Emergency department crowding: Factors influencing flow
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Chapter 7

Managing patient flow with triage streaming to identify patients for Dutch emergency nurse practitioners

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ABSTRACT

Introduction
We developed a stream system to the current triage system in order to manage patient flow at the emergency department and to clarify emergency nurse practitioner role boundaries.

Methods
Data on admission and death rates - indicating injury severity - and data on length of stay - indicating resource utilisation - were collected from 48,397 patients triaged in the Netherlands in 2009.

Results
A total of 24,294 (50.2%) patients were triaged as ‘suitable for treatment by an emergency nurse practitioner’ (ENP-stream). Remaining patients were triaged ‘medium care’ or ‘high care’. In the medium and high care groups, significantly more admissions took place (6100, 25.3%) and significantly more patients died at the emergency department (31, 0.1%) compared to the patient group in the ENP-stream (admissions: 840, 3.5%, \( P < 0.001 \) and deaths 0, 0.0%, \( P < 0.001 \)). The ENP-streaming is an accurate predictor of not needing to be admitted (PPV=97%) and of emergency department survival (PPV=100%). Mean length of stay was significantly shorter for patients in the ENP-stream compared to the other patients (back transformed values: 74 vs. 147 minutes, \( P <0.001 \)).

Conclusion
This study showed excellent correlation between the ENP-streaming and patients’ injury severity and resource utilisation, suggesting high internal validity of our triage streaming system. It clarifies the emergency nurse practitioner role, minimising the subjectivity of patient allocation.
INTRODUCTION

Because more and more people seek help at emergency departments (EDs), it is important to treat patients according to need, instead of according to order of arrival [1,2]. Triage has been defined as a dynamic decision-making process that prioritises a person’s need for medical care on arrival at an emergency department [3]. The goals of triage include: to rapidly identify patients with urgent, life-threatening conditions, to decrease congestion in emergency treatment areas, and to determine the most appropriate treatment area for patients presenting to the emergency department [4].

In many European hospitals, the Manchester Triage System (MTS), an algorithmic aid to the process of triage, is used [5]. The MTS utilises a series of flowcharts (based on main complaint) that lead the triage nurse to a logical choice of triage category. It is inevitable that this will direct resources away from less urgent cases [6], leading to longer waiting times for those patients who can wait safely. To prevent long waits for this category of patients, the Medical Centre Haaglanden (MCH) retrained seven emergency nurses into Emergency Nurse Practitioners (ENPs). These ENPs are now managing the less urgent patients, namely patients with minor injuries and minor illnesses. A separate three room Nurse Practitioner Unit (NPU) was built. The NPU operates between 7.30 a.m. and 11 p.m. In every day- and evening shift one ENP works at the NPU, treating 15-20 patients per shift. An experienced emergency physician is available for consultation.

In the Netherlands, ENPs are registered emergency nurses with a masters’ degree in advanced nursing practice. They are autonomous practitioners skilled in diagnosing and managing patients in a defined scope of practice. The ENPs used to select patients, waiting to be seen and of which they presumed to fall within their scope of practice, from the waiting room. However, often the triage level (combined with patients’ complaint as documented by the registration), was not specific enough to recognise suitability for ENP treatment, causing delays because of lengthy treatments by doctors, or waiting for an inpatient bed, while occupying a NPU room.

To identify patients suitable for treatment by an ENP, the triage categories are of little use. Our local protocols allow ENPs to diagnose and treat patients with a wide range of defined minor injuries and illnesses (e.g. simple fractures, wounds requiring suturing, burns, foreign objects in skin or body cavity, blunt limb trauma, infections of eye, ear or throat and many more) in triage categories 2-5.
It was not sufficient to simply assign all blue (triage category 5) and green (triage category 4) patients to the ENP. ENPs are able to treat certain categories of patients in triage category 2 (orange) and 3 (yellow) as well, while some patients in categories 4 and 5 should be treated by a physician. E.g., our ENPs can treat patients with a dislocation of the shoulder that were triaged in category 2 because of the pain. However, they are not sufficiently trained to treat asthmatic children in category 4.

