.66)	3.85 (3.22; 4.49)	3.87 (3.26; 4.49)
Billund	4.91 (3.97; 5.85)	4.18 (3.30; 5.07)	4.57 (3.68; 5.45)	4.42 (3.53; 5.30)	6.50 (5.35; 7.64)
Esbjerg	3.75 (3.39; 4.10)	3.54 (3.19; 3.88)	4.42 (4.03; 4.81)	5.31 (4.87; 5.74)	4.87 (4.46; 5.27)
Faaborg-Midtfyn	4.77 (4.15; 5.39)	3.84 (3.30; 4.39)	4.12 (3.57; 4.66)	4.22 (3.66; 4.78)	3.89 (3.34; 4.44)
Fanø	15.38 (7.00; 23.76)	16.66 (5.63; 27.70)	11.79 (5.46; 18.11)	15.31 (8.95; 21.67)	17.95 (9.55; 26.34)
Fredericia	5.16 (4.48; 5.84)	4.90 (4.26; 5.54)	4.54 (3.95; 5.14)	5.14 (4.52; 5.77)	5.69 (4.99; 6.38)
Haderslev	5.15 (4.52; 5.77)	5.35 (4.72; 5.98)	4.75 (4.19; 5.32)	4.96 (4.39; 5.54)	4.55 (4.00; 5.10)
Kerteminde	4.03 (3.01; 5.06)	5.82 (4.62; 7.01)	5.49 (4.47; 6.51)	5.86 (4.70; 7.03)	4.65 (3.69; 5.60)
Kolding	5.00 (4.52; 5.47)	4.78 (4.32; 5.25)	5.00 (4.53; 5.47)	5.22 (4.73; 5.72)	5.38 (4.88; 5.87)
Langeland	6.81 (5.13; 8.50)	6.53 (4.97; 8.08)	8.38 (6.50; 10.27)	7.07 (5.26; 8.89)	6.58 (4.86; 8.31)
Middelfart	4.33 (3.55; 5.12)	4.70 (3.91; 5.49)	4.74 (4.03; 5.45)	5.28 (4.49; 6.08)	5.01 (4.22; 5.79)
Nordfyns	4.77 (3.81; 5.73)	4.48 (3.57; 5.38)	4.48 (3.65; 5.31)	5.49 (4.51; 6.48)	4.60 (3.80; 5.39)
Nyborg	6.01 (5.03; 6.98)	4.99 (4.16; 5.82)	4.45 (3.64; 5.25)	5.18 (4.31; 6.05)	4.85 (4.01; 5.70)
Odense	2.54 (2.30; 2.78)	3.28 (3.01; 3.55)	3.88 (3.59; 4.17)	3.97 (3.68; 4.27)	4.06 (3.77; 4.36)
Svendborg	4.54 (3.99; 5.09)	4.58 (4.02; 5.14)	3.99 (3.47; 4.52)	4.47 (3.92; 5.03)	3.79 (3.28; 4.29)
Sønderborg	4.99 (4.51; 5.47)	5.03 (4.53; 5.53)	4.90 (4.41; 5.39)	4.70 (4.21; 5.18)	4.04 (3.61; 4.47)
Tønder	6.09 (5.27; 6.91)	5.47 (4.73; 6.21)	5.50 (4.77; 6.23)	5.71 (4.94; 6.48)	5.17 (4.45; 5.89)
Varde	4.14 (3.54; 4.74)	3.31 (2.79; 3.83)	3.76 (3.22; 4.30)	4.67 (4.04; 5.30)	4.47 (3.85; 5.08)
Vejen	3.73 (3.13; 4.33)	3.89 (3.29; 4.49)	5.03 (4.32; 5.74)	4.30 (3.66; 4.94)	5.38 (4.64; 6.13)
Vejle	5.19 (4.75; 5.63)	5.38 (4.93; 5.83)	5.21 (4.77; 5.65)	4.70 (4.29; 5.12)	4.78 (4.35; 5.20)
Ærø	8.97 (5.56; 12.38)	7.31 (4.15; 10.47)	7.75 (4.78; 10.72)	8.04 (4.55; 11.53)	8.23 (4.75; 11.72)
Central Denmark Region	5.34 (5.21; 5.47)	5.09 (4.97; 5.22)	4.97 (4.85; 5.10)	4.29 (4.18; 4.41)	3.38 (3.27; 3.48)
Aarhus	5.10 (4.82; 5.37)	5.24 (4.96; 5.52)	5.55 (5.27; 5.84)	4.30 (4.05; 4.56)	3.02 (2.81; 3.23)
Favrskov	5.00 (4.29; 5.71)	5.28 (4.57; 6.00)	5.90 (5.12; 6.68)	4.18 (3.52; 4.84)	3.89 (3.28; 4.49)
Hedensted	5.41 (4.69; 6.12)	4.54 (3.90; 5.17)	4.46 (3.82; 5.10)	4.72 (4.01; 5.43)	3.46 (2.88; 4.04)
Herning	5.30 (4.79; 5.81)	4.65 (4.17; 5.14)	4.76 (4.29; 5.23)	3.90 (3.47; 4.34)	3.36 (2.96; 3.75)
Holstebro	5.79 (5.16; 6.42)	5.54 (4.91; 6.17)	4.83 (4.26; 5.40)	5.61 (4.97; 6.25)	3.46 (2.96; 3.96)
