Original Article

Improving emergency department flow by introducing a simple time out moment (The TRAFFIC LIGHT study)

AJC Overgaauw, M Ligthart, K Aziljii, TC Minderhoud, JJ Sikkens, TH Biesheuvel & PWB Nanayakkara

Abstract

Background and importance: Long waiting times in the emergency department (ED) is an increasing problem in the recent years and is expected to become an even bigger problem in the future

Objective: We aimed to test the hypothesis whether increasing awareness of the time lapse with the treating physician, 2 hours after patient arrival, can reduce long patient turnaround time (TAT).

Method: In this prospective single-center cohort study we compared and analyzed patient TAT in the ED before and after implementation of a so called 'traffic light' moment 2 hours after patient arrival. At this 'traffic light" moment a team member contacted the treating physician to increased awareness over the time lapse. Difference in percentage of patients who stayed more than 4 hours in the ED before and after intervention was the primary outcome

Results: Between October 2nd 2021 and January 2nd,2022 1494 patients were included for primary outcome analysis. A total of 419 patients (n=740, 56.6%) had a TAT of less than 4 hour in the ED before intervention, compared to 497 (n=754, 65.9%) after intervention (p <0.001). Median time spent in de ED before intervention was 3:40 (IQR 2:24 – 5:04) compared to 3:15 (IQR 2:03 – 4:38) after intervention (p<0.001).

Conclusion: This simple and low-cost intervention reduces the ED length of stay significantly. Although multiple interventions will be required to ensure less patients spending more than 4-hours in the ED, a 'traffic light' moment can be a simple and an effective tool.

Keywords

Emergency care, Patient flow, Emergency room, Organisation of health services, Efficiency, Length of stay

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Introduction

The emergency department (ED) continues to be one of the most challenging wards with respect to patient turnaround time (TAT) internationally. Increasingly long TAT's at the ED`s has manifested itself into a global problem.[1–3] Prolonged ED stays are associated with adverse patient outcomes including increased mortality rates, preventable medical errors, poor pain management, prolonged hospitalizations and a lower patient satisfaction.[1–4] As shown in a 2010 study in Amsterdam, patients regularly spend more than four hours in the ED also in the Netherlands. In this study 13% of visits lasted longer than four hours.[5] Patients presenting for medical specialties such as internal medicine and neurology had the longest TAT`s.[5] Undergoing laboratory and radiology tests were also independent determinants of a prolonged ED length of stay.[6] Current practice shows us that, possibly due to shortage of staff and admission capacity, TAT's are increasing further.

In 2000, the National Health Service (NHS) in the UK implemented a time-based target (TBT), mandating that all patients presenting at the ED be admitted to the hospital or discharged in less than four hours,[7,8] resulting in a significant increase in number of patients staying less than four hours in the ED.[7–9] After the introduction of TBTs in the UK more countries followed and reported a subsequent increase in quality of care, patient safety and patient satisfaction.[9] Even when the targets were not fully met, emergency staff still found improvements in patient flow and reduction in access blocks demonstrating that the pursuit of TBTs were more efficient than reaching the target.[10–13]

TBTs are not implemented currently in the Netherlands and despite positive effects of a TBT there is also a downside. A 2021 Australian review found more stress, lower nursing morale and increase of staff turnover when targets were implemented,[9] and although TBTs had a positive impact on quality of care due to improvements in resources and patient flow, when simply pursuing the TBT became more important than patient needs, quality of care decreased. We think that not implementation of the target but creating more awareness of TATs in physicians working in the ER could possibly lead to a shorter TAT without losing quality of care and staff satisfaction. We hypothesized

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that increasing physicians time awareness may increase work efficiency and reduce overall TAT. To enhance time awareness, we introduced a so-called 'traffic light' moment. This moment occurred after 2 hours of patient arrival informing the assigned physician about the duration of stay through a four-question questionnaire. In this study, we aim to determine whether this 'traffic light' moment has a positive impact on TAT. We strived for a TAT less than 4-hour in 80% of all ED visits. Concurrent with this primary aim we registered contributing factors for long TAT such as the number of diagnostic tests and number of (sequential) consultations and consulting specialties.[6]

Method

Design & Setting

This prospective single-center cohort study was performed in the ED of the Amsterdam UMC, location VUmc. An academic, urban, level 1 trauma center that treats approximately 30000 emergency presentations per year.[14] Patients referred by the GP`s, 35% of all ED presentations, are seen by residents, always under supervision of an organ specialist, and 65% of patients are first seen by an emergency physician. There are 26 beds, 4 resuscitation rooms and one emergency CT scanner with 24/7 availability.

