Emergency Departments in the Netherlands

an exploration of characteristics and operational standards for the purpose of future optimization

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SpoedEisende Hulp afdelingen in Nederland

een exploratie van karakteristieken en operationele standaarden
ten behoeve van toekomstige optimalisatie

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Voor Joske

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General introduction and thesis outline

Gaakeer MI

This introduction is partly based on:
Emergency medicine in the Netherlands:
a short history provides a solid basis for future challenges

Gaakeer MI

van den Brand CL

Patka P

Eur J Emerg Med 2012, 19:131-135

1.1 | Emergency department

Emergency departments (EDs) are an important source of urgent and acute care for a large proportion of the Dutch population. Over the past decade approximately two million people have been treated in the country's available EDs each year [1,2]. In 2016 less than 17 percent of cases was self-referred [2]. More than 38 percent (700,000 patients) was hospitalized via the ED, accounting for almost half of all hospital admissions [2]. EDs unmistakably play a leading role in the delivery of hospital-based acute care, including emergency care, to the population in the Netherlands [3].

EDs have emerged from what was formerly known as emergency rooms (ERs) [4]. Starting in the 1950s, hospitals began to set up emergency facilities, usually in a remote part of the hospital. These facilities were staffed by one or more nurses and house staff resident physicians. If necessary, they could call on medical specialists [4]. Required qualifications for nurses nor for physicians working in EDs were not formulated. In fact, in 1996 as little as 12 percent of all physicians working in the ED had followed an advanced trauma life support course [5]. Furthermore, required specialized equipment was only brought to the facility on demand and initially only a few patients were treated there per day [4].

Modern EDs are no longer comparable to ERs from the past. Over the last thirty to forty years ERs have turned into more and more professionally staffed and substantially better equipped departments for the provision of complex acute care. The number of patients treated has increased dramatically and the category of patient has changed. Today's patients are more severely ill, older and they have more comorbidities [6]. In addition, the morbidity spectrum has shifted from communicable diseases to noncommunicable diseases such as cancer, cardiovascular diseases and trauma [7]. Other factors that have changed over time concern the wider environment. Treatment possibilities in medicine have increased, as have the expectations of patients. More extensive legislation and monitoring by healthcare authorities become a standard in medicine and in acute care [7]. Furthermore, there has been an increase in the number of patients admitted to hospital via the ED [2]. In the Netherlands EDs have become institutionalized. They are embedded within eleven regional acute care networks that offer differentiation and specialization in terms of specific forms of emergency care (e.g. Trauma, Cerebro Vascular Accident, acute Myocardial Infarction, and Acute Abdominal Aneurysm) [8]. In addition, from 2000 onwards, acute care provided by general practitioners has also become organized nationally in joint ventures, the so called General Practitioners Cooperatives (GPCs). Subsequently, cooperation between EDs and GPCs has increased over the last ten years [1,2]. As a result of all these changes, the working practices of a modern ED are significantly different from those that were used thirty, twenty or even ten years ago.

Although the term ED is being used by various stakeholders to refer to a range of different urgent care facilities, the 2012 International Federation for Emergency Medicine (IFEM) terminology project has clearly defined the entity of an ED unambiguously as: *'The area of a medical facility devoted to provision of an organized system of emergency medical care that is staffed by Emergency Medicine Specialist Physicians and/or Emergency Physicians (EPs) and has the basic resources to resuscitate, diagnose and treat patients with medical emergencies. The ED is a unique location at which patients are guaranteed access to emergency care 24 hours a day, 7 days a week. It is able to deal with all types of medical emergencies (illness, injury and mental health) in all age groups* [9].'

As resources determine the abilities of any ED, there seems to be an obvious need to establish (minimum) operational standards and thus an effective medical praxis baseline for the delivery of appropriate hospital-based acute and emergency care. However, in the Netherlands a standard of functionality, i.e. the extent to which facilities, diagnostics and healthcare providers are available in EDs, has not yet been decided. Even more, it is unclear how the availability of facilities, diagnostics and healthcare providers is currently organized [10]. In order to be able to optimize the ED landscape, more clarity might need to be given here.

1.2 | Emergency department staffing

Also ED human resources (staffing) professionalized. Already in 1990 an article entitled 'Emergency medicine: a new discipline urgently needed' was published in the Netherlands Journal of Medicine [11]. It presented the conclusions formulated during Belgian-Dutch workshops on emergency medicine, an initiative of a number of anesthesiologists and held in Belgium in 1989. However, by then although the initiative was well documented and well known, it did not get sufficient support and was not embedded within the medical care system in the Netherlands. Still, despite the fact that the original plan stranded, it has probably contributed to the creation of general awareness. The international conference 'Emergency medicine who cares?' took place in 1999 in Amsterdam. The same year the Dutch Society of Emergency Physicians (DSEP) has been established [7]. 1999 is the starting point of a new style of emergency medicine (EM) in the Netherlands [7]. From 1999 on groups of professionals presented, in the ED as well as in the EM chain, new ideas and new organization. From 1992 onwards all EDs gradually became staffed by trained ED-nurses. In addition, in the early 1990s ambulance services introduced a national training programme for ambulance nurses and ambulance drivers leading to the implementation of national guidelines in 1992 [7]. Since 2008, a uniform, nationwide, emergency medicine medical training programme has been in place [7]. In 2009 this medical emergency field was recognized as an area of special interest by the Central College Medical Specialties (CCMS) of the Royal Dutch Society for Medicine (KNMG) [7]. Although recognized as an independent profession, EM still lacks a full status as a basic medical specialty. Today about 650 emergency physicians (EPs) are active in the profession and their presence in EDs is increasing (Source: DSEP March 2019). The aim, based among other things on preferences formulated by the Dutch Healthcare and Youth Inspectorate, is to grow towards continuity of care delivered by EPs in all EDs throughout the Netherlands, irrespective of the time of day. The Dutch Society of Emergency Physicians supports emancipation towards a basic medical specialty of Emergency Medicine to connect in this way with the development of the profession in European Union and worldwide [7].

1.3 | Emergency department landscape optimization

All EDs together provide a frame for a country wide emergency care system. In the Netherlands this ED landscape is subdivided into eleven acute care regions [8]. Together EDs within each of these regions have the responsibility to guarantee sufficient availability and accessibility of emergency care in general as well as the aforementioned differentiated and specialized specific forms of emergency care, such as trauma, CVA, acute MI and AAA surgery to the public [8]. Both individual EDs and ED networks are integral part of the national healthcare system. In the Netherlands this system is well performing, but also expensive. In the ranking of the European Health Consumer Index the Netherlands is at the top for years [12]. At the same time, worldwide the Netherlands is among the top ten countries with the highest health care expenditure as a percentage of the gross domestic product (GDP) [13]. Cost control of health care is being pursued for sustainability in the future. In that context, in the Netherlands discussion takes place about nationwide optimization of the ED landscape. Several reports have been published on this topic [14-17]. The greatest emphasis lays on the number of EDs actually available at the time versus a proposed minimum number of EDs needed in the future where sufficient ED availability and accessibility for the general population could be maintained. The predominant idea was that by concentrating emergency care in fewer EDs, costs would be saved and quality of care would increase. Furthermore, there was the perception that the number of ED visits was increasing, and that self-referrals constituted 40–70% of the ED-population nationally, of which 60–80% was assumed to make use of ED care inappropriately [1,2]. Based on this, the assumption was that the number of ED visits should be reduced. In addition, although its origin remains unknown, the 45-minute standard (i.e. a 45-minute time limit for ambulance services to deliver patients to an ED, including arriving at the patient within 15 minutes after being dispatched), as specified by the Dutch government, applies as a restrictive measure for the level of accessibility [18,19]. Accelerated, but in line with the developments of previous decades, the number of EDs has declined gradually from 105 in 2010 to 82 in 2018 [2]. This reduction in number of EDs was in all cases a result of hospital mergers or closures [2]. In the Netherlands there are no free standing EDs [1,2]. More recently questions are being raised whether the intended nationwide optimization goals of cost reduction and quality improvement in fact are being achieved [20-23]. A reduction of the number of EDs as a strategy in itself accompanied by a reduction of hospitalization capacity, seems to have had limited effect. Meanwhile pressure throughout the acute care system has increased. A particularly growing problem concerns crowding in EDs with all its negative aspects [24-27]. It is important to realize that EDs do not exist on their own. Both individually and together, they function as an integral part of the acute health care system, which in itself is an integral part of the national health care system as a whole. This system approach is well reflected in the input-throughput-output conceptual model as described by Brent Asplin and colleagues in 2003. Optimization strategies focused exclusively on the ED component, without regard to the other components or the interaction between the components and the rest of the healthcare system, are therefore probably limited effective. In practice the term ED is being used for various of facilities with a wide variety of characteristics. Available insight into similarities and differences between EDs on a national scale is limited available and may well be insufficient. Therefore, for optimization

purposes, a more thorough and comprehensive insight into the ED landscape together with insight and understanding of interactions between components is needed to provide information that may contribute to more effective strategies which aim to optimize the ED landscape.

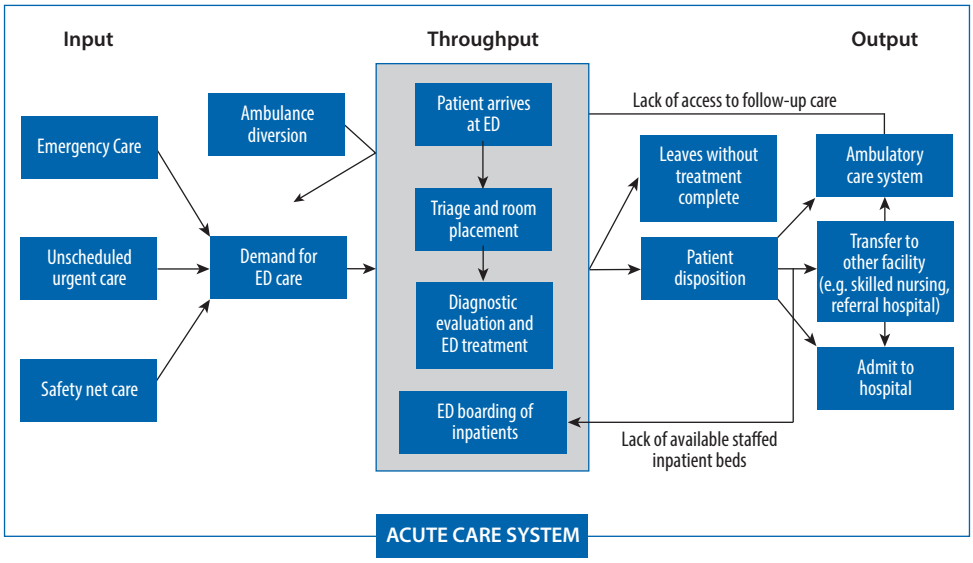

Figure | The Input – Throughput – Output Model of ED Congestion (*Asplin et al*)

1.4 | Emergency department registry

The national registry of administrative data of all available EDs in the Netherlands started in 2013 with a first national inventory of 2012 ED patient characteristics [1]. This registry information is available for research and was used in this thesis. Reason to carry out the first inventory was curiosity about the prevailing perception of patients in the ED and discrepancy with own observations. The expectation was that ED visits were increasing, that self-referrals constituted 40–70% of the national ED population and also that 60–80% of these self-referral visits were connected to an inappropriate use of EDs [1]. The data review should show whether this perception matched with actual practice. Since 2000 only a limited number of scientific papers had been published on the Dutch ED population in general and self-referrals in particular [1]. In 2012, there were great nationwide variations in the number of ED patients, the percentage of hospital admissions from the ED and the percentage of self-referrals [1]. In recent years, the number of patients did not seem to have increased, and was low compared to that in countries surrounding the Netherlands [1]. One third of all ED patients was hospitalised after presentation [1]. Contrary to nationwide perceptions, a minority of ED patients visited an ED on their own initiative (30%) [1]. These striking results from the first inventory were reason for us to repeat the inventory annually in order to detect trends of ED patient characteristics [2]. From 2012 to 2016 the following annual data from every ED have been collected: category of ED

(university, teaching, general), the total number of ED patients, the number of admissions from the ED, mode of patient arrival. Over 2016 an extra survey was conducted regarding the availability of facilities, diagnostics and medical specialist expertise in every ED. This first national registry has also given rise to the design and set-up of the independent, professional and much more extensive ED database: *Netherlands Emergency department Evaluation Database* (NEED Foundation).
Based on the IFEM definition EDs needed to meet all four following criteria to be eligible for inclusion in the database and studies reported in the current thesis:

1) They had to have a centrally organized location for the reception of patients in need of emergency care.
2) They had to ensure around the clock (24/7) availability and accessibility.
3) They had to be able to deal with illness, injury and mental health emergencies.
4) They had to serve all age categories.

The research in this thesis was performed nationally with high degree of participation. In 2012, 2013, 2014, 2015 and 2016 data were obtained from 96%, 93%, 97%, 99% and 100% of all EDs respectively.

1.5 | Aims of this thesis

As described earlier, ED landscape optimization does not automatically follow the reduction of the number of EDs. In addition, a reduction in the number of EDs may entail disadvantages, such as crowding. ED landscape optimization appears to be complex. Therefore the first aim of this thesis was to provide a comprehensive and nationwide picture, needed to provide better information that may contribute to new strategies, by exploring ED characteristics and differences and similarities. In this way, greater insight could be gained into variations and developments within the ED landscape as a whole. The second aim was to formulate operational standards as a guideline for future changes. In this thesis research is described in an attempt to answer several questions arising from both aims. Emergency Departments at Dutch hospitals have the attention of politicians, health insurers, care providers, patients and media. The perception that ED use is increasing, and that self-referrals constitute 40–70% of the national ED-patient population, is prominent in discussions about ED care [25-29]. It is also assumed that 60–80% of these self-referrals make inappropriate use of EDs [25-29]. The question now is whether these perceptions are based on facts, especially as further questions are raised by the few publications to have appeared on the Dutch ED population [30-35].

- ✓ *What are the actual numbers of EDs (academic, STZ, general) meeting the IFEM definition in 2012?*
- ✓ *What are the actual numbers of patients that were treated in an ED in 2012 and what is the distribution of the mode of arrival, including self-referrals? How do these findings relate to general assumptions and numbers known from previous years?*
- ✓ *How many patients are hospitalized via the ED in 2012?*

To improve quality and efficiency of emergency care in the Netherlands, policy makers have focussed in recent years on concentrating and differentiating emergency care and collaboration of EDs with out-of-hours general practice services (HAPs) [11-13]. We were interested to learn more about the possible effect of national policy on key ED data. This analysis may aid the evaluation of current ED care, and also the development of policy on the quality and effectiveness of emergency care.

- ✓ *How many EDs that met the IFEM definition remained available over the consecutive years 2012–2015?*
- ✓ *In what way did the cooperation between EDs and GPCs develop?*
- ✓ *How did key figures of EDs in the Netherlands develop over the consecutive years 2012–2015?*

In contrast to intensive care units, coronary care units and operating rooms a national framework with binding recommendations for ED resource planning is not available in the Netherlands. This seems primarily a local responsibility of hospital organizations. However, ED volumes are assumed to be relevant parameters for ED resource planning in several ways [36-40]. Despite the lack of a framework we wondered whether a number of obvious relationships between volumes on one side and resources on the other side actually could be demonstrated in the ED-landscape of the Netherlands. This knowledge may contribute to a better understanding of the current ED landscape and possibly give new insights for future policy.

- ✓ *How do ED patient volumes relate to numbers of ED treatment bays, numbers of hospital beds and volumes of ED-nurse staffing?*
- ✓ *How do hospitalization volumes relate to numbers of ED treatment bays, numbers of hospital beds and volumes of ED-nurse staffing?*

A standard for functionality, meaning the extent to which facilities, diagnostics and healthcare providers should be available in EDs, has not yet been formulated in the Netherlands. As resources determine the abilities of an acute medical service, it seems obvious to establish minimal operational standards and thereby a good medical praxis baseline for the delivery of appropriate hospital based acute and emergency care in available EDs. Examples from abroad are available [36-40].

- ✓ *What is the consensus in an expert panel of EPs on minimum requirements for facility, diagnostic and medical specialist availability for 24/7 available EDs remaining in the future in the Netherlands?*

The ED landscape in the Netherlands has changed considerably over the last decade. In the meantime much basic insight into the existing ED landscape, such as among others the extent to which facilities, diagnostics and medical specialist expertise are available in different EDs, still remains unknown. A more rigorous understanding of the functionality of individual EDs and a more thorough insight into similarities and differences between various EDs, could be useful in planning further optimization of the ED landscape and improving emergency care nationwide in the future.

- ✓ *What is the actual availability of facilities, diagnostics and medical specialist expertise across all EDs in the Netherlands?*
- ✓ *How does this national availability compare to the previously mentioned expert consensus on minimum requirements?*

1.6 | Thesis outline

This thesis is divided into two parts and eight chapters, structured as follows.

Part 1 includes a national exploration and interpretation of ED landscape characteristics.
Chapter 2 presents a national inventory of patients in the ED and explores patient numbers, ways of presentation and hospitalization numbers. It also deals with various assumptions about patients in the EDs in the Netherlands. The outcome provides greater clarity in this field an a national basis, something which was previously unavailable.
Chapter 3 discusses national developments of these key figures over the years 2012 to 2015; these were determined by means of a longitudinal inventory study. The results are interpreted in the context of national developments in terms of decreasing number of EDs and intensified cooperation between GPCs and EDs.
Chapter 4 presents an in-depth exploration of similarities as well as differences of ED characteristics within the ED landscape. This is done in two ways. Firstly by providing a national overview of the variation of characteristics and secondly by investigating the association between ED volume characteristics (number of patients and hospitalizations) on the one hand and measures of available ED and hospital resources (ED treatment bays, ED nurse staffing and number of hospital beds) on the other hand.

Part 2 of this thesis makes a start towards the development of more widely accepted operational standards for EDs and a national benchmark of availability.
In **Chapter 5**, a first step is taken to obtain consensus about minimum operational standards for 24/7 available EDs. To this end a two part e-Delphi approach is used. Part one identifies a list of possible ED elements and presents a definition of each of these elements. In the second part, consensus is sought on minimum operational standards that every future ED in the Netherlands should meet in terms of facility, diagnostic and the availability of medical specialists, regarding the new EP professional group.
In **Chapter 6** detailed information on methodological choices, decision rules, controlled feedback and response times in our e-Delphi study is shared based on the CREDES guidelines. In the medical literature articles based on the application of the Delphi method often lack this type of essential information, which results in low repeatability and limited insight into external validity.
Chapter 7 presents the actual availability of facility and medical (diagnostic & treatment) resources across EDs in the Netherlands. This offers the opportunity to test the sense of reality of the previous established consensus standard (**chapter 5**) in real situation and to compare EDs to each other.

Finally, **Chapter 8** considers discussion of the findings of our studies in the perspective of the current situation and elaborates on conceptual future ED landscape optimization. To conclude this dissertation, recommendations for further research are formulated and main conclusions are drawn.

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Part I

EXPLORATION OF EMERGENCY DEPARTMENT CHARACTERISTICS

Chapter 2

Patients and self-referrers at the emergency department: a nationwide survey

Gaakeer MI

van den Brand CL

Veugelers R

Patka P

Ned Tijdschr Geneeskd. 2014;158:A7128

Abstract

Objective

To quantify the number of patients presenting at emergency departments (EDs) in hospitals in the Netherlands.

Design

Mapping study at all EDs in the Netherlands.

Method

After approaching all 93 EDs that were operational 24/7 in December 2012, we collected data for 2012 on the total number of patients, the number of admissions from the ED and the number of self-referrals.

Results

Data was obtained from 89 EDs (96%) throughout the Netherlands, including eight university medical centres (UMCs) and 28 training hospital groups providing top-clinical care (STZ EDs). In 2012, there were 1,989,746 patients at these 89 EDs. Nationally, an average of 32% of ED patients were admitted to hospital (distribution: 8–54). On average, 30% of those presenting at an ED were self-referred (distribution: 3–76).

Conclusion

In 2012, there were great nationwide variations in the number of ED patients, the percentage of hospital admissions from the ED and the percentage of self-referrals. In recent years, the number of patients does not seem to have increased, and is low compared to that in other countries. One third of ED patients was hospitalized after presentation. Contrary to nationwide perceptions, a minority of ED patients visited an ED on their own initiative.

Background

Emergency Departments (EDs) at Dutch hospitals are the focus of politicians, health insurers, care providers, patients and media. The perception that ED use is increasing, and that self-referrals constitute 40–70% of the national ED-patient population, is prominent in discussions about ED care [1-5]. It is also assumed that 60–80% of these self-referrals make inappropriate use of EDs [1-5].
The question now is whether these perceptions are based on facts, especially as further questions are raised by the few publications to have appeared on the Dutch ED population (see 'Discussion'). We therefore established the number of patients who had visited an ED in the Netherlands in 2012, the number of clinical admissions from the ED, and the number of self-referrals at EDs in 2012. We used this nationwide survey to compare existing perceptions with actual practice.

Methods

All 93 EDs that were operational 24/7 in December 2012 were approached about participating in this national survey. The following annual data were collected: the total number of patients, the number of admissions from the ED and the number of self-referrals. We distinguished three categories of ED: those at academic hospitals, those at the main hospitals in hospital groups providing top-clinical care (STZ hospitals; STZ EDs), and those at general hospitals and smaller hospitals within the group of STZ hospitals (other EDs). Self-referrals were defined as patients who came to the ED of their own accord without any previous contact with GP, ambulance, police, medical specialists or other care professionals.

Results

Data from 2012 was obtained from 89 EDs (96%) throughout the Netherlands, including the eight UMCs and 28 STZ hospitals. Two of these 89 EDs could not indicate the percentage of self-referrals, while four could not indicate the percentage of patient admissions from the EDs. The total number of patients who visited the ED in 2012 was known at all 89 EDs.
The total number of patients at all 89 EDs was 1,989,746, with an average of 22,357 patients per ED (distribution: 6,000–50,000) (Figure 1). Extrapolated to all 93 EDs, the total number of ED visits in the Netherlands in 2012 was 2,079,172. This is equivalent to 124 ED visits per 1,000 inhabitants. The average number of ED visitors at academic hospital EDs was 26,737 (distribution: 19,000–34,000). On average, EDs at STZ hospitals saw 31,346 patients (distribution: 17,000–50,000), while other EDs saw 17,282 patients (distribution: 6,000–30,000).
The average nationwide percentage of admissions out of the total number of patients at the 85 EDs was 32% (distribution: 8%–54%) (Figure 2). For the academic hospitals, the average percentage of admissions from the ED was 31% (distribution: 20%–42%); for the STZ hospitals it was 32% (distribution: 8%–43%); and for the other EDs it was also 32% (distribution: 8%–54%).

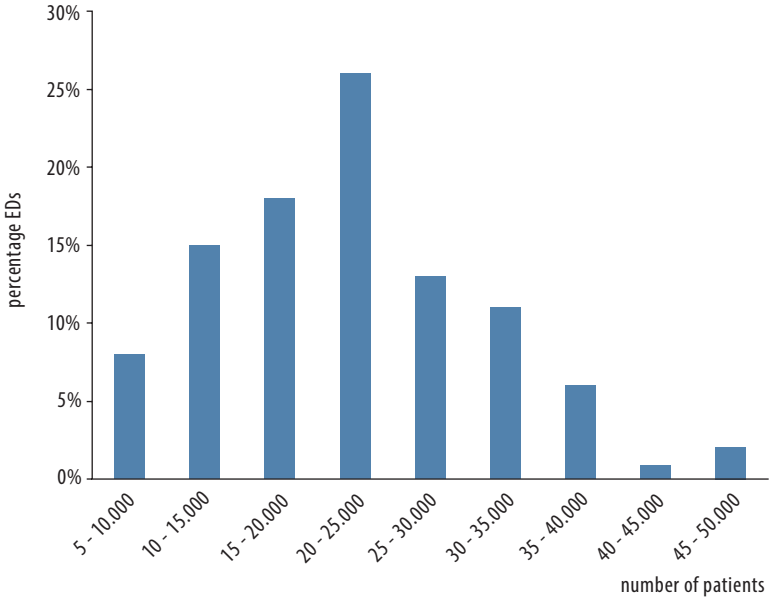

Figure 1 | Distribution of the number of patients in 89 EDs in 2012.

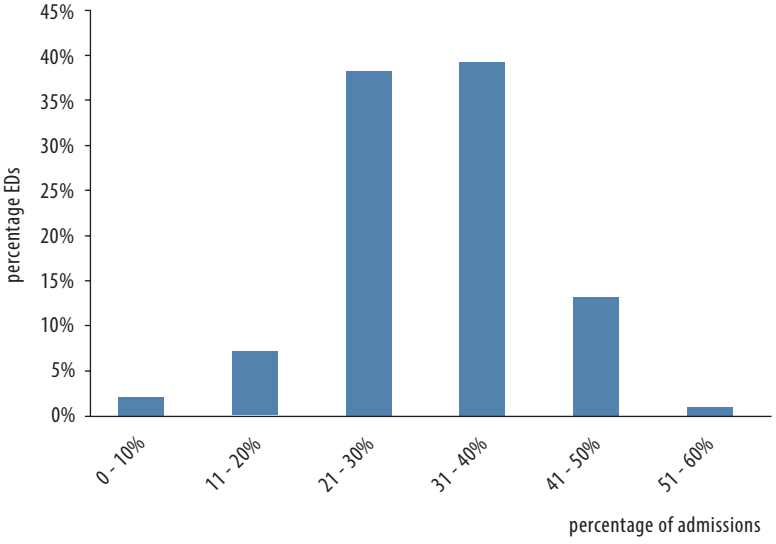

Figure 2 | Distribution of the percentage of patients admitted in 2012 after visiting 85 EDs.

The average nationwide percentage of self-referrals at the 87 EDs was 30% (distribution: 3%–76%) (Figure 3). At academic hospital EDs, the average percentage of self-referrals was 40% (distribution: 18%–65%); at EDs in STZ hospitals it was 35% (distribution: 4%–70%); and at other EDs it was 25% (distribution: 3%–76%).

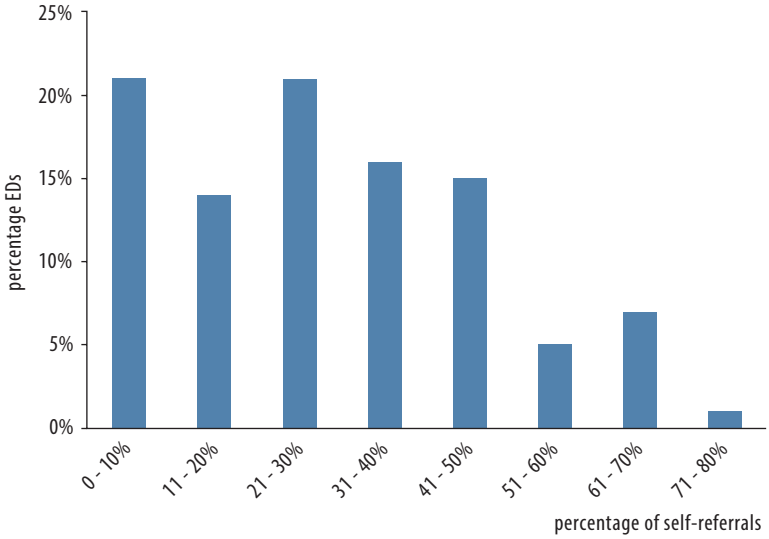

Figure 3 | Distribution of the percentage of self-referrals in 87 EDs in 2012.

Discussion

Since 2000, only a limited number of scientific publications have been published on the Dutch ED patient population in general and on self-referrals in particular [1-11]. Most publications date back to before 2008. Most are local or regional studies. Due to the great differences between individual EDs, it is doubtful that their conclusions can be extrapolated to the nationwide situation. For instance, some surveys examined only one category of self-referrals to the surgical or internal medicine department at a single location. Not only was the term 'inappropriate use' by self-referrals defined ambiguously, it was often determined on the basis of final diagnoses retrospectively. The results of many studies are opinion-forming in nature, and partly for this reason were published in non-peer-reviewed journals. All too often, authors refer to a small number of original studies before basing their reasoning on unfounded extrapolation. In some articles, the message is not supported by the reference provided. When reference is made to foreign studies, the extent to which they are relevant to the Dutch situation is not established. A systematic review is lacking, as is methodologically sound and controlled research that could help us to form a realistic picture of ED patients in the Netherlands.

Number of ED visits

Our survey shows a wide range in the volume of patients at EDs in the Netherlands: from 6,000 to 50,000 patients per year. While a majority of EDs (57%) see 15,000 to 30,000 patients per year, 8% of EDs see fewer than 10,000, and only 3% see more than 40,000. It is noteworthy that the total number of ED visits in 2012 (2,079,172 patients) did not increase relative to the number of ED visits estimated for 2009 (1.9-2.2 million) [12]. From an international perspective, the number of patients treated at EDs in the Netherlands is low: 124/1,000 inhabitants. Comparison shows that the figure is 413/1,000 inhabitants in the United Kingdom, 414/1,000 in the United States, and 430/1,000 in Canada [13-15].

Admissions from the ED

The percentage of admissions from EDs ranges from 8% to 54%. At 77% of EDs, 20–40% of those who presented were hospitalized. Nationally, an average of one in three presentations to an ED (32%) leads to hospitalization, regardless of the type of hospital. For many years, the role of EDs has no longer consisted solely of providing initial relief and treatment for people with immediately life-threatening conditions. Increasingly, GPs and secondary care hospital specialists use the options available at EDs for the rapid evaluation, diagnosis and first treatment of potentially ill patients. Emergency departments have professionalized, and their options for treatment have increased. In all respects, their role in the interface between primary and secondary care has been emancipated and has expanded.

Self-referrals at the ED

Throughout the country, there is also a wide variation in the percentage of self-referrals: 3% to 76%. The percentage seen at 72% of all EDs surveyed was less than 40%. While various publications assume that over 40% of patients at an ED are self-referrals [1-5]. At a national average of 30%, self-referrals represent a minority of the national ED population. It is striking that a higher average percentage of self-referrals was seen at the EDs of the eight academic hospitals (40%) than at the STZ-EDs (35%) and the other EDs (25%). A possible explanation for this is that academic hospitals and STZs are often situated in big cities.

Limitations

This survey has a number of limitations. First, only 89 of the 93 EDs (96%) participated. Second, the survey was based on data acquired from registration systems at individual hospitals, which we could not check for accuracy. The length of hospitalization and the reason for admission were not examined. Neither were we able to determine the percentage of hospitalizations among the self-referrals. Finally, we looked only at EDs and not at alternative emergency urgent care units such as het Havenziekenhuis (in Rotterdam), De Sionsberg (in Dokkum), and Ziekenhuis Amstelland (in Amstelveen).

Conclusion

There are considerable variations in the number of patients who visit EDs, the percentage of admissions from them, and the percentage of self-referrals. The total number of patients who present at an ED in the Netherlands seems to have been stable in recent years (2009–2012), and is lower than in other countries. One third of ED patients are hospitalized. Contrary to national perceptions, a minority of patients (30% on average) visited the ED of their own accord. To allow a well-founded discussion on optimizing emergency medicine, more thorough research is needed, both on the patient population at Dutch EDs and on the nationwide variations.

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Chapter 3

National developments in emergency departments in the Netherlands: Patients' numbers and modes of arrival 2012–2015

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Abstract

Objective

To obtain insight into key data from Emergency Departments (EDs) in the Netherlands, and to review their development over four years.

Design

Longitudinal mapping study.

Method

From 2012–2015 the following key data were mapped: number of EDs, number of patients, patients' mode of arrival, number of hospital admissions from ED, and forms of urgent care collaboration out-of-hours general practice services (HAPs).

Results

Data were obtained from an average of 96% of EDs. Between 2012 and 2015, the number of EDs dropped from 93 to 87. The percentage of EDs that collaborated with a hospital-based HAP increased from 49% to 79%. The total number of patients seen annually at an ED in the Netherlands dropped by 128,000 to 1,951,000. The number of patients presented at an ED by ambulance, mobile medical team or via the emergency number (112) increased by 2.6% to 16.0%. The proportion of patients referred from a GP or HAP increased by 7.8% to an average of 50.3%. The proportion of self-referrals dropped by 12.6% to 17.4%. The proportion of patients presenting at ED by another route remained constant at around 14%. National variations in modes of arrival remained large. Admissions to hospital from the ED rose by 5.6% to an average of 37.2%.

Conclusion

The number of EDs is falling, and collaboration between EDs and HAPs is increasing. The number of patients being seen at EDs is falling. The percentage of self-referrals is decreasing and the number of clinical admissions from the ED is rising appreciably. To achieve successful and consistent management strategies, more contextual data is needed on the nature and scope of the emergency care provided by EDs. A national registry is required.

Background

To improve the quality and efficiency of emergency care in the Netherlands, policy makers have worked in recent years towards concentrating and differentiating emergency care, integrating the collaboration of emergency departments (ED) with out-of-hours general practitioner cooperatives (GPCs), and reducing the number of self-referrals to EDs [1-4]. However, few nationally representative data were available on ED patients [5]. In 2012, the total number of patients seen on the ED did not appear to have changed relative to an estimate made in 2009, and a minority of patients presented at ED on their own initiative [5,6]. After these initial findings, we were interested to learn more about the possible effect of national policy on the key ED data. Accordingly, we did a trend analysis over 2012–2015. This analysis may aid the evaluation of current ED care, and also the development of policy on the quality and effectiveness of emergency care.

Method

Study design

This longitudinal mapping study covers the years 2012–2015. We mapped the number of EDs in the Netherlands, and also the following key data by year: number of patients seen, patients' mode of arrival, number of hospital admissions from the EDs, and form of collaboration with GPCs. For this study we used the ED definition used by the International Federation of Emergency Medicine: "*a clinical department for centrally organised emergency care that is available 24 hours a day and 7 days a week and should be able to deal with all types of medical emergencies in patients of all ages* [7]". We defined three categories of ED: University Medical Centre EDs (UMC EDs), EDs sited at the main hospitals of training hospital groups that provide top-tier clinical care (STZ EDs), and EDs sited at general hospitals together with EDs at the smaller hospitals within the group (general EDs). Where amalgamations of hospital organisations had taken place, the status accorded to the ED in 2012 remained unchanged. As a result, there were 26 STZ hospitals at the end of 2015, but the number of STZ EDs remained 27. We divided forms of urgent care collaboration with GPCs into five and mode of patient arrival in four groups (Table1).