Horsens	5.57 (5.04; 6.09)	4.85 (4.36; 5.35)	5.17 (4.65; 5.69)	4.25 (3.79; 4.71)	3.40 (2.98; 3.83)
Ikast-Brande	5.52 (4.77; 6.27)	4.79 (4.08; 5.51)	5.37 (4.60; 6.15)	4.40 (3.73; 5.07)	3.72 (3.07; 4.38)
Lemvig	6.75 (5.56; 7.93)	6.10 (5.01; 7.19)	6.68 (5.48; 7.87)	7.22 (5.96; 8.48)	3.41 (2.44; 4.38)
Norddjurs	6.43 (5.62; 7.25)	5.49 (4.75; 6.23)	4.59 (3.91; 5.28)	3.91 (3.28; 4.54)	4.02 (3.37; 4.68)
Odder	5.80 (4.70; 6.90)	5.14 (4.00; 6.28)	5.54 (4.44; 6.64)	5.36 (4.25; 6.47)	4.32 (3.22; 5.41)
Randers	5.64 (5.16; 6.13)	5.56 (5.08; 6.03)	4.20 (3.79; 4.61)	4.47 (4.03; 4.90)	3.50 (3.12; 3.87)
Ringkøbing-Skjern	4.89 (4.32; 5.47)	4.92 (4.34; 5.51)	4.47 (3.91; 5.03)	4.24 (3.71; 4.76)	3.44 (2.94; 3.93)
Samsø	16.73 (10.39; 23.07)	14.75 (9.11; 20.40)	16.35 (10.17; 22.54)	12.75 (5.89; 19.61)	10.81 (5.74; 15.88)
Silkeborg	6.05 (5.53; 6.57)	6.30 (5.76; 6.83)	6.15 (5.62; 6.68)	5.04 (4.57; 5.52)	4.21 (3.78; 4.65)
Skanderborg	5.36 (4.71; 6.01)	6.05 (5.32; 6.78)	5.53 (4.87; 6.20)	4.47 (3.86; 5.07)	2.97 (2.48; 3.46)
Skive	5.62 (4.97; 6.28)	5.48 (4.82; 6.14)	5.18 (4.54; 5.82)	4.68 (4.07; 5.29)	5.10 (4.44; 5.76)
Struer	6.27 (5.20; 7.34)	5.63 (4.58; 6.68)	6.32 (5.14; 7.50)	7.08 (5.87; 8.29)	3.78 (2.90; 4.67)
Syddjurs	5.54 (4.80; 6.27)	5.67 (4.93; 6.41)	4.53 (3.85; 5.21)	3.96 (3.32; 4.60)	4.46 (3.74; 5.18)
Viborg	5.88 (5.38; 6.38)	5.48 (5.00; 5.96)	5.52 (5.04; 6.00)	4.85 (4.39; 5.30)	4.83 (4.37; 5.28)
North Denmark Region	5.98 (5.78; 6.17)	5.18 (5.00; 5.36)	5.13 (4.95; 5.31)	4.59 (4.41; 4.76)	4.73 (4.56; 4.91)
Aalborg	5.52 (5.18; 5.85)	5.28 (4.95; 5.60)	4.87 (4.56; 5.18)	4.75 (4.44; 5.06)	5.00 (4.69; 5.32)
Brønderslev	4.32 (3.63; 5.01)	5.09 (4.34; 5.84)	4.76 (4.02; 5.49)	5.09 (4.32; 5.86)	5.39 (4.55; 6.24)
Frederikshavn	4.78 (4.25; 5.31)	5.03 (4.48; 5.58)	4.76 (4.23; 5.30)	4.88 (4.33; 5.44)	4.78 (4.24; 5.32)
Hjørring	4.81 (4.28; 5.33)	4.56 (4.04; 5.07)	4.65 (4.14; 5.17)	4.72 (4.18; 5.26)	4.66 (4.13; 5.18)
Jammerbugt	6.04 (5.28; 6.81)	5.65 (4.90; 6.39)	5.49 (4.73; 6.24)	5.21 (4.45; 5.96)	4.48 (3.79; 5.18)
Læsø	22.10 (10.17; 34.04)	19.96 (7.88; 32.03)	19.83 (5.94; 33.72)	24.69 (5.38; 44.01)	25.24 (6.13; 44.35)
Mariagerfjord	8.91 (8.00; 9.83)	7.64 (6.78; 8.50)	5.64 (4.91; 6.37)	6.34 (5.58; 7.10)	5.88 (5.17; 6.60)
Morsø	10.14 (8.82; 11.46)	6.33 (5.21; 7.46)	8.65 (7.41; 9.88)	6.09 (4.91; 7.27)	5.73 (4.67; 6.80)
Rebild	6.01 (5.09; 6.94)	5.24 (4.35; 6.13)	4.78 (3.95; 5.61)	4.58 (3.76; 5.41)	5.82 (4.84; 6.80)
Thisted	10.28 (9.36; 11.20)	5.83 (5.14; 6.52)	8.17 (7.33; 9.01)	5.25 (4.52; 5.98)	4.31 (3.70; 4.91)
Vesthimmerlands	5.52 (4.73; 6.31)	5.15 (4.42; 5.88)	4.97 (4.25; 5.70)	4.74 (4.01; 5.46)	5.42 (4.69; 6.15)

