Why you should read this article:

● To enhance your understanding of triage processes and of the primary aim of emergency triage
● To explore how the principles of lean management can be applied in a healthcare setting
● To read about a project successfully conducted to reduce triage time in an emergency department

Making more nurses, one minute at a time: an efficiency and quality improvement project in emergency triage

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Abstract

Emergency triage is a short-duration, high-volume process so small reductions in the time taken to triage one patient can have large repercussions on the total amount of triage time. At the emergency department of a large inner-city hospital, an efficiency and quality improvement project was undertaken to reduce the time taken to safely triage patients and optimise the use of triage nurses' time. The project involved removing processes that did not contribute to the primary aim of triage, supporting individual triage nurses to improve their performance where needed, and optimising the triage process. A 44% reduction in mean triage episode time was seen, equating to 18,000 minutes of triage nurses' time saved every month. This near doubling of triage capacity was associated with an improvement in triage accuracy. The article describes the project, which used lean management principles and statistical process control methods, and discusses its implications for emergency triage.

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THE EMERGENCY department (ED) of Manchester Royal Infirmary uses the third edition of the Manchester Triage System (Mackway-Jones et al 2014) to triage patients who present with undifferentiated illness or injury. This 5-level triage system has been shown to have substantial overall reliability (Mirhaghi et al 2017) and moderate-to-good validity for identifying high-urgency and low-urgency patients (Zachariasse et al 2019). It has also been shown to reduce the time taken for higher-acuity patients to be seen (Cicolo et al 2020). The Manchester Triage System has been criticised as being too long and too slow, and has been said to make little

difference to the mean overall time patients spend in the ED (Storm-Versloot et al 2014). However, simply implementing the Manchester Triage System does not automatically improve the efficiency and quality of emergency triage. Rigorously evaluated process redesign is required as well.

To assess the actual value of an ED triage system it is important to be clear about the primary aim of emergency triage, which is to ensure clinical safety by risk managing undifferentiated patients as they present (Mackway-Jones et al 2014). To put it another way, the aim of emergency triage is to ensure that patients with potentially serious

conditions are flagged up early in their journey and are given clinical priority.

This clarification of the primary aim of triage does not imply that the time taken to triage individual patients is unimportant. Triage is a short-duration, high-volume process and when the process is undertaken hundreds of times a day, small increases in the average time taken per patient soon add up. An increase in the total time required to complete the process will result in longer queues for triage, which must then be managed by increasing the number of nurses allocated to triage.

Triage time is affected by the design of the triage process and by the performance of individual triage nurses. Individual nurses will have differing levels of competence and confidence and perform triage at a pace that reflects these. Any intervention designed to alter triage time should be devised with consideration of triage process design and individual nurse performance.

Furthermore, in the authors' experience, the triage process can become inflated with additional processes that are not directly related to triage. Being the first clinical encounter with patients, triage is prone to being 'jumped on' by other healthcare professionals, who may see it as an early opportunity to have their particular clinical interest included in the patient care pathway.

Aim
The aim of this efficiency and quality improvement project was to reduce the time taken to safely triage individual patients and thereby optimise the use of triage nurses' time.

Method
Project principles and tools
The principles of lean management have been applied as quality improvement tools in healthcare for many years. Lawal et al (2014) described lean principles in healthcare as 'a set of operating philosophies and methods that help create a maximum value for patients by reducing waste and waits'. A lean management approach requires the team that owns a process to attempt continuously to reduce waste and improve the quality of its outputs. Eight areas of waste that occur in every industry have been identified and all are relevant to healthcare (NEJM Catalyst 2018). Of these eight areas of waste, 'waiting/idle time' and 'overprocessing' are the most relevant to emergency triage.

Electronic triage systems are rich in data that can be used to drive quality improvement

(Shah 2019). The data make it possible to measure the performance of a whole system easily and regularly and therefore share meaningful performance metrics with staff. This process can be enhanced by the use of statistical process control methods – defined by the American Society for Quality (2022) as 'statistical techniques to control a process or production method' – to highlight individual performance and change (Thor et al 2007).

Project outline
The project was undertaken in the ED at Manchester Royal Infirmary, a large inner-city teaching hospital. Between 300 and 450 undifferentiated new adult patients are seen in that ED each day. The project started in June 2019 and has run continuously since, although it was paused in September 2022 while a new electronic patient record was being implemented. This article reports on its results up to September 2021.

