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Change in injury pattern with mandatory, referred access compared to open access in an emergency department

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ABSTRACT

INTRODUCTION. This retrospective cohort study aimed to examine whether implementing mandatory referral changed the composition of patients visiting the Accident and Emergency (A&E) Department in relation to severity, demographics and activity at injury.

METHODS. Patients visiting the A&E Department at Odense University Hospital, Denmark, in 2008-2019, were divided into three time periods: before (four years before any changes in the operation of the A&E), transition period (the four years during which mandatory referral and the centralised emergency medical service were implemented) and after (the four years after these changes had been implemented). The incidence rate ratios and odds were calculated.

RESULTS. The absolute number of severe injuries declined, but to a lesser extent than the number of minor injuries. The incidence rate ratios throughout all subcategories, including severity, fracture, sex, age and activity at injury, indicate a smaller risk of visiting the A&E Department in the after period than in the before period, with a total lower (0.82 times; 95% confidence interval: 0.82-0.83 times) risk of visiting the A&E Department in the after period than in the before period.

CONCLUSIONS. Changing from open to referred access altered the composition of injuries for patients seen in the A&E Department, indicating a smaller risk of a visit with referred access than with open access. The odds of a visit being due to a major injury increased after implementing referred access, and the number of visits decreased.

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The most significant cause of death in Denmark among patients aged 1-34 years is injuries, which are by far the greatest cause of years of potential life lost in Denmark, particularly among Danish men aged 19-24 years [1]. In Denmark in the 2002-2017 period, the injuries recorded caused 51% of deaths among people aged 10-24 years, indicating a need for research on injuries and injury prevention [2].

Previous studies have shown that accident and emergency (A&E) department crowding negatively affects patient care and outcomes [3-5]. To improve injury treatment, it is crucial that only patients requiring A&E treatment receive such treatment, whereas those with minor injuries who may be treated by a general practitioner (GP) receive GP treatment only.

Studies showed that 84% of patients making non-urgent visits to A&E departments considered their visit

necessary, and many patients wrongly underestimated GPs' capabilities and also their own abilities, indicating a discrepancy between the views of medical professionals and patients regarding which injuries require A&E treatment and misconceptions concerning the purpose of A&E departments [6, 7].

A report from 2012 found that 29% of patients in an A&E department in Denmark could have been treated by their GP. Moreover, 9% required no treatment and could have cared for themselves at home [8]. A study on the Finnish population found that 84% of the visits to an A&E department were unnecessary [9]. Studies on Scottish and Swiss patients have shown that the numbers of non-urgent patients who could have been treated by their GPs are increasing in A&E departments [10-12].

To prioritise the most critical patients, a mandatory referral practice (MRP) was implemented in April 2014 at the A&E department at Odense University Hospital (OUH), Denmark. Before the MRP, the A&E department was open for both walk ins and referred patients; but after the MRP was implemented, patients needed a referral to gain access to the A&E Department. Referrals are made by GPs or via help line calls manned by doctors and nurses or calls to the Danish emergency number 1-1-2. In 2012, organisational changes were introduced and a centralised emergency medical service (CEMS) was established to ensure that patients could access a diverse range of expertise, while the orthopaedic department remained responsible for treating injuries [13].

It was presumed that the number of patients with minor injuries would decline after implementing the MRP and that the number of patients with major injuries would remain constant. A decline in the attendance rate of young patients after restricting access was considered likely as previous studies hypothesised that young patients (15-29 years old) have a higher attendance rate in the A&E department due to their higher rate of minor injuries [14]. A decrease in the number of male patients after implementing the MRP was also considered likely as previous studies showed that men have a higher attendance rate with minor injuries in A&E departments than women [14].

This study aimed to examine whether implementing a MRP changed the composition of patients visiting the A&E department in terms of severity, demographics and activity when sustaining injuries.