In various countries, ENPs play an important role in emergency care. However, each nurse and department has designed the ENP’s interference slightly different. There is a lack of consensus about role boundaries, titles, clinical accountability and educational requirements [7-9]. In an attempt to clarify ENP role boundaries and, at the same time, manage patient streaming, the MCH developed a stream system to the MTS, to identify patients suitable for treatment by ENPs [10]. We defined suitability for ENP treatment based on our local treatment protocols. The MTS flowcharts consist of several ‘discriminators’ that allows the triage nurse to allocate patients to one of the five clinical categories of the MTS (blue-red). Newly developed was a streaming element attached to each discriminator, indicating one out of three ED streams: 1. patients suitable for treatment by the trauma team, coronary care team, or stroke team (high care), 2. patients suitable for treatment by one of the physicians (medium care) and 3. patients suitable for treatment by a ENP (ENP-stream). The triage nurse selects one of the computerised MTS-flowcharts from a standardised complaint list. Then all relevant discriminators are displayed and the triage nurse chooses the discriminator that fits the patients’ condition best. Once the triage nurse assigns the MTS level based on the discriminator, the electronic system adds a mark indicating one of the three streams. E.g. for a patient with a swelling of her ankle, the triage nurse chooses the MTS flowchart ‘Limb problems’ and selects the discriminator ‘Swelling’. After selecting the discriminator, the electronic system adds ‘Nurse Practitioner Unit’ to the name of the patient in the computer screen (Figure 1). No changes were made in the registration and triage processes, therefore there was no need for additional training.

The purpose of this study is to validate the ENP-stream against ED patients’ injury severity and resource utilisation.

Validation of triage tools
The aim of triage is to sort patients according to clinical urgency. The aim of the ENP-stream is to identify patients suitable for treatment by an ENP at triage. In order to validate this ENP-stream, we would have to measure the stratification accuracy of patients it induces. However, there is no single outcome measure that captures this concept. Lack of consensus about outcome measures is a fundamental problem in the validation of triage tools [11].
To evaluate the validity of triage systems, researchers have used different proxy reference standards for prognosis. Amongst others, these include: length of stay (LOS), admission rate, intensive care admission rate, hospital charges, mortality, resource use, and a combination of vital signs at presentation, potentially life-threatening conditions, diagnostic resources, therapeutic interventions and follow-up [12-17].

Since resource use and admission rates are associated with the complexity and severity of a patient’s status, these parameters have been used as validity criteria in many studies [17-20]. In concordance with these studies, we used admission- and death rates (both markers for injury severity) and LOS (a marker for resource utilisation) as primary outcome measures to evaluate the validity of the ENP-stream. The assumption was that patients suitable for treatment by an ENP would have a smaller number of admissions and deaths and a shorter LOS than medium- or high care marked patients. Patients triaged as ‘suitable for treatment by an ENP’ that died or needed to be admitted were considered ‘under triaged’.

METHODS

Study design and setting
We conducted a retrospective, cross-sectional study in the emergency department of an urban, community teaching hospital in the Netherlands, with ±50,000 patients annually and an overall ED hospital admission rate of 20%. All patients were included, except for those who had left before physician or ENP assessment. The regional medical research ethics committee and the institutional review board approved the study.

Measures
Data were retrieved from the hospitals’ electronic patient database (ChipSoft, Amsterdam, the Netherlands).
Our primary outcome measures were admission rates, death at the emergency department and LOS. Length of stay was defined as the interval between patient arrival time and the moment the patient left the emergency department.

Data analysis
Patients who left before medical assessment, were removed from the original data file. The file was checked against medical records in case of missing data, outliers in LOS, and patients triaged with more than one discriminator. For patients triaged with more than one discriminator (for example, in the flowchart ‘limb problems’, the discriminators ‘gross deformity’ and ‘uncontrollable minor haemorrhage’, Figure 1.), the code that was actually used in practice (leading to the stream), was also used for analysis.
Pearson’s $\chi^2$ was used to examine the relationship between the ENP-stream and admission rates, and between the ENP-stream and death rates. To assess the ENP-stream as a predictor of not needing to be admitted or death, positive predictive values were calculated.

After normalising the LOS data with a logarithmic function, the relation between the ENP-stream and LOS was tested using an unpaired $t$ test.

Data analysis was performed using PASW (Predictive Analytics Software, version 17, Chicago, Illinois, USA).

