What are we waiting for? Factors influencing completion times in an academic and peripheral emergency department

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Factors influencing completion times in an academic and peripheral emergency department

I.L. Vegting[1], N. Alam[1], K. Ghanes[2,3], O. Jouini[2,3] F. Mulder[1], M. Vreeburg[4] T.Biesheuvel[5,] J. van Bokhorst[5], P. Go[4], G.M. Koole[2,3], , P.W.B. Nanayakkara[1,5]

1. Department of Internal Medicine, VU University Medical Centre, Amsterdam, The Netherlands.

2. Laboratoire Génie Industriel, Ecole Centrale Paris, Chatenay-Malabry, France

3. Department of Mathematics, VU University Amsterdam, The Netherlands

4. Department of Emergency Medicine, Sint Antonius hospital, Nieuwegein, The Netherlands

5. Department of Surgery, VU University Medical Centre, Amsterdam, The Netherlands.

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Corresponding author:

Dr. Prabath W.B. Nanayakkara MD, PhD, FRCP
Department of Internal Medicine
VU University Medical Centre
PO box 7057
1007 MB Amsterdam
The Netherlands

Tel. -31204444444 (Ext. *986791) Fax. -31204440505
Email: p.nanayakkara@vumc.nl

ABSTRACT

Background: A long waiting time in the Emergency Department (ED) is associated with higher morbidity and in hospital mortality. A completion time of more than four hours is a frequently used cut off point. Mostly, older and sicker patients exceed a completion time of four hours on the ED. The primary aim was to examine which factors currently contribute to overcrowding and a time to completion > 4 hours, on the ED's of two different hospitals namely: the VU Medical Center (VUmc), an academic level 1 trauma centre run and the St. Antonius Hospital, a large community hospital in Nieuwegein. In addition we wanted to compare the differences between these hospitals.

Methods: This is an observational study. In both aforementioned hospitals, the time steps in the process of diagnosing and treatment of all patients visiting ED were measured during four weeks. Patients triaged as Emergency Severity Index (ESI) category 2/3 or Manchester Triage System (MTS) orange/yellow were followed closely prospectively by researchers for more detailed information in the same period from 12:00 noon - 11:00 p.m.

Results: In the VUmc, 89% of the patients had a completion time less than four hours. The average completion time (n=2262) was 2:10 hours, (median 1:51 hours, range: 0:05-12:08). In the St. Antonius hospital, 77% of patients had a completion time shorter than four hours (n=1656). The average completion time in hours was (n=1655) was 2:49 (median 2:34, range: 0:08 – 11:04).

In the VUmc, a larger percentage ESI 1,2 and 3 patients did not achieve the 4 hour target (14%, 20% and 19%) compared to ESI 4 and 5 patients (2.7% and 0%), $p < 0.001$.

At the St. Antonius hospital, a greater percentage of Orange and Yellow categorized patients exceeded the four hour target (32% and 28%) compared to Red (8%) and Green/Blue (13%), $p<0.001$. For both hospitals there was a significant dependency between exceeding the four hour target and: whether a consultation was performed ($p<0.001$), the amount of radiology tests ($p<0.001$), and an age older than 65 years.

Conclusion: Factors leading to ED stagnation were similar in both hospitals namely old age, treatment by more than one specialty and undergoing radiological tests. Uniform remedial measures should be taken nationwide to deal with these factors to reduce stagnation in the ED`s.

INTRODUCTION

Long waiting times in the emergency department (ED) can lead to overcrowding and is associated with negative outcomes such as increased risk of hospital admission and in-hospital mortality (1). Therefore, optimizing ED patient flow is an important and a frequently discussed topic. Because the frequency and type of presentations are unpredictable, it remains a challenge for the emergency physicians and nurses to provide adequate care for all patients, especially during the busiest moments.

Overcrowding and long ED waiting times can occur when the maximum available care does not meet increasing demands. A recent study demonstrated that visiting an ED on crowded days resulted in delays in resuscitation efforts and higher in-hospital mortality (1). Also long waiting times in the ED are associated with increased risk of hospital admission and in-hospital mortality in patients who were discharged from the ED (2). In that light, we previously conducted a study at in the VU University Medical Center, Amsterdam, the Netherlands (VUmc), to obtain insight into factors that could contribute to a completion time of more than four hours (3) demonstrating that a vast majority of the patients left the ED within four hours (84%). However, the patients exceeding the four hour were older, sicker and treated by multiple consulting specialists. In addition, after finishing all diagnostic tests, there was a marked delay until the discharge probably caused by inefficient decision-making by the junior doctors (3). This study was conducted in a single academic centre only and therefore was not generalizable to community hospitals. For that reason, we decided to conduct a new study in two different hospitals: an academic center and a large community hospital. The primary aim was to examine which factors currently contribute to overcrowding and completion times longer than four hours on the ED in the VUmc, a level 1 trauma centre run by emergency physicians along with residents of other specialties and on an ED primarily run by EP's in a large community hospital, the St. Antonius Hospital in Nieuwegein and whether these different type of hospitals encounter the same problems in patient flow on the ED or not.

