

# Reinforcement of emergency department reduces acute admissions to medical department

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## ABSTRACT

**INTRODUCTION:** The medical decision capacity of emergency departments (ED) may rest within the department itself or depend on external consultation. The stepwise development of the ED at Zealand University Hospital, Køge, was used to analyse the influence of medical organisation in the ED on the hospital admission pattern.

**METHODS:** Data were recorded for the month of September of 2009, 2012 and 2014. These periods corresponded to the establishment of the department in 2009 and the 2012-period before organisational change was initiated in 2013, with a substantial increase in the number of senior physicians directly in charge of clinical decisions and the establishment of a limited bedding capacity. In 2014, the changes had been fully implemented. We analysed the number of patients admitted and their length of stay (LOS) in the ED and in the Department of Internal Medicine (DoM). The 30-day readmission and mortality rates were used as quality indicators.

**RESULTS:** A total of 1,106, 1,354 and 1,470 patients were admitted to the ED in 2009, 2012 and 2014, respectively. In 2009 and 2012, 42% of the patients were admitted to the DoM. In 2014, only 22% were admitted. The mean LOS for long-term admission at the DoM increased by 1.4 days from 2009 to 2014. Readmission and mortality rates did not change in three periods analysed.

**CONCLUSION:** Independent medical decision capacity and bed resources in the ED effectively change hospital logistics and reduce the number of admissions without negatively affecting patient safety in terms of readmission or short-term mortality.

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In 2007, the Danish Health Authority recommended reducing the number of hospitals providing emergency care [1]. Concurrently, the recommendation specified a number of requirements for a hospital to provide emergency care. As no specific recommendations were made in regard to the internal organisation of such hospitals, a number of Accident & Emergency solutions have been devised ranging from organisations with no independent medical staff to departments that are fully and independently medically staffed. In 2009, the Emergency Department (ED) at Zealand University Hospital, Køge, was

established. Junior physicians constitute the majority of the medical staff. The beginning of 2013 saw a substantial expansion of the department both in terms of senior medical staff directly involved in patient management and in the opening of a short-stay unit (SSU). Subsequently, the medical admissions ward at the Department of Internal Medicine (DoM) was closed in early 2014.

The purpose of the present study was to analyse the effect of the aforementioned developments in the structure of the ED on both the number of admissions and the length of stay (LOS) of patients admitted to the DoM. To control for quality of care, the 30-day re-admission and 30-day mortality rates were used as quality indicators. Three points in time were chosen for the study. September 2009 served as baseline and this baseline coincided with the establishment of the ED. September 2012 served as a status measurement prior to the expansion including senior medical staff and introducing a short stay unit, and in September 2014 we measured the effect of the expansion.

## METHODS

The study was approved by the Danish Data Protection Agency under the Regional Research Unit in Region Zealand (approval no. REG-65-2015).

For the months of September 2009, September 2012 and September 2014, patients admitted to the ED and the DoM were identified through the electronic admissions registry. A registry search was performed in the autumn of 2014. For each patient, the following information was available:

- Age at the time of admission
- Gender
- Date and time of admission and discharge
- Mode of discharge; i.e. whether patients were discharged to their home or transferred for further treatment at another department/institution
- Resident municipality (if the patient remained alive at the time of registry search).

LOS was calculated from dates and times of admission and discharge. To control for the effect of the closure of the admissions ward at the DoM in early 2014, the mean

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LOS was calculated for the total number of patients admitted to the DoM as well as for patients admitted for a period of time exceeding 24 hours.

To detect any bias in terms of dissimilarity of the admitted populations of patients over the three selected periods of time, the following parameters were analysed:

- Age: The age profile of the admitted patients was plotted as a percentage distribution in a clustered column chart using Microsoft Excel.
- Gender: The gender ratio was calculated.
- Municipality of residence: The distribution of the patients in terms of municipality of residence was plotted as a 100% stacked column chart using Microsoft Excel.
- The number and mean age of the inhabitants in the respective municipalities making up the catchment area for the ED was obtained for the years 2009, 2012 and 2014 from Statistics Denmark.

