Organisation of emergency departments: An evaluation of the policy design

PhD dissertation

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English summary

In Denmark, acutely ill patients account for about 8% of ambulant contacts and 71% of admissions to the hospitals, and the Danish emergency departments (EDs) are facing problems with crowding and limited resources. In 2007, a national policy of emergency care organisation was announced, and policy goals included consistent quality, continuity of care and efficient resource use no matter the time and place. Senior physicians serving as frontline staff at the ED was a ground-breaking feature of the policy. Senior physician competencies were meant to improve patient flow and diagnostic quality.

In Denmark, the regions have the responsibility to ensure policy implementation. However, implementation incentives were weak: The national policy was framed as recommendations primarily grounded in clinical experience and not evidence, and few implementation guidelines were provided. Furthermore, being a physician at the ED was not a prestigious career choice because, emergency medicine was not approved as a medical specialty in Denmark before 2017. Thus, this PhD project has investigated the national policy recommendations in terms of: implementation status and the effects on health, quality and costs. Furthermore, organisational determinants and effects of diagnostic quality were assessed. Hip fracture and erysipelas emergency episodes were chosen as study population. From organisational theory, we applied the multi-contingency model and information processing theory as an overall analytical framework.

From study I, which is a questionnaire-based survey of the policy implementation status, we found hesitant and heterogeneous translation from policy to practice, probably due to cooperation and recruitment challenges. According to the analytical framework, these issues might be caused by a lack of linkage between policy and theory. From study II, which is a register-based stepped-wedge study, we found increased ED autonomy, introduced by the policy, to increase 30-day readmission and episode costs only for hip fracture episodes. Night-time admissions were associated with increased 30-day readmission and mortality for hip fracture episodes and increased costs for both patient groups. From study III, which was a register-based observational study, we found senior physician employment at the EDs to be associated with diagnostic discrepancy. Furthermore, diagnostic discrepancy was associated with increased readmission for hip fracture episodes and increased episode costs for both groups.

Dansk resumé (Danish summary)

I Danmark er behandlingen af akutte patienter fordelt sådan, at 8 % behandles ambulant, og 71 % behandles under indlæggelse. De danske akutmodtagelser oplever problemer med overbelægning og begrænsede ressourcer. I 2007 udgav Sundhedsstyrelsen nationale anbefalinger om organisering af de danske akutmodtagelser med det formål at sikre ensartet behandling af høj kvalitet, sammenhængende patientforløb og optimal udnyttelse af ressourcerne - uanset tid og sted. En af de mest banebrydende anbefalinger var at speciallægen skulle være i front. Speciallægekompetencerne i akutmodtagelserne skulle bidrage til at sikre hurtig og korrekt visitation, diagnostik og behandling.

I Danmark har regionerne ansvaret for at sikre implementering af de politiske anbefalinger. Men incitamenterne for at få det ført ud i livet var svage: Den nationale politik var udformet som anbefalinger baseret på klinisk erfaring og ikke evidens, og der var givet få implementeringsanvisninger. Desuden var det for lægerne ikke et prestigefyldt karrierevalg, da akut medicin først blev godkendt som speciale i 2017. Dette ph.d.-projekt har derfor undersøgt de nationale anbefalinger i forhold til implementeringsstatus og effekten på helbred, kvalitet og omkostninger. Derudover er organisatoriske determinanter og effekter af diagnostisk kvalitet undersøgt. Studiepopulationen består af akutte forløb med hoftefraktur eller rosen. Der er fra organisationsteorien anvendt multikontingensmodellen og informationsbehandlingsteorien som projektets overordnede analytiske ramme.

Fra studie I, et spørgeskemabaseret studie, finder vi sløv og heterogen udmøntning af implementering fra politik til praksis, formentligt på grund af samarbejds- og rekrutteringsvanskeligheder. Ifølge den analytiske ramme skyldes disse problemer en manglende forbindelse imellem politik og teori. Fra stude II, et registerbaseret stepped-wedge-studie, finder vi, at forøget autoritet hos akutmodtagelserne resulterer i en stigning i genindlæggelser inden for 30 dage og i forløbsomkostninger for hoftefrakturer. Indlæggelse om natten er associeret med stigning i genindlæggelse og mortalitet for hoftefrakturer og forøgede omkostninger for begge grupper. Fra studie III, et observationelt registerbaseret studie, finder vi, at ansættelse af speciallæger i akutmodtagelsen er forbundet med diagnostisk diskrepans. Diagnostisk diskrepans er endvidere forbundet med forøget genindlæggelse inden for 30 dage for hoftefrakturer og forøgede forløbsomkostninger for begge grupper.

List of publications

The dissertation is based on the following papers:

I. Under review: Tipsmark LS, Sønderdahl A, Obel B, Søgaard R, Organisation of emergency departments: From policy to practice, International Journal of Health Planning and Management

II. Submitted: Tipsmark LS, Obel B, Andersson T, Søgaard R, Organisation introducing increased emergency department autonomy: a mixed effects approach to evaluate the effects of a national policy, PLOS ONE

III. Under review: Tipsmark LS, Obel B, Andersson T, Søgaard R, Organisational determinants and consequences of diagnostic discrepancy in emergency department patients: a national study of consecutive patients between 2008-2016, Scandinavian journal of trauma, resuscitation and emergency medicine

List of abbreviations

AIDS	Acquired immune deficiency syndrome
CI	Confidence interval
CPR	Personal identification number
CT	Computed tomography
DRG	Diagnosis-related group
ED	Emergency department
GP	General practitioner
ICD-10	International classification of diseases 10. edition
ICU	Intensive care unit
IP	Information processing
LUP	Danish national survey of patient experiences
MeSH	Medical subject heading
NA	Not available
OR	Odds ratio
PRISMA	Systematic reviews and meta-analysis
STEMI	ST-elevation myocardial infarction

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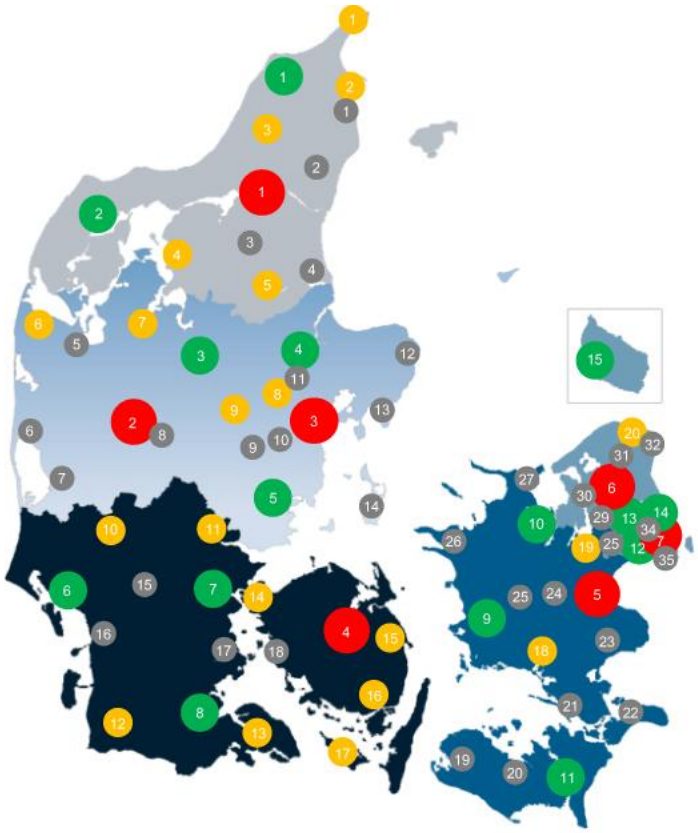
Introduction

In 2007, the Danish Health Authority announced a health policy concerning the organisation of the Danish emergency care sector (Sundhedsstyrelsen, 2007). The studies presented in this dissertation assess the implementation and the effects of policy as related to only the emergency department (ED) (hence the policy will be referred to as the ED policy). The introduction of the dissertation provides an overview of the organisation of the Danish healthcare system, in particular the development of ED organisation before and after the ED policy was announced. Furthermore, a systematic literature review was conducted to assess current evidence on selected ED policy recommendations. After the introduction, study methods will be presented and critically evaluated. Lastly, a reflective summary of the results will be presented and discussed in relation to related national and international research within the subject area. The dissertation will reflect on impacts related to the literature, ED policy and clinical practice, and discuss future aspects within the field. The three papers on which this PhD dissertation is based are found at the end of the dissertation.

The Danish healthcare sector

Denmark is a small and wealthy country with approximately 5.8 million inhabitants (Statistics Denmark, 2018). The health care system is primarily public and tax-financed (World Health Organization, 2018). The five regions of Denmark are responsible for the treatment in the public health care system and they manage the public hospitals (Danske Regioner, 2011). Around 40 public hospitals provide secondary healthcare for patients in Denmark. However, emergency services are only provided at 21 of the hospitals. Figure 1 presents a drawing illustrating that 21 ED are located at six newly built or largely extended hospitals (budgets of >3 billion DKK each) and 15 hospitals which have been modernised or extended (budgets of <3 billion DKK each) (Ministeriet for sundhed og Forebyggelse et al., 2014; Schmidt et al., 2019). Acutely ill patients account for about 8% of all outpatient and 71% of all inpatient admissions to Danish, publicly funded hospitals (Danske Regioner et al., 2016; Ministeriet for sundhed og Forebyggelse et al., 2014).



Cities listed according to region: North Denmark Region; Central Denmark Region; Region of Southern Denmark; Region Zealand; Capital Region of Denmark.

(1) Aalborg; (2) Gødstrup, (3) Aarhus; (4) Odense; (5) Køge; (6) Favrholm, (7) Copenhagen (Rigshospitalet).

(1) Hjørring, (2) Thisted; (3) Viborg, (4) Randers, (5) Horsens; (6) Esbjerg, (7) Kolding, (8) Aabenraa; (9) Slagelse, (10) Holbæk, (11) Nykøbing Falster; (12) Hvidovre, (13) Herlev-Gentofte, (14) Bisbebjerg, (15) Rønne.

(1) Skagen, (2) Frederikshavn, (3) Brønderslev, (4) Farsø, (5) Hobro; (6) Lemvig, (7) Skive, (8) Hammel, (9) Silkeborg; (10) Grindsted, (11) Vejle, (12) Tønder, (13) Sønderborg, (14) Middelfart, (15) Nyborg, (16) Svendborg, (17) Ærø; (18) Næstved, (19) Roskilde; (20) Hornbæk.

(1) Sæby, (2) Dronninglund, (3) Støvring, (4) Hadsund; (5) Struer, (6) Ringkøbing, (7) Tarm, (8) Ikast, (9) Brædstrup, (10) Skanderborg, (11) Hadsten, (12) Grenaa, (13) Ebeltoft, (14) Samsø; (15) Brørup, (16) Ribe, (17) Haderslev, (18) Assens; (19) Nakskov, (20) Maribo, (21) Vordingborg, (22) Stege, (23) Faxe, (24) Ringsted, (25) Sorø, (26) Kalundborg, (27) Odsherred; (28) Tåstrup, (29) Egedal (30), Frederikssund, (31) Fredensborg, (32) Helsingør, (34) Frederiksberg / Rødovre / Lyngby, (35) Tårnby / Amager.

Red: Newly build or largely extended hospitals with an emergency department (ED), Green: Extended or modernised hospitals with and ED, Yellow: Hospitals without an ED, grey: Health centres and acute clinics.

Figure 1 Hospitals in Denmark (Schmidt et al., 2019)

The organisation of Danish emergency departments prior to 2007

In Denmark, emergency care before 2007 was offered at several departments and at most hospitals in Denmark (Sundhedsstyrelsen, 2007). Emergency patients were received at a variety of departments according to the admission complaint. So, patients admitted to the EDs did not necessarily represent all emergency patients. The EDs were staffed by junior physicians, most of whom had no emergency medicine training and little supervision was provided by senior physicians (Folkestad et al., 2010). The limited clinical experience resulted in high admission rates and patient flow bottlenecks (Møllekær et al.,

2018; T. Ishøj, P. Qvist, 2005; Vork et al., 2011). Furthermore, the EDs were facing problems with crowding, e.g. due to increased life expectancy and limited resources (Danske Regioner et al., 2016; Ministeriet for sundhed og Forebyggelse et al., 2014). These issues increased the demands on the ED staff and posed a threat to patient safety (Department of Health, 2001; Drummond, 2002; McCaughey et al., 2012).

The Danish policy of emergency department organisation

In 2007, 24 recommendations regarding national emergency care organisation were announced in Denmark (Sundhedsstyrelsen, 2007). In the dissertation I focus on the policy-related ED changes, as it would not be possible to conduct a national evaluation of 24 recommendations covering different settings (prehospital, ED and ICU) and different data systems {Formatting Citation}.

This policy was based on an overall goal to establish high consistent quality, continuity of care and efficient use of resources in the Danish healthcare sector. The policy incentives, e.g., inclusion of more patients with several different diseases; increased specialisation among physicians and nurses, both between medical specialties and within each specialty; overcoming staffing shortages within all professions. Before the policy release, limited literature concerning the new policy recommendations was identified. Yet, it was based on the fundamental notion that there is a positive connection between volume, experience and quality. The policy contained 24 recommendations, of which 6 concerned the EDs. The ED recommendations covered:

- Centralisation of emergency patient admission
- One joint internal alarm call at the hospitals, e.g. applicable in connection with cardiac arrest
- Selected medical specialties and facilities should be present at the ED site, including availability of selected specialised equipment and senior physicians 24/7
- Catchment area of 200,000-400,000 citizens
- National guidelines concerning EDs and intensive care units (ICUs) and the cooperation between the two
- Skill set demands and relevant qualification upgrades accordingly

Centralisation of emergency medical services was advocated because it would improve access to specialised facilities, equipment, multidisciplinary teams and senior physicians, preferable 24/7.

Furthermore, centralisation was believed to improve interdisciplinary collaboration among medical specialties, enhance resource use and ensure fast-track diagnostics and treatment. To meet the recommendations of the process management focus, all ED-initiated coordination strategies, such as triage and flow coordinators, were designed to create consecutive and effective patient flows (Ministeriet for sundhed og Forebyggelse et al., 2014). Senior physicians serving as ED frontline staff was a central policy element, and senior physician competencies were among other factors meant to improve patient flow and diagnostic quality.

The remaining policy recommendations concerned (number of recommendations): Implementation and planning (4), Prehospital, including helicopter services, emergency dispatch centre and telemedicine (11), Local emergency services (1) and ICUs (2).

The full implementation was scheduled to take place over 5-10 years. The five regions were responsible for fulfilling these plans and national surveys would follow the ongoing implementation (Danske Regioner et al., 2016; Ministeriet for sundhed og Forebyggelse et al., 2014; Sundhedsstyrelsen, 2020).

Current evidence related to the policy recommendations

Given the potential impact on patient health and the functioning of healthcare systems, it is important to assess the current evidence related to the effect of the ED policy recommendations. To the best of my knowledge, there have been no published systematic literature reviews to evaluate the effect of organisational design strategies for emergency medical services. A previous review of the effectiveness and variation of acute medical units (Reid et al., 2016) analysed the acute medical unit as one strategy, whereas we try to divide these organisations into several organisational design strategies. Studies to provide evidence for planning and implementation of emergency medicine services could be undertaken by different investigators in the different disciplines involved, such as medicine, surgery, health management, health economics and quality control. This means that any published studies may not be easily identifiable or made readily available for organisational strategy planning and design. The following ED policy themes were chosen for further investigation: crowding, workload, patient flow, centralisation, multidisciplinary team, triage, education, clinical competences, senior physician. Evidence related to the themes was assessed in a systematic literature review. Review methods will be described the Methods section.

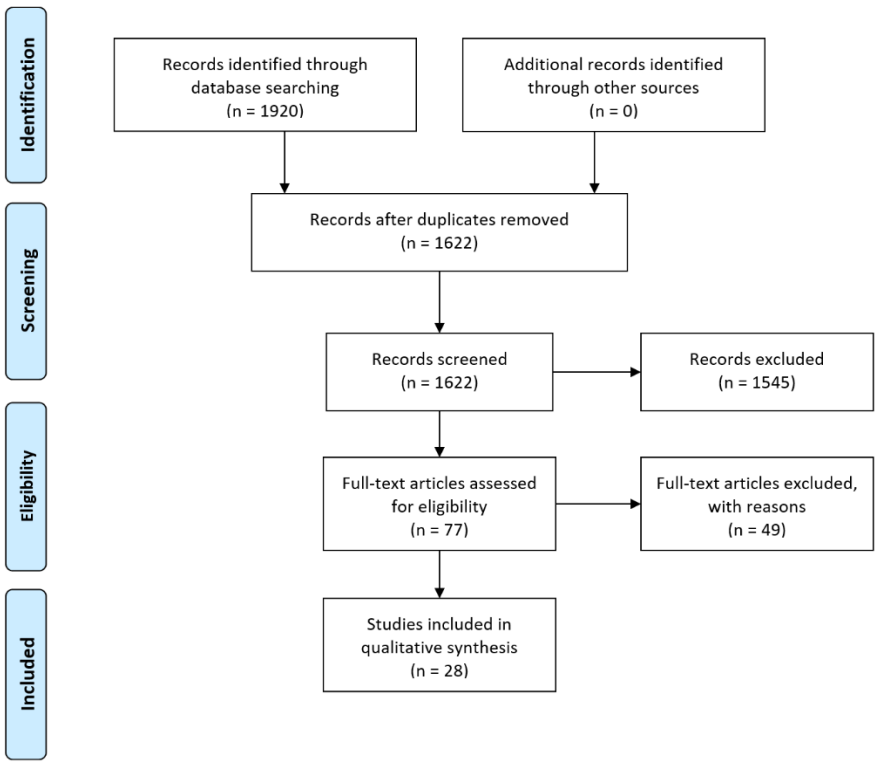


Figure 2 Literature flow diagram

Based on the literature search, 28 studies were included for the qualitative synthesis. The flow diagram is illustrated in Figure 2. Following review and discussion six organisational design strategies were identified as distinct organisational designs: 'physician in triage', 'senior physician', 'flow coordinator', 'multidisciplinary team', 'centralisation', and 'availability of specialised equipment', referred to as 'equipment'.

Table 1 summarises the desired effects (positive/in favour) and adverse effects (negative/against) of the different organisational designs according to the ED policy goals: health outcome, quality, and cost. Limited evidence was found to support the overall ED policy goal by the organisational design strategies. However, 'multidisciplinary team', physician in triage', 'senior physician' and 'flow coordinator', showed effective measures with positive findings on analysis, supporting the positive effect related primarily to the quality dimension. Effect measures were chosen homogenously in the studies, lacking the joint perspectives of all three dimensions. Overall, the studies focused on reporting quality measures, in this case indicators of process time, such as length of stay, left without being seen, and wait time. Health outcomes and cost were poorly represented with only 12 out of 98 analyses.

Table 1 Summary of evidence related to the emergency departments policy recommendation

Policy recommendations	Number of analyses	Number of significant analyses	Health		Quality		Cost	
			In favour	Against	In favour	Against	In favour	Against
Specialised equipment	3	3	-	-	1 (33.3)	2 (6-6.6)	-	-
Centralisation	17	15	4 (26.7)	1 (6.7)	5 (33.3)	4 (26.7)	1 (6.7)	-
Multidisciplinary team	30	19	1 (5.3)	-	17 (89.5)	-	1 (5.3)	-
Physician in triage	23	15	-	-	15 (100)	-	-	-
Flow coordinator	9	7	-	-	7 (100)	-	-	-
Senior Physician	16	15	2 (13.3)	-	11 (73.3)	-	2 (13.3)	-
Total (%)	98	74	7 (9.5)	1 (1.4)	56 (75.7)	6 (8.1)	4 (5.4)	-

Values are number of analyses (%). - = analyses not performed in literature or no significant results

Multidisciplinary team

Published studies represented different types of team structure, including adding a physician in triage to create a team consisting of a physician and a nurse (Imperato et al., 2012), to co-ordinated involvement of paramedics, nurses, anaesthetists, physicians, physiotherapists and surgeons in care pathways (Gholve et al., 2005). The 'team' was the most explored organisational design strategy included in 11 studies conducted mainly in western countries and based on study populations ranging from 294 patients to 33,367 patients or patient visits. The length of stay was the most frequently applied effect measure (in eight studies) (Imperato et al., 2012; Jarvis et al., 2014; Moloney et al., 2005; Muntlin Athlin et al., 2013; O'Brien et al., 2006; Sharma et al., 2013; Traub et al., 2016, 2015). Health outcomes in terms of mortality were applied in two studies and cost was applied in one study (Gholve et al., 2005; Moloney et al., 2005; Rooney et al., 2008). The 'team' was the only organisational design strategy in two of the studies and they only reported quality measures with positive effects (Gholve et al., 2005; Muntlin Athlin et al., 2013). When more than one organisational design strategy, the effect was still positive in all dimensions.

Physician involvement in patient triage

'Physician in triage' studies (nine studies) shared the same primary goal of prioritising patient treatment based on severity of their condition. Different types of triage systems were developed and different applications of these systems were used, either by a triage nurse and a physician in the triage area (Han et al., 2010; Imperato et al., 2012; Soremekun et al., 2012), a physician performing the triage (Rogg et al., 2013; White et al., 2012), or in a teamwork setting often composed of a nurse and a physician (Sharma et al., 2013; Traub et al., 2016, 2015; Travers and Lee, 2006). Studies including physician involvement in patient triage were primarily conducted in the USA (eight studies) based on a study population ranging

from 2,919 to 89,391 patients or patient visits (Han et al., 2010; Imperato et al., 2012; Rogg et al., 2013; Sharma et al., 2013; Soremekun et al., 2012; Traub et al., 2016, 2015; White et al., 2012). Quality measures were applied in all eight studies, including time-sensitive performance-indicators, with seven of them reporting a positive effect of 'physician in triage'. There were no effect measures related to health outcomes and cost. One study reported non-significant results of physicians in triage (Traub et al., 2016). This study compared physician in triage with a rotational patient assignment, which are two different front end processes designed to improve patient flow (Traub et al., 2016). Since the effect was positive for all studies, it was unknown if there was a positive effect of testing additional strategies simultaneously.

Senior physician involvement

Seven studies covered senior physicians in different settings such as working night shifts (Christmas et al., 2013), as an additional physician working with the triage nurse (Travers and Lee, 2006), as a rotational assistant from each specialty for 6–12 months (Korsten et al., 2014), or as part of an organisational change placing the senior physician as frontline staff (Mattsson et al., 2014). These studies were conducted primarily in Europe, based on study populations ranging from 576 to 4,622 patients or patient visits. The length of stay and wait time were the most commonly applied quality measure (six out of seven studies). Two studies analysed costs (Korsten et al., 2014; Subbe et al., 2014), and only one study analysed health outcomes (Mattsson et al., 2014). Three studies had a senior physician as the only organisational design strategy, and these studies showed a positive effect in all three dimensions (Christmas et al., 2013; Korsten et al., 2014; Subbe et al., 2014). The studies testing more than one strategy showed positive effects on quality and health measures.

