The effect of the employment of consultants in the Emergency Department on quality of care and equity – a quasi-experimental retrospective cohort study

Mette Bendtz Lindstroem (mlin0062@regionh.dk)
Copenhagen University Hospital, Hvidovre https://orcid.org/0000-0003-3892-6645

Ove Andersen
Clinical Research Centre, Copenhagen University Hospital, Hvidovre and Acute Medical Department, Copenhagen University Hospital, Hvidovre

Thomas Kallemose
Clinical Research Centre, Copenhagen University Hospital, Hvidovre

Line Jee Hartmann Rasmussen
Clinical Research Centre, Copenhagen University Hospital, Hvidovre and Department of Psychology and Neuroscience, Duke University, Durham NC

Susanne Rosthoej
Department of Public Health, Section of Biostatistics, University of Copenhagen

Signe Smith Jervelund
Department of Public Health, Section for Health Services Research, University of Copenhagen

Research article

Keywords: Emergency Medicine, Emergency Department, acute medical patients, frontloading, equity, socioeconomic status, readmission, mortality, length of stay, organisational intervention

Posted Date: December 7th, 2019

DOI: https://doi.org/10.21203/rs.2.18364/v1

Abstract

Background Crowding and bed occupancy are challenging issues in the hospitals with increasing acute admissions, caused by an aging population. Crowding in Emergency Departments (EDs) has a negative impact on length of hospitalisation, in-hospital mortality, patient safety, and flow. Thus, the Danish Health Authorities recommend the presence of specialist doctors in the ED who are dedicated to execute the clinical decision-making process. Thus, in 2016, the model of acute care was changed in the ED at Hvidovre Hospital, Denmark, to include consultant-led triage and continuous presence of consultants, referred to as Acute Medical Consultants. However, there is little evidence concerning the effect of consultants treating patients in the ED, and how it affects care for patients of varying socioeconomic status compared with other models of ED staffing. This study investigated whether the employment of Acute Medical Consultants in a Danish ED affected the quality of care for acutely admitted medical patients in terms of length of stay, readmission, mortality, and secondly how this effect was distributed across socioeconomic status in patients.

Methods Admission data for 9,869 adult medical patients admitted for up to 48 hours in the ED was collected in two separate 7-month periods, one prior to and one after the organisational intervention. Linear regression and Cox proportional hazards regression analyses adjusted for age, sex, comorbidities, level of education, and employment status were applied.

Results Following the employment of Acute Medical Consultants, an overall 11% increase in index-admissions was observed, and 90% of patients were discharged by an Acute Medical Consultant with a reduced mean length of stay by 1.4 hours (95% CI: 1.0 – 1.9). No significant change was found in in-hospital mortality, readmission, or mortality within 90 days after discharge. No difference was found in quality of care across socioeconomic status.

Conclusion The employment of Acute Medical Consultants in the ED was associated with reduced length of admission without a negative effect on the quality of care for ED-admitted medical patients in general, or for patients with lower socioeconomic status. Yet, in order to reduce readmission and mortality among acutely admitted patients, other means must be initiated.

Introduction

The Emergency Departments (EDs) in Denmark are currently reconfiguring acute hospital services as a means to ensure a safe and sustainable model of care with the purpose to meet higher demands and in order to serve an increasingly ageing population with chronic conditions, co-morbidities, and polypharmacy[1,2]. This involves the availability of Acute Medical Consultants who are initiating comprehensive medical services at the time of admission in the ED —also referred to as *frontloading*[3] —in order to improve access to diagnostics, with the ultimate aim of enhancing both the continuum and quality of care[4].

To fulfil the recommendations from the Danish National Board of Health for a timely advancement of the clinical process in the Danish EDs, Copenhagen University Hospital Hvidovre, Denmark, with a catchment area of 516.000 citizens and one of the largest EDs in Denmark, changed its model of acute care in the ED in August 2016. Prior to this, the ED had a nurse-led triage and was staffed with nurses and trainee doctors. At that point, consultants from the specialty wards would perform one daily round after morning conference, confirming or changing treatment plans and discharge of admitted patients. Following reconfiguration of the ED services, the ED employed their own Acute Medical Consultants whose job was to supervise trainee doctors and manage the ED triage, treatment, and discharge of patients, a system which is comparable to Acute Medical Units (AMUs) in the UK.

This 29-bed ED comprises part of the Danish publicly funded, free-of-charge healthcare system, which serves all acute medical patients referred to the hospital by General Practitioners, the emergency medical helpline, out-of-office doctors, or ambulances—with the exception of paediatric, gastroenterological, and obstetric patients, who are admitted to other specialised EDs at the hospital. At Hvidovre Hospital, the average daily ED patient admission intake is 45–60 patients with hospitalisation of up to 48 hours. Hvidovre Hospital's urban catchment area includes 517,000 people, of whom 21 percent has no further education following completion of elementary school[5], and 16 percent of adults younger than 65 years are outside the labour market[5]. There is a high prevalence of chronic conditions in Denmark, with two-thirds of the adult Danish population having one or more chronic condition[6]. Additionally, the citizens in this hospital catchment area run a significantly greater risk of having three or more chronic diseases when compared with other catchment areas in the Capital Region of Denmark[7].

Internationally, AMUs or similar acute admission facilities have been found to positively influence ED patient flow[8–13], while a lack of consultants in the ED has been found to contribute to poor quality of care[14]. Nevertheless, comparison and evaluation of the overall effectiveness of these acute admission facilities have been shown to be complicated due to local and national differences in health care systems, case-mix, staffing, and contexts, and it has been found that the evidence of the effect on patient outcome is deficient[15,16].