Data collection and analysis

The study took place between 30 January 2013 and 1 June 2016. In January of each year we e-mailed the in-person study contacts at EDs that had fulfilled the study criteria in the December of the preceding year (2012, 2013, 2014 and 2015), asking them to complete and return a standard form with the data requested. We obtained prior consent to participation by telephone. All data were entered into a Numbers database (Apple Inc.), and were reproduced using descriptive statistics. Each year, the total number of patients seen at all participating EDs and the number admitted from the participating EDs were included, and arithmetically extrapolated to the total number of EDs in the Netherlands.

Tabel 1 | Grouping of forms of cooperation between Emergency Medicine Departments and General Practitioner Cooperatives and of the origin of patients in the Emergency Medicine Department

Forms of cooperation between ED and GPC	Origin of patients in the ED
no cooperation	via ambulance, MMT, 112: without intervention of a general practitioner or nursing home doctor
cooperation with GPC outside the hospital	via local general practitioner or GPC, or referred by a nursing home doctor
parallel ED and GPC*	self-referrer
serial ED and GPC†	via another way, for example police, Radiology Department, psychiatric care or reassessment in the ED
fully integrated ED and GPC‡	

GPC = general practitioner cooperative; ED = Emergency Medicine Department; MMT = Mobile Medical Team.

* Parallel: GPC is located in the hospital with an individual reception of the ED, without common triage.

† Serial: GPC is located in the hospital with reception in front of the ED, in other words the GPC is located serial before the ED without common triage.

‡ Fully integrated: GPC and ED are located behind a common reception and common triage.

Results

Numbers of EDs and participation in the study

In 2012 there were 93 EDs in the Netherlands. This number fell to 89 in 2013, to 88 in 2014, and to 87 in 2015. In 2012, 2013, 2014 and 2015 we obtained data from 89 (96%), 83 (93%), 85 (97%) and 86 (99%) Dutch EDs, respectively. The eight university medical centres (UMCs) participated in the study every year. In 2013, 2014 and 2015, one STZ hospital – a different hospital each year – did not participate in the study. The variance in participation was slightly larger in the general EDs.

ED attendance

Over the 2012–2015 study period, the number of patients attending EDs in the Netherlands dropped by 128,000. In 2012, an estimated total of 2,079, 000 patients were seen at 93 EDs (extrapolated from 1,928,630 at 86 EDs). In 2015 this dropped to 1,951,000 patients (extrapolated from 1,928,630 at 86 EDs). Per 1,000 of the population, this represents a drop from 124 in 2012 to 115 in 2015. Over the period covered by the study, the average number of patients per ED remained constant at approximately 22,500. The national spread of patients at each ED remained unchanged; the largest ED saw seven times more patients than the smallest. (Table 2. For complete table see Supplement on www.ntvg.nl/D970).

Tabel 2 | The origin of patients in the EDs in the Netherlands and admissions from the EDs in the period 2012 - 2015*

Data	year				development†
	2012	2013	2014	2015	
total ED number	93	89	88	87	-6
number of participating Eds	89	83	85	86	gemiddeld 96%
total number of patients‡	2.079 .172	2.008.737	2.003.411	1.951.055	-128.116
origin; average in % (extremes)					
via 112, ambulance or MMT	13,4 (0,6–49,3)	13,7 (3,5–28,0)	15 ,9 (5,3–50,5)	16,0 (2,1–32,5)	+2,6%
via general practitioner or GPC	42,5 (10,3–86,5)	46,9 (6,0–91,3)	48,6 (11,8–98,4)	50,3 (14,0–76,5)	+7,8%
via other instances	13,7 (0,5–32,0)	13,7 (1,6–33,4)	13,8 (0,5–42,8)	14,6 (0,5–46,3)	+0,9%
self-referral	30,0 (3,2–76 ,3)	25,5 (2,5–75,0)	21,4 (0,7–57,7)	17,4 (2,7–58,9)	-1 2,6%
unknown	0,4	0,2	0,3	1,7	gmeiddeld 0,7%
c linical admission from the ED; average in % (extremes)	31,6 (8,4–54,1)	33,7 (11,6–49,6)	35,2 (13,6–69,4)	37,2 (16,8–78,0)	+5,6%

ED = Emergency Medicine Department; MMT = Mobile Medical Team; GPC = General Practitioner Cooperative.

*This is a simplified version of the original table. The original table can be found as an appendix to this article at www.ntvg.nl/D970.

†The development is the difference between the value in 2015 and in 2012, unless indicated otherwise.

‡The total number of patients is an estimate based on the extrapolation of the number of patients registered on the participating EDs

Mode of arrival of patients coming to ED

The proportion of patients presenting at the ED by ambulance, mobile medical team (MMT), and via the emergency number (112 in the Netherlands), rose by 2.6% from an average of 13.4% (range 0.6–49.3) in 2012 to 16.0% (2.1%–27.4%) in 2015. The proportion of patients referred from a GP or GPC together increased by 7.8% from an average of 42.5% in 2012 (10.3–86.5) to an average of 50.3% (14.0–76.5) in 2015. Some EDs provided us with specific information about the number of referrals from a GP and the number from GPCs (35% in 2012 and 54% in 2015). The increase in referrals from GPs was 2.4%; from HAPs it was 6.1%. The proportion of self-referrals dropped by 12.6% from an average of 30% in 2012 (3.2–76.3) to 17.4% in 2015 (2.7–58.9). The proportion of patients presenting at the ED by another route remained constant at around 14% (0.5–46). The national spread remained wide in all four groups of modes of referral.

Admissions from ED

The average percentage of clinical admissions from the ED rose by 5.6% from an average of 31.6% in 2012 to 37.2% in 2015. The absolute number of patients admitted directly from EDs at 89 locations in 2012 was 580,000. Extrapolated to all 93 EDs in the Netherlands, this amounts to approximately 606,000. In 2015, 674,000 patients were admitted from 86 EDs, totalling approximately 682,000 for all 87 EDs. This is not only an absolute increase of around 75,000 patients, but also a relative increase from 36 per 1,000 population in 2012 to 40 per 1,000 population in 2015.

Differences between categories of EDs

Extrapolated from the number of patients seen at each ED, the STZ EDs are the largest and the general hospital EDs the smallest. The UMC EDs had the highest percentage of self-referrals and the lowest percentage of patients referred by a general practitioner. General EDs had the lowest percentage of self-referrals and the highest percentage of patients referred by a general practitioner. Each year, there was a slight increase in the percentage of patients arriving at UMC EDs by ambulance, MMT or 112; this was not the case in the STZ or general EDs. The percentage of clinical admissions from the ED increased over all categories; the percentages per category did not differ greatly over the course of the years.

Collaboration of EDs with GPCs

During the study period, the percentage of EDs that had a collaborative arrangement with a hospital-based GPC increased from 49 to 79. The fastest growing group was the 'completely integrated GPC'. In each year of the study, the collaborative arrangement of parallel GPC and ED constituted the largest group. In 2015, 13% of EDs still did not have a formalized collaborative arrangement with a GPC (Figure 1).

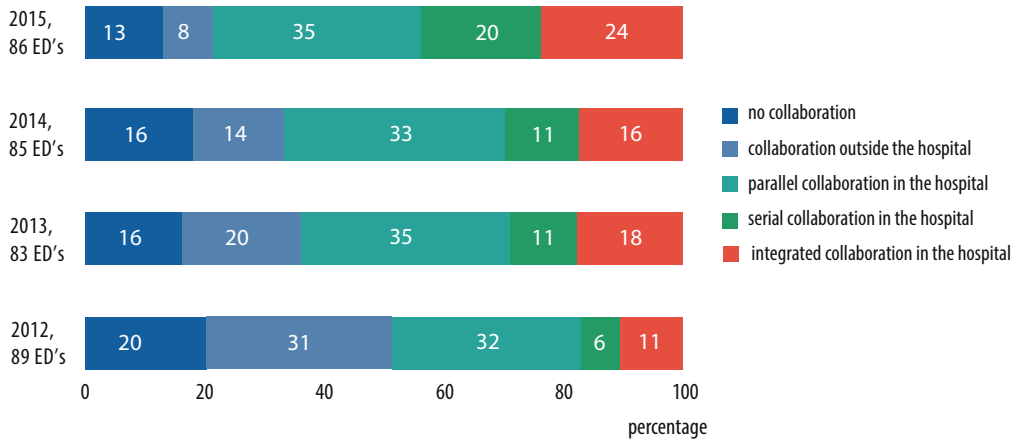

Figure 1 | National distribution of different kinds of cooperation between ED and GPC in the years 2012 - 2015. For each year cooperation forms are shown as percentage of the total number of EDs participating. Explanation of the different kinds of cooperation can be found in Table 1.

DISCUSSION

Main findings

From 2012–2015, the number of EDs in the Netherlands fell by 6 to 87. An increasing number of EDs embarked upon some form of collaboration with a GPC, or an existing collaboration was intensified. This meant that urgent care collaboration was increasingly located in one place. The variations 'completely integrated ED and GPC' and 'serial ED and GPC' increased, while the variant 'parallel ED and GPC' remained prevalent. During this period, the total number of patients seen at all the EDs in the Netherlands dropped slightly to just under two million per year (Table 2), from 124 to 115 attendances per 1,000 population. There was a shift in patients' modes of arrival to ED. Patients referred themselves directly to ED less often, but were more often sent in from the general practitioner or GPC, or came by ambulance, MMT or 112. The number of clinical admissions to hospital from the ED rose substantially from 36 to 40 per 1,000 population. Throughout the study period, there was great variation at all the EDs in patients' numbers and modes of arrival, and also in the percentage of clinical admissions.

Reduction in the number of EDs

A reduction in the number of EDs is not a new phenomenon. In 2010 the Netherlands had 105 EDs, against 128 in 1994 [8,9]. This reduction was limited by the governmental requirement that ambulances must be able to drive to an incident, transfer the patient to the ambulance, and transport the patient to the nearest ED within 45 minutes [4,10]. On the basis both of the leeway left by this policy requirement and of the continuing amalgamations of hospitals, a further reduction in the number of EDs is expected. An example of this is the announcement of the closure in 2017 of the

Antoniushove ED at the Haaglanden Medical Centre in The Hague. There is active public debate on the continued availability of a number of other EDs [11].

Patients on the ED

Our study showed that the total number of patients seen on EDs was higher than had been predicted in an estimate by the Netherlands Consumer Safety Institute *(VeiligheidNL),* which had forecast 1.8 million in 2013 [12]. While this estimate was based on the Netherlands Injury Information System (LIS) and sampling at 14 EDs at 12 hospitals, our survey covered nearly the whole country. Due to the large variation we have observed in the key data, the results of our sampling of EDs may not be broadly representative. Analysis of this variation on the basis of our data did not enable us to find a link between the variation in numbers and the type of urgent care collaboration with a GPC or the geographical regions. Despite the strong increase in the intensive collaboration between EDs and GPCs which is outlined in the figure, the reduction in the number of ED patients over recent years is not as great as one might expect. The literature is not unambiguous about the effect of the colocation of the ED with the GPC. Although an increase in efficiency is reported in a number of Dutch studies that reported on one or more location of urgent care collaboration [13-15], this increase was brought into doubt in a recent review of studies on the colocation of EDs and GPCs in a number of countries, including the Netherlands from 1980–2015 [16]. An observational study in the South East of the Netherlands showed that, where colocation was present, 22% of the ED care was transferred to the GPC [17]. However, follow-up studies in the same region showed neither an increase in efficiency nor any cost reduction (*Broekman et al*, written report, 2016) [18,19]. In addition, a substantial number of patients continued to be referred to ED by the GPC. For those patients who were ultimately referred to the ED, the consequence of this was significant increases in total waiting times and time spent in hospital (*Broekman et al*, written report, 2016) [18,19]. Our study shows that the number of self-referrals to ED from 2012–2015 dropped on average by 12.6%, and that referrals from general practitioners or GPCs increased by an average of 7.8%, due mainly to referrals from GPCs. From a national perspective, this appears to limit the effect of the substitution of EDs by GPCs. We also saw a 2.6% increase in the number of patients presented at ED by ambulance, MMT, or 112. From the ED perspective, current policy appears to be leading to a shift in the mode of admission of patients, but only in a very limited way to redeployment of care.

Admissions from ED

During the study period, the number of clinical admissions from EDs increased by 75,000. This increase is striking. During the same period, the total number of clinical admissions actually showed a falling trend [20]. This means that 43% of the total number of clinical admissions in 2015 were referred from the ED. The EDs appear to be functioning increasingly as 'admitting departments'.

Implications

Current policy is still based largely on three suppositions that previously determined the profile of EDs in the Netherlands: that the country would be able to manage with barely 50 EDs, that countrywide 40–70% of the patient population at EDs would consist of self-referrals, and that

some 60–80% of this population would use EDs inappropriately [5,21-25]. This profile should be modified. The percentage of self-referrals proved to be lower – in 2012, an average of 30% lower [5]. In approximately half the cases, Dutch studies have also shown that self-referrals were correct in choosing to be treated at an ED [26-28].

This means that the effect of the policy aimed at concentrating, reallocating and discouraging self-referral to the ED – which was based on these three suppositions – is probably much smaller than originally thought. While it is true to say that the number of self-referrals to the ED has dropped since 2012, the proportion of patients referred by general practice and presented by ambulance has also increased. Improved efficiency for patients and a reduction in costs have not as yet been achieved [16-18]. Recent reductions in the number of EDs appear to have a downside in the form of crowding, i.e., the remaining EDs have become excessively busy [29]. In 2012, 68% of Dutch EDs had to deal with crowding on a weekly or even daily basis [30]. Crowding is associated with the loss of quality and safety of care, reduced patient satisfaction, and the demotivation of ED personnel [29]. Before the number of EDs is reduced any further, there should be a greater focus on the ED and admission capacity of the remaining hospitals. To achieve a proper understanding of emergency care and to be able to guide the implementation of a consistent strategy for setting up a comprehensive and efficient system of integrated emergency care, it is essential that the standardised registration of complete key data becomes compulsory at all emergency care facilities.

Strenghts and limitations

One strength of this intervention study is the high level of participation of the EDs (over 95%), throughout the entire study period. In turn, a limitation is that participation was not 100%, and also that it was not equally distributed over the years. The study is based on data from the registry systems of individual hospitals and we were not able to check the correctness of these data as they are not national registers. However, the inventory was done in the same way each year and the data from all the hospitals were nearly always obtained from the same in-person study contact. The time span of our study was limited to four years. Finally, our study examined only centrally organized emergency departments that were operational 24 hours a day, 7 days a week. Alternative emergency entries to hospital such as 'acute admission departments', e.g. emergency outpatient clinics or urgent organ care (e.g. Urgent Coronary Care or Urgent Stroke Care) were not included. Patient streaming to secondary care via these modes was therefore not included in our study.

CONCLUSION

Annually, a shrinking number of EDs is seeing a slightly falling number of patients. From 2012–2015 the collaboration between EDs and GPCs intensified, and the number of self-referrals dropped from 30% to 17.4%. Concurrently, the number of patient referrals increased, and the total number of patients presenting at the ED dropped slightly from 124 to 115 per 1000 population. Moreover, the percentage of clinical admissions from the ED rose appreciably. If the capacity and the admitting capacity of the remaining EDs is not adjusted to accommodate these developments, a further

increase in crowding in Dutch EDs is predicted. For a successful and consistent management strategy, more contextual data on the nature and scope of the emergency care provided by EDs is necessary. A national registry is called for.

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Chapter 4

The emergency department landscape in the Netherlands: an exploration of characteristics and hypothesized relationships

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ABSTRACT

Background

Nationwide optimization of the emergency department (ED) landscape is being discussed in The Netherlands. The emphasis is put mostly on the number of EDs actually present at the time versus a proposed minimum number of EDs needed in the future. The predominant idea in general is that by concentrating emergency care in less EDs costs would be saved and quality of care would increase. However, structural insight into similarities as well as differences of ED-characteristics is missing. This knowledge and facts interpretation is needed to provide better steering information which could contribute to strategies aiming to optimize the ED-landscape. This study provides an in depth insight in the ED-landscape of The Netherlands by presentation of providing an overview of the variation in ED characteristics and by exploring associations between ED volume characteristics on one side and measures of available ED and hospital resources on the other side. Obtained insight can be a starting point towards more well-founded future optimization policy.

Method

This is a nationwide cross-sectional observational study. All 24/7 operational EDs meeting the IFEM definition in The Netherlands in December 2016 were identified, contacted and surveyed. Requested information was retrieved from local hospital information systems and entered into a database. Till August 1st 2017 data have been collected.

Results

All 87 eligible EDs in The Netherlands participated in this study (100%). All of them were hospital based. These were 8 university EDs (9%), 27 EDs in teaching hospitals (31%) and 52 in general hospitals (60%). On average 22,755 patients were seen per ED (range 6,082–53,196). On average 85% (range 44%–99%) was referred versus 15% self-referred (range 1%–56%). Further subdivision of the referred patients showed 17% 'emergency call' (range 0.5%–30%); 52% by GPC (range 16%–77%); 15% other referral (range 1%–52%). On average 38% of patients per ED (range 13%–76%) were hospitalized. ED treatment bays ranged from 4 to 36 and added nationally up to 1,401 (mean and median of 16 per ED). The number of hospital beds behind these EDs ranged from 104 to 1,339 and added up to 36,630 beds nationally (mean of 421 and median of 375 behind each ED). Information about ED-nurse workforce was available for 83 of 87 EDs and ranged from 11 to 65, adding up to 2,348 fte nationally (mean of 28 and median of 27 per ED).

We found positive and significant correlations, confirming all formulated hypotheses. The strongest correlation was seen between the number of patients seen in the ED versus ED-nurses workforce, followed by the number of patients seen in the ED versus ED treatment bays. The other hypotheses showed less positive significant correlations.

Conclusion

Our study shows that the ED-landscape is still multiform by numbers and specifications of individual ED-locations. This study identifies associations between patient and hospitalization volumes on on a national level on one side and number of ED treatment bays, ED-nurses workforce capacity and available hospital beds on the other side. These findings might be useful as input for the development of an ED resource allocation framework and more targeted optimization policy in the future.

BACKGROUND

Nationwide optimization of the emergency department (ED) landscape is being discussed in many countries all over the world for reasons such as cost reduction and quality improvement. In The Netherlands, one such country, several guiding reports on this topic have been published [1-3]. The emphasis here was mostly on the number of EDs actually present at the time versus a proposed minimum number of EDs needed in the future at which sufficient ED accessibility to the population could be maintained [1-3]. The predominant idea was that by concentrating emergency care in fewer EDs costs would be saved and quality of care would increase. The 45-minute standard (45-minute time limit for ambulance services to deliver patients to an ED, including arriving at the patient within 15 minutes after being dispatched) applies as a restrictive measure for this sufficient accessibility from the Dutch government [4,5]. In line with the development of last decades the number of EDs has declined gradually from 105 in 2010 to 87 in 2016. In all cases that was a result of mergers of hospital organizations [6]. However, whether the intended nationwide optimization goals of cost reduction and quality improvement are achieved is being questioned [7-10]. At the same time pressure across the width of the acute care system has increased and in particular crowding in EDs with all its negative aspects has become a growing problem [11-13]. We assumed that reducing the number of EDs as strategy in itself has limited effectiveness. This might be among other things because in practice a broad variation of departments in many ways is hiding behind the commonly used term ED. The diversity within the ED-landscape in The Netherlands has been demonstrated earlier [4,6,14]. However, structural insight into similarities as well as differences of ED-characteristics is missing. This knowledge is needed to provide better steering information which will contribute to strategies aiming to optimize the ED-landscape.

With this study we aimed to provide additional insight in the ED-landscape of The Netherlands in two ways. First by providing a national overview of the variation in ED characteristics. Secondly, we we investigated the association between ED volume characteristics (number of patients and hospitalizations) on one side and measures of available ED and hospital resources (ED treatment bays, ED-nursing staff and number of hospital beds) on the other side. Obtained insight can be a starting point towards more well-founded future optimization policy.

METHOD

Design

This is a nationwide cross-sectional observational study of administrative data. All 24/7 available and operational EDs meeting the IFEM definition in The Netherlands in December 2016 were identified, contacted and surveyed. In January 2017 a questionnaire was emailed, asking index contacts about key administrative data (reference date December 31th 2016). Requested information was retrieved from local hospital information systems and sent by email to the 1st author, who entered all information in a database. Till August 1st 2017 data have been collected. Over this period every month a prompt was given by email to those of who had not responded yet. Our goal beforehand

was to obtain participation of at least of 80% of all eligible EDs. Participation was entirely voluntary and withdrawal from the study could occur at any point.

Setting

The Netherlands is a West-European country with 17 million inhabitants and is one of the most densely populated countries worldwide (500 people per km^2 if water is excluded). Its gross domestic product (GDP) in 2016 was 770.85 billion of US Dollar and total expenditure on health care in that year was 13.6 % of GDP [15,16]. In 2016 life expectancy at birth for both sexes was estimated at 79.9 years for males and 83.1 years for females [17]. Primary care is highly developed and accessible to everyone through local general practitioner (GP-)offices during daytime and GP-cooperatives during the evenings, nights and weekends. GPs fulfill the role of gatekeepers for hospital care. At the end of 2016 emergency care was provided in 87 EDs with 24/7 availability spread over the country [6]. To date, there are over 540 trained and registered emergency physicians (EPs) working in 85% of all EDs. Annually about 115–124 ED presentations per 1,000 inhabitants were recorded.6 Almost all citizens have health care insurance, but with a mandatory healthcare excess (in Dutch: verplicht eigen risico) for ED/hospital based care.

Eligible EDs

Worldwide the term ED is being used to refer to a broad range of urgent care facilities. The International Federation for Emergency Medicine (IFEM) terminology project defined the entity of an ED in 2012 as: "*The area of a medical facility devoted to provision of an organized system of emergency medical care that is staffed by Emergency Medicine Specialist Physicians and/or Emergency Physicians (EPs) and has the basic resources to resuscitate, diagnose and treat patients with medical emergencies. The ED is a unique location at which patients are guaranteed access to emergency care 24 hours a day, 7 days a week. It is able to deal with all types of medical emergencies (illness, injury and mental health) in all age groups* [18]."To be included in our study EDs needed to meet all the following criteria from the IFEM definition in December 2016:

- Centrally organized location for the reception of patients in need for emergency care,
- Around the clock (24/7) availability and accessibility,
- Being able to deal with illness, injury and mental health emergencies,
- Serving all age categories.

ED characterization

There is no (inter)nationally validated instrument to profile EDs. In previous conducted research ED characterization has been done in different ways, all with their own added value [19-26]. Based on literature and guided by both our study aims, including pre formulated hypotheses, we consciously focused on the following administrative data. *Patient characteristics*: volume of visits (patients per year); distribution of age (0–18; 18–65; 65+); route of presentation: referred ('emergency call'; by GP(C); other referral) versus self-referral; hospital admissions through the ED (patients per year). *ED and hospital capacity*: number of ED treatment bays; number of hospital beds. *Workforce capacity*:

fulltime-equivalent (fte) of ED-nurses. In addition the following information with respect to each ED was gathered:

- method of cooperation with a general practitioner cooperative (GPC):
  - *Co-location:* ED and GPC are located separately.
  - *Parallel:* a GPC is located at a hospital and has its own reception desk within the ED. Separate triage procedure.
  - *Serial:* a GPC is located at the hospital, with a reception desk earlier in line than the hospital's. Serially, the GPC is thus positioned before the ED. Separate triage procedure.
  - *Integrated:* the GPC and ED share a reception desk. Common triage procedure.
- category of hospital the ED is located in (university; STZ; general). STZ is an exclusive partnership of 26 non-university training hospitals throughout the Netherlands. Together these hospitals house 27 EDs.

Hypothesized relationships

In contrast to intensive care units, coronary care units and operating rooms a national framework with binding recommendations for ED resource planning is not available in The Netherlands. This seems primarily a local responsibility of hospital organizations. However, ED volumes are assumed to be relevant parameters for ED resource planning in several ways [27-31]. Despite the lack of a framework we wondered whether a number of obvious relationships between volumes on one side and resources on the other side actually could be demonstrated in the ED-landscape of the Netherlands. In order to study these relationships the authors pre formulated 6 hypotheses listed below, which we aimed to confirm or refute.

ED patient volume versus available resources:

- *Hypothesis 1:* ED patient volumes correlate positively with numbers of ED treatment bays.
- *Hypothesis 2:* ED patient volumes correlate positively with numbers of hospital beds.
- *Hypothesis 3:* ED patient volumes correlate positively with volumes of ED-nurse staffing.

Hospitalizations through the ED versus available resources:

- *Hypothesis 4:* Hospitalization volumes correlate positively with numbers of ED treatment bays.
- *Hypothesis 5:* Hospitalization volumes correlate positively with numbers of hospital beds.
- *Hypothesis 6:* Hospitalization volumes correlate positively with volumes of ED-nurse staffing.

Data analysis

Our analysis included two steps. First, we used descriptive statistics to present current baseline ED landscape characteristics and the variation thereof. Second, to confirm or refute the hypotheses we used the Pearson correlation coefficient and calculated the adjusted R^2. Significance threshold was set at a *P* value of 0.05.

Ethics

Ethical approval for this study was obtained from the Medical Research Ethics Committee of the Erasmus University Medical Center in Rotterdam, The Netherlands (Ref. MEC-2014-322).

RESULTS

Eligible EDs and participation

All 87 eligible EDs in The Netherlands participated in this study (100%).

Characteristics of EDs

Every ED was hospital based. This were 8 university EDs (9%), 27 EDs in STZ hospitals (31%) and 52 in general hospitals (60%). Seventy-one EDs (82%) cooperated with a GPC located in the hospital. Of these 21 GPCs were located parallel, 25 serial and 25 integrated with the ED. The percentage registered self-referrals on average was 13%, 8% and 21% respectively. Sixteen EDs (18%) cooperated with a GPC located outside the hospital with on average 19% self-referrals.

The profile of further ED characteristics is presented in Table 1. A total of 1,979,726 patients were seen in all EDs together in 2016. This corresponds with an average of 22,755 patients per ED (range 6,082–53,196) and 116 patients per 1,000 inhabitants. Of all patients 18.2% (range 9%–30%) was 0 up to 18 years, 48.4% (range 39%–69%) was 18 up to 65 years and 33.8% (range 13%–51%) was 65 years and older. On average 85% (range 44%–99%) was referred versus 15% self-referred (range 1%–56%). Further subdivision of the referred patients showed 17% 'emergency call' (range 0.5%–30%); 52% by GPC (range 16%–77%); 15% other referral (range 1%–52%). In total 728.804 of all ED patients were admitted through all EDs together, on average 38% of patients per ED (range 13%–76%). ED treatment bays ranged from 4 to 36 and added nationally up to 1,401 (mean and median of 16 per ED). The number of hospital beds behind these EDs ranged from 104 to 1,339 and added up to 36,630 beds nationally (mean of 421 and median of 375 behind each ED). Information about ED-nurse workforce was available for 83 EDs and ranged from 11 to 65, adding up to 2,348 fte nationally (mean of 28 and median of 27 per ED).

Hypothesized relationships

The scatterplots with regression line and calculated adjusted R^2 for each of the six hypotheses are shown in Figures 1–6. We found positive and significant correlations, confirming all hypotheses.

The strongest correlation was seen between the number of patients seen in the ED versus ED-nurses workforce (*hypothesis 3:* Adj R^2: 0.736, $p < 0.000$), followed by the number of patients seen in the ED versus ED treatment bays (*hypothesis 1:* Adj R^2: 0.556, $p < 0.000$). The other hypotheses showed smaller though significant correlations, in decreasing order: hospitalization volumes versus volumes of ED-nurse staffing (*hypothesis 6:* Adj R^2: 0.358, $p < 0.000$); ED patient volumes versus the numbers of hospital beds (*hypothesis 2:* Adj R^2 0.352, $p < 0.000$); hospitalization volumes versus the numbers of ED treatment bays (*hypothesis 4:* Adj R^2: 0.243, $p < 0.000$); hospitalization volumes versus the numbers of hospital beds (*hypothesis 5:* Adj R^2: 0.241, $p < 0.000$). Despite these correlations all six scatterplots

show large variation, also within each different subgroup of EDs (academic, teaching and general). All academic EDs are located almost consistently above the correlation lines, indicating more resources available in relation to patient volume or hospitalization rate in comparison with teaching or general EDs. An obvious explanation for this could be that they all have tertiary care functions and are level I trauma centers and therefor need more resources we examined. It is remarkable that although the academic EDs handle and hospitalize a comparable number of patients, the number of available resources between themselves varies enormously. General EDs are located almost consistently below the correlation lines, indicating more patients or hospitalizations with less resources. A valid insight into the differences in workload between different types of EDs as possible explanation for the variance in resources is lacking.

Table 1 | ED characteristics

Patient volume and characteristics	Mean ± sd	Min	Max
ED patients (per year)	22,755 ± 9457	6082	53,196
Age patients			
% < 18	18.2 ± 4.5	9	30
% 18–64	48.4 ± 5.9	39	69
% 65+	33.8 ± 7.5	13	51
Entry route patients			
% self-referrals	14.9 ± 13.5	1.2	55.9
% primary care	51.8 ± 14.4	16.4	76.5
% EMS	16.6 ± 5.3	0.5	30.0
% other	15.2 ± 8.0	1.1	52.1
% admissions	38.2 ± 10.7	12.9	76.4
ED and hospital capacity			
ED beds	16.1 ± 6.6	4	36
Hospital beds	441.3 ± 245.3	104	1339
Workforce capacity			
FTE ED nurses	28.3 ± 11.0	11	65
Calculated ratios			
FTE ED nurse/ED bed	1.8 ± 0.5	0.9	3.5
FTE ED nurse/ED patient (per 24 h)	0.46 ± 0.97	0.30	0.72
Admissions/FTE ED nurse (per 24 h)	0.86 ± 0.31	0.18	2.24
ED beds/patient (per 24 h)	0.27 ± 0.08	0.16	0.54

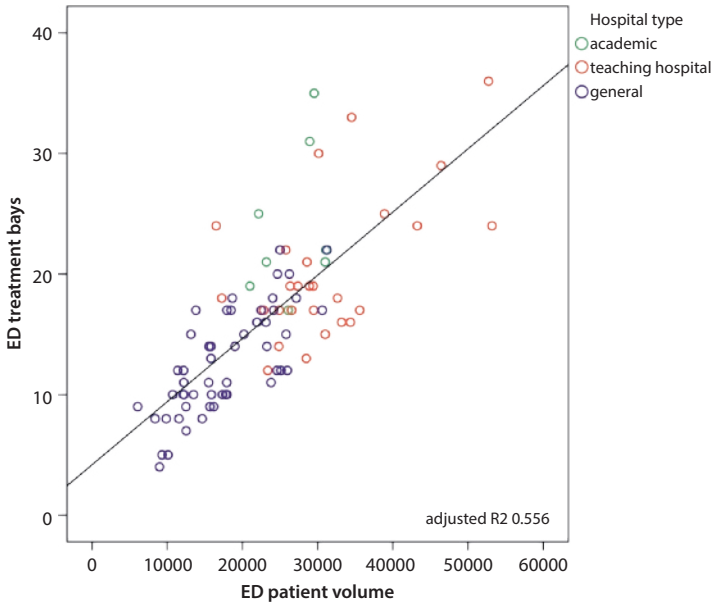

Figure 1 | ED patient volumes versus numbers of ED treatment bays. Subdivision to hospital type: academic, teaching hospital and general hospital. Including correlation line with calculated adjusted R^2.

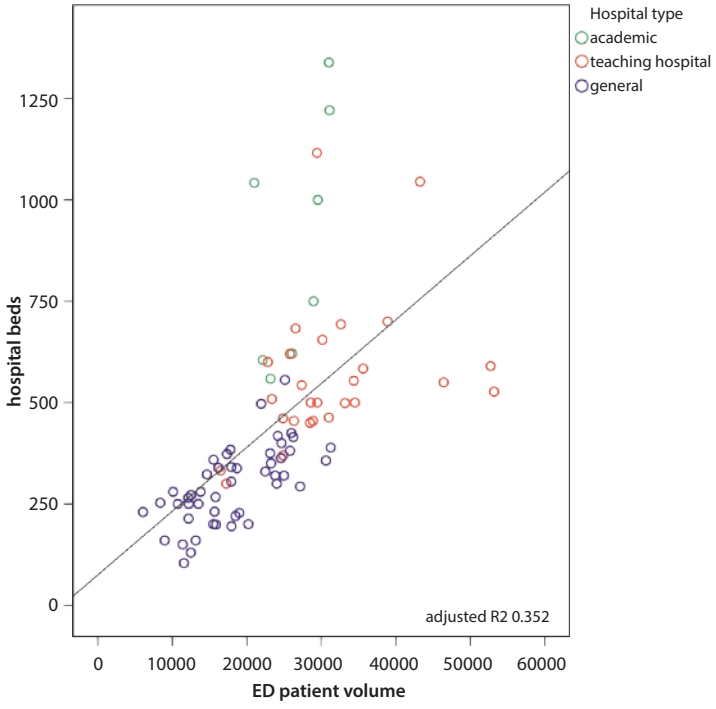

Figure 2 | ED patient volumes versus numbers of hospital beds. Subdivision to hospital type: academic, teaching hospital and general hospital. Including correlation line with calculated adjusted R^2.

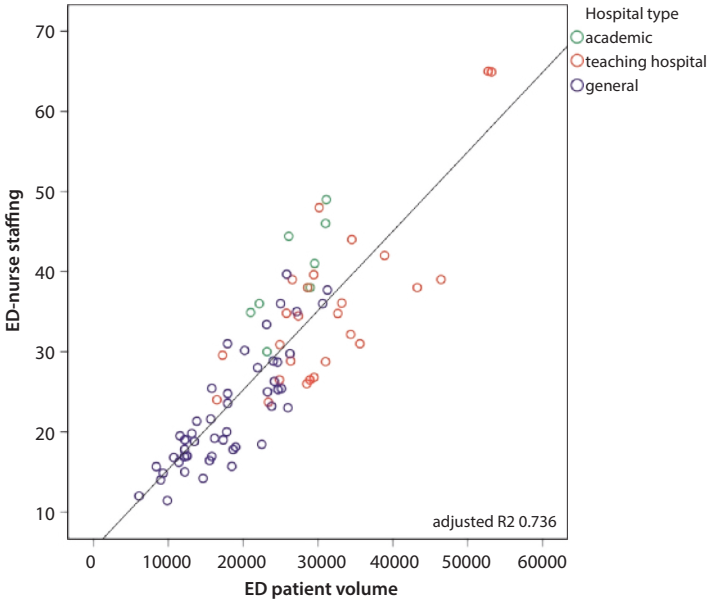

Figure 3 | ED patient volumes versus volumes of ED nurse staffing. Subdivision to hospital type: academic, teaching hospital and general hospital. Including correlation line with calculated adjusted R^2.

