Outcomes in elderly Danish citizens admitted with community-acquired pneumonia. Regional differences, in a public healthcare system

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Summary
Objectives: To evaluate regional differences in and risk factors for admission, length of stay, mortality, and readmission for community-acquired pneumonia in elderly Danish patients.
Methods: National registry study on elderly Danish citizens with an acute admission in 2009 owing to community-acquired pneumonia. We studied differences among hospitals in length of stay, in-hospital mortality, mortality within 30 days of discharge, and readmission within 30 days after discharge using Cox regression models with adjustments for age, sex, ventilatory support, and co-morbidity by Charlson’s index score.
Results: A total of 11,332 elderly citizens were admitted with community-acquired pneumonia. Mortality during admission and 30-days from discharge were 11.6% and 16.2%, respectively. Readmission rates within 30 days of discharge were 12.3%. There were significantly differences between hospitals in length of stay. A high Charlson index score and advanced age were significantly risk factors for death during admission and within 30 days of discharge. Male sex and high Charlson index score were significant risk factors for readmission. Admission to large bed capacity hospital was a significant risk factor for readmission within 30 days of discharge.

Abbreviations: CAP, Community-acquired pneumonia; HR, Hazard ratio; ICD, International Classification of Diseases; LOS, Length of stay; NIV, Non-invasive ventilation; SIR, Standardized incidence rate.
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Introduction

In industrialized countries, the population of elderly (aged ≥65 years) is growing, and the number of chronic diseases is rising. This is an economical- and capacity-challenge for all parts of the health service. Community-acquired pneumonia (CAP) is one of the five main reasons for acute admission and the third main reason for acute readmission in elderly Danish citizens. The incidence and admission rates for CAP are rising. Admission comprises up to 90% of all expenses for CAP. For CAP, as for other acute diseases, the presence of co-morbidities poses a challenge to length of stay (LOS), readmission and costs. We have only found few publications addressing the impact of admission for CAP on mortality and readmission in elderly persons who have multiple co-morbidities. Even though treatment of CAP follows international recommendations, outcomes can differ between hospitals due to different management of the complexity of the older medical patient. National evaluation of the clinical management of the older patients with CAP and their outcomes are essential for identification of potential feasible interventions with improvement of mortality, readmission and cost effectiveness.

We hypothesis that volume of CAP admissions, hospital size and hospital administration have impact on the management of the older medical patient with CAP.

Patients and methods

Setting

Denmark has a public healthcare system, which provides feeless, tax-paid treatment for primary medical care, hospitals, and homecare services uniformly for all citizens. The few Danish privately-funded hospitals have no acute patient intake. The hospitals in Denmark are organized within five regions with decentralised administration. All hospitals are obligated to pass a national accreditation program "The Danish Healthcare Quality Programme".

All citizens in Denmark have a unique civil registry number, which makes it possible to follow citizens in different national registers. Moreover, the hospitals are paid for delivering information about their admissions to the National Patient Registry, which enables information to be gathered about all admissions to Danish hospitals. This information includes diagnosis for the primary cause of admission and co-morbidities, which are recorded using the International Classification of Diseases (ICD) system. The ICD-10 was used in 2009.

Conclusions: Length of stay, rate of admission, mortality and readmission in elderly Danish patients with community-acquired pneumonia follows international findings. There are regional differences between hospitals. In depth investigation in regional differences could reveal potential feasible clinical interventions with an improvement of readmission-, mortality rates and cost.

The guidelines for treating CAP are set by the Danish Society of Respiratory Medicine, and follow international recommendations.

Population

We identified all admissions for patients aged ≥65 years, where pneumonia (ICD10; DJ09.0–DJ18.9 but excluding pulmonary mycosis: DJ17.2C and DJ17.2; and viral pneumonia, DJ12.2, DJ12.8, DJ12.9 and DJ17.1) was the primary cause of admission in 2009 in Denmark. Only acute admissions were recorded, and only the first admission for pneumonia for each patient was used for indexing.