A small number of studies have investigated the effect of consultants' presence in the ED setting on patient outcome, but with inconsistent results[12,17–20]. Based on these studies it would appear that the continuous presence of consultants in the ED compared to other models of ED staffing is likely to reduce length of stay (LOS); however, the results of these studies have been inconsistent, showing neither an effect on nor a reduction in readmission and mortality.

Patients in lower socioeconomic groups generally have poorer outcome of treatment[21] and inadequate access to the right level of healthcare compared with people in higher socioeconomic groups[22]. Yet, when health services are freely available, there is very little evidence of social inequity in the utilisation hereof for patients with the same disease[21]. Studies from Ireland found that low socioeconomic status (SES) was strongly associated with more acute medical admission, readmission, and death, but not with LOS[23]. To our knowledge, there has not yet been an investigation of whether the presence of Acute Medical Consultants affects the quality of care for acutely admitted medical patients across SES, despite its relevance when designing acute medical services that address the needs across the entire population.

Similarly, how the presence of Acute Medical Consultants in the ED, AMU, or similar acute facilities affects the quality of care in the Danish health care system has not previously been investigated. Therefore, this study investigated whether the employment of Acute Medical Consultants in a Danish ED improved quality of care in terms of lower LOS, readmission, and mortality, and how the potential effect on patients was distributed across SES. We hypothesised that there would be a greater likelihood that Acute Medical Consultants would apply a more holistic view on the patients and would consider the patients' potential additional medical conditions in the management plan, when compared with trainee doctors on ED duty from highly specialised medical wards. This would imply that there would be reduced acute readmissions and, furthermore, that the effect would be strongest for patients with lower SES, due to co-morbidities being strongly associated with low SES[24].

Design And Methods

Study design

The study is a retrospective, registry-based, quasi-experimental design comparing two separate open cohorts of patients acutely admitted to the ED in two 7-month periods before and after the organisational intervention at Hvidovre Hospital, respectively: 1 August, 2015 to 28 February, 2016 (the control cohort) and 1 August, 2016 to 28 February, 2017 (the intervention cohort). The inclusion period for the intervention cohort started on the first day of the Acute Medical Consultants' employment in the ED (1 August, 2016) and ended prior to the implementation of a new IT patient journal system (EPIC) in March 2017. To account for the potential introduction of bias related to seasonal deviation in disease patterns, the control cohort was collected at the same time of the year one year earlier.

Organisational intervention

Before the reconfiguration (control period): The ED was staffed with ED nurses and a medical team comprising four trainee doctors and one senior registrar from the respiratory or endocrinology wards. In addition, call for advice from geriatric and internal medicine (respiratory, endocrinology, cardiology, and infectious diseases) senior registrars or consultants was available from 9 am to 6 pm on weekdays. From 6 pm to 9 am and during weekends, consultant advice was only available from the cardiology and infectious disease specialties. Plans for treatment and discharge were confirmed by visiting consultants from the specialty wards, who performed one daily patient round after the morning conference or during the day upon request.

After the reconfiguration (intervention period): The ED services were reconfigured in August 2016. Following this, the ED was staffed with a Flowmaster, ED nurses, and an ED medical team on duty: five trainee doctors from the specialty wards and 1–2 Acute Medical Consultants who were employed in the ED. The Acute Medical Consultants were present from 9 am to 9 pm, seven days per week. From 9 pm to 9 am, one consultant or senior registrar was on call from the respiratory or endocrinological specialties and could be present at the ED within minutes, if needed.

Furthermore, call for advice from geriatric or internal medicine consultants (respiratory, endocrinology, cardiology, and infectious diseases) was available from 9 am to 9 pm. From 9 pm to 9 am and during weekends, consultant advice was available from the cardiology and infectious disease specialties. One of the Acute Medical Consultants was appointed a role as Flowmaster. The Flowmaster was responsible for clinical logistics and coordination with other departments at the hospital. In case of unavailability on the part of the Acute Medical Consultants, the Flowmaster role was carried out by a consultant or senior registrar from the specialty wards. In addition to the introduction of Acute Medical Consultants, a limit of 4 hours from admission to the presence of treatment plans was introduced.

The Acute Medical Consultants were responsible for the ED triage, investigation, treatment, and continuous discharge of all admitted medical patients in the ED bed-section, with the exception of patients with symptoms of an infectious disease, where a consultant or senior registrar from the Department of Infectious Diseases would approve the treatment plan before discharge from the ED (see additional file 1 for overview of significant organisational changes)

The medical specialty of Acute Medicine has only been present in Denmark since February 2018, i.e., after the study period, therefore the Acute Medical Consultants were specialised in thoracic surgery, internal medicine, nephrology, or cardiology, supplemented with a two-year Danish postgraduate degree in Acute Medicine.

Study population

The two patient cohorts were part of a larger study on ED standard admission blood tests and were included in the present study if they i) were admitted acutely to the ED bed-section during any of the study periods, ii) had admission blood samples analysed (mandatory for all ED patients), and iii) were aged ≥18 years old. Patients with a LOS >48 hours were excluded; 48 hours is the criteria for eligibility for admission to the ED bed-section and this period of time was chosen since the interest of the study was in investigating the effects for admitted patients who had been assessed and treated in the ED, rather than at the specialty wards. The index admission was defined as the first admission in the 7-month inclusion period. Patients were followed until either acute readmission or death, whichever occurred first, with administrative censoring taking place at 90 days from discharge or at the end of the cohort follow-up. Hospital admissions registered less than four hours apart were considered to be coherent and were regarded as the same hospitalisation; thus, readmission was defined as an acute admission more than 4 hours after discharge[25].