MATERIALS AND METHODS

Study design and Setting

The study was performed in the ED of the VUmc, Amsterdam, the Netherlands and St. Antonius Hospital, Nieuwegein, the Netherlands.
VUmc is an academic urban level 1 trauma centre in Amsterdam with approximately 29,000 ED visits per year. During the study period there were 11 residents in emergency medicine, amongst which were seven fellows of emergency medicine and four non-trainees working in shifts. Residents were supervised by four qualified EPs and one surgeon. The emergency medicine trainees and EP's belong to the surgical staff. At the ED of the VUmc, all patients presenting themselves without a referral from a general practitioner are seen by emergency medicine residents and qualified EPs. Depending on the needs of the patient, the EP can consult the medical specialists. If a patient needs more specialized care or needs to be admitted to the ward, the necessary specialism is consulted and the patient is handed over to the specialist for further treatment. Referred patients are seen by (non) trainee residents of various medical specialties under the supervision of medical specialists belonging to the particular department.

St. Antonius Hospital is a large community medical centre with approximately 23000 visits per year. There were 7 trainee residents in emergency medicine working in shifts. Both referred and non-reffered patients are seen by EP residents and supervised by qualified EPs or sometimes the patients were seen by residents of a specific specialty supervised by the medical specialist. Senior EPs were able to admit a patient for a specialism without consulting the specific medical specialist first.

Selection of Participants, data collection and processing

Data was collected for all consecutive patients age 18 years or older, presenting to the ED during a four-week period at VUmc from October 8th until November 4th 2012. At St. Antonius Hospital, the study was conducted during two periods of each two weeks from November 21th until December 5th 2012, and from February 11th until February 24th in 2013.

For all patients the following time moments were registered: ED arrival, triage, first contact with a physician, and discharge from the ED, in addition to information on triage level, type of referral, ordering of radiologic and diagnostic testing, discharge disposition, first and last consulting medical specialty and the total number of consultations. At VUmc, this data was extracted from paper forms filled in by nurses and physicians. At St. Antonius Hospital, data was retrieved from a computer system called Intracis.

In addition, trained observers, (medical students under the supervision of an internal medicine resident and a specialist) worked in shifts to cover all days of the previously defined study periods, from 12:00 noon - 11:00 p.m. to obtain detailed information on different consecutive steps in the process of individual ED patient flow. For this additional follow up the patients triaged to Emergency Severity Index (ESI) level 2 or 3 at VUmc, and Manchester Triage System (MTS) category orange or yellow at St. Antonius Hospital were selected (4, 5). This selection was based on the previous measurement, demonstrating that these categories had longer completion times (3).

The additional data collection included time moments for the ordering, conduction and evaluation of radiologic and diagnostic testing and the request, conduction and ending of a medical consultation. Also at what time the physician arrived at their final diagnostic conclusions on the ED and when the nurses were informed that the patient could leave the ED.

Outcome Measures

The primary aim of this study is to measure the durations of the different diagnostic and therapeutic procedures that a patient is subjected to during their stay in the ED, and to evaluate how which factor contribute to completion times longer than four hours. Secondly to compare whether there are differences in completion times between an academic centre run by fellows and specialists from various departments and a large urban hospital run primarily by the emergency physicians. And thirdly/finally to investigate whether the measures implemented after previous measurement at the VUmc have had a beneficial effect on completion times.

Primary Data Analysis

Data from VUmc and St. Antonius hospital were analyzed separately. Exceeding four hour completion time was selected as the primary endpoint. Patients were split into two groups: patients with a completion time on the ED of shorter than four hours or a completion time of longer than four hours.

For statistical analyses, two types of statistical tests were used. Pearson's chi-square test was used to assess the independence between the variable "exceeding or not exceeding the four hour target", and some other variables such as age category, triage level, the amount of consultations, etc. The null hypothesis, which is an independence between the two variables, was rejected if the p-value was smaller than 0.05 (significant dependency). The Mann-Whitney test, also called Wilcoxon or rank-sum test, was performed to compare the two populations of patients (exceeding and not exceeding the four hour target) in terms of some duration variables. If the p-value was smaller than 0.05, the null hypothesis that the distributions are similar was rejected which means that the two distributions are significantly different and there is a significant dependency between exceeding / not exceeding the four hour target and the chosen variable. The test allowed to see whether the two populations have significantly different distributions of some durations like door to doctor time and diagnostic tests for instance, and thus to know if there is a dependency between the two variables.

RESULTS

Characteristics of the Study Subjects

In the VUmc 2272 patients were seen at the ED between 8th of October and the 4th of November in 2012, a total of four weeks. A subgroup of 372 ESI2 and ESI3 patients was followed closely by researchers to obtain more detailed information. In the St. Antonius Hospital there were 1656 patients of which a total of 492 orange and yellow triaged patients were closely observed for detailed information. The average age of patients in the VUmc was 40 years (SD 24.1) this was significantly higher in the St. Antonius Hospital with an average age of 50 years (SD 23.6), $p<0.001$. Characteristics of all patients in both hospitals are summarized in table 1.

		Site, No. (%)				
Variable	**VUmc (n=2,272)**			**St. Antonius Hospital (n=1,656)**		
Age	0-17 years:	423	19%	0-17 years:	183	11%
	18-64 years:	1420	62%	18-64 years:	923	56%
	65+ years:	429	19%	65+ years:	550	33%
Triage category	ESI 1:	112	4.9%	Red:	26	1.6%
	ESI 2:	113	5%	Orange:	346	21%
	ESI 3:	1000	44%	Yellow:	698	42%
	ESI 4:	894	39.3%	Green:	581	35%
	ESI 5:	153	6.7%	Blue:	5	0.3%
Arrival	Ambulance	531	23%	Ambulance	225	28%*
	Traumahelicopter	4	0.2%			
Discharge destination	Home	1737	76.5%	Home	1025	61.9%
	Hospital admission	535	23.5%	Hospital admission	631	38.1%

* Data only known for the patients on the ED between February 11th until February 24th in 2013

Table 1. Characteristics

Time to completion

In the VUmc, 89% of the patients had a completion time less than four hours. The average completion time (n=2262) was 2:10 hours, (median 1:51 hours, range: 0:05-12:08). In the St. Antonius hospital, 77% of patients had a completion time shorter than four hours (n=1656). The average completion time in hours was (n=1655) was 2:49 (median 2:34, range: 0:08 – 11:04). Figure 1 demonstrates the cumulative distribution of completion times for both hospitals.