The following information was recorded from the National Patient Registry: age, sex, admission and discharge dates, hospital, municipality of the patient, primary cause of admission, co-morbidities, date of first acute readmission within 30 days of discharge, and ventilatory support by invasive and/or non-invasive ventilation (NIV). Two admissions occurring less than one day apart were recorded as one admission so as not to overestimate the number of readmissions. If the patient was transferred to another hospital, the admission was recorded for the hospital where the patient was first admitted. Data regarding death during admission and within 30 days after admission and discharge were recorded in the Danish Civil Registration.

The Charlson index score was calculated to determine the number and impact of co-morbidities. The Charlson comorbidity index was developed to predict mortality, and consists of 17 indicators, each representing a disease group with a significant mortality risk, and a score representing the risk severity. The ICD-10 codes were transformed to the 17 disease groups, using the method of Quan et al. 2005. All Charlson index scores ≥4 were categorized as being equal to 4.

When naming the hospitals, two letters were used, the first identifying the region in which the hospital was placed, and the second identifying the specific hospital within the region.

Statistical methods

Descriptive unadjusted comparisons between hospitals were made graphically for LOS for patients who survived to discharge (Fig. 1), death during admission, death within 30 days from discharge for patients who survived to be discharged, death within 30 days from admission for all patients (Fig. 2), and finally readmissions within 7, 14, and 30 days after discharge (Fig. 3).
Differences in time to these events among hospitals were analysed using Cox regressions models. All these analysis were adjusted for sex, age group, use of ventilatory support during admission, and the Charlson index score. Furthermore, we used effect parameterization for all hospital variables; i.e., the effect for a hospital is interpreted as the difference for that particular hospital compared to the mean effect for all the other hospitals. For the time-to-discharge analysis, we used a competing risk model where death during admission was the competing risk. In the analysis of time to in-hospital death, patients were censored when discharged. When analysing time to readmission, death was used as a competing risk. Hospitals with less than 200 elderly patients admitted with CAP in 2009 were grouped together as “few CAP admissions” hospitals. Hospitals with less than 500 beds capacity were designated “small”.

All analysis was carried out in SAS 9.2, and P < 0.05 was considered significant except when comparing hospitals, where a significance level of 0.01 was used to account for multiple testing.

Results

There were 12,753 acute admissions of Danish citizens’ ≥65 years of age in 2009 where CAP was registered as the primary reason for admission. These admissions were distributed among 11,322 different patients who were admitted to 37 different hospitals. Fifteen of the 37 hospitals had fewer than 200 elderly patients with CAP admitted in 2009, and were grouped together with the designation “few” in Figs. 1–3 and Table 3. The 10 hospitals designated as larger bed capacity hospitals were A/A, A/B, A/E, A/F, B/A, and C/A and additionally 4 hospitals being imbedded within the “few” group (see Figs. 1–3). Fifty two percent of the patients were treated at the 27 hospitals with less than 500 beds capacity. The standardized incidence rate (SIR) for hospitalisation was 12.7 per 1000 person-years in the age group ≥65 years. This 1.27% of the population of ≥65 years of age was admitted for a total of 93,169 days, which corresponds to 2.0% of the total hospitalisation days in Denmark. A description of the patient cohort is shown in Table 1.

Ventilatory support

A total of 305 patients (2.7%) received ventilatory support. The proportion of ventilatory support given between the age groups show trend towards decline of advanced medical support in older patients. See Table 2.

LOS

The median LOS for all patients was 6 days. The hospitals’ median LOS for patients surviving their hospitalisation are depicted in Fig. 1. When comparing time to discharge, using an adjusted Cox analyses, we found that hospitals A/C, C/A, C/B, and D/A all had shorter LOS compared with the other hospitals, whereas hospitals A/B, C/C, C/F, D/D, E/B, E/C, E/D, and E/E all had longer LOS than the other hospitals. These analyses indicated regional differences, with patients from region E being admitted for longer stays than those in the other hospitals.