METHODS

This retrospective cohort study was conducted at the OUH, Denmark. The A&E Department offers a free 24-hour emergency service. The study population was based on data from the Accident Analysis Group, which has provided systematic and quality-assured recording of all treated injuries and treatments following guidelines established by the National Patient Registry in Denmark since 1980 [15]. The data are registered as part of the patients' records, and the treating physicians' patient assessments and diagnoses are noted in the Registry.

The inclusion criterion was patients attending the orthopaedic A&E department at the OUH with an injury from 1 January 2008 to 31 December, 2019. Only patients residing in the municipalities of Odense, Nordfyn and Kerteminde at the time of their injury were included. The population composition is shown in **Table 1**. A patient visiting twice with the same injury was counted only once. All visits had at least one diagnosis registered. Visits due to non-traumatic causes, violence and suicide attempts were not included. No follow-up data were required as patient outcome was irrelevant to this study.

TABLE 1 Person-years in the three municipalities Odense, Kerteminde and Nordfyn before (2008-2011), during the transition period (2012-2015) and after (2016-2019) [16].

	Person-years		
	before: 2008-2011 (N = 967,052)	**transition period: 2012-2015 (N = 989,880)**	**after: 2016-2019 (N = 1,019,2**
Sex			
Male	476,152	488,844	504,900
Female	490,900	501,036	514,301
Age, yrs			
0-14	169,677	164,940	161,990
15-24	132,297	149,179	157,824
25-64	512,106	505,111	514,286
≥ 65	152,972	170,650	185,101

Data were drawn from the database on 19 May 2020.

The study was conducted according to ethical research guidelines; data were collected retrospectively and did not alter normal clinical management. Patient data were anonymised and treated securely throughout, ensuring confidentiality. Hence, ethical approval was unnecessary.

The outcome was the effect of implementing the MRP in the A&E Department based on two parameters: the number and composition of visits to the A&E Department.

The study size was determined by setting a timeline comprising three four-year time periods: 'before' (2008-2011), before any alterations in the open access operation of the A&E Department; the 'transition period' (2012-2015), during which two significant changes in the clinical practice in the A&E department were implemented (the MRP in 2014 and the CEMS in 2012); and 'after' (2016-2019), after these changes had been implemented.

The visits were divided into two categories: 'major injury' (amputations, nerve damage, intracranial injury and fractures (fractures of the teeth, nose, distal phalanx and the second to fifth toes were not included as fractures and therefore classified as `minor") and 'minor injury' (all other injuries) based on any International Classification of diseases, 10th version (ICD-10) diagnosis given during the immediate hospital contact or immediately following in-patient stay (complete list available on request).

Subgroup results are presented by sex, age and activity at time of injury. Activity was divided into five categories based on activity performed (as defined by the NOMESCO Classification of External Causes of Injuries, Fourth revised edition): traffic (EUA2, EUA0), work (EUA1), sport (EUA42, EUA5), home (EUA3*, excluding EUA36, EUA7) and other (all remaining activities such as EUA36, EUA4, excluding EUA42, EUA6, EUA8 and EUA9 along with all missing). EUA0 may be classified as both traffic and work, but were only included in the traffic category.

The three time periods were compared and proportions calculated with the corresponding 95% confidence intervals (CI). To accommodate changes in the number of visits following population growth, the visits were calculated as incidence rates (IR) defined as visits per 100,000 person-years. Person-years were based on sex and age-specific counts from Statistics Denmark for the three included municipalities [16]. Odds were calculated for severity. χ^2 tests were applied to compare groups and linear trends. All statistical analyses were performed using STATA v16.

Trial registration: not relevant.

RESULTS

Among 414,834 visits involving injuries seen in the Orthopaedic A&E Department at the OUH, a total of 118,683 visits were excluded due to residence in other municipalities, 12,367 were excluded as they were revisit with the same injury and none were excluded due to lack of diagnosis, leaving a total of 283,784 first-time visits in the study.

A total decrease in the number of patients was observed from the before (99,832) to the transition period (97,185) and from the transition period to the after period (86,767). The decrease in the number of patients from the before to the after period was observed in all subcategories except for patients aged 65+ years, who increased in number from the before period (13,949) to the after period (14,926). Visits due to major injuries and sport as activity at injury increased in number from the before to the transition period, followed by a larger decrease from the transition period to the after period, leaving a total decrease from the before period to the after period (**Table 2**).