Data collection

Patients admitted to the ED bed-section were identified via the hospital's Clinical Biochemistry database LABKA, as all ED patients have an initial set of standard routine blood tests analysed upon admission. Utilising these patients' unique personal identification numbers, which all Danish residents possess, age and sex were identified, and data on patients' diagnoses, admissions, and readmissions was collected from the Danish National Patient Registry (NPR), while data on mortality was collected from the Danish Civil Registration System. To identify comorbidity, the Charlson Comorbidity Index[26,27] was used, which is a weighted cumulative score where severe and multiple co-morbidities compound the score. In this way, the updated Charlson Comorbidity Index Score was calculated based on the last 10 years of patient records from the NPR for each patient, using a SAS macro as previously described[28]. Data on SES was obtained from the Population Education Register[29] and The Register-based Labour Force Statistics (RAS)[30], Statistics Denmark through data linkage. SES was assessed by highest attained level of education and labour status, each divided into three categories: short, middle, or long education, as well as employed, unemployed, or outside the labour market, respectively. Categorisation was decided upon in accordance with national health reporting[31].

Outcomes

Outcomes included LOS, acute unplanned readmissions, and mortality (in-hospital and after discharge). Readmissions and mortality were reported at four time points after discharge: at 72 hours and 7 days to reflect the quality of care of the hospitalisation and discharge process, and at 30 and 90 days to reflect the possible effect of Acute Medical Consultants with regard to disease management.

Statistical analysis

Quantitative variables are presented as mean and/or median with interquartile range (IQR), and comparisons were performed using a Welch two-sample t-test or, for non-normally distributed data, a Wilcoxon rank sum test. Categorical variables are presented as frequency with percentage, and comparisons were performed using the Chi-Square or Fisher's exact tests.

Cumulative incidences of readmission before and after the organisational intervention were determined using the Aalen-Johansen estimator[32], treating death as a competing risk and compared utilising Gray's test[33]. Due to a crossing of the cumulative incidence curves, analyses were repeated for day 0–21 and 21–90, separately.

Multivariable analyses were performed to compare the outcomes before and after the organisational intervention using logistic regression for in-hospital mortality, linear regression for LOS, and cause-specific Cox proportional hazards regression for readmission and mortality within 90 days, treating death as a censoring event for readmission. Models were fitted for all patients and stratified to patients with infectious and non-infectious diagnoses to avoid the introduction of bias related to potential longer waiting times for patients diagnosed with infectious diseases.

All analyses were adjusted for age, sex, educational level, employment status, and Charlson Comorbidity Index. The assumptions of proportional hazards and linearity for quantitative variables in the Cox model were assessed using cumulative sums of martingale residuals[34]. As the distribution of LOS did not normalise after logarithmic transformation, generalized least squares (GLS) were used for inference in the linear model, with observations weighted according to their estimated variance. Different variance functions were used, and model selection was based upon minimising the Akaike information criterion (AIC). The model for All Patients had the lowest AIC when using an exponential variance function for weights, and the models for Infectious or Non-infectious Diagnoses both had lowest AIC when using a power variance function. Comorbidity was included in all models in order to adjust for any difference in the distribution between patients before and after the organisational intervention, given the association between morbidity and risk of readmission and mortality[35].

In the analysis of the effect of the organisational intervention on the quality of care across SES, SES was included as a categorical variable.

A p-value <0.05 was considered statistically significant. All analyses were performed using SAS 9.3 (SAS Institute Inc., Cary, NC, USA) or R version 3.2.3 (R Foundation for Statistical Computing, Vienna, Austria)[36].

Results

Patient characteristics

The two cohorts consisted of 4,647 and 5,222 patients prior to and after the organisational intervention, respectively, showing an 11% increase in index-admissions (Table 1). After the organisational intervention, a statistically significant decrease was seen in the proportion of those patients who were admitted with diagnoses other than infectious disease (90.0% versus 91.2%, $p<0.03$), and a total increase in the number of infectious disease patients from 407 to 523.

There were no significant differences between the two cohorts with regard to distribution of sex, age, Charlson Comorbidity Index, and SES.

Table 1 Socioeconomic and clinical characteristics of acutely admitted medical patients in the Emergency Department (ED) bed-section, Copenhagen University Hospital Hvidovre, within two 7-month periods: one prior to and one after the organisational intervention and the employment of Acute Medical Consultants in the ED, *n*=9,869

	Before the organisational intervention	After the organisational intervention	*p*
Index-admissions in the ED, *n (%)*	4,647 (47.1)	5,222 (52.9)	<.001
Other diagnose than infection*	4,240 (91.2)	4,699 (90.0)	0.03
Diagnosed with infectious diseases**	407 (8.8)	523 (10.0)	
Sex, *n* (%)			0.51
Male	2,201 (47.4)	2,508 (48.0)	
Female	2,446 (52.7)	2,714 (52.0)	
Age (years), *n* (%)			0.61
18-24	358 (7.7)	447 (8.6)	
25-34	587 (12.6)	638 (12.2)	
35-44	612 (13.1)	665 (12.7)	
45-54	769 (16.6)	823 (15.8)	
55-64	702 (15.1)	811 (15.5)	
65-79	1,059 (22.8)	1,187 (22.7)	
80+	560 (12.1)	651 (12.5)	
Age (years), median (IQR)	55.0 (38.5-71.0)	55.4 (38.5-71.7)	0.60[1]
Employment status, *n* (%)	4,464 (96.1)	5,013 (96.0)	0.12
Employed	1,513 (33.9)	1,798 (35.9)	
Unemployed	71 (1.6)	72 (1.4)	
Outside the labour market	2,880 (64.5)	3,143 (62.7)	
Highest educational level, *n* (%)	4,606 (99.1)	5,168 (99.0)	0.39
Short	2,222 (48.2)	2,515 (48.7)	
Middle	1,675 (36.4)	1,819 (35.2)	
Long	709 (15.4)	834 (16.1)	
Charlson Comorbidity Index, *n* (%)	4,647 (100)	5,222 (100)	0.31
0	2,900 (62.4)	3,268 (62.6)	
1	642 (13.8)	740 (14.2)	
2	599 (12.9)	614 (11.7)	
3+	506 (10.9)	600 (11.5)	
Charlson Comorbidity Index, mean (IQR)	0 (0-1)	0 (0-1)	0.90[1]

IQR: Interquartile range

* Before the intervention: treated and discharged by a consultant or senior registrar from a specialized ward. After the intervention: treated and discharged by an Acute Medical Consultant.