Centralisation

There were seven studies that presented a wide variety of interventions aiming to increase efficiency in the ED by centralisation of emergency services including closing down hospitals to centralise health care (Daniel, 2014), reconfiguration of wards (Moloney et al., 2005; Rooney et al., 2008), capacity expansion (Crilly et al., 2014; Devkaran et al., 2009; Mumma et al., 2014), single entry for ED patients, and placing senior physicians upfront (Mattsson et al., 2014). These studies represent six different countries and study populations ranging from 4,584 to 286,037 patients or patient visits. Four studies had centralisation as the only organisational design strategy (Crilly et al., 2014; Daniel, 2014; Devkaran et al., 2009; Mumma et al.,

2014), three studies showed an overall negative effect on health and quality measures (Crilly et al., 2014; Daniel, 2014; Mumma et al., 2014). Mumma and colleagues showed negative results when expanding ED capacity without additional interventions (Mumma et al., 2014). The expansion was implemented without changing the resident physician staffing, nurse-to-patient ratio, and technician-to-patient ratio, and in the study period, ED input increased by 13% from pre-expansion to post-expansion, resulting in an unexploited use of beds due to limited nurse staffing. The study by Crilly et al. (Crilly et al., 2014) found that expanding ED capacity resulted in reduced in-hospital-mortality, but increased ambulance offload time, time to see a doctor, and length of stay. Patients arriving by ambulance increased in the study period by more than 2,000 in one year, resulting in offload delay that created access block and made it difficult to see a doctor within the time limits of the triage categories. Studies testing more than one strategy showed a positive effect in all dimensions.

Flow coordinator

The four studies concerned with flow coordination shared the same primary goal, to create flow in the ED The interventions included adding a liaison nurse,(Murphy et al., 2014) a triage liaison physician (Holroyd et al., 2007), a clinical assistant (Huang et al., 2013), and introduction of an ED facilitator team consisting of an attending physician, a physician assistant, and a nurse (Sharma et al., 2013). The studies were mainly conducted in western countries based on a study population ranging from 5,718 to 99,438 patients or patient visits. This organisational design strategy showed positive effects in terms of quality measures. The effect did not depend on the number of additional strategies applied.

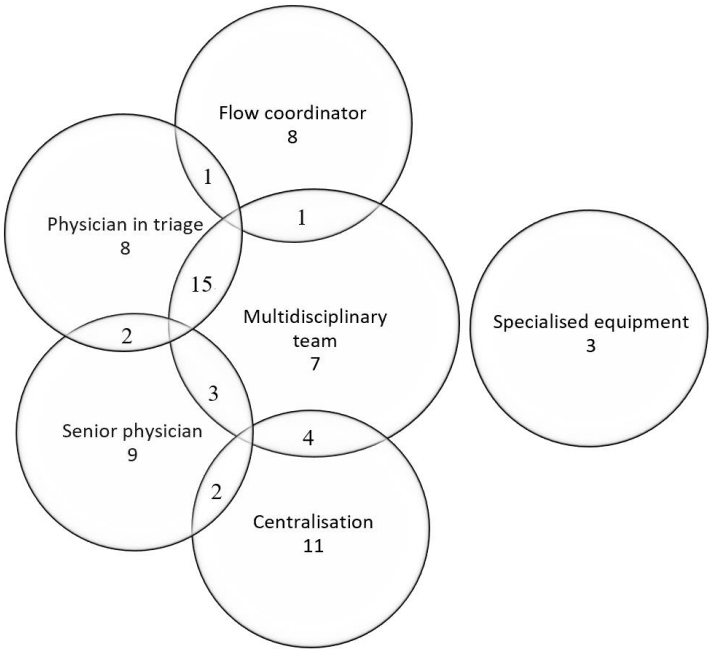
Specialised equipment

Two studies addressed the relevance of having diagnostic equipment available in the emergency department or in connection to the ED (Li et al., 2016; Poulin et al., 2015). A study from Taiwan was based on a study population of 293,426 patients (of whom 11.4% had a computed tomography (CT)-scan), reported that using CT scan in the ED may delay patient discharge (Li et al., 2016). A study from the USA reported the results from an interventional platform that was designed to improve procedural outcomes (Poulin et al., 2015). The intervention was designed to improve multidisciplinary collaboration and showed significant improvements on quality measures. However, this result is based on a small number of patients

(52) and concluded that the results could not be extended to long-term outcomes. The effects measured on quality measures showed an overall negative effect and no other dimensions were analysed.

Methodological issue of the included studies

Figure 3 illustrates the number of analyses that are either testing one or several organisational strategies simultaneously. When testing more than one strategy at a time, it is unclear whether the effects were attributable to only one design strategy, or the combination of strategies. Typically, the studies defined an organisational intervention composed of several design strategies and tested the effects of that intervention without being able to attribute effect to specific strategies.



Numbers indicates number of analyses

Figure 3 Focus on literature testing more than one strategy at the time

Table 2 shows the results based on whether the studies tested the effect of one or more organisational design strategies at a time. Since the 'multidisciplinary team' only had positive results, there was no evidence related to the effect of simultaneous testing. The same situation was found for 'physician in triage', 'senior physician' and 'flow coordinator'. 'Equipment' did not test more than one strategy.

Table 2 Extent of simultaneous testing of more than one organisational design strategy

Organisational design strategy	Number of analyses	Number of significant analyses	Health		Quality		Costs	
			In favour	Against	In favour	Against	In favour	Against
Specialised equipment								
One strategy	3	3	-	-	1 (33.3)	2 (66.6)	-	-
>1 strategy	0	0	-	-		-	-	-
Centralisation								
One strategy	11	9	1 (11.1)	1 (11.1)	3 (33.3)	4 (44.4)	-	-
>1 strategy	6	6	3 (50)	-	2 (33.3)	-	1 (16.6)	-
Multidisciplinary team								
One strategy	7	5	-	-	5 (100)	-	-	-
>1 strategy	23	14	1 (7.1)	-	12 (85.7)	-	1 (7.1)	-
Physician in triage								
One strategy	8	8	-	-	8 (100)	-	-	-
>1 strategy	15	7	-	-	7 (100)	-	-	-
Flow coordinator								
One strategy	8	6	-	-	6 (100)	-	-	-
>1 strategy	1	1	-	-	1 (100)	-	-	-
Senior Physician								
One strategy	9	8	-	-	6 (75)	-	2 (25)	-
>1 strategy	7	7	2 (28.6)	-	5 (71.4)	-	-	-
Total (%)	98	74	7 (9.5)	1 (1.4)	56 (75.7)	6 (8.1)	4 (5.4)	

Values are number of analyses (%). - = analyses not performed in literature or not significant results

Adverse effects were observed in three studies within 'centralisation' where simultaneous testing did not occur; two concerning capacity expansion and one concerning closure of hospitals (Crilly et al., 2014; Daniel, 2014; Mumma et al., 2014). Capacity expansion resulted in access block, because there were no other interventions implemented simultaneously in the organisation (Crilly et al., 2014; Mumma et al., 2014). To have a positive effect, these capacity interventions were dependent on improvements in other parts of the process. Closing hospitals without any additional service to support the population resulted in increased distance to a hospital and a decreased probability of surviving serious acute events, such as an acute myocardial infarction (Daniel, 2014). Implementing more than one organisational design strategy at a time seems to cause some synergistic effect, positively influencing results. This positive effect was seen in three studies within 'centralisation' where multiple interventions were included in the ED centralisation process (Mattsson et al., 2014; Moloney et al., 2005; Rooney et al., 2008). Introducing a single entrance for all ED patients and placing senior physicians upfront showed positive health outcome measures (Mattsson et al., 2014). Introducing a single entrance for all ED patients and implementing

multidisciplinary teams resulted in positive health outcomes in one study (Rooney et al., 2008), and positive quality and cost outcomes in another study (Moloney et al., 2005).

Table 3 provides an overview of the ED policy goals and the outcome measures applied in the studies. Twenty-three different overall effect measures were chosen for analysis and length of stay was by far the most frequently reported (21 analyses). This general choice implies a strong focus on process time, which was seen in the US studies (eight out of 21 analyses). Process time effect measures such as length of stay, wait time, time to physician and boarding time were the most popular choice within the quality dimension. The majority of these chosen quality measures represented an organisational perspective with the focus on optimising resource use, with measures overall indicating a positive effect. Only a small share of the quality measures represented the patient perspective, for instance by stating the service quality in complaint ratios and return within three and seven days, but none of these analyses were significant. There was no effect related to staff or system and neither adverse effect.

Table 3 Overall effect measures according to objectives of healthcare

Objectives of healthcare	Effect measure	Number of analyses	Number of significant analyses	Result	
				In favour	Against
Health	Mortality	6	4	3 (75)	1 (25)
	Disease indicators	1	1	1 (100)	-
Quality	Length of stay	21	19	16 (84)	3 (16)
	Left without being seen/treated	8	3	3 (100)	-
	Wait time	5	5	5 (100)	-
	Ambulance diversion	3	2	2 (100)	-
	Time to consultation	4	4	3 (75)	1 (25)
	Left without completing assessment	2	2	2 (100)	-
	Return within 3 days	2	-	-	-
	Left subsequent to being seen	1	-	-	-
	Proportion of patients admitted	1	1	1 (100)	-
	Time to disposition decision	1	1	1 (100)	-
	Return within 7 day	1	-	-	-
	Surgery within 24 hours	1	1	1 (100)	-
	Number of patients waiting	1	1	1 (100)	-
	Treated within 4 hours	1	1	1 (100)	-
	Boarding time	1	1	-	1 (100)
	Ambulance offload time	1	1	-	1 (100)
	Door-to-balloon-time	1	1	1 (100)	-
	Diagnostic errors	1	1	1 (100)	-
	Number of patients within teamwork time	1	-	-	-
	Complaint ratio	1	-	-	-
Cost	Cost/Hospital costs	3	3	3 (100)	-
Total		**67**	**52**	**45 (87)**	**7 (13)**

Values are number of analyses (%). - = analyses not performed in literature or not significant results

Health outcomes were rarely reported (seven analyses), and mortality was the primary focus (six out of seven analyses). The studies were primarily represented by European countries (four out of six studies) (Gholve et al., 2005; Mattsson et al., 2014; Muntlin Athlin et al., 2013; Rooney et al., 2008). The opposite was observed for quality measures, were the USA was the main provider of studies. Cost was analysed in only three studies (Korsten et al., 2014; Moloney et al., 2005; Subbe et al., 2014), and these were all undertaken in European countries (Ireland, UK, and Germany), in public hospitals, where resources were limited. In general, the choice of effect measure was influenced by geographical location, which also reflects the sector, public or private, governing the hospital.

Presently, the focus on organisation of emergency medicine services in Europe is to improve patient safety and quality of care. From the review, we found that there is limited published evidence in the literature due to the heterogeneity of the populations studied, narrow effect measures, and bias from non-constant settings, where more than one intervention are often tested simultaneously.

Literature reflections

Sequential organisational changes, instead of simultaneously introducing a range of different design strategies will allow for attribution of causal effects, and the lack of such a 'laboratory' approach to testing organisational design is one of the main caveats of the literature. Although ideal in theory, we acknowledge that this is difficult in practice due to the complexity of an organisational context. Some designs influence the entire treatment pathway while others affect only certain processes. However, simultaneous testing makes it difficult to distinguish which of the strategies are the main cause of the study result, and introduce the possibility of confounding factors. Contextual factors such as work culture, sick leave, and staff seniority are difficult to isolate from the intervention effect, and is a limitation of this literature review. These findings call for additional methodological approaches focusing on these factors as mediators.

Another consideration concerns the policy goals of health care and emergency medicine provision. In the Triple Aim framework (Berwick et al., 2008), quality is narrowly defined as the patient experience of care. It can be discussed whose value is captured when applying process time as the main effect measure, as was the case for most of the literature. The majority of published studies are concerned with quality measures dealing with the organisational designs, logistics, or technical efficiency. Studies investigating the effect of placing a 'physician in triage' and 'equipment' solely looked at quality measures and did not

evaluate costs associated with the organisational design strategy or health consequences. Studies from the USA mainly analysed quality measures (Han et al., 2010; Imperato et al., 2012; Murphy et al., 2014; Rogg et al., 2013; Sharma et al., 2013; Traub et al., 2016, 2015; White et al., 2012), while studies from European countries examined both health and cost measures along with quality (Christmas et al., 2013; Crilly et al., 2014; Gholve et al., 2005; Jarvis et al., 2014; Korsten et al., 2014; O'Brien et al., 2006; Rooney et al., 2008; Subbe et al., 2014). None of the studies included all three dimensions. Studies from the USA appear to be more focused on optimising time-consuming processes while studies from European countries appear to be more focused on health outcomes. According to the Triple Aim framework, healthcare system improvement requires simultaneous pursuit of all three aims; "*improving the experience of care, improvement of health of populations and reducing per capita costs of health care*" (Berwick et al., 2008). The study results reflected only parts of the overall aim of the organisational design strategies. The dominant focus on quality measures captured mainly the value of the working processes and to a lesser extent the value of the patient outcomes. Several studies found an association between overcrowding and increased patient mortality, which underlines the importance of including health outcomes in these studies (Miró et al., 1999; Richardson, 2006; Sprivulis et al., 2006). Given the goals of modern healthcare systems, where a trend seems to be a movement towards patient-centred health care, value and quality. However, where cost pressures remain, it seems imperative that future studies include a broader range of effect measures. Finally, new organisational strategies could, in the worst case, have unintended negative effects. This appears to have been largely ignored in the literature and is an important future consideration.

Motivation for this project

Currently, emergency services have been centralised to one department at fewer hospitals (from 40 to 21), and new ED facilities have been built across the country (Danske Regioner et al., 2016). Yet, a recent study, based on interviews (hospital and ED management/staff) from 2013 to 2015, found that the Danish EDs matched three different organisational models: the original organisation and two newly developed (Møllekær et al., 2018). The main differences being an increasing level of ED autonomy, primarily based on whether the EDs employed senior physicians or not. The study analysed the EDs as information processing (IP) units and applied the multi-contingency model (Burton et al., 2015), which was used to categorises the EDs according to organisational characteristics. The effects of the ED organisational models were analysed

in Central Denmark Region hospitals from 2011-2014, and the investigators found that patients discharged from EDs with the new organisational models (hybrid and independent) had a lower risk of death within seven days of discharge compared to the old organisational model (virtual) (Møllekær et al., 2019). Even though the new models seemed to improve patient health in a Danish region, it became clear that they were not fully operational 24/7. This led to further investigation of the "weekend effect" in a Danish ED, also in Central Denmark Region, which was confirmed (increased 30-day mortality) (Duvald et al., 2018). The IP theory (which the multi-contingency model is based upon) was afterwards applied to an ethnographic field study to explain and explore this weekend effect (Duvald, 2019). Results indicated that significant organisational design misfits occurred during the weekend, due to numerous organisation design changes, e.g. decreased availability of senior physicians. In 2014 the Danish Health Authority also found a large diversity in the organisations of the ED's (Ministeriet for sundhed og Forebyggelse et al., 2014). To streamline these, new recommendations were provided. They primarily concerned the coordination and recruitment challenges permeating the transition process.

Summing up the introduction, the ED policy was based on clinical experience rather than evidence, and it was framed as recommendations, with few implementation instructions. The policy implementation was incomplete and had resulted in heterogeneous ED organisations. The effects of the ED organisation covered one region and two outcome measures, one health (mortality) and one quality measure (length of stay). According to Donabedian's tripartition of the quality of care, I would like to cover all aspects: structure, concerning the setting in which the health care is provided; outcome, concerning the effect of the health care; and process, covering the processes around, e.g., patient diagnosis and provision of care (Donabedian, 1988). This motivated an implementation analysis from policy to practice between 2007 and 2017 in Denmark. The implementation status will be used to analyse the effects (health, quality and cost measure) of the increasing level of ED autonomy introduced by the policy. Furthermore, determinants and the effect of diagnostic discrepancy will be analysed. The effect studies will be analysed in the period from 2008 to 2016 from a national perspective. In the light of the recent successful application of the IP theory and multi-contingency model, it will serve as an analytical framework in this dissertation.

Hypotheses

According to the tendencies found in the literature and the ED policy intention, the policy-related effects are believed to benefit quality of care, health and contain costs. However, the policy implementation seems to be affected by communication issues between the EDs and the collaborating departments. If this is the case, we would expect these issues to influence the information flow between the departments and staff, possible affecting the diagnosis of patients and quality of care. Furthermore, according to the literature, some of the positive effects, might be due to a positive synergistic effect, and since the implementation might still be incomplete, it could decrease the potential benefits of the policy.

Aim

The aim of this PhD project was to analyse the process from policy to practice; the relation between organisational design of EDs and the quality of care, health outcome and cost; and determinants and consequences of diagnostic discrepancy. In the studies that make up this dissertation, the multi-contingency model and IP theory were applied as an overall analytical framework to guide analyses and understand the effects of the reorganisation. The following research questions were applied:

1. To what extent has the ED policy been implemented in Denmark?
2. What is the effect of the increased ED autonomy, introduced by the ED policy, on the quality of care, health outcome and episode costs?
3. Can organisational determinants predict diagnostic discrepancy and what are the consequences of diagnostic discrepancy on quality of care, health outcome and episode cost?

Method

The studies presented in this dissertation revolves around the implementation and effect of the ED policy, and is analysed in three quantitative studies, and they are overall guided by an analytical framework. In this section, the analytical framework is described including how this can help to understand ED processes and information flow and how the organisation might affect these. Furthermore, study methods (including the literature review) are briefly described, followed by a critical evaluation of central methodological aspects of each study.

Study I concerned the process from policy to practice, where implementation of ED policy recommendations was assessed in a survey. In study II, these survey data were merged with register data, to assess the effects of design changes related to the policy recommendation. In study III, organisational determinants for not being given the final diagnosis at the time of admission as well as its consequences to patient outcomes and costs were assessed based on the data from study II. The use of complex quantitative methods, unique data and a national perspective, makes for an important contribution to the existing literature in the field (Duvald, 2019; Duvald et al., 2018; Møllekær et al., 2019, 2018). In the literature review, evidence related to the ED policy recommendations was assessed.

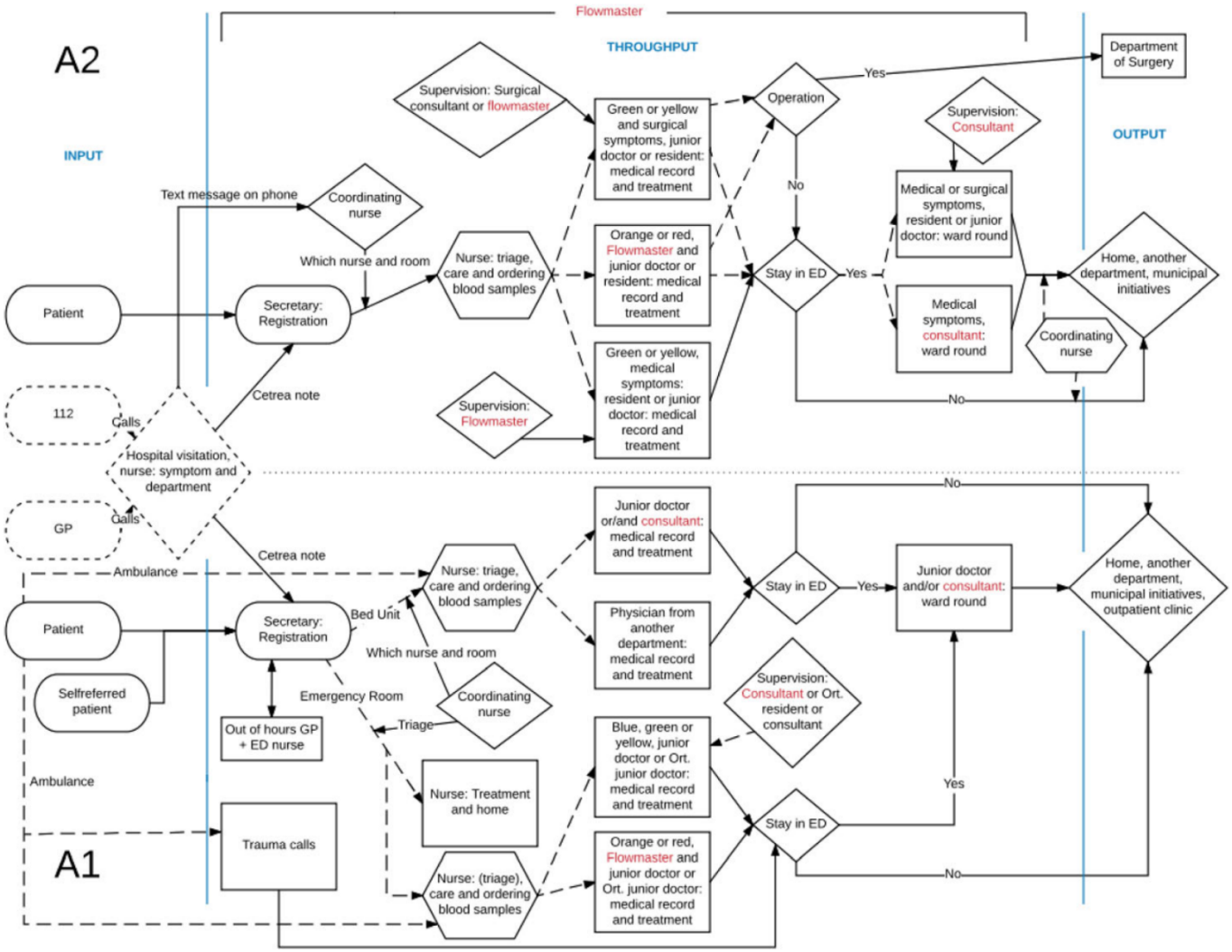
Analytical framework

Changing an organisation can be an extensive and complex task, and to improve our understanding of the process from policy to practice, we must use concepts from organisation theory. In the studies in this dissertation, the EDs are viewed as IP units, and in this section, IP demands and IP capacities in the ED are introduced.

In Denmark, the visitation process depends on the contact time (during office hours or not). Figure 4 illustrates the sequential work-processes and information flow in a Danish ED, primarily in office hours (Duvald, 2019). The figure represents universal ED processes, but minor local variations are expected among the Danish EDs. Before entering the ED, patients are either referred to the ED by a GP or 112 call (emergency visitation). These 112 patients might be brought in by ambulance or helicopter. When entering the ED, the patient is registered by a secretary, and a triage nurse collects vital signs (e.g. blood sample, pulse) and registers contact reason (often based on symptoms) to categorise the acuteness of the patient's condition (Aarhus Universitetshospital, 2020). The assigned triage colour defines the waiting

time until physician examination and which physician to do the examination (can a junior physician handle the patient or is a senior physician needed). The collected information is passed along (via e.g. Cetrea boards, a real-time information system) to the assigned physician who examines the patient. The collected information is used to proceed to the diagnostic process where additional information most often is needed, e.g. diagnostic imagine or additional tests. All the gathered information will be processed by the physician in the ED, on occasion in collaboration with a multidisciplinary team, flow coordinator or physicians from the ED or from other departments. Based on this information, the patient is diagnosed, and initial treatment is provided at the ED. If the patient can be discharged from the hospital within 48 hours the patient is most often treated at the ED. If not, the patient is admitted to another hospital department. The patient can be discharged to home, municipal initiative or outpatient clinic. The described ED work- and IP-flow primarily depicts EDs during the daytime.

Evening/night-time and weekends are characterised by a change in visitation, since GPs are only available on-call. There does not seem to be large differences in disease severity between weekday and weekend admissions (Duvald et al., 2018). The organisation of an ED can be described by the way information is processed and how decisions are made on the information.



ED=emergency department, GP=general practitioner
A1 and A2 are the names of the emergency departments' units analysed.

Figure 4 An emergency department illustrated as an information processing unit (Duvald, 2019)

The role of information processing in an organisation

Organisations can be viewed as IP systems, which perform tasks and coordinate and control their activities by processing information (Burton et al., 2015). A well-functioning organisation is an organisation where IP demands match the IP capacities (Galbraith, 1973). When the uncertainty increases, the IP demand increases. Yet, people and information systems have a limited capacity to process information, which is an important factor in the understanding of organisational and individual behaviour (Arrow, 1974). For an organisation to be effective, a balance between organisational structure and the uncertainty needs to be established. The organisations must therefore be able to cope with uncertainties (March and Simon, 1958;

Weick, 1969), which can be done by developing IP mechanisms (Zaltman et al., 1973), e.g. by systemising tasks or implementing information systems. Three sources of work-related uncertainty have been defined: subunit task characteristics, subunit task environment and inter-unit task interdependence (Tushman and Nadler, 1978).