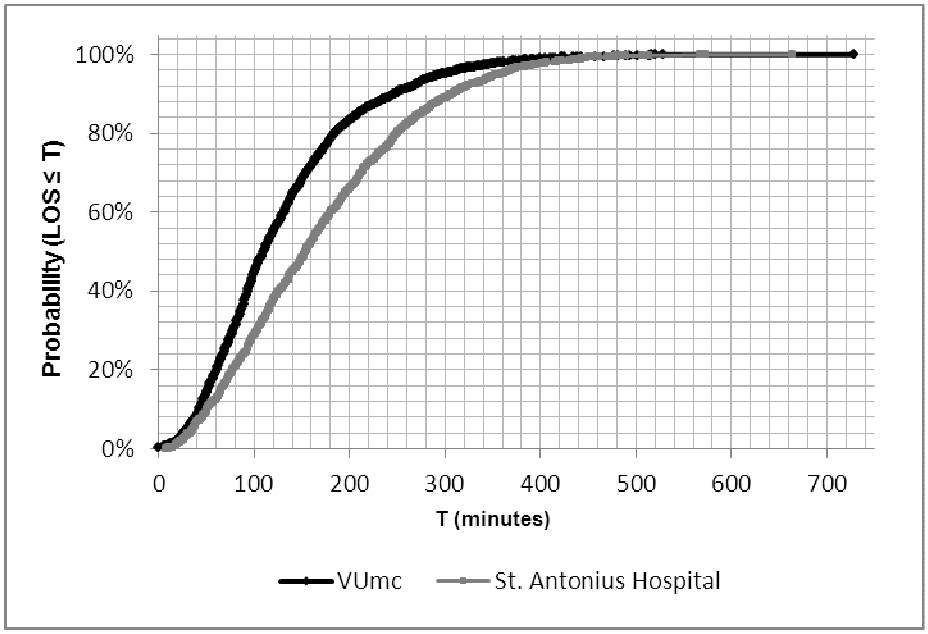

Fig 1. Cumulative distribution of completion time

Triage

In the VUmc, most patients were categorized as ESI 3 (44%) and ESI 4 (39%) (table 1). A larger percentage ESI 1,2 and 3 patients did not achieve the 4 hour target (14%, 20% and 19%) compared to ESI 4 and 5 patients (2.7% and 0%), $p < 0.001$.

At the St. Antonius hospital, most patients were categorized as Yellow (42%) and Green (35%). A greater percentage of Orange and Yellow categorized patients exceeded the four hour target (32% and 28%) compared to Red (8%) and Green/Blue (13%), $p<0.001$.

Number of specialties involved

For both hospitals there was a significant dependency between exceeding the four hour target and whether a consultation was performed ($p<0.001$). The realization of the four hour target was not linked to the amount of consultations.

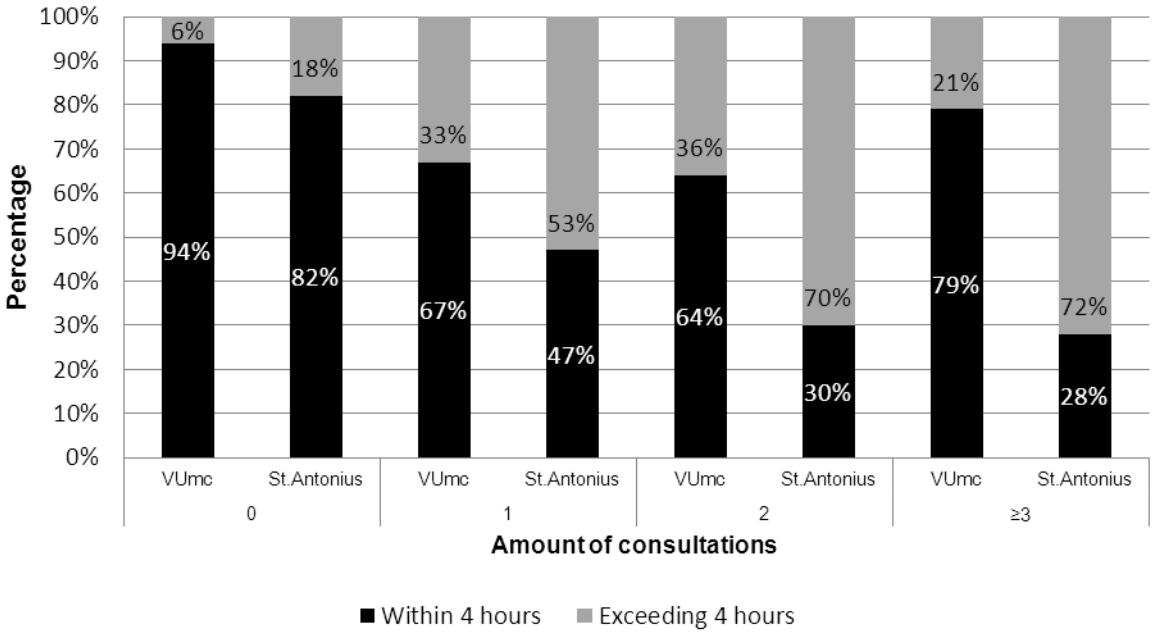

Fig 2. Amount of consultations per hospital and the four hour target

Age:

In both hospitals, patients older than 65 years were more likely to stay in the ED for more than four hours ($p<0.001$). Figure 7 demonstrates the average completion time per age category.