TABLE 2 Descriptive table of visits in the Accident and Emergency Department at Odense University Hospital, 2008-2019.

		Before: 2008-2011		Transition period: 2012-2015		After: 2016-2019		Pearson χ^2-test	
	All, n	n	proportion (95% CI)	n	proportion (95% CI)	n	proportion (95% CI)	difference	p value
Severity[a]								77.28	$< 10^{-4}$
Minor	232,814	82,602	0.83 (0.83-0.83)	79,777	0.82 (0.82-0.82)	70,435	0.81 (0.81-0.81)		
Major	50,970	17,230	0.17 (0.17-0.17)	17,408	0.18 (0.18-0.18)	16,332	0.19 (0.19-0.19)		
Sex								2.15	0.3409
Male	153,770	54268	0.54 (0.54-0.55)	52,625	0.54 (0.54-0.54)	46,877	0.54 (0.54-0.54)		
Female	130,014	45,564	0.46 (0.45-0.46)	44,560	0.46 (0.46-0.46)	39,890	0.46 (0.46-0.46)		
Age, yrs								405.88	$< 10^{-4}$
0-14	73,123	25,810	0.26 (0.26-0.26)	25,024	0.26 (0.25-0.26)	22,289	0.26 (0.25-0.26)		
15-24	57,041	20,291	0.20 (0.20-0.21)	19,936	0.21 (0.20-0.21)	16,814	0.19 (0.19-0.20)		
25-64	109,857	39,782	0.40 (0.40-0.40)	37,337	0.38 (0.38-0.39)	32,738	0.38 (0.37-0.38)		
≥ 65	43,763	13,949	0.14 (0.14-0.14)	14,888	0.15 (0.15-0.16)	14,926	0.17 (0.17-0.17)		
Activity at injury[b]								359.34	$< 10^{-4}$
Traffic	29,038	10,663	0.11 (0.10-0.11)	9,573	0.10 (0.10-0.10)	8,802	0.10 (0.10-0.10)		
Work	26,493	9,589	0.10 (0.09-0.10)	8,458	0.09 (0.09-0.09)	8,446	0.10 (0.10-0.10)		
Sport	38,437	12,564	0.13 (0.12-0.13)	13,955	0.14 (0.14-0.15)	11,918	0.14 (0.14-0.14)		
Home	86,289	31,158	0.31 (0.31-0.31)	30,117	0.31 (0.31-0.31)	25,014	0.29 (0.29-0.29)		
Other	103,527	35,858	0.36 (0.36-0.36)	35,082	0.36 (0.36-0.36)	32,587	0.38 (0.37-0.38)		
Total[c]	283,784	99,832	0.35 (0.35-0.35)	97,185	0.34 (0.34-0.34)	86,767	0.31 (0.30-0.31)		

CI = confidence interval.
a) Major injury (amputations, nerve damage, intracranial injury and fractures not including fractures of the teeth, nose, distal phalanx and the 2nd-5th toes) and minor injury (all other injuries) based on any ICD-10 diagnosis given during the immediate hospital contact or immediately following an inpatient stay (see supplementary material).
b) Categorized by activity code noted in the journal.
c) Total is an expression of the summarized number of visits within each separate category, and the proportions in total is an expression of the deviation of visits over the 3-time periods of the study.

The largest proportion of visits was minor injuries (proportion before: 0.83, transition: 0.82, after: 0.81). Most of the attenders were men (proportion before: 0.54, transition: 0.54, after: 0.54), most of the attenders were between 26 and 64 years old (proportion before: 0.40, transition: 0.40, after: 0.38) and the most frequent activity at injury was 'other' (proportion before: 0.36, transition: 0.36, after: 0.38) (Table 2).