In-hospital mortality

A total of 1303 patients (11.5%) died during admission. The proportion that died in each hospital is shown in the upper
Figure 2  Mortality data on elderly patients (≥65 years) admitted with community-acquired pneumonia (CAP). The upper panel shows the percentage of patients who died during admission. The middle panel shows the percentage of patients who died within 30 days of discharge. Patient who died during admission were censored. The lower panel shows the accumulated mortality during and after discharge during the period from admission to 30 days later. Hospitals: The first letter indicates the region and the second represents the individual hospital within the region. "Few" represent the cohort of patients pooled from hospitals with ≤200 CAP admission/year. Symbols ↓ and ↑ illustrates hospitals with higher or lower (p < 0.01) mortality respectively than the other hospitals by effect parameterization in Cox regression analysis with adjustment for: gender, age, ventilatory support and Charlson index score.
panel in Fig. 2. Mortality varied between 7% and 17%; however, when comparing time to in-hospital death in an adjusted Cox regression analysis, only hospitals A/D, C/A, and C/B differed significantly from the other hospitals, having a higher risk of in-hospital death. One hospital, C/F had a significantly lower risk of in-hospital death.

**Mortality 30 days from discharge**

Among the 10,019 patients who survived admission, 861 (8.6%) died within 30 days of discharge. The difference among hospitals in the proportion dying within 30 days after discharge is depicted in the middle panel of Fig. 2. These proportions differ between 4% and 13%. When comparing the hospitals using Cox regression analyses, patients discharged from hospitals A/E and E/C had a higher risk of dying within 30 days after discharge. When evaluating hospitals on mortality by the fixed time period of 30 days from admission, the deviating hospitals were the same as for mortality 30 days from discharge (see Fig. 2 lower panel).

**Readmission**

Four hundred seventy four patients (4.7%) were readmitted within 7 days of discharge, 800 (8.0%) within 14 days, and 1230 (12.3%) within 30 days. The differences between hospitals in the proportion of readmitted patients can be seen in Fig. 3. When comparing hospitals using Cox regression analyses, patients from hospitals A/A, A/E, A/F, and C/B had a higher risk of readmission within 7 days. A similar picture was seen for the risk of readmission within 14 and 30 days, where patients from hospitals A/A, A/E, and A/F had a significantly higher risk of readmission.

**Risk factors for adverse outcomes**

To give an overview of which of the addressed covariates that are central risk factors in elderly patients admitted with CAP regarding readmission, mortality during admission, 30 days from discharge and 30 days from admission, all the HR from the adjusted Cox regression analyses are given.
**Table 3** Cox regression analysis of time to discharge, mortality and readmission on explanatory variables, in conjunction to elderly patients (≥65 years) admitted with community-acquired pneumonia. Results are given as hazard ratios (HR) and a 95% confidence interval (CI). Significant: \( P < 0.01 \text{ HR are depicted in bold. } P < 0.05 \text{ are depicted in italic font. Non-significant are depicted in grey.}