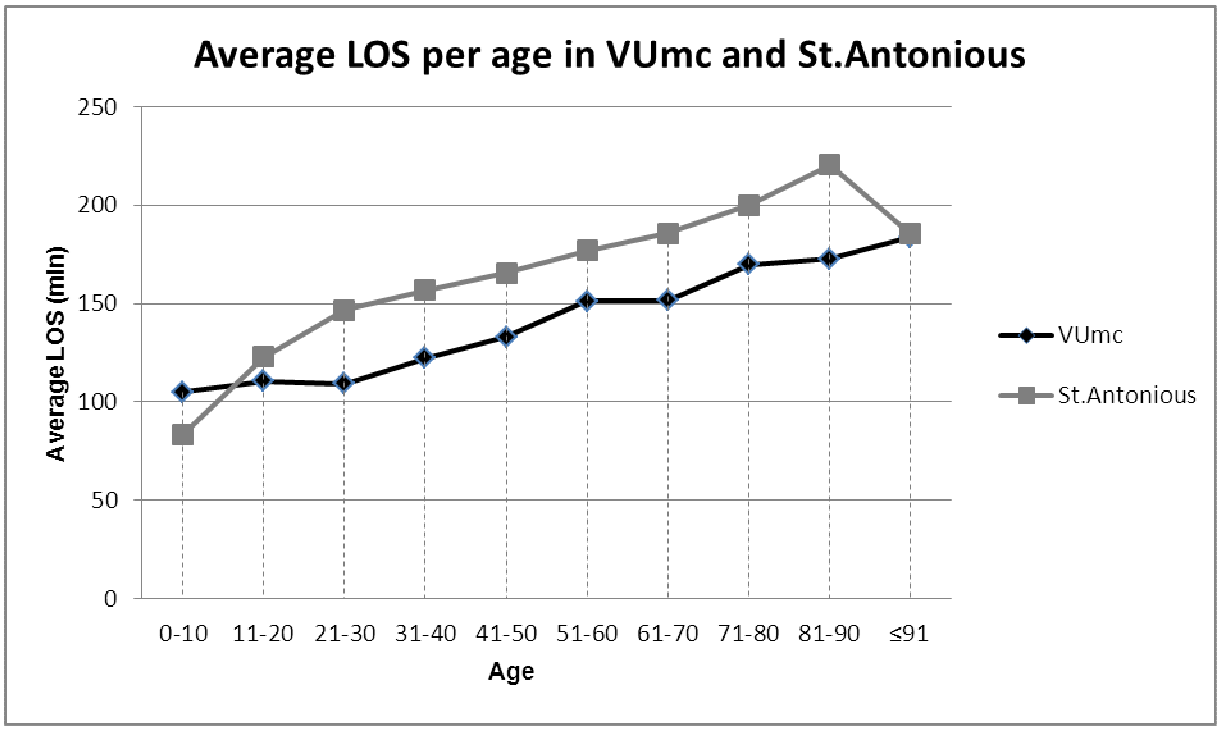

Fig 3. Avarage completion time per age in both hospitals

Arrival pattern

Most patients arrived between 9 a.m. and 11 p.m. An association was found for both VUmc (p=0.02) and St. Antonius Hospital (p=0.02) between arrival time and the four hour target. No significant differences were found in exceeding the four hour target between ED visits on different days of the week, VUmc (p=0.054), St. Antonius Hospital (p=0.16)