Table 4 Standardized number of ICU patients per 1,000 person-years of 15 years or older for the 5-year period between 2008 and 2012

	ICU patients per 1,000 person-years (95% CI)
Denmark	4.93 (4.90; 4.96)
Capital Region	4.32 (4.27; 4.37)
Zealand Region	5.10 (5.02; 5.17)
Region of Southern Denmark	4.85 (4.79; 4.92)
Central Denmark Region	5.32 (5.26; 5.39)
North Denmark Region	5.84 (5.75; 5.94)
Capital Region	4.32 (4.27; 4.37)
Albertslund	4.74 (4.18; 5.31)
Allerød	5.37 (4.72; 6.02)
Ballerup	4.26 (3.94; 4.58)
Bornholm	11.79 (11.24; 12.33)
Brøndby	4.91 (4.53; 5.30)
Dragør	5.50 (4.54; 6.46)
Egedal	4.73 (4.26; 5.21)
Fredensborg	5.99 (5.58; 6.41)
Frederiksberg	3.20 (3.01; 3.38)
Frederikssund	5.80 (5.42; 6.18)
Furesø	3.86 (3.51; 4.22)
Gentofte	3.46 (3.23; 3.69)
Gladsaxe	4.16 (3.89; 4.42)
Glostrup	5.36 (4.82; 5.90)
Gribskov	5.44 (5.06; 5.82)
Halsnæs	6.25 (5.78; 6.72)
Helsingør	6.99 (6.65; 7.33)
Herlev	4.30 (3.86; 4.74)
Hillerød	4.94 (4.60; 5.29)
Hvidovre	4.22 (3.92; 4.51)
Høje-Taastrup	5.08 (4.72; 5.44)
Hørsholm	5.43 (4.85; 6.00)
Ishøj	6.00 (5.26; 6.73)
København	4.00 (3.90; 4.10)
Lyngby-Taarbæk	3.53 (3.26; 3.79)
Rudersdal	3.42 (3.17; 3.67)
Rødovre	4.02 (3.68; 4.35)
Tårnby	3.68 (3.35; 4.00)
Vallensbæk	5.47 (4.55; 6.39)
Zealand Region	5.10 (5.02; 5.17)
Faxe	5.36 (4.90; 5.82)
Greve	4.05 (3.71; 4.39)
Guldborgsund	6.20 (5.91; 6.49)
Holbæk	6.14 (5.84; 6.45)
Kalundborg	6.45 (6.07; 6.83)
Køge	4.48 (4.20; 4.77)
Lejre	4.92 (4.36; 5.49)
Lolland	6.12 (5.79; 6.45)
Næstved	5.32 (5.07; 5.58)
Odsherred	6.64 (6.18; 7.09)
Ringsted	5.07 (4.64; 5.50)
Roskilde	3.93 (3.71; 4.15)
Slagelse	4.80 (4.56; 5.04)
Solrød	5.29 (4.65; 5.93)
Sorø	5.28 (4.83; 5.73)
Stevns	5.23 (4.61; 5.85)
Vordingborg	5.80 (5.46; 6.14)

	ICU patients per 1,000 person-years (95% CI)
Region of Southern Denmark	4.85 (4.79; 4.92)
Aabenraa	5.89 (5.58; 6.20)
Assens	4.11 (3.78; 4.45)
Billund	4.97 (4.49; 5.44)
Esbjerg	4.97 (4.77; 5.18)
Faaborg-Midtfyn	4.51 (4.22; 4.79)
Fanø	16.79 (11.38; 22.19)
Fredericia	5.52 (5.20; 5.85)
Haderslev	5.50 (5.20; 5.80)
Kerteminde	4.97 (4.40; 5.54)
Kolding	5.84 (5.58; 6.09)
Langeland	6.42 (5.39; 7.44)
Middelfart	5.03 (4.61; 5.45)
Nordfyns	4.65 (4.21; 5.09)
Nyborg	5.08 (4.62; 5.54)
Odense	4.04 (3.90; 4.19)
Svendborg	4.55 (4.28; 4.82)
Sønderborg	5.42 (5.16; 5.67)
Tønder	6.09 (5.70; 6.48)
Varde	4.35 (4.06; 4.64)
Vejen	4.86 (4.53; 5.20)
Vejle	5.93 (5.70; 6.16)
Ærø	7.16 (5.11; 9.21)
Central Denmark Region	5.32 (5.26; 5.39)
Aarhus	5.43 (5.29; 5.57)
Favrskov	5.29 (4.94; 5.65)
Hedensted	4.95 (4.60; 5.30)
Herning	4.96 (4.72; 5.20)
Holstebro	5.76 (5.45; 6.07)
Horsens	5.26 (5.01; 5.51)
Ikast-Brande	5.12 (4.76; 5.47)
Lemvig	6.10 (5.54; 6.66)
Norddjurs	5.35 (4.99; 5.72)
Odder	5.27 (4.69; 5.86)
Randers	5.26 (5.03; 5.49)
Ringkøbing-Skjern	4.87 (4.59; 5.15)
Samsø	13.75 (9.92; 17.57)
Silkeborg	6.13 (5.87; 6.39)
Skanderborg	5.44 (5.11; 5.77)
Skive	5.87 (5.53; 6.21)
Struer	6.04 (5.51; 6.58)
Syddjurs	5.04 (4.69; 5.39)
Viborg	6.01 (5.76; 6.27)
North Denmark Region	5.84 (5.75; 5.94)
Aalborg	5.79 (5.62; 5.96)
Brønderslev	5.30 (4.91; 5.68)
Frederikshavn	5.39 (5.11; 5.67)
Hjørring	5.26 (4.99; 5.53)
Jammerbugt	5.80 (5.42; 6.18)
Læsø	23.05 (12.97; 33.13)
Mariagerfjord	7.67 (7.26; 8.09)
Morsø	8.23 (7.59; 8.87)
Rebild	5.77 (5.29; 6.25)
Thisted	7.47 (7.07; 7.86)
Vesthimmerlands	5.59 (5.21; 5.96)

Table 5 Standardized number of ICU admissions per 1,000 person-years for the 5-year period between 2008 and 2012