** Before and after the intervention: treated and discharged by a consultant or senior registrar from Department of Infectious Diseases.

Difference is assessed using Wilcoxon rank sum test[1]

Length of stay

The patients who had been admitted after the organisational intervention had a significant reduction in mean LOS from 13.2 to 12.0 hours, i.e., 1.2 hours, p<0.001 (Table 2). The adjusted analysis showed a similar reduction of 1.3 hours, p<0.001 (95% CI: 0.8-1.7). When stratifying the patients by diagnosis, patients with non-infectious disease (in principle, discharged by an Acute Medical Consultant) had a significantly reduced LOS, by 1.4 hours, p<0.001 (95% CI: 1.0-1.9), while there was no change in the LOS observed in patients diagnosed with infectious disease (discharged by a consultant or senior registrar from the Department of Infectious Diseases) (Table 3).

Table 2 Univariable analysis of quality indicators of acutely admitted medical patients in the Emergency Department (ED) bed-section, Copenhagen University Hospital Hvidovre, within two 7-month periods: one prior to and one after the employment of Acute Medical Consultants in the ED, *n*=9,869

		Before the organisational intervention	After the organisational intervention	*p*
Admitted ED patients, *n*		4,647	5,222	
In-hospital mortality, *n* (%)				
All patients		63 (1.4)	81 (1.6)	0.42
- other diagnose than infection*		46 (1.1)	71 (1.5)	0.08
- diagnosed with infectious diseases**		17 (4.2)	10 (1.9)	0.04
Discharged ED patients, *n*		4,582	5,138	
Length of stay, hours, *Mean (Median, IQR)*				
All patients		13.2 (9.2, 4.5-19.7)	12.0 (7.8, 3.6-17.5)	<.001[1]
- other diagnose than infection*		13.0 (9.0, 4.5-19.3)	11.6 (7.6, 3.5-17.0)	<.001[1]
- diagnosed with infectious disease**		15.4 (11.2, 4.2-22.4)	15.0 (11.2, 4.5-21.9)	0.72[1]
Events during follow-up, *n*		4,584	5,141	
Readmission, 90 days follow-up, n (cumulative incidence competing risk, %)***				0.30
72 hours	Pt. other disease	205 (4.9)	210 (4.6)	
	Pt. infectious disease	17 (4.4)	38 (7.4)	
7 days	Pt. other disease	305 (7.3)	334 (7.3)	
	Pt. infectious disease	23 (5.9)	48 (9.4)	
30 days	Pt. other disease	617 (15.3)	644 (14.5)	
	Pt. infectious disease	61 (17.0)	73 (14.8)	
90 days	Pt. other disease	937 (25.4)	984 (24.5)	
	Pt. infectious disease	77 (23.5)	96 (21.7)	
Mortality, 90 days follow-up, n (cumulative incidence competing risk, %)***				0.12
72 hours	Pt. other disease	5 (0.1)	4 (0.1)	
	Pt. infectious disease	0 (0.0)	2 (0.4)	
7 days	Pt. other disease	14 (0.3)	9 (0.2)	
	Pt. infectious disease	2 (0.8)	2 (0.8)	
30 days	Pt. other disease	30 (0.7)	24 (0.5)	
	Pt. infectious disease	3 (0.8)	6 (1.2)	
90 days	Pt. other disease	47 (1.3)	36 (0.9)	
	Pt. infectious disease	5 (1.6)	6 (1.2)	

IQR: Interquartile range

* Before the intervention: treated and discharged by a consultant or senior registrar from a specialized ward. After the intervention: treated and discharged by an Acute Medical Consultant.

** Before and after the intervention: treated and discharged by a consultant or senior registrar from Department of Infectious Diseases.

*** Cumulative incidence was determined using the Aalen-Johansen estimator treating death as a competing risk.

Difference is assessed using Wilcoxon rank sum test[1]

Table 3 Multivariable regression models: Quality of Care Outcomes for acute admitted medical patients in the Emergency Department (ED) bed-section, Copenhagen University Hospital Hvidovre, within two 7-month periods: one prior to and one after the employment of Acute Medical Consultants in the ED, adjusted for age, sex, Charlson Comorbidity Index, education level, and employment status, *n*=9,392

Length of stay, hours, linear regression model	Estimate	95% CI	*p*
After the organisational intervention vs. before			
All patients	-1.3	-1.7 to -0.8	<.001
patients with other diagnose than infection	-1.4	-1.9 to -1.0	<.001
patients diagnosed with infectious diseases	-0.01	-1.7 to 1.7	0.99
Readmission up to 90 days, proportional hazards regression model	HR		
After the organisational intervention vs. before			
All patients	0.96	0.9-1.0	0.31
patients with other diagnose than infection	0.96	0.9-1.1	0.44
patients diagnosed with infectious diseases	0.91	0.7-1.2	0.53
In-hospital mortality, logistic regression model	OR		
After the organisational intervention vs. before			
All patients	1.05	0.7-1.5	0.80
patients with other diagnose than infection	1.28	0.9-1.9	0.21
patients diagnosed with infectious diseases	0.42	0.2-1.0	0.05
Mortality up to 90 days, proportional hazards regression model	HR		
After the organisational intervention vs. before			
All patients	0.97	0.8-1.2	0.81
patients with other diagnose than infection	0.93	0.7-1.2	0.64
patients diagnosed with infectious diseases	1.34	0.4-4.0	0.60

Readmission

Approximately 25% of all patients were readmitted within 90 days of discharge in both cohorts (Table 2). No significant differences were found between the cumulative incidences of readmission in the two cohorts There was no difference found when comparing the cumulative incidences before and after day 21, the point at which the incidence curves for readmission cross (Figure 1). In the adjusted multivariable Cox regression analysis, similar results were obtained (Table 3).