Using data from the ED's electronic management system, triage time was calculated for each triage episode by subtracting the time triage had started from the time triage had been completed. A mean ED triage episode time was calculated for each calendar month in June, July and August 2019 (Months 1, 2 and 3), the three months before quality improvement interventions started to be implemented.

Three discrete quality improvement interventions were then undertaken:
» Step 1: Lean waste management.
» Step 2: Optimising individual nurse performance.
» Step 3: Optimising process flow.
To ensure that the accuracy of triage would not be adversely affected, an audit was undertaken six months before step 1 and repeated six months after step 2. These two audits were undertaken in accordance with the method published by the Manchester Triage Group (Mackway-Jones et al 2014). Each audit looked at five triage episodes for each nurse. Over 70 triage nurses were included in one or both audits.

Project interventions
Step 1: Lean waste management
In September 2019 (Month 4), a lean waste identification exercise was undertaken. This involved a small team of senior nurses familiar with the triage system using low-level process mapping to identify all the processes that triage nurses were expected to undertake during one triage episode. Each identified process was considered in terms of its contribution

Key points

- The aim of emergency triage is to ensure clinical safety by risk managing undifferentiated patients as they present
- Small time savings on every triage episode can free up a large total amount of triage nurses' time
- Interventions designed to reduce triage time must consider process design and individual nurse performance
- Processes introduced in the triage system that do not serve the aim of triage unnecessarily prolong triage time
- Developing a triage gatekeeping function could help protect the time-critical process of emergency triage
- At a large emergency department, a quality improvement project led to a near doubling of triage capacity without reduction in quality or extra investment

towards the primary aim of emergency triage – that is, to ensure clinical safety by risk managing undifferentiated patients as they present (Mackway-Jones et al 2014). Processes that were identified as not contributing, or contributing only to a small extent, to the primary aim of triage – which are shown in Box 1 – were removed from the electronic triage system in October 2019 (Month 5). These processes were already taking place, in addition to triage, at a further nurse assessment, so from October 2019 onwards they were only performed at that further nurse assessment.

Step 2: Optimising individual nurse performance
From March 2020 (Month 10), the individual performance of triage nurses was examined every month for the remaining duration of the project. Before the project, nurses already had to enter their password into the ED's electronic management system before each triage episode. This meant that each triage episode could be attributed to an individual nurse – the nurse who had signed into the system for that episode. Data were retrieved from the electronic triage system and a mean monthly triage episode time was calculated for each nurse by adding all their triage episode times and dividing the total by the number of triage episodes they had carried out during that month.

The mean monthly triage episode times of individual nurses were displayed against the number of triage episodes they had carried out on a chart called a 'funnel plot'. The funnel plot showed 'outliers' whose mean triage episode time was either above the upper control limit or under the lower control limit. The control limits, calculated from the monthly dataset, indicated the acceptable variation between individuals.

Nurses whose mean triage episode time was above the upper control limit and who had carried out 51 or more triage episodes (in consideration of the fact that those who triage 50 patients or fewer have relatively little effect on the ED's mean triage episode

> **Box 1. Processes identified as not contributing, or contributing only to a small extent, to the primary aim of triage**
>
> » Sepsis screening pop-up
> » Frailty scoring pop-up
> » Asthma severity pop-up
> » Safeguarding tick box
> » Early warning score pop-up

time) were audited for the quality of their triage, in the same way as the accuracy of triage was audited.

Following the audit:
» If the nurse's triage quality had been found to be optimal, the nurse was engaged in a constructive discussion on how they could try to reduce their mean triage episode time without negatively affecting their triage quality. They were given practical tips, such as focusing the triage note on important matters. Their performance was reassessed over the course of the next few months.
» If the nurse's triage quality had been found to be suboptimal, a diagnostic period of supported triage was offered. This entailed a triage trainer observing the nurse over a number of shifts and providing detailed feedback on process and accuracy. The nurse's performance was then reassessed and, if it had not improved, they were offered additional preceptorship or, in some cases, a repeat triage training course.

