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SPECIAL ARTICLE

Analysing completion times in an academic emergency department: coordination of care is the weakest link

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ABSTRACT

Congestion with prolonged stay in the emergency department (ED) is associated with poor health outcomes. Many factors contribute to ED congestion.

This study investigates the length of time spent in the ED (time to completion) and the factors contributing to prolonged stay in an academic ED. Data of ED patients were prospectively collected during four weeks in February 2010. Presentation time, referrer, discharge destination, and medical specialities involved were registered in 2510 patients. Additional detailed data about relevant time steps were collected from 66 patients in the triage category *Emergency Severity Index (ESI)* 3. The Pearson's chi-square test and the Mann-Whitney test were used for statistical analysis.

Time to completion was longer than four hours in 13% of patients (average in total population 2:23 hours). In ESI 3 patients, 24% stayed longer than four hours in the ED (p<0.001). Internal medicine had most patients exceeding the four-hour target (37%), followed by neurology (29%). Undergoing a CT scan, treatment by multiple specialities, age above 65 years and hospital admission were associated with exceeding the four-hour target (p<0.001). The elapsed time between receiving test results and admission/discharge also influenced the completion time (p<0.001).

A significant percentage of vulnerable and ill patients with triage category ESI 3 exceeded the four-hour completion time in our ED. Absence of coordination of care when multiple specialists were involved and delay in the process of decision-making after completion of all diagnostics on the ED were among other factors responsible for this prolonged stay. Improving the coordination of care will, in our opinion, speed up the decision-making process and lead to shortening of completion times in many patients.

KEYWORDS

Completion time, decision-making, emergency department, four-hour target length of stay.

INTRODUCTION

In the past, increased congestion with long waiting times in emergency departments (EDs) in the United Kingdom (UK) was frequently noticed.[1] With the aim of reducing this congestion, the National Health Service in the UK set a target which prescribed that all patients presenting at the ED should be examined, treated, admitted or discharged (time to completion) in less than four hours.[2] This resulted in a tremendous improvement in the time to completion. Although congestion with long waiting times is frequently noticed in some EDs in the Netherlands, no target for time to completion is defined or enforced. In our opinion, it is preferable to keep the length of stay at the ED short, in order to transfer patients to a stable and a safe environment as soon as possible. It has been demonstrated that the length of stay at the ED is associated with high risk of morbidity and mortality, preventable medical errors, poor pain control, longer hospital stay and decreased patient satisfaction.[3-12] At the VU University Medical Centre (VUmc) Amsterdam, an academic tertiary care centre, it was noticed that in the past years the time to completion exceeded four hours in many patients. However, reasons for these delays were unclear and the exact percentage of patients spending more than four hours in the ED was unknown.

Therefore, in November 2009 we started a project to analyse ED congestion. The primary goal of this study was to measure the time to completion of the patients

presenting at the ED and to detect which factors and processes contribute to a longer completion time. A secondary goal of the project was to indentify methods to improve the time to completion and prevent excesses.

METHODS

The study was performed at the VU University Medical Centre, an academic, urban, Level I trauma centre. There are approximately 35,000 ED visits per year of which 65% are patients who presented themselves without a referral. These patients are first seen by the emergency physicians. Referred patients are seen by the residents of various specialities under supervision of a specialist. One qualified emergency physician, four emergency medicine trainees and six non-trainee doctors worked at the ED during the study. The trainees and non-trainees were either supervised by an emergency physician or a senior surgeon. During four weeks in February 2010, data were collected from all patients presenting at the ED. A computer system called 'Medical Office Data' was used to extract data including: the moment of presentation/registration, referrer, discharge destination, and the main medical speciality involved in the care of the patient. Triage level and discharge time were obtained by paper forms filled out by nurses for all patients.
In addition, a researcher followed a selected group of patients to collect more detailed data about relevant timestamps in the ED process, which were not registered in the Medical Office programme. These data included the moment a doctor visited the patient, the moment blood or urine samples were taken, the moment laboratory results were received at the ED, and the moment a patient was picked up and brought back from an imaging study.