We compared and analyzed patient TAT before and after implementation of a 'traffic light' moment. The study took place during a four-month period from October 2021 till January 2022. During the first two months baseline data were collected. In December 2021, the intervention was introduced, and the measurements continued for another two months. No further interventions targeting the improvement of patient flow were started during the study period.

Patient selection

Patients were included on all weekdays and two weekends per month during ED peak hours (12:00 AM to 09:00 PM).[6,14] All patients who came to the ED were eligible for inclusion. There were no exclusion criteria.

Intervention

Intervention consisted of short moment of contact between a student member of the team and the patient's treating physician. During this moment the physician was alerted on the time spent in the ER of his or her patient. Also, a questionnaire was performed comprising four short questions as shown in Table 1. Aim of this questionnaire was to provide further insights in possible reasons of delay in patient TAT. Intervention took place after 2 hours of each patient`s arrival in the ED and interviewers kept the interaction with the physician as short as possible.

Table 1. Intervention questions

Is the diagnosis clear? • Yes/No • If no, why not?
Did you consult your supervising physician? • *Yes*/No • If *no, why not?*
Do you know whether the patient should be admitted or not? • *Yes*, in this hospital • Yes, in another hospital • No, pa*tient will be discharged*
What can we do to speed-up the process? • *Physicians own answers*

Outcomes

Primary outcome was the difference in percentage of patients who stayed more than 4 hours in the ED before and after intervention. Secondary outcomes were the difference in median length of stay after intervention and variables that could have contributed to a prolonged TAT. We divided patients into two groups: those who were in the ED for more than 4 hours and those who stayed less than 4 hours, and investigated the following factors: number of consulting specialties, number of diagnostic tests, age, discharge destination, medical specialties involved and urgency code.

The urgency code is derived from the main complaints, vital functions and severity of symptoms according to the Netherlands Triage System (NTS).[14] There are 6 categories: U0 through U5. In patients triaged U0 and U1 there is a direct life-threatening situation, and the patient must be seen immediately. In patients triaged U2 the vital signs are not yet in danger, but they are threatened, or organ failure is present. These patients must be seen as soon as possible, but with a maximum of 10 minutes. Patients triaged U3 are urgent patients and need to be seen within 60 minutes. Patients triaged U4 or U5 are standard and non-urgent patients and need to be seen within 120 minutes and can be handed over to the (out of hours) general practitioner care post which is located next to the ED.[14]

Data collection

A research team member extracted relevant data for each included patient from the Electronic Patient Record (EPD). The following data was retrieved: date of ED presentation, age, emergency triage code, admitting specialty, number of consulting specialties, discharge destination and total amount of diagnostic tests. Diagnostic test included all radiology and lab examinations. Every radiology order was registered as one test. For lab exams one test was defined as the moment of drawing blood or calling the lab for

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additional tests. All patient data were stored together with the questionnaires in a Castor database and converted to SPSS for analysis. When patients got admitted, transferred, or discharged the total time spent in the ED was noted.

Statistical analysis and sample size

Statistical analysis was performed using SPSS version 28.0 (IBM Corp., Armonk, USA) and R version 4.2.1 (R Core Team (2022) with the lme4 package.[15] None of the team members performing the intervention were involved in statistical analysis and interpretation of data. For all patient characteristics and outcomes descriptive statistics were used. Normally distributed variables are presented as mean +/- SD, not normally distributed variables are given as medians with interquartile ranges. To determine-Whitney U test was used. For comparing frequencies distributions and means the Chi-squared test and the paired T-test were used. To compare trends in binary and continuous outcomes before and during the intervention period we used a linear probability random effects model and linear random effects model respectively, including a random intercept for the specialty for which the patient was presented. The continuous outcome TAT in hours was log-transformed prior to analysis. If the p value was smaller than 0.05, the null hypothesis was rejected. All results were visualized in a contingency table. A sample size of at least 485 patients per group was needed to demonstrate a 10% difference in the percentages of patients with a TAT < 4 hours, p value <0.05 and a power of 80%.

METC approval

The METc (Medical Ethics Review Committee) reviewed our proposed study and a waiver was assigned for informed consent. (METc number: 2021.0653)

Results

Patient characteristics

A total of 1619 patients presented to our ED during the inclusion period. With a median age of 57 years (SD 22.0), the two groups consisted of 777 (46.3%) patients before intervention and 842 (53.7%) after intervention. The intervention group was slightly older than the non-intervention group, 54 (SD 22.4) vs. 60 years (SD 22.1). More surgical patients were seen at the ED during the pre-intervention period. Further patient characteristics were evenly distributed between the two groups, as demonstrated in Table 2.