In-hospital mortality

The overall proportion of patients who died during hospitalisation did not differ significantly between the cohorts, at 1.4% and 1.6% before and after the organisational intervention, respectively (Table 2). The multivariable analysis confirmed this result (Table 3). However, a significant decrease in the in-hospital mortality was observed for patients with infectious disease (4.2% versus 1.9%, p 0.04) in the period following the organisational intervention.

90-day mortality

Approximately 1% of all patients died during the first 90 days of discharge with no statistically significant difference between the two

cohorts (Table 2). Similarly, multivariable analysis revealed a non-significant difference between the cohorts (Table 3).

Effect on the Quality of Care distributed across Socioeconomic Status

We found that the admission of patients across educational levels and employment status to the ED was similar before and after the organisational intervention (Table 1), which would indicate that any socioeconomically-patterned access to treatment at the ED was not affected by the organisational intervention.

We found no socioeconomically-patterned distribution of LOS, in-hospital mortality, or distribution of readmission and mortality up to 90 days following discharge (additional file 2a, 2b). The adjusted multivariable analyses of LOS, in-hospital mortality, 90-day readmission, and 90-day mortality revealed no significant difference either prior to or after the organisational intervention across all levels of education and employment status (p 0.14–0.95), see additional file 3-6.

Discussion

In this study of admitted ED patients, the findings suggest that Acute Medical Consultant-led triage, treatment, and discharge are associated with 1.4 hours shorter LOS and with no significant effect upon in-hospital mortality, readmission, or mortality within 90 days from discharge, when compared with the ED organisation with daily rounds and on-call senior registrars or consultants from the specialty wards. The clinical outcomes were evenly distributed across patients' SES, both before and after the organisational intervention at the ED. These results underline the fact that no systematic social inequity in patient-outcome for admitted medical patients at the ED was observed. This also suggests that the employment of Acute Medical Consultants per se do not have a measurable effect on the indicators of the quality of care for patients with low SES.

Reduced LOS following the employment of Acute Medical Consultants in EDs, AMUs, and similar treatment facilities has also been found in several studies from the UK and Australia[9,12,13,17,20]. However, most studies compare the outcome as a consequence of the advice from or the presence of a consultant versus the lack of presence. Only four studies compare one model of ED senior-led medical service to another[12,17,20]; of these, only one attempted to adjust for confounding and did not find an association between mean LOS and consultant availability[17] in contrast to our findings. This could be due to the fact that the study examined the effect on LOS for all acutely admitted patients to the hospital and not exclusively the ED admitted patients, which is therefore not directly comparable to the study population in our study.

Another indicator of effective service delivery is readmission rate, as patients returning to the hospital apply additional pressure to the health care system by increasing patient volume[37]. Our study confirmed the previous findings of no effect of models of consultant-led ED services on readmission rates[19,20] and the readmission rate which was found is similar to the one found at another Danish Acute Hospital[38]. These findings are in contrast to a British study that found a significant decrease in readmission within 28 days of discharge utilising adjusted analyses[17]. In the British study by Bell and colleagues, the comparison was made between an ED staffed with only trainee doctors and an ED staffed with senior registrars, consultants, and trainee doctors[17]. In addition to this, Bell et al. reported that the decrease in readmission was only related to the use of consultants, which is consistent with other studies of the positive effect on ED quality outcomes when comparing experienced doctors to trainee doctors[39,40]. Given the fact that our study compares two models of ED senior staffing, this could explain the difference in results.

In-hospital mortality or death shortly after discharge can be an indication of poor quality of care[41]. The unaffected mortality rates during and after hospital stay in our study are similar to the findings in other studies from the UK[20] and Denmark[18]. The Danish study used adjusted analyses and found an almost similar mortality risk for patients admitted to an ED that employs their own senior registrars or consultants in a manner similar to Hvidovre Hospital, compared with an ED with visiting consultants from the specialty wards[18]. An Australian study found an increase in in-hospital mortality when carrying out a comparison between two weeks of consultant-led triage and two weeks of consultant-led triage in combination with an acute medical assessment unit, but this study displayed only unadjusted analyses and had a very small sample size[12]. Bell et al. found a significantly lower in-hospital mortality rate ($p<0.01$) when using consultants in the ED compared to other grades of staff[17]. All other important possible or theoretical clinical confounders being equal, this would indicate that the quality of acute care assessed by mortality as an outcome measure does not differ significantly between specialty consultants and Acute Medical Consultants.

Yet, the reduced mortality rate for patients who were diagnosed with infectious disease could indicate that these patients may benefit from the timely advancement of treatment led by Acute Medical Consultants.

The introduction of Acute Medical Consultants entailed time-managed patient flow, which may have contributed to the shorter duration of hospital stay. In utilising this study design, we cannot definitively conclude whether the achieved effectiveness is indeed due to the Acute Medical Consultants' professionalism, or whether it is due to the time-framed treatment or other optimised processes. However, the national and international trends towards effective hospital stays with shorter LOS in order to meet increased hospitalisation rates[42] do align with the results from this study.