	ICU admissions per 1,000 person-years (95% CI)
Denmark	4.55 (4.54; 4.56)
Capital Region	3.91 (3.87; 3.96)
Zealand Region	4.68 (4.61; 4.75)
Region of Southern Denmark	4.47 (4.42; 4.52)
Central Denmark Region	4.96 (4.91; 5.02)
North Denmark Region	5.49 (5.41; 5.57)
Capital Region	3.91 (3.87; 3.96)
Albertslund	4.43 (3.95; 4.91)
Allerød	4.77 (4.22; 5.33)
Ballerup	3.84 (3.57; 4.12)
Bornholm	11.80 (11.30; 12.31)
Brøndby	4.56 (4.21; 4.90)
Dragør	5.15 (4.30; 6.00)
Egedal	4.27 (3.87; 4.67)
Fredensborg	5.43 (5.07; 5.79)
Frederiksberg	2.93 (2.76; 3.10)
Frederikssund	5.21 (4.88; 5.53)
Furesø	3.52 (3.21; 3.83)
Gentofte	3.08 (2.89; 3.27)
Gladsaxe	3.74 (3.51; 3.96)
Glostrup	5.06 (4.56; 5.56)
Gribskov	4.83 (4.50; 5.16)
Halsnæs	5.79 (5.37; 6.20)
Helsingør	6.25 (5.96; 6.54)
Herlev	4.13 (3.73; 4.54)
Hillerød	4.50 (4.21; 4.80)
Hvidovre	3.85 (3.59; 4.10)
Høje-Taastrup	4.89 (4.48; 5.30)
Hørsholm	4.91 (4.41; 5.40)
Ishøj	5.72 (5.07; 6.36)
København	3.61 (3.52; 3.70)
Lyngby-Taarbæk	3.21 (2.97; 3.45)
Rudersdal	3.08 (2.86; 3.30)
Rødovre	3.63 (3.34; 3.93)
Tårnby	3.36 (3.07; 3.64)
Vallensbæk	5.23 (4.40; 6.07)
Zealand Region	4.68 (4.61; 4.75)
Faxe	4.81 (4.41; 5.20)
Greve	3.71 (3.43; 4.00)
Guldborgsund	5.79 (5.53; 6.04)
Holbæk	5.71 (5.44; 5.97)
Kalundborg	6.04 (5.71; 6.37)
Køge	4.15 (3.90; 4.40)
Lejre	4.55 (4.06; 5.03)
Lolland	5.76 (5.47; 6.06)
Næstved	4.83 (4.61; 5.05)
Odsherred	6.24 (5.85; 6.63)
Ringsted	4.70 (4.32; 5.07)
Roskilde	3.60 (3.42; 3.79)
Slagelse	4.50 (4.29; 4.71)
Solrød	4.88 (4.32; 5.45)
Sorø	4.97 (4.57; 5.37)
Stevns	4.77 (4.22; 5.32)
Vordingborg	5.27 (4.98; 5.56)

	ICU admissions per 1,000 person-years (95% CI)
Region of Southern Denmark	4.47 (4.42; 4.52)
Aabenraa	5.43 (5.16; 5.70)
Assens	3.80 (3.51; 4.09)
Billund	4.65 (4.24; 5.07)
Esbjerg	4.66 (4.48; 4.84)
Faaborg-Midtfyn	4.18 (3.93; 4.43)
Fanø	16.37 (11.42; 21.31)
Fredericia	5.21 (4.92; 5.49)
Haderslev	5.10 (4.83; 5.36)
Kerteminde	4.75 (4.25; 5.25)
Kolding	5.44 (5.22; 5.66)
Langeland	6.47 (5.49; 7.46)
Middelfart	4.56 (4.22; 4.90)
Nordfyns	4.42 (4.03; 4.82)
Nyborg	4.73 (4.33; 5.12)
Odense	3.76 (3.63; 3.89)
Svendborg	4.14 (3.90; 4.37)
Sønderborg	4.93 (4.71; 5.15)
Tønder	5.57 (5.23; 5.90)
Varde	4.03 (3.77; 4.28)
Vejen	4.45 (4.16; 4.74)
Vejle	5.44 (5.24; 5.64)
Ærø	7.67 (5.66; 9.69)
Central Denmark Region	4.96 (4.91; 5.02)
Aarhus	5.02 (4.90; 5.15)
Favrskov	4.94 (4.63; 5.26)
Hedensted	4.55 (4.26; 4.84)
Herning	4.57 (4.36; 4.78)
Holstebro	5.33 (5.06; 5.60)
Horsens	4.94 (4.72; 5.16)
Ikast-Brande	4.72 (4.41; 5.03)
Lemvig	5.79 (5.28; 6.30)
Norddjurs	5.06 (4.74; 5.38)
Odder	4.84 (4.33; 5.34)
Randers	4.99 (4.79; 5.19)
Ringkøbing-Skjern	4.52 (4.27; 4.76)
Samsø	13.69 (10.05; 17.34)
Silkeborg	5.99 (5.76; 6.23)
Skanderborg	5.05 (4.76; 5.34)
Skive	5.46 (5.16; 5.75)
Struer	5.63 (5.14; 6.12)
Syddjurs	4.82 (4.51; 5.14)
Viborg	5.67 (5.45; 5.89)
North Denmark Region	5.49 (5.41; 5.57)
Aalborg	5.49 (5.34; 5.64)
Brønderslev	4.90 (4.56; 5.24)
Frederikshavn	5.02 (4.77; 5.27)
Hjørring	4.77 (4.54; 5.01)
Jammerbugt	5.54 (5.21; 5.87)
Læsø	23.50 (13.46; 33.54)
Mariagerfjord	7.20 (6.84; 7.57)
Morsø	7.80 (7.25; 8.36)
Rebild	5.43 (5.02; 5.84)
Thisted	7.17 (6.81; 7.52)
Vesthimmerlands	5.22 (4.89; 5.56)

Table 6 Standardized percentages of ICU admissions treated with mechanical ventilation for the 5-year period between 2008 and 2012

	Standardized percentage (95% CI)
Denmark	41 (41; 41)
Capital Region	45 (44; 46)
Zealand Region	39 (38; 39)
Region of Southern Denmark	41 (40; 42)
Central Denmark Region	37 (37; 38)
North Denmark Region	43 (42; 44)
Capital Region	45 (44; 46)
Albertslund	55 (46; 63)
Allerød	51 (42; 60)
Ballerup	59 (53; 65)
Bornholm	22 (20; 25)
Brøndby	53 (47; 59)
Dragør	75 (60; 89)
Egedal	48 (42; 54)
Fredensborg	39 (34; 43)
Frederiksberg	56 (52; 61)
Frederikssund	37 (34; 41)
Furesø	51 (44; 57)
Gentofte	55 (50; 61)
Gladsaxe	55 (50; 60)
Glostrup	58 (49; 66)
Gribskov	46 (41; 50)
Halsnæs	43 (39; 48)
Helsingør	33 (30; 36)
Herlev	57 (49; 66)
Hillerød	45 (40; 49)
Hvidovre	54 (49; 60)
Høje-Taastrup	52 (47; 58)
Hørsholm	46 (39; 53)
Ishøj	59 (49; 68)
København	55 (53; 56)
Lyngby-Taarbæk	54 (49; 60)
Rudersdal	49 (43; 54)
Rødovre	57 (51; 64)
Tårnby	62 (55; 69)
Vallensbæk	62 (50; 75)
Zealand Region	39 (38; 39)
Faxe	49 (44; 54)
Greve	49 (43; 54)
Guldborgsund	28 (25; 30)
Holbæk	38 (35; 41)
Kalundborg	35 (32; 38)
Køge	50 (45; 54)
Lejre	49 (42; 57)
Lolland	31 (28; 34)
Næstved	42 (39; 45)
Odsherred	39 (35; 43)
Ringsted	49 (43; 55)
Roskilde	45 (41; 49)
Slagelse	47 (43; 50)
Solrød	58 (49; 67)
Sorø	48 (43; 54)
Stevns	52 (44; 59)
Vordingborg	43 (39; 47)

