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Impact of the implementation of a fast-track on emergency department length of stay and quality of care indicators

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Abstract

Objectives: We aimed to evaluate the effect of the implementation of a fast-track on Emergency Department (ED) length of stay (LOS) and quality of care indicators.
Design: Difference-in-differences analysis.
Setting: Two large hospitals in the Champagne-Ardenne region, France.
Participants: Patients admitted to the emergency department between 13 January 2015 and 13 January 2017.
Intervention: Implementation of a fast-track for patients with small injuries or benign medical conditions, extension of the ED from 15 to 27 consultation rooms (13 January 2016).
Primary and Secondary Outcome Measures: Proportion of patients with LOS < 4h and proportion of access block situations (when patients cannot access an appropriate hospital bed within a reasonable amount of time: 8 hours). All-cause 7-day readmissions and 30-days readmissions.
Results: The emergency department of the intervention hospital registered 53768 stays in 2016 and 57965 in 2017 (+7.8%). During the same period, the control hospital registered 42133 and 43696 entries respectively (+3.7%). In the intervention hospital, the mean length of stay was 261 minutes before the intervention and 248 minutes after the intervention.
In the control hospital, the corresponding times were 262 and 265 minutes (exponentiated difference-in-differences (DID) estimator for ED LOS > 4h: 0.80; 95% confidence interval (CI) 0.76 – 0.84). The exponentiated DID estimator for access block was 1.12; 95% CI 1.03 – 1.22. In the intervention hospital, before the fast-track was implemented, an estimated 11.4% of admissions were 30-days readmissions. There was an increase in this proportion after the intervention (12.3%), also observed in the control group (from 12.0% to 12.6%).
Conclusions: The implementation of a fast-track was associated with a decrease in stays lasting ≥4 hours without a decrease in access block. Further studies are needed to evaluate the causes of variability in emergency department LOS and their connections to quality of care indicators.

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Keywords

Emergency Department – Length of stay – Fast-track – Hospital readmissions – Healthcare Quality

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Strengths and Limitations of this study

- We measured the effect of the implementation of a fast-track on length of stay and quality of care indicators

- Regional trends were controlled for using a difference-in-differences approach

- The intervention was the only major change in the intervention hospital. No structural changes took place in the control hospital during the study period

- Further studies could include more hospitals in the control group

Introduction

The number of annual emergency department (ED) visits has doubled between 1980 and 2004 in France [1], and is still rising (+3.7% between 2014 and 2015). This phenomenon has been observed in most developed countries [2], and is a challenge for physicians and policymakers. ED crowding was defined by the American College of Emergency Physicians (ACEP) as a mismatch between the need for emergency care and the emergency department's ability to provide this care [3]. ED crowding has been associated with longer ED length of stay (LOS) [4], inadequate pain management [5], and worse patient outcomes [6]. A crowded emergency department may sometimes need to fall back on ambulance diversion, redirecting patient flow to nearby hospitals. Moreover, overcrowding can worsen the impact of a public health crisis (terrorist attacks, epidemics …) [7]. Emergency departments are known to depend on hospital bed availability, and a hospital restructuration (sometimes driven by financial reasons) can impend the performance of an ED [8]. Finding the best organization for EDs is therefore a public health priority with ethical implications [3]. The causes of ED crowding include increased demand from patients, epidemics, lack of trained staff, and lack of hospital beds [9]. Numerous scores have been

proposed to measure ED crowding (EDWIN, NEDOCS, READI, Work Score) however their predictive power typically does not outperform simpler indicators such as bed occupancy [10,11]. Time series analysis can predict emergency department activity with a Relative Mean Absolute Performance (RMAP) of 90% [12]. A shorter length of stay results in less complications [13,14], higher odds of survival for severe patients [15], increased patient satisfaction [16,17], and lower healthcare spending [18]. It was also found to be associated with a shorter hospital stay (if the patient is admitted to the hospital thereafter)[19]. Emergency department LOS is therefore a healthcare quality indicator [20]. The optimization of patient flow has been studied extensively [21,22]. Numerous strategies have been proposed to regulate patient flow in the emergency department : Care Coordination Teams, whose mission involves orienting older patients towards appropriate healthcare, observation units (caring for patients up to 72h), chest pain units, home-based healthcare [23]. A common strategy is the use of fast-tracks, dedicated pathways aimed towards the fast delivery of healthcare for patients with benign medical conditions scheduled for rapid discharge. Fast-tracks have been implemented in small and larger hospitals [24]. In 2002, 58% of 17 surveyed Australian public hospitals functioned with a fast-track [23]. A Monte-Carlo simulation showed that implementing a fast-track with a dedicated nurse could shorten median waiting times up to 35% [25]. Previous studies have evaluated the effect of implementing a fast-track [26–29], however the lengths of these studies were short, typically less than 6 months. One 2-year study with a fast-track staffed with mid-level providers did not adjust for patient severity or regional trends [30]. The aim of this study was to assess the impact of an emergency department restructuration with the implementation of a fast-track on ED length of stay in the setting of a large hospital in France. Secondary objectives were to study predictors of ED LOS, and to assess the effect of

the emergency department restructuration on 7-day readmissions, 30-day readmissions, and the proportion of patients leaving without being seen.