Patients diagnosed with infectious disease did not have a shorter LOS after the employment of Acute Medical Consultants. One way of interpreting this could be that these patients were awaiting the discharge from a consultant from the department of infectious diseases. Another interpretation is that these patients are more complex to treat or require IV-antibiotics and therefore are admitted for a longer period. In the case of the latter, the LOS for this patient group has the potential to decrease in future when IV-treatment can soon be continued in municipalities at special rehabilitation centres for discharged patients.

This study observed an increase in all ED index admissions of 11% without a lowering in the quality of care in relation to mortality or readmissions. Due to the fact that a similar case-mix of patients before and after the intervention was observed, we do not expect that the retention of the quality of care could be related to change in referral pattern, e.g., general practitioners lowering the threshold of acute referral to the hospital, but rather to the employment of the Acute Medical Consultants.

There was no impact of SES found on the quality of care measures either before or after the organisational intervention. Thus, the results may indicate that the introduction of Acute Medical Consultants does not affect the quality of care for patients with low SES, and may thus indicate that the patient outcome for patients admitted to the ED at Hvidovre Hospital is independent of their educational level and employment status.

The effect of Acute Medical Consultants on the quality of care distributed across patients' SES status has not previously been subject to investigation, though the association between SES and patient outcomes is of considerable interest given that educational level is identified as a predictor of additional hospitalisations[43], readmissions, and mortality[44,45]. Our findings of equity in ED quality of care stand in contrast to previous findings from retrospective studies from an ED in Ireland; the Irish studies did not observe any association between LOS and lower SES of admitted patients when adjusted for comorbidities[23,46], but they found a social gradient in in-hospital mortality[23,46] and 30-day mortality[46]. The SES data in the Irish studies were based on patients' residential area level of SES and the study population was comprised of all acutely admitted patients, while the SES data in our study was based on individual SES measures and the study population was less severely ill, compared with the study population in the Irish studies, as our study population had a hospital stay of up to 48 hours in the ED. In comparing our study population with the catchment area population of Hvidovre Hospital, we found an extensive overrepresentation of ED patients with lower SES, with 48% of patients having had a short education compared to 29% in the catchment area population, and 15% of patients in the ED with a long education compared to 21% in the catchment area population[47]. This tendency has also been shown in large retrospective register-studies from France and Ireland[23,48]. The findings of evenly distributed comorbidities across SES before and after the organisational intervention in our study support the presumption that the social gradient in acute ED hospitalisations is explained by the socially unequal distribution of the disease burden in society and not related to ED staffing.

Strengths and limitations

A strength of this study lies in the use of retrospective national register data with individual patient data on hospital admissions, diagnoses, employment status, educational level, and mortality, and no loss to follow-up. Another strength is the fact that the complex intervention took place in real life and with a patient population representative of the EDs in Denmark.

Nonetheless, the study does have some limitations. The cohort was not designed for the purpose of this study. Using the availability of standard admission blood tests as the selection criteria to identify admitted ED patients may have resulted in a risk of missing very short hospital stays with discharge before the blood sample was given or patients who for whatever reason did not have their blood samples analysed. This problem should, however, be equally present in both control and intervention cohorts. Another limitation is the use of diagnoses as a proxy for discharge by ED consultants or consultants from Department of Infectious Diseases. The interpretation of reduced LOS is limited by the fact that we cannot definitively identify the extent of the reduction which can be attributed to a specific part of the ED stay, as the data does not permit us to separate the time waiting from the time receiving medical care. Notably, our study only investigated the distribution of the outcome across three levels of SES and thus any relation between the unemployment patient group and subgroups, e.g., homeless patients, drug users, or immigrants, who potentially could benefit from a longer LOS, is not assessed in this study.

Conclusion

The employment of Acute Medical Consultants at the ED was associated with reduced LOS without affecting in-hospital mortality, readmission, or mortality within 90 days after discharge. No impact of patients' SES was found on the quality of care measures, either before or after the organisational intervention at the ED, which may indicate a focus on social equity in the quality of care at this ED. This study may inform health care planners in their choice of organisational designs that can meet some of the challenges faced in an acute setting via enhancement of the efficiency of the acute services without loss of effectiveness.

List Of Abbreviations

AMU = Acute Medical Unit

CI = Confidence interval

ED = Emergency Department

HR = Hazard ratio

IQR = Interquartile range

LOS = Length of Stay

OR = Odds ratio

SES = Socioeconomic Status

References

1.Bernstein, S. L. *et al.* The effect of emergency department crowding on clinically oriented outcomes. *Acad. Emerg. Med. Off. J. Soc. Acad. Emerg. Med. 16,* 1–10 (2009).

2.Baier, N. *et al.* Emergency and urgent care systems in Australia, Denmark, England, France, Germany and the Netherlands—Analyzing organization, payment and reforms. *Health Policy 123,* 1–10 (2019).

3.Boyle, A., Fuld, J., Ahmed, V., Bennett, T. & Robinson, S. Does integrated emergency care reduce mortality and non-elective admissions? A retrospective analysis. *Emerg. Med. J. EMJ 29,* 208–212 (2012).

4.*Enhanced emergency health service—recommendations for regional planning.* (Danish Health Authority, 2007).

5.Lau, C. *et al. The Health Profile 2017 for the Capital Region and municipalities: Health Behaviour and Risk Factors.* https://www.frederiksberghospital.dk/ckff/sektioner/SSF/sundhedsprofilen/Documents/Sundhedsprofil%202017/Sundhedsprofil_2017_Sundhedsadf%c3%a6 (2018).