<table>
<thead>
<tr>
<th>Time to discharge</th>
<th>In-hospital death</th>
<th>Death within 30 days of discharge</th>
<th>Death within 30 days of admission</th>
<th>Readmission within 7 days of discharge</th>
<th>Readmission within 14 days of discharge</th>
<th>Readmission within 30 days of discharge</th>
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<tr>
<td>HR (95% CI)</td>
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<td>Men vs. Women</td>
<td>1.00 (0.96–1.04)</td>
<td>1.14 (1.02–1.27)</td>
<td>1.20 (1.05–1.37)</td>
<td>1.19 (1.09–1.31)</td>
<td>1.38 (1.15–1.65)</td>
<td>1.47 (1.27–1.69)</td>
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<td>Age b</td>
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<td>75–84 vs. 65–74</td>
<td>0.87 (0.83–0.91)</td>
<td>1.40 (1.21–1.63)</td>
<td>1.65 (1.37–1.98)</td>
<td>1.62 (1.43–1.84)</td>
<td>1.01 (0.82–1.25)</td>
<td>1.04 (0.89–1.22)</td>
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<td>65–74 vs. 65–74</td>
<td>0.81 (0.77–0.85)</td>
<td>2.31 (1.99–2.68)</td>
<td>3.12 (2.60–3.75)</td>
<td>2.91 (2.57–3.30)</td>
<td>1.05 (0.82–1.33)</td>
<td>1.02 (0.85–1.23)</td>
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<td>Ventilatory support c</td>
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<td>NIV vs. no support</td>
<td>0.48 (0.41–0.56)</td>
<td>2.44 (1.94–3.07)</td>
<td>1.45 (0.90–2.35)</td>
<td>3.04 (2.44–3.78)</td>
<td>0.76 (0.34–1.70)</td>
<td>0.82 (0.45–1.48)</td>
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<td>Invasive- vs. no support</td>
<td>0.22 (0.18–0.26)</td>
<td>1.79 (1.43–2.25)</td>
<td>0.25 (0.06–0.98)</td>
<td>3.12 (2.47–3.93)</td>
<td>0.91 (0.38–2.21)</td>
<td>0.75 (0.36–1.58)</td>
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<td>1 vs. 0</td>
<td>0.82 (0.79–0.86)</td>
<td>1.01 (0.88–1.16)</td>
<td>0.99 (0.84–1.18)</td>
<td>1.09 (0.97–1.22)</td>
<td>1.19 (0.95–1.50)</td>
<td>1.14 (0.96–1.36)</td>
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<td>2 vs. 0</td>
<td>0.70 (0.65–0.74)</td>
<td>1.52 (1.31–1.77)</td>
<td>2.17 (1.82–2.59)</td>
<td>2.06 (1.82–2.33)</td>
<td>2.58 (2.05–3.26)</td>
<td>2.32 (1.94–2.79)</td>
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<td>3 vs. 0</td>
<td>0.61 (0.54–0.69)</td>
<td>1.59 (1.23–2.05)</td>
<td>2.33 (1.70–3.20)</td>
<td>2.15 (1.73–2.66)</td>
<td>2.36 (1.53–3.64)</td>
<td>2.63 (1.92–3.61)</td>
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<td>4 vs. 0</td>
<td>0.43 (0.37–0.49)</td>
<td>2.24 (1.77–2.83)</td>
<td>2.66 (1.82–3.89)</td>
<td>3.17 (2.55–3.95)</td>
<td>3.01 (1.87–4.48)</td>
<td>3.15 (2.21–4.49)</td>
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<td>Hospital CAP e admissions</td>
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<td>Few vs. many</td>
<td>1.03 (0.97–1.09)</td>
<td>0.87 (0.73–1.03)</td>
<td>0.93 (0.75–1.14)</td>
<td>0.89 (0.77–1.03)</td>
<td>0.71 (0.52–0.97)</td>
<td>0.80 (0.64–1.00)</td>
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<td>Hospital size e</td>
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<td>Small vs large</td>
<td>0.98 (0.94–1.02)</td>
<td>0.91 (0.81–1.01)</td>
<td>0.83 (0.79–0.95)</td>
<td>0.88 (0.81–0.97)</td>
<td>0.66 (0.55–0.79)</td>
<td>0.72 (0.63–0.83)</td>
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Note: NIV: non-invasive ventilation. CAP: Community-acquired pneumonia.

\( a \) Adjusted for age.

\( b \) Adjusted for sex.

\( c \) Adjusted for age, sex and Carlson index score.

\( d \) Adjusted for age, sex and ventilatory support.

\( e \) Adjusted for age, sex, ventilatory support and Carlson index score. “Few” = < 200 CAP admission/year, “small” = < 500 beds capacity.
in Table 3. Significant levels are illustrated by colour intensity. Grey is non-significant. Black with bold font is significant with \( P < 0.01 \) and black in italic font is significantly with \( P < 0.05 \). Covariates are adjusted according to relevant confounders. The most predominant patient related risk factor is high Charlson index score which give higher risk for all outcomes addressed. Male gender was a risk factor regarding incidences occurring post discharge such as readmission and death 30 days from discharge, while ventilatory support and age mainly were risk factors for events occurring during admission with the only exceptions that high age and NIV had also impact on mortality 30 days from discharge. To survive invasive ventilatory support was correlated to a lower mortality 30 days from discharge. Regarding hospital related covariates admission to large bed capacity hospitals was correlated to severe events post discharge in all outcomes. Discharged from a hospital with few CAP admission was correlated with lower risk of early readmission within 7 days from discharge.

