Emergency department crowding: Factors influencing flow
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INTRODUCTION

This thesis focused on different aspects of emergency department (ED) crowding and patient flow at the emergency department, using the largest inner-city emergency department in the Netherlands as study setting for most of our research. Comparing our findings regarding patient flow (input-, throughput- and output factors) with international evidence might support health care professionals and hospital management in the process of recognising and mitigating ED crowding and in improving patient flow at emergency departments in the Netherlands.

DISCUSSION OF THE MAIN FINDINGS

PART I  CROWDING IN DUTCH EMERGENCY DEPARTMENTS

Sixty-eight percent of the responding Dutch ED nurse managers reported crowding occurring several times a week or even daily (chapter 2). Delays in consultations and laboratory and radiology services contributed to the problem. Admitted patients had a longer length of stay because of delays in obtaining inpatient beds. The reported crowding is well below that of studies performed in the USA in which 91% of the ED directors reported crowding to be a problem [1-3].

PART II  INPUT OF THE EMERGENCY DEPARTMENT

In our inner-city emergency department, 60% of our patients were self-referred, bypassing their general practitioner because of the EDs’ easy access and because they believed that hospital emergency care was necessary for their complaint (chapter 3). Compared to previously published data from Dutch emergency departments, our self-referral rate was high [4,5]. Our self-referrals had urgent medical problems more often than those in another Dutch study [6]. An urgent medical problem increases the risk of a prolonged length of stay and associated ED crowding.

Emergency department crowding causes long waiting times and delays in treatment [7-12]. Maintaining a non-crowded emergency department requires hospital and ED staff to optimise patient flow and decrease patients’ length of stay. Focusing on a timely discharge of patients that do not require admission is an important strategy for mitigating ED crowding [13]. Although the timely and swift treatment of patients is an important goal for emergency departments, it might lead to premature discharges [14] which, in turn may trigger unwanted ED return visits [15]. Patients returning to the emergency department within a few days of their visit or their stay at the hospital may contribute to ED crowding [15,16] and it is a vicious circle. In our study regarding ED return visits (chapter 4), unscheduled return
accounted for 5% of the ED visits. Our return visit rate compares well with other published
return rates [15-21]. Most associated factors (an immediate/high urgent or urgent triage
level, arriving during the night, having a longer length of stay at the first visit, suffering
from a wound or local infection, or a urinary problem) differ from previous studies, except
for ‘abdominal complaints’, which was found to be a risk factor in many studies [15,17,19].
The reasons for ED return were comparable with studies from other countries [15,21-23]:
most often illness-related, then patient-related and least often physician-related reasons,
prompted the patient back to the emergency department.

It has been documented that patients with frequent ED visits account for a disproportionate
amount of the total ED workload and contribute to ED crowding [24]. Frequent visitors
and highly frequent visitors are sometimes portrayed as unnecessarily clogging emergency
departments by presenting with primary care problems better treated elsewhere [25]. A
recent systematic review however, showed that many frequent visitors present with true
medical needs [26]. The majority of the presentations of frequent visitors are not suitable
for general practice [27]. Our findings in the study regarding high ED utilization (Chapter 5)
were consistent with the latest evidence regarding high ED utilization: both frequent visitors
and highly frequent visitors visited the emergency department for significant medical
problems: shortness of breath, abdominal pain, urinary tract problems and psychiatric
disorders. Frequent visitors had higher admission rates than patients with single visits. High
ED utilization seems to be less a problem than outlined in international literature: frequent
visitors and highly frequent visitors comprised only 0.5% of total ED patients, who presented
to the two emergency departments on 2,338 occasions (3.3% of total ED consultations in
one year). It is possible that the strong primary care network in the Netherlands prevents
part of the ED visits.

PART II   THROUGHPUT OF THE EMERGENCY DEPARTMENT

One of the strategies proposed to improve patient flow and reduce crowding in Medical
Centre Haaglanden was to allow trained emergency nurse practitioners to assess and treat
patients with non-urgent complaints (minor injuries or illnesses) autonomously. Non-urgent
presentation rates to emergency departments vary between 4.8 and 90% [28]. Non-urgent
ED patients may contribute to ED crowding [28,29].

Studies from Canada, Australia, the Middle Eastern and the United Kingdom have
demonstrated that emergency nurse practitioners are able to care for non-urgent ED
patients, reduce ED crowding and improve patient satisfaction [30-34]. However, no
allocation system or standardised approach in the assignment of presumed non-urgent
ED patients to emergency nurse practitioners was found in the literature. Therefore, we
adapted the current triage system and validated the triage streaming. This stream system has helped to clarify emergency nurse practitioners role and prevent long waiting times for patients with minor injuries and minor illnesses (chapter 6 and 7).