Changes were observed in the composition of patients, injury severity and activity at injury throughout the three time periods (Table 2). Although most of the injuries in all three time periods were categorised as minor, the proportion of major injuries increased continuously (proportion before: 0.17, transition: 0.18, after: 0.19) (Table 2).

The incidence rate ratios (IRRs) indicate a 0.82 times lower risk of visiting the A&E Department during the after period than during the before period, with the greatest change occurring in the population aged 15-24 years, with a 0.69 times lower risk of visiting the A&E Department in the after period than in the before period. Finally, the smallest of the observed changes occurred in the visits to the A&E Department with major injuries, population aged 0-14 years and sport as activity at injury, with a 0.90 times lower risk of visiting the A&E Department in the

after period than in the before period (**Table 3**).

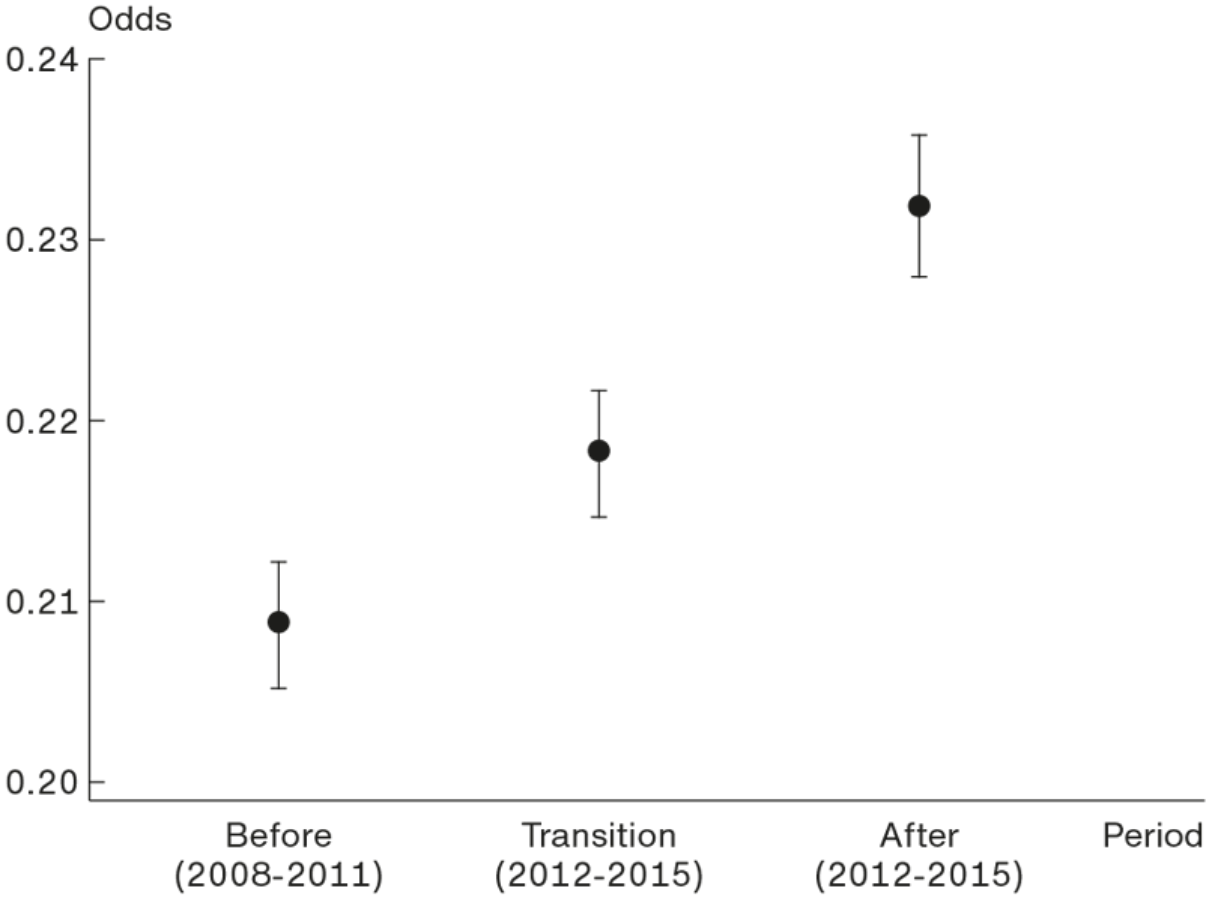
TABLE 3 The distribution of visits per 100.000 person-years throughout the three analysed time periods.