	Standardized percentage (95% CI)
Region of Southern Denmark	41 (40; 42)
Aabenraa	42 (39; 46)
Assens	49 (43; 55)
Billund	48 (41; 55)
Esbjerg	42 (40; 45)
Faaborg-Midtfyn	45 (40; 49)
Fanø	65 (39; 91)
Fredericia	45 (41; 49)
Haderslev	43 (40; 47)
Kerteminde	53 (45; 61)
Kolding	44 (41; 47)
Langeland	51 (42; 61)
Middelfart	47 (42; 52)
Nordfyns	49 (43; 56)
Nyborg	45 (39; 50)
Odense	45 (43; 48)
Svendborg	43 (39; 47)
Sønderborg	40 (37; 43)
Tønder	41 (37; 45)
Varde	44 (40; 49)
Vejen	45 (40; 49)
Vejle	39 (37; 41)
Ærø	60 (43; 77)
Central Denmark Region	37 (37; 38)
Aarhus	38 (36; 39)
Favrskov	37 (33; 42)
Hedensted	43 (38; 47)
Herning	39 (36; 42)
Holstebro	40 (36; 43)
Horsens	43 (40; 47)
Ikast-Brande	43 (38; 48)
Lemvig	48 (41; 54)
Norddjurs	39 (35; 44)
Odder	43 (36; 51)
Randers	35 (33; 38)
Ringkøbing-Skjern	41 (38; 45)
Samsø	65 (46; 83)
Silkeborg	34 (31; 36)
Skanderborg	40 (36; 44)
Skive	43 (39; 47)
Struer	43 (37; 49)
Syddjurs	38 (34; 42)
Viborg	41 (39; 44)
North Denmark Region	43 (42; 44)
Aalborg	45 (43; 47)
Brønderslev	54 (48; 59)
Frederikshavn	51 (47; 54)
Hjørring	48 (44; 52)
Jammerbugt	47 (43; 52)
Læsø	83 (51; 114)
Mariagerfjord	35 (32; 38)
Morsø	43 (37; 48)
Rebild	47 (41; 53)
Thisted	39 (35; 42)
Vesthimmerlands	47 (42; 52)

Table 7 Standardized admissions with mechanical ventilation (MV) per 1,000 person-years for the 5-year period between 2008 and 2012

	Admissions with MV per 1,000 person-years (95% CI)
Denmark	1.88 (1.87; 1.88)
Capital Region	1.81 (1.78; 1.84)
Zealand Region	1.79 (1.75; 1.83)
Region of Southern Denmark	1.87 (1.84; 1.91)
Central Denmark Region	1.84 (1.81; 1.87)
North Denmark Region	2.30 (2.24; 2.35)
Capital Region	1.81 (1.78; 1.84)
Albertslund	2.88 (2.34; 3.42)
Allerød	3.21 (2.59; 3.82)
Ballerup	2.46 (2.21; 2.71)
Bornholm	2.20 (1.90; 2.51)
Brøndby	2.82 (2.48; 3.16)
Dragør	4.46 (3.53; 5.39)
Egedal	2.20 (1.84; 2.57)
Fredensborg	2.41 (2.10; 2.73)
Frederiksberg	1.75 (1.60; 1.89)
Frederikssund	2.14 (1.89; 2.39)
Furesø	1.99 (1.69; 2.29)
Gentofte	1.78 (1.61; 1.94)
Gladsaxe	2.32 (2.12; 2.52)
Glostrup	3.61 (3.07; 4.15)
Gribskov	2.71 (2.41; 3.02)
Halsnæs	2.91 (2.54; 3.28)
Helsingør	2.24 (2.03; 2.45)
Herlev	2.91 (2.47; 3.35)
Hillerød	2.41 (2.14; 2.69)
Hvidovre	2.34 (2.11; 2.57)
Høje-Taastrup	2.78 (2.51; 3.05)
Hørsholm	2.93 (2.40; 3.47)
Ishøj	4.03 (3.24; 4.82)
København	2.05 (1.99; 2.12)
Lyngby-Taarbæk	2.09 (1.87; 2.31)
Rudersdal	1.85 (1.64; 2.06)
Rødovre	2.55 (2.25; 2.85)
Tårnby	2.44 (2.17; 2.72)
Vallensbæk	4.55 (3.48; 5.63)
Zealand Region	1.79 (1.75; 1.83)
Faxe	2.53 (2.22; 2.85)
Greve	2.09 (1.83; 2.35)
Guldborgsund	1.76 (1.59; 1.94)
Holbæk	2.37 (2.16; 2.57)
Kalundborg	2.54 (2.28; 2.79)
Køge	2.40 (2.18; 2.63)
Lejre	3.24 (2.62; 3.87)
Lolland	2.11 (1.85; 2.36)
Næstved	2.07 (1.91; 2.22)
Odsherred	2.76 (2.43; 3.10)
Ringsted	2.59 (2.26; 2.92)
Roskilde	1.76 (1.61; 1.91)
Slagelse	2.18 (2.02; 2.35)
Solrød	3.48 (2.81; 4.14)
Sorø	2.80 (2.42; 3.18)
Stevns	3.00 (2.47; 3.54)
Vordingborg	2.73 (2.47; 3.00)