The problem posed by redirecting a part of the patients to emergency nurse practitioners is safety of care. Are Dutch emergency nurse practitioners capable of treating patients with a diagnostic and management accuracy equivalent to that of a physician? We answered this question in chapter 8, accompanied with a description of the differences in patients’ waiting times and patients’ length of stay between emergency nurse practitioners and physicians. Our study confirmed that emergency nurse practitioners are able to care for non-urgent patients; there were no differences in diagnostic accuracy between physicians and emergency nurse practitioners. Furthermore, patients treated by emergency nurse practitioners as compared with patients treated by physicians had a shorter length of stay. Our results corroborate previous studies comparing emergency nurse practitioners with physicians in other countries [33,35].

**PART III OUTPUT OF THE EMERGENCY DEPARTMENT**

Since ED crowding is associated with long waiting times for patients before evaluation, it can lead to patients leaving the emergency department without being seen or treated by a physician or emergency nurse practitioner [36,37]. Our walkout rate (0.7%) (chapter 9) was relatively low compared to international data, perhaps because ED crowding is milder in the Netherlands compared to other countries. However, target times to treatment elapsed for 54% of the walkouts and 38% of the walkouts left before triage, suggesting that crowding issues did occur during the study.

Output issues, especially the inability to transfer emergency patients to inpatient beds and the resultant ‘boarding’ of admitted patients in the emergency department for long periods, are most commonly associated with ED crowding [38-43]. Ensuring that inpatients beds are available when they are required is essential if EDs are to operate efficiently [44] and ED crowding can be reduced most effectively by moving admitted patients to inpatient settings as rapidly as possible [45]. To increase throughput of acute patients Medical Centre Haaglanden Westeinde opened a flexible acute admission unit. Our qualitative evaluation revealed that the flexible acute admission unit reduced ED nurses’ workload (chapter 10). A before-and-after interventional study (chapter 11) showed a relevant reduction of the number of transfers of admitted patients to other hospitals. The expected increase in length of stay for special care patients and non-admitted patients was not observed for flexible acute admission unit-admissible patients. This finding suggests that flexible bed management might be useful in preventing ED crowding.
METHODOLOGICAL CONSIDERATIONS

LIMITATIONS
The limitations of each of the individual studies included in this thesis have been discussed in accompanying chapters. Here, we summarise some general methodological considerations.

Our studies, presenting different aspects of ED flow, were observational and explorative. Each study was conducted in response to questions posed by the Netherlands Society of Emergency Nurses (NVSHV) (chapter 2), the management of the emergency department of Medical Centre Haaglanden (chapters 4, 5, 6, 7 and 9) and hospital management (chapters 3, 8, 10 and 11). Although we were unable to test causal mechanisms as a result of the observational designs, our study results supply health care professionals and hospital management with valuable information regarding different aspects of patient flow and the state of ED crowding in the Netherlands.

We studied aspects of ED flow and factors related to ED crowding while lacking a standard definition of crowding and lacking a validated, objective measure of ED crowding. We used ED length of stay as a proxy for crowding to assess the effect of crowding on the studied subject (chapter 4, Unscheduled returns and chapter 5, High ED utilization) or the effect of the studied subject on crowding (chapter 10 and 11, Flexible acute admission unit). There is an accepted association between increased ED length of stay for admitted patients and crowding. This is based on the fact that boarding patients at the ED results in increased ED length of stay. However, increased ED length of stay will also contribute to crowding. The complicated relationship between ED length of stay, ED efficiency, ED capacity and ED crowding has not been fully explored [46]. The other measure we used (in chapter 9, Walkouts) was the crowding index, which was defined as the number of patients registered during the hour of registration of the index patient and the number of patients registered during the hour before the index patient [47]. The crowding index, as with length of stay, represents only one aspect of ED crowding and does not account for the intensity of care needed for the patients at the emergency department.

Measurements of crowding are not well developed internationally [46]. However, our purpose was to focus on different aspects of patient flow at the emergency department and to compare our findings regarding patient flow with international evidence. Both were possible since many retrospective, observational studies from North America and Australia have been carried out which used similar flow aspects and proxy measures.
Our studies took place in a single hospital, except for the study described in chapter 2 (which contained information regarding 63 emergency departments in the Netherlands) and the studies in chapters 5 and 9 (which were performed in two emergency departments). Our results presumably do not exactly represent other emergency departments in the Netherlands. Since the Medical Centre Haaglanden Westeinde was the largest emergency department in the Netherlands at the time of our studies, we assumed that crowding issues would be most prevalent in this study setting. However, our survey of ED crowding in chapter 2 showed that smaller emergency departments also suffer from crowding and some of these smaller emergency departments suffer from crowding even more often than some larger emergency departments in the Netherlands. Although the results in this thesis may not be literally transferred to other regions of the Netherlands, they provide an understanding of patient flow at Dutch emergency departments and factors related to ED crowding.