The role of task characteristics

The amount of task predictability and complexity in an organisation defines the amount of uncertainty the unit must deal with, since they are sources of the IP requirements (Comstock and Scott, 1977; Galbraith, 1973; Mohr, 1971; Overton et al., 1977; Tushman and Nadler, 1978). For example, routine tasks can be pre-planned and require minimal IP, whereas complex tasks that are associated with greater uncertainty cannot be pre-planned and require increased IP capacity (March and Simon, 1958; Thompson, 1967; Tushman and Nadler, 1978).

The role of task environment

Task environment is defined as external players interacting with organisational members (Downey et al., 1975; Downey and Solcum, 1975; Tushman and Nadler, 1978). The environment is therefore the source of uncertainty. In dynamic or changing environment, static rules and standard operating procedures are not sufficient to deal with the uncertainty (Tushman and Nadler, 1978).

The role of inter-unit task interdependence

If subunits are dependent upon other subunits to perform their tasks effectively, it affects the uncertainty, and effective coordination and joint problem solving are needed. If tasks are autonomous, it will lower the need for IP capacity (Tushman and Nadler, 1978).

The role of information processing in emergency departments

In the ED, task characteristics are complex, task and patient influx predictability are low and ED task complexity varies widely, since the ED receives a wide range of patients. Furthermore, during most ED tasks, time and information are restricted (Duvald, 2019; Tipsmark et al., 2020d). These factors contribute to a unpredictable and complex ED environment, which could be characterised as “turbulent” (Burton et al., 2020). To decrease the complexity clinical guidelines and cooperation agreements can be used. Moreover, environmental agility is needed to match the unpredictable influx of patients. This could

include an increased level of available resources, including staff and IP systems. Especially, the presence of senior physicians at the ED would contribute to increase IP capacity; thus, they are essential in the ED workflow (e.g. decision-making capacity). ED tasks are highly inter-unit interdependent, resulting in additional ED task uncertainty: diagnosing and treatment rely on resources from other departments, e.g. tests, diagnostic imaging and clinical expertise. In some cases, the treatment authority lies solely outside the ED, e.g. surgeons have the authority to decide whether a patient must undergo surgery or not (Duvald, 2019). Besides inter-unit interdependence, the co-solving design of ED tasks results in high-level ED task interdependence. To diagnose a patient the physician is dependent on the information gathered in the examination (e.g. physical examination and/or CT scan), which was chosen on the basis of triage information and so on (Duvald, 2019). Hence, an ED's task interdependence is associated with the level of available qualifications and resources to and in the ED; e.g. if an ED is staffed primarily by juniors, increased assistance from other departments to complete patient diagnostics and treatment is required. Adding to the uncertainty, non-ED physicians do not prioritise ED tasks leaving the ED even more vulnerable (Dansk Sundhedsinstitut, 2010; Duvald, 2019). Employing senior physicians at the ED might solve these problems. The organisational design of a typical Danish ED results in high work-related uncertainty both night and day, which needs to be handled effectively to fulfil the ED assignment.

Multi-contingency model

The multi-contingency model is based on IP and contingency theory (Burton and Obel, 2018). Contingency theory states that an organisation must be adaptable to the environment in which it operates. Hence, from a contingency perspective there is no best way to organise, but each organisational design is not equally efficient for an organisation (Galbraith, 1973; Tushman and Nadler, 1978). This also means that if the setting changes, then the IP needs changes, which require an organisational design change. Thus, a misfit between design components in an organisation negatively affects effectiveness and performance of the organisation. Figure 5 shows Burton and Obel's multi-contingency model (Burton et al., 2015), which covers 14 organisational design dimensions. All the dimensions are connected; if one dimension is altered, it will affect the relationship to the rest of the dimensions. The more misfits between dimensions, the more the organisation's decision-making competencies and performance will be reduced. To obtain an organisational fit, the organisation's IP needs must match the IP capacity of the organisation (Galbraith, 1973).

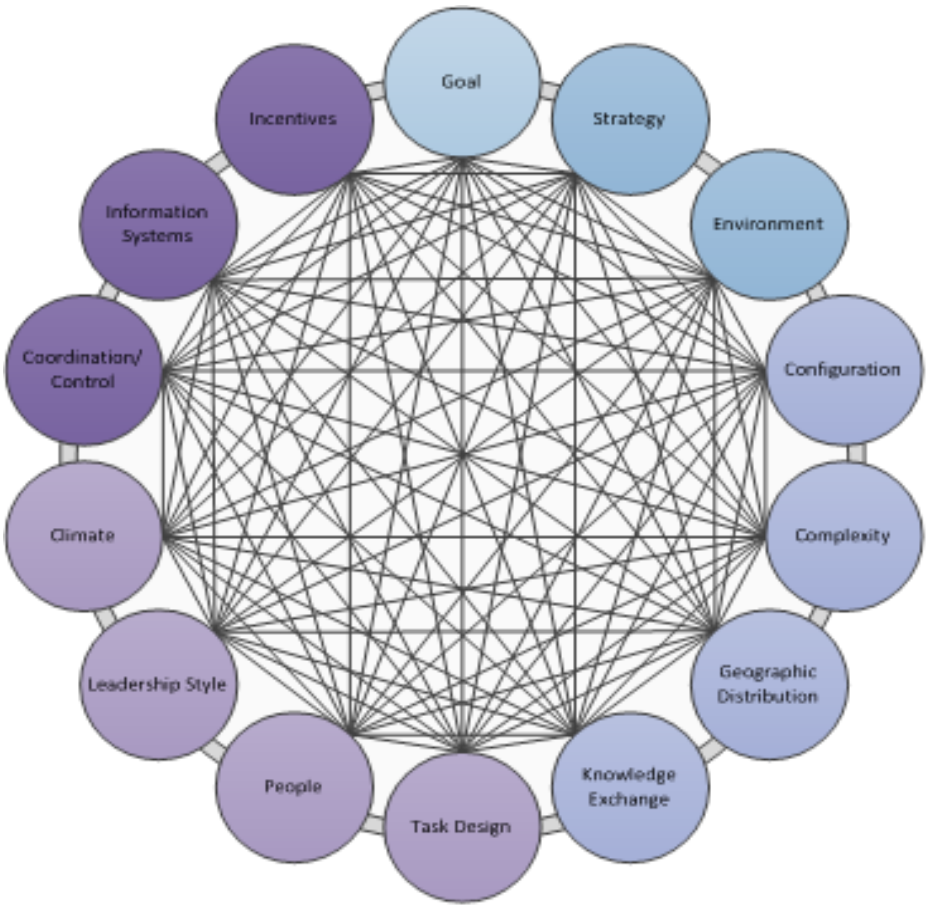
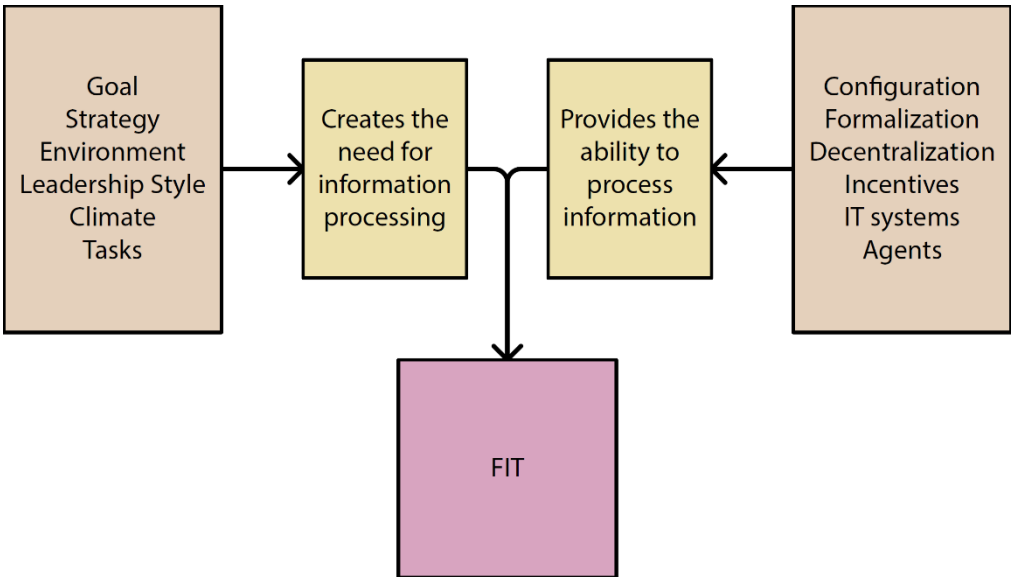


Figure 5 The multi-contingency model (Burton et al., 2015)

This is also illustrated in Figure 6, which categorises the organisational design dimensions according to which creates IP needs (left) and which creates IP capacity (Burton et al., 2020). In previous work by Møllekær et al., an expert panel selected ED relevant organisational design dimensions from the 14 original dimensions (Møllekær, 2018). These included (original definitions) goal, strategy, setting (environment), structure, staff, coordination (coordination and control), staff (people/agents) and incentives structure. ED goals and environment were not found to substantially vary across the Danish EDs. Thus, the remaining organisational design dimensions were chosen as analytical framework.



Configuration=structure, formalization and decentralization=coordination and control mechanisms, agents=people/staff

Figure 6 The information processing model (Burton et al., 2020)

Based on the description of the ED as an IP system, the multi-contingency model and IP theory were chosen as the analytic framework. The framework has been useful in analysing health care organisation. Research also shows that the framework can explain up to 30% of variations in performance (Burton et al., 2002; Doty et al., 1993). The multi-contingency model includes dimensions influencing the organisation's performance. It is an identification tool of fits and misfits within an organisation. I have also chosen to apply the multi-contingency model to help select important organisational dimensions for analysis.

There are a number of slightly different multi-contingency models. These include the Galbraith Star model (Kates and Galbraith, 2010) and the Miles and Snow model (Miles et al., 1978). The competing values model (Quinn and Rohrbaugh, 1983) could also have been chosen. The Burton and Obel model presented above is a little more comprehensive and incorporates the important parts from the other models. Furthermore, it has been used to describe the organisation of EDs in Denmark, which allows the current study to relate to previous studies.

Study I

A cross-sectional study was undertaken among all 21 Danish EDs from 16 March to 28 August 2017. Organisational characteristics were collected, covering whether and, if so, when the ED policy recommendations were implemented at the EDs. The organisational characteristics were based on themes

from the Danish ED policy (Sundhedsstyrelsen, 2007)(hence they are also referred to as policy recommendations), e.g. availability of specialised equipment (covering seven different pieces of specialised equipment), location of ED facilities (centralisation), use of interdisciplinary teams, triage and flow coordinators, employment of senior physicians, availability of senior physicians 24/7 and qualification upgrades. Senior physician employment is originally not at recommendation, but it was the best indication of whether or not the senior was present at the ED. External physician can be asked to leave the ED if important tasks emerges at his or her department of employment. The analytical framework was among other factors applied to categorise policy recommendations, see Table 4.

Table 4 Policy recommendations categorised according to the analytical framework (Tipsmark et al., 2020d)

Organisational design dimension	Policy recommendations
Strategy – How the ED plans to achieve its goals	NA
Structure – Steps taken to achieve ED goals.	Specialised equipment Specialised equipment 24 hours Centralisation
Coordination– How the ED services are broken down into tasks	Multidisciplinary teams Triage Flow coordinator
Staff – Who staffs the ED	Senior physician Senior physician 24 hours Qualification upgrade
Incentive structure – How staff performance is rewarded	NA

ED=emergency department, NA=not applicable

Questionnaire design

A purpose-designed internet-based questionnaire was constructed with predefined multiple-choice categories. The questionnaire can be found in Appendix 4. The questions were designed to be exhaustive and mutually exclusive included the possibility of “I do not know”. The questionnaire design results in data which can be used to construct time-series data and cumulative implementation proportions at specified time points. The questionnaire was set-up in SurveyXact (Rambøll Management Consulting, Aarhus N, Denmark).

Validation and pilot testing

During the questionnaire construction, several people were involved to ensure the validity of the questionnaire, among others a former ED nurse with many years’ experience, ensured the terminology and content of the questions. The questionnaire was tested for psychometric properties in a pilot test with a special focus on the understanding and face validity (whether the questions captured all aspects of the

topic to acquire the necessary data (Ball, 2019; Mokkink et al., 2010)). The pilot test was performed by four ED experts (two chief physicians from two different Danish EDs, one head nurse and one ED researcher), a professor in health Economics, a professor in management and three questionnaire construction experts. After the pilot test, the questionnaire was revised accordingly. Since the questionnaire was answered by management from all Danish EDs, the external validity was high. The questionnaire reliability was not assessed; however, it was not consider to be an issue, since the respondents are asked about facts and not subjective factors such as patient reported outcome measures (Mokkink et al., 2010).

Choice of respondents

To ensure eligibility and reduce selection bias, choice of respondents was crucial. During the policy implementation high staff turnover has been observed at the EDs (VIVE, 2018). An ED researcher helped select either the chief physician or head nurse, according to which of the two had the longest track record at the given ED. If they were equally long, the questionnaire was distributed to the chief physician. If he or she was not able to answer, it was distributed to the other ED manager. In a few EDs, short employment periods forced us to collect answers from several respondents at the ED. In one instance, we had to contact a former chief physician, to obtain answers to large parts of the questionnaire. Non-responders were reminded by email (up to two times) and were afterwards given a call, resulting in a 100% response rate. The respondents who primarily answered the questionnaire consisted of 16 chief physicians and 5 head nurses, who had a mean employment period of 5.26 years (min/max 1-10 years).

Study design reflections

Survey studies provide the opportunity to quickly gather large amounts of information. They offer a snapshot of the current situation, and in the present case, retrospective questions provided a timeline of the policy implementation. Online questionnaire were used instead of paper versions based on the advantages of low costs, high speed and flexibility in the development, distribution and analysis phases (Ball, 2019). The use of online platforms with predefined designs, easy distribution options and quick data extraction from the online platform to a statistical software keeps the costs at a minimum. Besides the advantages for the researcher, online questionnaires are also often preferred by respondents because they can fill out the questionnaires when it best suited them. This might have a positive effect on the

response rate (Ball, 2019; Callegaro et al., 2015). Since there is no interviewer, it reduces the tendency of the respondents to answer in a way that they expect the interviewer wants them to (Juul, 2013; Porta, 2014). A related issue is the social desirability effect (Phillips and Clancy, 1972). It is prestigious to manage a first-mover ED, thus the respondents might embellish the answers. Response anonymity in the study results hopefully reduces this issue.

The effectiveness of questionnaires comes at a price of less detailed information compared to interviews and the possibility to explain questions or terms if any doubts occurred. Yet, interviews are highly time-consuming and costly (transportation, time and, if necessary, compensation to the interviewed staff, for his/her time), and it would not eradicate the risk of selection and recall bias, that might be the largest obstacle in study I. Recall bias is inevitable when trying to construct a timeline from 2007 to 2016.

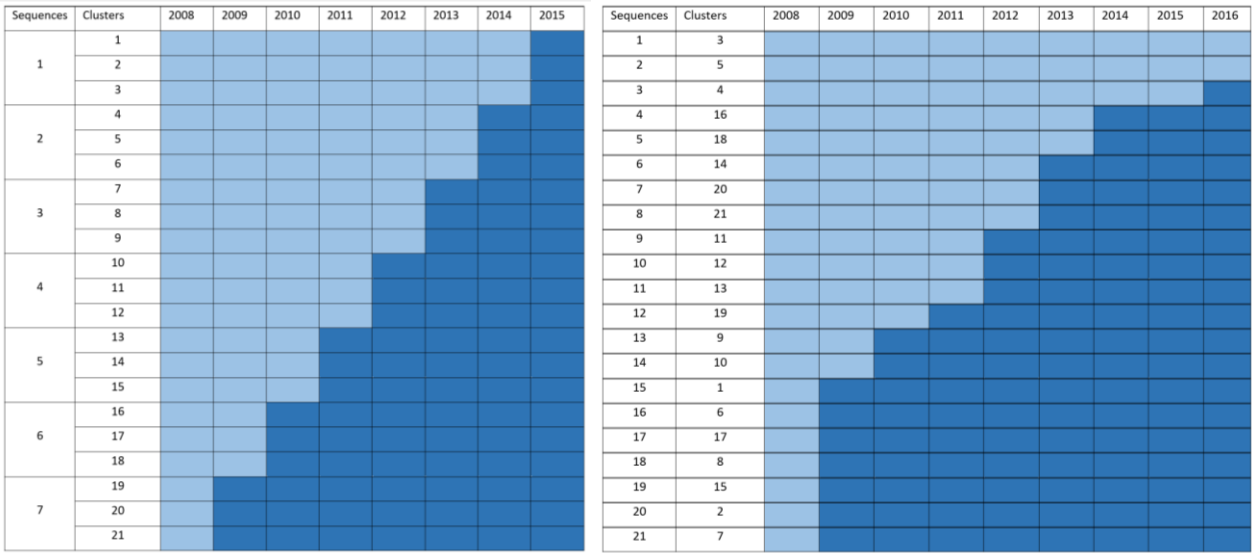
Study II

A non-randomised stepped-wedge study including all episodes with an acute diagnosis of hip fracture (n=79,697) or erysipelas (n=39,000) at a Danish ED (m=21) from 2008-2016 was performed. The effects (health, quality and costs) of increased ED autonomy introduced by the ED policy were analysed. We defined the number of years since introduction of senior physician employment at the ED as a proxy for ED autonomy. Episode and department characteristics were retrieved from register data, and organisational ED characteristics were retrieved from survey data (study I). Mixed effects models were applied to handle the hierarchical data structure (episode and department levels) and control for secular trends.

Stepped wedge

The stepped wedge design indicates that the clusters (in this case the EDs) switch from the control group to the intervention group at different time points (Hemming et al., 2015). Frequently, in prospective studies, the clusters are randomised to a sequence, which determines the order in which the clusters switch to the intervention group. It is possible to decide how many clusters that switch per sequence, at which time intervals the sequence can switch to the intervention group and how many sequences the study period is divided into. The time-period could, e.g., be years, months or days. In the present observational study, the EDs decided when and if they wanted to employ senior physicians (stepwise implementation); hence sequences and time-periods were not defined and randomisation was not possible (Barker et al., 2016). Figure 7 illustrates the difference between a cluster randomised stepped

wedge (left – hypothetical example) and a non-randomised stepped-wedge study (right – the observed data). The hypothetical example includes a total of 21 clusters, 3 clusters are randomly selected to switch to the intervention during each sequence, resulting in 7 sequences before all 21 clusters have switched to intervention. In our study, the 21 clusters (EDs) self-selected into the intervention at a time point of their own choice, which we monitored in calendar years.



The light blue colour indicates periods where the cluster is in the control group. Dark blue indicates the intervention group.

Figure 7 Difference between a non-randomised and a cluster randomised stepped-wedge study.

The lack of randomisation in our stepped wedge study is to some extent handled by adjusting for a number of observed episode- and department-level characteristics. Even though is it not randomised, the stepped-wedge design still enhance precision of the analyses compared to less complex designs (Barker et al., 2016; Hemming et al., 2015). For example, in a cluster randomised controlled trial (not stepped wedge), the cluster is either randomised to the control or intervention group. In a stepped-wedge study, the clusters are first in the control group and will eventually switch to the intervention group, which means that the clusters act as their own control (Hemming et al., 2015). This strength can be compromised if the cluster does not switch to the intervention group and if unobserved department or episode characteristics change at the same as the intervention is implemented. In the present study, two EDs, did not implement the intervention. As it only involved two EDs, it is expected to have minimal effect on the external validity of the results. Concerning the unobserved characteristics (that could change at the same time as the intervention was implemented), this could, for example, be the ED management being

replaced, resulting in a new strategy which included senior physician employment. Due to the high turnover in ED management, this might be the case at some EDs. However, it would only lead to confounding if the change in management affect the outcomes.

There are some general issues which must be considered for stepped-wedge studies, randomised or not: The stepwise implementation means that the control episodes generally will be in the early study period and intervention episode in the late period. And as this is the case with this policy implementation, other organisational changes do occur during the study period, which may have an effect on the outcomes measures. This means that time is associated with the intervention and potentially the outcome. To handle this, we need to adjust for time (secular trends) in the analyses (Brown and Lilford, 2006; Hemming et al., 2015). Another important issue in stepped-wedge studies is the number of clusters included (Barker et al., 2016; Leyrat et al., 2018; Li and Redden, 2015). This subject is still being investigated with the aim to obtain a common consensus. A minimum of 10 clusters is recommended, but 30 or more are desired (Barker et al., 2016; Li and Redden, 2015; Snijders and Bosker, 2012). A small number of clusters can result in an inflated type 1 error, which means that the confidence intervals (CIs) are too small, and we might reject a true null hypothesis (Li and Redden, 2015). To account for this shortcoming, small sample correction was applied. This was done by calculating CIs by use of the t-distribution instead of the normal distribution (Leyrat et al., 2018).

Study population

To ensure case-mix continuity, the population was selected by diagnosis instead of organisational unit. Local politics, such as temporary visitation of an emergency patient to other departments, could induce sample bias. During the selected period, the hospitals were centralised and organised according to the ED policy. Yet, in 2007, 40 hospitals received emergency patients, whereas this number was reduced to 21 in 2016. Organisational ID was recoded for the episodes in the year before 2017, corresponding to the final 21 ED units. This also ensured case-mix continuity within each ED catchment area. The study population was identified as emergency contacts (C_AKUT=1) with either a hip fracture (International Classification of Diseases (ICD) version 10 DS720, DS721, DS721A, DS721B, DS722) or erysipelas (ICD-10 DA469). If the patient during the time presented with both diagnoses at two separate admissions, then they were both included. The diagnoses were chosen by an ED senior physician based on high ED volume and stable diagnostic and treatment history during the study period. In addition, a previous study indicated that the

diagnosis and treatment of patient with a hip fracture were specially challenged in the new organisation (Shulzhenko and Obel, 2015). Hence, it was interesting to see whether any effect differences could be observed.

Register data

After the relevant emergency episodes were identified in the Danish National Patient Register (Lynge et al., 2011), the episode CPRs (personal identification numbers) were then merged with complete data from all the registers (Hjollund et al., 2007; Lynge et al., 2011; Pedersen, 2011) to find all hospital-related activity up to 30 days post discharge after the emergency episode. These data were used to construct episode characteristics and episode outcomes, and the data were merged with survey data to define the intervention variable and time. Table 5 provides an overview of the mixed effects models' variables, scaling and time of observation data source. The outcome data on the identified episodes, were used to construct yearly department characteristics, established on the basis of means during the year before the episodes. Hence, register data from 2007 was therefore included only to construct department characteristics concerning 2008, and afterwards deleted from the dataset. Teaching hospital status was identified through publicly available information. At last, the dataset was merged with organisational design characteristics (ED policy recommendations) from survey data on organisation to define the intervention variable and time.