	Before: 2008-2011		Transition period: 2012-2015		After: 2016-2019		IRR[d]	
	n	IR (95% CI)	n	IR (95% CI)	n	IR (95% CI)	IRR (95% CI)	p value
Severity[a]								
Minor	82,602	8,542 (8,486-8,598)	79,777	8,059 (8,006-8,113)	70,435	6,911 (6,862-6,960)	0.81 (0.80-0.82)	$< 10^{-4}$
Major	17,230	1,782 (1,755-1,808)	17,408	1,759 (1,733-1,785)	16,332	1,602 (1,578-1,627)	0.90 (0.88-0.92)	$< 10^{-4}$
Sex								
Male	54,268	11,397 (11,307-11,488)	52,625	10,765 (10,678-10,852)	46,877	9,284 (9,204-9,365)	0.84 (0.82-0.85)	$< 10^{-4}$
Female	45,564	9,282 (9,201-9,363)	44,560	8,894 (8,815-8,973)	39,890	7,756 (7,683-7,830)	0.81 (0.80-0.82)	$< 10^{-4}$
Age, yrs								
0-14	25,810	15,211 (15,041-15,383)	25,024	15,172 (14,999-15,346)	22,289	13,759 (13,592-13,928)	0.90 (0.89-0.92)	$< 10^{-4}$
15-24	20,291	15,337 (15,144-15,533)	19,936	13,364 (13,192-13,538)	16,814	10,654 (10,502-10,807)	0.69 (0.68-0.71)	$< 10^{-4}$
25-64	39,782	7,768 (7,695-7,842)	37,337	7,392 (7,320-7,464)	32,738	6,366 (6,299-6,433)	0.82 (0.81-0.83)	$< 10^{-4}$
≥ 65	13,949	9,119 (8,975-9,264)	14,888	8,724 (8,591-8,859)	14,926	8,064 (7,940-8,189)	0.88 (0.86-0.91)	$< 10^{-4}$
Activity at injury[b]								
Traffic	10,663	1,103 (1,082-1,124)	9,573	967 (948-987)	8,802	864 (846-882)	0.78 (0.76-0.81)	$< 10^{-4}$
Work	9,589	992 (972-1,012)	8,458	854 (836-873)	8,446	829 (811-846)	0.84 (0.81-0.86)	$< 10^{-4}$
Sport	12,564	1,299 (1,277-1,322)	13,955	1,410 (1,387-1,433)	11,918	1,169 (1,149-1,190)	0.90 (0.88-0.92)	$< 10^{-4}$
Home	31,158	3,222 (3,187-3,257)	30,117	3,042 (3,009-3,077)	25,014	2,454 (2,424-2,484)	0.76 (0.75-0.77)	$< 10^{-4}$
Other	35,858	3,708 (3,670-3,746)	35,082	3,544 (3,508-3,581)	32,587	3,197 (3,163-3,232)	0.86 (0.85-0.88)	$< 10^{-4}$
Total[c]	99,832	10,323 (10,263-10,384)	97,185	9,818 (9,759-9,877)	86,767	8,513 (8,459-8,568)	0.82 (0.82-0.83)	$< 10^{-4}$

CI = confidence interval; IR = incidence rate; IRR = incidence rate ratio.
a) Major injury (amputations, nerve damage, intracranial injury and fractures not including fractures of the teeth, nose, distal phalanx and the 2nd-5th toes) and minor injury (all other injuries) based on any ICD-10 diagnosis given during the immediate hospital contact or immediately following an inpatient stay (see appendix).
b) Categorized by activity code noted in the journal.
c) Total is an expression of the summarized number of visits within each separate category
d) The IRR is exclusively calculated on the IRs from the 2 time periods before and after, and transition period is not included in this ratio.