Figure 1 shows an example of a monthly funnel plot. The nurses deemed to require support for improving their mean triage episode time are those whose 'plot' is above the upper control line and who have carried out 51 triage episodes or more.

Step 3: Optimising process flow
From January 2021 (Month 20), triage was undertaken earlier in the patient journey so that it would take place before patients were booked in by clerical staff, in a move to preregistration triage. Furthermore, the interface on the ED's electronic triage system was redesigned to optimise nurses' interactions with the system. The number of 'clicks' and 'tabs' was reduced and the processes were reordered to make their sequence more logical.

Outcomes
Mean triage episode time
The primary outcome measure was the mean time taken to complete one episode of triage. Figure 2 shows the mean triage episode time from June 2019 (Month 1) to September 2021 (Month 28). The timing of the three quality improvement steps is shown so that their temporal association with changes in mean triage episode time can be seen.

In the three months before step 1, the mean monthly ED triage episode time was 4 minutes and 45 seconds. In the six months between step 1 and step 2, the mean triage episode time was 4 minutes and 15 seconds, which means there had been a mean time saving of 30 seconds per triage episode.

After step 2, a further reduction in mean triage episode time of 38 seconds occurred, so that at Month 19 (December 2020), the mean triage time was 3 minutes and 37 seconds. This equated to a reduction of 1 minute and 8 seconds (24%) from the starting value.

After step 3, the mean triage episode time further decreased by 58 seconds so that at Month 25 (June 2021), it was 2 minutes and 39 seconds. This equated to a reduction of 2 minutes and 6 seconds (44%) from the starting value. Overall, there had been a 2 minutes and 6 seconds (44%) reduction in mean triage episode time.

Total triage time
Figure 3 shows the total triage time saved each month against the number of patients attending the ED. The total triage time saved each month was obtained by multiplying the mean time saved per triage episode by the number of patients attending the ED during that month. The total triage time is therefore influenced not only by the reductions in mean triage episode time seen following steps 1, 2 and 3, but also by the number of patients attending the ED. A higher number of patients increases the time saved.

Initially, the number of triage patients was relatively steady at about 6,500 per month. During the coronavirus disease 2019 (COVID-19) pandemic, this number initially declined, then increased and then declined again. After most COVID-19 restrictions had been lifted, it reached an all-time high.

Accuracy of triage
Comparing the results of the audits undertaken six months before step 1 and six months after step 2 showed that the accuracy of triage had improved by 24%. This overall improvement was due to a reduction in the number of incomplete assessments combined with reductions in the numbers of incorrect selections of 'presentation' and 'discriminator'. 'Presentation' refers to 53 presentational flow charts that are available to triage nurses to choose from for each patient. The 'discriminator' refers to the most acute sign or symptom with which the patient presents. Table 1 summarises the results of the two audits of the accuracy of triage.

Discussion
Time savings
As shown above, there had been, from June 2019 to September 2021, a reduction in mean triage episode time of 2 minutes and 6 seconds (44%), which represents a near doubling of triage capacity without extra investment.

Figure 1. Example of a monthly funnel plot showing individual nurses' mean triage episode time against their number of triage episodes
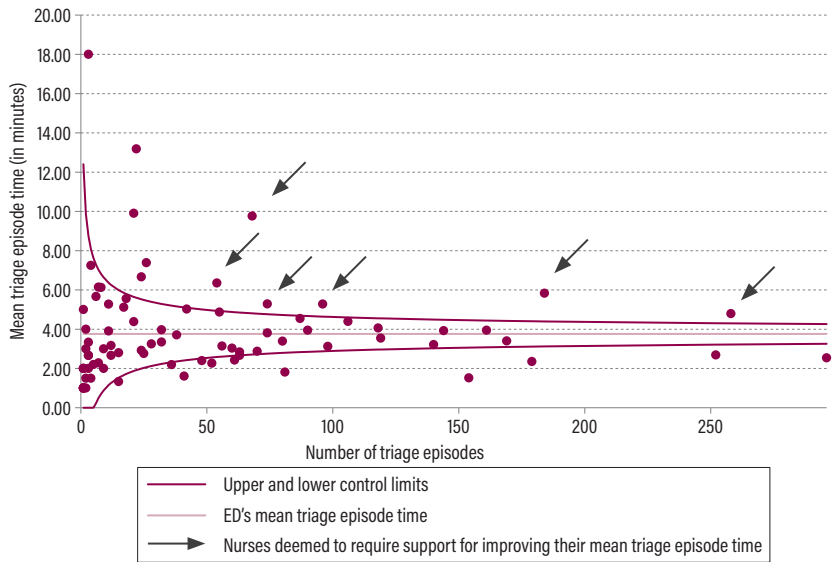