The Boston triage system (ESI) was used in the ED to indentify patients from ESI level 1 (highest acuteness) to ESI level 5 (lowest acuteness).[13] The researcher followed patients with triage category *Emergency Severity Index* 3 on weekdays from approximately 12.00 hours until 20.00 hours, because earlier data showed that this was the busiest time of the day, and that ESI 3 patients had longer completion times. This additional data collection lasted three weeks in February 2010 and provided a subgroup of 66 patients.

DEFINITIONS

Door-to-doctor time

We defined *door-to-doctor time* as the time that elapsed between registration and the first visit of a physician. Triage and the waiting time for a doctor are part of the *door-to-doctor time*.

Diagnostic tests

To get some insight into the role of diagnostic tests in the length of the ED stay, we divided the total time spent at the ED in three subprocesses.

- Prediagnostic tests: Time from arrival at the ED until the first request for a diagnostic test. For example: taking a blood sample and sending it to the laboratory, a request for an X-ray or CT scan, or a request for any other kind of diagnostic test.
- Diagnostic tests: Time between the request for the first diagnostic test until the results of the last diagnostic test are available. This also includes waiting times between different diagnostic tests.
- Time after diagnostic tests: Time from the last result of the diagnostic tests until discharge.

PRIMARY DATA ANALYSIS

The patients were split into two groups: the patients who had a time to completion of shorter than four hours and the patients who spent longer than four hours at the ED. In addition, factors and processes that contributed to a longer time to completion were identified. For categorical factors, such as triage category and medical speciality, contingency tables were used. In every contingency table this division of patients is set against a categorical patient factor. For statistical analysis, the Pearson's chi-square test was used. If the p value was smaller than 0.05, the null hypothesis was rejected. For subprocesses, such as *door-to-doctor time*, the time intervals were analysed. To calculate the time interval of a process, the data of the followed subgroup (n=66) were mainly used for these analyses. The time intervals of various processes were compared between patients who exceeded the four-hour target and the patients whose completion time was within four hours. The Mann-Whitney test was used for statistical analysis of these processes.

RESULTS

Time to completion (n=2510)

In February 2010, 84% of the patients had a time to completion of less than four hours. Another 13% of the patients had a time to completion longer than four hours. Completion time data were not available for the remaining 3% of the patients. The average time to completion was 2:23 hours, the median was 2:01 hours. *Figure 1* depicts the distribution of the time to completion. The largest group of patients had a completion time between one and two hours, while the longest measured time to completion exceeded 13 hours.

Figure 1. *Distribution completion time; n = 2444*

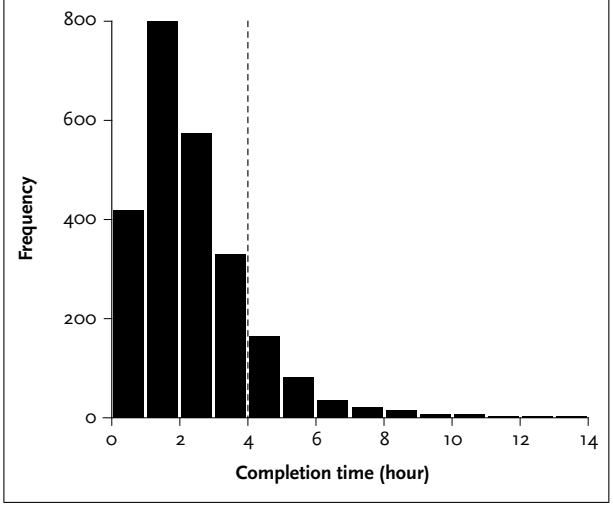
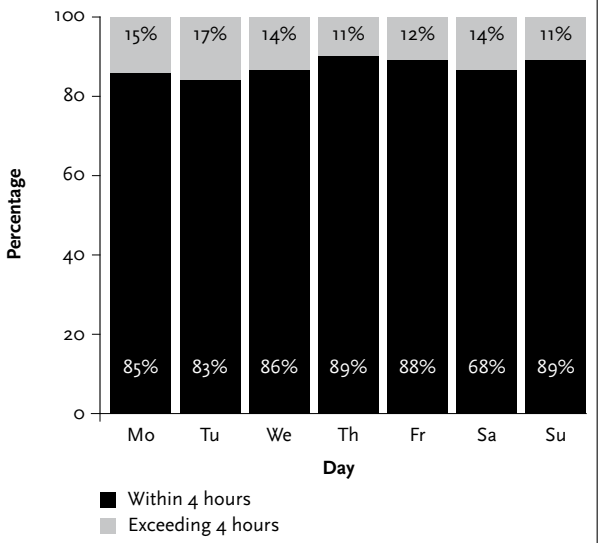