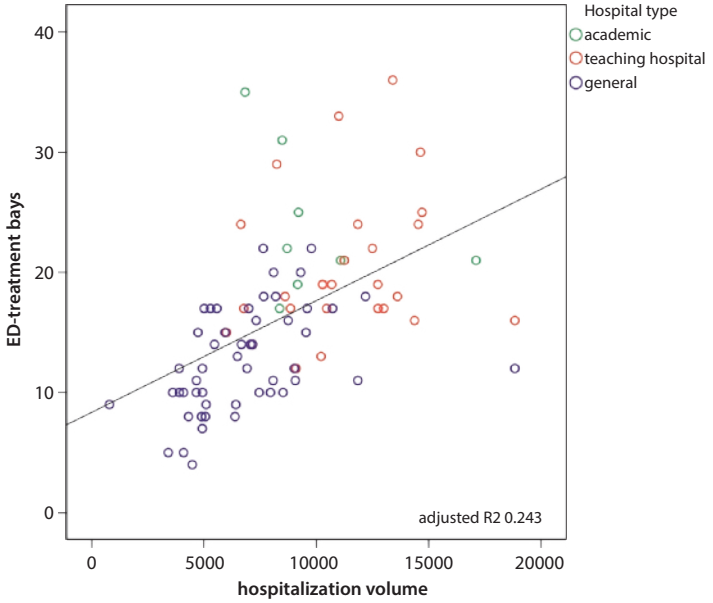

Figure 4 | Hospitalization volumes versus numbers of ED treatment bays. Subdivision to hospital type: academic, teaching hospital and general hospital. Including correlation line with calculated adjusted R^2.

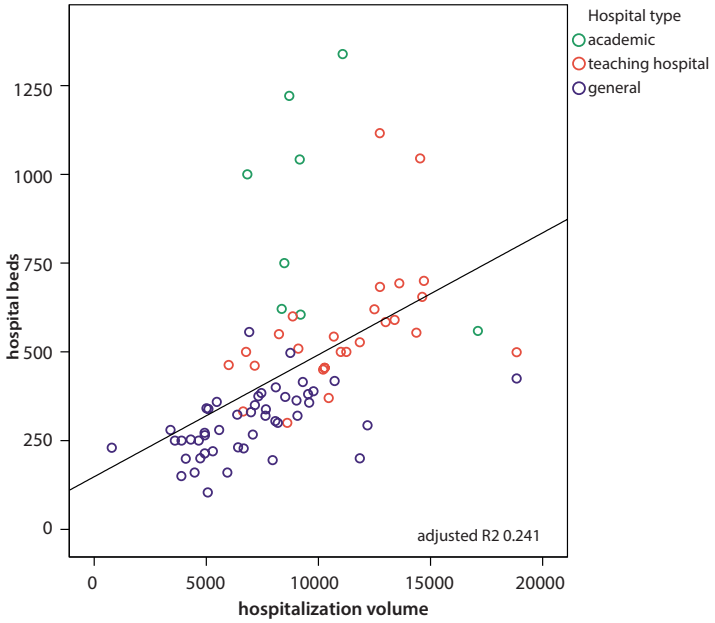

Figure 5 | Hospitalization volumes versus numbers of hospital beds. Subdivision to hospital type: academic, teaching hospital and general hospital. Including correlation line with calculated adjusted R^2.

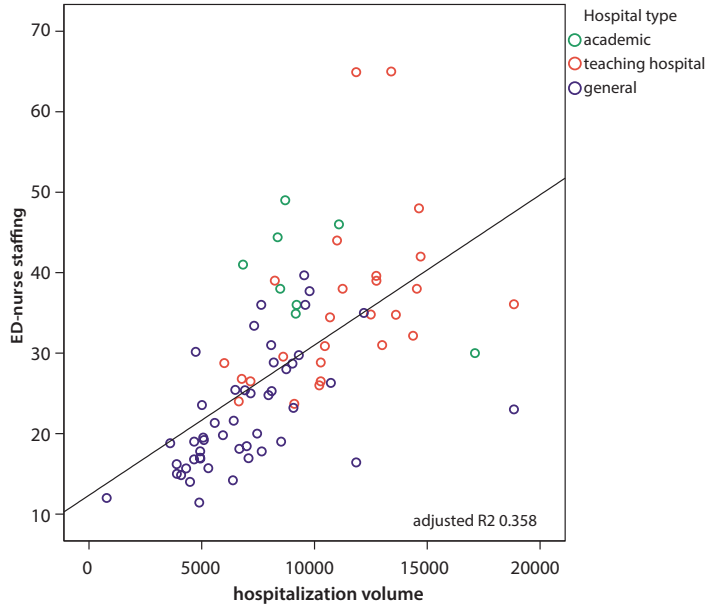

Figure 6 | Hospitalization volumes versus volumes of ED nurse staffing. Subdivision to hospital type: academic, teaching hospital and general hospital. Including correlation line with calculated adjusted R^2.

DISCUSSION

This study, to our knowledge the first in its kind, demonstrates that the ED-landscape in The Netherlands consists of a broad variety of EDs in regard to their individual profiles. In addition, on a national level this study identifies associations between patient and hospitalization volumes on one side and number of ED treatment bays, ED-nurses workforce capacity and available hospital beds on the other side. These findings form a first step towards more insight into the ED-landscape present and might be useful as input for the development of an ED resource allocation framework and more targeted optimization policy in the future.

Based on characteristics we examined EDs in The Netherlands apparently can not be considered as equals. In line with findings of previous research these departments continue to show a multiform landscape [4,6,14]. Reduction in the number of EDs over the years seems to have had little or no influence on this picture [6]. Other countries report comparable variation between ED profiles [19-22]. It is notable that with an average volume of about 23,000 patients (range 6,000–53,000) and an average of 16 treatment bays (range 4–36) EDs in The Netherlands are relatively small in an international perspective. In 2016 the number of patients seen in an ED equals 116 patients per 1,000 inhabitants. For comparison, in Belgium 290/1,000, in the United Kingdom 264/1,000 and in France 279/1,000 inhabitants [32]. Together with both a low percentage of self-referrals (average 15%, range 1%–56%) and a high percentage hospitalization of patients seen in the ED (average 38%, range 13%–76%), in general EDs in The Netherlands might be considered as fairly efficient. At the same time, there is still a broad range of variation among EDs that is insufficiently understood. More insight into backgrounds of this variation and critical interpretation hereof might enable targeted interventions to achieve even more efficiency.

The second aim was to investigate relationships between a selection of volume and resource characteristics on a national level. Because there is no national ED-framework yet, we hypothesized relationships as a first method of explorative research. No generally accepted relevant correlation hypotheses are available in literature. Therefore we had to formulate them ourselves first. Despite limitations the use of hypotheses can be seen as useful first indicators towards better understanding how available EDs relate to one another in regard to specific characteristics. We formulated six hypotheses around ED patient volumes and hospitalization of ED patients on one side and available resources on the other side and found both positive and significant correlations. Although this might seem obvious at first sight, these findings highlight at the same time the question that explains the differences present. How can it be that EDs with an equal volume of ED patients or hospitalizations do so with huge differences in terms of resources? These and other differences need to be investigated and explained in order to explore where there is actually room to improve quality and reduce costs.

In daily practice our findings establishes a baseline understanding of ED characteristics and mutual relationships. First of all this can serve as a starter towards the development of an ED resource allocation framework and in line with this as input for an ED benchmark-instrument. This development however does require more comprehensive insight into characteristics of individual EDs, how these departments relate to one another and especially adequate explanations for mutual

differences. For example, to compare ED resource planning information such as distribution of patient volume and admission volume during the day/week/months; severity of the illnesses or injuries treated; length of stay in the ED together with insight into reasons for admission should be taken into account. Our findings must be seen as a first step and give rise to a more extensive assessment of ED characteristics and interpretation of variation. Secondly, when coupled with mandatory reporting annual assessment may become an instrument to determine targeted interventions for ED-landscape optimization policy for reasons such as cost reduction, quality improvement and preventing crowding on one side and to monitor the effects of this policy in more detail on the other side.

Our study may also give direction to future research aiming to provide additional insight in the ED-landscape and the effect of interventions on costs, quality and crowding. Thus far, we have used annual surveys on a voluntary basis. Further studies could benefit from a mandatory national ED-registration coupled with more extensive reporting, including variables to correct for case mix differences on the level of patients (f.i. severity/complexity of patients) and ED units themselves (type of hospital, structure with GPC, geographical location). Future research is needed to achieve more and better insight into characteristics of individual EDs, the mutual connection of this, how individual EDs relate to national outcomes and adequate explanations for deviations. Studies are also needed to explore how, as far as ED care is concerned, economies of scale relate to scale disadvantages. In addition, it would be useful to identify objective national volume to resource ratios which can serve as a reference point for local interpretation. Our findings can also be of interest to the international reader. After all, a more detailed insight and understanding of the Dutch ED-landscape makes it possible to compare more accurately with this landscape in the own country, for example when looking for optimization options.

Although our study has its strengths, like 100% participation and high degree of completeness of requested data we acknowledge that several limitations may impact study results. The study was based on data obtained from registrations of individual EDs. We were not able to check for accuracy of all registries ourselves. Second, an (inter)nationally validated instrument to characterize EDs does not exist. In this explorative study we investigated a selection of administrative characteristics. Although among others based on previously conducted and comparable research, we do not pretend to be complete or have used the only best method. Thirdly, as far as we have been able to verify this is the first study using hypothesis to explore relations between characteristics within the ED-landscape. No generally accepted relevant correlation hypotheses are available in literature. Therefore we had to formulate them first. Although this is not validated we believe this is a method worthwhile in order to obtain better insight. Despite the limitations the use of hypotheses can be seen as useful first indicators towards better understanding how available EDs relate to one another in regard to their characteristics. Fourthly, we have studied centrally organized EDs that were operational and available 24 hours a day, 7 days a week. Alternative hospital entrances for urgent care were not part of our study, but may be included in the future. Finally, the authors were aware that ideally comparing ED resource planning should take more basic information then patient volume and hospitalization volume into account. Unfortunately this information was not available.

Despite these limitations our study provides more insight in the ED landscape of the Netherlands than was available to date.

CONCLUSION

In conclusion, our study shows that the ED-landscape is still multiform by numbers and specifications of individual ED-locations. At the same time this study identifies on a national level associations between patient and hospitalization volumes on one side and number of ED treatment bays, ED-nurses workforce capacity and available hospital beds on the other side. These findings establish a baseline understanding of how EDs relate to one another and form a first step towards more insight into the ED-landscape present and might be useful as input for the development of an ED resource allocation framework and more targeted optimization policy in the future.

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Part 2

OPERATIONAL STANDARDS FOR EMERGENCY DEPARTMENTS

Chapter 5

Minimum operational standards for 24/7 available emergency departments in the Netherlands

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ABSTRACT

Objective

To effectuate a consensus of Emergency Physicians (EPs) on minimum requirements for facility, diagnostic and medical specialist availability as a first step towards minimum operational standards for 24/7 available EDs in the Netherlands.

Methods

A two part e-Delphi via online surveys was performed between January 2015 and May 2016, using a panel of 20 experts in emergency medicine (EM). The aim of part one was to reach agreement on a list of possible ED elements and their definitions. The second part addressed the actual study objective to reach consensus on operational standards. Successive rounds were submitted to the members of the panel online using SurveyMonkey. Results of each survey round were discussed and interpreted in agreement with all authors in preparation for the next round. Reaching consensus, defined as 70% or more agreement or disagreement amongst the panel, on the level of all items was the endpoint of this study.

Results

Both part one and two required five rounds. The dropout rate of the expert panel remained zero. The availability of 52 facility and diagnostic functionalities and the manner in which 17 medical specialties should be available to every 24/7 ED were agreed upon by the expert panel.

Conclusion

An expert panel agreed upon minimum operational standards for EDs in the Netherlands. These results are helpful as a first step towards a more widely supported standard for future 24/7 available EDs in the Netherlands and in addition to this other urgent care facilities.

BACKGROUND

Developments within the acute care landscape organization in the Netherlands have focused on a reduction in the number of emergency departments (EDs) and their collaboration with general practitioner cooperatives (GPC) [1-3]. There has been limited attention for describing and characterizing EDs, both the one present today as those that will remain in the future. In 2012 the International Federation for Emergency Medicine (IFEM) terminology project has defined an ED as: '*The area of a medical facility devoted to provision of an organized system of emergency medical care that is staffed by Emergency Medicine Specialist Physicians and/or Emergency Physicians (EPs) and has the basic resources to resuscitate, diagnose and treat patients with medical emergencies. The ED is an unique location at which patients are guaranteed access to emergency care 24 hours a day, 7 days a week. It is able to deal with all types of medical emergencies (illness, injury and mental health) in all age groups*' [4]. Although the Dutch Society of Emergency Physicians (DSEP) endorses this definition, a standard for functionality, meaning the extent to which facilities, diagnostics and health care providers are available in these departments, has not yet been formulated. While at the same time precisely EDs which are available 24/7 play a leading role in the delivery of hospital based acute care, including emergency care, to the population [5-7]. As resources determine the abilities of an acute medical service, it seems obvious to establish minimal operational standards and thereby a good medical praxis baseline for the delivery of appropriate hospital based acute and emergency care in 24/7 available EDs.

The objective of this study was to effectuate a consensus of EPs on minimum requirements for facility, diagnostic and medical specialist availability as a first step towards minimum operational standards for in the future remaining 24/7 available EDs in the Netherlands.

METHODS

Study design

We conducted a two part e-Delphi via online surveys between January 2015 and May 2016. A panel of 20 experts in emergency medicine (EM) from the Netherlands, was involved in this study. Both parts consisted of a series of rounds to gather and refine information until expert consensus was reached. The aim was to reach agreement on the definitions of every possible ED element first. In the second part the actual study objective was addressed. Reaching consensus or non-consensus on the level of all items was the endpoint of this study. Ethical approval for this study was obtained from the Medical Research Ethics Committee of the Erasmus University Medical Center in Rotterdam (Ref. MEC-2014-322).

Study setting

In the Netherlands almost all citizens have health insurance, but with a deductible for hospital/ED care. Therefor patients may have to pay an additional fee when visiting an ED. Primary care is highly developed and accessible to everyone through local GP offices during daytime and 119 GPCs during

the evenings, nights and weekends. GPs are considered gatekeepers for hospital care, apart from emergency calls (112 throughout Europe) ED care included. Hospital based EM is provided in 87 EDs with 24/7 availability country wide, of which eight university hospitals [8]. Patient ED visits are almost 2 million a year (115 per 1.000 inhabitants) [8]. The organization of acute care is subdivided into eleven regional acute care networks [9]. Currently about 500 registered EPs are employed in 85% of all EDs.

Definition consensus

Expert consensus was reached when there was adequate concordance, defined as 70% or more agreement (positive consensus) or disagreement (negative consensus) amongst the members of the expert panel on each question-item [10].

Expert panel

The panel of experts was put together on the basis of 'premises', 'inclusion criteria', 'exclusion criteria' and 'additional competencies'. The criteria were agreed by all authors. The final panel included 20 EPs, certified for at least five years, from a representative broad range of EDs, all of them practicing EM on a daily basis. Of the expert panel members 10/20 were experienced as ED director; 11/20 possessed cross-departmental healthcare administrative experience; 14/20 had been involved in building a new ED in the five years prior the start of this study; 16/20 were faculty member of a training residency. It was a nationally distributed panel, with members working in different types of hospitals (6/20 academic hospital; 8/20 association of tertiary medical teaching hospitals; 6/20 general hospitals), together with a distribution of the members over the eleven existing regional acute care networks. Members of the panel remained anonymous to each other throughout the entire study and participated in this way in the Dutch ED Study Group. All members gave written informed consent for their participation, after having received an introductory email explaining the intent and design of this study. Participation was entirely voluntary and withdrawal from the study could occur at any point.

Compiling the starting list from literature

A literature search was performed between August and October 2014. Based on available relevant (inter)national guidelines and policy statements and the herein recurrent identified elements, we composed and fine-tuned a list of possible ED facility and diagnostic elements and their suggested definitions [4,11-15]. Medical specialties were not further explicitly defined as they are defined in Dutch law. A list of 55 ED elements with a proposal of their descriptions was presented to the panel members as a starting point of the study. Part one focused on the definitions of all elements. Part two focused on consensus of the necessity of these elements for every 24/7 ED.

Questionnaire design

Part one

In the first round besides discussing the suggested definitions, the expert panel was enabled to comment on the proposed list of possible ED elements, add elements they felt were lacking or

argue why an element should be excluded. In the second round additional elements with suggested definitions were submitted to the expert panel and in this way taken into account in further discussion rounds. In successive rounds arguments were shared on the basis of which definitions of elements were adapted until (positive) consensus on each element-definition was reached.

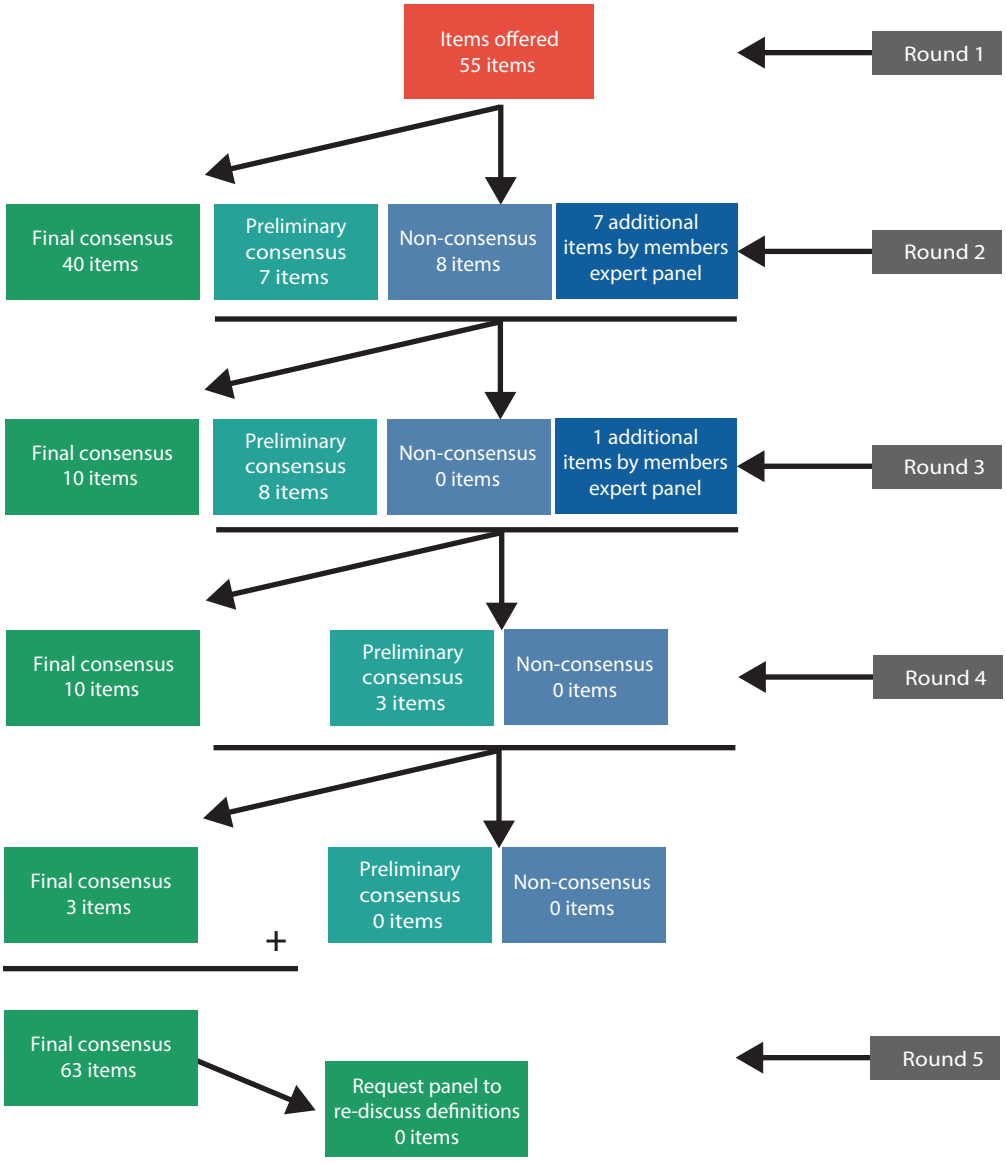

Figure 1 | Rounds and results for part 1 of the study.

Part two

In part two the actual study question was addressed: *Which minimum operational standards should every in the future remaining 24/7 ED in the Netherlands meet regarding facility, diagnostic and medical specialist availability?* Besides the defined elements from part one, medical specialties were also included. Arguments were shared in successive rounds on the basis of whether consensus (positive and negative) or non-consensus was reached on each item.

Online surveys

The successive rounds were submitted to the members of the expert panel online using SurveyMonkey. Results of each survey round were discussed and interpreted in agreement with all authors in preparation for the next round.

RESULTS

Rounds and participation

Both parts required five rounds. The dropout rate of the expert panel remained zero during the entire study, but an increasing number of prompts in each following round was necessary to get a full response.

Part one: elements and definitions

The panel added seven items to the proposed list of possible ED elements in round two and one more in round three. During each discussion round arguments were shared online and resulted in three possible outcomes: 'final consensus' (consensus without additional arguments shared by at least two or more members of the expert panel); 'preliminary consensus' (consensus but with arguments for an adjustment shared by two or more members of the panel); or 'non-consensus'. The elements in the latter two groups were re-submitted to the expert panel after the description had been adjusted. After the first three rounds the panel had agreed on a list of 63 possible elements and after a total of four rounds consensus was reached with regard to the description for all of them. The fifth and last round was used as a final confirmation round and ended without any comment from the panel.

Table 1 | Delphi rounds in study part one and final descriptions that consensus was reached upon

ED item	R1	R2	R3	R4	R5	consensus descriptions
Parking ED			95%			Ample parking space adjacent to the ED entrance for ambulatory ED patients and their next of kin.
Kiss & Ride zone ED			95%			A zone where a vehicle is allowed to stop in order to drop off or pick up somebody. Parking is not allowed.
Ambulatory entrance	85%					Single ED entrance for referred or self-referred patients that present to ED independently. This entrance may be combined via several ways with an after-hours GP clinic.
Reception		84%				A counter immediately following the ambulatory patient ED entrance where referred of non-referred ambulatory patients may be received and registered.
Ambulance entrance	95%					Single ED entrance separated from the ambulatory patient ED entrance for patients brought in by ambulance. Ambulances can unload their patients in a sheltered space. There is ample parking for ambulances.
Registration for ED patients arrived by ambulances		90%				Registration desk where patients brought in by ambulances may be registered.
Security		95%				Hospital security present in ED or on-call and arrival in ED within 5 minutes if required.
Waiting room		95%				Allocated space where patients and their next kin/company can wait (after registration and/or triage while awaiting further assessment and treatment.
Childrens waiting room		95%				Child friendly space where patients up to 18 years of age and their next of kin separate form the adult ED waiting room, can wait for their assessment and treatment after they have been registered and/or triaged.
Childrens corner in waiting room		95%				Part of the waiting room which is designed for children/adolescents in a child friendly way, sometimes separated from adult patients, where they can await their treatment.
Waiting room toilets		95%				Patient toilets adjacent to the waiting room(s)
Toilet for disabled		100%				Modified toilet facilitating independent use by people with physical disability, adjacent to the waiting room.
Triage room		100%				A space adjacent to the ambulatory patient ED entrance, reception and waiting room where the urgency of the need for treatment can be determined.
Staff workstation		95%				Centrally located work space in the ED for writing notes, discussions, advice, referrals and central monitoring of patients.
Central monitoring		95%				A central location in ED where values and waveforms of vital signs (such as heart rate and oxygen saturation) can be seen and heard.

ED item	R1	R2	R3	R4	R5	consensus descriptions
Fast track	95%					An area of ED dedicated to the management of patients without a major illness, who do not require resuscitation or monitoring, in order to assess, treat and rapidly discharge them from the ED. Organized as a separate patient flow in the ED.
Adult treatment room	95%					A dedicated room for assessment, treatment and stay of adults. Besides a stretcher, there are chairs available. There is equipment for supplemental oxygen therapy, suction, assessment and monitoring of vital signs.
Pediatric treatment room	90%					Dedicated child friendly room for assessment, treatment and stay for children. Besides a stretcher, there are chairs available. There is equipment for supplemental oxygen therapy, suction, assessment and monitoring vital signs.
ENT room	75%					Dedicated treatment room for ED patients requiring ENT assessment and treatment.
Eye room	80%					Dedicated treatment room for ED patients requiring ophthalmic assessment and treatment with a slit lamp.
Burns room	80%					Dedicated treatment room dedicated for of ED patients with burns with a shower to cool down burns.
Isolation room	95%					A room to assess, treat and keep patients requiring isolation. These room(s) have a pressurized air-handling system and have an anteroom.

ED item	R1	R2	R3	R4	R5	consensus descriptions
Decontamination-unit (fully fitted version)				100%		This version is a construction divided into 4 separate spaces: 1. Staff dressing room (not contaminated): this space has all personal protection equipment (PPE) available required for staff to perform a decontamination. This space can be entered from the outside and has an entry to the space for decontaminated victims. 2. De-robing area victim (=contaminated): a victim enters from the outside directly into this space. Here the victim can be disrobed by staff 3. Decontamination area (= contaminated): in this area the victim will be decontaminated. 4. Drying off area (=not contaminated): in this area the victim will be dried and clean clothes or a blanket will be provided. From this area onwards the victim will be treated as any other ED patient. In the decontamination area there are 2 flexible water hoses on a reel, each with a separate thermostatic tap. The water drainage of the areas are designed to prevent flow from one area to the other and that contaminated water is collected. The decontamination area is also equipped with facilities to provide eye irrigation with warm water. The de-robing and decontamination areas have negative pressure ventilation to prevent potentially poisonous vapors flowing to other areas. The air leaving the space will flow via an air handling system to the roof of the decontamination unit to prevent emission of contaminated air. The entire unit can be heated up to an ambient temperature of maximal 32°C in order to prevent hypothermia in victims during decontamination. Going the wrong way within the unit is prevented by modified one-way doors. For example, a staff member cannot go from the de-robing area back to the staff dressing room.
Decontamination-unit (minimally fitted version)				95%		This version contains several outdoor showers adjacent to the ED. There are also facilities for eye irrigation. Water temperature can be regulated to a minimum of 25 degrees.
Acute mental health room		95%				A quiet room suitable for assessment, treatment and stay of psychiatric or agitated patients.
Gynaecology room	80%					A room suitably equipped for a gynecologic examination.
Resuscitation room			100%			A room suitably equipped for resuscitation, such as CPR and stabilization of patients presenting with acute heart failure, CVA, severe sepsis and shock not due to trauma or intoxication. The room is readily accessible from the ambulance entrance and is suitable for both invasive as non-invasive ventilation.
Trauma room			100%			A room designed and equipped according to the Dutch Society of Trauma Surgery guidelines and suitable for the acute care of trauma patients. The room is readily accessible from the ambulance entrance and is suitable for both invasive as non-invasive ventilation. The room is equipped with the necessary X-ray facilities.

ED item	R1	R2	R3	R4	R5	consensus descriptions
Plaster room	85%					Room designed for application of plasters with a plaster trolley.
Patient toilets in the ED	100%					Female and male patient toilets in the ED. If not accessible for the disabled patient, a separate patient toilet for the disabled in the ED.
Staff toilets	100%					Female and male staff toilets in ED.
Staff showers	80%					Shower for ED staff.
Overnight room			95%			Area with a bed in or adjacent to ED where ED staff can rest if work load permits.
Staff room	85%					Area in the ED where ED staff can have a break to eat or drink.
Reception non ED staff	75%					Area in ED where ambulance crews, police and other care providers not employed at the hospital can perform their administrative duties and eat and drink.
Seminar room	80%					Area in the ED with audiovisual facilities for handovers, meetings and education.
Offices			100%			Rooms for ED consultants, ED trainees and ED secretary in or adjacent to ED for administrative, research, educational and managerial purposes.
ED medication room			100%			Lockable room in the ED where medication can be safely stored, including temperature sensitive medication.
ED medication preparation room			95%			Area in ED where medication can be prepared for administering.
Equipment room	95%					Lockable room in the ED for storage of materials such as wheel chairs, additional stretchers, ventilators, etc..
Store room	90%					Lockable room for sufficient storage of disposable supplies.
Dirty utility room	100%					Area for collection of used equipment with a patient utensil sanitiser.
Linen trolley storage room	95%					Area in ED where linen trolleys can be kept without getting in the way.
Storage room mobile equipment	95%					Area in the ED where mobile equipment (such as Procedural Sedation and Analgesia trolley, ultrasound machine, portable X-ray device, bladder scan, etc.) can be kept without getting in the way.
ED CT bay	80%					Area in ED equipped and suitable with a CT scanner.
X-ray room	90%					Area in the ED (not in the trauma room) equipped and suitable for conventional radiography.
Relatives room	100%					Room for relatives of the patient awaiting treatment and where relatives can be informed.
Mourning room		95%				Separate room in the ED where a deceased patient can be moved and where loved ones can say farewell to a deceased patient before transfer to a morgue.
Short stay unit		100%				Facility with trained staff and monitoring in or adjacent to ED where ED patients that have received their initial treatment can stay for further investigations, discharge after a period of observation or hospital admission.

ED item	R1	R2	R3	R4	R5	consensus descriptions
Operating theatre	80%					Availability of an operation theatre and a (on-call) surgical team for emergency surgery (start within 30 minutes after announcement/request)
Dialysis	90%					24/7 Availability of emergency dialysis (start within 30 minutes after announcement/request, including staff/ nephrologist/intensivist if required).
Intensive care unit	85%					On-site ICU.
Laboratory	95%					Availability (24/7) of laboratory facilities and presence of staff for emergency investigations.
Conventional radiography	100%					Availability (24/7) of conventional radiography in the ED by radiographers and if required, assessment by a radiologist.
Bedside ultrasonography			95%			Availability (24/7) of performing and assessing emergency bedside sonography in ED, immediately on patient arrival.
Ultrasonography				100%		Availability (24/7) to perform ultrasonography within an hour of patients arrival to the ED to exclude or diagnose a specific condition.
Emergency CT	100%					Availability (24/7) of CT imaging, immediately after patient arrival and immediate reporting by a radiologist immediately after finishing the CT scan (potentially via telehealth).
Emergency MRI	75%					Availability (24/7) of MRI imaging, immediately after patient arrival and immediate reporting by a radiologist immediately after finishing the MRI scan (potentially via telehealth).
Emergency angiography	90%					Availability (24/7) of emergency angiography for diagnostics and possible embolisation (start within 30 minutes of announcement/request; including calling in staff/interventional radiologist if required).
Emergency GI tract endoscopy	90%					Availability (24/7) of emergency gastro-intestinal endoscopy (start within 30 minutes of announcement/request; including calling in staff/gastroenterologist if required).
Emergency ENT endoscopy	95%					Availability (24/7) of emergency ENT endoscopy (start within 30 minutes of announcement/request; including calling in staff/ENT doctor if required).
Emergency bronchoscopy	95%					Availability (24/7) of emergency bronchoscopy (start within 30 minutes of announcement/request; including calling in staff/respiratory physician if required).
Pacemaker interrogation			90%			Availability (24/7) of cardiac pacemaker or ICD interrogation (start within 30 minutes of announcement/request; including calling in a pacemaker technician if required).

Part two: minimum operational standards

Results obtained in part one formed the groundwork for the second part of the study. Besides the defined 63 possible ED elements, 29 medical specialties were also submitted here, each time asking the panel about the necessity of availability for every ED. Round one produced positive consensus of opinion (88%) on 39 facility and diagnostic elements and negative consensus of opinion (79%) on 4 elements. Fast track availability (80%); children's waiting room (80%); fully fitted decontamination-unit (85%) and ED CT bay (70%) were excluded with a negative consensus and without a required alternative. Round one produced positive consensus (90%) on 3 out of 29 medical specialties. The remaining 20 items and 26 medical specialties that did not reach consensus were sent back to the experts in the next round, together with collected arguments. After round two and three another 7 and 10 facility and diagnostic elements respectively had reached negative consensus (80%). The availability of 6 elements with a negative consensus (acute mental health room, 75%; short stay unit, 70%; dialysis, 90%; emergency MRI, 80%; emergency angiography, 85%; pacemaker interrogation, 80%) was excluded without a locally required alternative. The other 11 elements with a negative consensus (registration for ED patients arrived by ambulances, 80%; ENT room, 100%; ophthalmology room, 85%; burns room, 75%; gynecology room, 75%; plaster room, 70%; staff showers, 85%; reception non ED staff, 75%; seminar room, 80%; linen trolley storage room, 75%; mourning room, 85%) were also excluded, but with an alternative required locally by the panel. The physical spaces were not required as such, however, while maintaining the specific functionalities. Additionally round two produced positive consensus of opinion, on average 79%, on the availability of 9 medical specialties and negative consensus (70%) on one medical specialty. Round 3 produced 9 negative agreements of opinion (84%). The remaining 3 elements and 7 medical specialties that had not reached consensus after round three, were sent back to the experts in the fourth round, again with collected arguments. Round four resulted in a positive consensus on two other facility and diagnostic items (75%) and five medical specialties (79%). Non-consensus was reached on 1 element and 2 medical specialties. Round five was used as a final confirmation round and ended without any comment from the panel members.