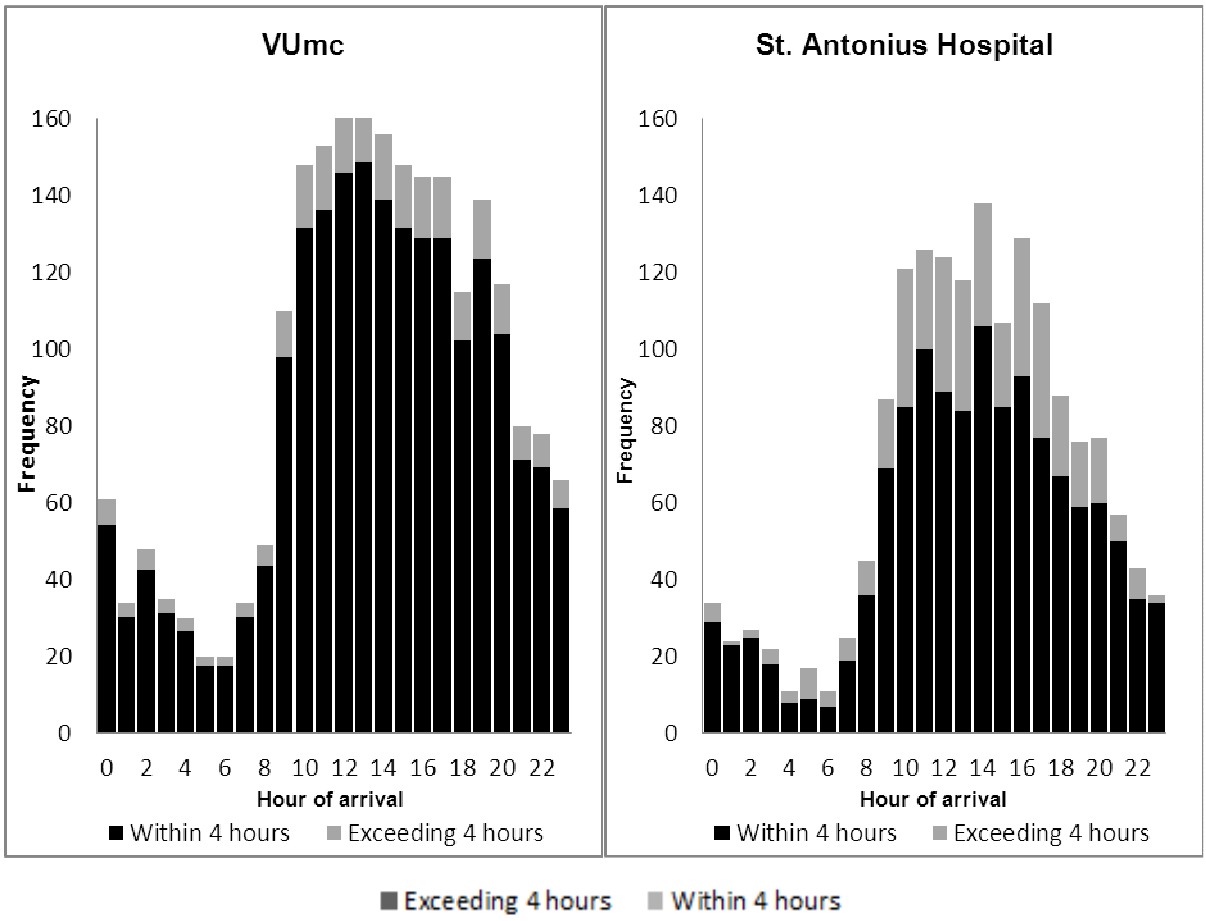

Fig 4. Four hour target and time of arrival

Door to doctor time

In the VUmc, the door to doctor time was not significantly different between patients who did or did not exceed the four hour target, p=0.07 (figure 3). In St. Antonius hospital, there was a significant correlation for this analysis, p<0.001 (figure 3).

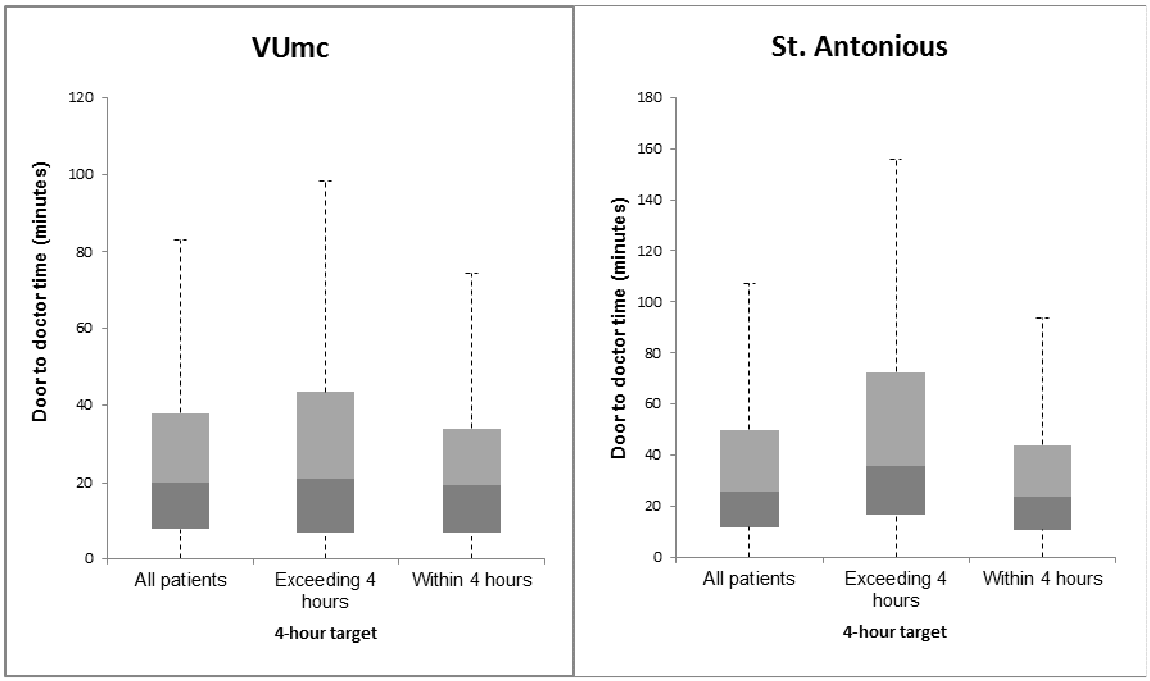

Fig 5. Door to doctor time in minutes and the four hour target

The door-to-doctor time for all patients and for the subgroup of detailed measured patients are demonstrated in table 2.