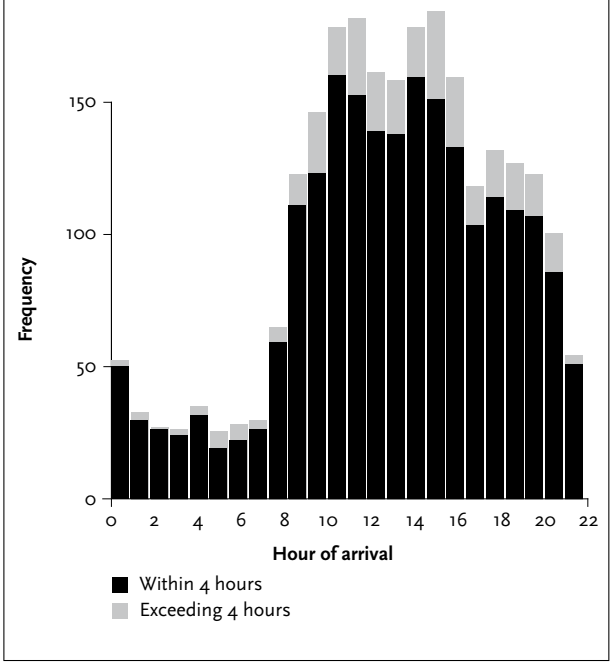
Figure 3. *Realisation of the four-hour target per day of the week; n = 2444*



Arrival pattern (n=2444)

Most patients in the ED arrived between 09.00 and 22.00 hours (*figure 2*). No association was demonstrated between the arrival time of a patient and the four-hour target, p=0.49. No difference was found in exceeding the four-hour target between ED visits on week or weekend days as shown in *figure 3*, p=0.19.

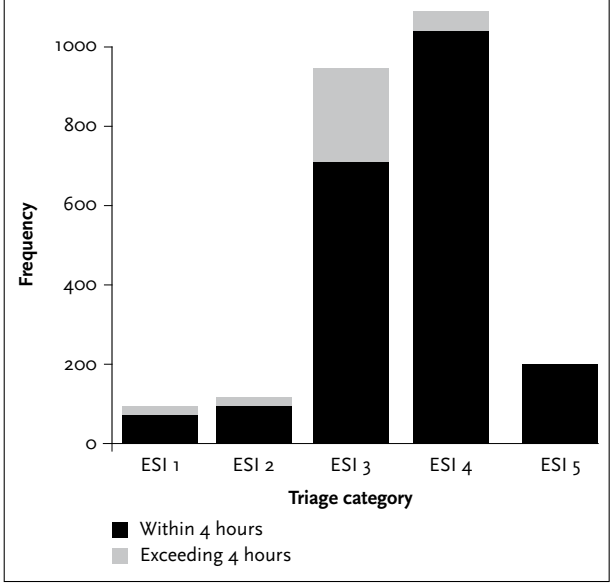
Figure 2. *Barplot arrival pattern of ED patients with a completion time within four hours (dark) and ED patients with a completion time exceeding four hours (light); n = 2444*



Triage (n=2437)

Most patients (45%) were categorised as ESI 4, followed by ESI 3 (39%), as illustrated in *figure 4*. A large percentage of ESI 1, ESI 2, and ESI 3 patients did not achieve the four-hour target (22%, 19%, and 24%) compared with the patients categorised as ESI 4 or ESI 5 (5% and 1%). There was a dependency between the triage level and the