Table 2. Baseline Characteristics of al included patients. The results are expressed as a percentage of the total number of patients.

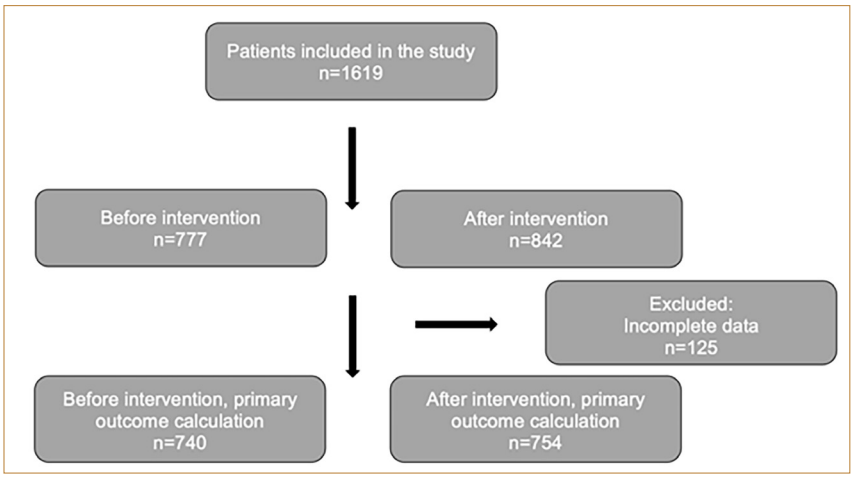
	Total patients (n=1619)		Before intervention (n=777)		After intervention (n=842)	
Age, median (SD), y	57	(22.0)	54	(22.4)	60	(22.1)
> 60 year; n (%)	740	(45,7%)	326	(42,0%)	414	(49,2%)
Urgency code:						
U1; n (%)	148	(9.1%)	77	(9.9%)	71	(8.4%)
U2; n (%)	445	(27.5%)	216	(27.8%)	229	(27.2%)
U3; n (%)	540	(33.4%)	256	(32.9%)	284	(33.7%)
U4; n (%)	116	(7.2%)	60	(7.7%)	56	(6.7%)
U5; n (%)	183	(11.3%)	79	(10.2%)	104	(12.4%)
U(unknown); n (%)	164	(10.1%)	82	(10.6%)	82	(9.7%)
Admission specialty:						
Medical; n (%)	706	(43.6%)	308	(39.6%)	398	(47.3%)
Surgical; n (%)	913	(56.4%)	469	(60.4%)	444	(52.7%)
Number of consulting specialties, median (IQR)	1	(1-1)	1	(1-1)	1	(1-1)
Number of sequential diagnostic tests, median (IQR)	2	(1-2)	2	(1-2)	2	(1-2)
Discharge destination:						
Home; n (%)	1038	(64.1%)	511	(65.8%)	527	(62.6%)
Nursing ward; n (%)	452	(27.9%)	217	(27.9%)	235	(27.9%)
Transfer to other hospital; n (%)	43	(2.7%)	25	(3.2%)	18	(2.1%)
Return nursing home; n (%)	5	(0.3%)	3	(0.4%)	2	(0.2%)

SD: standard deviation; IQR: interquartile range; n: number of patients; y: years

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Total time reduction and TAT differences

1494 patients (92.2%) got included for analysis of our primary outcome, with 740 patients before intervention and 754 after intervention. 125 patients were excluded due to missing data, as shown in flowchart 1. A total of 578 patients had a TAT of more than 4 hour in the ED, with 321 patients (55.5%) before intervention and 257 (44.5%) after intervention (p <0.001, Table 3. Median time spent in de ED before intervention was 3h:40min (IQR 2:24 – 5:04) compared to 3h:15min (IQR 2:03 – 4:38) after intervention (p<0.001). Both the percentage of TAT >4h and the median time spent in de ED showed an increasing trend in the pre-intervention period, which changed significantly during the intervention period for both outcomes; p=0.013 and p=0.002 respectively (Figure 1 & Figure 2).