	VUmc		**St. Antonius**	
All patients	**Minutes, N**	**Mean±s.e**	**Minutes, N**	**Mean±s.e**
Triage-time	7:11 N = 2204	1:12	12:08 N = 1656	00:19
Door to doctor time	27:08 N = 2258	00:34	37:20 N = 1655	00:54
Detailed patients	**Minutes, N**	**Mean±s.e**	**Minutes, N**	**Mean±s.e**
Triage time	6:12 N = 361	1:41	14:04 N = 494	00:46
Door to doctor	37:16 N = 371	01:51	39:44 N = 494	01:43

Table 2.

Medical specialty

In the VUmc, most patients were seen by EPs and 4% of these patients exceeded the four hour target. In 29% of the surgery patients, the four-hour target was exceeded, followed by neurology (27%) and internal medicine (24%).

In the St Antonius Hospital, most patients were seen by the EP`s on behalf of different departments. The internal medicine department had the largest percentage of patients exceeding the four hour target (40%) followed by lung diseases (35%) neurology (33%) and surgery (14%). In both hospitals a significant dependency was found between specialty and exceeding the four hour target ($p<0.001$).

Diagnostic tests

In the VUmc data of 283 detailed patients was useful for analyzing diagnostic tests. No significant difference in duration of 'prediagnostic tests' was found for patients who did or did not exceed the four hour target ($p=0.12$). For 'diagnostic tests' and 'time after diagnostic tests' there was a significant difference (both $p<0.001$). In the St. Antonius Hospital there was a significant difference in the duration of all the sub processes for patients (n=349) who did or did not exceed the 4 hour-target.

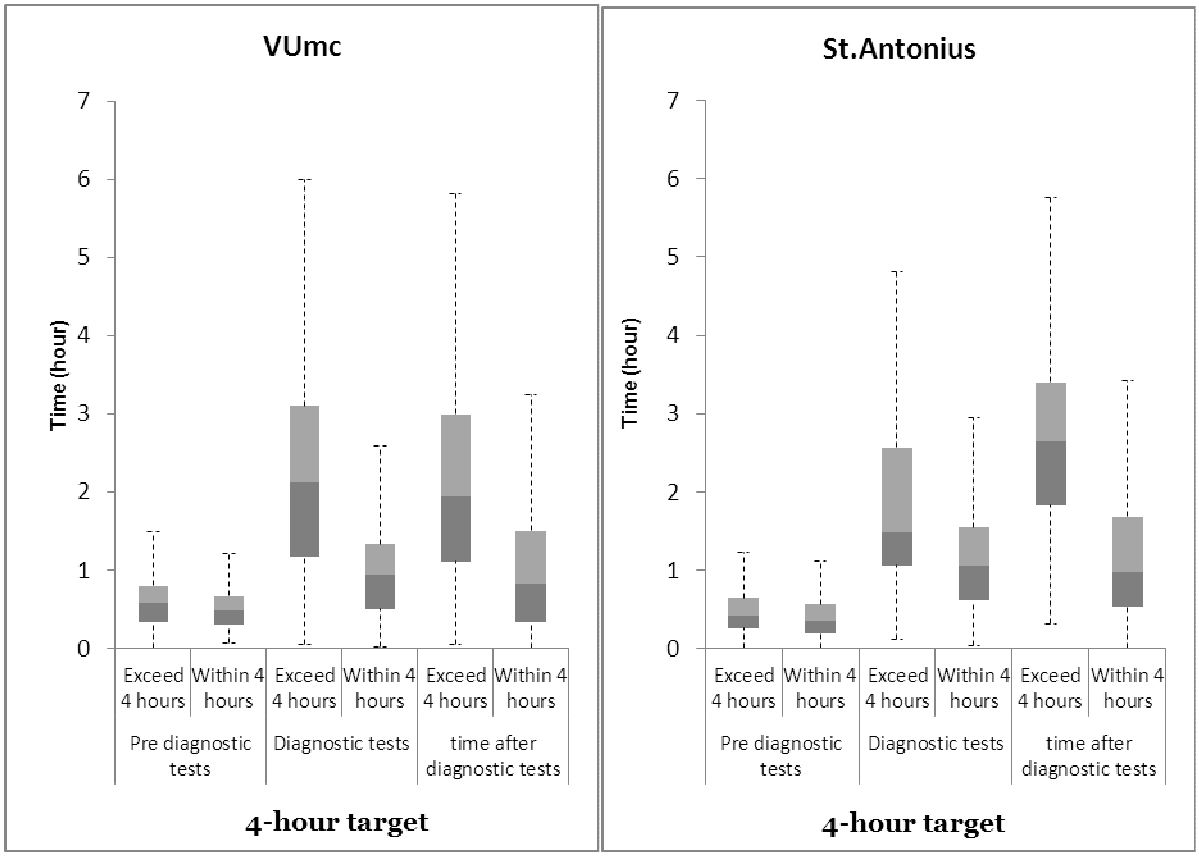

Fig 5.

Radiology

In the VUmc, 34% of patients underwent a X-ray, followed by Ct-scan (11.4%), Ultrasound (8%) and MRI (0.4%). In the st. Antonius Hospital, 49% of patients underwent a X-ray, followed by CT-scan (15%), ultrasound (7.9%) and MRI (0.4%).