Figure 4. *Barplot triage levels of ED patients with a completion time within four hours (dark) and ED patients with a completion time exceeding four hours (light); n = 2437*

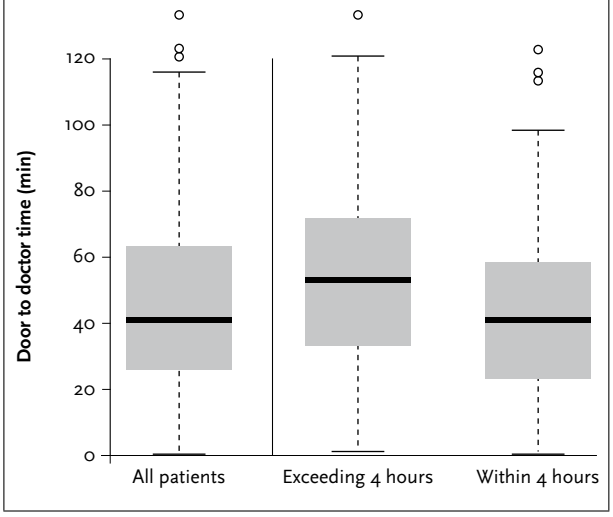


realisation of the four-hour target, p<0.001. In absolute numbers, most patients who had a time to completion longer than four hours were ESI 3 patients.

Door-to-doctor time (n=66)

The average *door-to-doctor time* was 48 minutes. Half of the patients of the followed group had to wait less than 41 minutes for a doctor, as depicted in *figure 5*. The *door-to-doctor time* was not significantly different between patients who did or did not exceed the four-hour target, p=0.37.

Figure 5. *Boxplots of the door to doctor time for all patients (n=66) (left), and the patients with a completion time exceeding (n=15) and within four hours separately (n=51) (right). The bold line in the box of a boxplot represents the 50% percentile (the median). The top of the box represents the 75% percentile and the bottom of the box the 25% percentile*



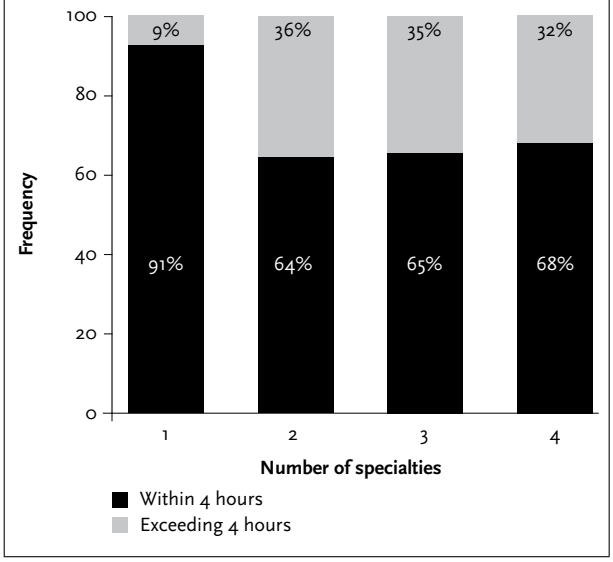
Medical speciality (n=2144)

Most patients were treated by the emergency physicians and 5% of this group had a time to completion longer than four hours. In absolute number and percentage, internal medicine had the most patients exceeding the four-hour target (37%), in percentage followed by neurology (29%) and surgery (28%). There is a dependency between the medical speciality and meeting the four-hour target, p<0.001.

Number of specialities involved (n=2444)

If multiple specialists were involved in the care, patients were more likely to exceed the four-hour target than patients who were treated by only one speciality, p<0.05. This is shown in *figure 6*.