Discussion

We show significant regional differences in LOS for elderly patients admitted to Danish Hospitals for CAP in 2009, but only few differences in readmission and mortality frequencies. There were no differences when comparing hospitals sized by admission volume. Admission at hospitals with bed capacity higher than 500 beds was a significant risk factor for mortality and readmission within 30 days of discharge. A high Charlson index score was an independent significant risk factor for all outcomes.

The CAP admission rate found in the present study does not suggest signs of inclining admission rates in Denmark. The SIR for hospitalisation of CAP in our investigation was 12.7 per 1000 person-years in those aged \( \geq 65 \) years. Thomsen and colleagues, who formerly conducted a Danish cohort study corresponding to areas of region D and E of our study, found SIR of 12.5 and 18.3 for the age groups 65–79 years and \( > 85 \) years, respectively. In-hospital mortality rates in our investigation were 10.5% and 20.4% for age groups 65–69 years and 90 years, respectively.

The CAP admission rate found in the present study does not suggest signs of inclining admission rates in Denmark. Thomsen et al. showed an 11% decline in 30-days mortality from admission in the first to the second half of their observation period (1993–2003), which is in line with international results. Our mortality rate 30 days from admission is lower than that of Thomsen et al. (16.2% for those aged \( \geq 65 \) years), but there were differences in inclusion diagnosis and in age and co-morbidity composition. Our CAP mortality rate follows international reported rates for the age group. Kaplan et al. found in-hospital mortality rates in the USA of 7.8% and 15.4% for the age groups 65–69 years and 90 years, respectively. In-hospital mortality rates in Canada were 10.5% and 20.4% for the age groups 65–74 years and \( > 85 \) years, respectively.

We are unable to make conclusions about trends in pneumonia mortality rates for the elderly patients in Denmark. Thomsen et al. showed an 11% decline in 30-days mortality from admission in the first to the second half of their observation period (1993–2003), which is in line with international results. Our mortality rate 30 days from admission is lower than that of Thomsen et al. (16.2% for those aged \( \geq 65 \) years), but there were differences in inclusion diagnosis and in age and co-morbidity composition. Our CAP mortality rate follows international reported rates for the age group. Kaplan et al. found in-hospital mortality rates in the USA of 7.8% and 15.4% for the age groups 65–69 years and 90 years, respectively. In-hospital mortality rates in Canada were 10.5% and 20.4% for the age groups 65–74 years and \( > 85 \) years, respectively.

Ventilatory support by NIV or invasive ventilation was a significant risk factor for in-hospital mortality and LOS. For the risk of mortality 30 days from discharge, invasive ventilatory support was negatively correlated while NIV was correlated to higher mortality risk. Ventilatory support had no impact on readmission (see Table 3). Similar to findings in the USA and Canada, it seems that advanced medical support is declining with advanced age. Carrie et al., Ewig et al. and Kapland et al. also found that expensive in-patient treatment for CAP declined with advanced age owing to medical judgement not to use advanced medical support. Acceptability of the decline in ventilatory support by higher age is an ethical debate. Judgement on whether or not to offer ventilatory support is a clinical judgement based on the patients’ potential of cure and secondarily on relief. In this aspect it is expectable that use of ventilatory support is declining with age due to the fact that the physical reserve capacity to overcome an infection such as CAP is potential lower in older patients.
probably due to this judgement that in-hospital mortality is higher for NIV than invasive ventilatory support with the later been more harmful due to higher level of side effect and thereby offer only to those with highest potential of recovery (see Table 3). This effect is probably also the reason for the significantly lower mortality 30 days from discharge among those who survive invasive ventilatory support. Another reason for the skewed distribution of ventilatory support between age groups could be that older patients are more reluctant to accept ventilatory support. It is beyond the scope of this study design to elaborate on whether or not ventilatory support is offered timely and sufficiently in older medical patients with CAP.