All radiology tests were correlated with a significant higher chance to exceed the four hour target. The patients in the VUmc which did not have any radiologic tests, had a chance of 4.9% in exceeding the four hour target. This chance to exceed the target increased to 8.5% in patients only undergoing X-ray(s) ($p=0.002$), and to 35.3% for patients only receiving Ct-scan(s) ($p<0.001$) and 33.3% for patients undergoing only ultrasound(s) ($p<0.001$). In the St. Antonius Hospital the chance to exceed the four hour target was 11% for those who did not have radiologic tests. This chance increased to 22% for patients having only X-rays(s) ($p<0.001$), to 49% for patients undergoing only CT-scan(s) ($p<0.001$) and to 45% for only undergoing ultrasound(s) ($p<0.001$).

For both hospitals there was a significant correlation for the amount of radiology tests and exceeding the four hour target ($p<0.001$).

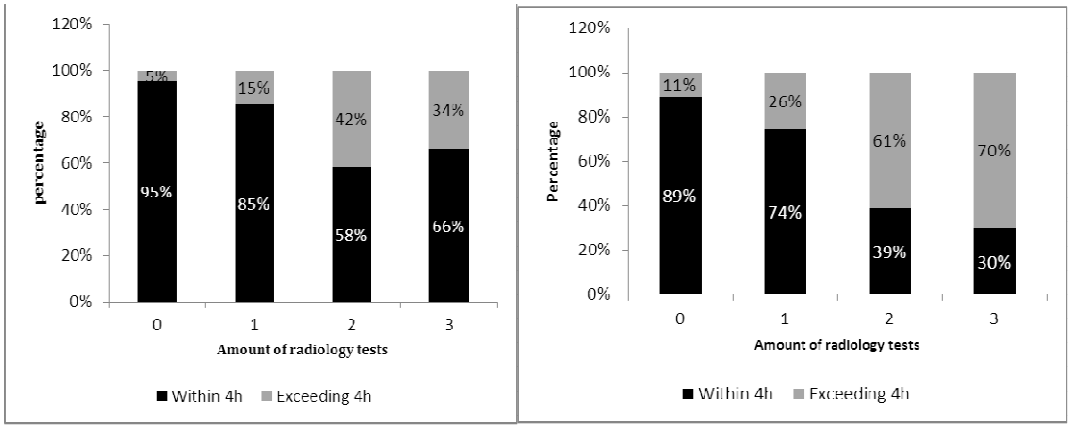

Fig 6.

Discharge destination:

In both hospitals, most ED visits did not result in a hospital admission (table 1). Patients who were admitted or transferred elsewhere, were more likely to exceed the four hour target in the VUmc (25% and 29% of exceeding) comparing to those who were discharged (7%)

($p<0.001$). In St. Antonius hospital 37.5% of admitted patients and 57.1% of transferred patients exceeded the four hour target compared to 11.5% of released patients ($p<0.001$).

VUmc 2010 compared to 2012

In February 2010, 84% of patients in the VUmc had a completion time of less than four hours and the averagecompletion time was 2:23 hours (n=2444). This was 89% in 2012 with an average completion time of 2:10 hours (n=2262)

The average door-to-doctor time was 48 minutes in the subgroup of detail patients (n=66) in study of 2010. This was 37 minutes in the subgroup of 371detail patients in this study in 2012.

In the previous study and in this study, no association was found in the VUmc between the arrival time of a patient and the four hour target. The previous study in the VUmc demonstrated that the internal medicine had most patients exceeding the four hour target (37%), followed by neurology (29%) and surgery (28%). In this study, internal medicine accounted for 24% of the cases exceeding the four hour target. In both studies, 39% of patients were triaged as ESI 3. In 2010 24% of these patients did not achieve the four hour target, this was 19% in 2012. In both studies the absolute number of patients exceeding the four hour target, were ESI 3 patients. In 2010 and 2012 for both sub process ‘diagnostic tests’ and ‘time after diagnostic test’ there was a significant difference in durations of patients who do and do not exceed the four hour target (Figure 5).

DISCUSSION

In this study we found that patients older than 65 years, patients seen by more than one specialism and patients undergoing radiological tests are more likely to have longer completion times in both hospitals. We aimed to detect factors contributing to a longer stay on the ED in two hospitals with different work procedures and a different patient population., In the VUmc a higher percentage ESI 1 patients were seen compared to the amount of RED triaged patients in the St. Antonius Hospital, due to the fact that the VUmc is a level 1 trauma centre. However more Orange triaged patients were seen in the St. Antonius Hospital compared to ESI 2 patient in the VUmc, probably because acute cardiology patients (mostly ESI 2) are not presented on the ED in the VUmc but on the cardiology department. Notably more older patients were seen in the St. Antonius hospital. In the VUmc, non-reffered patients were seen by EP trainees who were supervised by a qualified EP. If the expertise of a specific specialty was needed, a resident of this specialty was consulted and supervised by the medical specialist. Referred patients were directly seen by the residents of a specific specialty and supervised by the medical specialist. In the St. Antonius Hospital, both referred and non-referred patients were mostly seen by EP residents and some were seen by residents from a specific specialty. Senior EP's were able to independently discharge or admit a patient for a specific specialty without consulting a medical specialist of this department. As a result of this difference in work procedure, more consultations were performed in the VUmc.