Figure 6. *Number of specialties involved in the care at the ED and realisation of the four-hour target; n = 2444*

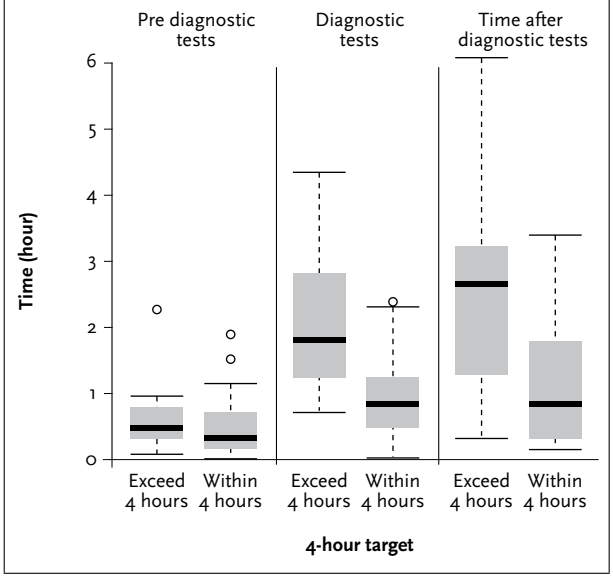


Diagnostic tests (n=66)

The durations of the above-mentioned subprocesses were analysed for the subgroup, and are illustrated in *figure 7*. For 15 of the 66 followed patients, the division in subprocesses could not be made because no diagnostic tests were performed or data were incomplete.

From the three defined subprocesses, the duration of *prediagnostic tests* is the shortest, and the *time after*

Figure 7. *Boxplots of the durations of the sub-processes pre diagnostic tests, diagnostic tests and time after diagnostic tests for the patients with a completion time exceeding four hours (n=14) and within four hours (n =37)*



diagnostic tests is the longest. The medians of the durations of the three subprocesses for all followed patients are 24, 62 and 78 minutes, respectively

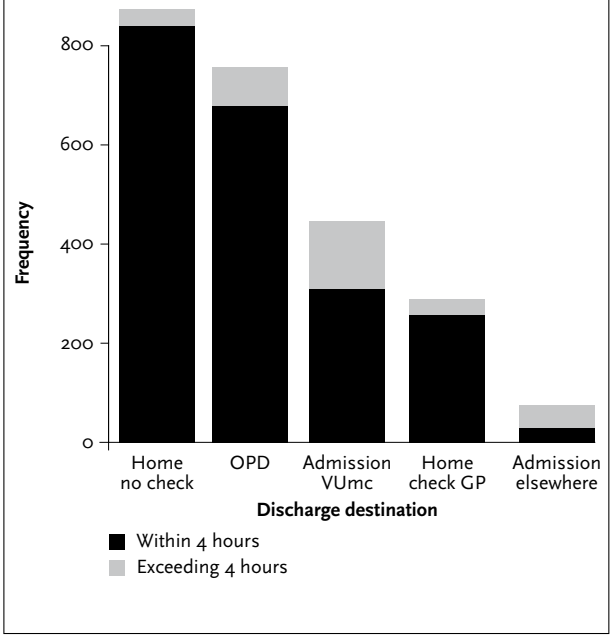
For *prediagnostic tests*, there is no significant difference in the duration for patients who do and do not exceed the target, p=0.23. For the other two subprocesses there is a significant difference in the durations for patients who do and do not exceed the target, p<0.001 and p=0.002, indicating that durations of these subprocesses influence the realization of the four-hour target.

Almost half of the patients at the ED (45%) underwent an X-ray, and 10% of the patients underwent a CT scan. The percentage of patients exceeding the four-hour target is almost the same for patients with and without an X-ray (11% and 16%). However, there is a dependency between undergoing a CT scan and exceeding the four-hour target, p<0.001.

Discharge destination (n=2421)

The largest group of patients is discharged home, with or without further treatment from their general practitioner or at an outpatient department (OPD), as depicted in *figure 8*. From all patients, 18% were admitted to the VUmc and 3% were transferred to another hospital for admission. In patients who were admitted to the VUmc or another hospital, a larger percentage exceeded the four-hour target than patients who were discharged home, p<0.001.