Methods

We conducted a difference-in-differences analysis [31,32]. This method is classically used in economics[33] and involves a control group to attempt to model the counterfactual: what would have happened if the intervention group had continued evolving with a common trend with the control group before the intervention.

Population

The region in which the study takes place is one of the least densely populated regions in France. The age structure of the region resembles the pooled age structure of the rest of the country. The intervention hospital (Troyes Hospital) was a large hospital with 442 medical beds, 127 surgical beds and 63 beds dedicated to gynaecology and obstetrics, serving an area of approximately 40 kilometres radius (25 miles). The emergency department hosts an observation unit. The control hospital (Manchester Hospital, located in Charleville-Mézières) was in the same region, and had 375 medical bed, 101 surgical beds, and 63 beds for gynaecology and obstetrics.

Patient and Public involvement

Patients were not involved in the design or analysis of this study.

Intervention

The intervention included an extension of the ED from 15 to 27 consultation rooms, and the opening of a fast-track for patients with small injuries or benign medical conditions. The fast-track is a healthcare pathway for the assessment and treatment of low severity patients, situated in a dedicated area of the emergency department. Two ED physicians managed adult patients and paediatric traumatology in the fast-track. When ED physicians were not available, they were replaced by residents. Gynaecology and psychiatry patients could also be managed in dedicated areas of the fast-track. Entry criteria for the fast-track were pre-defined in a protocol (Supplementary Appendix 1).

Outcomes

The main outcome was an emergency department length of stay ≥ 4 hours [34,35]. LOS was defined as the time elapsed between registration in the ED to the time the patient is discharged from the ED. The secondary outcome was access block, defined by the Australasian College for Emergency Medicine as the situation where patients who need hospital care cannot access an appropriate hospital bed within a reasonable delay (8 hours) [36]. We used the Patient State (PS) classification [12] presented in Table 1 to identify patients that needed to be admitted to the hospital (PS 3, 4, 5, 6 and 7). Time to physician appraisal and LOS were extracted from local hospital databases (data extracted from Resurgences© in the intervention hospital and Urqual© in the control hospital). Quality of care indicators included were the number of patients leaving without being seen [37] and the monthly proportion of 30-day and 7-day readmissions.

Table 1: Patient State (PS) classification for patients admitted to the emergency department

PS class	Description
PS1	Outpatient with moderate treatment
PS2	Outpatient with major treatment
PS3	Inpatient with moderate treatment
PS4	Inpatient with major treatment
PS5	Patients requiring immediate treatment, not classified elsewhere
PS6	Patients requiring immediate intensive care/resuscitation
PS7	Died in emergency Department

Statistical methods

Continuous variables were summarized with means and standard deviations. Categorical variables were presented with absolute frequencies and proportions. Multiple logistic regression models were estimated with Generalized Estimating Equations [38] to account for the within-patient correlation in LOS. The difference-in-difference estimate was modelled as the coefficient of the interaction between time (before or after the intervention) and location. The indicator variable for calculating the difference-in-difference estimate was coded 1 in the "post" period for the intervention hospital, and 0 otherwise. The model was $\text{Logit}(p) = \alpha + \pi P + \gamma L + \delta D + T'\tau + X'\beta$, with p being the probability of the outcome, α the intercept, P an indicator variable for period, L an indicator variable for location, D the interaction between period and location (difference-in-differences indicator), T a vector of additional time variables (effect of being admitted during the night, the weekend or winter months) and X a vector of individual-level covariates. All clinically significant predictors of LOS were included in the model. Age was grouped in categories relevant to clinical practice. Primary diagnosis was defined using chapters of the International Classification of Disease (10^{th} revision) to avoid problems in estimation due to

sparse data. Patient severity was included in the model using the PS classification [12]. If one of the components of the PS classification was missing, PS was imputed to the most likely category based on available data in the classification. Time variables included indicator variables for admission during the night (22:00 – 06:00), and during weekends (Saturday and Sunday). An indicator variable for December and January, where flu epidemics often occur, was included in the model. The study sample was a convenience sample with a time window constructed symmetrically around the intervention, allowing to control for seasonal effects. Statistical analyses were performed using SAS software version 9.4 (The SAS Institute Inc., Cary, NC, USA). Data management and figures were realised using R version 3.3.4 [39].