CONCLUSIONS

We conclude that problems with patient flow exist in the Netherlands. Although crowding has not been the focus of research, clearly many Dutch emergency departments struggle with it. Most departments are implementing interventions to improve patient flow in order to prevent ED crowding.

Our study results suggest that it is possible to reduce the input of patients at our emergency department: a number of the self-referrals are suitable for primary care and some of the unscheduled returns may be prevented. The rate of frequent visits is very low and the majority of these visits are made for significant medical problems. Efforts focusing on this small group of patients will have minimal impact on ED use and on ED crowding.

A stream triage system may be used to objectively identify patients suitable for treatment by emergency nurse practitioners. Since the emergency nurse practitioners showed high diagnostic accuracy, the emergency nurse practitioner model of care is an important strategy in reducing length of stay of ED patients and may prevent ED crowding.

One of the predictors of leaving without treatment was arrival during crowded conditions. Waiting time was the main reason for leaving. When ED crowding evolves, strategies addressing long waiting times are required.

The implementation of the flexible acute admission unit alleviated output issues at our emergency department. Improving processes at the emergency department will reduce patients’ length of stay. The effect of reduced ED length of stay on mitigating the problem of ED crowding needs further research.
INTERNATIONALLY, RESEARCH AT EMERGENCY DEPARTMENTS HAS BEEN FOCUSING ON TRYING TO DEFINE AND MEASURE ED CROWDING. MEASURES USED IN THE LITERATURE TO QUANTIFY CROWDING ARE CATEGORIZED INTO FIVE TYPES [48]: CLINICIAN OPINION, INPUT FACTORS, THROUGHPUT FACTORS, OUTPUT FACTORS AND MULTIDIMENSIONAL SCALES. INPUT MEASURES OF CROWDING INCLUDE WAITING TIME [49,50], TIME TO PHYSICIAN [51], WAITING ROOM FILLED > 6 HOURS/DAY [1,3], NUMBER OF PATIENTS REGISTERED [52,53], AMBULANCE DIVERSION EPISODES [54] AND NUMBER OF PATIENTS AWAITING TRIAGE [53]. THROUGHPUT MEASURES OF CROWDING INCLUDE ED BEDS AT CAPACITY > 6 HOURS [1,3], NUMBER OF FULL ROOMS [53], TOTAL NUMBER OF PATIENTS IN EMERGENCY DEPARTMENT [41,51,53,55-57], ED OCCUPANCY RATE [49-51,54,58,59], NUMBER OF ED DIAGNOSTIC ORDERS [60], NUMBER OF PATIENTS PER NURSE OR PHYSICIAN [41,54] AND ED LENGTH OF STAY [49-52,54]. OUTPUT MEASURES OF CROWDING INCLUDE THE NUMBER OR PERCENTAGE OF ADMISSIONS [56,61,62], THE NUMBER OR PERCENTAGE OF BOARDERS [49-54,58,61-64], BOARDING TIME [49-51,53,54,57,58,63], ED ADMISSION TRANSFER RATE [54], THE NUMBER OF INPATIENTS READY FOR DISCHARGE [54], PATIENTS LEAVING WITHOUT BEING SEEN [58, 60] AND INPATIENT OCCUPANCY LEVEL [54,56,60-62]. FINALLY, SEVERAL MULTIDIMENSIONAL SCALES ARE USED TO QUANTIFY CROWDING [65-70]. IN THE NETHERLANDS, ONLY ONE STUDY USING A CROWDING SCALE HAS BEEN PUBLISHED [71]. MANY EMERGENCY DEPARTMENTS IN THE NETHERLANDS DO NOT USE ELECTRONIC PATIENT TRACKING SYSTEMS THAT ROUTINELY COLLECT THE DATA ELEMENTS NEEDED TO COMPUTE CROWDING SCALE SCORES.

INSTEAD OF CALLING FOR ACTION TO START COLLECTING DATA ELEMENTS TO COMPUTE CROWDING SCALE SCORES IN ALL DUTCH EMERGENCY DEPARTMENTS, WE WOULD RECOMMEND TO MEASURING PATIENT FLOW ITEMS. AS BRENT ASPLIN WROTE: "INSTEAD OF DEFINING AND MEASURING WHAT WE DON’T WANT TO HAPPEN, WE SHOULD START DEFINING AND MEASURING WHAT WE WANT TO HAPPEN [72]." MEASURING PATIENT FLOW ITEMS CONSISTENTLY ACROSS SITES AND THROUGHOUT TIME WOULD ENABLE RESEARCHERS TO STUDY THE EFFECTS OF INTERVENTIONS AIMED TO PREVENT ED CROWDING OR TO REDUCE ED CROWDING. THE INPUT-THROUGHPUT-OUTPUT CONCEPTUAL MODEL OF INTERVENTIONS (FIGURE 1) CLARIFIES THE ED PROCESSES THAT MAY IMPROVE PATIENT FLOW AND CONSEQUENTLY, ALLEVIATE CROWDING IF THEY ARE CHANGED [73].