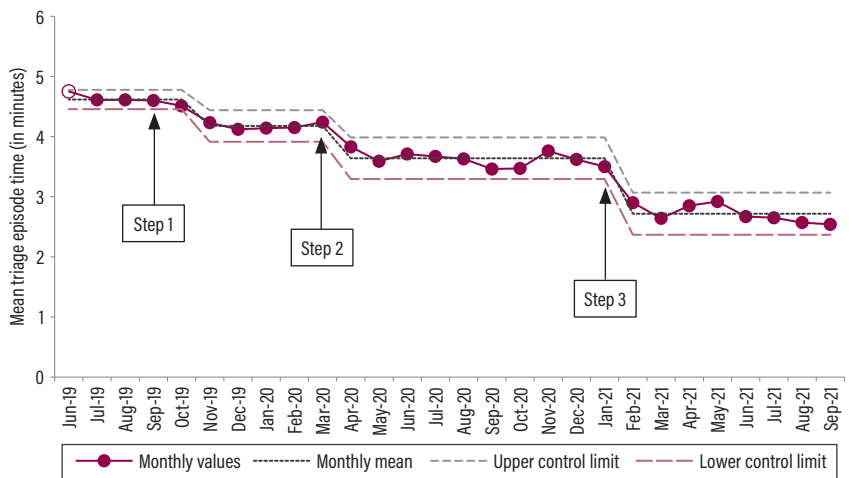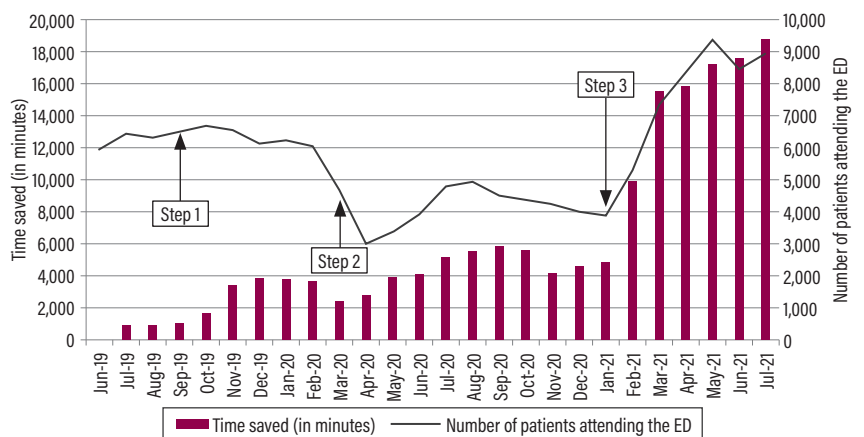**Figure 2.** Mean triage episode time

Figure 3. Total triage time saved each month against number of patients attending the ED

At current activity levels in the ED (almost 9,000 monthly triage episodes), this equates to a saving of 18,000 minutes of triage nurses' time every month – or 25 long day shifts (12 hours worked, 13 hours present including unpaid breaks) or two nurses working full time added to the staffing list.

Even though the time saved for each triage episode was small (just over 2 minutes), the total amount of nurses' time saved was large (25 long day shifts). This time can be used to increase the capacity of the triage nursing team, which is what happened at the Manchester Royal Infirmary ED. Alternatively, it can be reinvested elsewhere in the ED by reducing the number of nurses allocated to triage and redeploying triage nurses to other roles.

There is always a risk that senior hospital managers will regard increased clinical efficiency as a productivity gain that can save them money rather than an opportunity to reinvest resources elsewhere. While it is not possible to prevent such views from prevailing, particularly since hospital managers are under enormous pressure to save money from their budgets every financial year, it would be preferable that the use of any possible savings is discussed and determined at the outset of the project.