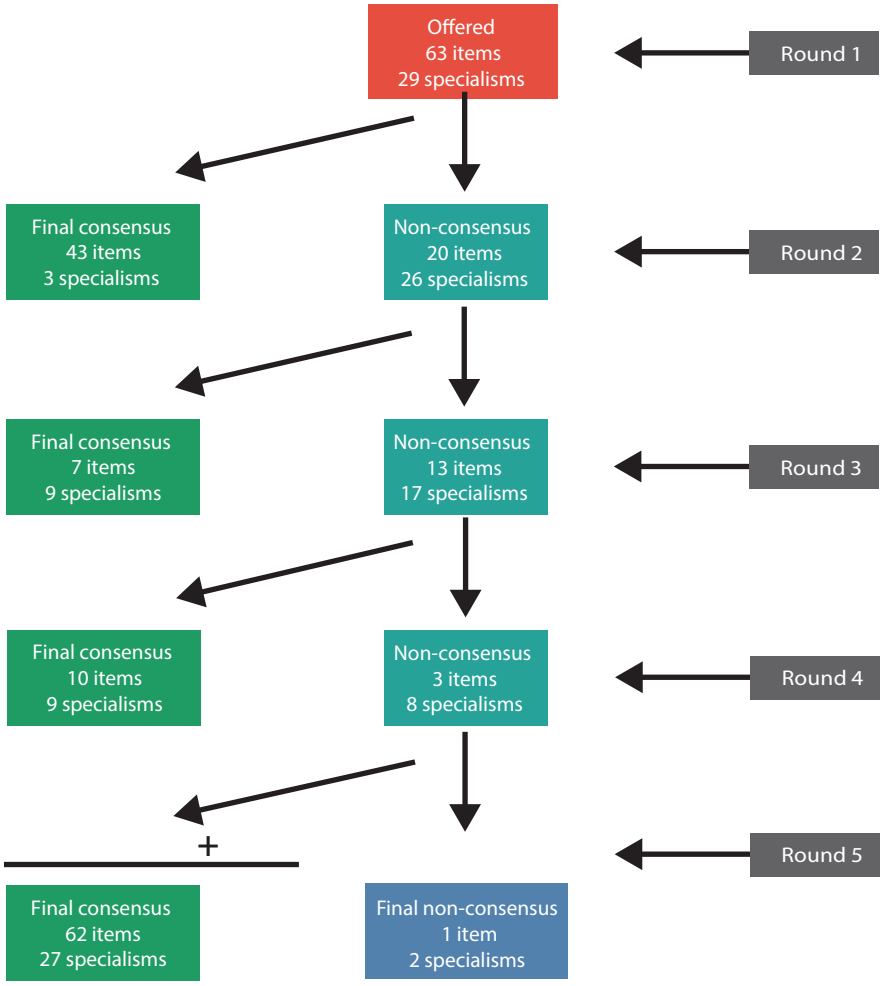

Figure 2 | Rounds and results for part two of the study

Table 2 | Part 2, way of consensus on facility availability

Way of consensus	Elements
Available in every 24/7 ED in the way as defined in part one of the study (41 ×)	Parking ED (R1, 75%); Kiss-and-Ride zone ED (R1, 75%); ambulatory entrance (R1, 85%); reception (R1, 85%); ambulance entrance (R1, 95%); security (R1, 75%); waiting room (R1, 95%); children's waiting corner in the waiting room (R1, 80%); waiting room toilets (R1, 90%); toilet for disabled (R1 85%); triage room (R1, 75%); staff working station (R1, 95%); central monitoring (R1, 100%); adult treatment room (R1, 95%); pediatric treatment room (R1, 75%); isolation room (R1, 85%); minimally fitted version decontamination unit (R1, 90%); resuscitation room (R1, 95%); trauma room (R1, 85%); patient toilets in the ED (R1, 95%); staff toilets (R1, 100%); staff room (R1 95%); ED medication room (R1, 100%); ED medication preparation room (R1, 90%); equipment room (R1, 85%); store room (R1, 90%); dirty utility room (R1, 100%); storage room mobile equipment (R1, 85%); relatives room (R1, 85%); operating theater (R1, 85%); ICU (R1, 80%); laboratory (R1, 100%); conventional radiography (R1, 95%); bedside ultrasonography (R1, 95%); ultrasonography (R1, 100%); emergency CT (R1, 100%); emergency GI tract endoscopy (R1, 75%); emergency ENT endoscopy (R1, 80%); emergency bronchoscopy (R1, 75%); offices (R4, 75%); radiography room (R4, 90%)
Available in every 24/7 ED, not in the way as defined in part one of the study, but maintaining the functionality in an alternative way (11 ×)	Registration for ED patients arrived by ambulances (R3, 80%); ENT room (R3, 100%); eye room (R3, 85%); burns room (R2, 75%); gynecology room (R3, 75%); plaster room (R2, 70%); staff showers (R2, 85%); reception for non-ED staff (R3, 75%); seminar room (R3, 80%); linen trolley storage room (R3, 75%); mourning room (R3, 85%)
Not available in every 24/7 ED as defined in part 1 of the study or in an alternative way (10 ×)	Fast-track (R1, 80%); fully fitted version decontamination unit (R1, 85%); children's waiting room (R1, 80%); ED CT bay (R1, 70%); short-stay unit (R2, 70%); dialysis (R2, 90%); acute mental health room (R2, 75%); emergency MRI (R2, 80%); emergency angiography (R3, 85%); pacemaker interrogation (R3, 80%)
No consensus (1 ×)	Overnight room

CT, computed tomography; ED, emergency department; GI tract, gastrointestinal tract.

Table 3 | Part 2, way of consensus on specialist availability

Way of consensus	Medical specialties
24/7 present in the ED	Emergency physician (R1, 90%)
24/7 present in the hospital and able to be in the ED within 30 min	Intensivist, if not responsible for acute airway management in the ED (R4, 70%)
24/7 on-call and able to be in the ED within 30 min	General internist (R2, 75%); gastroenterologist (R2, 85%); general surgeon (R2, 80%); cardiologist (R2, 85%); neurologist (R2, 70%); pulmonologist (R2, 85%); ENT doctor (R2, 75%); pediatrician (R2, 75%); gynecologist (R2, 70%)
24/7 on-call and able to be in the ED within 60 min	Ophthalmologist (R4, 85%)
24/7 available for consultation by phone	Microbiologist (R1, 90%); hospital pharmacist (R1, 90%); psychiatrist (R3, 75%)
Consensus about availability, but not about in what way	Anesthesiologist (R5, 90%)
Consensus about availability, but in different ways	Radiologist, 24/7 on-call and able to be in the ED within 5 min if responsible for emergency ultrasound/within 30 min to interpret radio diagnostics within 30 min/within 60 min to interpret nonurgent diagnosis (R3, 80%)
Presence and availability for each ED not required	Acute internist (R2, 70%); trauma surgeon (R3, 70%); vascular surgeon (R3, 80%); gastrointestinal surgeon (R3, 75%); plastic surgeon (R3, 95%); oral surgeon (R3, 85%); neurosurgeon (R3, 95%); interventional cardiologist (R3, 95%); dermatologist (R4, 80%); interventional radiologist (R3, 90%);
No consensus about availability for each ED	Geriatrician; orthopedic surgeon

ED, emergency department.

DISCUSSION

Main findings

This study identified a valid expert opinion on minimal operational standards for every 24/7 ED in the Netherlands, using a two part e-Delphi technique. Widespread agreement was reached among the panel on the availability of 52 facility and diagnostic functionalities and the manner in which 17 medical specialties should be available.

Reflections on web-based discussions

Discussion rounds took place during quite a long period of time, between January 2015 and May 2016. Reasons being the number of elements, response time given to and taken by the panel members and also time needed by the authors to analyze and organize the responses in order to give it back to the panel members again. It is noteworthy that we maintained 100% participation during all consecutive rounds. We speculate that this commitment was due to an intense interest and understanding of EPs for the development of standards for the departments in which they practice.

As authors we observed non-divisive discussions in which the panel members shared arguments in a reasonable and constructive way within the group as a whole.
In general, the focus of discussion was more around the availability of medical specialties rather than the availability of facility and diagnostic functionalities. The expert panel agreed upon ten elements out of a list of 63 proposed items, that do not need to be available in every ED. They felt that fast track primarily concerns logistical organization and that every ED has to determine the need themselves. The availability of a fully fitted decontamination unit was considered mandatory on a regional level only, however every ED should have a minimally fitted decontamination room. Although a CT bay situated in every ED was not considered necessary, the availability of a CT bay anywhere within the hospital was. Regional availability of dialysis, emergency MRI, emergency angiography and pacemaker interrogation was considered sufficient.
No consensus was reached on only one item, the availability of an overnight room. The discussion surrounding this item focused more on whether an EP on shift is allowed to rest if circumstances allowed him/her to do so. We hypothesize that the relatively limited discussion on facility and diagnostic items is due to the availability of rather fully-equipped EDs country wide. Therefore the members of the expert panel share the same frame of reference.
In regard to the availability of medical specialties the panel expressly recognized the central role of the 24/7 presence of an EP and clearly seemed to acknowledge the need for cooperation with hospital based medical specialties. At the same time they suggested the potential for rescheduling medical responsibilities in the ED, making the availability of a number of specialties to every ED unnecessary, and regionalization of specific types of acute care. Unsurprisingly an EP was deemed necessary in every ED by the expert panel, which consisted solely of EPs. Surprisingly this was with a consensus of 90%, not 100%. The expertise of an acute medicine specialist in every ED was not valued by the panel above available expertise of any other kind of internist. The availability of a neurosurgeon, an interventional cardiologist or an interventional radiologist were considered unnecessary in every ED as long as they were regionally available, mirroring existing practice in the Netherlands. It is noteworthy that neither certain surgical subspecialties (trauma, vascular, gastrointestinal, plastics, oral/maxillofacial) were considered necessary for every ED, again as long as they were regionally available. No consensus was reached with regard to the necessity of availability of geriatricians and orthopedic surgeons.

Study findings in the context of existing literature

To the best of our knowledge, the present study is the first to investigate a consensus on minimal operational ED standards for both facility, diagnostic and medical specialty availability in this way. Internationally design guidelines and standards from government agencies and EM professional organizations based on expert groups are available [4,11-15]. No such standard or guideline exists for EDs in the Netherlands, where at the same time a comprehensive multidisciplinary directive on intensive care units has been available since 2006 [16,17]. This directive includes architectural and facility aspects, a framework for staffing (including span of control of an intensivist and defining responsibilities), organizational preconditions and the availability of support services and diagnostics. ED care in the Netherlands needs to catch up in order to find appropriate connection

here. With regard to availability of facilities and diagnostics, the results of our study seem to be largely consistent with existing international standards [11-15]. We haven't been able to find (inter) national literature or standards regarding availability of different kinds of medicals specialists for care in the ED.

Strengths and limitations

This study has several strengths. We brought together a geographically representative panel of EPs. There was no dropout among the panel members during all rounds. We maintained anonymity and confidentiality of responses and we achieved 100% consensus with respect to the list of elements and their definitions at the end of part one affording an unambiguous starting point for part two of the study. It has also several weaknesses. Firstly, there are general concerns about the reliability, validity and credibility of the Delphi-methodology [10,18,19]. No evidence based guidelines exist for determining consensus and composition of an expert panel. It can be argued that a consensus approach can lead to a diluted version of the best option and the result represents the lowest common denominator. In addition, anonymity may lead to a lack of accountability as responses cannot be traced back to the individual. Secondly, an universally agreed level of consensus does not exist for the Delphi method. In this study we have set the minimum degree of consensus required at 70% [10]. In reality however, the degrees of consensus were much better, strengthening the outcome of our study. Thirdly, our expert panel consisted solely of EPs, while currently both EPs and other medical specialists care for patients in EDs. However, EPs are increasingly forming the medical backbone of EDs in the Netherlands and are the only physicians working full-time, around-the-clock in the ED. Therefore their opinions weigh heavily. As an ED-blueprint isn't available, various parties have taken a stand in the debate on the functionality of EDs. Here the profession of EPs speaks out. Fourthly, the dominant ideology in the Netherlands over recent years has been the one that advocates ED consolidation together with their integration with GPCs. Members of the panel may have been influenced hereby, as well as by the circumstances of their own hospitals. It was challenging to ensure that all panel members continued to keep in mind the objectives of the process clearly and maintained the discussion on a certain level of abstraction, free from local bias. However, we think these biases would be applicable to any panel, irrespective of their composition. Fifthly, we started the expert panel discussion with a proposed list of possible ED elements from literature. This entails the risk of maximizing facilities, rather than innovating and improving the model. Sixthly, this study was performed in the Netherlands, which is limiting generalizability to other countries. Finally, where emergency care is a multidisciplinary field, any standard needs to have support among the various emergency care stakeholders before it can be adopted.

Implications

A thorough understanding of the ED landscape present is fundamental in order to achieve future optimization of the balance between efficiency and the best possible quality of individual patient emergency care. Results of our study may contribute to this in several ways. Internationally, because the functionality of an ED crosses national borders, our results can boost discussion and research about minimum operational ED standards in other high income countries as well. After all, although

minimum needs of an ED have been developed by professional societies in a small number of high income countries, in most of them, like in the Netherlands, these are not available. Additionally our study demonstrates a methodology that can be used in other jurisdictions to gain consensus on ED facility standards. On a national level this is an initial study that provides a starting point for further discussion and a first reference for future comparisons and policy making in regard to the ED landscape. It can be used to consider the layout of the current acute care landscape. With this study we have explicitly not attempted to classify ED levels or specific functions. Goal was to define a minimum of standards all future 24/7 available EDs must comply with. This framework can then be used towards characterizing acute care facilities other than 24/7 EDs on one side and different ED levels or EDs with specific functions on the other side. On a local level it can be used for bench-marking by hospitals evaluating the functionality of their ED service.

Several implications for further research derive from presented findings. First, the logical next step for future research would be a follow-up inventory study of the real availability of facilities, diagnostics and medical specialties present in all Dutch EDs and to bench-mark these findings with the findings from this study. Second, we inventoried the availability of medical specialists. Instead future research could focus on identifying minimum competencies and skills that are needed in every ED. Third, future research may seek to broaden the consensus on minimum operational standards among other stakeholders involved in emergency care.

CONCLUSION

This study presents an e-Delphi methodology resulting in a consensus on the definitions and required minimum for the operational standards for facility, diagnostic and medical specialist availability for 24/7 available EDs. These results are helpful as a first step towards a more widely supported standard for future 24/7 available EDs in the Netherlands and in addition to this other urgent care facilities.

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Chapter 6

Improving design choices in Delphi studies in medicine: the case of an exemplary physician multi-round panel study with 100% response

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ABSTRACT

Background

A proper application of the Delphi technique is essential for obtaining valid research results. Medical researchers regularly use Delphi studies, but reports often lack detailed information on methodological choices, decision rules and controlled feedback: in the medical literature, papers focusing on Delphi methodology issues are rare. Details on response times since the use of electronic surveys are lacking. We aimed to bridge some gaps by providing a real world example on methodological choices and response times in detail.

Methods

The objective of our e(lectronic)-Delphi study was to determine minimum standards for emergency departments (EDs) in the Netherlands. We decided on a two-part design with many explicit decision rules. Part 1 focused on gathering and defining items, and Part 2 addressed the main research question using an online survey tool. A two-person consensus rule was applied throughout: even after consensus on specific items was reached, panelists could reopen the discussion as long as at least two panelists argued similarly. Per round, used reminders and individual responses times were noted. We kept record of the methodological considerations and evaluations made by the research team in advance and during the study.

Results

The study was performed in eight rounds and an additional confirmation round. Response rates were 100% in all rounds, resulting in 100% consensus in Part 1 and 96% consensus in Part 2. Our decision rules proved to be stable and easily applicable. Items with negative advice required more rounds before consensus was reached. Response delays were mostly due to late starts, but once panelists started, they nearly always finished the questionnaire on the same day. Reminders often yielded rapid responses. Intra-individual differences in response time were large, but quick responders remained quick.

Conclusions

We advise those considering Delphi study to follow the CREDES guideline, consider a 2-part design, invest in personal commitment of the panelists, set clear decision rules, use a consistent lay-out, and send out your reminders early. Taking this overall approach may assist researchers in future execution and may help to improve the quality of Delphi designs in terms of improved rigor and higher response rates.

BACKGROUND

Medical researchers commonly use the Delphi technique for consensus studies. A proper execution of this technique is essential for a study's validity, but the present medical literature on the topic has so far remained rather vague. In this paper, we discuss several methodological issues and panel response characteristics based on our study amongst an expert panel of Emergency Physicians [1].

The Delphi technique is designed to obtain the most reliable consensus of opinion in a group of experts. It attempts to achieve this by means of a series of questionnaires interspersed with controlled feedback including group statistical responses [2,3]. Anonymity amongst panelists prevents the occurrence of individual dominance that may result from strong verbalization, track records or professional dominance. It also allows panel members to change their opinion on the basis of arguments presented by the other panel members without publicly admitting that they have done so. These advantages are assumed to increase reliability of consensus.4 When an online survey tool is applied, the term e-Delphi (electronic) is used.

Since the early nineteen-fifties, the Delphi technique has been widely used in a large number of diverse domains such as the military, business, education, social science and health care [4]. It can be used for a wide range of complex research aims, including forecasting, issue identification, issue prioritization, ranking, policy formation and concept-framework development [5,6]. However, the method's versatility is both a strength and a weakness. Practitioners are often willing, and sometimes even eager, to modify Delphi to meet their own decision-making and forecasting needs. In some cases, these modifications are meaningful and contribute to a better understanding of the technique; in other cases, they are random and arbitrary – thus undermining quality and credibility [4].

Reports of medical studies using Delphi often lack detailed information on how Delphi studies are conducted. This may be partly due to medical journal word count limits, but it results in low repeatability and limited insight into external validity. To address this matter, a guideline for reporting (CREDES, table 1) was recently published [7]. Still, most of the existing methodological literature on Delphi will not be found by using common search strategies for medical research in databases such as PubMed and Embase, and medical researchers may therefore easily overlook these. For novel users, however, such information is crucial, because the method's apparent simplicity is in contrast with the work and the difficulty involved in its proper execution [3]. Time it takes to complete a Delphi study is usually underestimated and respond rates are often disappointingly low [8,9]. Deficient application of the technique will lead to poor validity of the results [3,5,10]. In addition, little has so far been published on the way in which panelists respond to the presented rounds, what circumstances contribute to high response rates in a panel or how these can be optimized.

We give insight into the methodological challenges from our Delphi study on ED standards. We present the solutions we chose based on the available data and how these turned out. We aim to aid others who plan a Delphi Design and therewith improving future quality. In addition we provide details on response times from this e-Delphi.

METHODS

The objective of our e(lectronic)-Delphi study was to determine minimum standards for emergency departments (EDs) in the Netherlands. We based our methodological choices on available literature; we discussed and decided on these within our full research group, and kept record of the methodological considerations and evaluations made by the research team in advance and during the study. Per round, used reminders and individual responses times were noted.

Purpose and rationale of our Delphi

The study that is used as an example in this article gained a consensus among Emergency Physicians on minimum operational standards for emergency departments (EDs) in the Netherlands [1]. The study focused on three domains: ED facilities, diagnostics and availability of medical specialists. Its background is the rapidly changing emergency health care environment, where a clear view on the minimum standards of a hospital-based 24/7 ED is important for delivering adequate care for patients with undifferentiated, urgent or emergent complaints.

Prior information for establishing a panel's knowledge base

Panelists were provided with information on the study's purpose and rationale, including the definition of ED that was used. Experts remained anonymous and unknown to each other throughout the entire process. One selection criterion for our panelists was a prior possession of the required knowledge base [1], therefore no additional information on ED operational standards was provided. In this way, risk of influencing the experts' judgements was eliminated.

Unstructured (classical) or structured (modified) first round

In a 'classical' Delphi, the first round is unstructured, allowing free scope for experts to elaborate on issues they deem important. Commonly, however, this round is structured to save time and effort for both the monitor team and the panelists [6].

We assumed that interpretation differences amongst panelists with respect to the items involved could exist and therewith affect the discussion of the main research question in a negative manner. To avoid such miscommunication on items, we added Part 1 prior to focusing on the main research goal in Part 2, both parts consisting of several rounds. In Part 1 we combined the collection of all relevant items from the literature and the panel, with reaching consensus among panelists regarding the definition of these items. Additionally, adding a consensus path before introducing the main research question allowed the panel and the monitor team to familiarize themselves with the method and the online survey tool. Such clear definitions will also aid interpretability of the results for others.

We started our study in a semi-structured fashion (Part 1, Round 1): panelists were provided with a list of items and a proposed definition for each of these. Panelists were then asked to do two things. First, they were invited to add all items that could possibly be regarded as an ED facility or a diagnostic option for an ED. To stimulate panel members to submit plain as well as more uncommon items in the first round, we made sure that the provided list included items that panelists would

most likely consider to be necessary for every ED in Part 2 (for example, every ED needs a toilet) as well as unnecessary (for example, every ED should have an MRI scanner on the shop floor). Next, the panelists rated and commented on the provided definitions. Once all items had been gathered and consensus on the definitions of all items had been reached, we proceeded with Part 2. Part 2 focused on the main research topic: minimum ED standards in three domains (ED facilities, diagnostics and availability of medical specialists), for which the defined items resulting from Part 1 and a list of all medical specialties were used.

Table 1 | Desiging an e-Delphi using CREDES

- Define purpose and rationale of DELPHI
- Prior information for establishing the knowledge base of the panel
- Unstructured (classical) or structured (modified) first round
- Required question type (qualitive or quantitative)
- Define consensus and non-consensus
- Clear and transparent guidelines on how to proceed from round to round
  - purpose of round
  - what if no consensus is reached after several iterations?
  - do items need to be deleted in next rounds (consensus/rated irrelevant)?
  - do items need to be refined in next rounds (when and how)?
  - number of rounds
  - define what determines the last round
- Strategy for processing results between survey rounds
- Development of materials/instruments (platform/lay-out/questions)
- Pilot materials/instruments
- Selection of experts
- Role of research team
- Strategy to improve resonse rate
- Validate final report externally

Required question type (qualitative or quantitative)

In Part 1, panelists were asked dichotomously if they could agree with a proposed definition. Open text fields were used for panelists to explain their choices and to add their opinions on remarks made by their colleagues. Open fields were also used to include any additional items.

In Part 2, the domains 'ED facilities' and 'diagnostic availability' started dichotomously, but they were converted into multiple-choice options when two or more panel members suggested a similar adjustment or condition. This was added in the next round, for example "agree, only when condition x is satisfied".

In the third domain (availability of medical specialists), we first aimed at a yes-no level of necessity. Additionally, we wanted more information on the degree to which the panel felt this was necessary. We used a multiple choice approach to limit the time and effort asked from panelists, for example "agree, 24/7 availability" and "agree, 24/7 availability by phone as well as physically available within

30 minutes". Again, when two panelists added a similar remark, this was added as an answer option. Items that were selected by fewer than two panelists were omitted in the next round, but panelists were offered the opportunity to disagree with the remaining options when they were not convinced by the motivations given by other panelists.

Define consensus and non-consensus

Consensus was assumed to have been reached when at least 70% agreement was achieved. Our decision rules are presented in Table 2. When consensus was reached, members could ask for an item to be re-discussed, but a motivation was required. Again, a threshold of two similar motivations was needed for an item to be discussed in the next round. We opted for this approach to enhance the validation of the consensus reached. It also provided panelists with the opportunity to individually avoid process loss due to early closure (through reaching agreement on the first solution that nobody strongly objects to with the aim to achieve consensus rather than aiming for the best possible judgment that is agreed upon wholeheartedly by most). The obvious disadvantage in this case is that it required more time and effort on the part of the panelists.

Table 2 | Defined and applied decision rules

• consensus is declared at 70% agreement
• 2 similar requests warrant re-introduction of a consensus declared item
• 2 similar suggestions for change-addition in answer options resulted in no consensus after 4 round without major change or suggestion for change is accepted as non-consensus

Clear and transparent guidelines on how to proceed from round to round

We decided not to set a fixed number of rounds. In stead we set endpoints and decision rules indicating when to add changes and when to accept. Classically, the number of iterations seldom exceeds one or two rounds, when most changes in panelists' responses are expected [6,11]. However, the possibility to respond to the provided feedback and consensus are essential for improving validity [6]. The downside of multiple rounds could be that panelists (even 'holdouts') can become tired of discussing the same item again and tend to lean towards closure and changing their opinion towards the mean if the number of rounds keep increasing [11,12] or drop out [9]. We tried to minimize such weariness amongst panelists by making sure the surveys were easy to fill out, with a clear and consistent presentation, in order to minimize the amount of time needed. In the introduction of each round the purpose of each part/round was explained to the panel and decision rules relevant to the specific round were shared. The survey then started with the pages with items on which no consensus was reached previously (Figure 1), followed by items on which consensus was reached in the previous rounds together with all remarks. Only when the panelists did not wish a consented upon item back for rediscussing, such item was deleted from the next round.

When a similar suggestion for adjustment of an item was made by at least two panelists, it was changed and the adjusted item was put forward for discussion again in the next round. This rule was also applied when consensus was reached in the same round as suggestions for change were made;

we called this reached consensus 'preliminary consensus'. The item was adjusted and put forward again in the next round (an example is included in the Results section below). When in Part 2, Round 4 no consensus was reached and no suggestions for change were made, nor major shifts in opinion were seen, we accepted non-consensus with respect to these items.

Strategy for processing results between survey rounds

The online survey tool generated the pooled results per round. Quantitative data were expressed in percentages as statistical group response. Newly generated items were included in the next round. Qualitative data were presented per item; presenting arguments from the last round separately from the arguments from the previous rounds.

Our rule for modification required 2 similar suggestions for adjustment. Two members of the research team (RV and MG) individually judged all comments on similarity. In case of disagreement, the data were discussed in the full research team.

Development of materials/instruments (platform / lay-out / questions)

An online survey tool was used (SurveyMonkey.com®) with a clear lay-out that was identical in all rounds (Figure 1). We presented one item per page, including a statistical summary of the former round, and anonymized remarks from prior rounds. Each member of the panel received an individual invitation for each survey. A survey could be closed and continued whenever the panelists wanted this.

Pilot materials / instruments

Surveys were built per round by one researcher (RV). No formal pilot was performed. The functionality of each round was tested using different mail servers and operating systems and checked by a second researcher. When agreed upon, the survey was sent to the panel and a dummy version was sent to the research team for control purposes.

Selection of experts

One of the key aspects of a rigorous Delphi study is the selection of experts for the panel, as this is crucial for the validity of the resulting consensus. Therefore, much thought should be given to assembling a representative panel. Steps in this selection process include identifying the classes of experts, completing these with names, contacting individuals and letting them nominate others for inclusion, ranking individuals on the basis of qualifications, inviting individuals and finally asking for their commitment [5]. Gaining commitment from high-profile and busy panelists depends on the way in which this process evolves. Incentives to participate could include being invited to join a selective group and the opportunity to learn from the consensus process [5]. We did not pay our experts, nor did we give them presents of any kind. The ideal number of panelists for a Delphi is not set in stone, but a recommended number is 10 to 18 for ensuring the development of productive group dynamics and for arriving at consensus among experts [7,13].

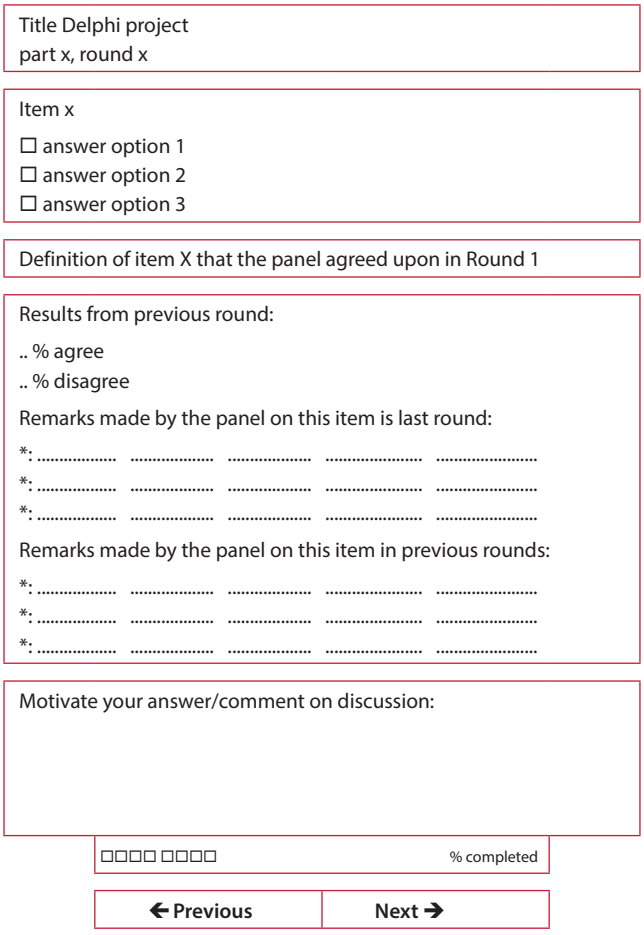

Figure 1 | Components of online survey. The design was identical for each page of the surveys and consisted of the following components.

We recruited our panel among Emergency Physicians (EPs) to guarantee a broad but direct clinical view on the topic. We added the following requirement: 15 to 25 members had to be included from all over the country (i.e. one to two members of each of the country's 11 predefined regions of acute care), balanced between working in academic, semi-academic and rural hospitals. We aimed for EPs with demonstrated competence in management or education (Table 3), added names to our list and called the highest-ranking EP in each region. Calls were made by MG, a Dutch EP well known by most EPs as the former Chairman of the Dutch Society of EPs. EPs were informed about the aim of the study, the methodology, the importance of anonymity, and we emphasized the amount of the time that they needed to invest. When other EPs were nominated, we ranked them on our list. Verbal informed consent was obtained from all panelists.

Table 3 | Composition of expert panel

Number of panel members	20
Registered Emergency Physician	20
Working clinically in a 24/7 hospital-based ED	20
Experience as ED manager	10
Experience in sector or hospital management	11
Experience with ED design within last 5 years	14
Experience as educator in ED specialty training	16
At least 3 years of working experience as registered	19
LNAZ region	
Groningen	2
Zwolle	1
Enschde	2
Nijmegen	2
Tilburg	2
Rotterdam	1
Utrecht	2
Leiden	2
Amsterdam VUMC	2
Amsterdam AMC	2
Hospital type	
academic	6
semi-academic	8
rural	6

Role of research team

The research team designed the study and set the decision rules, in regard of the available literature. They applied these rules and closely monitored and evaluated the methodological aspects and managed the overall study process. The summary statistics and panelists' input were interpreted and discussed by the full research team. Minutes of these meetings were kept in a log. Members were careful not to influence panelists' opinions, and none of the members had a conflict of interest.

Strategy to improve response rate

Improving response rates started in the inclusion process of the panel. Each panelist had personal contact with the main researcher (MG). A 'personal touch' together with clear explanation the study process and stressing the importance of commitment to the study for the validity of the results can enhance response rates [8].

After inclusion, panelists received an e-mail with study details and additional message in the week leading up to each round. The link to the survey was sent by e-mail and a text message was sent by

phone. When the research team felt it was necessary, panelists received a reminder. This was done on the basis of prior response times of the individual panelists, expected duration of completion and national holidays. Panelists were prompted by one researcher (MG).

Final draft

According to CREDES, results from a Delphi study should be reviewed by an external board before implementation. Our study consensus was not set up for direct implementation, [1] since emergency care is a multidisciplinary field and support amongst the various emergency care stakeholders. It was however the starting point for further discussion about the development of standards for EDs.

RESULTS

Panel participation

The expert panel consisted of 20 EPs. Their experience and backgrounds are shown in Table 3. Only one EP nominated a more experienced colleague, who agreed to participate instead. Per round, we sent a maximum of two e-mails with the link to the survey, up to four reminders, and we made a maximum of two calls. This led to a 100% response rate without any dropouts.

Item throughput

Part 1 started with 55 items. After four rounds, no items were requested back for re-discussion, and this left us with 63 items and consensus on definitions for all of these (Figure 2). In Part 2, we started with these 63 items and added 29 medical specialties. After four rounds, this resulted in consensus on 61 (97%) items and 27 (93%) specialties (Figure 3), and no items were requested back.

Percentages agreement

The first round in Part 1 resulted in an average agreement of 85% per item, varying from 55% to 100% for different items. For items in which consensus was reached in the first round, average agreement was 89%. The average agreement percentage in the non-consensus group was 63%. If an item needed several rounds to reach consensus, the ultimate average agreement percentage for this item was higher: 98% vs 89%.

We clearly experienced the added value of the decision rule of continuing when two panelists submit similar suggestions for adjustment, irrespective of the agreement percentage: definition agreement for CBRN room (room for treating patient with Chemical, Biological, Radiological and Nuclear contamination) was 79% in Round 2, which was enough agreement to call this a consensus. However, because more than one panelist had made a similar remark for adjustment, we continued the discussion. The results that followed led us to split the definition into two separate items (CBRN room minimum option and CBRN room maximum option), and in the next round 90% consensus was reached for both items. The process was then repeated again, based on the same decision rule, which resulted in 100% and 95% consensus, respectively.

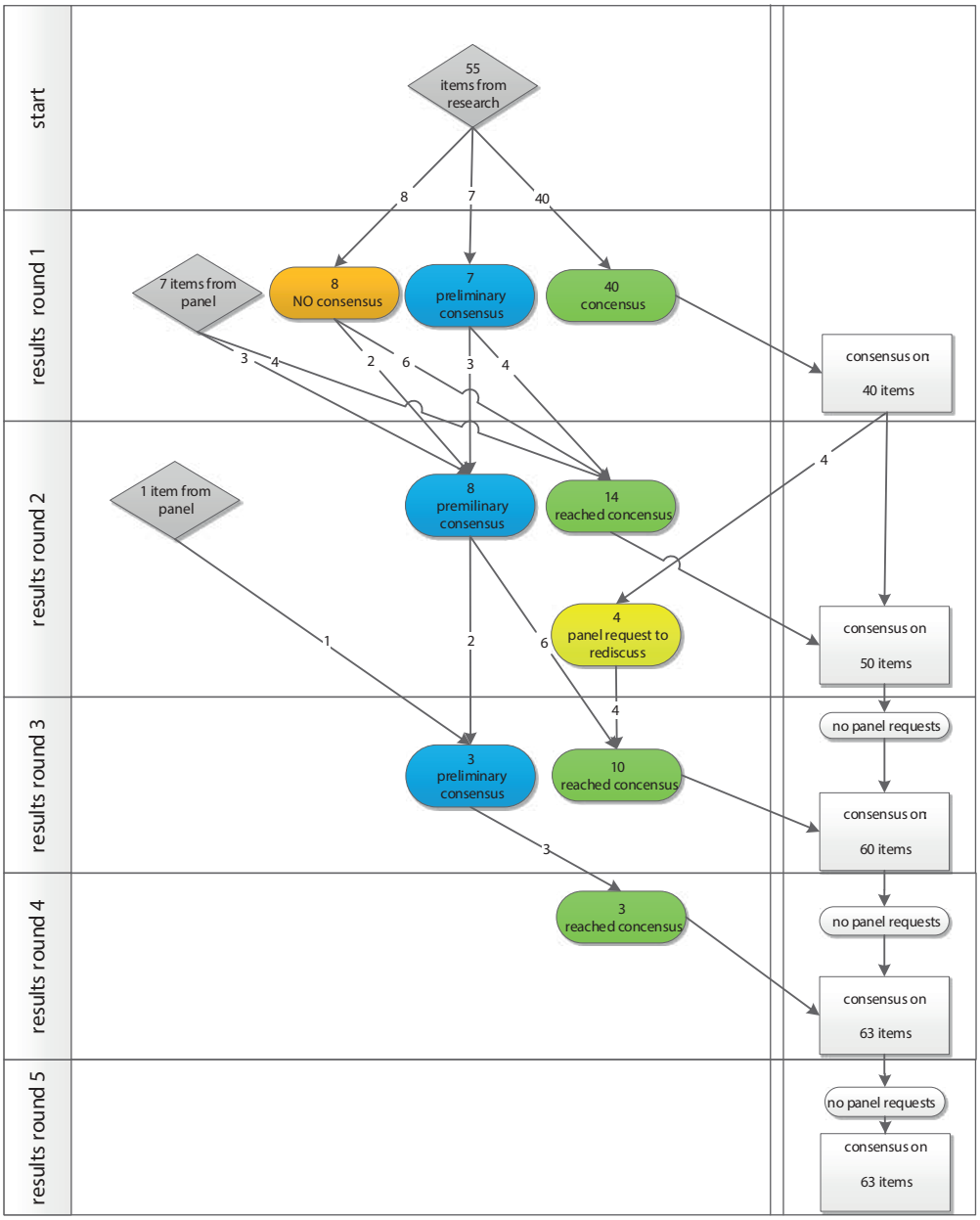

Figure 2 | Flowchart part 1 Delphi study Dutch ED.