Despite these differences, both hospitals were facing largely the same problems. Factors increasing the chance of exceeding the four hour target were: older age, having at least one consultation and undergoing radiologic testing. Patients exceeding four hour target were predominantly found in the more severe triage categories. However in the most acute category (ESI 1 or category Red), patients are treated on the shock room by a team of specialists directly after arrival on the ED with the opportunity to perform radiologic testing on bedside, resulting in a relatively short completion time on the ED. Patients in triage categories ESI 2/3 and Orange/Yellow however are not initially seen by a team of specialists despite the fact that this group of patients is also relatively old and frequently have multiple co-morbidities demanding the expertise of more than one specialist. Consultations occurred consecutively in these patients contributing to a longer completion time in both hospitals. Brick et al, also concluded that multiple consultations and advanced aged were significantly associated with

longer stay on the ED (6). Consulted physicians tend to treat the patient individually, one after the other, instead of working as a team. This fragmented delivery of care increases the length of stay and may thereby lead complications and reduced patient satisfaction. A proposed solution for this problem in our previous study was the introduction of assessment teams for these patients. Especially in old patients with multiple comorbidities it was decided that specialties such as internal medicine, neurology, surgery or emergency physicians should be called upon to examine the patients together as a team at the outset so that multiple, consecutive consultations could be avoided. However, although we have propagated this concept intensively in the last few months the doctors still seem to follow the traditional method of examining/treating these patients consecutively one after the other.

In 2010 the completion times were measured in the VUmc in order to explore the delaying factors contributing to stagnation on the ED. After the results were known, new measures were implemented to improve the patient flow. The most important measure was that supervising internal medicine specialist stayed in the hospital until 11 p.m. instead of 6 p.m. In addition the shifts covered by qualified EPs were adjusted. During weekdays the shifts were extended from 8 am – 5 pm to 8 am – 11 pm and in the weekend they were ought to be available for supervision by phone. Two years later we notice some improvements, the completion time within four hours has increased from 84% in 2010 to 89% in this study. The internal medicine department showed the largest decrease in patients exceeding the four-hour target, from 37% to 24%. This is probably due to the increased working hours of the supervising internal medicine specialists which probably quicken the decision making process. Bucheli also demonstrated that adding a second physician during the evening shifts of the internal medicine department significantly reduced the time spent on the ED (7). In addition the change in the mindset of the residents and specialists of the internal medicine department after the publication of the first results might have improved the working efficiency on the ED of this specialism

Despite booking the abovementioned improvements compared to 2010, we do experience some of the same problems in the VUmc. We still see that patients stay relatively long on the ED after al diagnostic tests are finished. After interviewing a few nurses and residents, it was proposed that the main cause for this delay was the lack of direct supervision on the ED. Residents often see patients alone on the ED and telephone their supervisor after finishing anamnesis, physical examination and first diagnostic tests. They tend to collect patients and/or

problems before they call their supervisor especially during late hours when the senior specialist is not in the hospital anymore. In addition, during daytime supervisors are not always directly available to discuss a case on the phone with the resident, because they are also busy supervising on the wards or surgical room.

Furthermore, the use of diagnostic procedures such as CT scans has increased in the last decade, as they improve diagnostics and therapeutic decision making, but on the other hand they also take up long waiting time (8,9). In this study, all radiologic tests were correlated with a longer completion time on the ED, and CT-scan especially. It is known that it takes time before all the images of the CT-scan are uploaded and available for the Radiologist to interpret. In our opinion more emphasis should be placed on timely performance and interpretation of radiology tesing in the ED setting.

Even though ED crowding and long waiting times are an intensely debated issue and a serious problem in many countries, the Netherlands together with some other Scandinavian countries seem to perform relatively well in delivering timely patient care at the ED (10). This may also be due to a strong network of patient care outside the ED, such as the prehospital and primary care which is also available after-hours which make it easy for the clinicians to discuss the case with the GP`s and take necessary measures together. However, the patients who do stay longer in our hospital are old and vulnerable which increasing the risk of complications in this group. As shown in an earlier study these patients are known to have about 3 comorbidities en used on average 5.3 different medications (11). Therefore in our opinion these results should be taken seriously and remedial measures such as introduction of assessment teams, improving the direct supervision of residence to speed up the process of decision making, and increasing the radiological support in the ED should be introduced in the ED`s.

STUDY LIMITATIONS

In this study detailed information was only obtained by the researchers for ESI 2/3 and Orange/Yellow categorized patients. We chose to closely observe this group because earlier research pointed out that this group had in absolute numbers the longest LOS on the ED. Selection of these patients might underexpose logistic problems occurring in the other triage categories. However, as the length the stay in these triage categories were significantly lower we presume that impact of this selection on the overall results were minimal. This study was

performed in two large hospitals with a large number of inclusions which makes the study generalizable to the situation in the Netherlands.

In both hospitals the measuring period was not at the same time. Seasonal influence may alter the situation. However the benefit of measuring in both hospitals one after another is that we had the same team of researchers, using the same technique during both study periods. Finally the researchers were physically present on the ED floor to note every step in the process of the selected patients. This might alter the attitude of the treating physician/nurses, and speed up or slow down the normal routine of the physicians and nurses on the ED.

CONCLUSION

In this study performed on the ED's of two different hospitals with different working strategies and patient population, we see that the factors leading to ED stagnation were similar namely: Old age of the patients, treatment by more than one specialty and undergoing radiological tests. Compared to the measurements in 2009 for the internal medicine department, we do see some improvements in the VUmc during this study. This department extended the hours in which the supervising specialist was in the hospital after the study results in 2009. This more direct contact between supervisors and resident might help to quicken the process of decision making, after al diagnostic tests are performed. Despite this small improvement still the same vulnerable group of patients has the longest completion time on the ED. We have noticed that is is difficult to make substantial changes in the workflow of an emergency department. We still think that uniform remedial measures should be taken nationwide to deal with these factors to reduce stagnation in the ED`s.

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