Flowchart 1. Patient inclusion.
n: number of patients

Secondary outcomes

A higher median age was observed in the patient group with an ED stay over 4 hours (60.5 years (SD 19.1)) compared to less than 4 hours [49.0 years (SD 23.4) (p<0.001)]. There was a minor but significant difference (difference of 0.28 (p<0.001)) in number of consultations in > 4-hour TAT group. Median of consultations, however, was 1 in both groups (n=915, SD 0.41 in patients staying < 4 hours and n=578, SD 0.70 in patients staying > 4 hours). The number of diagnostic tests differed by 0.66, with no statistical significance (p=0.005). The majority of patients who exceeded the TBT were triaged U2 (n=215, (37% of a total of 579 patients with TBT > 4 hours)) or

Table 3. Time reduction + differences in TAT of more than 4 hours before and after intervention. The results are expressed as median time and as percentage of total number of patients.

Total patients (n=1494)	No intervention (n=740)	Intervention (n=754)	p*
Total time in ED, median (IQR), hh:mm	03:40 (02:24-05:04)	03:15 (02:03-4:38)	<0.001
Patient TAT > 4 hours; n (%)	321 (43.4%)	257 (34.1%)	<0.001

ED: emergency department; IQR: interquartile range; TAT: turnaround time; n: number of patients

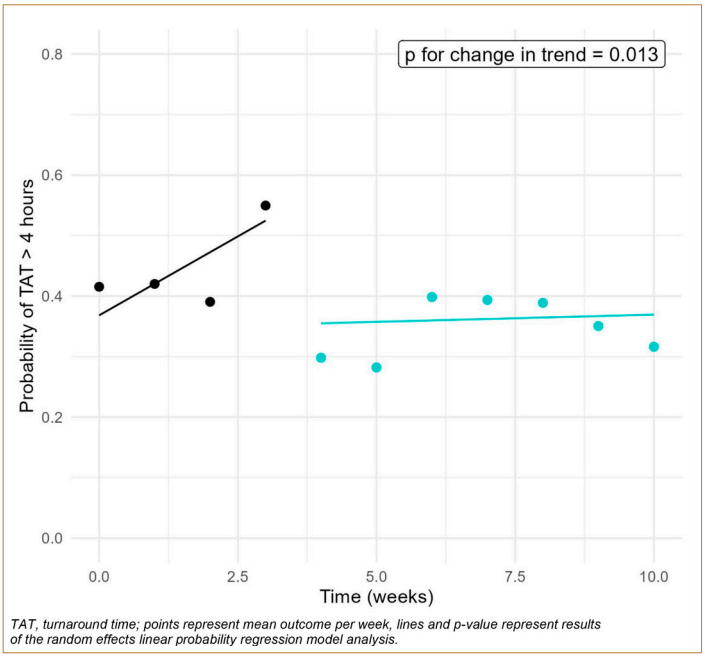


Figure 1. Patients with turnaround time > 4 hours over time
TAT, turnaround time; points represent mean outcome per week, lines and p-value represent results of the random effects linear probability regression model analysis.

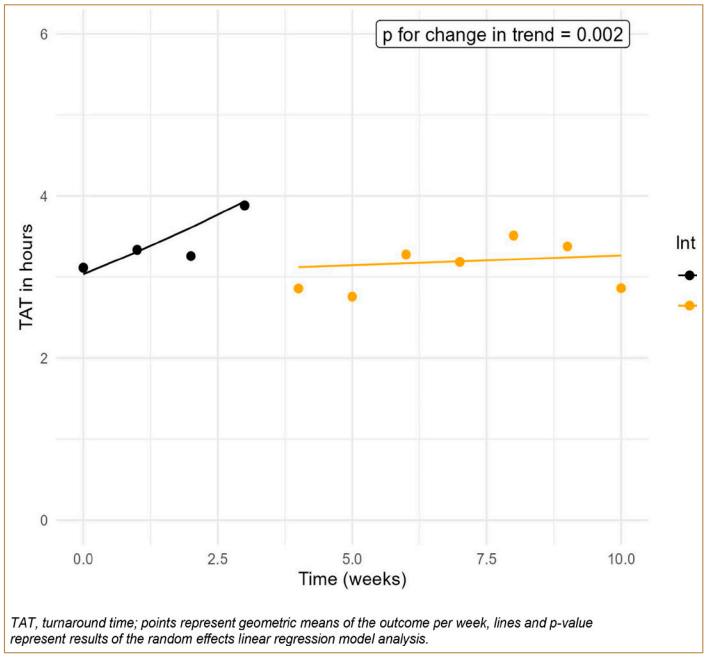


Figure 2. Patients turnaround time over time
TAT, turnaround time; points represent geometric means of the outcome per week, lines and p-value represent results of the random effects linear regression model analysis.