In the first round of Part 2, we found an average agreement of 79% (50–100%) with respect to facilities and 77% (50–100%) with respect to diagnostics. For those items (facilities and diagnostics) in which consensus was reached in the first round, average agreement was 87%. Average agreement on items that did not reach consensus in Round 1 was 59%.

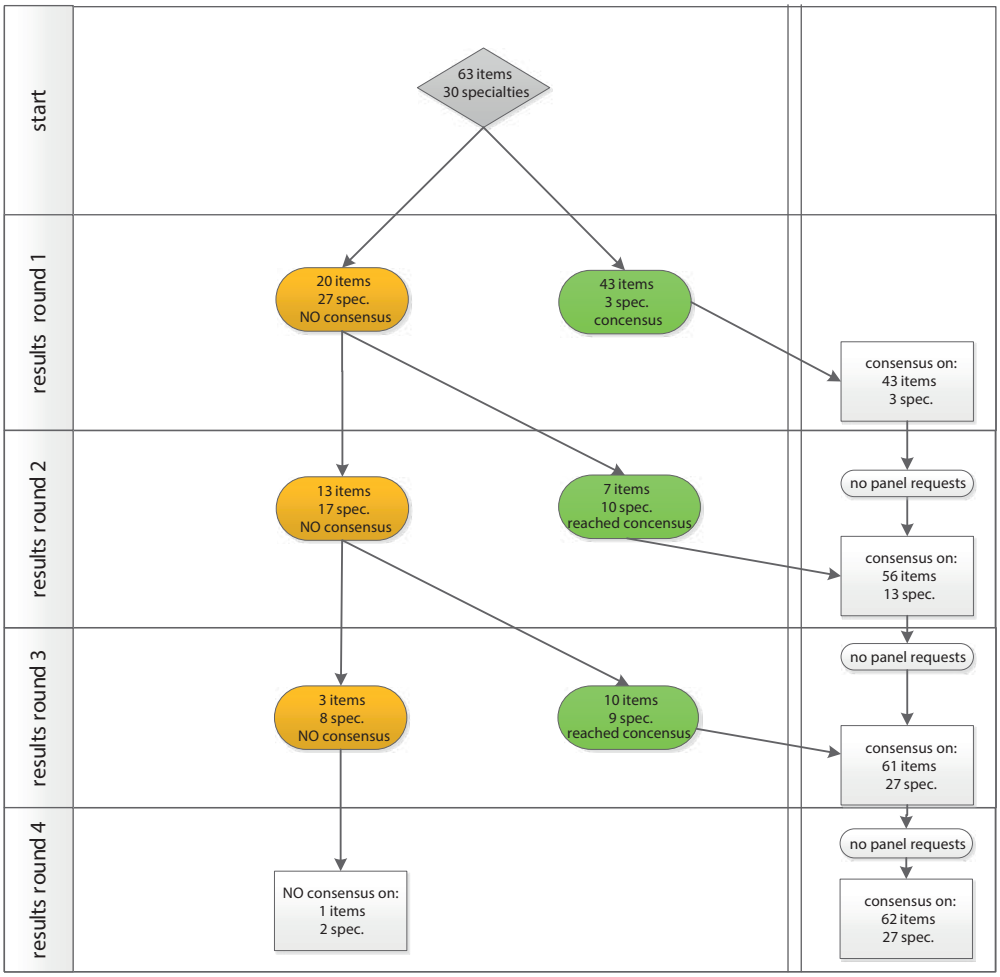

Figure 3 | Flowchart part 2 Delphi study Dutch ED

In Part 2, a third domain (availability of medical specialists) was added. On the basis of a yes/no scale, this resulted in agreement for 90% of the 30 medical specialties in the first round; this remained 90%. On the scale used for the degree of this availability, there was little agreement in the first round (only for 10% of specialties), but in the final round consensus was reached for 90% of specialties. A striking change was seen for plastic surgeon necessity: in Round 1, 15% of our panelists supported the idea that a plastic surgeon was not necessary in every ED (=consensus on 'necessary'), but this changed to 95% (=consensus on 'not necessary') when, based on panelists' input, an option was added for the condition that regional availability should be guaranteed instead.

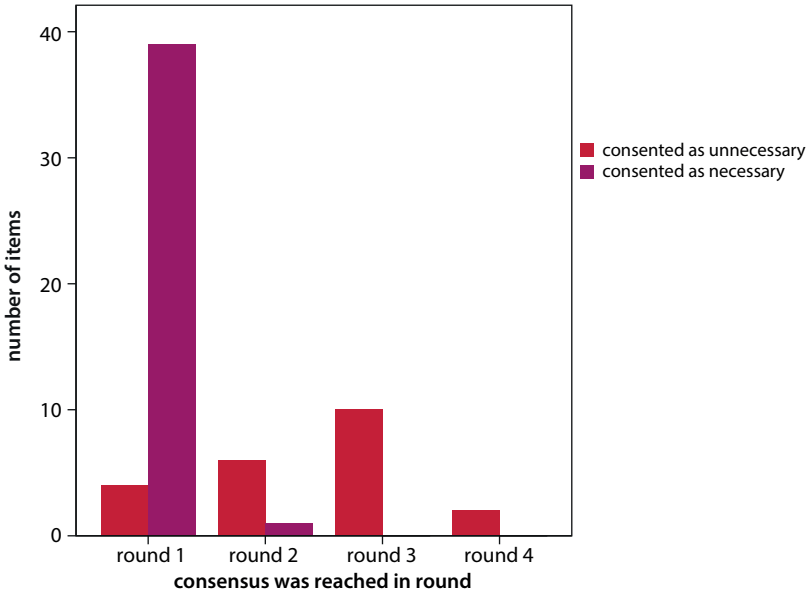

Figure 4 | Deemed necessity and influence on number of rounds to reach consensus

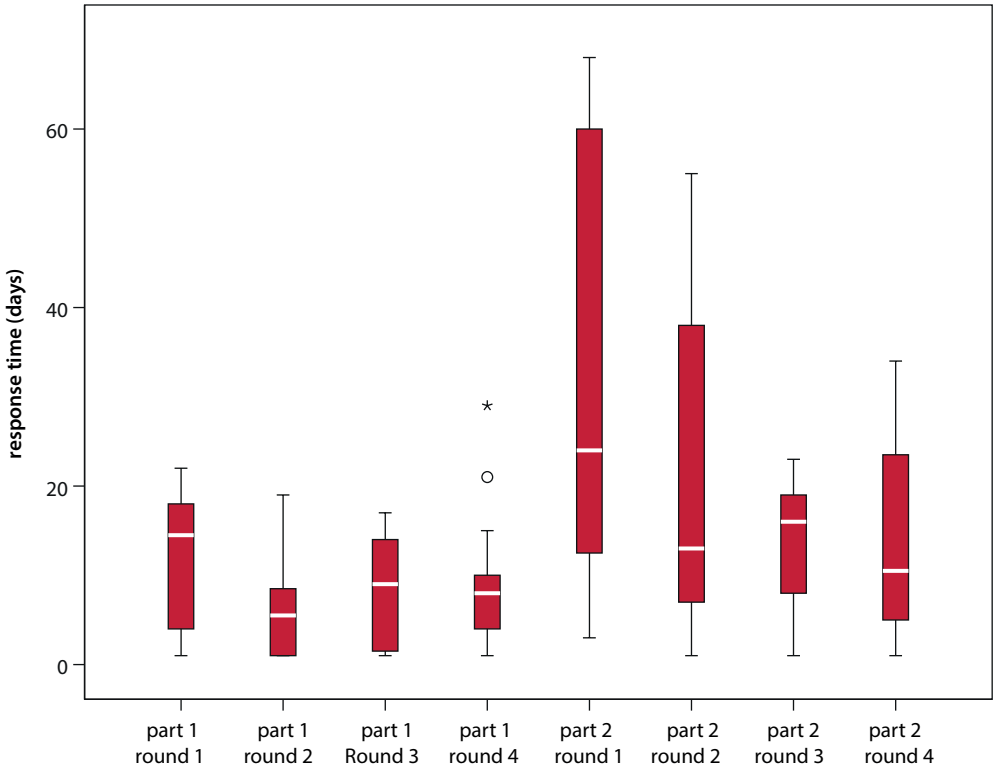

Figure 5 | Response times and reminders

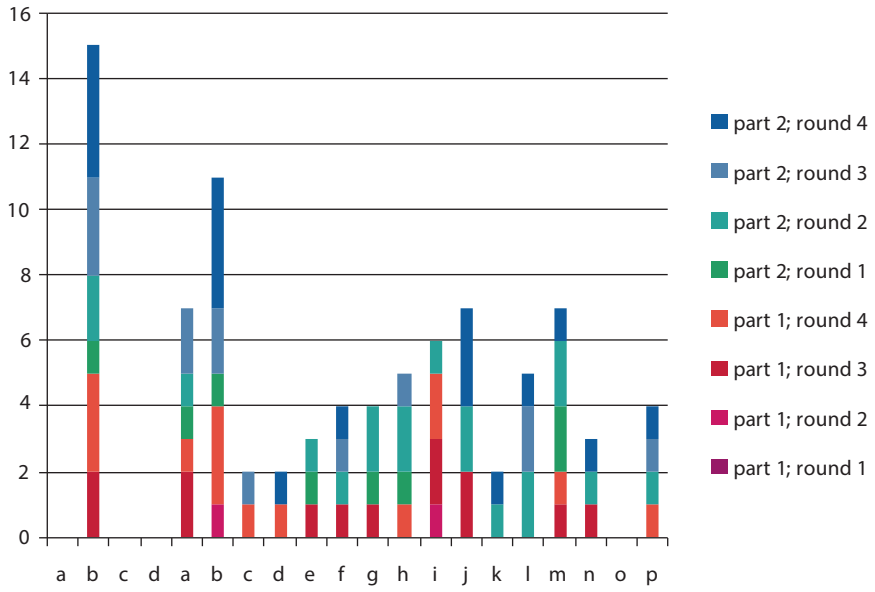

Figure 6 | Deemed necessity and influence on number of rounds to reach consensus

Agreement with regard to regarded necessity

For items (facilities and diagnostics) that were deemed nessesary, consensus was reached in the first round for 97% of the items concerned (3% in Round 2). When items were considered unnecessary, consensus was reached in the first round for 18% of the items (27% in Round 2, 45% in Round 3, 5% in Round 4, 5% in Round 5). Items that resulted in consensus on necessity mostly took one round, whereas items that resulted in consensus on non-necessity needed an average 2.45 rounds (Figure 6). Of the 22 items that were considered unnecessary, there were 13 items for which the panel set the condition that (part of) their functionalities should be available in another way before consensus was reached.

Panel participation and response

We found large differences in response time between panelists and between rounds (Figure 4). Response time consists of the time needed to fill in a questionnaire as well as waiting time until the panelist opens the survey. In our study, once panelists started filling in the questionnaire, they nearly always finished the questionnaire on the same day (on average 80%). We did not keep data on how often and for how long the survey was accessed.

In all rounds, panelists were prompted to respond. The timing and method of sending reminders (see Figure 5) was not standardized. Timing depended upon the expected time needed to respond perceived by the research group. This was based on i.e. the panelist's previous responses, the expected time investment and national holidays. Three panel members did not need any prompts,

and one member was prompted 15 times over the eight content rounds (Figure 7). In total, these Delphi rounds took 17 months to complete.

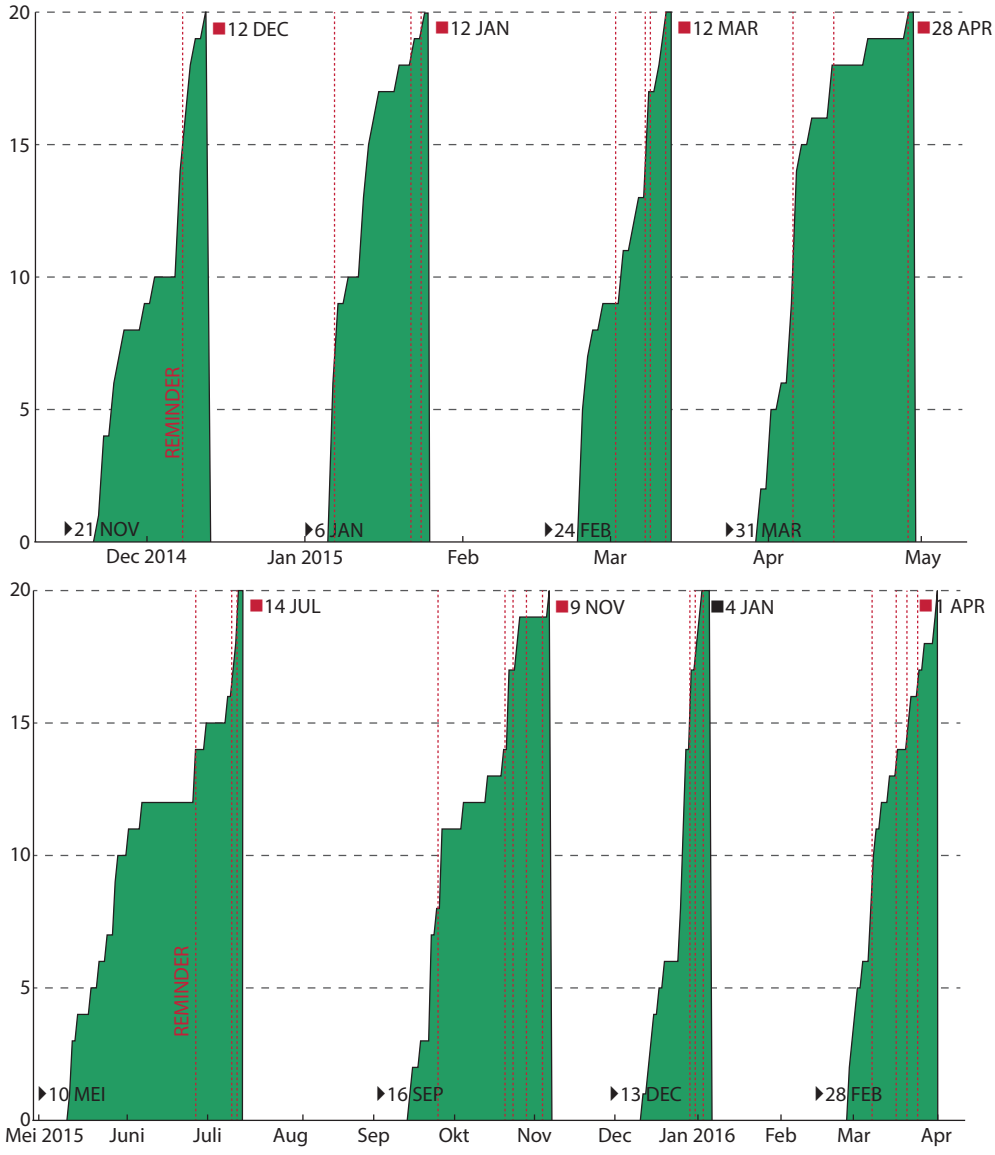

Figure 7 | Number of reminders sent to individual panelists in total and per round.

DISCUSSION

The quality of a Delphi study strongly depends on its design and the quality of its execution. Recently, guidelines have been published on conducting and reporting of Delphi (CREDES). However, little has so far been published on practical design choices and how these ultimately play out. This paper tried to fill some of these gaps.

In the first part of our 2-part design, we not only collected possible items but also established a common language. We could not find previous studies that did this in a similar way. Defining items took several rounds confirming our assumption that individual items can be interpreted differently by different panelists. After Part 1 had been successfully completed, there appeared to be little miscommunication in the panel responses in Part 2. Another advantage of our two-part structure was that both the panel and the research group became acquainted with the method before focusing on the main research question. A disadvantage could be the time investment needed for extra rounds, but in view of our 100% response rate this does not have to be a problem. Another downside was that panelists were so eager to start answering the main research question that they found it hard to limit themselves to the definitions considered in Part 1. Keeping a steady focus also remained difficult in Part 2, as panelists tended to dwell on the items in other situations. For example, panelists could present arguments specifically related to EDs in cardiac intervention centers, although our study explicitly focused only on the minimum requirements for 24/7 EDs regardless of size or type.

There are no strict guidelines on the correct number of rounds. The number of rounds gets set in advance or rounds continue until consensus had been reached, no further changes take place or return rates diminish [8]. We decided to apply clear and strict decision rules to reduce the risk of bias due to subjectivity or inappropriate influence from the research team. Having a total number of four rounds in Part 1 and four rounds in Part 2 did not influence the response rate negatively. Our decision rules worked out well and proved to be applicable without disagreement on their interpretation, and no adjustments or violations were needed. Our approach structured the interpretation of the panelists' input and the response of the research team. To complete the cycle of feedback, we added a ninth and final confirmative round with the option for panelists to ask for items to be discussed again. This did not add anything of significance. Nevertheless, it made sense to adhere to the decision rules, even after the last consensus round, to make our work methodologically sound.

Questions about the first two domains were presented with yes/no answers and free text to elaborate on the rationale behind panelists' choices and to add remarks on results from previous rounds. This was effective. For the third domain (availability of medical specialists), we used a structured approach. We wanted yes/no answers as well as opinions on the way in which options should be put into place. We selected multiple options based on common practice (yes, 24/7; yes, on call < 30 min, etc.). In hindsight, we would approach this differently next time. A better option would be to ask yes/no questions and to add a compulsory text box for panelists to indicate what they believe the minimum availability option would be. Such an approach could stimulate out-of-the-box suggestions and possibly support for such an option in the next round.

Building an online Delphi study requires suitable software and effective lay-out choices. In the absence of major players in this specific field, we selected a well-known and commonly applied survey tool. We used clear and identical formats in each round. After the second round in Part 1 of our study, we made all essential questions compulsory and kept the text boxes optional. In hindsight, as mentioned above, this should have been done from the start. We retained the option to stop and restart at any time, and we also retained the option to go back to the survey at a later moment to make changes or additions for as long as the round was open. This remains a logical choice.

Considerations based on social influencing principles are of importance in the Delphi technique. Generally reported are the reasons for blinding of panelist: to avoid group pressure, avoid people to change their opinion towards the most dominant or most highly respected panelist and ensuring panelist feel free to change their view. In addition, similar principles can help to improve response rate. This was previously suggested by McKenna [9,15] as the 'personal touch'. In our study the main researcher recruited personally by phone. This added not only the principle of liking (knowing each other and having similar goals), but added authority (being a well-known and highly respected colleague) as well as some reciprocity (service as provided in the past by being chairman) [16]. Setting a similar goal during the recruitment (a consensus standard as a means toward improving the ED-landscape) strengthened the principle of liking. This type of information and personal contact during the recruitment process most likely set the basis of the project's success.

No best strategy is known for sending out reminders, but persistence in following up is felt to be important [8]. We decided to individualize reminders. Considering our 100% response rate, we may conclude that this is an effective strategy, although there is room for improvement. For example, sending reminders at earlier moments might have shortened response delays in the first round of Part 2. In our study, response delays were very rarely due to the time that was needed to complete a survey, but almost always due to delays in opening and starting the survey. Once a panelist started the survey, the questionnaire was almost always finished in one day. Individualizing reminders seems justified since interpersonal differences proved to be large, while intrapersonal differences were limited. For example, one panelist needed more than one reminder for all but the first survey round, while some needed none, and others needed one reminder in some rounds. If this is representative for other panels, it suggests that panelists that need several reminders in the earlier rounds might need more later on as well. We would suggest making an early start when late responders need to be reminded. An advantage of sending e-mail reminders was that panelists did not need to search for their link in a previous message. On the other hand, text messages and telephone reminders are perceived as more personal and are likely to have more emotional impact.

We also found differences concerning the time of day when panelists submitted their responses: this was spread over 24 hours of the day, most likely corresponding to their shift work as a doctor. Efficacy of the type and the timing of reminders might be influenced by this as well.

Items that resulted in consensus on non-necessity took more rounds (Figure 6). This might be due to the fact that people generally find it harder to say 'no' than to say 'yes'. In our study, panelists wanted to set a condition before saying 'no' to an ED item because they wanted to ensure access to proper healthcare for all patients. Taking this type of panelist behavior into consideration prior to running a study will likely lead to a more accurate estimation of the number of rounds (resources) needed.

There is no rule that specifies which cut-off value for consensus should be used. Commonly applied levels vary between 51% and 80% [14]. Interested in the effect on the results we estimate what effect increasing the cut-off value from 70% to 80% would have had on our results. We found that, in general, a majority of items showed an increase in consensus with an increasing number of rounds, although this increase became less and less steep [11]. Therefore, it seems reasonable to assume that accepted items with consensus in early rounds which varied between 70% and 80% might have resulted in higher consensus if they had been retained in another round. We can confirm this for items that were repeated in extra rounds (following our two-similar decision rule) all nine items passed the 80% mark. In Part 1, we accepted 8% (3/36) of the items within the 70–80% range, and in Part 2 this was 38% (15/63 items) and 31% (9/29) for specialist availability. Eleven of these items were accepted in a first round, four in a second round and three in a third round. In view of these findings, we conclude that changing the cut-off value would most likely not have had major effects on our results.

Response times are shown in Figure 4 and Figure 5. Since response times tend to be influenced by many factors, study researchers should discuss these and offer explanations or interpretations. In our first survey, it took a reminder to motivate half of the panelists to respond. We saw clear effects of sending out reminders: in the last rounds, we sent individualized reminders spread over a short period of time. This was done for logistical reasons so as to be able to contact panelists individually. The duration of the first round in Part 2 proved to be longer than the duration of other rounds. The time needed to complete this survey was by far the longest, and therefore the research team felt that panelists should be allowed more time to submit their responses. The team did not, however, realize at that moment that response times were mostly influenced by delays in opening the survey rather than by the time that was needed to complete it. The third round was short, most likely due to the fact that by then consensus had been reached for most items. Furthermore, panelists might have had more time because the period concerned was a holiday period and reminders were sent out at an early stage. The longer duration of round four was no surprise: with continuing rounds response exhaustions occurs in panelists [9], especially with busy experts and hard-pressed clinicians [8].

CONCLUSIONS

In conclusion, in this article we describe the methodological considerations and relevant practical aspects of our Delphi study that resulted with a 100% response rate in detail. It exemplifies the value of systematic approach to design choices. Based on this experience we advise those considering Delphi study to reach consensus on a topic the following. You should follow the CREDES guideline. Consider a 2-part design, including a first part to establish a common language and to familiarize both the panelists and the research team with the online tool that is used. Invest in personal commitment of the panelists during the recruitment phase. Set clear decision rules to help consistency during the process as well as to keep the process comprehensible for the panelists. Leave items that have reached consensus out of the next rounds but use a confirmation round in which panelist get the option to reintroduce such items back into the discussion. Design your e-Delhi in a clear and

consistent lay-out throughout the full study. Expect items that result in a negative advice to require more rounds before consensus is reached. And send out your reminders early. Our data suggest that delays in survey responses are usually due to participants not opening a survey as opposed to taking a long to fill it out. A rigorous plan for reminders will aid both high response rate and timely completion of surveys. Taking this overall approach may assist researchers in future execution and may help to improve the quality of Delphi designs in terms of improved rigor and higher response rates.

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Chapter 7

The emergency department landscape in the Netherlands: a national benchmark of the availability of facilities, diagnostics and medical specialist expertise

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Huijsman R

PLOS | ONE, submitted

ABSTRACT

Objective

This study aimed to quantify and benchmark the availability of facility and medical (diagnostic & treatment) resources across all Emergency Departments (EDs) in the Netherlands. We empirically tested the sense of reality of the very recent e-Delphi consensus on minimum operational standards for 24/7 EDs and benchmarked different types of EDs against this consensus standard. The results can be guiding for hospital administrators and national policy makers.

Methods

We performed a nationwide cross-sectional descriptive study, using an online questionnaire based on our recent consensus standard. All EDs in the Netherlands that met the definition as formulated by the International Federation for Emergency Medicine terminology project in 2012 were questioned.

Results

The response rate was 95%. In general the availability of resources was high. EDs met the consensus standard to a large extent, on average 88%. EDs in university and teaching hospitals met the standard to a higher degree than EDs in general hospitals. Moreover, general hospital EDs varied remarkably between each other in the extent to which they did or did not meet the standard.

Conclusion

EDs in the Netherlands largely comply with our recent e-Delphi consensus on minimal operational standards for every 24/7 ED. However, there is still a considerable variation in the availability of facility and medical (diagnostic & treatment) resources. This signals the necessity of a national guideline in order to further clarify and standardize ED functionality in the Netherlands.

BACKGROUND

The emergency department (ED) landscape in the Netherlands has changed considerably over the last decade. First of all the number of EDs has decreased substantial from 105 in 2010 to 87 in 2016 [1,2]. At the same time the volume of patients seen in all EDs together has remained approximately 2 million per year in that period [1-4]. Meanwhile patients have become older and present with more complex illnesses [5,6]. Nationally the proportion of patients referred by general practitioners or ambulance services has increased significantly from 70% in 2012 to 85% in 2016 [2]. In the same period the percentage of patients being hospitalized from the EDs has increased from 32% to 38%, while at the same time the number of hospital beds has been reduced substantially [2]. These changes have contributed to EDs increasingly becoming burdened with crowding [6,7]. This phenomenon in Dutch EDs and its negative impact on patient care and staff wellbeing now often leads to public emergency cries [6,8]. Despite crowding as a strongly disadvantageous downside, the aforementioned developments are expected to continue unabated in the future [9,10].

In the meantime basic insights into the existing ED landscape is still lacking, such as the extent to which facility and medical (diagnostic & treatment) resources are available in individual EDs. Also, despite various reports that have been published over the years, there is no definitive guiding ED framework implemented in the Netherlands yet [11-14]. Such a framework, based on a better understanding of the functionality of individual EDs and a more thorough insight into similarities and differences between various EDs, could be useful in planning further optimization of the ED landscape and improving emergency care nationwide in the future.

We recently performed an e-Delphi study to effectuate expert consensus of emergency physicians (EPs) on minimum requirements for operational standards for facility and medical (diagnostic & treatment) resources availability as a baseline for every 24/7 ED in the Netherlands [15]. This consensus was intended as an impetus for the development of a national directive for ED functionality. In follow-up to this the present study aimed to gain insight in the actual availability of facility and medical (diagnostic & treatment) resources across EDs in the Netherlands. This is relevant for two main reasons. First, it offers the unique opportunity to test the sense of reality of the consensus standard reached previously in real situation. In this way it could become clear if this consensus can serve as a basis for the development of a national guideline. Second, it offers the opportunity to compare EDs to each other and to benchmark against the consensus on minimum requirements. In this way future ED policies of hospitals and the national government can be guided.

METHODS

Design

We performed a nationwide cross-sectional descriptive study in the Netherlands from 1 May 2016 to 30 April 2017, using an online questionnaire based on the consensus standard [15]. All EDs that met the definition as formulated by the International Federation for Emergency Medicine (IFEM) terminology project in 2012 were eligible [16].

Procedure

First, index contacts of all eligible EDs were contacted by telephone and asked to participate in this study under assurance of anonymity of data provided. Next, for the study period we collected the data. Participation was entirely voluntary and withdrawal from the study could occur at any point. Ethical approval for this study was obtained from the Medical research Ethics Committee of the Erasmus University Medical Center in Rotterdam (Ref. MEC-2014-322).

Questionnaire and measures

An online questionnaire was created using SurveyMonkey and provided to all index contacts. Information regarding the availability of facility and medical (diagnostic & treatment) resources was collected. For both the list and description of these facility and medical (diagnostic & treatment) elements we used the consensus as was reached among the expert panel in the previously mentioned e-Delphi study (Table 2) [15]. Respondents were, although allowed, urged not to skip any question.

Analysis

All data was checked for integrity and entered in a research database. We used Numbers (version 5.3) for overview and statistical analysis. For this purpose, the items were subdivided into two groups (mandatory and additional items), in accordance with the consensus as achieved in the e-Delphi study that had been carried out previously (Box 1) [15]. The expert panel had not reached consensus on the availability of an 'overnight room'. This single item was left out of consideration in further analysis. For this study each item was also labeled as a 'facility-item' (no direct relation to diagnostics or treatment) or 'medical item' (direct relation to diagnostics or treatment). First RV and MG independently labeled all items. Items that scored differently and were discussed. Items that couldn't be labeled then were presented to a third researcher (PP) in order to be labeled.

Group A items (39x): facility and diagnostic items that should be available in every ED, in the way as defined in the previous e-Delphi study. Parking ED; Kiss & Ride zone ED; Ambulatory entrance; Reception; Ambulance entrance; Security ; waiting room; Children's waiting corner in waiting room; Waiting room toilets; Toilet for disabled; Triage room; Staff working station; Central monitoring; Adult treatment room; Pediatric treatment room; Isolation room; Minimally fitted version decontamination-unit; Resuscitation room; Trauma room; Patients toilets in the ED; Staff toilets; Staff room; ED medication room; ED medication preparation room; Equipment room; Store room; Dirty utility room; Storage room mobile equipment; Relatives room; Operating theatre; Intensive care unit; Laboratory; Bedside ultrasonography; Ultrasonography; Emergency GI tract endoscopy; Emergency ENT endoscopy; Emergency bronchoscopy; Offices; Conventional radiography; Registration for ED patients arrived by ambulances; ENT room; Eye room; Burns room; Gynecology room; Plaster room; Staff showers; Reception for non ED staff; Seminar room; Linnen trolley storage room; Mourning room; Emergency CT; X-ray room.

Group B (10x): items not needed to be available in every 24/7 ED as defined in previous e-Delphi study nor in an alternative way. Fast track; Fully fitted version decontamination-unit; Children's waiting room; ED CT bay; Short stay unit; Dialysis ; Acute mental health room; Emergency MRI; Emergency angiography; Pacemaker interrogation.

Box 1 | Expert opinion on minimal operational standards for every 24/7 ED as defined in a previous e-Delphi study. [15] For item consensus descriptions, see table 2.

RESULTS

Enrollment

During the study period 87 EDs met the IFEM ED definition and were found to be eligible. One General Hospital ED (GH-ED) refrained from participation in the study for its own reasons in advance, so 86 EDs were included in this study (inclusion 99%). Of these 86 EDs 2 did not respond and 2 responded substantially incompletely. These 4, all GH-EDs, were excluded, leaving a response rate of 95%. Finally, complete surveys were collected from 82 out of 87 EDs, including 8 university hospital EDs (UH-EDs), 27 teaching hospital EDs (TH-EDs) and 47 general hospital EDs (GH-EDs). In Table 1 key characteristics are shown.

Item labels

Of all items 6 mandatory items were labeled differently by RV and MG. Mutual discussion resulted in agreement on 4 item labels more. The remaining 2 mandatory items were presented to a third researcher (PP) and labeled.

Resource availability

An overview of the availability of facility and medical (diagnostic & treatment) items in all the participating EDs is shown in Table 2. All items are arranged in two main groups (52 mandatory and 10 additional items) and in both groups to an increasing degree of absence thereof in all 82 EDs together. Each item is shown as 'facility item' (white rows) or 'medical item' (grey rows). In addition, Table 2 shows the absence of resources differentiated by ED category (UH-ED, TH-ED and GH-ED).

Consensus benchmark

Four EDs (5%), 1 UH-ED and 3 TH-EDs, fully complied with the consensus on operational standards (100% availability of the 52 mandatory items). The 52 mandatory items were available in all EDs, UH-EDs, TH-EDs and GH-EDs, on average 88%, 95%, 93% and 84% respectively (Table 3). The 10 additional items were available in all EDs, UH-EDs, TH-EDs and GH-EDs, on average 48%, 65%, 66% and 35% respectively (Table 3). Twenty-eight GH-EDs (60%) did comply with the consensus standard for 85% or more, matching the group of UH-EDs and TH-EDs. Nineteen GH-EDs (40%) met the standard for less than 85% (the lower limit for UH-EDs and TH-EDs), with at the bottom of this group 3 EDs meeting the standard for 46%, 60% and 63% respectively.

Table 1 | Key characteristics 82 EDs included

	All EDs (82)	UH-EDs (8)	TH-EDs (27)	GH-EDs (47)
Patient volume	1.891.252	213.032	846.528	831.692
range	6.082–53.196	21.000–31.098	16.500–53.198	6.082–30.618
median	23.314	27.524	29.427	17.805
% Self-referred				
range	1,2%–55,9%	9,7%–51,6%	1,4%–55,9%	1,2%–44,7%
median	10,5%	29,5%	10%	7,3%
% Hospitalized				
range	12,9%–76,4%	23,1%–73,8%	17,7%–56,8%	12,9%–76,4%
median	38,8%	33,9%	39%	38,2%
Number of treatment bays	1.327	191	544	592
range	4–36	17–35	12–36	4–22
median	17	22	19	12

Table 2 | ED items with descriptions and number of EDs missing each of them. Group A = mandatory items, group B = additional items. White rows = facility items, Light dark red rows = medical (diagnostic & treatment) items.