	Admissions with MV per 1,000 person-years (95% CI)
Region of Southern Denmark	1.87 (1.84; 1.91)
Aabenraa	2.57 (2.35; 2.78)
Assens	2.14 (1.85; 2.43)
Billund	2.60 (2.21; 3.00)
Esbjerg	2.01 (1.89; 2.13)
Faaborg-Midtfyn	2.06 (1.85; 2.27)
Fanø	13.25 (7.64; 18.86)
Fredericia	2.49 (2.27; 2.72)
Haderslev	2.45 (2.25; 2.65)
Kerteminde	2.91 (2.39; 3.44)
Kolding	2.42 (2.27; 2.57)
Langeland	4.28 (3.26; 5.30)
Middelfart	2.54 (2.22; 2.87)
Nordfyns	2.76 (2.35; 3.18)
Nyborg	2.52 (2.15; 2.89)
Odense	1.80 (1.70; 1.89)
Svendborg	1.97 (1.78; 2.17)
Sønderborg	2.09 (1.93; 2.25)
Tønder	2.59 (2.33; 2.85)
Varde	1.96 (1.74; 2.18)
Vejen	2.21 (1.96; 2.47)
Vejle	2.17 (2.03; 2.31)
Ærø	5.92 (3.91; 7.93)
Central Denmark Region	1.84 (1.81; 1.87)
Aarhus	1.87 (1.79; 1.94)
Favrskov	2.16 (1.90; 2.41)
Hedensted	2.28 (2.02; 2.54)
Herning	1.96 (1.80; 2.11)
Holstebro	2.34 (2.14; 2.55)
Horsens	2.20 (2.04; 2.36)
Ikast-Brande	2.34 (2.07; 2.61)
Lemvig	3.11 (2.66; 3.56)
Norddjurs	2.47 (2.18; 2.77)
Odder	2.94 (2.36; 3.52)
Randers	1.78 (1.65; 1.91)
Ringkøbing-Skjern	2.11 (1.91; 2.31)
Samsø	11.80 (7.67; 15.93)
Silkeborg	2.03 (1.89; 2.18)
Skanderborg	2.09 (1.86; 2.32)
Skive	2.42 (2.20; 2.65)
Struer	3.00 (2.53; 3.47)
Syddjurs	2.24 (1.95; 2.53)
Viborg	2.34 (2.19; 2.48)
North Denmark Region	2.30 (2.24; 2.35)
Aalborg	2.40 (2.30; 2.50)
Brønderslev	2.90 (2.59; 3.22)
Frederikshavn	2.57 (2.38; 2.76)
Hjørring	2.33 (2.15; 2.50)
Jammerbugt	2.86 (2.57; 3.16)
Læsø	17.06 (9.46; 24.65)
Mariagerfjord	2.70 (2.44; 2.97)
Morsø	3.53 (3.04; 4.03)
Rebild	2.99 (2.60; 3.38)
Thisted	2.78 (2.52; 3.03)
Vesthimmerlands	2.61 (2.33; 2.89)

Table 8 Standardized percentages of ICU admissions treated with non-invasive ventilation for the 5-year period between 2008 and 2012

	Standardized percentage (95% CI)
Denmark	12 (12; 13)
Capital Region	12 (12; 12)
Zealand Region	14 (14; 15)
Region of Southern Denmark	15 (14; 15)
Central Denmark Region	12 (12; 13)
North Denmark Region	9 (8; 9)
Capital Region	12 (12; 12)
Albertslund	35 (26; 45)
Allerød	27 (17; 37)
Ballerup	22 (17; 27)
Bornholm	10 (8; 12)
Brøndby	27 (22; 32)
Dragør	48 (27; 68)
Egedal	23 (17; 28)
Fredensborg	18 (14; 21)
Frederiksberg	17 (15; 20)
Frederikssund	20 (16; 23)
Furesø	27 (20; 33)
Gentofte	13 (10; 16)
Gladsaxe	18 (14; 21)
Glostrup	33 (25; 40)
Gribskov	14 (11; 17)
Halsnæs	18 (14; 22)
Helsingør	12 (11; 14)
Herlev	26 (19; 33)
Hillerød	20 (16; 24)
Hvidovre	25 (21; 29)
Høje-Taastrup	24 (20; 28)
Hørsholm	17 (12; 23)
Ishøj	36 (27; 46)
København	17 (16; 18)
Lyngby-Taarbæk	17 (13; 21)
Rudersdal	18 (14; 22)
Rødovre	25 (16; 34)
Tårnby	22 (17; 27)
Vallensbæk	48 (28; 67)
Zealand Region	14 (14; 15)
Faxe	24 (19; 29)
Greve	23 (19; 28)
Guldborgsund	19 (17; 21)
Holbæk	22 (19; 24)
Kalundborg	17 (14; 19)
Køge	22 (19; 26)
Lejre	28 (20; 36)
Lolland	19 (17; 21)
Næstved	13 (11; 15)
Odsherred	18 (14; 21)
Ringsted	21 (16; 26)
Roskilde	22 (19; 25)
Slagelse	15 (13; 18)
Solrød	33 (23; 44)
Sorø	21 (16; 26)
Stevns	25 (19; 32)
Vordingborg	18 (15; 21)