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Table 4. TAT prolonging variables. The results are expressed as a percentage of the total number of patients.

		ED stay < 4 hours		ED stay > 4 hours		p[x]
Age, mean (SD), y		48.98	(SD 23.4)	60.50	(SD 19.1)	<0.001
Number of consulting specialities, mean (SD)		1.12	(SD 0.411)	1.40	(SD 0.696)	<0.001
Number of diagnostic tests, mean (SD)		1.51	(SD 0.888)	2.17	(SD 1.048)	=0.005
Urgency code:						
U1 (n=135)		79	(58.5%)	56	(41.5%)	=0.485
U2 (n=418)		203	(48.6%)	215	(51.4%)	<0.001
U3 (n=509)		334	(65.6%)	175	(34.4%)	=0.014
U4 (n=111)		84	(75.7%)	27	(24.3%)	=0.001
U5 (n=171)		119	(69.6%)	52	(30.4%)	=0.018
U(unknown) (n=148)		94	(57.3%)	54	(42.7%)	=0.562
Admission specialty:						
	Medical (n=677)	342	(50.5%)	335	(49.5%)	*<0.001*
	Surgical (n=817)	574	(70.3%)	243	(29.7%)	
Discharge destination:						
	Home (n=1016)	725	(71.4%)	291	(28.6%)	<0.001
	Nursing ward (n=431)	174	(40.4%)	257	(59.6%)	<0.001
	Transfer to other hospital (n=41)	14	(34.1%)	27	(65.9%)	<0.001
	Return nursing home (n=5)	2	(40%)	3	(60.0%)	=0.327

ED: emergency department; SD: standard deviation; TAT: turnaround time; n: number of patients; y: years

U3 (n=175, (30% of 579 patients)). Patients seen by medical specialities accounted for 335 (49.5%) who spent more than 4 hours in the ED, compared to 243 (29.7%) surgical patients (p<0.001). Among the patients who got admitted to a hospital ward 257 (59.6%) spent more than 4 hours in the emergency room (ER). The results were similar for transfers to other hospitals, with 27 (65.9%) patients exceeding the TBT. All results are displayed in Table 4.

Questionnaire

The questionnaire was completed in 231 patients. Of them, 107 patient had a length of stay on the ED > 4 hours. In approximately half of patients there was a clear diagnosis (53% in the overall group, 47% in patients with TAT > 4 hours). In majority of patients the supervisor was consulted and in a minority of patients it was already clear that they would be admitted to the hospital. (Table 5). In patients with TAT > 4 hours, 10 of 107 patients waited on consultation from another specialist. 33 of 107 waited on imaging results, 9 of 107 waited on lab results. Similar results were seen in the overall group. Decreasing the waiting time on lab or imaging results was also the most common suggestion of the physicians to improve. In 10 out of 231 questionnaires the physician answered that he/she was very busy with other patients.

Table 5. Answers to questionnaire (n= 231)

	Total (n =231)	> 4hours (n=107)
Clear diagnosis	123 (53%)	50 (47%)
Supervisor consulted	197 (85%)	90 (84%)
Plan to admit	79 (34%)	34 (32%)

Discussion

This study showed that a 'traffic light' moment is an easy and feasible tool for ER's to reduce the number of patients spending more than 4 hours in the ED and to reduce median duration of stay. This is in line with a similar study design of Asha et al.[16] showing a 5.6% decrease in patients spending over 4 hours in the ED after intervention. Perera et al.[17] demonstrated a slightly smaller median time reduction of 18 minutes, 4:04 (IQR 2.22 – 6.53) compared to 3:46 (IQR 2.18 – 6.25), who did not focus on increasing physician time consciousness; instead, they solely followed a government-mandated TBT of 4 hours.

TAT prolonging variables

The need of admission to the hospital, U2 triage, age ≥ 60 and the number of consulting specialties were factors associated with a prolonged TAT. This is in line with earlier studies on prolonged ED stay.[17–20] Remarkably, we found no significant difference in the number of diagnostic tests performed between patients with a TAT longer or shorter than 4 hours. This is in contrast with Ryan et al.[18], who showed that patients who need radiological or blood testing were over four times more likely to spend more than four hours in the ED. However, if we look closer at our data (Figure 2), TAT

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does seem to increase with the number of diagnostic tests performed. Waiting on results of imaging or lab was the most common reason said by the treating physicians themselves for a longer TAT. These results are in line with a Dutch cohort study that showed longer laboratory turnaround times are associated with a longer TAT. We agree with their conclusion that laboratory turnaround times are a promising intervention target to further improve TAT.[21]

Limitations and strengths

The major strength of our study was the simplicity and potential low cost of the intervention which makes is replicable in its feasibility and easy to adopt by other EDs if they so desire. Additionally, the longitudinal design with repeated measures within each period allowed us to control for pre-existing trends.