Contribution of each intervention to the time savings
The contribution of each project intervention to the overall reduction of 2 minutes and 6 seconds in mean triage episode time was not equal, since:
» Step 1, which consisted in identifying and removing processes that did not contribute to the primary aim of triage, was followed by a mean saving of 30 seconds per triage episode.
» Step 2, which consisted in evaluating individual nurse performance and supporting nurses to improve their performance where needed, was followed by a further mean saving of 38 seconds per triage episode.
» Step 3, which consisted in introducing preregistration triage and optimising the electronic triage system, was followed by a further reduction of 58 seconds in mean triage episode time.

Step 1
While 30 seconds was the smallest reduction in mean triage episode time seen after implementation of any of the three quality improvement steps, it was the easiest to achieve and appears to be easy to maintain. Processes that were removed from the electronic triage system at Step 1 included:
» An asthma severity pop-up – the specialist asthma nursing team had suggested adding this to the triage system after an incident review of a missed case of brittle asthma.
» A frailty scoring pop-up – a national requirement for frailty scoring in emergency care had led to the introduction of frailty scoring at triage.
Each process removed from the triage system may be short in itself, but when the processes are aggregated they take a considerable amount of triage nurses' time. It is perhaps surprising that no one had previously challenged the inclusion of wasteful additions to triage and it is worth reflecting on the reasons why these processes had been allowed to 'creep into' the time-critical process of emergency triage.

To clinicians and managers who want to ensure that a particular process happens – usually after a critical incident review or as part of a quality improvement project – triage is a tempting target. If they can embed their own process into the triage system, they can ensure that it is applied to every patient who enters the ED. If they have direct access to departmental managers and/or the IT staff who manage the electronic triage system, they can obtain agreement to 'insert' their own process into the triage system without being challenged.

Constant vigilance is required to minimise that risk. One possible approach is to reinforce triage governance processes. Triage could be declared a critical process to which no changes can be made without the formal approval of a gatekeeper, who would have to be a senior emergency nurse. The gatekeeper would consider the costs and benefits of any proposed change. They would need to see an evidence-based estimate of the time it would take to carry out the new process and a clear statement of the expected benefits. Triage nurses would need be involved in the decision-making since they have a deep understanding of triage.

Step 2
Step 2 was perhaps the most rewarding aspect of the project. As shown by informal feedback, the nurses reacted positively to the method used for determining who among them needed

Table 1. Results of the two audits of the accuracy of triage

	Overall accuracy	Incomplete assessment	Incorrect selection of presentation	Incorrect selection of discriminator
Six months before step 1	62%	6%	12%	20%
Six months after step 2	86%	1%	4%	9%

support to improve their mean triage episode time. Nurses felt that this had been done fairly. Most nurses showed a great interest in finding out where they were positioned on the funnel plots – which were displayed every month in the ED in anonymised form – and then sought to improve their mean triage episode time if needed. The monthly publication of the funnel plot led to regular informal one-to-one discussions with triage nurses.

Step 3

In hindsight, some of the process changes implemented at step 3 could have been implemented at step 1. However, separating the interventions at step 1 (minimising waste) and step 3 (optimising flow) also had benefits, notably the ability to link time savings to each discrete step when discussing triage governance processes.

Accuracy of triage

All three interventions appeared to have contributed to an overall reduction in the mean time taken to perform one triage episode. This was, somewhat surprisingly, associated with a positive effect on the accuracy of triage between the start of the project and step 2. The authors did not directly investigate the cause of that improvement in triage quality, but they suspect that it reflected the positive effects of the regular informal one-to-one discussions with triage nurses prompted by the monthly publication of funnel plots.

Conclusion

In the course of this project at the Manchester Royal Infirmary ED, which consisted of implementing three discrete quality improvement interventions, a near doubling of triage capacity was seen without extra investment and without reduction in triage quality. The optimisation of triage nurses' time can be used to increase the capacity of the triage nursing team or to redeploy triage nurses to other roles in the ED – if the temptation to save money in the hospital budget can be resisted. One of the interventions consisted in removing processes that did not contribute to the primary aim of triage. To prevent such processes from being included in the triage process in the first place, it could be useful to reinforce triage governance and develop a triage gatekeeping function. Triage nurses need to be involved in decisions regarding triage processes because they are directly affected by them and have a deep understanding of triage.

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