A high Charlson index score was the only significant risk factor for both in-hospital and post discharge events addressed. Regarding readmissions within 30 days of discharge, we are unable to differentiate the causes of readmission. Caplastegui et al. showed in a cohort of individuals >18 years admitted due to CAP that ~65% of readmissions within 30 days of discharge were non-pneumonia related readmissions caused by decompensated co-morbidity; age >65 years and a Charlson index score ≥2 were risk factors for readmission, which are in line with Jin Y et al.’s conclusions.7,11 In contrast, as given in Table 3, we did not find age to be a risk factor for readmission.

There were regional differences in LOS with especial region E where all hospitals under the same decentralised administration had longer LOS compared to the other hospitals with Cox regression analyses adjusted for age, sex, Charlson index score and ventilatory support. Differences between regions in recommendations for discharge and cooperation with the primary healthcare system could be a potential explanation for the observed regional differences in LOS. Jin Y et al. showed in Alberta Canada that urban hospitals had longer LOS compared to rural and regional hospitals.11 In comparison Danish population density is high with low transit time to hospital. The hospitals in region E is best described as rural to regional. Hospital bed capacity was not a risk factor for LOS. Our finding is there by in contrast to Jin Y.

When comparing regional differences in mortality and readmission by Cox regression analyses with adjustment for age, sex, CAP severity by ventilatory support and Charlson index score, only a small subset of hospitals diverged, with only 5 of the 23 letter designated hospitals having a deviation of higher mortality at some point (hospital A/D, A/E, C/A, C/B, and E/C. See Fig. 2) and only 4 with higher readmission rates (hospital A/A, A/E, A/F, and C/B. See Fig. 3). These findings could potential be explained by statistically type one error, but looking at trends most of these hospitals were large bed capacity hospitals (4 of 6) and all within the city boundary of the 4 largest cities in Denmark. Bed capacity in the Cox regression analyses was also of significant risk factor for readmission and post discharge mortality (see Table 3). There can be several explanations for this finding. Patient related parameters could be higher incidence of severe CAP infections at large hospital facilities. For hospital related parameters demand for higher patient turnover per bed in large capacity hospitals could influence on when and in what condition patients were discharged, which again would influence on incidence of readmission and mortality.7 Clinical management of timing administration of antibiotics, assessing severity and conduction of relevant intervention upon the degree severity all influence on in-hospital mortality.13,15 In an audit of 100 randomly selected medical charts within the cohort we did not detect any regional differences in these parameters (unpublished). One of the deviation hospitals (CE), who had significantly higher in-hospital mortality and readmission rate within 7 days from discharge, is a specialised geriatric hospital. This patient cohort have potentially higher incidence of frailty due to the selection given by the indication of geriatric admission. Low functional capacity is a significant risk factor for both mortality and readmission.16,27 Hospitals with few CAP admissions did not deviate in mortality from higher CAP volume hospitals and regarding readmission rates they had lower 7 days readmission rates (P < 0.05) than high volume CAP hospitals (see Table 3). This is in contrast with the findings in Canadian settings where hospitals with high volume CAP admission, had lower readmission rates than hospitals with low volume CAP admission. In the same cohort Marrie T J et al. showed lower in-hospital mortality in larger CAP volume hospitals than in smaller CAP volume hospitals in Canada, although more severe CAP was treated in larger CAP volume hospitals.12

The hospitals collected under the designation “few” in our study is a diverse group of some of the smallest rural hospitals and some of the largest urban hospitals in Denmark. Differences in outcomes within these diverge setting could be imbedded within these data. High CAP volume pr physician have shown negative association with in-hospital mortality even though these physician treated more severe cases.13 It is beyond the boundaries of this study to conclude the impact of this in the Danish medical settings.