When looking at our study's results and the intervention some limitations should be taken into consideration. First, due to lack of resources, this non-funded study only includes patients during peak times in our ER. Although the effect of the intervention is expected to be highest during these hours, effects of our intervention on TAT outside of these hours cannot be ascertained. Also, in our design a junior student approached the threating physician with the intervention questionnaire. It was remarkable that at the beginning of the intervention they were often unable to convince the threating physician to complete the questionnaire. After a lecture intervention by a senior member of staff adherence to the intervention improved. However, this had a major contribution to the 8% of our population that were lost for primary outcome analysis. We hypothesize that by giving the task of "traffic light" to a more senior member of staff will improve adherence and can decrease the TAT even more. Also, it can be proposed to use a digital "traffic light", but further research before implementing is needed.

Our study design did not allow for placebo-control and blinding of the intervention, which made it vulnerable to the Hawthorne effect: i.e. physicians in the intervention period may have changed their practice because they knew they were being studied, not because of the intervention itself. Also, although not registered, due to a high turnover of ER consultants, it is highly possible that different physicians were contacted before and after our intervention. Finally, awareness regarding ED length of stay might be influenced by more factors than our intervention.

Recommendations

It is noteworthy that one single intervention cannot be justified as a remedy to a problem as complex as prolonged TAT in the ED. The deployment of multiple interventions, each with tiny gains, should be taken into consideration when hypothesizing about the solution.[15]

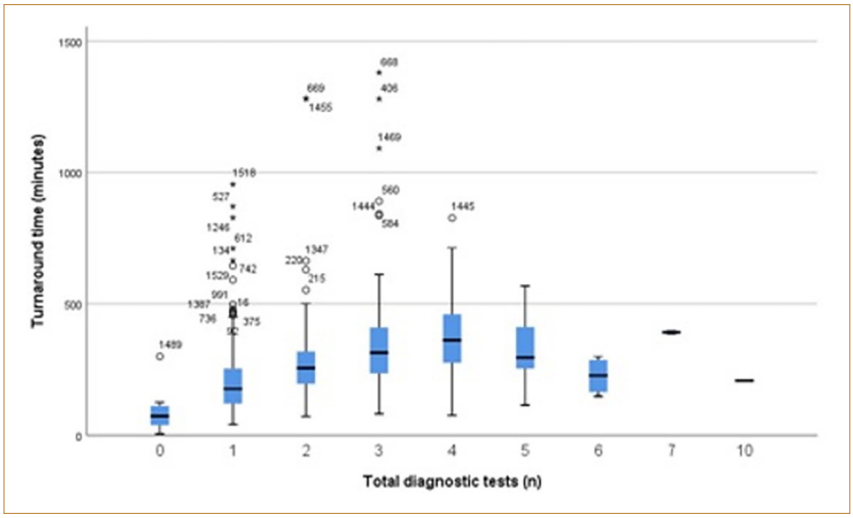


Figure 3. Turnaround time (min) per total diagnostic tests

Furthermore, in this study, most fundamental causes for a longer TAT were linked to organizational constraints such as lack of beds and radiological imaging. Most of these organizational causes could be classed as external since they were caused by forces beyond the ED's control. This means that initiatives aimed at reducing TAT should encompass the entire acute healthcare chain rather than just the ED, adopting a 'whole hospital approach'.[9,14]

Conclusion

Our simple and low-cost intervention reduces the ED length of stay by a significant amount. Although multiple interventions will be required to ensure 80% of all patients spending less than 4-hours in the ED, a 'traffic light' moment is a clear contributing factor. To maximize our intervention's impact further research is needed regarding its effect on ED staff satisfaction, in hospital length of stay and mortality.

Conflicts of Interest and Source of Funding

None of the authors declare any conflicts of interest. There was no funding of this study,

Abbreviations

ED: emergency department
EJC: Emergency Journey Coordinator
ER: emergency room
TAT: turnaround time
TBT: time based target
IQR: interquartile range
METc: Medical Ethics Review Committee
n: number of patients
NEAT: National Emergency Access Target
NHS: National Health Service
SD: standard deviation
y: years

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