			Number of EDs missing each item			
			All EDs	UH-EDs (8)	TH-EDs (27)	GH-EDs (47)
Group A: mandatory ED items and consensus descriptions						
1	Adult treatment room	A dedicated room for assessment, treatment and stay of adults. Besides a stretcher, there are chairs available. There is equipment for supplemental oxygen therapy, suction, assessment and monitoring of vital signs.	0	0	0	0
2	Dirty utility room	Area for collection of used equipment with a patient utensil sanitiser.	0	0	0	0
3	Operating theatre	Availability of an operation theatre and a (on-call) surgical team for emergency surgery (within 30 minutes after announcement/request)	0	0	0	0
4	Registration for ED patients arrived by ambulances	Registration desk where patients brought in by ambulances may be registered or remaining the functionality in an alternative way.	0	0	0	0
5	Reception for non ED staff	Area in ED where ambulance crews, police and other care providers not employed at the hospital can perform their administrative duties and eat and drink or remaining the functionality in an alternative way.	0	0	0	0
6	Linen trolley storage room	Area in ED where linen trolleys can be kept without getting in the way or remaining the functionality in an alternative way.	0	0	0	0

			Number of EDs missing each item			
			All EDs	UH-EDs (8)	TH-EDs (27)	GH-EDs (47)
7	Mourning facility	Separate room in the ED where a deceased patient can be moved and where loved ones can say farewell to a deceased patient before transfer to a morgue or remaining the functionality in an alternative way.	0	0	0	0
8	Burns facility	Dedicated treatment room dedicated for of ED patients with burns with a shower to cool down burns or remaining the functionality in an alternative way.	1	0	1	0
9	Staff room	Area in the ED where ED staff can have a break to eat or drink or remaining the functionality in an alternative way.	1	0	0	1
10	Central monitoring	A central location in ED where values and waveforms of vital signs (such as heart rate and oxygen saturation) can be seen and heard.	1	0	0	1
11	Laboratory	Availability (24/7) of laboratory facilities and presence of staff for emergency investigations.	1	0	0	1
12	Plaster room	Room designed for application of plasters with a plaster trolley or remaining the functionality in an alternative way.	2	0	0	2
13	Emergency CT	Availability (24/7) of CT imaging, immediately after patient arrival and immediate reporting by a radiologist immediately after finishing the CT scan (potentially via telehealth) or remaining the functionality in an alternative way.	2	0	0	2
14	Waiting room	Allocated space where patients and their next kin/ company can wait (after registration and/or triage while awaiting further assessment and treatment.	2	0	0	2
15	ED medication room	Lockable room in the ED where medication can be safely stored, including temperature sensitive medication.	2	0	0	2
16	Conventional radiography	Availability (24/7) of conventional radiography in the ED by radiographers and, if required, assessment by a radiologist.	2	0	0	2
17	Triage room	A space adjacent to the ambulatory patient ED entrance, reception and waiting room where the urgency of the need for treatment can be determined.	3	0	1	2
18	Resuscitation room	A room suitably equipped for resuscitation, such as CPR and stabilization of patients presenting with acute heart failure, CVA, severe sepsis and shock not due to trauma or intoxication. The room is readily accessible from the ambulance entrance and is suitable for both invasive as non-invasive ventilation.	3	0	1	2
19	Staff workstation	Centrally located work space in the ED for writing notes, discussions, advice, referrals and central monitoring of patients.	3	0	0	3

			Number of EDs missing each item			
			All EDs	UH-EDs (8)	TH-EDs (27)	GH-EDs (47)
20	Security	Hospital security present in ED or on-call and arrival in ED within 5 minutes if required.	3	0	0	3
21	Ultrasonography	Availability (24/7) to perform ultrasonography within an hour of patients arrival to the ED to exclude or diagnose a specific condition.	4	0	0	4
22	Reception	A counter immediately following the ambulatory patient ED entrance where referred of non-referred ambulatory patients may be received and registered.	5	0	1	4
23	Store room	Lockable room for sufficient storage of disposable supplies.	5	0	0	5
24	Staff toilets	Female and male staff toilets in ED.	5	0	0	5
25	Intensive care	On-site ICU	5	0	0	5
26	Ambulance entrance	Single ED entrance separated from the ambulatory patient ED entrance for patients brought in by ambulance. Ambulances can unload their patients in a sheltered space. There is ample parking for ambulances.	6	0	2	4
27	Waiting room toilets	Patient toilets adjacent to the waiting room(s)	6	0	0	6
28	ED medication preparation room	Area in ED where medication can be prepared for administering.	6	1	1	4
29	Patient toilets in the ED	Female and male patient toilets in the ED. If not accessible for the disabled patient, a separate patient toilet for the disabled in the ED.	7	0	2	5
30	Emergency bronchoscopy	Availability (24/7) of emergency bronchoscopy (start within 30 minutes of announcement/request; including calling in staff/respiratory physician if required).	8	0	0	8
31	Emergency ENT endoscopy	Availability (24/7) of emergency ENT endoscopy (start within 30 minutes of announcement/request; including calling in staff/ENT doctor if required).	9	0	0	9
32	Trauma room	A room designed and equipped according to the Dutch Society of Trauma Surgery guidelines and suitable for the acute care of trauma patients. The room is readily accessible from the ambulance entrance and is suitable for both invasive as non-invasive ventilation. The room is equipped with the necessary X-ray facilities.	10	0	0	10
33	ENT facility	Dedicated treatment room for ED patients requiring ENT assessment and treatment or remaining the functionality in an alternative way.	10	0	0	10
34	Staff shower	Shower for ED staff.	11	0	0	11
35	Radiographic room	Area in the ED (not in the trauma room) equipped and suitable for conventional radiography or remaining the functionality in an alternative way.	11	0	0	11

			Number of EDs missing each item			
			All EDs	UH-EDs (8)	TH-EDs (27)	GH-EDs (47)
36	Offices	Rooms for ED consultants, ED trainees and ED secretary in or adjacent to ED for administrative, research, educational and managerial purposes.	11	0	0	11
37	Relatives room	Room for relatives of the patient awaiting treatment and where relatives can be informed.	12	0	3	9
38	Ambulatory entrance	Single ED entrance for referred or self-referred patients that present to ED independently. This entrance may be combined via several ways with an after-hours GP clinic.	14	1	3	10
39	Pediatric treatment room	Dedicated child friendly room for assessment, treatment and stay for children. Besides a stretcher, there are chairs available. There is equipment for supplemental oxygen therapy, suction, assessment and monitoring vital signs.	14	2	0	12
40	Emergency GI tract endoscopy	Availability (24/7) of emergency gastro-intestinal endoscopy (start within 30 minutes of announcement/ request; including calling in staff/gastroenterologist if required).	14	0	0	14
41	Storage room mobile equipment	Area in the ED where mobile equipment (such as Procedural Sedation and Analgesia trolley, ultrasound machine, portable X-ray device, bladder scan, etc.) can be kept without getting in the way.	18	1	4	13
42	Kiss & Ride zone ED	A zone where a vehicle is allowed to stop in order to drop off or pick up somebody. Parking is not allowed.	21	1	10	10
43	Toilet for disabled	Modified toilet facilitating independent use by people with physical disability, adjacent to the waiting room.	21	0	8	13
44	Isolation room	A room to assess, treat and keep patients requiring isolation. These room(s) have a pressurized air-handling system and have an anteroom.	21	0	2	19
45	Parking ED	Ample parking space adjacent to the ED entrance for ambulatory ED patients and their next of kin.	22	0	4	18
46	Equipment room	Lockable room in the ED for storage of materials such as wheel chairs, additional stretchers, ventilators, etc..	22	0	4	18
47	Childrens corner in waiting room	Part of the waiting room which is designed for children/ adolescents in a child friendly way, sometimes separated from adult patients, where they can await their treatment.	23	1	8	14
48	Eye room	Dedicated treatment room for ED patients requiring ophthalmic assessment and treatment with a slit lamp or remaining the functionality in an alternative way.	29	0	7	22
49	Bedside ultrasonography	Availability (24/7) of performing and assessing emergency bedside sonography in ED, immediately on patient arrival.	31	0	5	26

			Number of EDs missing each item			
			All EDs	UH-EDs (8)	TH-EDs (27)	GH-EDs (47)
50	Decontamination-unit (minimally fitted version)	This version contains several outdoor showers adjacent to the ED. There are also facilities for eye irrigation. Water temperature can be regulated to a minimum of 25 degrees.	32	4	10	18
51	Seminar room	Area in the ED with audiovisual facilities for handovers, meetings and education or remaining the functionality in an alternative way.	34	3	2	29
52	Gynaecology room	A room suitably equipped for a gynecologic examination or remaining the functionality in an alternative way.	52	2	12	38
Group B: additional ED items and consensus descriptions						
1	Dialysis	24/7 Availability of emergency dialysis (start within 30 minutes after announcement/request, including staff/ nephrologist/intensivist if required).	18	0	0	18
2	Emergency angiography	Availability (24/7) of emergency angiography for diagnostics and possible embolisation (start within 30 minutes of announcement/request; including calling in staff/interventional radiologist if required).	19	0	2	17
3	Emergency MRI	Availability (24/7) of MRI imaging, immediately after patient arrival and immediate reporting by a radiologist immediately after finishing the MRI scan (potentially via telehealth).	20	0	2	18
4	Pacemaker interrogation	Availability (24/7) of cardiac pacemaker or ICD interrogation (start within 30 minutes of announcement/request; including calling in a pacemaker technician if required).	25	0	7	18
5	Fast track	An area of ED dedicated to the management of patients without a major illness, who do not require resuscitation or monitoring, in order to assess, treat and rapidly discharge them from the ED. Organized as a separate patient flow in the ED.	43	6	6	31
6	Short stay unit	Facility with trained staff and monitoring in or adjacent to ED where ED patients that have received their initial treatment can stay for further investigations, discharge after a period of observation or hospital admission.	48	6	10	32

			Number of EDs missing each item			
			All EDs	UH-EDs (8)	TH-EDs (27)	GH-EDs (47)
7	Decontamination-unit (fully fitted version)	This version is a construction divided into 4 separate spaces: 1. Staff dressing room (not contaminated): this space has all personal protection equipment (PPE) available required for staff to perform a decontamination. This space can be entered from the outside and has an entry to the space for decontaminated victims. 2. De-robing area victim (=contaminated): a victim enters from the outside directly into this space. Here the victim can be disrobed by staff 3. Decontamination area (= contaminated): in this area the victim will be decontaminated. 4. Drying off area (=not contaminated): in this area the victim will be dried and clean clothes or a blanket will be provided. From this area onwards the victim will be treated as any other ED patient. In the decontamination area there are 2 flexible water hoses on a reel, each with a separate thermostatic tap. The water drainage of the areas are designed to prevent flow from one area to the other and that contaminated water is collected. The decontamination area is also equipped with facilities to provide eye irrigation with warm water. The de-robing and decontamination areas have negative pressure ventilation to prevent potentially poisonous vapors flowing to other areas. The air leaving the space will flow via an air handling system to the roof of the decontamination unit to prevent emission of contaminated air. The entire unit can be heated up to an ambient temperature of maximal 32°C in order to prevent hypothermia in victims during decontamination. Going the wrong way within the unit is prevented by modified one-way doors. For example, a staff member cannot go from the de-robing area back to the staff dressing room.	60	3	17	40
8	ED CT bay	Area in ED equipped and suitable with a CT scanner.	60	2	13	45
9	Acute mental health room	A quiet room suitable for assessment, treatment and stay of psychiatric or agitated patients.	63	5	18	40
10	Childrens waiting room	Child friendly space where patients up to 18 years of age and their next of kin separate form the adult ED waiting room, can wait for their assessment and treatment after they have been registered and/or triaged.	67	6	16	45

Table 3 | Degree to which EDs met in 2017 the consensus on operational standards

	Group A items		Group B items	
	Average	Median	Average	Median
All EDs	88% (60%–100%)	90%	48% (0–100%)	50%
UH-EDs	95% (90%–100%)	95%	65% (50%–80%)	65%
TH-EDs	93% (85%–100%)	94%	66% (20%–100%)	70%
GH-EDs	84% (46%–98%)	87%	35% (0-70%)	30%

DISCUSSION

Main findings

The present study with a response rate of 95% examined the availability of ED resources throughout the Netherlands. These findings were tested against the minimal operational ED standards as reached consensus upon by an EP expert panel in a previous e-Delphi study [15]. EDs met this standard to a large extent, although a substantial part of the category GH-EDs did to a considerably lower degree. Moreover, the group of GH-EDs showed a remarkable intra-group variation in terms of mandatory resource availability. As far as the additional resource availability was concerned, UH-EDs and TH-EDs clearly left GH-EDs behind, although here UH-EDs and TH-EDs showed a remarkable intra-group variation.

Reflexions on findings

We found that in general relative to the consensus standard the availability of mandatory facility and medical (diagnostic & treatment) ED resources was high. Although only 4 EDs (5%) fully met the standard, all UH-EDs and all TH-ED measured up to the standard for 85% or more and in line with these 28 out of 47 (60%) GH-EDs did. Hospitals seemed to be aware of the need to equip an ED properly. At the same time, 19 out of 47 (40%) of all GH-EDs lagged behind and met the standard less than 85%. The distinction between the degree of mandatory ED resource availability was mainly within the GH-ED category, rather than between different ED categories. Our findings could point out a potential vulnerable subgroup of EDs.

At the same time did 95% of all participating EDs not fully comply with the consensus standard by missing 1 or more mandatory items. *Twenty-six items* (Table 2, number 8 to 33) missed in a rather limited number of 1 to 10 EDs. However, especially the absence of many of the medical (diagnostic & treatment) items touches the functionality of an ED in a substantial way: 'burns facility', 'laboratory', plaster facility', emergency CT', 'conventional radiography', ultrasonography' and 'intensive care'. Most of these items are considered indispensable to an ED as diagnostic tools for life-threatening conditions [16]. One may question for the Dutch situation whether an ED without these resources available is future-proof. Remarkably the 1 TH-ED missing 'burn facility' concerned one of the three burn centers in the Netherlands. However, here all patients with burns were taken care of apart from the ED and besides it appears that the ED is about to be adjusted on this point. The 1 GH-

ED which had indicated to miss 'laboratory' could indeed perform standard laboratory tests, but didn't have a staff for exceptional emergency investigations available 24/7 (which according to the standard should be the case). The 2 GH-EDs without 'plaster facility', 1 of the 2 GH-EDs without 'conventional radiography' and 1 of the 4 GH-EDs without 'ultrasonography' available are part of the group EDs that have been closed since the execution of this study. Five EDs without an 'ICU on site' concerned secondary ED locations within a hospital organization resulting from a merger with (still) multiple locations. *Nineteen items* (Table 2, number 35 to 52) were not available in significantly more, varying from 11 to 52 EDs. Many of these items concerned facility provisions at the front door of EDs: 'ambulatory entrance', 'kiss & ride zone', 'parking ED' and 'childrens corner in waiting room'. The presence of these items might not always have to be expedient, for example in case of a low patient volume, and might therefore be decided per ED. Eye-catching is the absence of the following medical (diagnostic & treatment) items that touch the functionality of an ED: 'emergency GI tract endoscopy', 'isolation room', 'eye facility', 'bedside ultrasound', 'decontamination-unit limited fitted version' and 'gynecology facility'. 'Gynecology facility' was absent in 81% of all EDs, reflecting that acute care for this patient category is mainly organized outside the ED. The same was true for 'eye facility', although with 49% absence to a lesser extent. The e-Delphi consensus standard states that both these facilities should be present at every ED, but closer consideration of the standard might be appropriate here. If available and adequately organized at the hospital site in an alternative way, the added value of availability in the ED might be questioned. Furthermore, a limited fitted CBRN room was available in 61% of all EDs. Combined with a limited availability of the 'fully fitted CBRN' (15%), apparently not all EDs were prepared to receive patients of this kind of accidents. Standards and insight into the availability should be made explicit here. 'Bedside sonography' lacked in 19% of the TH-EDs and 55% of the GH-EDs. Today, point of care ultrasound (POCUS) has to be considered standard of care in emergency medicine and should be made available in every ED.

Study findings in context of existing literature

In international literature ED landscapes of different countries have been characterized and described in publications before [17-19]. Studies focussed especially on describing the number, distribution and usage patterns of EDs, as we did ourselves for Dutch EDs in [1,2,5]. To our knowledge the current study was the first describing the actual availability of facility and medical (diagnostic & treatment) resources so detailed and nationwide complete. We haven't been able to find a comparable national comprehensive benchmark in regard to ED resource availability. *Sanchez et al.* (2013) published a national profile with to some extent capabilities of EDs in Switzerland [18]. Where comparison of items availability was possible (resuscitation room, laboratory, conventional radiography, emergency CT, operating room) EDs in the Netherlands scored consistently higher. *Wen et al.* published a national survey of EDs in Denmark and again where comparison of items was possible, availability of resources on Dutch EDs was never less [19]. Extensive publications regarding availability of ED resources mainly concern guidelines about what should be available, not about what actually is available [21-25]. The e-Delphi study and the list of items derived from this was among other based on these guidelines.

Strengths and limitations

The almost complete study participation (99%) and a final response rate of 95% has yielded a reliable picture of EDs in the Netherlands. The study offers an unique opportunity to compare this existing ED landscape against the standard. Limitations of this study are those inherent to survey studies. Information was gathered through contact persons in all EDs (all experienced EPs or nurse managers). Although we are confident they have provided the correct information, we have not been able to verify this ourselves. A side note to this study is that we have looked at the availability of facility and medical (diagnostic & treatment) items. However, the possibilities of an ED are also largely determined by the presence of professional competences from medical specialists and other healthcare professionals. This will be part of a follow-up study. Furthermore, we did not investigate the reasons why 78 EDs didn't fully comply with the consensus standard or the reasons for variation of resource availability. Another possible limitation could be that 15 of the 71 EP index contacts (out of 82 in total) had also participated in the expert panel of the e-Delphi study conducted previously. We have looked at this, but could not distinguish a different reaction from this group. Finally, it must be stated that the number of EDs has dropped to 80 since the completion of this study. However, recalculation without these 6 GH-EDs didn't change the results of our study in a relevant way.

Implications

This benchmark study findings, together with the minimal operational ED standards as reached consensus upon by an EP expert panel in a previous e-Delphi study [15], is useful to policy makers for future optimizing the ED landscape in the Netherlands. After all, delivery of quality emergency care by healthcare professionals requires adequate resources in and adjacent to an ED [15,16,18]. Therefore already in 2012, the Health Council of the Netherlands called on parties involved to formulate sharp and detailed quality requirements for EDs [12]. Where a comprehensive multidisciplinary directive on Intensive Care Units (ICUs) has been available since 2006, in the Netherlands no such directive exists for EDs up to the present day, other than the minimal operational standards EP experts reached consensus upon in 2016 [15,20]. Ideally, this EP consensus standard should now be translated to a widely supported national comprehensive directive with a less voluntary character. In addition, the degree to which individual EDs meet the minimal operational standard should be made public. Our findings offer opportunities at different levels. *Nationally*, they can contribute to underpinning choices in the process of optimization of the ED landscape through two possible strategies. First, continuation of the reduction strategy, but based on knowledge about the presence and absence of resources and steering from a set framework. The current ED reduction policy is still mainly based on mergers of hospital organizations followed by lateralization of emergency care to one location, rather than the identification of vulnerable EDs based on a consensus operational standard. Second, a strategy whereby EDs must comply with the standard, or can explain why certain resources are not available. *Regionally*, at the level of the existing 11 regional acute networks in the Netherlands, our findings can contribute to a more substantiated discussion about future design and organization of emergency care networks. Knowledge of what is available and possible in all EDs regionally offers the

opportunity to spread volume of acute care in order to prevent healthcare demand from exceeding the capacity of only a few EDs in that region. This might prevent exacerbation of crowding. In addition, spread of care prevents vulnerability of the system and dependence on a limited number of dominant institutions. *Locally*, ED leaders together with their hospital management can evaluate the position of their department in relation to the consensus standard and other EDs in their comparison group. In this way direction can be chosen in terms of institutional ambitions regarding the ED. Also, our findings could already be used in case of new construction of an ED.

Conclusion

EDs in the Netherlands mostly comply with the expert consensus on minimal operational standards for 24/7 ED. However, there is a considerable variation in the availability of facility and medical (diagnostic & treatment) resources and the extent to which the consensus standard is met in General Hospitals based ED's. Therefore the consensus standard seems to be an appropriate basis for the development of a national ED guideline in order to achieve better clarity of ED functionality.

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Part 3

CONCLUSIONS

Chapter 8

General discussion

Gaakeer MI

The emergency departments (ED) in the Netherlands are the focus of this thesis. In general these EDs provide high level emergency care. Nevertheless, they form a multiform landscape regarding size, architectural build, available diagnostic and therapeutic options as well as staffing. In this thesis we approach this multiform landscape of EDs in two ways. First, by providing a comprehensive and nationwide picture of EDs focussing on their differences and similarities. Secondly, we realized a minimum operational standard for 24/7 available EDs.
This chapter will, after listing the research questions, discuss the main findings of this thesis in the perspective of current knowledge and ED landscape (re)organization. Also, an overview of methodological considerations will be provided. In the end recommendations for further research and future policy will be formulated. Our findings might support ED directors, hospital administrators and national policy makers in the process of future ED landscape optimization.

1.1 | RESEARCH QUESTIONS

The following research questions were addressed in this thesis:

1) What is the number of patients visiting an ED, the number of hospital admissions from the ED, and the number of self-referrals at EDs in the Netherlands? To what extent do these findings correspond with existing perceptions?
2) How does national policy effect the number of EDs, collaboration of EDs with out-of-hours general practitioner cooperatives (GPCs), the number of patients visiting an ED, patients' mode of arrival, number of hospital admissions from the ED?
3) In what way do ED volume characteristics on one side relate to available ED and hospital resources on the other side?
4) What should be the minimum operational requirements with respect to facility, diagnostic and medical specialist availability for EDs in the Netherlands?
5) What facility and medical resources are actually available across all EDs in the Netherlands and how does this relate to formulated minimum operational requirements?

In order to answer the research questions, five studies were performed in the period from 2013 to 2017. As basis for the research a national database for ED characteristics was set up. Every year index contacts of all EDs were approached to provide fixed key characteristics, annually supplemented with additional survey information where necessary. Questionnaires were used to collect the data. Studies presented in **chapters 2**, **3**, **4** and **7** concern nationwide cross-sectional observational studies using data from this national database. In order to answer research question 3, additionally 6 hypotheses were formulated which were aimed to confirm or refute. In order to answer research question 4 an online two-part e-Delphi study was performed, presented in **chapter 5** and **6**.

1.2 | MAIN FINDINGS

Five research questions were addressed, each answered in a separate chapter. Below, the most prominent results are summarized per research question.

ED patients

Beforehand, we doubted whether the assumptions about patients in the EDs in the Netherlands, such as an ever-growing number and a majority of self-referrers,
were correct. After all, it turned out that hardly any methodologically well-designed and controlled research had been carried out before. In **chapter 2** we have studied nationally the number of patients who had visited an ED in the Netherlands in 2012, the number of clinical admissions from the EDs, and the number of self-referrals at EDs in 2012. We aimed to test assumptions and give clarity about patient numbers in the ED.

In total 1,989,746 patients were treated in 89 participating EDs out of 93 present in the Netherlands at the time. Extrapolated to all 93 EDs, the total number of ED visits was 2,079,172. This number corresponds with the number of ED visits estimated previously for 2009, 1.9–2.2 million. From an international perspective, the number of patients treated at EDs in the Netherlands was low: 124/1,000 inhabitants. Comparison showed that the figure was 413/1,000 inhabitants in the United Kingdom, 414/1,000 in the United States, and 430/1,000 in Canada. ED patient volumes varied from 6.000 to 50.000 per department. On average 32% of all ED patients was hospitalized (range 8%–54%). On average 30% of all ED patients was registered as self-referred (range 3%–76%).

We concluded that compared to estimates regarding the number of ED patients in 2009, the total volume of patients in 2012 did not seem to have increased worth mentioning and was low in an international perspective. One third of ED patients was hospitalized after presentation. Contrary to nationwide perceptions, only 30% of ED patients visited an ED on their own initiative. There were great nationwide variations in the number of ED patients, the percentage of hospital admissions from the ED and the percentage of self-referrals.

ED developments

To improve the quality and efficiency of ED care in the Netherlands, policy makers have worked towards concentrating and differentiating emergency care, and to intensify the collaboration of EDs with out-of-hours general practice services (GPCs). The objective of the study reported in **chapter 3** was to obtain insight into the developments of key data from EDs in the Netherlands over several years. In this way we wanted to provide insight into the effect of national policy on ED characteristics. The results show that between 2012 and 2015, the number of EDs dropped from 93 to 87. The percentage of EDs that collaborated with a hospital-based GPC increased from 49% to 79%. The total number of patients seen annually at an ED in the Netherlands dropped by 128,000 to 1,951,000 (– 6%). The number of patients presented at an ED by ambulance, mobile medical team or via the emergency number (112) increased from 13,4% to 16.0%. The proportion of patients referred from a GP or GPC increased from 42,5% to an average of 50.3%. The proportion of self-referrals dropped from 30% to 17.4%. The proportion of patients presenting at an ED by another route remained

constant at around 14%. Admissions to hospital from the ED rose by 5.6% to an average of 37.2%. National variations in number of patients, modes of arrival and hospital admission rate per ED remained large.

It was concluded that the number of EDs continues to decrease, and collaboration between EDs and GPCs is increasing. The number of patients being seen at EDs over the studied period has been reduced slightly. The percentage of self-referrals is decreasing and the number of clinical admissions from the ED is rising appreciably. To achieve successful and consistent management strategies, more contextual data is needed on the nature and scope of the emergency care provided by EDs. We recommend a national registry.

Mutual relationships

In **chapter 4** we aimed to provide additional insight in the ED landscape of the Netherlands in two ways. First by providing a national overview of the variation in ED characteristics. Second by investigating the association between the ED volume characteristics (number of patients and hospitalizations) on one side and measures of available ED and hospital resources (ED treatment bays, ED nursing staff and number of hospital beds) on the other side. In order to study these relationships we formulated 6 hypotheses, which we aimed to confirm or refute.

All EDs in the Netherlands were hospital based and patient volumes varied from 6,000 to 53,000. On average 85% (range 44% to 99%) was referred and 38% (range 13% to 76%) hospitalized. ED treatment bays ranged from 4 to 36 and the number of hospital beds behind these EDs ranged from 104 to 1,339. ED-nurse workforce ranged from 11 to 65. We found positive and significant correlations, confirming all hypotheses.

It was concluded that the ED landscape is multiform by numbers and specifications of individual ED locations. At the same time on a national level associations have been identified between patient and hospitalization volumes on one side and number of treatment bays, ED-nurses workforce capacity and available hospital beds on the other side.

Operational standards

In the Netherlands a standard in the sense of the extent to which facilities, diagnostics and healthcare providers must be available, has not been formulated yet. We effectuated a consensus of emergency physicians on minimum requirements for facility, diagnostic and medical specialist availability in **chapter 5**. This consensus was intended as a first step towards minimum operational standards for 24/7 available EDs in the Netherlands.

In part one of the study a list of 63 possible ED elements was agreed upon by the expert panel. Consensus was reached with regard to the description for all of them after a total of four rounds. In part two the expert panel agreed upon the mandatory availability of 52 facility and diagnostic functionalities and the manner in which 17 medical specialties should be available in every 24/7 ED. Both parts needed four rounds and were ended with a fifth and last round as a final confirmation round that ended without any comment from the panel members.

This study has yielded a widespread agreement among the panel on the availability of 52 facility and diagnostic functionalities and the manner in which 17 medical specialties should be available in

every 24/7 available ED. This consensus is useful as a first step towards the development of quality framework for future 24/7 available EDs in the Netherlands.

Resource availability

In follow up to the study on minimal operational standards the objective of the study reported in **chapter 6** was to gain insight in the actual availability of facility and medical (diagnostic and treatment) resources across EDs in the Netherlands. This offers the opportunity to test the sense of reality of the previous established consensus standard (**chapter 5**) in real situation and to compare EDs to each other, as well as to benchmark them against the consensus on minimum requirements. The results show that four EDs (5%), 1 UH-ED and 3 TH-EDs, fully complied with the consensus on operational standards (100% of the 52 mandatory items available). All 82 EDs together met on average 88% of this standard (range 46%–100%, median 90%). UH-EDs met the consensus standard on average 95% (range 90%–100%, median 95%), TH-EDs 93% (range 85%–100%, median 94%) and GH-EDs 84% (range 46%–98%, median 87%). UH-EDs met the standard for at least 90% and TH-EDs for at least 85%. Twenty-eight GH-EDs (60%) did comply with the consensus standard for 85% or more, matching the group of UH-EDs and TH-EDs. Nineteen GH-EDs (40%) met the standard for less than 85% (the lower limit for UH-EDs and TH-EDs), with at the bottom of this group 5 EDs meeting the standard for 46%, 60%, 63% and 2x 71% respectively.

We concluded that in general the availability of resources in EDs in the Netherlands was high and that EDs met the consensus standard to a large extent. However, there is a considerable variation in the availability of facility and medical (diagnostic & treatment) resources and the extent to which the consensus standard is met in general hospital based EDs. The consensus standard seems have a good sense of reality and to be an appropriate basis for the development of a national ED guideline.

1.3 | THEORETICAL CONSIDERATIONS

Patients in the ED

Volumes and trends

EDs in many high-income countries are experiencing ongoing increasing numbers of patient presentations over a longer period of time and at a faster rate than population growth [1,2]. Across these countries, for which data were available, growth was on average 2,4% each year, although the number of ED visits in each country varied considerably. Reported numbers of ED patients were the highest in Portugal, Spain, Canada, Greece and the United States, with over 400 visits per 1,000 population. On the other hand, in Germany, New Zealand, Poland, Switzerland and the Netherlands fewer than 200 visits per 1,000 population were reported [2]. Regardless of the different numbers, to date internationally the rising trend of ED utilization seems to have hardly been changed, if at all by government or policy interventions that aimed to do so [3-7].

In the Netherlands publications on the total number of ED patients are scarce. However, available numbers have remained fairly stable around 2 million visits per year since 2006. Based on data retrieved from around 14 reference EDs across the country the Netherlands Consumer Safety Institute

(VeiligheidNL) extrapolates to national numbers each year. It was estimated that 1,8 million patients had visited an ED in 2006, 2,0 million in 2012, 2,1 million patients in 2015 and 2,0 million patients again in 2016 (source, with permission: VeiligheidNL). Our research across all ED present shows total visit numbers of 2.079.172 in 2012 and 1.951.055 patients in 2015, a decrease of –128.116 visits (-6%) [8]. In 2016, the number of ED patients had increased slightly again to 1,979,726 patients (+ 1,5%) [9]. In the Netherlands this means around 120 ED visits per 1,000 population per year [8,9].

Visit determinants

Differences in numbers between countries in the demand for care in an ED are explained by various determinants both on the supply and the demand side. The most important on the supply side are insufficient access to primary health care and a shortage of out-of-hours care services [2,10-12]. This factor is reflected in the amount of self-referrals in the ED. In addition, on the supply side the role of EDs in itself has changed, to the convenience of both hospital medical specialists and general practitioners (GPs) [13]. Traditionally the most important role of EDs is to stabilize critically ill and injured patients and to initiate first treatments [13]. However, hospital medical specialists and GPs are increasingly relying on EDs to assess and treat patients with potentially serious problems in the ED [13]. EDs support local GP practices and outpatient clinics by performing complex diagnostic workups and handling overflow [13]. In addition, EDs increasingly serve as an important entrance of hospital admissions [13,14]. On the demand side perceived severity by patients, the experienced convenience by patients and socio-economic factors are associated with patients seeking care in an ED themselves. These factors are also reflected in the amount of self-referrals in the ED [2,15]. Finally, age distribution of a population is an important demand-side factor [2].

(Self-)referrals

As mentioned, numbers of self-referrers reflect a combination of supply and demand determinants: a lack of access to primary health care and a shortage of out-of-hours care services, perceived severity by patients, experienced convenience by patients and all kinds of socio-economic factors. Self-referrers are often considered to be 'inappropriate' or 'non-urgent' ED visits, that should be managed elsewhere [16]. Internationally reported percentages of inappropriate ED visits vary from around 12% in the UK and the USA to 56% in Belgium [16]. Unfortunately, in literature the term inappropriate use by self-referrals is defined ambiguously and is almost always determined on the basis of final diagnoses retrospectively [17]. In the Netherlands numbers on self-referrals vary widely [17]. Two high-profile opinion articles published in 2011 and 2013 stated that 43% to 70% of the total ED patient volume in the Netherlands concerned self-referrers at the time [18,19]. Reference was made to 4 loco regional studies published in peer reviewed medical journals previously [20-23]. However, the national representativeness of these studies might be questioned [17]. Noteworthy, none of these four references mentions the percentage of 70% self-referrals [17]. More recent research done by *Valk et al* in 2011 (published in 2015) mentions 47% self-referrals in 1 academic ED [24]. Research done by *Van der Linden et al* in 2010 (published 2014) mentions 60,5% self-referrals in 1 Dutch non-academic level 1 trauma centre [25]. *Kraaijvanger et al.* conducted a study in 2012 (published in 2016) in an ED of a community teaching hospital and found 25,8% self-referrals

[26]. Nevertheless, a systematic review is lacking, as was methodologically sound and controlled research that could help us to form a realistic picture of ED patients throughout the Netherlands [17]. The Dutch Healthcare Authority reports nationally 36% and 23% self-referrals in 2013 and 2016 respectively [27]. Our research across all EDs in the Netherlands shows that in 2012 of all patients 70% was referred in one way or another. We found on average 30% self-referrers [17]. From 2012 to 2016, the proportion of referred patients increased to 85%, leaving 15% self-referrers in 2016 [8]. In addition to our results, various other studies classified 48% to 59% of the self-referrers in the period from 2010 till 2012 as appropriate ED visits [24,26]. The overall number of self-referrers is trending to be smaller during last years.