As quality indicators for evaluation of the clinical performance at the ED, the 30-day readmission rate and the 30-day mortality rate were calculated. For analysis of the 30-

day readmission rate, the patients discharged directly to their home from the ED were cross-referenced with admissions for September and October for the respective years. Re-admitted cases were assessed retrospectively by two of the authors (JHS and GE) to establish whether re-admittance could be related to the index admission. For analysis of 30-day mortality, patients admitted to the ED were cross-referenced with mortality records from Region Zealand for September and October of the respective years. The mortality rate was calculated for the population of patients admitted to the ED as a whole as well as for patients discharged to their home from the ED.

### Statistics

Differences in age and LOS were analysed using Student's t-test. Differences in the number of patients admitted to the DoM compared with patients discharged to their home were analysed using the chi-squared test. This test was also used to test for differences in re-admission rate and mortality rates. A probability value of less than 0.05 was considered statistically significant. For multiple tests, the p-value was adjusted according to the Bonferroni method.

*Trial registration:* not relevant.

FIGURE 1

**A.** Bar chart showing the age distribution of the patients admitted to the Emergency Department over the three periods of study (the month of September for 2009, 2012 and 2014). A successive rightward shift in the age distribution over the three periods in question is noticed.

**B.** Stacked bar chart showing the disposition of the patients admitted to the Emergency Department (exact figures quoted in the results section).

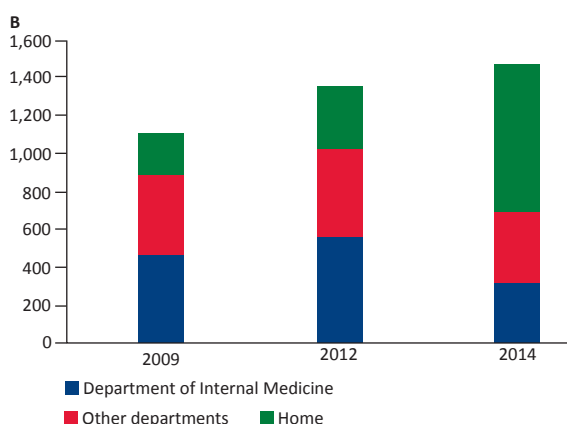
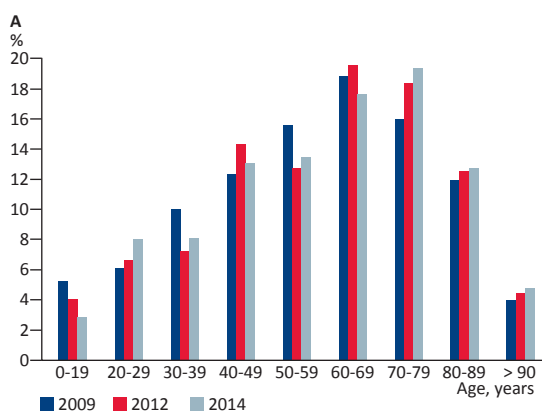
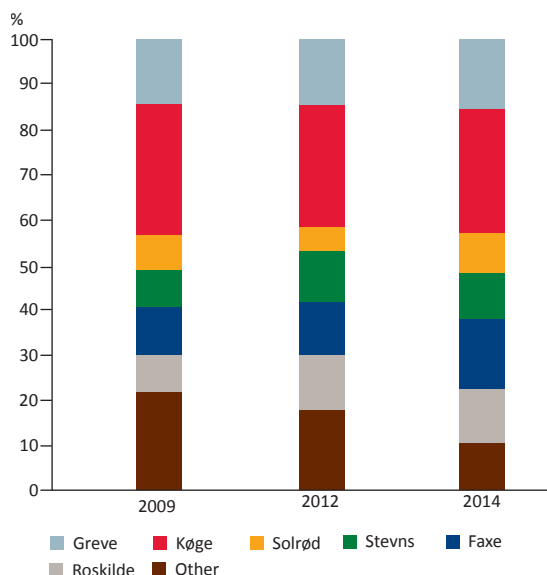


FIGURE 2

Stacked 100% bar chart showing the municipality of residence of the patients admitted to the Emergency Department. This information was available for patients who were alive at the time of the registry search (Autumn 2014). Hence, data were available for 71%, 80% and 91% of patients for the three periods of study, respectively. Although the indexed form skews data, the stacked 100% bar chart was chosen for reasons of graphical clarity.