In the perspective on regional difference in outcome, hospitals A/C and D/A are notable in their ability to be the 2 only hospitals with significantly shorter LOS without deviating mortality or readmission rates.

Among the strengths of our study is the use of the Danish public healthcare system, which provides treatment to all citizens. The Danish Civil Personal Registration allows a population-based design, with inclusion of all admissions, readmissions, and a complete follow up for mortality. The Danish National Patient Registry enables us to adjust for co-morbidities. Our observation period is a full calendar year, which includes seasonal variations.

Limitations include that admission and co-morbidity diagnoses are based on routine clinical discharge registrations with the possibility of miscoding. The positive predictive value of a diagnosis of pneumonia in the National Patient Registry has previously been estimated to be 90% (95% CI 82–95%).5 The database’s ability to assess Charlson index score have formerly been validated with a PPV of 98% (95% CI 96.9–98.8) for the Charlson’s diagnose groups.28 The only data on CAP severity in our study is the surrogate data on the use of ventilatory support. The severity of CAP is likely to have an impact on LOS and mortality.19,22 Likewise, it is a limitation that our data do not contain information on microbiologic analysis, functional assessment, nursing home residency, and nutritional state, since all factors could potentially impact the incidence, mortality rate, and LOS.20,22,26,27,29–32
In summary on the national level, our results for LOS, admissions- mortality- and readmission rates, in conjunction to CAP admission in older patients, follows previous international publications. Regarding risk factors for the outcomes addressed is in agreement with international findings. Co-morbidity, age, CAP severity and probably male gender are factors that should be addressed when clinical assessing mortality risk in older patients admitted with CAP. When regarding readmission the same risk factors are essential with exception of age which was not an isolated risk factor for readmission. There were significant regional differences in LOS. Even though the Danish hospitals in general are homogenous, when comparing outcomes of mortality and readmission, there are deviations which are beyond the explanation of skewed distribution of male gender, age and co-morbidity which are known risk factors. When trying to improve outcomes for elderly patients admitted with CAP focussing on managing the infection is not sufficiently. As shown in our data the risk profile for in-hospital event and post discharge are very different and intervention thereby also. Future research in older patients admitted with CAP should focus on the aspects of ageing rather than age by looking in to differences within the age groups. Older patients are prone to have higher incidence of frailty and co-morbidities. Rehabilitation of elderly patients during hospitalisation and post discharge should be investigated for the potential of protecting against or stabilizing co-morbidity and frailty pathology. This should include aspects such as nutrition, fluid therapy, early mobilization, co-morbidity stabilizing therapy, and patient information. In the perspective of spares resources it is essential to develop risk profile that is clinical feasible in the acute medical settings for identifying patients in risk of in-hospital event and secondarily for event post discharge. Further elaboration on differences in outcomes of CAP between hospitals should include patient related data of the severity of CAP and pre-morbid functional capacity. In addition it is necessary to focus on hospital related data such as: clinical management of the diseases including co-morbidity and physician volume per patient, patient turnover per bed. Within the Danish public healthcare system differences in these clinical practice between larger and small bed capacity hospitals is of special interest and could reveal potentially feasible intervention with impact on mortality, readmission and cost for older patients admitted with CAP.

Conclusions

LOS for CAP in elderly Danish citizens and mortality and readmission rates follows international findings. Patient related risk factors for mortality were male gender, CAP severity, high Charlson index score and age. Age is not a risk factor for readmission. There are regional differences in LOS mortality and readmission between hospitals. When adjusting for patient related risk factors available admission to high bed capacity hospital is a significant risk factor for severe event post-discharge such as readmission and death. In depth investigation in regional differences of practical scopes could reveal potential feasible clinical intervention and new patient related risk factors with improvement of readmission-, mortality rates and cost.

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Ethical approval

This study was solely based on register databases with no discomfort for the involved participates and approval from ethical comity was not necessary.

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Conflict of interest statement

None of the participating authors have personal or financial relationships that may give any conflict of interest in this study.

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