Elderly patients

Older age is an important determinant for the use of care in the ED [28-30]. Elderly people tend to stay longer in the ED than younger people and more diagnostic tests are performed on older patients [31,32]. The treatment process of care for the elderly patients in the ED differs from that for younger people, because they have more complex and more diseases or health conditions when compared with other age groups [31,32]. In addition, hospital admission rate is higher for elderly people than younger people [33,34]. The presence of elderly patients in the ED is increasing in countries facing an aging population, like the Netherlands [2,35]. Regarding the distribution of age in Dutch EDs the Dutch Healthcare Authority reports that 29,1% of the ED population was older than 65 years in 2013 and 33% in 2016 [27]. Numbers provided by the Dutch Consumer Safety Institute show that 23% of all ED patients was 65 of age and older in 2006, 30% in 2013 and 32% in 2016. Our national inventory shows that 34,0% of all ED patients was 65 of age and older in 2016 [8]. In addition, we found an enormous variation of this percentage across different parts of the Netherlands, ranging from 27% to 41% [8]. Nevertheless, the number of elderly patient ED visits is steadily increasing during last years and the forecast is that this trend will continue as the older age generation will increase in number in the near future.

Hospitalizations

Hospitalization numbers may reflect the role of EDs that has changed in itself, making it an important entrance for hospitalizations [13,14]. On the other hand, hospitalization numbers may also reflect the effectiveness of the 'second line' gatekeepers role of EDs [36]. Finally, admission numbers via the ED also may apply as a potential measure of the intensity of care provided in the ED [13,26]. In other words, hospitalization numbers need interpretation before conclusions can be drawn.

In England emergency admissions via the ED increased from 22% in 2007 to 29% in 2017 [37]. At the same time a decrease is observed in the number of hospital admissions via GP-offices [38]. This indicates that the ED is increasingly being used as an entrance for hospital admissions. In Australia hospital admission rate was 31% in 2016 [39]. On the other hand, in the USA the percentage of ED visits that resulted in hospitalization decreased in all age groups in the period from 2006 to 2015 [40,41]. Among patients aged 65 and older and aged under 18 years, the percentage of ED visits followed by hospital admission decreased with 20% and 27% respectively [40,41]. This decrease might be explained by an intensification of diagnostics in the ED, allowing more people to be discharged

rather than needing to be admitted [42]. Here, hospitalization numbers seem to reflect the 'second line' gatekeeping role of an ED. In the Netherlands 33,2% of all ED patients was hospitalized in 2013 and 36% in 2016 according to the Dutch Healthcare Authority [27]. In our studies we found an increase of hospitalizations from 32% of all ED patients in 2012 against 38% in 2016 [8,9].

ED patient considerations

In the Netherlands about 2 million people per year (120 patients per 1,000 population) are seen and treated at the ED [8,9]. These numbers appear to be reasonable stable over the last 10 years [8,9]. From an worldwide and even European point of view the Netherlands is consistently among the countries with the lowest numbers of patients in the ED [2]. This will be mainly due to good accessibility to primary health care and also favorable socio-economic factors, compared with most other countries [43]. But even than, the policy over the past ten years has been strongly focused on further reducing the number of patients in the ED. Despite different interventions, patient volume in all EDs together has not decreased substantially, if at all [8]. On the other hand, the number of ED patients in the Netherlands has not increased either, in contrast to almost every prosperous country around [8].

The most obvious intervention to reduce ED visits has been the mandatory intensification of collaboration between EDs and GPCs. During our study period we observed an increase of the percentage of EDs with a collaborative arrangement with an in hospital-based GPC from 49% to 79%. In the same period the number of self-referrals decreased nationwide indeed [8]. Here the Dutch Healthcare Authority reports slightly higher percentages then we found in our national surveys [27]. However, this observed decrease deserves clarification and nuance. Literature is not unambiguous about the effect of colocation of EDs with GPCs. A review of studies on the colocation of EDs and GPCs in a number of countries, including the Netherlands from 1980 till 2015, concluded there is little evidence to support the implementation of colocated ED-GPC models [44]. An increase in efficiency is reported in a several Dutch studies that report on one or more locations of urgent care collaboration [45-47]. In addition, a regional observational study in the south-east of the Netherlands showed admittedly that, where colocation was present, 22% of ED care was transferred away from the ED [48]. However, follow-up studies in the same region showed neither an increase in efficiency nor any cost reduction [49]. Moreover, a substantial number of patients who now referred themselves to a GPC continued to be referred to EDs by the GPCs in the second instance [48,49]. For those patients the consequences were a significant increase in total waiting times and time spent in hospital [49]. Our study suggests a similar effect. We observed that nationally the number of self-referrals to an ED decreased on average by 15% [8,9]. However, at the same time referrals from GP offices and GPCs together increased by an average of 9%, due mainly to referrals from GPCs [8,9]. We also noticed a 3% increase in the number of patients presented at an ED by ambulance, MMT or 112 calls. This leads to the premise that the national trend towards colocation of EDs with GPCs in the Netherlands merely has led towards a different mode of arrival of the same patient categories on the ED and only to a limited extent reallocation of care. A possible explanation could be that in the past a substantial part of self-referrers might have referred themselves quite adequately to an ED directly, thus limiting the effect of patient reallocation through colocation of ED and GPC.

Another perspective needs to be mentioned. In the Netherlands is being tried to further optimize an ED usage that, in an international or European perspective, seems rather efficient already. Another important explanation might be that the assumed volume of self-referrers, mostly based on local studies, appeared to be less nationally representative, than in our study. Another intervention to reduce ED visits that has been introduced and seems to have limited effect is the introduction and rise of a mandatory health insurance excess (in Dutch: verplicht eigen risico). Dutch citizens are obligated to have a health care insurance. In these, people still need to pay mandatory excess: this is a set part of the cost per year when health care is used. This mandatory excess is not applicable for GP and GPC care, but it is applicable for all hospital costs, including ED care. In 2011 (published in 2014) *Valk et al* investigated the willingness to make a copayment at an academic hospital ED and found that about 70% of the self-referrals were willing to make a copayment [50]. However, it is possible that both interventions have contributed to the fact that the ED visits in the Netherlands have not increased.

On contrary, between 2012 and 2015 we observed a temporary decrease in the number of ED patients. Whether this has been the effect of policy remains uncertain. Another plausible explanation can be found in the economic recession in the Netherlands in this period. It is known that in time of recession, care consumption decreases [51]. The future will have to prove whether the number of ED visits really can be reduced structurally and substantially, or that the volume remains about similar or increases.

The share of older people in the total group of ED patients is substantially increasing indeed. This is logical given the aging of the population in the Netherlands. However, this increase of older age seen in the ED population seems to be less profound than one could have expected by the aging of society [52,27]. Another explanation given for the increase of elderly population in the ED is the effect of government policy in which older people are supported to live at home longer. Here the health of elderly might be monitored less adequately. Health deterioration could be noticed and picked up late [53,54]. So can a minor additional medical problem, the balance that allowed people to live at home change the situation so that ED visit is warranted.

An increasing proportion of ED patients is being admitted to the hospital. What causes this increase in the Netherlands? It was calculated by ActiZ (an umbrella society for organizations that are supporting elderly, chronically ill and youth) that of all elderly patients admitted to a hospital via an ED, 60% was without needing specialist medical care [55]. This often concerns elderly people with, for example, well-being complaints such as loneliness and depression, of which the GP believes that staying at home is no longer possible [55]. This could indicate insufficient effectiveness of both first line and second line gatekeeping in combination with a lack of an adequate alternatives other than hospitalization. In addition, in the Netherlands the share of hospital admissions via the ED compared to the total number of hospital admissions is increasing [56]. This indicates a changing role of the ED, making it an increasingly important entrance for hospital admissions. Finally, the proportion of elderly people of the total number of patients in the ED is increasing, reflecting more intensive care [8,31-33]. Further detailed research is needed to interpret this effect on hospitalization increase number adequately.

How many EDs must be there?

Nationwide optimization of the ED landscape is being discussed in multiple countries around the world. The dominant strategy is centralization towards fewer EDs with the argument that EDs serving a higher volume of patients are more efficient and result in higher quality of care.

ED number trend

The general trend in prosperous countries is a decreasing number of EDs. We discuss a number of countries including the Netherlands for illustration purposes. In the United States the number of EDs has decreased by 11% within the past two decades [58,59]. In nonrural areas the number even declined by 27% [57,58]. For-profit ownership, location in a competitive market, safety-net status and low profit margin were associated with increased risk of ED closure [58]. In England the reduction of EDs is suggested to be 8% in the 10-year period leading up to 2011 [60]. These ED were closed for reasons of safety, sustainability or affordability [60]. Although formal numbers identifying ED closures after 2012 seem not to be available, media have reported multiple closures between 2012 and 2017. In 2017 media reported of NHS sustainability and transformation plans, suggesting further closures [61]. Denmark is frequently cited as an example of a country with a successful proactive ED reduction policy. Here the number of acute hospitals has been reduced from 40 to 21 since 2007 [62]. However, this was accompanied by a fundamental change in the way emergency care used to be organized. In the 21 remaining acute hospitals the previously dispersed single specialty emergency and acute care units (Franco-German Emergency Medical Services System) were now integrated to one so-called 'joint acute facility' per hospital (Anglo-American Emergency Medical Services System). In other words, centrally organized multidisciplinary EDs, as we're familiar with in the Netherlands, United Kingdom and United States, were introduced here for the first time. Parallel with this reform of acute hospital care, acute care ambulances were introduced, as well as mobile emergency care physicians on the ground and Emergency care helicopters to assist ambulance crews. Some regions established additional local urgent care clinics. This and more has been part of a complete healthcare organization reform, what again resulted from a top-down major reform of the administrative and political structure in Denmark [62]. In Germany the number of EDs is decreasing in a similar way. Historically there have been separately staffed 'emergency admission areas' within individual hospitals for internal medicine, surgery, trauma, gynecology and obstetrics, pediatrics, etc. (Franco-German Emergency Medical Services System). In the last two decades more and more hospitals have created centrally organized multidisciplinary EDs (Anglo-American Emergency Medical Services System) [63]. Formal ED numbers in Germany seem to be not available. Denmark and Germany show as examples that looking only at the number of EDs is not enough. It is also necessary to look at which entity is meant precisely by the term 'ED' and which type of Emergency Medicine Services System is involved.

In the Netherlands nationwide reconfiguration of the ED landscape is also a much-discussed topic, which has been intensified especially since the Health Council of the Netherlands published its report 'Medical specialist care 20/20, Close by and further away' in October 2011 [64]. This included a vision of how hospital care, including ED care should be organized differently in the future. Reason for publication was insight into the fact that the demand for care would increase sharply in the coming

years, while the available financial space to meet this demand was and would remain limited. In addition, a change in the demand for care was foreseen: an increasing number of chronically ill patients, who moreover would often have multiple disorders at the same time. Several additional reports specific on the redesign of the ED landscape were published subsequently [65,66]. The emphasis in all these reports was invariably on reducing the number of EDs present at the time towards an assumed minimum number of EDs needed in the future at which sufficient ED accessibility to the population could be maintained. Predominant arguments have been consequently that a substantial part of all ED patients wouldn't belong here and that by concentrating emergency care in fewer EDs costs can be saved and increased patient volumes will improve quality of care [64-66]. Our research shows that the number of EDs in the Netherlands is decreasing over a period of several decades and has always been the result of hospital mergers or closure. Hereby each non-categorical hospital organization has retained at least one ED. In the Netherlands there are no free standing EDs. In 1994 there were 128 EDs and in 2010 this number had decreased to 105 [8,18]. In 2012 we counted 93 EDs, decreasing to 87 in 2016 [8,18]. In the following years, another 9 ED locations were closed, leaving 78 EDs meeting the IFEM definition in January 2019.

ED number considerations

In order to adress the key question 'How many EDs must be there?' in the light of the centralization policy pursued in the Netherlands, we discuss six different theoretical perspectives to determine the number of EDs in a country.

1.3.1 | Public perspective

From this perspective is the number of EDs determined by the ease of access to an ED as the public experiences, which is in generally determined by what people are accustomed to. The nearness of an ED appeals to a sense of safety. In case of a medical emergency people would like to have a fully equipped and ready ED on every street corner so to speak. This can be deduced from the public engagement in discussions about the closure of every ED in the Netherlands, which almost without exception releases a strong response from the local community. In general people prefer their emergency care to be local. At the same time, a balance must be found between peoples ability to access an ED and sense of safety on one side and ensuring that the quality of ED care is as high as possible and economically affordable on the other side. Naturally, availability of an ED on every street corner is not realistic. On the other hand, the question of how many EDs should be available is difficult to answer. Thoughts of how the distribution of EDs impacts on patient convenience or safety needs to be balanced against several other perspectives that influence choices about the number of EDs that must be there.

1.3. 2 | Quality perspective

From this perspective is the number of EDs determined by compliance with a certain validated quality of care standard and quality measurement. However, today performance measurement of care in an integrated care location as the ED is still fragmented and incomplete [67]. A validated standardized assessment of quality of care across the ED is missing [67,68]. In the absence of an

evidence-based integral ED care performance measurement framework, the focus is usually on volume, a limited number of diagnoses, timeline measures and availability of operational standards, leaving performance of by far the most care delivered in the ED unmeasured [67].

1.3. 3 | Geographical perspective

From this perspective is the number of EDs determined by establishing the number of regions in a country and the number of EDs per region. Regions can be identified in different ways. It is possible to opt for existing geographical regions, such as provinces or otherwise historically established parts of the country. The scale of the selected number of EDs present in these regions may vary and should be determined by the number of inhabitants per catchment area. It can also be chosen to define a catchment area per ED with regard to the number of inhabitants. The selected number of EDs present per region then determines the demarcation of regions. In this way ED scales will be approximately the same, while the size of regions and distances that must be traveled may vary. In 2006 the Royal College of Surgeons of England suggested that the preferred catchment population size for an acute general hospital providing the full range of facilities, specialist staff and expertise for both elective and emergency medical and surgical care would be 450,000 to 500,000 people, and should serve a population of at least 300,000 people [69,70]. In Denmark guidelines issued by the National Board of Health state that an acute hospital should serve a population between 200,000 and 400,000 people [62]. However, these figures are not scientifically substantiated and especially based on expert opinions. In the Netherlands acute care is subdivided into 11 regional acute networks, which have emerged from the since 1998 existing trauma regions, organized around 11 available trauma centers. The report 'Medical specialist care 20/20, Close by and further away' states: *'only large (so general) hospitals and UMCs have an emergency department. One large ED per region is enough'* [64]. This view was supported by the statement that '*an ED is available for when care must be provided as soon as possible, but in any case within a few minutes to a few hours, to prevent death or irreversible damage to health due to an acute life-threatening condition or an accident' (definition acute care by Health Council of the Netherlands, 2003)*. It was supposed that if this definition would strictly be adhered to, ED figures showed that the number of EDs could be reduced substantially, under the conditions of network approach and scaling up. Our research shows that the number of ED patients has not been reduced substantially since [8].

1.3. 4 | Time limit perspective

From this perspective is the number and dispersion of EDs determined by setting a time limit (corresponding to a travel distance) within which people must have access to an ED. The key question here is which time limit (corresponding to a travel distance) does justice to the various conditions for which timely emergency care makes a significant contribution to patient outcomes, the so called emergency care-sensitive conditions (ECSCs) [71,72]? There is good evidence for improved outcomes at higher volumes outweighing increased travel times/distances to specialized centers for some ECSCs: major trauma patients with multiple injuries, primary angioplasty for acute myocardial infarction, ruptured acute abdominal aneurysm and severe head trauma [74-76]. However, this evidence does not exist for the other ECSCs, such as for example cerebrovascular

accidents, sepsis, exacerbation asthma/COPD, acute heart failure, anaphylaxis, a stuffy child, nor for ED care across the board (non ECSCs) [73-75]. The volume-quality relationship only applies to a very limited number of rare emergencies. Although often done, this cannot be extrapolated to all ED care. Finally, a time limit (corresponding to a travel distance) towards an ED will also be highly dependent on the organization and treatment options of prehospital care providers. In the Netherlands a time limit exists, the so-called 45-minute standard. This implies that patients must be able to be delivered in an ED by ambulance within 45 minutes from anywhere in the Netherlands, including arriving at the patient within 15 minutes after being dispatched (emergency call, 112). This standard applies as a restrictive measure for sufficient accessibility from the Dutch government. Annually the number of vulnerable EDs is determined on the basis of this ambulance driving time model [76]. A vulnerable ED is an ED that when it is closed a part of the population can no longer be brought in an ED by ambulance within the 45-minute time limit. The consequence is that if closure threatens a vulnerable ED, the government will intervene. At the same time, if closure threatens a non-vulnerable ED, the government will not intervene, as was recently the case with the bankruptcy of two hospitals.However, it is unclear what this 45-minute time limit is based upon. There are no substantively objective arguments supporting this time limit regarding the accessibility of an ED. Just recently this has been acknowledged by the Minister of Health in the Netherlands, who has commissioned research into substantiation of a time limit of any number in the Netherlands.

1.3. 5 | Economic perspective

The cost-benefit structure of EDs is complex and poorly understood [77]. An important reason might be that the price (what is being charged) of an ED can fairly simple be identified, whereas true costs and to a greater extent revenues are intertwined within the broader hospital finances. Which parts of hospital costs or earnings are generated by the ED directly or indirectly is difficult to identify. In discussions price and costs are often confused. At the same time, the financing system in the Netherlands offers little transparency in the distinction between the two.

On a hospital level, an ED guarantees admissions of patients with acute and emergent pathology to the hospital, and subsequently generates an out-patient follow-up care path both from patients discharged from the ED and the hospital wards after admission. High level and available ED care can also establish a good reputation for the hospital. Internationally the majority of ED closures were associated with the closing of the entire hospital [59,79]. In the Netherlands it was also calculated that a hospital without an ED would probably not be viable [78]. Therefore hospitals hold on to their own ED, because of supposed financial dependency. Our research shows that in the Netherlands a reduction in the number of EDs has almost always been the result of hospital mergers whereby at least one ED remains available to the new hospital organization [8,9]. Only recently two EDs were closed because the hospitals to which they were affiliated went bankrupt. It should be noted that this were the only two private hospitals in the Netherlands.

On a national level, the potential financial effect of reducing the ED number in the Netherlands was studied empirically [78]. It showed a potential saving of on ED costs if the ED number would be halved. In relation to the total costs of hospitals, this benefit would be a reduction of less than 0,5% on the total budget. In addition, it was also calculated that follow up costs would increase partly

because on average hospital admission in a larger hospital turns out to be more expensive. It was concluded that there are no financial economic benefits resulting from concentration of ED care [78]. It is regularly suggested to finance acute care, including ED care on the basis of a regional budget. In such policy the number of EDs in a region is based on the budget set for a region and thereafter the allocation of acute care amongst the various providers (for example hospitals and GPCs). In this way regions should be motivated to organize acute and emergency care in a most efficient way, also resulting in an efficient number of EDs. For the time being this is a theoretical perspective.

1.3. 6 | Logistic perspective

The most common approach of ED logistics is the ED input-throughput-output conceptual model as published by *Brent Asplin and colleagues* in 2003 (Figure 1) [80]. The three components, input, throughput and output are interdependent. The ED chain logistic process disrupts when a mismatch between these components occurs, causing stagnation of within the acute care chain, resulting in ED crowding. Although the model focuses on logistics from an ED perspective, the model places the ED in the perspective of the acute care system as a whole and also its interaction with the delivery of chronic and preventive care [80].

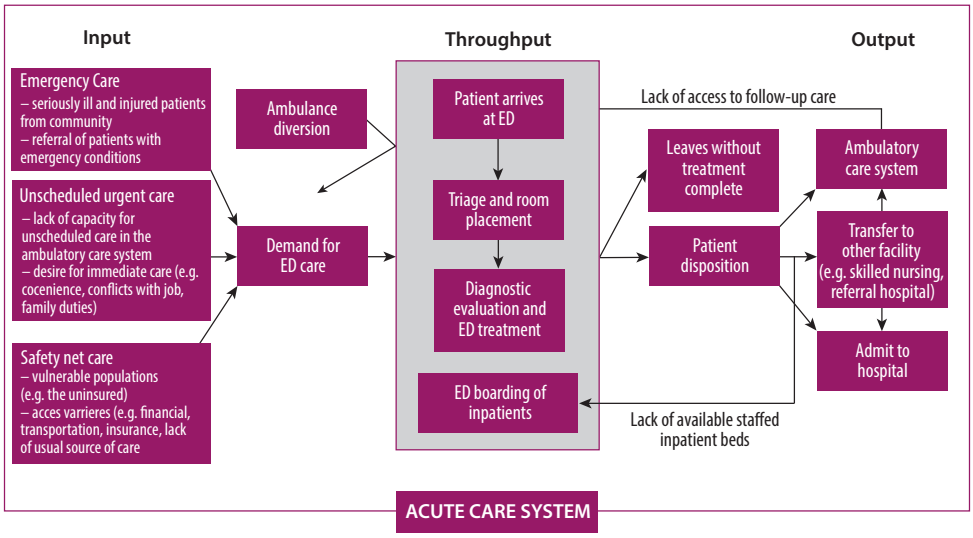

Figure 1 | The Input - Throughput - Output Model of ED congestion *(Asplin et al)*

ED crowding is the situation where the number of patients occupying the ED is beyond the capacity for which the ED is designed and resourced to manage at any one time [80]. ED crowding is associated with many negative effects, such as increased patient mortality, more medication errors and medical errors, longer waiting times to diagnosis and to receive time-sensitive-care, increased costs both within and outside the hospital and poor patient experience [81-87]. In addition, ED crowding

decreases the productivity of ED staff, increases the risk of a burn out and increases the staff turn over. ED crowding is considered as one of the greatest challenges to delivering safe, high quality, urgent and emergency care [81-87]. Worldwide ED crowding is a major and growing problem and EDs in the Netherlands are increasingly faced with this phenomenon [88]. On the input-side in the Netherlands the ED population has not changed substantially in numbers, while the referral rate has increased substantially. In the ED column the number of EDs has decreased continuously and at the same time the level of diagnostics and treatments demanded in the ED increased. The aging ED population requires more intensive care. Finally, on the output-side the rate of patients that needs to be admitted to hospital increases, while the number of hospital beds has decreased dramatically [8,9,88]. These developments illustrate that an ED is an integral part of an (acute) care network and that capacity problems in the ED require a coherent cluster of measures in all three components of the input – throughput – output conceptual model [88].

1.4 | METHODOLOGICAL CONSIDERATIONS

We used different research methods to address our research questions. These included multiple quantitative cross-sectional questionnaire studies and a two part e-Delphi methodology study. Limitations of each of the individual studies included have been discussed in accompanying chapters. In this paragraph, we discuss especially general methodological considerations for this thesis.

The first consideration relates to the definition for ED entities included in this thesis. As mentioned earlier in several chapters we have consistently limited eligibility criteria to those that met the definition as has been drawn up by the International Federation for Emergency Medicine (IFEM) terminology project in 2012.

> *"An ED is the area of a medical facility devoted to provision of an organized system of emergency medical care that is staffed by Emergency Medicine Specialist Physicians and/or Emergency Physicians (EPs) and has the basic resources to resuscitate, diagnose and treat patients with medical emergencies. The ED is a unique location at which patients are guaranteed access to emergency care 24 hours a day, 7 days a week. It is able to deal with all types of medical emergencies (illness, injury and mental health) in all age groups* [89]."
>
> *In concrete terms this meant that EDs had to meet the following criteria to be included in our consecutive studies:*
>
> - *a centrally organized location for the reception of patients in need for emergency care,*
> - *being able to deal with illness, injury and mental health emergencies,*
> - *serving all age categories,*
> - *around the clock (24/7) availability and accessibility to the public.*

In the Netherlands the point 'around the clock (24/7) availability and accessibility to the public' is being debated. In this context, in 2009 the Breedveld Working Group proposed an ED quality

classification, stating that ED closure at night should be possible, provided that emergency care remains guaranteed in the immediate vicinity [90]. Then in 2012 this position was taken over by the Health Council of the Netherlands in its report 'A solid foundation is a must! Quality at a basic Accident and Emergency Department within a regional network' and in 2013 by Zorgverzekeraars Nederland (the umbrella organization of ten health Insurers in the Netherlands) in its report 'Vision on emergency care quality' [91,92]. However, the Dutch Society of Emergency Physicians endorses the IFEM definition, including 24/7 availability and accessibility to the public. In addition, in practice hospitals do not appear to be inclined to close their ED at night, due to financial and organizational consequences. If night-time closures takes place, it always concerns an ED of a hospital organization with multiple (ED-)locations, whereby another ED stays open around the clock seven days a week [8,9]. In practice the result usually appears to be further reduction of emergency care and finally complete closure of the relevant ED location [8,9]. In the international community of emergency medicine 24/7 availability and accessibility of an ED to the public, as expressed in the adage 'Anyone, Anytime, Anything', is considered not only an essential core value, but even the main purpose of an ED [93].

Strengths of this thesis are its nationwide character and the high level of participation of EDs in each study. Our research covered all EDs throughout the Netherlands, what had not been done before. Previous studies have extrapolated locoregional findings to a national picture [8,9,18]. In addition, annual estimations by the Netherlands Consumer Safety Institute (VeiligheidNL) are based on the Netherlands Injury Information System (LIS) sampling 14 EDs at 12 hospitals [8,9,18]. The willingness to participate was great in every study included in this thesis. A strong motivation for index contacts to participate seemed to be the lack of insight into nationally representative ED characteristics and the need for them. For our studies we used a network of index contacts. Maintaining the contact network has been an important point of attention throughout the execution of the research presented in this thesis, besides performing the actual research. In retrospect we have underestimated the time needed to keep everyone involved and enthusiastic to supply the requested data again and again. In addition to the amount of data we requested, it appeared that information we requested for was often not readily available in many of the participating hospitals. Our contact persons had to spend a lot of time themselves collecting the required information from their hospital information systems. Nonetheless, with perseverance, over the years we have succeeded in maintaining a very high level of participation in all studies, resulting in representative outcomes.

An important objective of this thesis was the anonymity guarantee. Participation always took place under the guarantee of anonymity, that is to say that individual EDs should not be traceable by other parties. This was required by many ED directors, because of the fear for data being abused for other than scientific purposes by third parties. To fulfill this commitment to participants we were only able to present the results at a nationally aggregated level. Unfortunately we couldn't show the regional variation, which is indeed there. This diversity across the ED landscape should be taken into account when drawing up national policy.

For the quantitative studies reported in **chapters 2**, **3** and **4**, some overlapping methodological considerations exist. Both studies were based on data derived from registry systems of individual hospitals and we were not able to check the unambiguity of these data, for example the mode

of arrival of patients coming to the EDs. Additional information, such as length of hospitalization, reasons for admission and the percentage of hospitalizations among self-referrals, was not available, although this could have been helpful in better interpretation to the findings.
For the explorative study described in **chapter 4** we used hypotheses to explore relations between characteristics within the ED landscape. These correlation hypotheses were not available in literature. Therefore we had to formulate them ourselves. Although not validated we are convinced this is a method worthwhile in order to obtain better insight towards better understanding how available EDs relate to one another in regard to their characteristics.
The execution of the two part e-Delphi study is reported in both **chapters 5** and **6**.
Medical researchers regularly use the Delphi study technique, but scientific publications often lack detailed information on methodological choices, decision rules and controlled feedback. After study and consideration we have made a number of choices with regard to the design of the study, about which discussion remains possible. For example, we have set the degree of consensus required at 70% or more. Although this threshold is most commonly used, another degree of consensus had been justifiable, also for the degrees of consensus were already much better. Nevertheless, we do not think the results of our study would be radically different.
In addition, we have opted for an expert panel that consisted exclusively of EPs, instead of involving other medical discipline specialists. We estimated that especially the execution of the study would have lasted longer.
Finally, for the benchmark study reported in chapter 7 we depended on information provided by all index contacts. We might have suffered from desirable answers. The availability of resources could have been presented more positive than is the case in reality.

1.5 | NEXT STEPS

Future optimization

ED care should be always readily available in a safe, effective, patient-centered, timely, efficient and equitable manner for everyone in the Netherlands [94]. In the present day policy makers lack solid evidence to guide them towards the optimal ED landscape for this matter. Consequently, policy is being made based mainly on common knowledge, assumptions and political convictions. This situation calls for a fundamental reconsideration. Based on our research and discussed theoretical considerations, we advocate the development of an ED directive based on comprehensive scientific research in the field of emergency medicine in the Netherlands and furthermore in line with what is known and being developed in this area internationally.

Recent and current ED quality improvement projects

In the last decade several initiatives taken, aimed to improve quality of ED care in the Netherlands. In 2012 the Health Council of the Netherlands published its report *A solid foundation is a must!* at which the credo '*Close by if possible, a little further away if necessary'* was introduced [91]. It postulates that good quality, effective acute care benefits from a diversified mix of generally available basic quality

EDs and focussed specialized EDs. The statutory standards for accessibility, in the Netherlands the 45-minute time limit, provided a guideline for dividing up tasks between individual EDs/hospitals and eight recommendations in regard to 'basic EDs' were given. Firstly, a basic ED must have competences to be able to deal with a wide range of acute complaints. Secondly, during all opening hours both a trained and certified emergency physician (EP) and ED nurse should be present. Thirdly, the following specialties must be available quickly: surgery, anesthesiology, medicine, cardiology, pediatrics, ENT, gynecology, neurology and radiology. Fourthly, scientific associations must formulate further requirements about availability. Fifthly, EDs must distribute tasks optimally within regions. Sixthly, opening up basic EDs is also a matter of division of tasks. Seventh, a binding regional management is needed. Eight, the financing must support regional cooperation. With its recommendations, the Health Council built carefully on the 2009 report *Emergency care: from a solid foundation*, which had proposed a system consisting of three different types of EDs: 'full EDs' in university medical centers, 'profile EDs' in hospitals with support facilities in the form of specialized care departments and 'basic EDs' whose activities would primarily involve resuscitation, stabilization and the treatment of common, but not highly complex acute problems [90]. In 2015 Zorginstituut Nederland published the report Emergency care must be good: indicators and standards for six emergency care indications [95]. This report followed *Quality Vision Emergency Care*, a vision from Zorgverzekeraars Nederland (an umbrella organization of healthcare insurers in the Netherlands) and intended to establish quality indicators and standards for six emergency care indications: acute myocardial infarction, cerebrovascular accident, fracture of the hip, multitrauma, ruptured acute abdominal aneurysm and birth care [92]. Because parties involved were unable to agree among themselves, Zorginstituut Nederland had to use its perseverance to set an indicator set for each of the six indications. In 2018 the Quality framework emergency care chain was published, which describes how involved healthcare parties want to work together in order to offer every patient with an acute care demand 24/7 emergency care of good quality [96]. In follow up to this report a *Quality standard Intramural Emergency care* is in the final phase of development at this moment. Recommendations will be made with regard to adequate triage, patient transfer, availability of laboratory and radiological imaging, agreements on distribution of accountability, adequate pain management and how to approach a confused patient. With our research we have provided national baseline data on patient numbers, referral-routes, age distribution and admission rates. In addition, we performed a formal Delphi study reaching the first consensus on minimal operational standards for EDs from a single ED profession. Subsequently, we show that the availability of facility and diagnostic items varies considerably among EDs.

ED directive considerations

In the Netherlands the current state of affairs regarding quality in the ED is a patchwork of a limited number of mostly general recommendations. The emphasis is strongly on structure indicators, limited on process indicators and hardly on outcome indicators. Apart from a small set of diagnoses, the vast majority of ED care delivered remains unmeasured. Strategies to optimize ED care nationally are complex and result from a consideration of many, possible conflicting perspectives. A complicating factor is that, although there is a significant focus on quality of ED care, a great deal

of insights and consequently scientific evidence in regard to ED care in general and quality of ED care in particular is still lacking. Moreover, in the absence of a consistent quality measurement of ED care, it is hard to establish which intervention is effective. It is time to focus more critically on improvement of ED care. Future optimization of ED care in the Netherlands should be based on a more extensive national ED quality framework. Gained knowledge and reported initiatives can be brought together here. We make the following recommendations with regard to the composition of such an ED directive.

1) The following areas should be addressed: a) patient care; b) staff education, training and availability; c) research; d) department operational standards; e) local and regional embedding of the department (co-dependencies); f) administration.
2) All six domains of quality of care should be captured: safety, effectiveness, patient-centeredness, timeliness, efficiency and equitability.
3) For each domain a selection of evidence based structure, process and outcome indicators should be pursued and included.
4) Participation of EDs in a national quality registration for the purpose of evaluation and to guide interventions should be secured.
5) Method of local visitations on the basis of the framework and measured performance should be included.
6) A periodic evaluation and adjustment of the directive should be captured.

1.6 | STEPPING STONES TOWARDS AN ED DIRECTIVE

In order to effectuate such a standard, a number of requirements should be realized.

Direction

Guaranteeing safe and high quality ED care is a responsibility of the government. More direction seems justified. It is only natural that the profession of EPs through their scientific association Dutch Society of Emergency Physicians (DSEP) is closely involved. The profession itself should take the ultimate responsibility to raise the bar in regard to ED care quality and plotting the lines towards an ED directive. After all, EPs are increasingly forming the medical backbone of EDs in the Netherlands and are the only physicians working full-time, around-the-clock and integral across all acute presentations in the ED. In addition, the DSEP has an extensive international network including leaders in the field of ED care quality, which can be used to benefit in the Netherlands.

Registration

In order to optimize performance, facilitate monitoring and support research, there must be an overview and data made easier accessible. Electronic health record (EHR) systems in EDs need to be standardized and shaped more adequately for these purposes. In addition, selected data should be gathered in a national database, making both benchmarking and scientific research possible. In 2015 six founding hospitals/EDs already have initiated the Netherlands Emergency department

Evaluation Database and more hospitals/EDs are connected since. Participation of all other EDs is warranted.

Research

Academic and Teaching Hospitals should established emergency medicine research groups, which focus on quality of ED care in a broader sense. Available scientific or empiric evidence should be interpreted critically and if not available should be sought. A collective ED quality research agenda may be helpful for oversight and coordination between different research groups. It is important to give priority to measures that address common serious disease processes. In addition, community-type measures for transparency in the areas of insurance coverage, collections, ED charges and costs of resource use should be developed and incorporated.

Publicly report

The demand for transparency is rightly growing. Quality of ED care should be made publicly visible as an incentive for continuous improvement. For example, all available EDs can be indicated on a public and digitally accessible map with insight into a carefully and coordinated selection of characteristics and quality indicators.

Financial support

The development of ED quality policy and an ED quality standard will need adequate funding. Hospital organizations together with Health Care Insurers have a primary responsibility, among other sources of financing.