	Standardized percentage (95% CI)
Region of Southern Denmark	15 (14; 15)
Aabenraa	14 (12; 16)
Assens	23 (19; 28)
Billund	25 (19; 31)
Esbjerg	19 (17; 21)
Faaborg-Midtfyn	23 (19; 26)
Fanø	88 (33; 44)
Fredericia	17 (14; 19)
Haderslev	13 (11; 15)
Kerteminde	27 (20; 34)
Kolding	17 (15; 19)
Langeland	34 (26; 43)
Middelfart	20 (16; 24)
Nordfyns	24 (18; 29)
Nyborg	27 (22; 31)
Odense	17 (15; 18)
Svendborg	25 (22; 28)
Sønderborg	16 (14; 18)
Tønder	16 (13; 19)
Varde	22 (18; 25)
Vejen	18 (15; 22)
Vejle	21 (19; 22)
Ærø	41 (21; 60)
Central Denmark Region	12 (12; 13)
Aarhus	13 (12; 14)
Favrskov	17 (14; 21)
Hedensted	22 (19; 26)
Herning	14 (12; 16)
Holstebro	16 (13; 18)
Horsens	19 (16; 21)
Ikast-Brande	21 (17; 25)
Lemvig	19 (14; 24)
Norddjurs	16 (12; 19)
Odder	29 (22; 36)
Randers	11 (9; 12)
Ringkøbing-Skjern	16 (13; 18)
Samsø	33 (11; 54)
Silkeborg	17 (16; 19)
Skanderborg	20 (17; 23)
Skive	18 (15; 21)
Struer	21 (15; 27)
Syddjurs	16 (13; 20)
Viborg	16 (15; 18)
North Denmark Region	9 (8; 9)
Aalborg	10 (9; 11)
Brønderslev	15 (11; 19)
Frederikshavn	12 (10; 14)
Hjørring	12 (10; 15)
Jammerbugt	15 (11; 18)
Læsø	48 (4; 93)
Mariagerfjord	10 (8; 12)
Morsø	22 (17; 27)
Rebild	14 (10; 18)
Thisted	14 (12; 17)
Vesthimmerlands	13 (9; 16)

Table 9 Standardized percentages of ICU admissions treated with acute renal replacement therapy for the 5-year period between 2008 and 2012

	Standardized percentage (95% CI)
Denmark	6 (6; 6)
Capital Region	8 (7; 8)
Zealand Region	6 (6; 7)
Region of Southern Denmark	6 (6; 6)
Central Denmark Region	5 (5; 6)
North Denmark Region	5 (4; 5)
Capital Region	8 (7; 8)
Albertslund	18 (11; 24)
Allerød	18 (10; 26)
Ballerup	15 (12; 19)
Bornholm	7 (5; 9)
Brøndby	16 (11; 20)
Dragør	34 (18; 51)
Egedal	19 (14; 24)
Fredensborg	12 (8; 15)
Frederiksberg	14 (11; 16)
Frederikssund	11 (8; 14)
Furesø	20 (12; 27)
Gentofte	13 (10; 17)
Gladsaxe	12 (9; 15)
Glostrup	21 (14; 28)
Gribskov	14 (9; 18)
Halsnæs	14 (10; 18)
Helsingør	8 (6; 10)
Herlev	24 (16; 33)
Hillerød	11 (8; 14)
Hvidovre	20 (15; 24)
Høje-Taastrup	15 (11; 18)
Hørsholm	17 (11; 24)
Ishøj	22 (14; 30)
København	11 (10; 12)
Lyngby-Taarbæk	14 (10; 18)
Rudersdal	13 (10; 17)
Rødovre	20 (14; 25)
Tårnby	18 (13; 23)
Vallensbæk	29 (11; 46)
Zealand Region	6 (6; 7)
Faxe	14 (11; 18)
Greve	14 (10; 18)
Guldborgsund	8 (6; 9)
Holbæk	11 (9; 13)
Kalundborg	11 (9; 13)
Køge	13 (9; 16)
Lejre	18 (11; 26)
Lolland	9 (7; 11)
Næstved	11 (9; 13)
Odsherred	13 (10; 16)
Ringsted	15 (10; 20)
Roskilde	10 (8; 13)
Slagelse	11 (9; 13)
Solrød	24 (14; 33)
Sorø	16 (12; 21)
Stevns	22 (14; 29)
Vordingborg	11 (9; 13)

	Standardized percentage (95% CI)
Region of Southern Denmark	6 (6; 6)
Aabenraa	9 (7; 11)
Assens	13 (9; 17)
Billund	18 (12; 24)
Esbjerg	9 (8; 11)
Faaborg-Midtfyn	11 (8; 14)
Fanø	70 (0; 139)
Fredericia	12 (9; 14)
Haderslev	10 (7; 12)
Kerteminde	22 (13; 30)
Kolding	9 (8; 11)
Langeland	26 (13; 38)
Middelfart	16 (11; 20)
Nordfyns	18 (13; 23)
Nyborg	13 (9; 18)
Odense	8 (7; 9)
Svendborg	10 (8; 13)
Sønderborg	9 (7; 10)
Tønder	9 (6; 11)
Varde	15 (11; 18)
Vejen	11 (7; 14)
Vejle	8 (7; 9)
Ærø	49 (5; 93)
Central Denmark Region	5 (5; 6)
Aarhus	7 (6; 8)
Favrskov	9 (5; 12)
Hedensted	12 (8; 16)
Herning	10 (8; 11)
Holstebro	11 (9; 14)
Horsens	10 (8; 12)
Ikast-Brande	13 (9; 17)
Lemvig	15 (9; 21)
Norddjurs	12 (8; 15)
Odder	18 (10; 26)
Randers	8 (6; 10)
Ringkøbing-Skjern	10 (8; 13)
Samsø	38 (3; 72)
Silkeborg	6 (5; 8)
Skanderborg	12 (8; 15)
Skive	9 (7; 12)
Struer	19 (12; 25)
Syddjurs	11 (8; 13)
Viborg	7 (5; 8)
North Denmark Region	5 (4; 5)
Aalborg	6 (5; 7)
Brønderslev	11 (8; 15)
Frederikshavn	9 (7; 11)
Hjørring	10 (8; 12)
Jammerbugt	12 (9; 16)
Læsø	45 (-8; 98)
Mariagerfjord	8 (6; 11)
Morsø	14 (8; 20)
Rebild	15 (9; 21)
Thisted	8 (6; 10)
Vesthimmerlands	11 (8; 15)