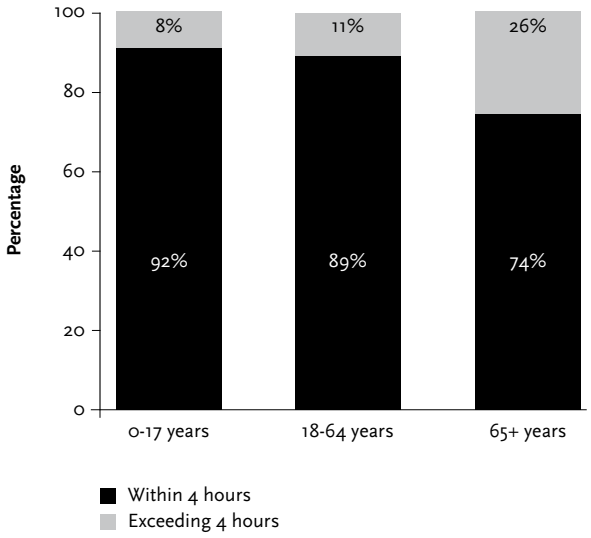
Figure 8. *Barplot of five main discharge destinations of ED patients with a completion time within four hours (dark) and ED patients with a completion time exceeding four hours (light); (n = 2421)*



Age (n=2444)

Compared with the rest, a significantly larger percentage of patients older than 65 years tended to stay in the ED for more than four hours (*figure 9*, p<0.001).

Figure 9. *Realization of the four-hour target per age category (n = 2444)*



DISCUSSION

We demonstrated that 13% of the patients who presented at our ED had a time to completion longer than four hours. However, for patients categorised as ESI 3, this number was 24%. In addition, among the patients treated by internal medicine and neurology departments, 37% and 29% had a time to completion of more than four hours, respectively. Patients aged above 65 years, consultation of multiple specialities on the ED, ESI 3 category and usage of diagnostic tests such as a CT scan were also associated with a higher risk of exceeding the four-hour target. These patients are vulnerable to develop complications during a longer ED stay and therefore in need of effective and timely treatment strategy.

In the UK the four-hour target was introduced to ensure that patients do not wait too long in the ED from arrival to admission or discharge.[14] In 2004, it was decided that 90% of the patients presenting to the ED should achieve this target. This target was raised to 98% in 2005 leading to a dramatic improvement in the congestion at the EDs. However, a spike in discharge or admission of patients during the last 20 minutes of the four hours was noticed, demonstrating that achieving the target had probably become a goal itself.[2] A later study showed that this spike

was still present and even larger than in 2004.[15] After a heated debate the UK government decided to replace the four-hour target with a more balanced list of performance indicators with the aim of reducing the ED congestion and improving the acute care. Although some studies did not demonstrate beneficial effects on the quality of care with the strict enforcement of the target[16] other studies have clearly shown that delays at the ED are associated with a worse prognosis and less patient satisfaction.[17,18] Therefore, total time spent on the ED remains one of the indicators of quality of care in the UK.[19] However, modern practice involves more investigations such as CT scans and more early treatments. As a result a few patients may benefit from a longer period of active treatment in the ED. There is a distinction to be made between unnecessary waiting and active treatment. Therefore, timelines will always remain an important element of any balanced approach to the quality of care. Frequently used measures in the UK to reduce the waiting times in the ED are additional senior doctor hours, creation of a four-hour monitor role, improved access to emergency beds or additional hours for nonclinical staff, junior doctors and nurses. No particular individual measure has been found to be the most important factor; rather it is the number of measures and the amount of effort which leads to improvement of the waiting time spent on the emergency department.[20] Bucheli *et al.* concluded that additional physicians significantly reduced the length of stay of medical emergency department patients.[21]