Table 5 Variables included in the mixed effects models (Tipsmark et al., 2020a)

Variable	Definition	Scaling	Time of observation	Source
ED autonomy	Duration of senior physicians employed at the ED (year)	Continuous	Episode year	Survey data, study I
Department heterogeneity	Teaching hospital	Dummy	Episode year - 1	Publicly data
	Annual episode volume (number)	Continuous	Episode year – 1	(Lynge et al., 2011)
	Annual mean 30-day mortality (%)	Continuous	Episode year – 1	(Pedersen, 2011)
	Annual mean 30-day readmission (%)	Continuous	Episode year – 1	(Lynge et al., 2011)
	Annual mean episode cost (2018-DKK)	Continuous	Episode year – 1	(Sundhedsstyrelsen, 2009)
Episode heterogeneity	Male gender	Dummy	-	(Lynge et al., 2011)
	Age (year)	Continuous	Episode year	(Lynge et al., 2011)
	Elixhauser co-morbidity	31 dummies	Episode year	(Lynge et al., 2011)
Time of episode	Admission date (year)	Continuous	Episode year	(Lynge et al., 2011)
Outcome	30-day readmission	Dummy	Episode year	(Lynge et al., 2011)
	30-day mortality	Dummy	Episode year	(Pedersen, 2011)
	Episode cost (2018-DKK)	Continuous	Episode year	(Sundhedsstyrelsen, 2009)

ED = emergency department

Definition of comorbidity

To account for comorbidity the Elixhauser comorbidity measure was applied. However, the Charlson Comorbidity Index is often used in health research (Charlson et al., 1987). It dates to 1987 and it is based on 17 comorbidities. The index is somewhat outdated due to changes in treatment strategies. E.g. the incidence and mortality of hepatitis and acquired immune deficiency syndrome (AIDS) have decreased over the years, especially in Western countries (AIDS-Fondet, 2019; Vogt et al., 2008). The Elixhauser comorbidity measure (Elixhauser et al., 1998) was applied in its updated version and is based on 31 common comorbidities (Garland et al., 2012; Quan et al., 2005).

Choice of outcome measures

Choice of outcome measure can potentially affect results. Thus, we could have included more or different outcome measures. Length of stay could have been interesting to include, as the included conditions are time sensitive; however, the data did not contain valid information to construct this variable. One could argue that, if length of stay affects the treatment outcome, we most likely would detect some of the effect in the readmission and mortality outcome measure. It would also be interesting to look at patient-reported outcomes. In Denmark, LUP (Danish National Survey of Patient Experiences) data are available, unfortunately CPR numbers are not stored with the data, so it is not possible to merge the date to episode data. Department level aggregations would not provide reliable data, since we only include two different diagnoses, which might be affected differently by the change in organisation (Shulzhenko and Obel, 2015).

To reflect quality of care, 30-day readmission was chosen, defined by acute readmission to any hospital department up to 30 days post discharge. To increase the likelihood of only including readmissions relevant to the episode of interest, I did not include readmissions due to cancer treatment, accidents and mental disease. This was in line with national monitoring guidelines (Sundhedsdatastyrelsen, 2018). To reflect health, 30-day mortality was chosen, defined by mortality up to 30 days post diagnosis (Medicare.gov, 2020). Episode costs were estimated in 2018-DKK and log-transformed due to screwed data (Jones, 2007) Episode costs included resource use from time of admission to time of discharge. The Reference Cost database delivers patient-level data (as opposed to Diagnosis-Related grouping (DRG)-tariffs; however, it is not complete.

Handling missing data

All analyses are considered complete except regarding episode costs. The year 2016 was not availability from the reference cost database, so it is not considered missing. The outcome 'episode costs' was affected by missing observations (11%). It is a well-known problem that the hospitals do not always get to report their cost allocation data. However, sporadic missing values can also occur. To observe whether there are any differences in episode and department characteristics, I have listed the characteristics according to diagnoses and missingness in Table 6. Generally, it is shown that episode characteristic and department outcomes are quite similar. Yet, it is noted that the hospitals that did report the resource allocation data are not teaching hospitals and have a lower episode volume compared to hospitals that did report it. This means that the data on the episode level could be *missing completely at random* (which we assume) and that the data at the department level are *missing at random or missing not at random* (Sterne et al., 2009). We accounted for the systematic differences between the missing and observed estimates and all the other factors in Table 6.

Table 6 Episode and department characteristics according to missingness of cost data[1]

	Hip fracture		**Erysipelas**	
Episode mean (SD)	**Not missing (n=64,770, 89%)**	**Missing (n=7,785, 11%)**	**Not missing (n=30,720, 87%)**	**Missing (n=4,2523, 13%)**
Male gender (%)	0.32 (0.46)	0.31 (0.46)	0.57 (0.50)	0.58 (0.49)
Age (years)	78.93(12.12)	78.96 (12.21)	62.42 (17.76)	63.48 (17.48)
Elixhauser Index[a]	0.28 (0.66)	0.32 (0.67)	0.40 (0.77)	0.43 (0.81)
30-day readmission (%)	0.10 (0.30)	0.11 (0.31)	0.13 (0.34)	0.14 (0.34)
30-day mortality (%)	0.10 (0.29)	0.10 (0.28)	0.02 (0.13)	0.02 (0.14)
Episode cost (DKK 2018)	71,993 (62,125)	-	26,410 (38,928)	-
Departments mean (SD)	**(m=158, 97%)**	**(m=5, 3%)**	**(m=157, 96%)**	**(m=6, 4%)**
Teaching status (%)	0.16 (0.37)	0	0.16 (0.37)	0
Episode volume	443 (220)	122 (107)	200 (147)	41 (36)
30-day readmission (%)	0.10 (0.05)	0.09 (0.02)	0.13 (0.04)	0.10 (0.07)
30-day mortality (%)	0.10 (0.03)	0.10 (0.05)	0.02 (0.01)	0.02 (0.03)
Episode cost (DKK 2018)	75,020 (26,577)	-	33,951 (25,743)	-

SD=standard deviation, [1]Excluding 2016 data

We did not impute the missing data at the episode level but at the department level, and costs were imputed using last year's department costs (last value carried forward) (Sterne et al., 2009). The department imputation is done to keep as many episodes as possible from the affected EDs in the analyses, which would otherwise have been deleted in the mixed effects models. This method does not

account for the uncertainty linked to the missing data, and multiple imputation would have been the most accurate method to handle this. However, this method required special software and special statistical skills.

Table 7 illustrates at which departments and in which years the cost data were missing. Around half of the missing costs are from 2013. Eleven EDs in both diagnosis groups have over 10% missing costs. Two EDs have whole years with missing episode costs, and thereby missing department costs (grey cells). Since lagged means of department costs were used, the grey cells will be moved to the following year, excluding these years from the analyses (except 2012 in ID 18, which is imputed).

The white cells do not contain any observations, and in ID 6 this was due to exclusion from the analyses (due to too few episodes).

Table 7 Number of episodes with missing cost data per department (ID) over time

		Year									
	ID	2007*	2008	2009	2010	2011	2012	2013	2014	2015	Total (%)
Hip fracture	1		14		3	4	24	543		12	600 (13)
	2		4				18	510		10	542 (13)
	3		24	656			27	626		17	1,350 (23)
	4		23	609		7	22	639		14	1,314 (25)
	5		77	72	69	81	2	67		1	369 (60)
	6					na	na	na	na	na	0 (0)
	7							656			656 (14)
	8		2					315			317 (12)
	9		3				1	364			368 (12)
	10									4	4 (0)
	11		229					2		12	243 (6)
	12				1					19	20 (0)
	13							2	1	4	7 (0)
	14		1		3	457				2	461 (12)
	15									4	4 (0)
	16		12			1	3	6	270	4	295 (10)
	17					7	257			43	267 (13)
	18		1		8	293	314	312	3	5	936 (33)
	19				2	2	3			13	20 (0)
	20				1		6				7 (0)
	21						3				3 (0)
Total (%)		-	390 (4)	1,337 (15)	87 (1)	852 (10)	680 (8)	4,041 (46)	274 (4)	124 (1)	7,785 (11)
Erysipe-las	1		17		109	109	10	369	1	7	622 (19)
	2						2	285		4	291 (9)
	3		2	200		1	6	420	5	20	654 (17)
	4		3	279		130	1	581	7	3	1,004 (21)
	5		29	28	33	28		24		2	144 (35)
	6					na	na	na	na	na	0 (0)
	7							378		1	379 (13)
	8		2					99			101 (14)
	9							182		4	186 (13)
	10										0 (0)
	11		70			1	1	1		1	74 (5)
	12		88	2	8					4	102 (5)
	13							72		2	74 (7)
	14				1	207					208 (14)
	15									8	8 (1)
	16		4				3	1	145	1	154 (13)
	17					1	124			1	126 (16)
	18					145	113	128	7		393 (39)
	19										0 (0)
	20									-	0 (0)
	21		na			3			-	-	3 (0)
Total (%)		-	215 (7)	509 (15)	151 (4)	625 (16)	260 (6)	2,540 (58)	165 (1)	182 (1)	4,523 (13)

na: not applicable
Blue: department cost not missing, grey: missing department costs, white: no observations,
*2007 is only included to construct department means for 2008, 2007 is deleted afterwards.

Mixed effects models

The data have a hierarchical nature, where episodes cluster by EDs. This structure is likely to cause non-independent data because episodes from the same ED will tend to correlate. One difficulty in statistical modelling is dealing with this dependence, but mixed effects models can tackle the challenges associated with this data structure. The model can incorporate the additional level, which might help explain variation and potential differences between these clusters (by incorporation a random effect of EDs) (Barker et al., 2016; Snijders and Bosker, 2012; Wainwright et al., 2007) Furthermore, the mixed effects models can handle missing outcome data, especially in the outcome data (Buuren, 2018).

Sensitivity analysis

Sensitivity analyses are important to test the robustness of the study results. Many different sensitivity analyses were preformed, and here I will present the most important ones.

Due to the senior physician staffing shortage, night shifts at the ED are often handled by a combination of in- and out-sourcing of senior physician competencies. This means that the job is done by a combination of senior physicians from the ED, other hospital departments or junior physicians – if senior physicians are not available (Duvald, 2019; Duvald et al., 2018; Møllekær et al., 2018; Tipsmark et al., 2020d). This results in a change from a process-oriented workflow to a functional-oriented workflow, and thereby a change in ED autonomy. An interaction term of the ED autonomy and the time of a patient episode (daytime 7:00 a.m. to 10:59 p.m., night-time 11 p.m. to 6:59 a.m.) was applied in the models. To further explore a potential effect of episode time, I have made two additional models with interaction of weekend (yes/no) and weekend night inspired recent studies concerning the admission time and the weekend effect (Duvald et al., 2018; Vest-Hansen et al., 2015).

Assumptions affecting outcome measure were tested to make sure that changes did not affects study conclusions. When performing episode-level analyses, we include all relevant episodes. This means that if a patient had more than one relevant episode in the period between the initial episode and death, a patient could be registered with more than one 30-day mortality. Hence, episode-level analyses were exchanged for patient-level analyses only where first-time episodes were included. Use of the 30-day outcome measure versus 7-day outcome measure is debated, because the longer the included post-episode is, the more uncertain it is whether death or readmission is related to the hospital episode. It is therefore relevant to test these definitions by decreasing the post-episode from 30 to 7 days in sensitivity

analyses (David L. Chin et al., 2016). As mentioned, readmission is a proxy for quality of care, and poor quality is associated with increased healthcare costs, some due to preventable readmissions (Massachusetts Center for Health Information and Analysis, 2016). Hence, analyses of the inclusion of readmission costs were applied.

Study III

An observational study of emergency admissions for hip fracture episodes (n = 69,928) and erysipelas episodes (n = 37,558) from 1 January 2008 to 10 September 2016 at all Danish EDs (m = 21) was performed. Organisational determinants and effects of diagnostic discrepancy were analysed. We defined diagnostic discrepancy as a change in diagnose (discharge versus admission diagnoses). Thus, episodes were included if the patients were ≥18 years of age and discharged with a diagnosis of hip fracture or erysipelas. Episodes costs were collected, and episodes were followed for 30 days post discharge to collect 30-day readmissions and mortality. Data on organisational determinants were retrieved from survey data (study I), and episode and department characteristics were retrieved from register data. The data were analysed in mixed effects.

Diagnostic discrepancy as measure of diagnostic quality

In this study, we used two definitions of diagnostic discrepancy in the analyses. Definition 1 covered hierarchically and diagnostically different diagnoses, and definition 2 only covered diagnostically different diagnoses, see Table 8.

Table 8 Definition of diagnostic discrepancy (Hautz et al., 2019; Tipsmark et al., 2020b)

Outcome	Discharge compared to admission diagnosis	Explanation	Example
No diagnostic discrepancy	Identical	The discharge diagnosis was the same as the admission diagnosis	
	More precise	The discharge diagnosis was more precise than admission diagnosis	A patient is admitted with S70.0 Fracture of femur and is discharge with S72.2 Subtrochanteric fracture
Diagnostic discrepancy	Hierarchically different	The discharge diagnosis was listed as a secondary admission diagnosis	A patient is discharged with erysipelas, which was a secondary diagnosis at admission
	Diagnostically different	The discharge diagnosis was not among the admission diagnoses. The definition is given if none of the previous descriptions match the episode	A patient is admitted with dehydration as admission diagnosis and discharged with hip fracture

Diagnostic discrepancy is an objective measure because it relies solely on a comparison of discharge and admission diagnoses, whereas diagnostic error is an evaluation of whether the change in diagnosis was due to an error. The objectivity is both a strength and a weakness; hence the measure is not affected by the opinion of the reviewing physician, but it potentially overestimates the problem. This is especially the case because we did not evaluate whether diagnostic discrepancy was due to a differential diagnosis. The downside of diagnostic error studies is that they are often single-centre studies with small sample sizes, since diagnostic error determination requires assessment of clinical records by clinical experts (Chellis et al., 2001; Hautz et al., 2019; Moonen et al., 2017).

Study design reflections

The studies in the literature on diagnostic discrepancy have a rather simple study design, comparing discharge diagnoses with admission diagnoses. This is done because it is assumed in these studies that the discharge diagnosis is more accurate than the admission diagnosis. I believe this assumption to be very reasonable, especially for patients who enter through the ED. The broad spectrum of patients and the board spectrum of different physicians diagnosing the patients increases the risk of providing the wrong admission diagnosis. Furthermore, some patients might be given unspecified diagnoses at admission due to, e.g., overcrowding in the ED at the time of the admission. The diagnostic discrepancy definition resulted in a slightly decreased study population in study III than in study II. In study III, it was only required that the patient during the admission at some point presented with either hip fracture or erysipelas.

Organisational determinants

Organisational determinants in study III correspond to most of the organisational design strategies in study I and all seven in study II (sensitivity analyses). In study II, we argue that it is more appropriate to only use senior physician employment rather than all seven organisational design strategies due to correlations among several of the strategies. In Table 9, it is shown that there is a correlation between senior physician employment and senior physician 24 hours, flow coordinator, multidisciplinary team and decision authority. Strong correlation is often considered >0.70, which is only the case for flow coordinators and multidisciplinary teams (Mindrila and Phoebe, 2013). From study I we experienced that the implementation of the two coordination strategies occurred almost simultaneously.

Table 9 Correlation between the organisational design strategies

Correlation matrix	SP employed at the ED	SP 24-hour	External SP	Flow coor-dinator	Multidiscipli-nary teams	Decision authority	Facilities in one building
SP employed at the ED	1.00						
SP 24-hour	0.51	1.00					
External SP	0.15	-0.03	1.00				
Flow coordinator	0.65	0.38	0.41	1.00			
Multidisciplinary team	0.58	0.39	0.48	0.83	1.00		
Decision authority	0.59	0.48	-0.04	0.36	0.37	1.00	
Facilities in one building	0.03	0.35	-0.03	0.06	0.05	0.11	1.00

ED=Emergency department, SP=Senior physicians

In study II and III several sensitivity analyses were performed to test the validity of the interventions' definition. First, all models were tested defining the intervention in two way: including all seven variables in the model and only senior physician employment in the model. Second, interaction terms were added between correlated organisational determinants (all possible combinations were tested), yet it did not change the overall results.

Adaptation of the model from study II

The study II model was meticulously planned to match the study design. Since the design has not changed substantially, a new model would not improve the study estimates. The outcomes measures in study II were also adapted in study III. The outcome measures are well known and acknowledged, which increases the comparability across national and international studies. By applying the same measures, it is also easier to reflect on effects in studies II and III.

General data protection regulation and ethics

This PhD project was approved by the Danish Data Protection Agency (journal number 2012-58-006). Furthermore, the project did not have to be approved by the Central Denmark Region Committees on Health Research Ethics (case number 1-10-72-181-20), since it was not considered a health research study (section 2 (1) in the Consolidation Act section 1083 of 15 September 2017). We do not retrieve any biological data from the subjects and the register data have were always anonymised.

Literature review

A systematic review of the literature was undertaken according to the current Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines (Moher et al., 2009). A systematic search of the published literature from 1 January 2005 to 13 May 2016 was conducted in the following databases:

PubMed, CINAHL, Embase, EconLit, and RePEc. Search strategy, selection process and summary of findings tables can be found in Appendix 1 Search strategy.

Validity

To the best of our knowledge, this is the first systematic literature review of the effects of organisational design strategies related to the emergency medical services. However, we found a few studies comparable at some points. The first study was a review of cause, effect, and solutions to ED crowding reported by Hoot and Aronsky (Hoot and Aronsky, 2008). They addressed the issues of the primary reporting of patient process times, and the simultaneous testing of interventions, which confirm our findings. The second study was a review of economic evaluations on centralisation of specialised healthcare services by Bhattaria et al. (Bhattarai et al., 2016). They conducted a systematic review of methods and included studies conducted both in emergency (14 studies) and non-emergency settings (50 studies), which makes it difficult to compare results. However, they found major limitations in the study methods, and concluded that this may lead to wrong decision on centralisation. The third and last study was a review of the effectiveness and variation of acute medical units by Reid and colleagues (Reid et al., 2016). They conclude that acute medical units are associated with reductions in lengths of stay and mortality. Acute medical units are large-scale change in organisations, and includes implementation of multiple interventions, which might have a synergistic effect, positively influencing results, as suggested in our review.

Instead of PRISMA guidelines other methods for systematic reviews could have been considered, such as Realist Review, which is focused on the effects being highly dependent on context and implementation (Pawson et al., 2005). This might have given a deeper understand of which strategies would have the intended effects in which settings.

Method reflections

The strength of the review is the comprehensive nature of the range of organisational design strategies, which may provide healthcare decision makers with an overview of recent trends and related consequences. Besides expectations of improved process time for the majority of the strategies, such approaches may also provide policy makers with the awareness of potential unknown side effects that might occur following implementation.

A potential weakness could have been that a manual searching of references was not done, which may have resulted in relevant studies being missed. Organisational studies were not necessarily classified as such and relevant Medical Subject Heading (MeSH) terms could not always be used to identify these studies. To maximise the likelihood of capturing relevant studies, we applied broad search terms, including several qualitative key words. As an example, studies on centralisation were reported as studies of closure of hospitals or consolidation of all emergency functions into one department.

When deciding on the relevant organisational design strategies to include in our review, several issues were discussed. Availability of specialised equipment was not directly included in any of the organisational search terms, but we found it relevant because the argumentation of centralisation was based on the possibility of having more specialised equipment available (Li et al., 2016; Sundhedsstyrelsen, 2007). We did not find any relevant articles on education, since we looked for studies related to the effect of the education of emergency physicians and emergency nurses, and not short-term educational programmes to improve some specific emergency skills.

The heterogeneous settings, strategies and effect measures made the conduction of a quantitative analysis unfeasible. However, if this had been possible, this would have increased the study quality.

Main results and reflections

To provide all Danish citizens with emergency care, the EDs are scattered across the country. Hence, ED settings and resources vary accordingly (Sundhedsstyrelsen, 2007). Meaning that EDs serving large populations are often located at large well-equipped teaching hospitals with a broad range of medical specialist available. This might not be the case in peripheral regions where it is not possible to attract qualified staff and it is not feasible to have all kinds of specialised equipment. Table 10 provides an overview of different ED characteristics, primarily based on the survey data from 2017.

Table 10 Characteristics of Danish emergency departments (m=21) (Tipsmark et al., 2020d)

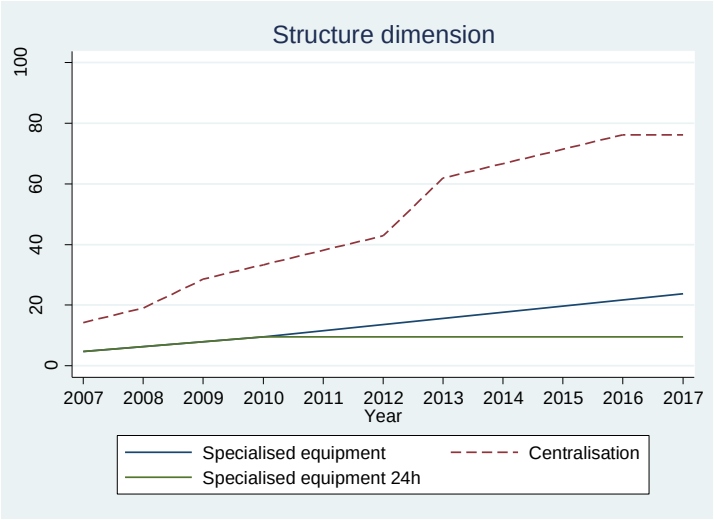
		n (%)
Size of catchment area (citizens)[1]	0-100,000	2 (10)
	100,001-200,000	3 (14)
	200,001-300,000	9 (43)
	300,001-400,000	3 (14)
	400,001-500,000	4 (19)
Teaching hospitals[1]	Percentage of EDs	4 (19)
Patient groups according to diagnosis[2]	Cardiology (excl. STEMI patients)	16 (76)
	Neurology (excl. thrombolysis patients)	17 (81)
	Oncology	8 (38)
	Gynaecology	8 (38)
	Other patients	19 (90)
Staff employed at the ED[2]	Physicians	15 (71)
	Senior physicians	19 (90)
	Nurses	19 (90)
	Emergency nurses	19 (90)
Senior physicians present at the ED 24/7[2]	Percentage of EDs	12 (57)
Medical specialty present at the same location as the ED[2]	Internal medicine	21 (100)
	Orthopaedic surgery	20 (95)
	Surgery	21 (100)
	Anaesthesiology	20 (95)
	Diagnostic radiology	20 (95)
	Clinical biochemistry	19 (90)
Equipment present at the same location as the ED[2]	Conventional x-ray	21 (100)
	Ultrasound (incl. echocardiography)	20 (95)
	Computed tomography scan	20 (95)
	Magnetic resonance imaging	20 (95)
	Interventional radiology	13 (62)
	Invasive cardiology	5 (24)
	Emergency surgery facilities	20 (95)

[1] Publicly available data, [2] survey data, STEMI=ST-Elevation Myocardial Infarction ED=emergency department

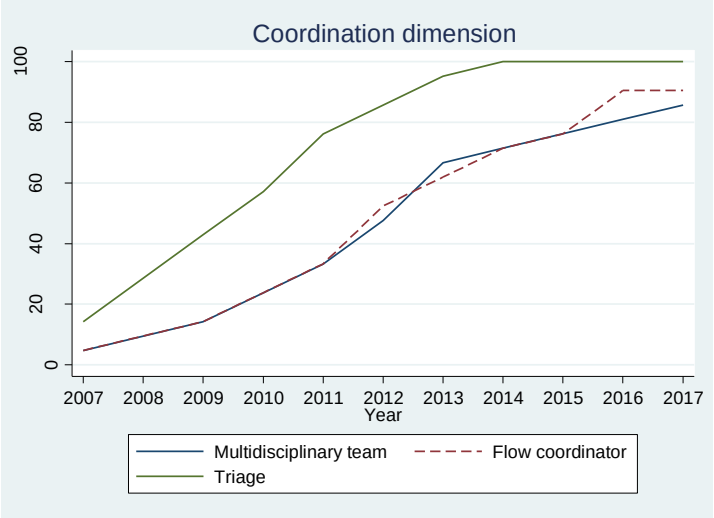
Most Danish EDs have a catchment area between 100,001 and 400,000 citizens, receive cardiology, neurology and other patients, have different staff (qualifications) employed, and a wide range of medical specialties and facilities available. Yet, almost half of the EDs do not have senior physicians present 24/7 and very few have invasive cardiology, both of which are a policy recommendation.