## RESULTS

In the years 2009, 2012 and 2014, a total of 1,106, 1,354 and 1,470 patients, respectively, were admitted to the ED. Their mean age was 58 years in 2009 and 60 years in 2012 and 2014. The increase in mean age was statistically significant ( $p < 0.05$ ). The age distribution is shown in **Figure 1A** where it is observed that patients aged 50-59 years were more frequently admitted in 2009 than in 2012 and 2014, whereas patients aged 70-79 years were more frequent in years 2012 and 2014. The percentage of male patients was 47% of in 2009 and 2012, and 48% in 2014. This difference was non-significant.

In 2009, 465 patients (42% of the total number of patients admitted to the ED) were transferred to the DoM for further evaluation, 422 patients (38%) were transferred to other departments, and 219 patients (20%) were discharged to their home, either for further care by their general practitioner or referred for specialist evaluation in out-patient clinics. In 2012, the same figures were 566 (42%), 464 (34%) and 324 patients (24%), respectively. In 2014, the figures were 324 (22%), 376 (26%) and 770 patients (52%), respectively. These data are summarised in **Figure 1B**. The reduction in admittance to the DoM between 2012 and 2014 was highly statistically significant with a p-value below 0.0001. The number of patients from the ED who were admitted to the DoM for more than 24 hours was 298 (corresponding to 27% of the total number of patients admitted to the ED) in 2009. The corresponding numbers were 359 (27%) patients in 2012 and 248 (17%) in 2014.

LOS for patients referred to the DoM from the ED was 3.7 days in 2009, 4.1 days in 2012 and 5.9 days in 2014. The increase in LOS between 2012 and 2014 and between 2009 and 2014 was statistically significant ( $p < 0.001$ ). Excluding patients staying less than 24 hours, LOS was 5.4 days in 2009, 6.1 days in 2012 and 6.8 days in 2014. The increase in LOS for patients admitted to the DoM for more than 24 hours did not reach statistical significance. LOS in the ED was 2.3 hours in 2009, 3.4 hours in 2012 and 9.5 hours in 2014.

The re-admission rate to the ED within 30 days of discharge to home did not change between the three time periods. In 2009, 24 out of 183 patients discharged home from the ED were re-admitted within 30 days of discharge corresponding to 13%. In 2012 the same figures were 37 out of 279 patients (13%), and in 2014 the figures were 93 out of 632 patients (15%). These differences did not reach statistical significance. The proportion of re-admittances that could be related to the index admission was 67%, 70% and 69% for the three periods of time, respectively.

The 30-day standard mortality for all the patients admitted to the ED was 43 per 1,000 patients in 2009, 44 per 1,000 patients in 2012 and 39 per 1,000 patients



Examining a patient upon arrival at the Emergency Department.

in 2014. For patients discharged to their home from the ED, the standard mortality rates were 22, 25 and 24 per 1,000 patients, respectively. These differences did not reach statistical significance.

The municipalities making up the catchment area for the ED were Greve, Solrød, Køge, Stevns, Faxe and Roskilde. The total population of these municipalities was 264,478 in 2009, 266,717 in 2012 and 270,364 in 2014. The mean age of the population in the catchment area was 40.2 years in 2009, 41.0 years in 2012 and 41.6 years in 2014.

The resident municipality was available for 71% of the patients in 2009, 80% of the patients in 2012 and 91% of the patients in 2014. **Figure 2** shows a 100% stacked column chart displaying the distribution of patients in terms of municipality of residence.

## DISCUSSION

The data show the profound impact that an ED can have on hospital logistics. Over the years 2009 to 2014, the number of admittances to the DoM was reduced by 30% despite a 33% increase in the total number of admittances to the ED. This occurred without an increase in re-admittance rate or an increase in short-term mortality. The activity of the ED was studied at three different points in time which were marked by significant changes in the organisation of the department. Møllekær et al have described the different ways of organising EDs in Denmark [2]. In brief, they describe four different types of organisation; an embedded model where specialised hospital departments have individual emergency clinics, a virtual model where the department has organisational and nursing staff whereas physicians are provided by specialised hospital departments, a hybrid model with some independent clinical decision-making supported by specialised hospital departments, and finally an inde-

FIGURE 3

Summary of the four types of organisation of emergency departments in Denmark depicting the relation between personnel organisation and the carrier of responsibility for patient treatment in the emergency department (figure adopted with kind permission of Dr Anders Møllekær [2]).