1.7 | CLOSING COMMENT

The ultimate goal of this thesis is to investigate EDs in the Netherlands. More thorough insight is needed in the planning of further optimization of the ED landscape and improving quality of ED care nationwide in the future. It should be borne in mind that there are more than 17 million potential ED patients in the Netherlands, of which 2 million per year are actually treated in an ED. When needed high quality ED care should be readily available to *Anyone, for Anything, at Anytime*. That's what each ED should be prepared for.

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Chapter 9

Summary of findings - English

PART 1 | EXPLORATION OF EMERGENCY DEPARTMENT CHARACTERISTICS

Emergency Care is being concentrated by reducing the number of Emergency Departments (ED's). Policymakers base their actions the assumption that this would reduce costs and enhance quality. However insight was lacking in the functionality of the ED's, i.e. the extent to which facilities, diagnostics and healthcare providers are available. As such resources determine the abilities of any ED, there seems to be an obvious need to establish (minimum) operational standard. In order to be able to decide on fitting strategies to optimize the ED landscape, more clarity was needed. **Part 1** focuses on filling the gaps of knowledge on number of ED visits, self-referrals, GPC collaboration and correlation between patient volume and available recourses per hospital type.

Chapter 2: In this nation wide survey we obtained data of 96% of all Dutch ED's. We calculated the total number of ED visits in NL in 2012 at 2,079,172, which corresponds to 124 ED visits per 1,000 inhabitants. We showed that total numbers of ED patients varied between 6,000–50,000 with an average of 22,357 patients per ED per year. The upper ranges were covered by teaching hospital ED's and the lower ranges were covered by the general hospitals. These ED volumes are low compared to most other countries. The admission rate was on average 32% for all hospital types, with percentages up to 52% for general hospitals. The self-referral rates showed major differences per hospital. The average number of self-referrals was 30%, ranging from 3% to 76%. On average, the academic hospitals had most self-referrals (40%), then teaching hospitals (35%) and general hospitals 25%. But the highest percentage was also a general hospital. This showed that the self-referral rate was lower than previously assumed.

Chapter 3: In this chapter we show trends in ED data from 2012 up to 2015. The number of ED's in the Netherlands was reduced from 93 to 87. A 6% decrease in patient visits was seen resulting in 1,951,000 ED visits in the Netherlands in 2015, which corresponds to 115 ED visits per 1,000 inhabitants. The percentage of self-referrals lowered from 32% to 17.4% on average. More patients arrived by ambulance and the emergency number (2,6% in 2012 to 16% in 2015) and via the GP or GPC (7,8% in 2012 to 50,3% in 2015). More ED's had a collaboration with a hospital based GPC, (49% in 2012 versus 79% in 2015) accounting for some of the change in numbers. Hospital admission rate increased to 37,2% on average.

Chapter 4: This national study, that included all Dutch ED's, we show the 2016 data and study associations between characteristics of ED volume and available resources. Compared to 2015 there was no further reduction in ED's. The number of patient visits did not decrease further but showed a slight increase to 1,979,726, corresponding to 116 ED visits per 1,000 inhabitants in 2016. Self-referral decreased to 15% on average (1%–56%) and 38% of patients was hospitalized similarly to 2015. The Netherlands had 1,401 ED treatment areas (16 per ED on average, ranging 4 to 36), with 36,630 hospital beds behind the ED's in total. The ED-nurse workforce was 2,348 fte nationally.

We studied the correlation between patient volume and available recourses. The two measures of patient volume were "number patients seen in the ED" and "number of patients hospitalized through the ED". The three measures of available resources were "the number of ED-nurses", "the number of ED treatment bays" and "number of hospital beds". We demonstrated a strong correlation between the number of patients seen in the ED and the number of ED-nurses (Adj R^2: 0.736), and the number of ED treatment bays (Adj R^2: 0.556). The other correlations were less strong but all were statistically significant ($p < 0.000$).

The scatterplots demonstrate a wide variation between the ED's. A distinct difference is seen between the different types of hospitals: the academic EDs have the highest resources available per ED patient volume, and the general hospitals the least. The teaching hospitals vary gravely and are positioned in the middle. A partial explanation could be in the care-load per patient in academic ED's is higher, but a complete explanation for the differences in resource distribution is lacking.

PART 2 | OPERATIONAL STANDARDS FOR EMERGENCY DEPARTMENTS

In **Part 2** we take an opening step towards minimum operational standards for 24/7 available EDs in the Netherlands with regard to availability of facilities, diagnostics and medical specialists. It provides a first overview of the emergency department landscape in the Netherlands.

Chapter 5: A consensus standard is presented for minimum operational standards with regard to the availability of facilities, diagnostics and medical specialties for the ED. This was achieved within a panel of Emergency Physicians. Delphi technique was used to gain a most reliable result. The anonymity of panel members within this method avoids the dominance of individual opinions and panelists can freely change their opinion based on the anonymous arguments of other panelists.

We gained a 100% response rate throughout. The panelist were asked if certain elements were necessary for every 24/7 ED regardless of hospital type or differential focus. In total 63 possible ED elements and 29 medical specialties were brought up, defined and discussed in a series of consecutive rounds. The panel reached a positive consensus on the need for 41 items for all ED's. Negative consensus (not necessary for every ED) was reached on 10 items. For 11 facilities the panel concluded that they were not needed, but only under specified conditions, such as availability of a similar functionality without a designated physical space or requiring regional availability in a nearby hospital. The panel was unable to reach a consensus on 1 element and 2 medical specialties. This is a first step towards a broader supported standard for 24/7 available EDs in the Netherlands.

Chapter 6: This chapter focuses on the methodological aspects of the used Delphi technique. Application of this technique requires many design choices and proper application is a requisite for achieving valid research results. We use our study to provide a detailed example of the application of a two-part design, explicit decision rules and to provide insight into reminders and response times. We advise to follow the CREDES guidelines. We recommend considering a 2-part design to set a common language and familiarize the panel and research-team with the used method. We also advise to invest in personal commitment of the panelists early, to set clear decision rules, and

to use a consistent and clear screen-lay-out. The results suggest that reminders should be sent out early because delay in response is most likely due to delay in starting then the time needed to fill in the questionnaires.

Chapter 7 This chapter provides an overview of the emergency department landscape in the Netherlands. This establishes a national benchmark of the availability of facilities, diagnostics and medical specialist expertise. An on-online questionnaire based on our recent consensus standard, was sent to all ED's, and 95% responded. There was a high availability of recourses in general. The consensus standard on minimal operational standards for every 24/7 ED that was set in chapter 5, was met to a large extent, on average 88%. EDs in university and teaching hospitals complied with the consensus standard to a higher degree than in general hospitals. The variability amongst general hospital EDs was high. We conclude there is still considerable variation in available facility and medical (diagnostic & treatment) resources. This shows the need for a national guideline to further clarify and standardize ED functionality in the Netherlands.

Chapter 8 reflects on the above set against the national and international available data. It presents a route toward future optimization and an ED directive.

Chapter 10

Samenvatting – Nederlands

DEEL 1 | EXPLORATIE VAN KARAKTERISTIEKEN VAN AFDELINGEN SPOEDEISENDE HULP

Spoedeisende zorg wordt geconcentreerd door het aantal SEH's te verminderen. Beleidsmakers baseren hun acties hierbij op de aanname dat dit kosten verlaagt en kwaliteit verbetert. Er miste echter inzicht in de bestaande SEH functionaliteit, d.w.z. de mate waarin faciliteiten, diagnostiek en zorgprofessionals beschikbaar zijn op de SEH's. Aangezien dit de mogelijkheden van elke SEH bepaalt, is er een duidelijke noodzaak om een (minimum) operationele standaard vast te stellen. Om passende beleidskeuzes te kunnen maken om SEH-landschap te optimaliseren, is meer inzicht nodig. **Deel 1** richt zich op het vullen van kennishiaten in het aantal ED-bezoeken, zelfverwijzers, HAP-SEH-samenwerkingsverbanden en de correlatie tussen patiëntvolume en beschikbare middelen per ziekenhuistype.

Hoofdstuk 2: In deze landelijke enquête verkregen we gegevens van 96% van alle Nederlandse SEH's. We berekende het totale aantal SEH-bezoeken in NL in 2012 op 2.079.172, wat overeenkomt met 124 SEH-bezoeken per 1000 inwoners. We toonden aan dat het totale aantal SEH-patiënten varieerde tussen 6.000–50.000 met een gemiddelde van 22.357 patiënten per SEH per jaar. De STZ-ziekenhuizen zitten aan de bovengrens en de algemene ziekenhuizen aan de ondergrens. De meeste SEH's van alle types zaten rond het gemiddelde aantal SEH bezoeken. Het gemiddelde opnamepercentage was 32% voor alle ziekenhuistypes, met percentages tot 52% voor algemene ziekenhuizen. Het zelf-verwijzingspercentage toonden grote verschillen per ziekenhuis. Het gemiddeld aantal zelfverwijzers was 30%, variërend van 3% tot 76%. Gemiddeld hadden de academische ziekenhuizen de meeste zelfverwijzers (40%), dan de STZ (35%) en algemene ziekenhuizen 25%. Maar het hoogste percentage was ook een algemeen ziekenhuis. Dit toonde aan dat de zelf-verwijzers percentage lager was dan tot op dat moment werd verondersteld.

Hoofdstuk 3: In dit hoofdstuk laten we trends zien in SEH-data van 2012 tot 2015. Het aantal SEH's in Nederland is teruggebracht van 93 naar 87. Er wordt een afname van 6% van het aantal patiëntbezoeken gezien, naar 1.951.000 in Nederland. Dat komt overeen met 115 SEH-bezoeken per 1000 inwoners in 2015. Het gemiddelde percentage zelfverwijzers daalde van 32% naar 17,4%. Er arriveerden wel meer patiënten per ambulance / het noodnummer (2,6% in 2012 tot 16% in 2015) en ook het aantal patiënten via de huisarts / HAP nam toe (7,8% in 2012 naar 50,3% in 2015). Een deel van deze wijziging wordt verklaart door de stijging is van het aantal samenwerkingsverbanden met ziekenhuis-gebaseerde-HAPs (49% in 2012 versus 79% in 2015). Het percentage ziekenhuisopnames is gemiddeld gestegen naar 37,2%.

Hoofdstuk 4: In dit onderzoek laten we de gegevens zien uit 2016 van alle Nederlandse SEH's en bestuderen we de correlatie tussen SEH-patientvolume en beschikbare middelen. Ten opzichte van 2015 was er geen verdere reductie van het aantal SEH's. Het aantal patiëntenbezoeken daalde niet verder, maar vertoonde een lichte stijging tot 1.979.726 in 2016, wat overeenkomt met 116 SEH-bezoeken per 1000 inwoners. Het gemiddeld percentage zelfverwijzers daalde naar 15% (1%–56%) en van de patiënten werd gemiddeld 38% opgenomen in het ziekenhuis vergelijkbaar met 2015. Nederland had 1.401 SEH-behandelplekken (gemiddeld 16 per SEH, variërend van 4 tot 36), met

achter de SEH's in totaal 36.630 ziekenhuisbedden. In totaal werkten er in Nederland 2.348 fte SEH-verpleegkundigen.
We bekeken de correlatie tussen patiëntvolume en beschikbare bronnen. De twee maten van patiëntvolume waren "aantal patiënten gezien in de SEH" en "aantal patiënten opgenomen in het ziekenhuis". De drie maten van beschikbare middelen waren "het aantal SEH-verpleegkundigen", "het aantal SEH-behandelplekken" en "het aantal ziekenhuisbedden". We toonden een sterke correlatie aan tussen het aantal patiënten gezien op de SEH en het aantal SEH-verpleegkundigen (Adj R2: 0,736) en het aantal SEH-behandelplekken (Adj R^2: 0,556). De andere correlaties waren minder sterk, maar ze waren allemaal statistisch significant ($p < 0{,}000$).
De scatterplots tonen de grote variatie tussen de SEH's. Er is een duidelijk verschil tussen de verschillende soorten ziekenhuizen: de academische SEH's bevinden hebben de meeste beschikbare middelen per SEH-patiëntvolume en de algemene ziekenhuizen het minste. De STZ zitten in het midden maar hun onderlinge variatie is groot. Een gedeeltelijke verklaring kan zijn dat de gemiddelde zorgzwaarte per patiënt op academische SEH's hoger is, maar een volledige verklaring voor de verschillen in verdeling van de middelen ontbreekt.

DEEL 2 | OPERATIONELE STANDAARDEN VOOR SPOED-EISENDE HULPEN

In **deel 2** zetten we een eerste stap naar minimale operationele normen voor 24/7 beschikbare SEH's in Nederland met betrekking tot de beschikbaarheid van faciliteiten, diagnostiek en medisch specialisten. Het biedt een eerste overzicht van het SEH landschap in Nederland.
Hoofdstuk 5: Een consensus standaard wordt gepresenteerd voor minimale operationele normen met betrekking tot de beschikbaarheid van faciliteiten, diagnostiek en medische specialiteiten voor SEH's. Deze werd bereikt binnen een panel van SEH-artsen^{knmg}. Voor een optimale betrouwbaarheid werd gebruik gemaakt van de Delphi-techniek. De anonimiteit van panelleden binnen deze methode voorkomt dat dominantie van individuele meningen en biedt de ruimte om zonder gezichtsverlies van mening te kunnen veranderen op basis van geanonimiseerde argumenten van anderen. We hebben overal een 100% respons gekregen. De panellid werd gevraagd of bepaalde elementen nodig waren voor èvery 24/7 ED ongeacht ziekenhuistype of differentiële focus. In totaal werden 63 mogelijke ED-elementen en 29 medische specialismen aan de orde gesteld, gedefinieerd en besproken in een reeks opeenvolgende ronden. Het panel bereikte een positieve consensus over de noodzaak van 41 items (..faciliteit & .. diagnostische functionaliteiten) voor alle ED's. Negatieve consensus (niet noodzakelijk voor elke ED) werd bereikt op 10 items (..faciliteit & .. diagnostische functionaliteiten). Voor 11 faciliteiten concludeerde het panel dat ze niet nodig waren, maar alleen onder gespecificeerde voorwaarden, zoals de beschikbaarheid van een vergelijkbare functionaliteit zonder een aangewezen fysieke ruimte of regionale beschikbaarheid in een nabijgelegen zieken-

huis. Op 1 element en 2 medische specialismen kon het panel geen consensus bereiken. Dit is een eerste stap naar een bredere ondersteunde standaard voor 24/7 beschikbare ED's in Nederland.

Hoofdstuk 6: Dit hoofdstuk richt zich op de methodologische aspecten van de gebruikte Delphi-techniek. Toepassing van deze techniek vereist veel design keuzes en een juiste toepassing is een vereiste voor het behalen van valide onderzoeksresultaten. We gebruiken onze studie om een gedetailleerd voorbeeld te geven over de toepassing van een tweedelig design, expliciete beslisregels en om inzicht te geven in reminders en reactietijden. We adviseren om de CREDES-richtlijn te volgen. We adviseren een tweedelig design te overwegen om zeker te stellen dat begrippen op eenzelfde manier geïnterpreteerd worden en om zowel het panel als het onderzoeksteam vertrouwd te laten raken met de gebruikte methode. Ook adviseren we vroeg in persoonlijke betrokkenheid van de panelleden te investeren, duidelijke beslissingsregels vast te stellen en gebruik te maken van een consistente en duidelijke schermlay-out. De resultaten suggereren dat herinneringen vroegtijdig moeten worden verzonden omdat vertraging in de reactie hoogstwaarschijnlijk te wijten is aan vertraging bij het starten en de tijd die nodig is om de vragenlijsten in te vullen.

Hoofdstuk 7: Dit hoofdstuk biedt een overzicht van het landschap van de afdeling spoedeisende hulp in Nederland. Hiermee wordt een nationale benchmark vastgesteld voor de beschikbaarheid van faciliteiten en de diagnostische en medisch specialistische beschikbaarheid. Op online vragenlijst op basis van onze recente consensus standaard werd verzonden naar alle SEH's, met een 95% response rate. Er was een hoge beschikbaarheid van middelen in het algemeen. De consensusnorm inzake minimale operationele normen voor elke 24/7 ED die in hoofdstuk 5 werd vastgelegd, werd gemiddeld met 88% gehaald. SEH's van universitaire en STZ ziekenhuizen voldeden in hogere mate aan de consensusnorm dan die van algemene ziekenhuizen. De variabiliteit tussen de SEH's van algemene ziekenhuizen was groot. We concluderen dat er aanzienlijke variatie is in faciliteiten en diagnostische en medisch specialistische beschikbaarheid. Hieruit blijkt de noodzaak van een nationale richtlijn om SEH-functionaliteit in Nederland verder te verduidelijken en standaardiseren.

Hoofdstuk 8 reflecteert op het bovenstaande binnen de nationale en internationale beschikbare gegevens. Het presenteert een route naar toekomstige optimalisatie en een SEH-standaard.

APPENDICES

LIST OF PUBLICATIONS

Journal papers

Update of the CHIP (CT in head Injury Patients) decision rule for patients with minor head injury

Crispijn L van den Brand* (MD), Kelly A Foks* (MD), Hester F Lingsma (PhD), Joukje van der Naalt (MD, PhD), Bram Jacobs (MD, PhD), Eline de Jong (MD), Hugo den Boogert (MD)[6], Özcan Sir (MD), Peter Patka (MD, PhD)[2], Suzanne Polinder (PhD), ***Menno I Gaakeer (MD)***, Charlotte E Schutte (MD), Kim E Jie (MD, PhD), Huib F Visee (MD), Myriam GM Hunink (MD, PhD), Eef Reijners (MD), Meriam Braaksma (MD), Guus G Schoonman (MD, PhD), Ewout W Steyerberg (PhD), Diederik WJ Dippel (MD, PhD)[4], Korné Jellema (MD, PhD) * both authors contributed equally

JAMA, submitted

Emergency departments in the Netherlands: a national benchmark of resources availability

Gaakeer MI, Veugelers R, Patka P, Huijsman R.

PLOS | ONE, submitted

Improving design choices in Delphi studies in medicine: the case of an exemplary physician multi-round panel study with 100% response

Veugelers R, ***Gaakeer MI***, Patka P, Huijsman R.

BMC Methodology, resubmitted

Risk of Intracranial Complications in Minor Head Injury: The Role of Loss of Consciousness and Post-Traumatic Amnesia in a Multi-Center Observational Study

Foks KA, Dijkland SA, Lingsma HF, et al. Collaborator ***Gaakeer MI***.

J of Neurotrauma. published online 10 April 2019|http://doi.org/10.1089/neu.2018.6354

Minimum operational standards for 24/7 available emergency departments in the Netherlands: a first step taken by emergency physicians using an e-Delphi approach

Gaakeer MI, Veugelers R, Patka P, Huijsman R; on behalf of the Dutch ED Study Group.

Eur J Emerg Med. 2019 Apr;26(2):86-93. doi: 10.1097/MEJ.0000000000000494.

A different crowd, a different crowding level? The predefined thresholds of crowding scales may not be optimal for all emergency departments

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Gaakeer MI, Veugelers R, Lieshout JM, Patka P, Huijsman R
Int J Emerg Med 2018 September 11:35. doi.org/10.1186/s12245-018-0196-5.

External validation of computed tomography decision rules in minor head injury: prospective cohort study
Foks KA, van den Brand CL, Lingsma HF, van der Naalt J, Jacobs B, de Jong E, den Boogert H, Sit Ö, Patka P, Polinder S, ***Gaakeer MI***, Schutte CE, Jie KE, Visee HF, Hunink MGM, Reijners E, Braaksma M, Schoonman GG, Steyerberg EW, Jellema K, Dippel DWJ.
BMJ. 2018 Aug 24;362:k3527. doi: 10.1136/bmj.k3527.

Diving accident-induced arterial gas embolism
Nijk PD, van Rees Vellinga TP, van Lieshout JM, ***Gaakeer MI***
Ned Tijdschr Geneeskd. 2017;161:D1459. Dutch.

Are Dutch Hospitals Prepared for Chemical, Biological or Radionuclear Incidents? A Survey Study
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Smithuis JW, Gips E, van Rees Vellinga TP, ***Gaakeer MI***.
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A nurse-initiated pain protocol in the ED improves pain treatment in patients with acute musculoskeletal pain
Pierik JG, Berben SA, IJzerman MJ, ***Gaakeer MI***, van Eenennaam FL, van Vugt AB, Doggen CJ.
Int Emerg Nurs. 2016 Mar 8. pii: S1755-599X(16)30003-9. doi: 10.1016/j.ienj.2016.02.001.

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Pierik JG, IJzerman MJ, ***Gaakeer MI***, Vollenbroek-Hutten MM, van Vugt AB, Doggen CJ.
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Pierik JG, IJzerman MJ, ***Gaakeer MI***, Berben SA, van Eenennaam FL, van Vugt AB, Doggen CJ.
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Koning SW, ***Gaakeer MI***, Veugelers R.
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Int J Emerg Med. 2013 Jun 20;6(1):19. doi: 10.1186/1865-1380-6-19.

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van Gemert JP, de Vree LM, Hessels RA, ***Gaakeer MI***.
Int J Emerg Med. 2012 Dec 31;5(1):45. doi: 10.1186/1865-1380-5-45.

Emergency medicine in the Netherlands: a short history provides a solid basis for future challenges
Gaakeer MI, van den Brand CL, Patka P.
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van der Vlies CH, Olthof DC, ***Gaakeer MI***, Ponsen KJ, van Delden OM, Goslings JC.
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Ned Tijdschr Geneeskd. 2011;155:A2241. Review. Dutch.

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Gaakeer MI, van Lieshout JM, Bierens JJ.
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Pediatr Infect Dis J. 2003 Jan;22(1):70-6

Opinion papers

Drukte op de SEH vergt integrale aanpak
Gaakeer MI, van der Erf S, van der Linden MC, Baden D.
Medisch Contact 8 February 2018. https://www.medischcontact.nl/nieuws/laatste-nieuws/artikel/drukte-op-de-seh-vergt-integrale-aanpak.htm

Opleiding SEH-arts toe aan vakverdieping
Gaakeer MI, van den Brand CL, Lieshout JM, Patka P.
Medisch Contact 7 February 2013. https://www.medischcontact.nl/nieuws/laatste-nieuws/artikel/opleiding-seh-arts-toe-aan-vakverdieping-2.htm

Textbook

Leerboek acute geneeskunde, probleemgerichte aanpak
Redactie: A.B. van Vugt, ***M.I. Gaakeer***, W. Henny, C. Motz, S.E. Schutte, E.C.T.H. Tan
Reeds Business 2014

Leerboek acute geneeskunde, probleemgerichte aanpak. Vierde herzieke druk
Redactie: A.B. van Vugt, ***M.I. Gaakeer***, W. Henny, H.A.H. Kaasjager, C. Motz, E.c.T.H. Tan, Th.W. Wulterkens
Bohn Stafleu van Loghum, Houten 2018

PhD Portfolio

	Institute	Year	Workload (ECTS)
Courses/ Workshops			
Leadership Essentials Course by the Institutional Emergency Department Leadership Institute	IEDLI	2015	2,5
Scientific integrity	EU	2016	0,3
IEDLI Certified Emergency Department Executive (CEDE) Certification Course	IEDLI	2016	2
Emergency ultrasound	DEUS	2017	2
Shut up and write	IEDLI	2017	1
Masterclass medische informatie de baas	NTvG	2017	1
Acute airway management course	NVIC	2017	2
Self-presentation: presenting yourself and your research	EU	2018	2,5
IEDLI Emergency Department Design Course	IEDLI	2018	1
Oral presentations			
Optimal care for self-referred patients, myths and facts about ED visits in the Netherlands *8th European Congress on Emergency Medicine (September 29, Amsterdam)*	EuSEM	2014	1
Changes in acute health care organization in the Netherlands, less is more! *8th European Congress on Emergency Medicine (September 30, Amsterdam)*	EuSEM	2014	1
Changing the ED landscape in the Netherlands: less is more? *International Conference on Emergency Medicine (June 14th, Hong Kong)*	IFEM	2014	1
Optimal care for self-referred patients *National Triage Congress (Zeist)*	NTS	2015	1
The added value of Emergency Medicine *Zeeuws symposium (April 14th, Zierikzee)*	IFEM/ NVSHA	2016	1

	Institute	Year	Workload (ECTS)
Crowding in the ED *NVSHA symposium (December 14th, Amersfoort)*	NVSHA	2016	0,5
Emergency department numbers and crowding in the Netherlands, *IFEM/NVSHA Symposium Crowding in the ED: who cares?* *(June 9th, Egmond aan Zee)*	IFEM/ NVSHA	2017	1
The Emergency Department of the future *ADRZ Emergency Medicine Symposium Stormvloed (June 19th, Goes)*	ADRZ	2018	1

(Inter)national scientific meetings

7th Dutch North Sea Emergency Medicine Conference *(June, Egmond aan Zee)*	NVSHA	2014	0,4
International Conference on Emergency Medicine *(June, Hong Kong)*	IFEM	2014	0,6
8th European Congress on Emergency Medicine *(September, Amsterdam)*	EuSEM	2014	0,6
8th Dutch North Sea Emergency Medicine Conference *(June, Egmond aan Zee)*	NVSHA	2015	0,4
9th Dutch North Sea Emergency Medicine Conference *(June, Egmond aan Zee)*	NVSHA	2016	0,4
SMACC DUB *(June, Dublin)*	SMACC	2016	0,6
10th Dutch North Sea Emergency Medicine Conference *(June, Egmond aan Zee)*	NVSHA	2017	0,2
IFEM/NVSHA Symposium Crowding in the ED: who cares? *(June, Egmond aan Zee)*	IFEM/ NVSHA	2017	0,2
DAS SMACC *(June, Berlin)*	SMACC	2017	0,6
ADRZ Emergency Medicine Symposium Stormvloed *(June 19th, Goes)*	ADRZ	2018	0,2

Member of the editorial board textbook 'Leerboek acute geneeskunde'	BSL	2014 2019	5

	Institute	Year	Workload (ECTS)
(Inter)national journal peer review activity			
The Dutch Journal of Medicine: 9x		2014 2019	0,9
Emergency Medicine Journal: 5x		2014 2018	0,5
European Journal of Emergency Medicine:		2014 2019	
International Journal of Emergency Medicine: 5x		2014 2018	0,5
European Journal of General Practice: 1x		2017	0,1
Health Policy: 1x		2016	0,1
Journal of Internal Medicine: 1x		2015	0,1
The Netherlands Journal of Medicine: 1x		2017	0,1
Resident teaching and supervision			
Supervision residents in the Emergency Department	ADRZ	2014 2019	5
Internship trainer (RGS recognized) for general practitioner residents in the ED	ADRZ	2016 2019	5
Teacher STARtclass SBOH (2013; 2014; 2015)	SBOH	2013 2015	5
Supervising emergency medicine residents with collecting and analyzing data, writing, revising and submitting several manuscrips (peer reviewed publications included).	ADRZ	2013 2019	5
Total ECTS PhD period			**51,3**

CURRICULUM VITAE

Menno Iskander Gaakeer, born on the 28th of March 1974 in Maastricht, is above all daddy of his wonderful daughter, Joske. In 1992 Menno graduated from the atheneum at the Willem de Zwijger College in Papendrecht and started studying economics at the Erasmus University in Rotterdam. However, he was grabbed by medicine and changed his field of study. In 1994 Menno started studying medicine at the Erasmus University in Rotterdam and finished his internships cum laude in November 2001. Hereafter Menno worked at the departments of surgery and emergency medicine of the Albert Schweitzer hospital in Dordrecht, Amphia hospital in Breda and the Oosterschelde hospital in Goes. In 2007, after one more year working at the Intensive Care Unit of the Amphia Hospital in Breda he participated in a group of pioneering trainees that builded a new training program in emergency medicine at the Albert Schweitzer hospital in Dordrecht, under supervision of dr. Paul Vegt and David Hugelmeyer. During his residency, Menno started doing research in the field of emergency medicine together with, among others, dr. Rebekka Veugelers. In 2010 he was registered as emergency physician and started working at the emergency medicine department of Medisch Spectrum Twente in Enschede and thereafter of the University Medical Center Utrecht. In addition, he chaired the board of the Dutch Society of Emergency Physicians (NVSHA) from 2010 till 2014, participates in the editorial board of the textbook 'Leerboek acute geneeskunde' since 2010, founded the Netherlands Emergency Medicine Research fund (SGOfonds) in 2013 and cofounded the Netherlands Emergency department Evaluation Database (NEED) foundation in 2016. Since 2014, Menno has been working at the emergency medicine department of the Adrz Hospital in Goes. His research concerns different topics in emergency medicine and in particular the organization of emergency department care in the Netherlands. Menno started his PhD-research on this subject in 2014.

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DANKWOORD

Wil je snel gaan ga dan alleen, wil je ver komen ga dan samen.

Promoveren lag na het behalen van mijn artsexamen niet direct in de lijn van mijn bedoelingen. Ik wilde vooral dokter zijn en ik geloof ook nu nog steeds niet dat een promotie van een arts een betere dokter maakt. Tegelijkertijd speelt nieuwsgierigheid voortdurend in mijn hoofd en ben ik gefascineerd geraakt door de (her)inrichting en (her)organisatie van spoedzorg in het algemeen en intramurale spoedzorg in het bijzonder. Mijn promotietraject komt hier uit voort en heeft mij geholpen om me in dit onderwerp verder te verdiepen. Het promoveren heeft mij als SEH-artsKNMG en als persoon daarmee veel gegeven.

Dit proefschrift is tot stand gekomen dankzij velen, binnen en buiten de Spoedeisende Geneeskunde, professioneel en privé. Ik wil iedereen daarvoor bedanken. Een aantal mensen ben ik bijzonder schatplichtig en noem ik met name(n).

Tegen alle tradities in dank ik allereerst mijn directe collegae uit de vakgroep Spoedeisende Geneeskunde van het Adrz in Goes. Lieve Lot Schutte, Saskia van der Heijden, Judith Bek, Rebekka Veugelers, Tim van der Sterren, Robert Jan Berman, Iwan Dierckx, Sjors van Lieshout en Michiel Heufke. Bedankt voor altijd jullie geduld, begrip, ondersteuning, vertrouwen en soms jullie scepsis met een glimlach bij alles wat ik bedenk of doe uit enthousiasme voor ons vak en in het bijzonder mijn promotie-traject. Bijzondere dank voor de ruimte welke jullie me gaven toen ik struikelde, om te blijven liggen, weer op te staan en om terug te komen in mijn balans. In alle ontregeling en weerstand welke ik persoonlijk ontmoette, zijn jullie mij onvoorwaardelijk en met heel veel flexibiliteit blijven steunen, zodat ik werk met zorg voor Joske kan combineren en mijn onderzoek heb kunnen voortzetten. Zonder deze uitzonderlijke collegialiteit had ik mijn proefschrift zeker niet voltooid en was dat wat me het meest dierbaar is op grotere afstand gekomen. Jullie zijn voor mij stuk voor stuk heel bijzondere mensen en vormen met elkaar een fantastische vakgroep waar ik met veel plezier en trots deel van uitmaak. Ik wens nog heel veel jaren met elk van jullie in Zeeland te mogen samenwerken voor patiënten die zorg op onze afdeling SEH nodig hebben, om ons vak Spoedeisende Geneeskunde en onze afdeling SEH verder te emanciperen en persoonlijk te blijven groeien.

Prof. dr. P. Patka, hooggeleerde promotor, beste Peter. Wij hebben elkaar leren kennen ruim voor aanvang van mijn promotietraject. Met plezier denk ik terug aan ons contact binnen het Concilium Spoedeisende Geneeskunde, onze eerste publicaties samen in de European Journal of Emergency Medicine en het Medisch Contact en de verschillende symposia welke we georganiseerd hebben. Ik ben je diep dankbaar voor hoe je na de geboorte van Joske mij met raad en daad hebt bijgestaan in mijn zoektocht naar de beste plek voor de operatieve behandeling van haar doofheid. Ondanks je emeritaat, waarvan je met je vrouw, jullie kinderen en kleinkinderen bent gaan genieten, wilde je

graag mijn promotor zijn. Ik wil je danken voor de kans die je mij geboden hebt door dit traject met mij aan te gaan, alle tijd welke je voor mij hebt vrijgemaakt en je gastvrijheid thuis. Gedurende de afgelopen jaren heb ik veel mogen leren van jouw kennis en ervaring als onderzoeker. Daarbij heb je met geduld mij telkens ruimte en vertrouwen gegeven eigen keuzes te maken. Naast alle overleg over de inhoud van ons onderzoek en manuscripten ben je altijd persoonlijke belangstelling blijven tonen. Beste Peter, dankjewel voor deze mooie samenwerking en alles wat je voor mij hebt betekend.

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Dr. R. Veugelers, hooggeachte copromotor, beste Rebekka. We hebben het gerealiseerd, mijn promotie binnen het domein van de Spoedeisende Geneeskunde, zoals we het zes jaar geleden bedacht hebben. De emancipatie van ons vakgebied stond zeker toen wat betreft wetenschap nog aan het begin en dat vonden wij een extra mooie uitdaging. Geen lopende onderzoekslijnen, geen georganiseerde onderzoeksgroepen, geen structurele onderzoeksgelden. Zelf pionieren en bouwen, net zoals we met de opleiding Spoedeisende Geneeskunde in het Albert Schweitzer ziekenhuis hadden gedaan. Vanuit het onderzoek waar ik mee bezig was zijn we begonnen mensen te betrekken en een promotieplan vorm te geven. De combinatie van onderzoek doen met werken in de continuïteit, samen met ingrijpende mooie, waarvan de geboortes van Thomas en Benthe niet onvermeld mogen blijven, maar ook verdrietige gebeurtenissen in onze levens maakten het geen gemakkelijke weg. Ik overdrijf niet als ik zeg dat zonder jou dit proefschrift er niet was geweest. Dankjewel voor je vertrouwen en geduld, onze bespiegelingen en vergezichten tijdens vele koffiemomenten, onze wandelingen of op onze afdeling voor-tijdens-na het werk. Dit allemaal natuurlijk naast je kritische inhoudelijke blik op mijn onderzoeksprotocollen en manuscripten, voor het zijn van mijn SPSS of überhaupt ICT achtervang, voor het mede dragen van mijn promotietraject en alles-alles wat je daar voor hebt gedaan. We zijn al weer vervolgonderzoek aan het bedenken voor na het klinken van 'mijn' Hora est. Wellicht een promotietraject voor een nieuwe collega in Goes? Vooruit! Dankjewel voor de gezelligheid welke ik buiten het werk om met Joske mag vinden

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