MANY INTERVENTIONS OF VARYING COMPLEXITY, INTENSITY AND DURATION HAVE BEEN APPLIED TO IMPROVE ED PATIENT FLOW AND ADDRESS THE ISSUE OF ED CROWDING AT THE SAME TIME [73]. ADDITIONAL PERSONNEL MAY REDUCE THE PATIENT LENGTH OF STAY AND THE RATE OF PATIENTS LEAVING THE EMERGENCY DEPARTMENT WITHOUT BEING SEEN BY A PHYSICIAN OR EMERGENCY NURSE PRACTITIONER [74,75]. IMPLEMENTING POINT-OF-CARE LABORATORY TESTING MAY DECREASE THE LENGTH OF STAY [76]. TRAINING NURSING STAFF TO ORDER X-RAYS AT TRIAGE IS HELPFUL AND CUTS THE PATIENTS’ STAY BY AROUND 20 MINUTES [77]. OBSERVATION UNITS MAY REDUCE THE LENGTH OF STAY FOR OUTPATIENTS, DECREASE AMBULANCE DIVERSION, REDUCE THE NUMBER OF BOARDING PATIENTS AND REDUCE THE...
rate of patients leaving without being seen [44,78,79]. Increasing the number of critical care beds may reduce ambulance diversion [86]. Most interventions generate a moderate to large effect on ED crowding [73], however, similar interventions were implemented at different hospitals with varied success [80]. Before interventions are instituted, it is critical to identify what the main causes of crowding are in an emergency department [81] and how to make the flow through that specific emergency department more efficient.

![Diagram](image.png)

**Figure 1.** Input-throughput-output conceptual model of interventions to alleviate ED crowding [73]. Model adapted from Asplin et al. [90] and Fatovich [91].

In conclusion, potential interventions to improve patient flow through the emergency department depend on the causes of ED crowding. In the Netherlands, input factors (such as the number of self-referrals presenting at the emergency department and the frequent users of the emergency department), were considered to be an important cause of ED crowding. A solution to this problem would be the implementation of general practitioner cooperatives at emergency departments and the referral of patients with minor complaints to a general practitioner. Internationally, research investigating the causes of crowding initially focused on input factors such as the use of the emergency department for non-urgent complaints [24,82-85]. More recent research suggests that input factors are probably not the root cause of the problem of ED crowding [81]. Discouraging the use of the emergency department for non-urgent issues will not have a meaningful impact on reducing waiting times for other patients or lessen crowding [86,87]. Strategies aimed at diverting patients with minor conditions may not work [88]: *while patients with minor conditions wait for care, they do so in the waiting room, thus not preventing access by seriously ill or injured patients to the emergency department.*
Rather, output issues especially the inability to transfer emergency patients to inpatient beds and the resultant boarding of admitted patients in the emergency department for long periods, are most commonly associated with ED crowding [38]. Nowadays, ED crowding is seen as a *local manifestation of a systemic disease* [29]. It is not a problem that results solely from problems in the ED or one that can be addressed using only ED-based solutions [72]. For example, there is a reasonable body of evidence correlating hospital occupancy with ED crowding [46].

In order to understand the complexity of the problem and the state of ED crowding in the Netherlands, we need robust, long-term data collection and analysis at national level. *Who* or *what* is causing crowding at the emergency departments in the Netherlands? The lack of consistent collection of standardised ED data at institutional and national levels impairs the ability to quantify ED use and ED flow issues. No national registration database regarding setting characteristics and input- throughput- and output factors of the emergency departments in the Netherlands exists. LET’S START REGISTERING NOW!

**KEY RECOMMENDATIONS**

- The Netherlands Society of Emergency Physicians (NVSHA), the Netherlands Society of Emergency Nurses (NVSHV) and government agencies should partner to bring together leadership dedicated to solve ED crowding. Since patients are harmed in crowded emergency departments [89], crowding should be considered as unacceptable.
- A consistent collection of standardised ED data (ED setting characteristics and input-throughput- and output factors) at institutional and national levels is needed to accurately measure and monitor ED use and ED flow nationwide and to measure and evaluate the effect of interventions to improve patient flow.
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