The odds of having a major injury showed a statistically significant increase throughout the three time periods from 21% to 23% (**Figure 1**) (trend test: $\chi^2 = 76.5$, one degree of freedom, $p < 10^{-4}$).

FIGURE 1 The odds that a visit to the accident and emergency department was due to a major injury before (2008-2011), during (2012-2015) and after (2016-2019) the transition period.



DISCUSSION

The number of visits to the A&E Department was reduced by 13.1% in the after period compared with the before period despite a population growth of 5.4% person-years in the after period compared with the before period, indicating 18.5% fewer visits to the A&E department in the after period than in the before period.

Regardless of the changes in referral practice, the decline in the number of major injuries most likely reflects the general preventive efforts leading to documented lower numbers of official traffic and work injuries [2, 17]. These changes are an underlying process reflected in the documented larger decline in the number and IR for minor injuries than major injuries. With the considerably smaller decline in major injuries, this leads to reported significant changes in the odds of a patient having a major injury.

Although the number of patients aged 65+ years increased from the before period to the after period, a decline in the IR from the before period to the after period indicates that the increased number of visits was due to an increase in the population aged 65+ years and not to more frequent injuries in that age group.

The IRRs throughout all subcategories indicate a smaller risk of visiting the A&E department for the population

in the after period than in the before period.

A study from Switzerland found continued growth in the number of visits with 'non-life-threatening conditions' in an A&E department, with most of the visits being self-referrals [18]. This continuous growth stopped after restricting access by implementing an MRP.

An alternative to unnecessary treatment is qualified first aid at home. Studies showed that first aid training may improve trauma outcomes; furthermore, training improves the likelihood of providing high-quality first aid and may thus potentially prevent A&E department crowding [19].

A study on the Swiss population found the most frequent attenders to be young and male. Similarly, based on the IRs in the before period, males aged 15-24 years had the highest attendance rate [20]. In the after period, those aged 15-24 years (0.69 times) and men (0.84 times) had a lower risk of visiting the A&E Department than they did in the before period. Thus, the risk of those with the highest A&E attendance rate in the before period (men aged 15-24 years) declined in the after period.

A strength of this study is that it was based on a complete dataset from a 12-year period, and that the study population comprised a population that geographically represents a mix of urban and rural areas, making them demographically and industrially comparable to Denmark as a whole [16].

A weakness of this study is that one person can represent multiple visits in the numerator of the IR calculation but only one in the denominator. An additional weakness is that the categorisation of injuries by severity as major and minor assumed that those with injuries in the major category always seek professional medical treatment, while those in the minor category do not. With this categorisation, the minor injury group will inevitably contain some injuries requiring treatment, but this could in principle be given in a less specialised location, e.g. general practice.

A thorough time-series analysis of the visits during the transition period should be performed in a later study, including evaluation of the possible consequences of the organisational change, including the implementation of the CEMS.

Another method of assessing the changes following the introduction of the CEMS and the MRP would be to assess changes in patient outcomes. Previous studies have shown that A&E department crowding negatively affects patient care and outcomes. Thus, implementing a CEMS and an MRP, with the subsequent decrease in the number of patients should improve patient outcomes [3-5].

With such documented changes in the frequency and composition of visits to the A&E Department following the MRP and the CEMS, it is crucial that publications document the referral method and relevantly divides the injuries in future studies.

CONCLUSIONS

Changing from open to referred access changed the composition of injuries for patients seen in the A&E Department, indicating a smaller risk of visiting the A&E Department with referred access than with open access. Although most of the injuries in all three time periods were categorised as minor, the proportion of major injuries increased continuously. Consequently, the odds of a visit being due to a major injury increased after implementing referred access, and the number of visits to the A&E Department was reduced by 18.5%.

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Conflicts of interest Potential conflicts of interest have been declared. Disclosure forms provided by the authors are available with the article at ugeskriftet.dk/dmj

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