In our study, although completion time of 84% seems satisfactory, most of the patients who stayed longer than four hours in the ED were old and vulnerable patients belonging to the ESI 3 category. In addition, there were patients who stayed much longer than the expected four hours. Consecutive consultations by different specialists, in patients with complex pathology, was one of the main reasons for these extreme delays. In our study it was evident that when a patient is treated by more than two specialities the chance of exceeding the four-hour target was high. The different specialities tended to work individually and not as a team. With the involvement of multiple specialities the coordination of care was lacking. Therefore, in our opinion different specialities should work as team and see these patients together rather than examining/treating these patients consecutively. We are in the process of introducing 'assessment teams' consisting of emergency physicians, internists, surgeons and a neurologist who will see a patient together with the aim of formulating a diagnostic/treatment plan. Internists or the emergency physicians will coordinate these assessment teams.

We also analysed a few subprocesses in our ED to discover which processes contributed most to a longer time to completion. One of the main findings of this subgroup analysis was that the elapsed time between receiving all diagnostic results and admission/discharge had the biggest influence on the time to completion. In our opinion this is probably due to the delay in decision-making, although this was not tested in our study.

In our opinion, one of the possible causes for this delay in decision-making is that junior doctors treat most of the patients and need time to consult the case with their supervisors. Furthermore, the junior doctor sometimes has to wait before he can proceed because the supervisor is busy with multiple patients. In addition, especially during the night, the junior doctors tend to collect patients before phoning the specialist for advice, so that the specialist would not be disturbed too many times during sleep. Another reason for delay is that it takes time before test results are available, or because the doctor was not aware of the fact that the diagnostic tests have already been performed.

For patients admitted to the hospital, the *time after diagnostic tests* is even longer than for patients who are discharged home. This is probably caused by the limited availability of hospital beds which leads to a time-consuming search for a bed or transfers to other hospitals. Creating an acute medical unit (AMU), observation beds or more inpatient beds may solve this problem.[22,23] Not all AMUs will achieve the same results but numerous studies have shown beneficial effects on length of stay, mortality, readmission rates and lower costs per admission when an AMU is well run.[24] At present there is no AMU at the VUmc but we are planning to open an acute medical unit within a few months.

After the results were known, several measures were introduced in our department to shorten the length of stay on the ED for patients. The measures mainly focussed on improving supervision and coordination. We are in the process of increasing the number of emergency physicians to cover all the shifts 24/7. The working hours of senior doctors in the internal medicine and surgery department on the emergency room have been adjusted to cover the busiest moments at the ED (12.00 hours to 22.00 hours). A study in the UK showed that presence of a consultant might have positive effects on the patient length of stay and decision-making.[25] For this reason, a coordinating physician has been appointed 24/7 and regular time out moments have been created five times a day. During these time outs the head nurse and coordinating physician analyse if queuing or any other logistical problem occurs and if necessary measures are taken to solve these problems as soon as possible. Furthermore, preferential service levels have been agreed with the radiology and other departments. Cases with time to completion of more than four hours are discussed on a regular basis and

structural problems are solved when possible. The number of emergency physicians will be extended in the coming months with the aim of having an emergency physician in the ED during all the shifts. Another strategy to improve health outcomes of acute patients is to start treatment as soon as possible in the ED, for example: administration of antibiotics.[26] Steps have already been taken to implement these measures in our ED. We are planning to investigate the results of all these measures in a following study.

STUDY LIMITATIONS

The period used to collect data covered only four weeks. This means that seasonal influences which can alter the patient population in the ED have not been accounted for. Furthermore, the subgroup analysis is based on a small group of 66 patients. The reason for this relatively small group is that it is time consuming to record all steps in the processes on the ED due to lack of an electronic tracking system. This is a single-centre study, which can influence results due to regional practice variation or because of the chance that a specific doctor is absent during the study period. However, we do not think this was a problem since this is a large hospital with a wide variety of specialities and many specialists. No specific speciality was under-represented during the study.

CONCLUSION

In this cross-sectional study we demonstrated that a significant percentage of vulnerable and ill patients tend to exceed the four hours spent in our ED. The lack of coordination of care in vulnerable patients contributed most to this stagnation. Improving the coordination of care will in our opinion lead to significant reduction in ED queuing.

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