Policy implementation from 2007 to 2017

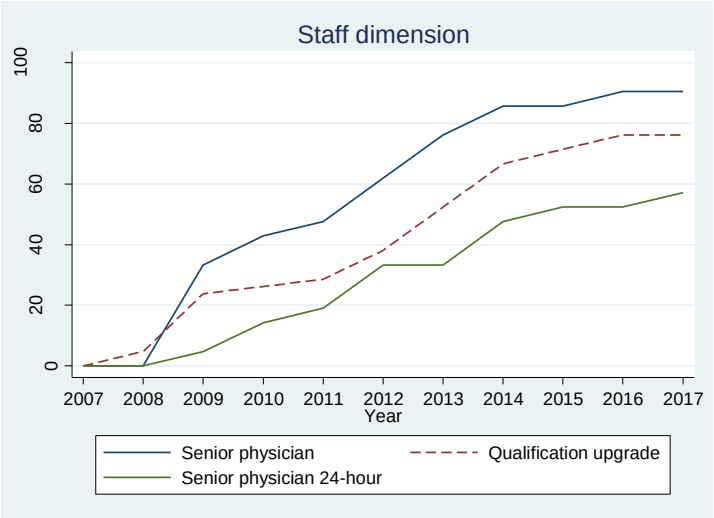
In study I, policy implementation status was assessed, and in Figure 8 the implementation curves are shown categorised according to the organisational design dimension which they match. Overall, we found that the implementation had been a rather slow process, and the policy implementation was still incomplete in 2017. Almost ¼ of the EDs had not implemented all the recommendation in one of the three dimensions. The greater part of the EDs had implemented policy recommendations under the coordination and staff dimension during the 11-year period. None of the recommendations matched the strategy and incentives dimension and the structure dimension had a rather divided implementation, with a low proportion (24%) of specialised equipment available and medium-high proportion of centralisation (76%) in 2017 (Figure 8a). According to the policy, the EDs were recommended to have seven different types of equipment available (mentioned in Table 10), and this definition was also applied in the figure. Yet, the low implementation curve is primarily due to the low level of invasive cardiology availability. The six remaining equipment types are implemented at over half of the EDs. Yet, the 24-hour equipment implementation is even lower and terminates at 10% as the lowest of all recommendations. The lack of available equipment day or night may weaken the ED patient flow and ED autonomy. Centralisation, which in this case is defined as the ED being in the same building was implemented in 76% of the EDs. In many cases, this was dependent on ED facilities being built or modernised. Thus, ED management did not have the main responsibility to achieve this. Generally, the structure dimension relies on external factors, e.g. decisions made at the hospital, regional or national level (such as budgets and building plans). The coordination dimension was characterised by very steep implementation curves that terminated at around 90%, triage being the only one that reached 100% (Figure 8b). It is worth noticing that triage implementation might also be affected by international trends. Triage has been a research topic for several years and is well described and evaluated (Engebretsen et al., 2013; Hinson et al., 2019; Zachariasse et al., 2019).



a)



b)



c)

Figure 8 Policy implementation across organisational design dimensions (Tipsmark et al., 2020d)

Compared to the structure and staff dimensions, these coordination strategies are more easily implemented, since these do not require cooperation with other departments and are not huge economic burdens to the EDs. The staff dimension is implemented at over half of the EDs, with implementation rates from 57% (24-hour availability of senior physicians) to 90% (senior physician employment) in 2017. You could argue it is easier and faster to improve staff qualifications and availability than it is to build or modernise EDs, but not as easy as implementing coordination strategies (Figure 8c). Yet, coordination and staff are more aligned, since it, e.g., ideally requires a senior physician in a multidisciplinary team, and for a team to reach its full potential require some kind of routine (Gholve et al., 2005; Manser, 2009; Sharma et al., 2013), which might best be obtained if the senior physician is employed at the ED. An obstacle for employing senior physicians at the EDs, was the lack of incentives to work at the EDs, which first gained a major improvement in 2017 where emergency medicine was approved as a medical specialty (Sundhedsstyrelsen, 2017a).

Lack of policy recommendations targeting incentives (for senior physicians to work at the ED) appears to be one of the main challenges, causing coordination and recruitment issues that further affect implementation of other policy recommendations. The lack of policy recommendations targeting the strategy dimension (concerning out- or insourcing of ED tasks) seems to have resulted in diverse organisation models in Denmark (Møllekær et al., 2018). The choice of model has been found to be crucial because it influences patient outcome (Møllekær et al., 2019).

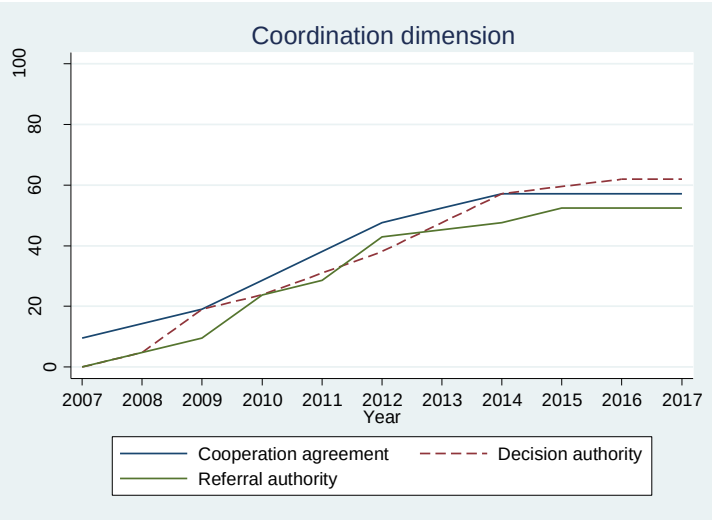


Figure 9 Coordination strategies develop by emergency departments (Tipsmark et al., 2020d)

The majority of EDs (86%) tried to handle the coordination and recruitment challenges by developing new coordination and collaboration strategies, see Figure 9. These were even developed before the new coordination strategies, framed as policy recommendations, were released in 2014. It is worth noticing that neither of the lacking dimensions were targeted in the policy recommendations from 2014.

Effects of introducing increased emergency department autonomy

In study II, the effects of introducing increased ED autonomy were assessed with regard to hip fracture and erysipelas episodes. From Table 11 it appears that episode characteristics have remained stable over time. Hip fracture episodes primarily consist of women (around 68%) around 79 years of age, with 30-day readmission and mortality of approximately 10%. Episode costs seemed to drop in 2015, to some extent explained by implant cost reductions. Slightly more men (56%) than women had an erysipelas episode. Patients were around 62 years of age, and a 30-day readmission and mortality were approximately 13% and 2%, respectively. A potential decrease in episode costs were observed in 2012 and 2015. The implementation curve of increased ED autonomy can be found in Figure 8c under senior physician (employment), which we applied as a proxy.

Table 11 Episode characteristics at selected years (Tipsmark et al., 2020a)

	2008	2012	2015
Hip fracture (n)	**9,341**	**9,016**	**11,236**
Episode mean (SD)			
Male gender (%)	0.30 (0.46)	0.32 (0.47)	0.32 (0.47)
Age (years)	79.06 (12.10)	79.00 (12.06)	78.93 (12.32)
Elixhauser Index[a]	0.26 (0.61)	0.28 (0.66)	0.31 (0.72)
30-day readmission (%)	0.11 (0.31)	0.11 (0.31)	0.09 (0.29)
30-day mortality (%)	0.10 (0.30)	0.10 (0.30)	0.09 (0.28)
Episode cost (DKK 2018)	79,489 (65,486)	75,283 (63,325)	50,533 (55,209)
Erysipelas (n)	**3,224**	**4,338**	**6,433**
Episode mean (SD)			
Male gender (%)	0.56 (0.50)	0.56 (0.50)	0.58 (0.49)
Age (years)	62.73 (17.24)	63.52 (17.60)	60.84 (18.34)
Elixhauser Index[c]	0.48 (0.82)	0.43 (0.79)	0.31 (0.73)
30-day readmission (%)	0.13 (0.33)	0.13 (0.34)	0.14 (0.35)
30-day mortality (%)	0.02 (0.13)	0.02 (0.14)	0.02 (0.13)
Episode cost (DKK 2018)	32,842 (44,985)	26,800 (35,269)	20,020 (34,644)

ED = emergency department, SD=standard deviation

[a] Total, unweighted score (the 19 individual variables cannot be shown according to the General Data Protection Act).

Increased ED autonomy does not seem to have any positive effects, instead higher readmission rates of 3.0% per year (p<0.05) and episode costs 6 % per year (p<0.001) were found in hip fracture episodes, Table 12. This corresponds to an average increase from 889 readmissions and 73,471 DKK per year for EDs without increased autonomy to 915 readmissions and 77,771 DKK per year for EDs with increased autonomy. According to the analytical framework, some advantages of ED autonomy were expected. Decreased 7-day mortality of up to 28% (p<0.001) was also found in Møllekær and colleagues' recent contribution (Møllekær et al., 2019). The effect was assessed in Central Denmark Region from 2011 to 2014. The fact that we applied different study designs (unit of analyses, inclusion criteria and analyses) might explain some of the result differences. Another study analysed performance and costs after the organisational changes of the somatic hospital sector in Denmark since 2007 (which included the ED policy) (Christiansen and Vrangbæk, 2018). The authors found increased hospital productivity and stable costs after 2007. However, hospital staff experienced increased workload pressure. Since the study did not include any patient outcomes, it is difficult to compare the results. Increased productivity does not necessarily result in increased quality of care and improved patient outcomes. However, increased productivity is often used as in indicator of patient accessibility and convenience and it may decrease waiting time, which is service quality to patients.

Table 12 Effects of increased emergency department autonomy and the interaction with admission time (Tipsmark et al., 2020a)

	30-day readmission OR (95% CI)	30-day mortality OR (95% CI)	Episode costs Log cost (95% CI)
Hip fracture			
Increased autonomy	1.030 (1.001-1.059)	1.014 (0.985-1.044)	0.059 (0.049-0.069)
Interaction admission time of day			
07.00 am-10.59 pm	1.026 (0.996-1.055)	1,008 (0.980-1.036)	0.052 (0.040-0.063)
11.00 pm-06.59 am	1.045 (1.012-1.079)	1.038 (1.004-1.072)	0.086 (0.074-0.097)
Erysipelas			
Increased autonomy	0.996 (0.967-1.024)	1,.046 (0.976-1.117)	-0.005 (-0.022-0.011)
Interaction admission time of day			
07.00 am-10.59 pm	0.995 (0.967-1.023)	1.047 (0.982-1.115)	-0.012 (-0.025-0.004)
11.00 pm-06.59 am	1.001 (0.964-1.039)	1.039 (0.947-1.138)	0.080 (0.057-0.100)

OR = odds ratio, CI = confidence interval. Results are coefficients from mixed effects models expressing the effect of each additional year of senior physicians being employed by the emergency department; 30-day readmission and 30-day mortality are OR (95% CI) and episode costs are log cost (95% CI). All estimates are adjusted for all covariates shown in Table 1 (episode-level age, gender and comorbidity and department-level teaching status, episode volume, and average episode costs, 30-day readmission and 30-day mortality).

In Table 12, the sensitivity analysis including an interaction term of admission time was included. We found that night-time episodes are associated with increased readmission (p<0.05) and mortality (p<0.05)

for hip fracture episodes and increased episode costs (p<0.001) for both groups when comparing with day-time episodes. Based on our knowledge of out-of-hours staffing shortage and thereby decreased IP capacity, these results are not surprising. This was also supported by Duvald et al. (Duvald et al., 2018), who found that weekend evening were associated with increased mortality of hazard ratio of 1.32 (95% CI 1.03–1.70, P = 0.027) compared with weekday daytime, and the study states that this may also be the case for out-of-hours on weekdays (Duvald, 2019). A study by Shulzhenko and Obel of hip fracture pathways also found fewer physicians in an ED out-of-hours, causing hip fracture patients not to be prioritised based on level of acuteness (Shulzhenko and Obel, 2015). Moreover, the orthopaedists taking regular shifts had no incentives to take part in the hip fracture treatment in the EDs because, they were not satisfied with the ED working conditions and felt that the orthopaedic issues in the ED were not challenging enough. These results underlines the difficulties of combining functionally oriented specialised departments (non-ED autonomy) and the process-oriented workflow of the EDs (ED autonomy), which must be dealt with to secure performance (Burton et al., 2015; Robert Duncan, 1979).

All organisational design strategies were also tested in a sensitivity analysis in our model. They were used as alternative specifications of increased autonomy, Table 13.

Table 13 Sensitivity analyses based on alternative specification of emergency department autonomy (Tipsmark et al., 2020a)

	30-day readmission OR (95% CI)	30-day mortality OR (95% CI)	Episode costs Log cost (95% CI)
Hip fracture			
Senior physicians employed at the ED	1.004 (0.886-1.137)	1.004 (0.887-1.135)	0.067 (0.028-0.105)
Senior physicians 24-hour	0.944 (0.827-1.076)	1.120 (0.982-1.276)	-0.113 (-0.154- -0.070)
External senior physicians	1.035 (0.925-1.158)	0.960 (0.857-1.073)	-0.220 (-0.256- -0.184)
Flow coordinator	0.967 (0.859-1.089)	0.989 (0.876-1.114)	0.113 (0.077-0.150)
Multidisciplinary teams	1.049 (0.929-1.176)	1.077 (0.954-1.214)	-0.070 (-0.105- -0.035)
Decision authority	1.138 (1.021-1.267)	1.020 (0.913-1.137)	0.056 (0.021-0.092)
Facilities in one building	0.978 (0.865-1.104)	1.025 (0.907-1.158)	0.086 (0.044-0.128)
Erysipelas			
Senior physicians employed at the ED	0.797 (0.685-0.927)	1.380 (0.986-1.920)	0.178 (0.105-0.251)
Senior physicians 24-hour	1.004 (0.857-1.176)	0.882 (0.631-1.234)	-0.284 (-0.365- -0.202)
External senior physicians	0.974 (0.853-1.112)	0.650 (0.477-0.883)	-0.221 (-0.290- -0.152)
Flow coordinator	1.056 (0.910-1.225)	1.251 (0.885-1.762)	0.094 (0.025-0.163)
Multidisciplinary teams	1.220 (1.051-1.415)	1.150 (0.800-1.660)	-0.060 (-0.126- 0.008)
Decision authority	0.928 (0.815-1.056)	0.764 (0.571-1.022)	0.192 (0.118-0.265)
Facilities in one building	0.935 (0.820-1.067)	1.140 (0.853-1.522)	0.416 (0.332-0.498)

OR odds ratio, CI confidence interval, ED emergency department

Results are coefficients from mixed effects models expressing the effect of each additional year of senior physicians being employed by the emergency department; 30-day readmission and 30-day mortality are OR (95% CI) and episode costs are log cost (95% CI). All estimates are adjusted for all covariates shown in Table 1 (episode-level age, gender and comorbidity and department-level teaching status, episode volume, and average episode costs, 30-day readmission and 30-day mortality).

Generally, readmission and mortality are insignificant, whereas costs are significant. This means that cost is the largest methodological uncertainty concerning organisational design strategies used to define ED autonomy. Additional sensitivity analyses were preformed, e.g. alternative specifications of the outcome measure and the effect of weekend admissions, an overall they did not change results of the analyses.

Exploring other organisational and methodological factors

To further explore the notion that the missing positive effect is not caused by the methodological factors, a new approach was tested. The intervention might need some time to be fully operational and most effective. Hence, we excluded the implementation year of senior physician employment and the year after, and year since implementation was first counted hereafter. Nevertheless, this did not change the overall direction of the results, and for most of the outcomes it was even less in favour of the intervention. In acknowledgement of the diversity of the ED settings, I further excluded the three smallest EDs form the analysis (they would have the least favourable conditions to implement the policy recommendations), and this did not change the results.

Organisation determinants of diagnostic discrepancy

As we did not find any major effects on the health outcome related to the policy, we will assess the diagnostic quality at the ED, which is an intermediate outcome related to the process quality at the ED. From the hip fracture episodes, diagnostic discrepancy was found in 3.3% and 8.5% from erysipelas episodes, Table 14. Overall, episodes with and without diagnostic discrepancy did not differ, except for 30-day mortality (hip fracture) and 30-day readmission (erysipelas). At the department level, 30-day mortality differed (hip fracture). By incorporating all the organisational design dimensions, we might get some guidance regarding how to organise an ED and we could comment on tendencies.

Table 14 Episode and department characteristics for patients without and with diagnostic discrepancy (Tipsmark et al., 2020b)

	Hip fracture (n=69,928)			Erysipelas (n=37,558)		
	No diagnostic discrepancy (n=67,620, 96.7%)	Diagnostic discrepancy (n=2,308, 3.3%)	p- value	No diagnostic discrepancy (n=34,352, 91.5%)	Diagnostic discrepancy (n=3,206, 8.5%)	p- value
Episode means (SD)						
Male gender (%)	0.31 (0.46)	0.38 (0.49)	<0.001	0.57 (0.49)	0.56 (0.50)	0.093
Age (years)	78.73 (12.30)	77.89 (12.63)	<0.001	61.46 (17.82)	67.55 (16.33)	<0.001
Elixhauser index[a]	0.27 (0.65)	0.50 (0.88)	<0.001	0.36 (0.74)	0.69 (0.96)	<0.001
30-day readmission (%)	0.09 (0.29)	0.14 (0.35)	<0.001	0.13 (0.34)	0.14 (0.34)	0.283
30-day mortality (%)	0.09 (0.29)	0.10 (0.30)	0.139	0.01 (0.11)	0.02 (0.15)	<0.001
Episode cost (2018-DKK)	61,682 (45,458)	101,823 (78,770)	<0.001	20,818 (27,610)	44,645 (44,191)	<0.001
Departments means (SD)						
Teaching status (%)	0.22 (0.41)	0.32 (0.47)	<0.001	0.17 (0.38)	0.37 (0.48)	<0.001
Episode volume (n)	549 (216)	502 (189)	<0.001	350 (252)	273 (166)	<0.001
30-day readmission (%)	0,10 (0.05)	0.10 (0.03)	<0.001	0.13 (0.03)	0.13 (0.03)	<0.001
30-day mortality (%)	0.10 (0.02)	0.10 (0.02)	0.360	0.02 (0.01)	0.02 (0.01)	<0.001
Episode cost (2018-DKK)	73,048 (22,766)	80,913 (24,538)	<0.001	32,047 (22,362)	33,563 (21,300)	<0.001

ED = emergency department, SD= standard deviation
[a] Total, unweighted score (the 19 individual variables cannot be shown according to the General Data Protection Act).

From Table 15 we find that the employment of senior physician substantially increases the diagnostic discrepancy. Yet, diagnostic discrepancy does not seem to be related to the senior physician because the available of senior physicians 24/7 and external senior physicians decreases diagnostic discrepancy. Thus, patients should be diagnosed by senior physicians and not junior physicians. Furthermore, it appears that senior physician employment is an important organisational design strategy, confirming our choice of study II.

Table 15 Organisational determinants of diagnostic discrepancy (Tipsmark et al., 2020b)

	Hip fracture (n=69,928)		Erysipelas (n=37,558)	
Organisational determinants	Definition 1[1] OR (95% CI)	Definition 2[2] OR (95% CI)	Definition 1[1] OR (95% CI)	Definition 2[2] OR (95% CI)
Senior physicians employed at the ED	2.75 (2.15-3.50)	3.59 (2.72-4.74)	3.29 (2.65-4.08)	3.59 (2.86-4.50)
Senior physicians 24-hour	0.68 (0.53-0.88)	0.64 (0.47-0.84)	1.09 (0.86-1.37)	1.23 (0.96-1.56)
External senior physicians	0.50 (0.39-0.65)	0.50 (0.38-0.66)	0.44 (0.36-0.54)	0.41 (0.33-0.50)
Flow coordinator	0.97 (0.75-1.23)	0.97 (0.75-1.28)	0.69 (0.55-0.84)	0.61 (0.49-0.75)
Multidisciplinary team	1.50 (1.19-1.88)	1.42 (1.10-1.82)	1.40 (1.15-1.70)	1.52 (1.24-1.85)
Decision authority	1.83 (1.47-2.27)	1.94 (1.52-2.47)	1.80 (1.49-2.18)	1.77 (1.45-2.15)
Facilities in one building	0.65 (0.52-0.81)	0.52 (0.41-0.67)	1.39 (1.13-1.73)	1.39 (1.11-1.75)

ED=emergency department, CI = confidence interval, OR = odds ratio
[1]Hierarchically and diagnostically different diagnoses were defined as diagnostic discrepancy
[2]Diagnostically different diagnoses were defined as diagnostic discrepancy. All estimates are adjusted for episode-level age, gender and comorbidity and department-level teaching status, episode volume, and average 30-day readmission, 30-day mortality and episode costs.

Diagnostic quality is related to the IP requirements and IP capacity at the ED. Senior physicians provide IP capacity to the ED, which our results confirm. Although employing senior physicians could provide a more stable IP capacity, this was is not confirmed by the results. One could ponder whether this reflects the general level of emergency medicine expertise and ED experience of the senior physicians who have been employed at the EDs. If a senior orthopaedist is employed at the ED, it is most reasonable that he or she takes care of orthopaedic patients. But if the orthopaedist is the only available resource at the time of admission of a diabetic patient, the orthopaedist must handle this situation in the best way possible. On the other hand, if the orthopaedist was only called upon when an orthopaedic patient was in need of their clinical expertise, this would be a better match. The medical specialty of emergency medicine might improve this imbalance over time.

Sensitivity analyses only including senior physician employment as organisational strategy, did not change the results of senior physician employment's association with diagnostic discrepancy, further confirming the importance of senior physician employment and our choice in study II.

Effect of diagnostic discrepancy

Diagnostic discrepancy is found to increase 30-day readmission by 45% and episode costs by 79% for hip fracture episodes and 171% for erysipelas episodes, Table 16. This is corresponding to a mean increased of 30-day readmission from 9.45% to 13.76% ($p<0.001$) comparing hip fracture episodes with no diagnostic discrepancy and episodes with diagnostic discrepancy. Concerning episode costs this corresponds to an

increase from mean 61,681 DKK to 109,860 DKK (p<0.001) for hip fracture episodes and from mean 20,818 DKK vs 56,329 DKK (p<0.001) for erysipelas episodes compared with episodes without DD.

Table 16 Consequences of diagnostic discrepancy (Tipsmark et al., 2020b)

	30-day readmission OR (95% CI)	30-day mortality OR (95% CI)	Episode costs Log cost (95% CI)
Hip fracture (n=69,928)			
Definition 1[1]	1.45 (1.27-1.65)	1.10 (0.94-1.29)	0.58 (0.53-0.63)
Definition 2[2]	1.41 (1.23-1.62)	1.07 (0.90-1.27)	0.57 (0.52-0.62)
Erysipelas (n=37,558)			
Definition 1[1]	0.98 (0.87-1.10)	1.20 (0.91-1.57)	1.00 (0.93-1.05)
Definition 2[2]	1.00 (0.89-1.13)	1.23 (0.92-1.61)	0.98 (0.92-1.04)

OR = odds ratio, CI = confidence interval,
[1]Hierarchically and diagnostically different diagnoses were defined as diagnostic discrepancy
[2]Diagnostically different diagnoses were defined as diagnostic discrepancy.
All estimates are adjusted for the covariates: episode-level age, gender and comorbidity and department-level teaching status, episode volume, and average 30-day readmission, 30-day mortality and episode costs.