MODEL	EMBEDDED	VIRTUAL	HYBRID	INDEPENDENT
<b>Personel</b>	Staffed by nurses as well as junior and senior physicians	Nurses and administrative staff	Nurses, administrative staff and a small group of permanent senior physicians	Staffed by nurses as well as junior and senior physicians
<b>Patient management</b>	Physicians from specialised medical department	Physicians from specialised medical departments	Physicians from emergency dept. and specialised medical departments	Physicians from the emergency department
<b>Clinical responsibility</b>	Specialised medical department	Specialised medical department	Specialised medical department	Emergency department
<b>Focus</b>	Diseases particular to speciality in question	Diseases particular to speciality in question	Oriented towards flow. Wide spectrum of disease	Oriented towards flow. Wide spectrum of disease

pendent model where the department is staffed by senior medical staff also responsible for clinical decision-making (Figure 3). When the ED in Køge was established in 2009, it was organised according to the hybrid model. In 2012, the organisation of the department was essentially unchanged. This is reflected by the fact that the proportion of patients admitted to the DoM was similar to the proportion of patients admitted in 2009. Through the changes introduced in the organisation of the ED in 2013, with employment of senior medical staff responsible for clinical decisions and establishment of an SSU, the department moved from the hybrid model to the independent model. The radical effect of this change of the organisation on hospital logistics was clearly seen in 2014, where – relative to 2012 – admissions to the DoM were reduced by 47%, admissions to other departments by 25% and discharge to the patients' home or referral for out-patient evaluation rose by 119%. LOS for patients referred to the DoM increased by 26%, probably reflecting an increased selection of patients in need of longer term admission. These changes occurred without any change in the 30-day re-admission rate or 30-day mortality of patients admitted to and discharged to their home from the ED. In sum, we conclude that the organisational changes improved the 'gatekeeper' function of the ED, allowing for better discrimination between patients in need of ward admission and those who could

be handled appropriately in a primary care or outpatient setting. However, our data do not allow us to perform a cost-benefit analysis to determine if the changes also carried financial benefits.

The conclusions presuppose a similar case mix in all three periods. As a surrogate measure for similarity, demographic data were obtained for the department's catchment area. The demographic situation was not completely stable; there was a slight increase in population as well as an increase in the mean age of the population. In 2010, Faxe hospital, a small community hospital, closed down. This explains the jump from approximately 1,100 patients per month to approximately 1,400 patients per month. This is represented by the relative increase in patients from Faxe and Stevn. Whilst admissions from the municipalities of Køge, Greve and Solrød remained stable, accounting for approximately 50% of the patients, the proportion of patients from outside the catchment area diminished during the three periods in question. Taken together, the increased mean age of the population and the reduction in patients from outside the catchment area would suggest a higher degree of morbidity among patients being admitted to the ED in Køge. The demographic changes observed therefore do not suggest bias that would invalidate our conclusions.

Mortality is a so-called hard-core end point. The

choice of this end point is based both on the fact that it may be applied broadly over the spectrum of cases covered in an ED and that it may actually be appreciated from statistical records.

Short-stay units were introduced some four decades ago to cater for distinct groups of patients, e.g. surgical or paediatric patients [3, 4]. In the late 1980s and early 1990s, the concept was also adopted by EDs. However, the use of such units is subject to wide variation concerning both acceptable LOS and the types of patients that are to be admitted to the SSU. This evidently precludes any generalised statement about SSUs. A study from 2000 described the establishment of a hospital-run SSU in relation to emergency admission focussing on the benefits to be gained from short-term admission of patients with discharge diagnoses such as chronic obstructive lung disease, pneumonia, congestive heart failure, urinary tract infection and cellulitis [5]. A review from 2011 concluded that for comparable conditions SSUs lead to shorter stay than ordinary wards [6]. However, Burkhardt et al argue that patients admitted to stationary wards may not be compared with patients admitted to SSU's since admittance to stationary wards is never a random decision, but based on the individual patient's needs [7]. Moreover, a study from 2014 did not find that an SSU stay for the undifferentiated medical patient itself carried any benefit in terms of bed capacity [8]. The present data do not allow for any independent evaluation of the effect of a SSU since employment of senior medical staff to substantiate clinical decision-making as well as the opening of the SSU occurred simultaneously. In our hands, the SSU was used for short-term diagnostic observation, initiation of treatment of common infectious diseases, or for the holding of a patient for definite daytime transferral to an off-premises specialised department.

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