Table 10 Standardized percentages of ICU admissions treated with inotropes/vasopressors for the 5-year period between 2008 and 2012

	Standardized percentage (95% CI)
Denmark	33 (33; 33)
Capital Region	31 (30; 32)
Zealand Region	33 (32; 33)
Region of Southern Denmark	38 (37; 38)
Central Denmark Region	31 (31; 32)
North Denmark Region	34 (33; 35)
Capital Region	31 (30; 32)
Albertslund	45 (37; 52)
Allerød	36 (28; 43)
Ballerup	44 (39; 49)
Bornholm	22 (19; 24)
Brøndby	38 (33; 43)
Dragør	55 (41; 69)
Egedal	37 (31; 42)
Fredensborg	26 (22; 30)
Frederiksberg	42 (38; 46)
Frederikssund	25 (21; 28)
Furesø	43 (36; 50)
Gentofte	42 (37; 46)
Gladsaxe	38 (34; 43)
Glostrup	50 (42; 58)
Gribskov	28 (24; 32)
Halsnæs	31 (26; 35)
Helsingør	23 (21; 26)
Herlev	47 (39; 55)
Hillerød	31 (27; 35)
Hvidovre	34 (30; 39)
Høje-Taastrup	44 (39; 49)
Hørsholm	37 (30; 44)
Ishøj	47 (37; 56)
København	37 (36; 39)
Lyngby-Taarbæk	45 (40; 50)
Rudersdal	41 (36; 45)
Rødovre	43 (37; 49)
Tårnby	42 (36; 48)
Vallensbæk	56 (42; 71)
Zealand Region	33 (32; 33)
Faxe	44 (39; 49)
Greve	43 (38; 48)
Guldborgsund	31 (28; 33)
Holbæk	31 (28; 33)
Kalundborg	32 (29; 35)
Køge	42 (38; 47)
Lejre	45 (38; 53)
Lolland	32 (29; 35)
Næstved	38 (35; 40)
Odsherred	30 (26; 33)
Ringsted	43 (37; 49)
Roskilde	41 (37; 44)
Slagelse	37 (34; 40)
Solrød	52 (43; 61)
Sorø	40 (34; 45)
Stevns	47 (40; 55)
Vordingborg	40 (36; 43)

	Standardized percentage (95% CI)
Region of Southern Denmark	38 (37; 38)
Aabenraa	44 (41; 48)
Assens	44 (39; 50)
Billund	45 (38; 52)
Esbjerg	39 (36; 41)
Faaborg-Midtfyn	39 (35; 43)
Fanø	62 (39; 86)
Fredericia	41 (37; 45)
Haderslev	43 (39; 46)
Kerteminde	48 (40; 56)
Kolding	41 (38; 43)
Langeland	45 (36; 54)
Middelfart	46 (40; 51)
Nordfyns	51 (44; 57)
Nyborg	40 (35; 46)
Odense	41 (39; 43)
Svendborg	35 (32; 39)
Sønderborg	42 (39; 45)
Tønder	41 (37; 45)
Varde	43 (38; 47)
Vejen	43 (38; 48)
Vejle	34 (31; 36)
Ærø	57 (40; 75)
Central Denmark Region	31 (31; 32)
Aarhus	31 (30; 33)
Favrskov	32 (28; 36)
Hedensted	38 (34; 42)
Herning	37 (34; 41)
Holstebro	36 (33; 40)
Horsens	38 (35; 41)
Ikast-Brande	37 (33; 42)
Lemvig	42 (36; 48)
Norddjurs	36 (32; 40)
Odder	43 (35; 50)
Randers	29 (27; 31)
Ringkøbing-Skjern	37 (33; 41)
Samsø	63 (42; 85)
Silkeborg	30 (28; 33)
Skanderborg	37 (33; 41)
Skive	34 (30; 37)
Struer	39 (33; 45)
Syddjurs	35 (31; 39)
Viborg	34 (32; 37)
North Denmark Region	34 (33; 3)
Aalborg	36 (34; 38)
Brønderslev	44 (39; 49)
Frederikshavn	38 (35; 41)
Hjørring	34 (31; 37)
Jammerbugt	39 (35; 43)
Læsø	77 (45; 110)
Mariagerfjord	31 (28; 34)
Morsø	40 (34; 46)
Rebild	43 (37; 49)
Thisted	34 (30; 37)
Vesthimmerlands	43 (38; 47)

Table 11 Patient type and SAPS II for patients who were admitted to intensive care units in Denmark between 2010 and 2012

Patient characteristics	**Denmark**	**Regions**				
		North Denmark Region	*Central Denmark Region*	*Region of Southern Denmark*	*Capital Region*	*Zealand Region*
Patient type (2010-212), n (%)						
Medical	29,225 (39.1)	3,843 (39.8)	7,414 (42.8)	7,124 (40.4)	5,493 (30.6)	5,351 (44.1)
Acute surgical	18,980 (25.4)	3,040 (31.5)	4,884 (28.2)	5,141 (29.1)	3,167 (17.6)	2,748 (22.6)
Elective surgical	11,075 (14.8)	2,203 (22.8)	1,826 (10.5)	4,582 (26.0)	1,343 (7.5)	1,121 (9.2)
Not registered	15,449 (20.7)	559 (5.8)	3,220 (18.6)	806 (4.6)	7,947 (44.3)	2,917 (24.0)
SAPS II (2010-2012)						
25th percentile	30	29	26	32	33	32
Median	41	40	36	42	45	44
75th percentile	53	53	47	55	58	59
Scored, n (%)	13,554 (18.1)	1,019 (10.6)	4,508 (26.0)	3,561 (20.2)	2,853 (15.9)	1,613 (13.3)
Not scored, n (%)	12,119 (16.2)	2,286 (23.7)	1,842 (10.6)	5,263 (29.8)	695 (3.9)	2,033 (16.8)
Not relevant, n (%)	49,056 (65.7)	6,340 (65.7)	10,994 (63.4)	8,829 (50.0)	14,402 (80.2)	8,491 (70.0)