Mechanisms leading to suboptimal diagnoses have previously been assessed (Bartlett, 1998; Berner and Graber, 2008; Graber et al., 2005; Hautz et al., 2019; Moonen et al., 2017; Van Den Berge and Mamede, 2013), and one of these studies (Graber et al., 2005) found diagnostic errors to be associated with system-related and cognitive factors, including teamwork, as also found in the present study. Increased costs have been found to a potential consequences of diagnostic error (Schaffer et al., 2017; Thomas et al., 1999) and a recent study found increased in-hospital mortality and length of stay among patients with diagnostic discrepancy (Hautz et al., 2019). This study is the most comparable, due to methodological similarities (used diagnostic discrepancy and both reported health and quality of care outcomes). In-hospital mortality was included in our 30-day measure (since it is recorded as from the day of diagnosis), yet we still found no effects on this outcome. The difference in mortality between the two studies may therefore be due to other methodological differences, e.g., size of study population and included diagnoses.

Discussion

The studies of this PhD project were performed to evaluate different aspects of the Danish policy on ED organisation. In Study I, we found that policy implementation was hesitant and varied across organisational dimensions. The highest implementation rate applied to the coordination dimension (multidisciplinary teams, triage, flow coordinator); the lowest to the structure dimension (specialised equipment and centralisation). The policy was found not to include recommendations targeting the dimensions of strategy and incentive structure. In Study II, we found that increased ED autonomy (senior physician employment) increased 30-day readmission and episode costs only for hip fracture episodes. ED admission during night-time at hospitals with ED autonomy was associated with increased 30-day readmission and 30-day mortality for hip fracture episodes and increased episode costs for both patient groups. In Study III, we identified organisational determinants associated with diagnostic discrepancy, and found that senior physician employment was the strongest determinant. Moreover, diagnostic discrepancy was associated with increased 30-day readmission among hip fracture episodes and increased episode costs in both groups. The literature review produced little evidence that the organisational design strategies of the policy were instrumental in securing the overall policy goals of improving quality of care and health and containing costs. Adverse effects could have been overlooked because of the narrow outcome perspective of the studies reviewed. The choice of effect measures seems to hinge on geographical location and hospital governance. Furthermore, the complexity of some of the strategies obscures efforts to identify whether the effect depends on the implementation of several strategies or just a single one.

Potential explanations for studies

According to Donabedian's quality of care definition (Donabedian, 1988), we have analysed all three aspects: structure (Study I), outcome (Study II) and process (Study III). Policy implementation was slow and incomplete as demonstrated in Study I and had few major policy implications, as shown in Study II. One could therefore argue that it might take a while before it is possible to detect any positive policy effects, especially as far as patients' outcomes are concerned. Moreover, the outcomes may simply not have been sensitive enough. Confirming that time and sensitivity were not the reason, we found no effects favouring the policy we assessed an intermediate outcome in Study III. In Study III, we identified which

organisational determinants were associated with diagnostic discrepancy. Contrary to our expectations, senior physician employment was positively associated with diagnostic discrepancy. Yet, this may reflect a mismatch between seniors' qualifications and patients' needs, since senior physician employment was negatively associated with diagnostic discrepancy under the organisational design dimension 'external senior physicians'. Overall, the results of the PhD studies seem to be affected by the continuous changes in ED's organisation and context. For example, many of the EDs moved to new or modernised buildings. Hence, the ED facilities were not available from day one, which caused set-ups to be temporary; indeed, some of the EDs are still awaiting new facilities (Danske Regioner et al., 2016). Furthermore, incentives to cooperate with the ED and incentives to work in the ED seem to be key factors in the implementation process and in the ED's organisational design (Duvald, 2019; Møllekær et al., 2018; Shulzhenko and Obel, 2015; Tipsmark et al., 2020d). Provision of such incentives could potentially benefit patient's health and staffs' wellbeing (Duvald et al., 2018; Møllekær et al., 2019; Shulzhenko and Obel, 2015). One could ponder if incentives could exchange cooperation for collaboration, bringing involved parties together and through concerted action obtain the shared goal of providing the best care for emergency patients. To achieve this, it would seem particularly important to achieve a high degree of involvement from the external, collaborating departments, for example concerning the working conditions at the ED (Shulzhenko and Obel, 2015).

Organisational studies have taught us that reorganisation can be very difficult and is seldom beneficial (Burton et al., 2015); in fact, studies found that organisational changes could lead to anxiety and stress among staff, causing productivity and motivation to decline (Beauchamp and Bray, 2001; Dahl and Pierce, 2019; Parker et al., 2017). Another study found that 80% of organisations failed to achieve the intended results, and pursuing change harmed the organisation in 10% of cases (Heidari-Robinson and Heywood, 2016). The study reported that some of the main pitfalls were resistance from staff and/or leaders, insufficient resources to achieve change (people, time and money), staff resignation due to numerous organisational changes and unplanned activities arising, e.g., due to unforeseen challenges. These observations are very well aligned with the challenges confronting the EDs studied in the present PhD dissertation. For instance, unforeseen challenges could be the lack of experts in acute conditions to handle acute patients and lack of suitable facilities to support the new organisational design. These challenges make up some of the organisational misfits in the EDs. Then, if an organisation suffers from organisational

misfits, managers might try to fix the situation by changing other organisational design dimensions. However, this very often leads to even more misfits, at least temporarily, until the organisational designs has been fully aligned (the organisational misfits develop like an inverted u curve) (Burton et al., 2020). Recent studies also found that when a design is not fully planned and executed, systems tend to self-evolve (Livijn, 2020; Pedersen, 2018). Hence, coordination mechanisms seem to have been created in the absence of policy-given design principles (Study I). This can create role conflict and role confusion (Corkindale, 2011). These issues become even more important when the implementation period is long and changes have not been planned in the right order (Baum and Wally, 2003; Burton et al., 2015). We hope that the current organisational changes in the ED have passed the top of the curve, so that we may see future results favouring the new organisation.

Challenges of measuring organisational change

Difficulties in measuring organisational change are numerous; first, an organisation is multidimensional. The multi-contingency model states that 14 dimensions of an organisation can be measured; we chose to include only five of them in our analytical framework (Burton et al., 2015). Moreover, theories use different definitions of measuring organisational change (Kates and Galbraith, 2010; Miles et al., 1978; Quinn and Rohrbaugh, 1983). Our choice of measurement was informed by the insights of previous studies of the Danish ED setting (Møllekær et al., 2019, 2018), where ED clinical experts and organisational experts were involved in choosing relevant organisational design dimensions. Thus, they validated our choice, but this is no guarantee that the right choice was made. Second, the long study period increased the likelihood that other initiatives were implemented aimed at improving the quality of care of ED patients. Third, we cannot expect the effects of organisational change on patient outcomes to be similar in all contexts. Local ED characteristic such as culture, tradition and performance are important factors. Furthermore, the structure of the non-ED part of the hospital as well as prehospital and municipal initiatives also have an impact. Many of these characteristics are exceedingly difficult to measure. Moreover, their characteristics cannot be extracted from data held in registers, and they are therefore unobserved characteristics in this PhD project. One could argue that 21 separate analyses of each ED should have been performed. Yet, the objective of this PhD study was to analyse the effect at the national level.

Challenges of measuring effects

Measuring effects of organisational change may be even more difficult since the above-mentioned obstacles also apply to the choice of effect measure. The effect measures in the studies of this PhD dissertation were selected from the Triple Aim framework, which describes an approach to optimise health system performance. This framework argues that new organisational designs must be established to simultaneously achieve the Triple Aim dimensions: improved population health, enhanced patient-experienced quality and cost containment (Berwick et al., 2008; IHI, 2014). Mortality was applied as a health measure; yet, more disease-specific outcomes could have been applied instead. As far as measuring patient-experienced quality was concerned, the original thought was to include LUP data. However, CPR numbers are not stored with LUP data, so we were unable to use LUP data in this study. Instead, readmission was chosen as a quality measure. Still, other measures could have been applied, e.g. a process time measure. In Study III, diagnostic quality was applied as a quality measure and as an intermediate outcome. Instead of evaluating outcome from a patient perspective, we could have chosen staff's perspective by measuring their satisfaction; or we could have obtained staff's evaluation of the reorganisation. Alternatively, a system perspective could have been adopted, e.g., by monitoring waiting time or productivity (which has previously been done (Christiansen and Vrangbæk, 2018)).

Other aspects of internal validity

Aspects of internal validity as discussed above were also discussed in the Method section. Some of the most important factors are potential recall and selection bias in Study I and lack of randomisations in Study II and III. Recognising the many obstacles and uncertainties associated with measuring effects of organisational changes, I acknowledge that our results are only an indication of possible policy effects.

Generalisability

The study results are to some extent generalisable to publicly financed healthcare systems where EDs are the main entrance to the hospital. In Study I, we found that slow implementation might be related to the missing linkage of policy with theory. The incomplete design plan could have led the ED managers to develop a new solution. Yet, linking policy and theory might improve the translation from policy into practice (Craig et al., 2008; Tipsmark et al., 2020d), and this would presumably apply in all settings (national and abroad). In Study II, the results are more difficult to extrapolate to different settings as they

presumably illustrate the organisational misfits that were present during the study period. Hence, the effects are context dependent. Yet, the discussion of the mechanisms of action (mismatch of resources, lack of incentives, chaotic context, synergistic effects) is generic. In Study III, some of the same issues apply. Organisational determinants can influence the likelihood of diagnostic discrepancy in all settings; however, other organisational determinants may be important in other settings. Diagnostic discrepancy is a more general issue and something that can be measured and appraised in all settings; therefore, the conclusion that diagnostic discrepancy can affect outcomes is generalisable.

Limitations

As discussed in the method section, several limitations apply to each study. Some are the missing episode cost data and the unobserved characteristics. In the literature review, the literature search was performed in May 2016; hence, relevant studies might have been published in the meantime. An updated search revealed nine relevant studies. The most relevant studies have been discussed in this dissertation (Christiansen and Vrangbæk, 2018; Duvald et al., 2018; Møllekær et al., 2019). In the remaining studies, three are from Nordic countries (Liu et al., 2019, 2018; Mustonen et al., 2017), one from England (Wilkinson et al., 2019), one from Turkey (Basak, 2017) and one from Australia (Burke et al., 2017).

Conclusion

From the studies in this PhD dissertation, we conclude that some literature does assess ED policy recommendations; yet, limited evidence was found to support overall policy goal achievement. Furthermore, we found that policy implementation has come a long way. Yet, the implementation remains incomplete and heterogeneous. The implementation seems to be related to difference in ED contexts. Lastly, we found organisational design to have an impact on diagnostic quality and patients' outcomes and that it affected diagnoses differently.

Contributions

Several studies on ED organisation found organisational design to be associated with patient outcomes (Duvald, 2019; Duvald et al., 2018; Møllekær et al., 2019) which we can confirm (Study II and III). In addition, we also found organisational design to be associated with episode costs. According to the literature of diagnostic quality, a recent study found diagnostic discrepancy to increase mortality and

length of stay. Furthermore, they analysed patient and physician characteristics, but found no association with diagnostic discrepancy (Hautz et al., 2019). Thus, they recommended to assess the ED context instead. We analysed the organisational design and found it to be associated with diagnostic discrepancy. Furthermore, we can confirm that diagnostic discrepancy is associated with patient outcomes. In addition, we also found that diagnostic discrepancy increased episode costs.

From contingency theory, we know that some dimensions are easier to change than others, for example management and climate are more difficult to change than formalisation (reflects the organisation's rules). Thus, it is easy to change or ad a rule, but it is more difficult to get staff to follow the rule, which is related to incentives (Burton et al., 2020). However, to ensure that change is successful, the dimensions must be implemented in a particular order; e.g., it is best to implement structure before coordination (Burton et al., 2015; Burton and Obel, 2018). In the Danish ED, we found that coordination was the first implemented organisational design element and structure was the last to be implemented (Study I). Thus, we can confirm that there is a preferred order of implementation in the Danish EDs, albeit this is not in accordance with the literature.

Policy implications

To ensure an optimal effect of the process of redesigning an organisation, design decisions must be aligned for all organisational dimensions in the multi-contingency model (Burton et al., 2015). Accordingly, before releasing a policy, its preconditions must be specified and brought into place. This was not the case for the ED policy in the present setting where resources were lacking, e.g. senior emergency physician staffing for handling emergency patients, and facilities and equipment for supporting the new organisation. These challenges led to hesitant and heterogeneous policy implementation, which was hardly surprising (Burton et al., 2020; Burton and Obel, 2018; Tushman and Nadler, 1978). Nor is it surprising that EDs developed new coordination strategies to handle the most pertinent issues (Livijn, 2020; Pedersen, 2018). Drawing on evidence from multiple disciplines relevant to the policy question, we might be able to identify an optimal design reflecting the particular situation and context of the Danish EDs. Furthermore, to ensure that the organisational changes are progressing as intended and to ensure a quick solution to the implementation issues, frequent policy evaluation seems to be a must (follow-up reports and research). A singular focus on policy would risk ignoring the importance implementation which has the largest effect on treatment.

The findings of the present PhD dissertation offer no incentive for ED managers and policy makers to change the ED's organisation. However, this PhD does confirm that important issues need to be further investigated from a clinical and a political point of view.

Perspectives and future research

Highly agile organisations seem to have an advantage as they can accomplish change more effectively than less agile organisations (Burton et al., 2020). Thus, it would be interesting to analyse the effects of the EDs' agility. Furthermore, as the EDs' context was very turbulent during (e.g. moving to new or modernised facilities) the study period, it would be interesting to account for this factor in our analyses.

Our results indicate that there are some effect differences between the two patient groups, most likely due to different diagnosing and treatment requirements. Hence, to increase the external validity, it would be relevant to analyse the effects on additional patient groups entering through the ED.

Due to the Covid-19 pandemic, significant ED organisational changes have occurred over the past year (Hvidovre Hopsital, 2020; NB Nyt, 2020). This might be an indication of the effect of cooperation turning into collaboration, and it will be interesting to study the derived effects of this pandemic on the ED organisation.

In October 2020, 33 new policy recommendations of emergency medicine care in Denmark were announced (Sundhedsstyrelsen, 2020). Compared to the 2007 policy recommendations, these recommendations are directly addressing which competences need to be available at the ED and the rest of the hospital, and they advocate the sharing of senior physician competencies among hospitals. Moreover, to ensure a homogeneous quality of care, the EDs need to fulfil the long-term recommendation of staffing senior physicians at the frontline. For the first time, the recommendations also cover the municipalities' emergency initiatives with a view to strengthening cooperation between all the emergency initiatives and cooperation must be improved to ensure that equal attention is devoted to psychiatric and somatic aspects of health. These new recommendations are much in line with some of the thoughts presented in the present dissertation. In the future, it would be interesting to analyse the emergency care at hospitals including psychiatric patients and to analyse the effects from a societal perspective including primary sector data.

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Appendices

Appendix 1 Search strategy

Embase:

#1 'emergency medicine':ti,ab OR 'emergency department*':ti,ab OR 'emergency unit*':ti,ab OR 'emergency room*':ti,ab OR 'Accident and Emergency Department*':ti,ab OR 'Emergency Ward*':ti,ab OR 'Acute medical unit*':ti,ab OR 'emergency hospital*':ti,ab OR 'acute hospital care*':ti,ab

#2 'crowding*':ab,ti OR 'workload':ab,ti OR 'patient flow':ab,ti OR centralization:ab,ti OR centralisation:ab,ti OR centralized*:ab,ti OR centralised*:ab,ti OR 'interdisciplinary team*'':ab,ti OR ‘team work’':ab,ti OR 'triage':ab,ti OR 'education':ab,ti OR 'clinical competenc*':ab,ti OR 'clinical skill*':ab,ti OR 'chief physician*':ab,ti OR 'medical specialist*':ab,ti OR 'specialist doctor*':ab,ti OR 'consultant physician*':ab,ti AND [embase]/lim

#3 'outcome*':ti,ab OR 'effect*':ti,ab OR 'consequence*':ti,ab OR 'reduce*':ti,ab OR 'reduction*':ti,ab OR 'increase*':ti,ab OR 'increasing*':ti,ab) NOT ('qualitative research'/exp OR 'Qualitative':ti OR 'cross-sectional study'/exp OR 'cross-sectional study':ti OR 'cross-sectional studies':ti

#1 AND #2 AND #3

Filter: Publications after 01.01.2005

Pubmed

#1 ((Emergency department*[Title/Abstract] OR Emergency Unit*[Title/Abstract] OR Emergency Room*[Title/Abstract] OR "Accident and Emergency Department*"[Title/Abstract] OR Emergency

Ward*[Title/Abstract] OR Acute medical unit*[Title/Abstract] OR Emergency Service*[Title/Abstract] OR acute hospital care*[Title/Abstract] OR emergency medicine*[Title/Abstract]) NOT (Psychiatr*[Title/Abstract] OR mental illness*[Title/Abstract] OR Mental disorder*[Title/Abstract] OR Paediatri*[Title/Abstract] OR Pediatri*[Title/Abstract] OR prehospital*[Title/Abstract] OR paramedic*[Title/Abstract] OR children*[Title/Abstract] OR newborn*[Title/Abstract] OR infant*[Title/Abstract] OR neonates*[Title/Abstract]))

#2 (Crowding[Title/Abstract] OR "Workload"[Mesh] OR "patient flow"[Title/Abstract] OR centralization[Title/Abstract] OR centralisation[Title/Abstract] OR "Centralized Hospital Services"[Mesh] OR "Patient Care Team"[Mesh] OR interdisciplinary team*[Title/abstract] OR triage[Title/Abstract] OR education[Title/Abstract] OR Clinical Competenc*[Title/Abstract] OR clinical skill*[Title/Abstract] OR chief physician*[Title/Abstract] OR medical specialist*[Title/Abstract] OR specialist doctor*[Title/Abstract] OR consultant physician*[Title/Abstract])

#3 (("Cohort Studies"[Mesh] OR "cohort study"[Title] OR "Cohort studies"[Title] OR controlled clinical trial[Publication Type] OR "Case-Control Studies"[Mesh] OR (case*[Title] AND control*[Title])) AND (outcome*[Title/Abstract] OR effect*[Title/Abstract] OR consequence*[Title/Abstract] OR reduce*[Title/Abstract] OR reduction*[Title/Abstract] OR increase*[Title/Abstract] OR increasing*[Title/Abstract]) NOT (Qualitative[Title] OR "Qualitative Research"[Mesh] OR "Cross-Sectional Studies"[Title] OR "Cross-Sectional Study"[Title] OR "Cross-Sectional Studies"[Mesh]))

#1 AND #2 AND #3

Filter: English, Danish + publications after 01.01.2005

Cinahl

#1 AB "emergency medicine" OR AB "emergency department*" OR AB "Emergency Unit*" OR AB "Emergency Room*" OR AB ("Accident and Emergency Department*") OR AB "Emergency Ward*" OR AB "Acute medical unit*" OR AB "Emergency Service*" OR AB "acute hospital care*" NOT (AB Psychiatr* OR AB "mental illness*" OR AB "Mental disorder*" OR AB Paediatri* OR AB Pediatri* OR AB prehospital* OR AB paramedic* OR AB children* OR AB newborn* OR AB infant* OR AB neonates*)

#2 (MH “Crowding) OR (MH "Workload") OR AB "patient flow" OR AB centralization OR AB centralize* OR

(MH "Multidisciplinary Care Team+") OR (MH “Triage”) OR AB education OR AB Clinical Competenc* OR AB clinical skill* OR AB “chief physician*” OR AB “medical specialist*” OR AB “specialist doctor*” OR AB “consultant physician*”

#3 (MH "Randomized Controlled Trials") OR (MH "Case Control Studies") OR (MH "Double-Blind Studies") OR (MH "Prospective Studies") OR (MH "Concurrent Prospective Studies") OR (MH "Nonconcurrent Prospective Studies") OR (MH "Panel Studies") OR (MH "Pseudolongitudinal Studies") OR (MH "Single-Blind Studies") OR (MH "Triple-Blind Studies") OR (MH "Correlational Studies") OR TI "cohort study" OR TI "cohort studies" OR TI (case AND control) AND (AB outcome* OR AB effect* OR AB consequence* OR AB reduce* OR AB reduction* OR AB increase* OR increasing*) NOT (TI Qualitative OR TI "Cross-Sectional Studies" OR TI "Cross-Sectional Study" OR (MM "Cross Sectional Studies") OR (MM "Qualitative Studies"))

#1 AND #2 AND #3

Filter: English, Danish + publications after 01.01.2005

EconLit

#1 (ab("emergency department*" OR "emergency unit*" OR "accident and emergency department*" OR "emergency room*" OR "Emergency Ward*" OR "acute medical unit*" OR "emergency service*" OR “emergency medicine*”) NOT ab(Psychiatr* OR "mental illness*" OR "Mental disorder*" OR Paediatri* OR Pediatri* OR prehospital* OR paramedic* OR children* OR newborn* OR infant* OR neonates*))

#2 ab(crowding OR workload* OR "patient flow" OR centralization OR centralisation OR Centralize* OR centralise* OR "interdisciplinary team*" OR “team work*” OR triage OR education OR "Clinical Competence*" OR “clinical skill*” OR "chief physician*" OR "medical specialist*" OR "specialist doctor*" OR "consultant physician*")

#1 AND #2

Filter: English, Danish + publications after 01.01.2005 + Scholarly Journals

RePec

#1 (("emergency department*" | "emergency unit*" | "accident and emergency department*" | "emergency room*" | "acute medical unit*" | "Emergency Ward*" | "emergency service*" | "emergency medicine") ~ (Psychiatr* | "mental illness*" | "Mental disorder*" | Paediatri* | Pediatri* | prehospital* | paramedic* | children* | newborn* | infant* | neonates*))

#2 (crowding | workload | "patient flow" | centralization | centralisation | Centralize* | Centralise* | "interdisciplinary team*" | “team work” | triage | education | "Clinical Competence*" | “clinical skill*” | "chief physician*" | "medical specialist*" | "specialist doctor*" | "consultant physician*")

#1 AND #2

Filter: Publications after 01.01.2005

Appendix 2 Systematic review method

Selection of published studies

After duplicates were removed, there were 1,622 remaining studies that were left after the first screening process; 1,545 studies were excluded based on title and abstract; 77 studies were identified for inclusion in full-text review. There were 49 studies that were excluded for the following reasons: interventions not relevant in to the scope of this study (n = 31); a study design that did not comply with the eligibility criteria (n = 8); no full-text of the publication available (n = 6); a non-ED setting (n = 2). There were 28 studies in the final assessment.

Following review and discussion (between Line Stjernholm Tipsmark (LST), Ann Sønderdahl (AS) and Rikke Søgaard (RS)), six organisational design strategies were identified as distinct organisational designs: 'physician in triage', 'senior physician', 'flow coordinator', 'multidisciplinary team', 'Centralisation', and 'availability of specialised equipment', referred to as 'equipment'.

Thirty-nine percent of the publications (11 out of 28) combined two or three of the selected organisational design strategies in their studies (Sharma et al. and Travers et al. are the only articles that appear in three strategies). Furthermore, the majority of studies included more than one effect measure, leading to 28 studies representing 98 analyses.

Eligibility criteria for published studies

The search strategy was based on three eligible criteria relating to the following: the field of research, the organisational design, and the study design. The field of research was emergency medicine practiced in EDs or acute medical units. Excluding studies concerning emergency psychiatric departments or patients and emergency paediatric departments or patients. The organisational design strategies were themes of the Danish Health Authority's recommendations regarding organisation of emergency service in Denmark (Sundhedsstyrelsen, 2007) and included: centralisation; triage; interdisciplinary teams; patient flow; staff qualification; use of senior physicians instead of junior doctors when consulting patients.

Original longitudinal studies analysing outcome measures based on quantitative data were included. A modified version of the British Medical Journal (BMJ) search strategy for cohort studies was applied (BMJ Clinical Evidence, 2012). Study design was not applicable in the and RePEc search.

Identification of published studies

The identified studies were initially screened by title and abstract by two independent reviewers (LST and AS). Studies that met the eligible criteria were obtained as full-text versions. The reviewers independently examined the full-text publications to ensure eligibility. If there were disagreements regarding study eligibility, a consensus was reached based on discussion. The reasons for exclusion of publications were recorded.