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**Figure 1.** Allocation of patients with limb problems to one of the three ED streams, based on MTS discriminators.
RESULTS

In 2009, 49,474 patients visited the emergency department, of which 1,077 (2.2%) left before medical assessment. The remaining 48,397 patients were analysed. Of these, 24,294 (50.2%) were triaged with the ENP-stream: patients suitable for treatment by an ENP.

In the medium and high care-marked patient groups, significantly more admissions took place (6,100, 25.3%) in comparison to the patient group with the ENP-stream (840, 3.5%) ($P < 0.001$). The positive predictive value shows that the ENP-stream is an accurate predictor of not needing to be admitted (PPV=97%). The patient group with an ENP-stream needing to be admitted (considered to be under triaged) included significantly more patients with back pain ($P = 0.007$), head injuries ($P < 0.001$), limb problems ($P < 0.001$), local infections and abscesses ($P < 0.001$), a sore throat ($P = 0.037$) or urinary problems ($P < 0.001$).

In the medium and high care-marked patient groups, significantly more patients died at the emergency department (31, 0.1%) compared to the patient group with an ENP-stream (0, 0.0%) ($P < 0.001$). Thus, the positive predictive value of the ENP-extension on ED survival was 100%.

In the medium and high care-marked patient groups, mean LOS was significantly longer (back transformed value: 147 minutes) in comparison to the patient group with an ENP-stream (back transformed value: 74 minutes) ($P < 0.001$).

DISCUSSION

Research has demonstrated that ENPs are able to care for low acuity patients within the emergency department [9,21-23]. However, there has never been a standardised, validated approach in the assignment of presumed low acuity patients to ENPs. Wide acceptance of an objective streaming system could minimise the subjectivity of the patient’s allocation, clarify ENP role boundaries, provide greater uniformity between the ENPs and improve research possibilities.

A small amount of the patients with the ENP-stream (3.5%), were under triaged (admitted). Although the literature demonstrates this to be lower than the amount of under triage associated with ‘regular’ triage systems [24], the MTS streaming system could even be further improved by reducing this number.
The group of under triaged patients included many subjects presenting with back pain, head injuries, limb problems, local infections and abscesses, a sore throat or urinary problems. Although these patients needed to be admitted, analyses of their patient files showed that four out of these six diagnostic groups (head injuries, limb problems, local infections and abscesses and urinary problems) could be handled perfectly well by ENPs. However, final diagnoses of the patients triaged with back pain or a sore throat indicated that it might be better to remove the ENP-streaming from these two groups.

ENP-marked, admitted patients with head injuries, limb problems, local infections and abscesses and urinary problems were considered under triaged, but the reasons for their admission were often straightforward and captured in protocols. Since ENPs are able to identify those patients in need of admission and/or more specialised care, ENP treatment of these patients is not hazardous. Amongst others, reasons for admission were: fractured limbs needing reposition in the operating room, monitoring consciousness level of intoxicated patients (alcohol/drugs), incision and drainage of an abscess under sedation, or the need for intravenous antibiotics and fluid resuscitation. Since ENPs can identify these patients while independently treating all other patients with the same triage streaming, marking these patients as suitable for treatment by an ENP is safe and efficient.

However, in patients triaged within the flowchart ‘sore throat’ or ‘back pain’, the safety of ENP treatment and thus ENP-marking appeared to be questionable. While most patients with a sore throat can be treated by an ENP, final diagnoses demonstrate that some of these patients can better be treated by a physician to recognise serious problems. Final diagnoses included pneumonia, lung carcinoma, leukaemia, pericarditis and even one patient with an aphasia based on ischemic brain injury. The same is applicable for the flowchart ‘back pain’, since this included patients with, amongst others, spondylodiscitis, neoplastic metastases, pneumothorax, long embolism and pyelonephritis. Although part of these patients were triaged in the wrong way (they would not have been marked as a patient suitable for treatment by an ENP if the MTS had been used properly), we recommend partial removal of these triage categories from the ENP streaming, to improve patient safety. If the streaming codes ‘hot adult’ and ‘moderate pain’ in the flow cart ‘sore throat’ and the extension codes ‘moderate pain’ and ‘unable to walk’ in the flow chart ‘back pain’ would be regarded as medium care in stead of ENP care, the ENP-streaming of the MTS would be further improved. Although this adaptation reduces efficiency and most of these patients can be treated by ENPs perfectly well, a ‘sore throat’ or ‘back pain’ might be the only sign of having a serious underlying disease. To prevent ENPs from misdiagnosing these patients, a physician should treat patients with previously mentioned streaming codes.
Furthermore, in order to improve the results of the MTS streaming system, the MTS should be used correctly and patients should be triaged with the most specific discriminator possible. Only if no specific discriminators suggest a higher categorisation, general discriminators such as ‘severe pain’, ‘moderate pain’, or ‘pain’ should be chosen. In many of the under triaged patients in the research population, the discriminators ‘pain’ or ‘moderate pain’ -both leading to the ENP-streaming- were used while another discriminator -leading to a medium or high care streaming- would be more appropriate. More accurate use of the MTS would reduce the amount of under triage (3.5%) even further.