6.Hvidberg, M. F., Johnsen, S. P., Davidsen, M. & Ehlers, L. A Nationwide Study of Prevalence Rates and Characteristics of 199 Chronic Conditions in Denmark. *PharmacoEconomics - Open* (2019) doi:10.1007/s41669–019–0167–7.

7.Lau, C. *et al. The Health Profile 2013 for the Capital Region and municipalities: Chronic Disease.* https://www.frederiksberghospital.dk/ckff/sektioner/SSF/sundhedsprofilen/Documents/Sundhedsprofil%202013/Sundhedsprofil%202013%20-%20Kronisk%20sygdom.pdf (2015).

8.Aldridge, C. *et al.* Weekend specialist intensity and admission mortality in acute hospital trusts in England: a cross-sectional study. *The Lancet 388,* 178–186 (2016).

9.Sen, A. *et al.* The impact of consultant delivered service in emergency medicine: the Wrexham Model. *Emerg. Med. J. EMJ 29,* 366–371 (2012).

10.Christmas, E., Johnson, I. & Locker, T. The impact of 24 h consultant shop floor presence on emergency department performance: a natural experiment. *Emerg. Med. J. EMJ 30,* 360–362 (2013).

11.White, A. L., Armstrong, P. A. R. & Thakore, S. Impact of senior clinical review on patient disposition from the emergency department. *Emerg. Med. J. EMJ 27,* 262–265, 296 (2010).

12.Elder, E., Johnston, A. N. B. & Crilly, J. Improving emergency department throughput: An outcomes evaluation of two additional models of care. *Int. Emerg. Nurs. 25,* 19–26 (2016).

13.Leong, K. *et al.* A retrospective study of seven-day consultant working: reductions in mortality and length of stay. *J. R. Coll. Physicians Edinb. 45,* 261–267 (2015).

14.Imison, C. The reconfiguration of hospital services: is there evidence to guide us? *Future Hosp. J. 2,* 137–141 (2015).

15.Reid, L. E. M. *et al.* The effectiveness and variation of acute medical units: a systematic review. *Int. J. Qual. Health Care J. Int. Soc. Qual. Health Care 28,* 433–446 (2016).

16.Strøm, C. *et al.* Hospitalisation in short-stay units for adults with internal medicine diseases and conditions. *Cochrane Database Syst. Rev. 8,* CD012370 (2018).

17.Bell, D., Lambourne, A., Percival, F., Laverty, A. A. & Ward, D. K. Consultant Input in Acute Medical Admissions and Patient Outcomes in Hospitals in England: A Multivariate Analysis. *PLOS ONE 8,* e61476 (2013).

18.Moellekaer, A. *et al.* Risk of death within 7 days of discharge from emergency departments with different organizational models. *Eur. J. Emerg. Med. Publish Ahead of Print,* (2019).

19.Wilson, H. *et al.* Readmission rates of older patients (age >75 years) discharged within 48 hours of admission to the Acute Medical Unit, Norwich: observational study. *Future Hosp. J. 1,* 23–25 (2014).

20.McNeill, G., Brahmbhatt, D. H., Prevost, A. T. & Trepte, N. J. B. What is the effect of a consultant presence in an acute medical unit? *Clin. Med. Lond. Engl. 9,* 214–218 (2009).

21.Gulliford, M. *et al.* What does 'access to health care' mean? *J. Health Serv. Res. Policy 7,* 186–188 (2002).

22.van Doorslaer, E. *et al.* Equity in the delivery of health care in Europe and the US. *J. Health Econ. 19,* 553–583 (2000).

23.Cournane, S. *et al.* Social deprivation and hospital admission rates, length of stay and readmissions in emergency medical admissions. *Eur. J. Intern. Med. 26,* 766–771 (2015).

24.Adler, N. E. *et al.* Socioeconomic status and health: The challenge of the gradient. *Am. Psychol. 49,* 15–24 (1994).

25.The Danish Ministry of Health, The Danish Ministry of Finance, The Danish Ministry of Economic Affairs and the Interior, Danish Regions & KL. *Insight into the results of the healthcare system 2016.* (2016).

26.Quan, H. *et al.* Updating and validating the Charlson comorbidity index and score for risk adjustment in hospital discharge abstracts using data from 6 countries. *Am. J. Epidemiol. 173,* 676–682 (2011).

27.Thygesen, S. K., Christiansen, C. F., Christensen, S., Lash, T. L. & Sørensen, H. T. The predictive value of ICD–10 diagnostic coding used to assess Charlson comorbidity index conditions in the population-based Danish National Registry of Patients. *BMC Med. Res. Methodol. 11,* 83 (2011).

28.Haupt, T. *et al.* Plasma suPAR levels are associated with mortality, admission time, and Charlson Comorbidity Index in the acutely admitted medical patient: a prospective observational study. *Crit. Care 16,* R130 (2012).

29.Jensen, V. M. & Rasmussen, A. W. Danish education registers. *Scand. J. Public Health 39,* 91–94 (2011).

30.Petersson, F., Baadsgaard, M. & Thygesen, L. C. Danish registers on personal labour market affiliation. *Scand. J. Public Health 39,* 95–98 (2011).

31.Johansen, N. *et al. The Health Profile 2017 for the Capital Region and municipalities: Chronic Diseases.* (2018).

32.Andersen, P. K., Borgan, O., Gill, R. D. & Keiding, N. *Statistical Models Based on Counting Processes.* (Springer-Verlag, 1993).

33.Gray, R. J. A Class of K-Sample Tests for Comparing the Cumulative Incidence of a Competing Risk. *Ann. Stat. 16,* 1141–1154 (1988).

34.Lin, D. Y., Wei, L. J. & Ying, Z. Checking the Cox Model with Cumulative Sums of Martingale-Based Residuals. *Biometrika 80,* 557–572 (1993).