Data collection

A summary of the findings and study data were recorded in table form, independently by two reviewers (LST and AS). The data that was tabulated and analysed included the nature of the published study, country, setting, population, design, baseline findings, organisational designs, effect measures, and authors' main findings. Differences in the assignment of data extraction were resolved by discussion.
In the interpretation of results, the effect measures were categorised according to multifaceted policy goals including health outcome, quality and cost (Berwick et al., 2008). To explore the effect of the study methods, results were further summarised in relation to testing more than one organisational design strategy and in relation to the choice of effect measures.

Appendix 3 List of studies categorised according to organisational design strategies

Table 17 Summary of findings 'multidisciplinary team'

Study	Setting	Population	Design	Baseline	Intervention	Organisational designs	Effect measures	Authors' main findings
Imperato, J. et al. 2012. USA	A 23-bed ED in a community teaching hospital, with 36,000 adult and paediatric patients annually	ED patients, 17,631 visits: 8,620 pre-intervention and 9,011 post-intervention	Retrospective 3 months before-and-after study, On July 1, 2008, the PIT program was initiated. Study period, 1 April 2008 to 31 September 2008	The ED is staffed by board-certified emergency medicine physicians who evaluate all patients, with double coverage for 16 h, and single coverage for 8 h a day	Additional attending physician was assigned to triage during the hours 1:00 p.m. to 9:00 p.m. An RN and ED technician from the main ED was reassigned to be part of the triage team	- Multidisciplinary team - Physician in triage	Time from registration to AP Length of stay Ambulance diversion Left without being seen	Was reduced by 36 min (p\0.01) (positive) Was reduced by 12 min (p\0.01) (positive) Number of days on diversion (24 vs. 9 days) was decreased (p\0.01) (positive) NSD
Sharma, R. et al. 2013. USA	An urban, academic tertiary, level-1 trauma centre, with 80,000 ED visits	ED patients, low-acuity treated and released, 9,245 visits: 4,472 visits pre-intervention, 4,773 visits post-intervention	Retrospective cohort, before-and-after, Study period: June–October 2009 and June–October 2010. Intervention was implemented March 2010-June 2010	No information available	ED discharge facilitator team (an emergency AP, a physician assistant, and an RN), operate from 10:00 a.m. to 8:00 p.m. on weekdays	- Multidisciplinary team - Physician in triage - Flow coordinator	Length of stay	Reduced by 1 h 18 min (95% CI 1 h 11 min to 1 h 27 min). By regression analysis, the LOS was 28 min shorter (95% CI of difference 22 to 33 min) (positive)
Traub, S. J. et al. 2015. USA	A 24-bed ED located in a suburban tertiary care teaching hospital, with 24,500 annual visits	ED patients, 2,919 visits: 1,478 visits pre-intervention, and 1,441 visits post-intervention	Retrospective 3 months before-and-after study, Study period: Pre-intervention November 2010-January 2011, post-intervention February–April 2011	34–35 h of attending physician coverage on Mondays and Fridays from 10:00 a.m. to 10:00 p.m.	Rapid Medical Assessment (RMA) team (AP and nurse), Mondays and Fridays from 11:00 a.m. to 8:00 p.m.	- Multidisciplinary team - Physician in triage	Length of stay Left without being seen	RMA was associated with a decrease in LOS of 36.1 min (95% CI21.8–50.4) (positive). NSD
Traub, S. J. et al. 2016. USA	A 24-bed ED located in a suburban tertiary care teaching hospital, with 26,000 annual visits	ED patients, 3,775 visits: 1,869 visits during PIT and 1,906 visits during RPA.	Retrospective cohort review, matched days, Patients seen on 23 days using PIT with those patients seen on 23 matched days using RPA	Rotational patient assignment	One nurse and one physician at triage from 11:00 a.m. to 8:00 p.m.	- Multidisciplinary team - Physician in triage	Length of stay Left without being seen, LSBS, 72R, 72 R/A, CR	NSD[1] NSD
Gholve, P. A. et al. 2005. UK	Not available	ED patients, fractured neck of femur, 294 patients: pre-intervention (from another study) 143 patients, post-period: 151 patients	Prospective case control study. February-November 2002, compared with a fast-track system between January-October 2001	Fast track	Multidisciplinary integrated care pathway. Co-ordinated involvement of paramedics, nurses, anaesthetists, physicians, physiotherapist and surgeon	- Multidisciplinary team	Left without being seen Admission time Surgery within 24h 30-day mortality	Was reduced by 3.9 days in with team (P<0.001) (positive). NSD 77% in the team group had surgery within 24 h of admission compared with 71% in the control group (P=0.048) (positive). NSD
Jarvis, P. et al. 2014.	District general Hospital with 65,000 annual ED visits	ED patients, excluding patients with minor injuries (i.e. patients with	Prospective cohort study, before-and-after. Pre-intervention: 1 April to 24 May 2013.	Traditional, nurse-led triage with one consultant and one ED middle grade doctor	Team (an additional consultant, senior nurse and a healthcare assistant) from 09:00 to	- Multidisciplinary team - Senior physician	Length of stay	Was reduced by 53 minutes or 41.1% (P=0.0025) (positive)

UK		isolated limb injury). 4,622 patients: 3,835 patients pre-intervention and 787 patients post-intervention	Post-intervention 30 September to 18 October 2013	providing the senior decision-maker's role to the whole ED	17:00hr			
Moloney, E.D. et al. 2005. Ireland	A tertiary referral centre serving as a secondary care centre for emergency medical admissions (no information about annual visits)	ED patients, requiring hospitalisation[3]. 10,566 episodes among 7,857 patients in the study period (no information about before-and-after)	Retrospective analysis, before-and-after. Pre-intervention: 1 January to 31 December 2002. Post-intervention: 1 January to 31 December 2003	In 2002, patients were admitted directly to a variety of wards, many of which were not affiliated with a medical specialty under the care of a named consultant physician	Acute medical admission unit	- Multidisciplinary team - Centralisation	Length of stay Patients waiting for beds in the ED Hospital cost	For all physician teams: shortened from 6 to 5 days (p<0.0001). Patients seen by GP had a shorter LOS (5 days) than those seen by sub-specialists (6 days) (p<0.0001) (positive). Reduced by 30% (p<0.001) (positive). Hospital cost savings were estimated at approximately 4,039 bed-days and €1,714,152 (positive).
Rooney, T. et al. 2008. Ireland	A tertiary referral centre serving as a secondary care centre for emergency medical admissions (no information about annual visits)	ED patients, requiring hospitalisation[2]. 33,367 episodes were recorded among 19,528 patients. Pre-intervention 3,049 patients were admitted over 5,476 episodes	Prospective study, before-and-after. Pre-intervention 1 January-31 December 2002 Post-intervention: 1 January to 31 December 2006	In 2002, patients were admitted directly to a variety of wards many of which were not affiliated with a medical specialty, under the care of a named consultant physician	Acute medical admission unit	- Multidisciplinary team - Centralisation	Mortality	Decreased from 12.6% to 7.0% (P<0.0001) (positive)
O'Brien, D. et al. 2006. Australia	ED of a 500-bed metropolitan tertiary adult teaching hospital with 43,000 annual ED visits	ED patients, likely to be discharged, Australasian Triage Scale 3-5	Prospective cohort study, before-and-after, 12-week trial period in June 2004	No information available	Team: a junior ED doctor, a registered nurse and an ED consultant from 09:00 and 22:00 on weekdays and 09:30 and 18:00 on weekends	- Multidisciplinary team - Senior physician	Wait time Length of stay	20.3% (–18 min; 95%CI, –26 min to –10 min) relative reduction (positive). 18.0% (–41 min; 95%CI, –52 min to –30 min) relative reduction (positive)
Travers, J.P, and Lee, F.C.Y. 2006. Singapore	Not available	ED patients, serious but not life-threatening (PACS 3). Study population: 576 patients. 286 pre-intervention and 290 post-intervention	Case-control study, 10 intervention days and 10 matched control days	No information available	A senior emergency physician and nurse both triage patients and decide on treatment and disposition, operating from 10:00 a.m. to 4:00 p.m.	- Multidisciplinary team - Physician in triage	Wait time Being seen within 30 min	The average wait time was 19 min on experimental days as compared with 35.5 min on control days (P<0.05) (positive). 78% being seen within 30 min in the experimental group compared with 48% on control days (P<0.05) (positive)
Athlin, Å.M. et al. 2013. Sweden	A level-1 trauma hospital, with an ED serving more than 55,000 patients annually	ED patients, a total of 1,838 patient visits were studied	Longitudinal interventional cohort study, before-and-after. Data were collected for five two-week periods during a period of 1.5 years: before, after and three	Nurses allocate patients among physicians and led the organisational work. Staff are involved in patient's care within their specialty. Work processes were arranged around tasks rather than	Teamwork (one physician, one RN and one AN). Was first implemented 8 am to 9 pm, on weekdays. One year after, implementation teamwork was	- Multidisciplinary team	Patients within team work time Time to physician Total visit time Treated within 4 h	NSD Decreased by 11 minutes at the last follow-up (p = 0.0005) (positive). 39 minutes shorter at last follow-up (p <0.0001) (positive). Was met in 71% in the last follow-up compared with 59% (p = 0.0005)

			follow-up periods (5,11 and 16 months)	patients	implemented 24-7			(positive)

[1]Rotational patient assignment was associated with a 14-min reduction in median LOS compared with PIT (95% CI 5-26.5). Multivariate logistic regression analysis showed non-significant reduction in rotational patient assignment vs. physician in triage (204 min vs. 217 min.).
[2] Patients requiring coronary and intensive care not included
AN= assistant nurses, ATS= Australasian Triage Scale, CR=complaint ratio, ED= emergency department, LSBS=Left subsequent to being seen, GP= general physician, NDS=no significant difference, RN= registered nurses, TTS= Time to first assessment by ED physician, 72R=early returns to the ED within 72 hours of their first visit, 72R/A=early returns who were admitted on the second visit

Table 18 Summary of findings 'physician in triage'

Study	Setting	Population	Design	Baseline	Intervention	Organisational designs	Effect measures	Authors main findings
Han, J. H. et al. 2010. USA	Urban, academic tertiary care, Level I trauma centre, with 50,000 annual visits	ED patients, 17,265 patients: 8,569 pre-intervention, 8,696 post-intervention	Retrospective 9-week before-and-after study. Pre-period: 11 May 2005 to 10 July 2005 and post-period: 11 July 2005 to 9 September 2005	Not available (No physician in triage)	Physician in triage 7 days a week from 1:00 p.m. to 9:00 p.m.	-Physician in triage	Length of stay Left without being seen. Ambulance diversion	Overall decreased by 11 min (P<0.001), was entirely attributed to non-admitted patients (P<0.001) (positive). Decreased from 4.5% to 2.5% (positive). Decreased from 5.6 days per month to 3.2 days per month (positive)
White, B. et al. 2012. USA	Urban, academic, Level I trauma centre for adult and paediatric patient with 85,000 annual visits	ED patients, excluding non-emergent and psychiatric patients. 27,156 patients: 12,936 pre-intervention and 14,220 post-intervention	Retrospective observational, 3-month before-and-after study. Intervention was implemented December 2007. Pre-period: September– November 2007 and post-period: September–November 2008	Standard course with triage, registration and disposition, frequently including a substantial stay in the waiting room both before-and-after triage	Physician-led screening program (START) and team, operating 12 h per day, from 11:00 a.m.–11:00 p.m., 7 days per week.	-Physician in triage	Length of stay Left without completion assessment	Decreased by 29 min (p < 0.001). Median LOS for discharged patients decreased by 23 min (p < 0.001) and by 31 min for admitted patients (positive). Decreased by 1.7% (p < 0.001) (positive)
Soreme-kun, O. A. et al. 2012. USA	Urban tertiary academic centre with 90,000 annual visits	ED patients, medium-acuity, 20,318 patients: 9,506 pre-inte rvention and 10,812 post-intervention	Retrospective 1-year before-and-after study, MR analysis. Intervention was implemented December 2007	Nurse-triage	Attending physician in triage evaluated all the medium-acuity patients in the waiting room from 11:00 a.m. to 11:00 p.m.	- Physician in triage	Time to disposition decision	Decreased by 6 min (p=0.025). Similar results were observed from the MR models (positive)
Imperato, J. et al. 2012. USA	A 23-bed ED in a community teaching hospital, with 36,000 adult and paediatric patients annually	ED patients, 17,631 visits: 8,620 pre-intervention and 9,011 post-intervention	Retrospective 3-months before-and-after study. On 1 July 2008, the PIT program was initiated. Study period, 1 April 2008 to 31 September 2008	Nurse-triage	Physician in triage from 1:00 p.m. to 9:00 p.m. daily.	- Multidisciplinary team -Physician in triage	Time from registration to AP Length of stay Ambulance diversion Left without being seen	Was reduced by 36 min (p<0.01) (positive). Was reduced by 12 min (p<0.01) (positive). Number of days on diversion (24 vs. 9 days) were decreased (p< 0.01) (positive). NSD
Rogg, J. et al. 2013.	A tertiary care urban academic, level-1 trauma	ED patients, excluding non-emergent and	Retrospective, observational, before-and-after study. Intervention	Standard course with triage, registration and disposition. Frequently	START, operates 12 h per day, from 11:00 a.m. to 11:00 p.m., 7 days per	-Physician in triage	Length of stay	Decreased 56 minutes/patient (p < 0.0001) and for non-START patients22 minutes/patient (p < 0.0001) decreased

USA	centre (adult and paediatric patients) with 90,000 annual ED visits	psychiatric patients. 89,391 patients: 39,142 pre-intervention, 50,249 post-intervention	was implemented December 2007 Study period: December 2006 - November 2010.	including a substantial stay in the waiting room both before-and–after triage[1]	week		Left without completion assessment	(positive). Decreased from 4.8% to 2.9% (p < 0.0001) (positive)
Sharma, R. et al. 2013. USA	An urban, academic tertiary, level-1 trauma centre, with 80,000 ED visits	ED patients, low-acuity treated and released, 9,245 visits: 4,472 visits pre-intervention, 4,773 visits post-intervention	Retrospective cohort, before-and-after. Study period: June–October 2009 and June–October 2010. Intervention was implemented March 2010-June 2010	No information available	ED discharge facilitator team (an emergency AP, a physician assistant and a RN), operates from 10:00 a.m. to 8:00 p.m. on weekdays. Additional intervention: team, flow coordinator	- Multidisciplinary team -Physician in triage - Flow coordinator	Length of stay	Reduced by 1 h 18 min (95% CI 1 h 11 min to 1 h 27 min). By regression analysis, the LOS was 28 min shorter (95% CI of difference 22 to 33 min) (positive)
Traub, S. J. et al. 2015. USA	A 24-bed ED in a suburban tertiary care teaching hospital, with 24,500 annual visits	ED patients, 2919 visits: 1478 visits pre-intervention, and 1441 visits post-intervention	Retrospective 3 months before-and-after study, Study period: Pre-intervention November 2010-January 2011, post-intervention February–April 2011	34–35 h of attending physician coverage on Mondays and Fridays from 10:00 a.m. to 10:00 p.m.	Rapid Medical Assessment (RMA) team (AP and nurse). Mondays and Fridays from 11:00 a.m. to 8:00 p.m.	- Multidisciplinary team -Physician in triage	Length of stay Left without being seen	Decrease by 36.1 min (95% CI21.8–50.4) (positive). NSD
Traub, S. J. et al. 2016. USA	A 24-bed ED located in a suburban tertiary care teaching hospital, with 26,000 annual visits	ED patients, 3775 visits: 1,869 visits during PIT and 1,906 visits during RPA	Retrospective cohort review, matched days. Patients seen on 23 days using PIT with those patients seen on 23 matched days using RPA	Rotational patient assignment	PIT. One nurse and one physician at triage from 11:00 a.m. to 8:00 p.m.	- Multidisciplinary team -Physician in triage	Length of stay Left without being seen, LSBS,72R,72 R/A,CR	NSD[2] NSD
Travers, J.P, and Lee, F.C.Y. 2006. Singapore	Not available	ED patients, serious but not life-threatening (PACS 3). Study population: 576 patients. 286 pre-intervention and 290 post-intervention	Case-control study, 10 intervention days and 10 matched control days	No information available	A senior emergency physician and nurse both triage patients and decide on treatment and disposition, operating from 10:00 a.m. to 4:00 p.m.	- Multidisciplinary team -Physician in triage - Senior physician	Wait time Being seen within 30 min	19 min on experimental days as compared with 35.5 min on control days (P<0.05) (positive). 78% being seen within 30minin the experimental group compared with 48% on control days (P<0.05) (positive)

[1] Information based on White, B. et al. 2012.

[2]Rotational patient assignment was associated with a 14-min reduction in median LOS compared with PIT (95% CI 5-26.5). In a multivariate logistic regression analysis, a non-significant reduction in rotational patient assignment vs. physician in triage was seen (204 min vs. 217 min.).

AP= attending physician, CR=complaint ratio, ED= emergency department, LSBS=Left subsequent to being seen, MR=multivariable regression, NDS=no significant difference, PASC=Patient Acuity Score, RN=registered nurse, WR= waiting room, START = Supplemented Triage and Rapid Treatment, 72R=early returns to the ED within 72 hours of their first visit, 72R/A=early returns who were admitted on the second visit.

Table 19 Summary of findings 'senior physician'

Study	Setting	Population	Design	Baseline	Intervention	Organisational designs	Effect measures	Main findings
Christmas, E. et al. 2012. UK	District general hospital with 75,000 new ED visits annually	ED patients (including patients under 16)	Prospective observational study. Study period: 1 February 2010 to 2 August 2010	Middle-grade working night shifts	Consultants working 26 night shifts	-Senior physician	Wait time Length of stay Proportion of patients admitted Return within 7 days	19.6 min less (P=0.012) (positive). 20.5 min less (P=0.001) (positive). 3.9% less (P=0.039) (positive). NSD

Subbe, C.P. et al. 2014. UK	District general hospital with 643 beds, serving a population of 250,000.	ED patients, very low risk of dying, SCS=0/3, 2765 patients. 1,276 pre-intervention and 1,489 post-intervention	Prospective cohort study, before-and-after. Results were adjusted for the degree of frailty as measured by the CFS. A six-month baseline and intervention phase were compared	Patients are assessed by a junior doctor who reviews the emergency physician and GP findings, orders investigations and starts treatment. Patients are then admitted to specialist services	Navigator (an advanced practitioner with prescribing competencies) worked four days per week. The Navigator would collate results and present to the senior in charge	-Senior physician	Length of stay Cost	Reduced by a mean of 1.85 days (p<0.001). This was true even after adjustment for frailty (p<0.001) (positive). Over the six-month period, the cost of care was reduced by £250,158 with no increase in readmissions or 30-day mortality (positive)
Jarvis, P. et al. 2014. UK	District general hospital with 65,000 annual ED visits.	ED patients, excluding patients with minor injuries (i.e. patients with isolated limb injury). 4,622 patients: 3,835 patients' pre-intervention and 787 patients' post-intervention	Prospective cohort study, before-and-after. Pre-intervention:1 April-24 May 2013. Post-intervention 30 September to 18 October 2013.	Traditional, nurse-led triage with one consultant and one ED middle grade doctor providing the senior decision-maker role to the whole ED	Team (an additional consultant, senior nurse and a health-care assistant) from 09:00 and 17:00hr	Multidisciplinary team -Senior physician	Length of stay	Was reduced by 53 minutes or 41.1% (P=0.0025) (positive)
Travers, J.P, and Lee, F.C.Y. 2006. Singapore	Not available	ED patients, serious but not life-threatening (PACS 3). Study population: 576 patients. 286 pre-intervention and 290 post-intervention	Case-control study, 10 intervention days and 10 matched control days.	No information available	A senior emergency physician and nurse both triage patients and decide on treatment and disposition, operating from 10:00 a.m. to 4:00 p.m.	-Senior physician -Physician in triage	Wait time Being seen within 30 min	19 min on experimental days as compared with 35.5 min on control days (P<0.05) (positive). 78% was seen within 30 min in the experimental group compared with 48% on control days (P<0.05) (positive)
Korsten, P. et al. 2014. Germany	The interdisciplinary ED at a tertiary healthcare institution (no information on visits)	All ED patients except paediatric, gynaecologic and surgical cases	Retrospective observational study, before and-after. In 2005/2006, the main ED was reorganised. Before (January–December 2005) and after (January–December 2010)	No information available	Rotation assistants of each specialty for a period of 6–12 months. Clinical decisions were only made by senior physicians	-Senior physician	Length of stay Diagnostic errors Hospital costs	Reduced from 9.4 to 4.5 h (P<0.001) (positive). Reduced from 17.2 to 8.5% (P=0.002) (positive). A reduction of patient-related hospital costs of 8.9% was achieved by restriction of diagnostic tests (positive)
Mattsson, M. et al. 2014. Denmark	A hospital with 24,249 small-injury patients and 12,861 patients admitted to the ED in 2008	Stroke, COPD, heart failure, hip fracture and acute bleeding and perforation patients who sought medical attention in the ED. Study population: 4,584 patient cases. Pre-intervention: 1,914 patient cases and post-intervention 2670 patient cases	Quasi experimental design, before-and-after. Baseline from January-December 2008 and post-intervention from January-December 2012.	No information available	Organisation introducing: a single entrance for all emergency patients, triage, a specialist in the front and use of electronic overview boards and electronic patient files	- Senior physician - Centralisation	Stroke COPD Heart failure Bleeding ulcer Hip fracture 30-day mortality	The five disease indicators are evaluated as one health measure with overall positive effect. A positive change was seen in all of the eight indicators (P < 0.001) (positive). Indicators were unchanged. Two of eight indicators were improved (p < 0.01) (positive). Two of five indicators were improved (p < 0.01). The two indicators improved (p < 0.001) (positive). Reductions in 30 day-mortality the patients admitted with stroke were

								seen (p = 0.024) (positive)
O'Brien, D. et al. 2006. Australia	ED of a 500-bed metropolitan tertiary adult teaching hospital with 43,000 annual ED visits	ED patients, likely to be discharged, Australasian Triage Scale 3-5	Prospective cohort study, before-and-after, 12-week trial period in June 2004	No information available	Team: a junior ED doctor, a registered nurse and an ED consultant from 09:00 and 22:00 on weekdays and 09:30 and 18:00 on weekends	-Senior physician - Multidisciplinary team	Wait time Length of stay	20.3% (–18 min; 95%CI, –26 min to –10 min) relative reduction (positive). 18.0% (–41 min; 95%CI, –52 min to –30 min) relative reduction (positive)

CFS=Clinical Frailty Scale, COPD= chronic obstructive pulmonary disease, ED= emergency department, GP=general practitioner, NDS=no significant difference, SCS=Simple Clinical Score

Table 20 Summary of findings 'centralisation'

Study	Setting	Population	Design	Baseline	Intervention	Organisational designs	Effect measures	Authors main findings
Mumma B.E. et al. 2014. USA	Urban, academic ED; 50,000 visits	Triaged ED patients. Study population: 91,254 patients. 42,896 pre-intervention and 48,358 post-intervention	Retrospective cohort study, before-and-after. Pre-intervention November 1,2009-September 30,2010, post-intervention November 1,2010-September 30,2011	Prior to the intervention, the patients were treated primarily by physician extenders	ED expansion from 128 to 145 beds.	- Centralisation	Left without being treated Boarding time	NSD The increase in ED boarding hours was independently associated with the ED expansion (p = 0.005) (negative)
Crilly, J. L. et al. 2014. Australia	Three regional public hospitals; 800,000 visits	All patient (n = 286,037) presentations arriving to three EDs. (No information about before-and-after)	Retrospective comparative cohort study. Study period: 3 September 2006-2 September 2008.	No information available	ED expansion from 81 to 122 beds	- Centralisation	In-hospital mortality Ambulance offload time Time to see doctor Length of stay	Decreased by 1.5% based on the patient's last index of admission (positive). Proportion of patients not offloaded within 30 minutes increased by 4% (negative). Median time to see a doctor increased by 4 min (negative) Increased by 65 and 21 minutes for admitted and non-admitted patients (negative), respectively
Avdic, D. 2014. Sweden	Recorded number of AMI in all Swedish hospitals from 1990 to 2010	All Swedish residents who suffered an AMI between 1990 and 2010 (n = 817,000). (No information about before-and-after)	Retrospective cohort study using policy-induced variation in hospital distance arising from ED closure and data on all AMI death in Sweden	No information available	Centralisation, closing 16 hospitals	- Centralisation	Effect of distance on mortality	Estimated results shows a clear and gradually declining probability of surviving an AMI as residential distance from ED increases. The estimated coefficients are highly significant for distance between 31-40, 41-50 and 51-60 km but not for 11-20 and 21-30 km (negative)[1]
Molony, E.D. et al. 2005. Ireland	A tertiary referral centre serving as a secondary care centre for emergency medical admissions (no information about annual visits)	ED patients, requiring hospitalisation[2]. 10,566 episodes among 7,857 patients in the study period (no information about before-and-after)	Retrospective analysis, before-and-after. Pre-intervention: 1 January to 31 December 2002. Post-intervention: 1 January to 31 December 2003.	In 2002, patients were admitted directly to a variety of wards, many of which were not affiliated with a medical specialty under the care of a named consultant physician.	Acute medical admission unit	- Centralisation -Multidisciplinary team	Length of stay Patients waiting for beds in the	For all physician teams: shortened from 6 to 5 days (p<0.0001). Patients seen by GP had a shorter LOS (5 days) than those seen by sub-specialists (6 days) (p<0.0001) (positive). Reduced by 30% (p<0.001) (positive).