Reducing the number of admissions among patients triaged with the ENP-streaming to 0% is impossible and unnecessary. Admission of ENP-marked patients can not be completely avoided without very large groups of patients with the same diagnoses being excluded from the ENP-streaming. In spite of their admission, most of these ENP-marked patients can be managed by ENPs since they are trained to identify the patients that require handover to medical staff. Besides, our ENPs can consult emergency physicians any time while the patient remains at the NPU.

One of the objectives of ENPs handling patients with minor injuries and minor illnesses was to reduce waiting times for patients with less urgent symptoms. These patients experience the longest waits, especially when they present to an emergency department with more than 30,000 visits annually or a teaching hospital [25]. However, while waiting times are expected to be relatively long for patients triaged with the ENP-streaming, total LOS should be relatively short. Waiting time is just a minor part of LOS. We presumed total LOS to be a marker for resource utilisation [26]. Although we did not account for waiting time in our study, LOS indeed turned out to be significantly shorter for ENP-marked patients (74 minutes), than for the medium and high care-marked patients (147 minutes, $P < 0.001$). This upholds the presumption that ENP-marked patients need a less extensive kind of care.

The MTS streaming system in our hospital has evolved to be an effective aid to improve the flow of patients and is well accepted by patients and staff. Emergency department personnel expressed no resistance to the implementation of ENPs. We believe this was partly due to the clear role boundaries on the one hand, and flexibility on the other. Although staff and management verbalised their satisfaction with the streaming system of the MTS, no formal evaluation was conducted.
Limitations
The most important limitation of our research is that we evaluated the validity of the triage streaming system based on its accuracy in predicting hospital admission, mortality and LOS. The premise was that in patients in the ENP-stream, LOS should be shorter and admission and death rates should be lower in comparison to patients in a medium or high care-stream. This seems reasonable, since patients triaged as suitable for treatment by an ENP should be those with relatively uncomplicated problems. In absence of a clear reference standard, the MTS streaming system can not be validated without using these kinds or proxy measures.

A second limitation of our study is that it is not possible to compare our findings to other study results, because of the different methods used to allocate patients to ENPs and the lack of other research on this subject. Therefore, our study is limited to the experience of one hospital. More studies on the same subject and in other settings are necessary to evaluate external validity of the triage streaming system. We acknowledge that consensus view, on which this streaming system is based, is the weakest form of evidence. However, being in function now for over three years, combined with the fact that the MTS is a well accepted triage system, we believe the streaming system is only a minor adjustment with great potential.

Thirdly, working with retrospective data, data inaccuracies or flaws in the computer system could have biased the results. Nevertheless, it is unlikely that patients were not entered into the emergency departments’ computer system, as well as it is unlikely that inaccuracies were unequally divided over the different patient categories that were investigated.

CONCLUSIONS
Our study showed excellent correlation between the ENP-streaming and patient severity (admission and death rates) and resource utilisation (LOS), suggesting high internal validity of the triage streaming system.

We believe the ENP model of care to be an important strategy in the management of increased service demands and therefore, in preventing or handling ED overcrowding. A streaming system based on discriminators of an accepted triage system to objectively identify patients suitable for treatment by ENPs, is one of the possibilities to clarify the ENP role, minimise the subjectivity of patient allocation and increase research possibilities. In the emergency department of the MCH, triage nurses are perfectly able to decide which patients to assign to an ENP.
REFERENCES