35.Juul-Larsen, H. G., Petersen, J., Sivertsen, D. M. & Andersen, O. Prevalence and overlap of Disease Management Program diseases in older hospitalized patients. *Eur. J. Ageing* 1–11 (2017) doi:10.1007/s10433–017–0412–9.

36.R Core Team. *R: A language and environment for statistical computing.* (R Foundation for Statistical Computing, 2015).

37.Goldman, R. D., Ong, M. & Macpherson, A. Unscheduled Return Visits to the Pediatric Emergency Department-One-Year Experience: *Pediatr. Emerg. Care 22,* 545–549 (2006).

38.Lehn, S. F., Zwisler, A.-D., Pedersen, S. G. H., Gjørup, T. & Thygesen, L. C. Development of a prediction model for 30-day acute readmissions among older medical patients: the influence of social factors along with other patient-specific and organisational factors. *BMJ Open Qual. 8,* e000544 (2019).

39.Conway, R., O'Riordan, D. & Silke, B. Consultant experience as a determinant of outcomes in emergency medical admissions. *Eur. J. Intern. Med. 25,* 151–155 (2014).

40.Li, C.-J. *et al.* The Impact of Emergency Physician Seniority on Clinical Efficiency, Emergency Department Resource Use, Patient Outcomes, and Disposition Accuracy: *Medicine (Baltimore) 95,* e2706 (2016).

41.Alfaraj, S. Z. & Pines, J. M. What we can learn from Medicare data on early deaths after emergency department discharge. *J. Thorac. Dis. 9,* 1752–1755 (2017).

42.Galipeau, J. *et al.* Effectiveness and safety of short-stay units in the emergency department: a systematic review. *Acad. Emerg. Med. Off. J. Soc. Acad. Emerg. Med. 22,* 893–907 (2015).

43.Frølich, A., Ghith, N., Schiøtz, M., Jacobsen, R. & Stockmarr, A. Multimorbidity and healthcare utilization: A register-based study in Denmark. *bioRxiv* 574293 (2019) doi:10.1101/574293.

44.Marmot, M. G. *Status Syndrome: How Your Social Standing Directly Affects Your Health and Life Expectancy.* (Bloomsbury Publishing PLC, 2004).

45.Ministeriet for Sundhed og Forebyggelse, Statens Serum Institut, Danmark & Sundhedsstyrelsen. *Ulighed i sundhed - kroniske og langvarige sygdomme.* (Ministeriet for Sundhed og Forebyggelse, 2014).

46.Conway, R., Galvin, S., Coveney, S., O'Riordan, D. & Silke, B. Deprivation as an outcome determinant in emergency medical admissions. *QJM Mon. J. Assoc. Physicians 106,* 245–251 (2013).

47.Statistikbanken. *Befolkningens højeste fuldførte uddannelse (15–69 år)* (2016).

48.Colineaux, H. *et al.* Is the use of emergency departments socially patterned? *Int. J. Public Health 63,* 397–407 (2018).

Declarations

Ethics approval and consent to participate

The study was approved by the Danish Health and Medicines Authority: Amendment to approval 3-3013-1061/1, Danish Data Protection Agency: HVH-2014-018 (I-Suite nr: 02767) and The Danish Patient Safety Authority (FSEID-00002943). There was no need of approval from the National Committee on Health Research Ethics since only registries were used.

Consent for publication

Not applicable

Availability of data and material

The data that support the findings of this study are available from Statistics Denmark but restrictions apply to the availability of these data, which were used under license for the current study, and therefore they are not publicly available.

Competing interests

The authors declare that they have no competing interests

Funding

LJHR was supported by a postdoctoral fellowship through grant R288-2018-380 from the Lundbeck Foundation.

Authors' contributions

ML, OA, and SSJ has contributed to the conception of the study. ML and LJHR have performed data collection and data management. ML, TK, and SR have carried out the analysis. All authors contributed with interpretation of data, critically revision of the manuscript, and read and approved the final version.

Acknowledgements

The authors wish to acknowledge the former and present management of the Emergency Department, Hvidovre Hospital, for their help with describing the organisational setting prior and after employment of Acute Medical Consultants.

Figures

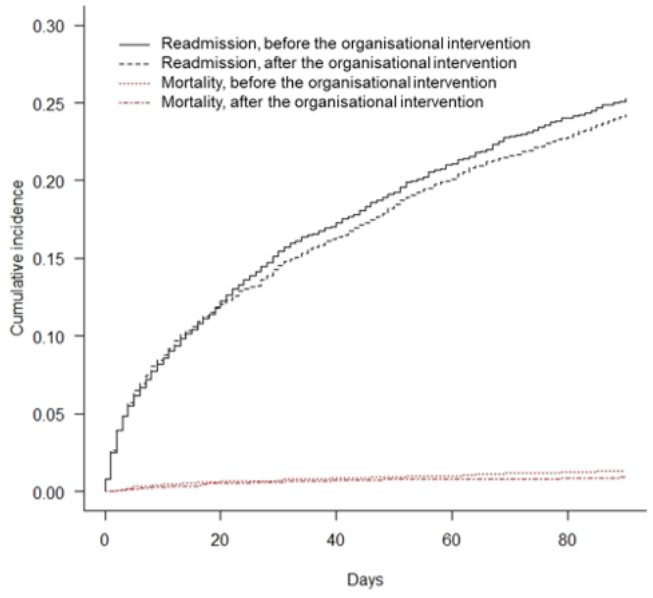

Figure 1

Cumulative incidence of readmission with death as competing risk before and after the organisational intervention in the ED including the employment of Acute Medical Consultants

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Additionalfile5Inhospitalmortality.docx
- Additionalfile6Mortalityupto90days.docx