							ED Hospital cost	Hospital cost savings were estimated at approximately 4,039 bed-days and €1,714,152 (positive)
Rooney, T. et al. 2008. Ireland	A tertiary referral centre serving as a secondary care centre for emergency medical admissions (no information about annual visits)	ED patients, requiring hospitalisation[2]. 33,367 episodes were recorded among 19,528 patients. Pre-intervention 3,049 patients were admitted over 5,476 episodes.	Prospective study, before-and-after. Pre-intervention 1 January-31 December 2002 Post-intervention: 1 January-31 December 2006	In 2002, patients were admitted directly to a variety of wards, many of which were not affiliated with a medical specialty under the care of a named consultant physician	Acute medical admission unit	- Centralisation -Multidisciplinary team	Mortality	Decreased from 12.6% to 7.0% (P<0.0001) (positive)
Devkaran, S. et al. 2009. The United Arab Emirates	Urban tertiary care general hospital; 70,000 visits	ED patients, minor injuries and illnesses, CTAS 4/5. Pre-intervention control group n = 4,779 and post-intervention study group n = 5,706	Quasi experimental design, before (January 2005) and after (January 2006)	Junior staff who worked in the main ED in 2005, were assigned to the FTA in 2006. It is not specified whether the patients were triaged	ED expansion, Implementation of a fast track area 7 additional beds	- Centralisation	Wait time Left without being seen Length of stay Mortality	Decreased by 22 min (CTAS 4) (P < 0.001). Decreased by 28 min (CTAS 5) (P < 0.001) post FTA. The mean await time of urgent patients (CTAS 2/3) was also significantly reduced (P < 0.001) (positive). Reduced from 4.7% to 0.7% (P < 0.001) (positive). Reduced for non-urgent patients (CTAS 4/5) (p< 0.001), but not urgent patients (CTAS 2) (p = 0.016) and (CTAS 3) (p = 0.77) (overall positive) NSD
Mattsson, M. et al. 2014. Denmark	A hospital with 24,249 small-injury patients and 12,861 patients admitted to the ED in 2008	Stroke, COPD, heart failure, hip fracture and acute bleeding and perforation patients who sought medical attention in the ED. Study population: 4,584 patient cases. Pre-intervention: 1,914 patient cases and post-intervention 2670 patient cases	Quasi-experimental design, before-and-after. Baseline from January to December 2008 and post-intervention from January to December 2012.	No information available	Organisation introducing: a single entrance for all emergency patients, triage, a specialist in the front and use of electronic overview boards and electronic patient files	- Senior physician - Centralisation	Stroke COPD, Heart failure Bleeding ulcer Hip fracture 30-day mortality	The five disease indicators are evaluated as one health measure with overall positive effect. A positive change was seen in all of the eight indicators (P < 0.001) (positive). Indicators were unchanged. Two of eight indicators were improved (p < 0.01) (positive). Two of five indicators were improved (p < 0.01). The two indicators improved (p < 0.001) (positive). Reductions in 30-day mortality the patients admitted with stroke were seen (p = 0.024) (positive)

[1]The effect is concentrated to the first year after the closures, indicating that no long-run elevated AMI mortality from the closures seems to have occurred.
[2]Patients requiring coronary and intensive care are not included
AMI= acute myocardial infarction, COPD= chronic obstructive pulmonary disease, CTAS=Canadian Triage Acuity Scale, ED= emergency department, NDS=no significant difference,

Table 21 Summary of findings 'flow coordinator'

Study	Setting	Population	Design	Baseline	Intervention	Organisational designs	Effect measures	Authors main findings
Sharma, R. et al. 2013. USA	An urban, academic tertiary, level-1 trauma centre, with 80,000 ED visits	ED patients, low-acuity treated and released, 9,245 visits: 4,472 visits pre-intervention, 4,773 visits post-intervention	Retrospective cohort, before-and-after. Study period: June to October 2009 and June to October 2010. Intervention was implemented March 2010 to June 2010	No information available	ED discharge facilitator team (an emergency AT, a physician assistant, and a RN), operates from 10:00 a.m. to 8:00 p.m. on weekdays	- Flow coordinator -Multidisciplinary team	Length of stay	Average LOS was reduced by 1 h 18 min (95% CI 1 h 11 min to 1 h 27 min). By regression analysis, the LOS was 28 min shorter (95% CI of difference 22 to 33 min) (positive)
Murphy, S.O. et al. 2014. USA	An academic medical centre that serves as a quaternary and tertiary referral centre.	ED patients. Study population 99,438: Pre-intervention 46,624 patients, post-intervention 49,814 patients	Retrospective analysis 1 year before-and-after. Study period: 1 October 2011 to 30 September 2013.	Push system. Bed meetings focused on inpatient status and staffing	Flow coordinator, (emergency nurses) was used between 9:00 AM and 9:30 PM. Push and pull system. Throughput meetings (replacing bed meetings) encompass a broader view of patient movement	- Flow coordinator	Length of stay Left without being seen Hospital diversion	Decreased by 87.6 minutes (P =0.001) (positive). Lowered rate by 1.5% (P=0.002) (positive). Monthly hospital diversion decreased from 93 h to 43.3 h (P=0.008) (positive)
Holroyd et al.2007. Canada	An academic teaching hospital, with an urban tertiary care ED serving 55,000 adult patients annually	ED patients older than 17 years. Study population: 5,718 Intervention: 2,831 patients, control: 2,887 patients	Randomised controlled trail. Study period: December 9, 2005-February 9, 2006 divided into three two-week blocks; within each block, seven days were randomised to the intervention and the other seven to control	Standard emergency physician clinical shifts	Triage liaison physicians from 11:00 AM to 8:00 PM in addition to standard emergency physician clinical shifts	- Flow coordinator	Length of stay Left without being seen Ambulance diversion	Decreased by 36 minutes (P=0.001) (positive). NSD[1] NSD
Huang, E. et al. 2013. Taiwan	An urban, academic tertiary medical centre with 100,000 ED visits annually.	ED adult non-trauma patients. Study population: 38,207patients. 12,257 cases and 25,950 controls	Retrospective cohort study, year before-and-after. Study period: 1 September 2007-1 September 2008. The first control group: patients treated from 1 June to 31 August 2008, the second control group: patients treated from 1 September to 30 November 2007. The case group: patients treated from 1 September to 30 November 2008.	The day shift was staffed by four physicians, including residents and board-certified physicians; the night shift was staffed by three physicians. The number of physicians and nurses was the same during the study and control periods	Adding a flow coordinator (one clinicalassistant[2]) 24 h each day	- Flow coordinator	Wait time Left without being seen	Reduced 4.51 min (17.8%) compared with first control group (P<0.0001) and 7.41 min (26.2%) shorter than that of the second control group (P<0.0001) (positive). Decreased by 87 patients compared with the first control group (P=0.004). Decreased by 114 patients compared with the second control group (P=0.0001) (positive.

[1] Decreased from 6.6% to 5.4% (a 20% relative decrease) (unadjusted p = 0.02). After adjusting for the correlated nature of the data, this reduction was no longer significant (p = 0.20)

[2]Clinical assistants were required to have a bachelor's degree in a related medical field, such as nursing or clinical laboratory technology, and received pre-vocational training to familiarise them with relevant medical affairs and administrative processes in the ED.

ED= emergency department

Table 22 Summary of findings 'specialised equipment'

Study	Setting	Population	Design	Baseline	Intervention	Organisational design	Effect measures	Authors main findings
Poulin, M. et al. 2015. USA	ED of a university medical centre	Patients with STEMI, who underwent primary percutaneous coronary intervention. Study population 52 patients	Retrospective cohort study, before-and after. Study period: September 2010-February 2014	Separation of surgery, interventional radiology and interventional cardiology	New hospital design-interventional platform	None	Door-to-balloon time	Improved by 11.7 minutes (P = 0.016), and all cases had a DTB time 90 minutes or less as compared with 90.4% prior (positive)
Li, C. J. et al.2016. Taiwan	Five EDs. Two tertiary referral medical centres and three secondary regional hospitals. Cumulative visits; 480,000 annuals	Non-trauma ED patients. Study population: 293,426 patients before-and-after population. 11.4% had a CT scan (Of the 11.4% 95.9% had one CT scan, 3.7% had two CT scans and 0.4% had three CT scans)	Retrospective 1-year cohort study. Study period was included from 1 July 2011 to 30 June 201	No CT scan during ED stay	CT scan during ED stay (patients who had undergone at least one CT Scan during ED stay)	None	Emergency Length of stay Hospital length of stay	Increased for the CT group from 13 h to 16.6 h (p < 0.001) (negative). Increased for the CT group from 12.5 to 12.7 days (p < 0.001) (negative)

CT= Computed tomography ED=emergency department, STEMI= ST Segment Elevation Myocardial Infarction

Appendix 4 Questionnaire

Spørgsmål om anciennitet

Hvor mange år har du været ansat i din nuværende stilling i akutafdelingen?

- ❑ <1
- ❑ 1
- ❑ 2
- ❑ 3
- ❑ 4
- ❑ 5
- ❑ 6
- ❑ 7
- ❑ 8
- ❑ 9
- ❑ 10
- ❑ >10

Du skal nu besvare spørgsmål om, hvorvidt forskellige organisatoriske tiltag er implementeret i akutafdelingen.
Herefter er vi interesserede i at få oplyst implementeringstidspunktet. I nogle tilfælde kan implementering foregå i en løbede process. Her er vi interesserede i tidspunktet til og med implementering af det senste element i processen.
Hvis de organisatoriske tiltag ikke er implementeret på nuværende tidspunkt, skal der blot afkrydses i "Ikke relevant" i spørgsmålet om implementeringstidspunktet.

Spørgsmål om specialer og faciliteter i relation til akutafdelingen

Hvilke patientgrupper modtages som hovedregel i akutmodtagelsen?

- ❑ Børn - ortopædkirurgi
- ❑ Børn - medicin
- ❑ Børn - kirurgi
- ❑ Kardiologi (undtagen STEMI-patienter)
- ❑ Neurologi (undtagen trombolysepatienter)
- ❑ Onkologi
- ❑ Gynækologi
- ❑ Andre specialer
- ❑ Ingen af ovenstående
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at de angivne patientgrupper har været modtaget i akutafdelingen?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010

- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

I hvor mange bygninger er akutafdelingens forskellige afsnit placeret?

- ❑ I en bygning
- ❑ I to bygninger
- ❑ I tre bygninger
- ❑ I fire bygninger
- ❑ I mere end fire bygninger
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at denne placering har været gældende?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

Hvilke specialer er tilgængelige på matriklen, hvor akutmodtagelsen er beliggende?

- ❑ Intern medicin
- ❑ Ortopædkirurgi
- ❑ Kirurgi
- ❑ Anæstesiologi
- ❑ Diagnostisk radiologi
- ❑ Klinisk biokemi
- ❑ Ingen af ovenstående specialer
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at de angivne specialer har været tilgængelige?

- ❑ Før 2008

- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

Hvilke af følgende faciliteter er i dag tilgængelige på matriklen, hvor akutmodtagelsen er beliggende:

- ❑ Konventionel røntgenundersøgelse
- ❑ Ultralydsundersøgelse, herunder ekkokadiografi
- ❑ CT-scanning
- ❑ MR-scanning
- ❑ Interventionsradiologi
- ❑ Invasiv kardiologi
- ❑ Akutte operationsfaciliteter
- ❑ Ingen af ovenstående
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at de angivne faciliteter har været tilgængelige?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

Hvilke af følgende faciliteter er i dag tilgængelige i døgndækning på matriklen, hvor akutmodtagelsen er beliggende:

- ❑ Konventionel røntgenundersøgelse
- ❑ Ultralydsundersøgelse, herunder ekkokadiografi
- ❑ CT-scanning

- ❑ MR-scanning
- ❑ Interventionsradiologi
- ❑ Invasiv kardiologi
- ❑ Akutte operationsfaciliteter
- ❑ Ingen af ovenstående
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at de angivne faciliteter har været tilgængelige i døgndækning?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

Spørgsmål omkring personale tilknyttet akutmodtagelsen

Hvilke af følgende speciallæger er i dag repræsenteret ved tilstedeværelsesvagt i døgndækning?

- ❑ Intern medicin
- ❑ Ortopædkirurgi
- ❑ Kirurgi
- ❑ Anæstesiologi
- ❑ Speciallæger med kompetence i at udføre akutte ultralydsundersøgelser (herunder ekkokardiografi eller FAST/FATE)
- ❑ Ingen af ovenstående
- ❑ Ved ikke

Fra hvilket årstal vil du mene, de angivne speciallæger har været repræsenteret ved tilstedeværelsesvagt i døgndækning?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016

- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

Er speciallæger fra diagnostisk radiologi i dag som minimum repræsenteret ved rådighedsvagt i døgndækning?

- ❑ Ja
- ❑ Nej
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at dette har været gældende?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

Hvilke specialer er i dag som minimum tilgængelige for rådgivning i døgndækning?

- ❑ Klinisk mikrobiolog
- ❑ Infektionsmedicin
- ❑ Ingen af ovenstående
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at ovenstående besvarelse har været gældende?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

Er der i dag som udgangspunkt speciallæger til stede i akutafdelingen i døgndækning?

- ❑ Ja
- ❑ Nej
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at ovenstående besvarelse har været gældende?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

Hvilke vagter er i dag som udgangspunkt ikke dækket af speciallæger i hverdagen?

- ❑ Dagvagter
- ❑ Aftenvagter
- ❑ Nattevagter
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at ovenstående besvarelse har været gældende?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

Hvilke vagter er i dag som udgangspunkt ikke dækket af speciallæger i weekenden?

- ❑ Dagvagter
- ❑ Aftenvagter
- ❑ Nattevagter

❑ Ved ikke

Fra hvilket årstal vil du mene, at ovenstående besvarelse har været gældende?

❑ Før 2008
❑ 2008
❑ 2009
❑ 2010
❑ 2011
❑ 2012
❑ 2013
❑ 2014
❑ 2015
❑ 2016
❑ 2017
❑ Ved ikke
❑ Ikke relevant

Hvilke af følgende faggrupper er i dag ansat i akutafdelingen?

	Ved ikke	Ikke ansat	Ansat	Hvor mange fuldtidsstillinger vil du mene, at akutafdelingen er nomineret til (angiv antal)?
Læge (f.eks. KBU, intro-, hoveduddannelse)	(3) ❑	(2) ❑	(1) ❑	____
Speciallæge uden akutuddannelse	(3) ❑	(2) ❑	(1) ❑	____
Speciallæge med akutuddannelse	(3) ❑	(2) ❑	(1) ❑	____
Akutlæge uden speciallægeuddannelse	(3) ❑	(2) ❑	(1) ❑	____
Sygeplejerske uden akutuddannelse	(3) ❑	(2) ❑	(1) ❑	____
Sygeplejerske med hele eller dele af akutuddannelsen	(3) ❑	(2) ❑	(1) ❑	____

Fra hvilket årstal vil du mene, I begyndte at ansætte speciallæger (med eller uden akutuddannelse) i akutafdelingen?

❑ Før 2008
❑ 2008
❑ 2009
❑ 2010
❑ 2011
❑ 2012
❑ 2013
❑ 2014
❑ 2015
❑ 2016
❑ 2017

- ❑ Ved ikke

På hvilken måde er speciallægerne fra sygehusets andre afdelinger primært tilknyttet akutafdelingen i dag?

- ❑ De kan tilkaldes ved behov
- ❑ De er tilgængelige for telefonkonference relateret til deres speciale
- ❑ De tilkaldes til at modtage egne specialepatienter i akutafdeling
- ❑ De tager vagter på skift i akutafdelingen som en fast del af arbejdsplanen
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at denne tilknytning har været gældende?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

Hvor ofte anvender I vikarierende speciallæger/akutlæger?

- ❑ Aldrig
- ❑ 1-2 gange i kvartalet
- ❑ 1-2 gange om måneden
- ❑ 1-2 gange om ugen
- ❑ 3-6 gange om ugen
- ❑ Hver dag
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at det angivne omfang har været gældende?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017

- ❑ Ved ikke
- ❑ Ikke relevant

Hvor ofte anvender I vikarierende ikke-speciallæger?

- ❑ Aldrig
- ❑ 1-2 gange i kvartalet
- ❑ 1-2 gange om måneden
- ❑ 1-2 gange om ugen
- ❑ 3-6 gange om ugen
- ❑ Hver dag
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at det angivne omfang har været gældende?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

Hvad er den primære årsag til anvendelsen af vikarierende læger?

- ❑ Sygdom/fravær
- ❑ Problemer med at dække vagtarbejde (aften, nat og weekend)
- ❑ Længerevarende rekrutteringsproblemer
- ❑ Ved ikke

Er der formuleret specifikke kompetencekrav for læger ansat i akutmodtagelsen?

- ❑ Ja
- ❑ Nej
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at dette har været gældende?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012

- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

Er der formuleret specifikke kompetencekrav for sygeplejersker ansat i akutmodtagelsen?

- ❑ Ja
- ❑ Nej
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at dette har været gældende?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

Har I valgt at opkvalificere (nogle af) lægerne ved at sende dem på akutuddannelse (dansk eller udenlandsk)?

- ❑ Ja
- ❑ Nej
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at dette har været gældende?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017

- ❑ Ved ikke
- ❑ Ikke relevant

Har I valgt at opkvalificere (nogle af) sygeplejerskerne ved at sende dem på akutuddannelse (dansk eller udenlandsk)?

- ❑ Ja
- ❑ Nej
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at dette har været gældende?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

Spørgsmål om implementering af nye tiltag i forbindelse med reorganiseringen af akutmodtagelsen

Anvender I en flowkoordinator (en læge eller sygeplejerske der er ansvarlig for at skabe flow i akutafdelingen)?

- ❑ Ja
- ❑ Nej
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at dette har været gældende?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017
- ❑ Ved ikke

- ❑ Ikke relevant

Anvender I tværfaglige teams, der løbende samarbejder og diskuterer diagnosticering og behandling af patienterne?

- ❑ Ja
- ❑ Nej
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at dette har været gældende?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

Anvender i triagering?

- ❑ Ja
- ❑ Nej
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at dette har været gældende?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

I hvilket omfang anvender I samarbejdsaftaler med specialafdelingerne i forhold til lægedækning og visitationsret?

- ❑ Aldrig
- ❑ I meget lille omfang
- ❑ I mindre omfang
- ❑ I moderat omfang
- ❑ I stort omfang
- ❑ I meget stort omfang
- ❑ Altid
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at det angivne omfang har været gældende?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

I hvilket omfang anvendes kliniske retningslinjer og retningslinjer for patientforløb?

- ❑ Aldrig
- ❑ I meget lille omfang
- ❑ I mindre omfang
- ❑ I moderat omfang
- ❑ I stort omfang
- ❑ I meget stort omfang
- ❑ Altid
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at det angivne omfang har været gældende?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015

- ❑ 2016
- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

I hvilket omfang kan speciallæger i akutafdelingen træffe beslutninger om behandling uden at konsultere læger fra andre afdelinger?

- ❑ Aldrig
- ❑ I meget lille omfang
- ❑ I mindre omfang
- ❑ I moderat omfang
- ❑ I stort omfang
- ❑ I meget stort omfang
- ❑ Altid
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at det angivne omfang har været gældende?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

I hvilket omfang anvendes procesorienterede arbejdsgange som f.eks. tværfaglige teams, fast-track-system og blå spor?

- ❑ Aldrig
- ❑ I meget lille omfang
- ❑ I mindre omfang
- ❑ I moderat omfang
- ❑ I stort omfang
- ❑ I meget stort omfang
- ❑ Altid
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at det angivne omfang har været gældende?

- ❑ Før 2008
- ❑ 2008

- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

I hvilket omfang har I fokus på at anvende og udvikle eksisterende ressourcer som f.eks. at optimere processer og spare ressourcer?

- ❑ Aldrig
- ❑ I meget lille omfang
- ❑ I mindre omfang
- ❑ I moderat omfang
- ❑ I stort omfang
- ❑ I meget stort omfang
- ❑ Altid
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at det angivne omfang har været gældende?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

I hvilket omfang har I fokus på at forbedre patientbehandlingen ved f.eks. at anvende nyeste teknologi og viden?

- ❑ Aldrig
- ❑ I meget lille omfang
- ❑ I mindre omfang
- ❑ I moderat omfang
- ❑ I stort omfang

- ❑ I meget stort omfang
- ❑ Altid
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at det angivne omfang har været gældende?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

Hvilke af følgende specialeafdelinger har akutafdelingen visitationsretten over (kan tage beslutning om overflytning af patienter)?

- ❑ Ortopædkirurgisk afdeling
- ❑ Abdominalkirurgisk afdeling
- ❑ Intern medicinsk afdeling
- ❑ Andre specialafdelinger
- ❑ Ingen af ovenstående
- ❑ Ved ikke

Fra hvilket årstal vil du mene, at ovenstående besvarelse har været gældende?

- ❑ Før 2008
- ❑ 2008
- ❑ 2009
- ❑ 2010
- ❑ 2011
- ❑ 2012
- ❑ 2013
- ❑ 2014
- ❑ 2015
- ❑ 2016
- ❑ 2017
- ❑ Ved ikke
- ❑ Ikke relevant

<u>Spørgsmål om effekten af nye tiltag i forbindelse med reorganiseringen</u>

Svarene på de følgende to spørgsmål vil blive anvendt internt til fortolkning af resultater.

Hvilke tiltag har efter din mening haft den mest positive effekt for patientforløbet i akutmodtagelsen?

_____
_____
_____
_____
_____

Hvilke tiltag har efter din mening haft de største negative konsekvenser for patientforløbet i akutmodtagelsen?

_____
_____
_____
_____
_____

Paper I

Organisation of emergency departments: From policy to practice

Paper II

Organisation introducing increased emergency department autonomy: a mixed effects approach to evaluate the effects of a national policy

Paper III

Organisational determinants and consequences of diagnostic discrepancy in emergency departments: a national study of consecutive episodes between 2008-2016

Declaration of Co-Authorship