Ethics Statement

All legal requirements for epidemiological studies were respected, and the French national commission governing the application of data privacy laws issued an approval for the project. Since the study was strictly observational, in accordance with the laws that regulate "non-interventional clinical research" in France, namely articles L.1121-1 and R.1121-2 of the Public Health Code, it did not require a written informed consent from participants or approval from an ethics committee.

Results

Between 13 January 2015 and 13 January 2017, 111733 ED stays were registered in the intervention hospital, and 85829 in the control hospital (Figure 1).

Figure 1 Flowchart

The Emergency department of the intervention hospital registered 53768 stays in 2016 and 57965 in 2017 (+7.8%). During the same period, the control hospital registered 42133 and 43696 admissions respectively (+3.7%). Additional physicians, nurses and assistant nurses allocated to the ED after the intervention are shown in Table 2.

Table 2: Physicians, nurses and assistant nurses in the intervention hospital

Category	2015	2016
ED physicians FTE	11.5	14.5
Nurse FTE	35.3	36.8
Assistant nurse FTE	16.8	19.5

FTE: Full-Time Equivalents

Mean age was higher in the control hospital (Table 3). The mean length of stay in the intervention hospital ED was 261 min (Standard Deviation 213) before the intervention and 248 min (SD 217) after the intervention. In the control group, the mean length of stay before the intervention was 262 min (SD 392) and 265 min (SD 393) after the intervention. In the intervention hospital, the proportion of patients with LOS < 4 hours changed from 55.2% to 60.6%. The proportion of patients with LOS < 4 hours was stable in the control group. Patients admitted to the hospital after the emergency department had a significantly longer ED LOS than outpatients (420 min vs 210 min). Within the subgroups of patients subsequently admitted to the intervention hospital, patients consulting for pneumonia had a decrease in mean time to physician assessment after the intervention: from 128 min (SD 122.5) to 123 min (SD 123.9). Stroke patients also had decreased waiting times: from 108 (SD 111) to 90 (SD 89) minutes. The time to physician assessment remained unchanged for patients consulting for myocardial infarction and heart failure: from 110 (SD 115) before the intervention to 109 (SD 114) minutes after the intervention.

Table 3: Demographic characteristics of study population, readmissions, time to medical assessment and length of stay in the intervention and control hospitals

	Intervention		P-value	Control		P-value
	2015-2016 mean (SD) or n (%)	2016-2017 mean (SD) or n (%)		2015-2016 mean (SD) or n (%)	2016-2017 mean (SD) or n (%)	
n	53768	57965	-	42133	43696	-
Age (years): mean (SD)	40.4 (27.3)	39.8 (27.4)	0.0002	45.4 (25.3)	45.4 (25.2)	0.81
Sex: *female – n* (%)	26712 (49.7)	29235 (50.4)	0.001	20171 (47.9)	21338 (48.8)	0.005
Length of stay (min): mean (SD)	260.67 (212.65)	248.36 (216.96)	<0.0001	262.78 (392.34)	265.04 (392.48)	0.40
7-day readmissions: *n (%)*	3177 (5.9)	3642 (6.3)	0.01	2600 (6.2)	2689 (6.2)	0.92
30-day readmissions: *n* (%)	6105 (11.4)	7129 (12.3)	<0.0001	5048 (12.0)	5489 (12.6)	0.01
Patients admitted to hospital after emergency department: *n*	14795	14864	-	7530	7592	-
Length of stay (min): mean (SD)	342 (221)	367 (251)	<0.0001	536 (532)	566 (554)	<0.001
Injuries (ICD-10 codes S00 to T98)						
n	2470	2341	-	1242	1165	-
Time to medical assessment (min): mean (SD)	119.53 (111)	99.35 (90)	<0.0001	34.79 (39)	38.24 (46)	0.05
Patients not admitted to hospital after emergency department						
n	38971	43100	-	34603	36104	-
Length of stay (min): mean (SD)	230 (201)	208 (188)	<0.0001	203 (325)	201 (314)	0.51
Injuries (ICD-10 codes S00 to T98)						
n	11992	13170	-	14902	15467	-
Time to medical assessment (min): mean (SD)	130.27 (97.6)	100.23 (78.0)	<0.0001	39.93 (37.35)	44.43 (45.30)	<0.0001

ICD-10: International Classification of Disease, 10th revision

The exponentiated difference-in-differences estimate was 0.798 (95% CI 0.762 - 0.836, p<0.0001), therefore the intervention successfully reduced the number of ED stays with LOS ≥ 4 hours (Table 4). This coefficient can be interpreted as a ratio of odds ratios. However, the estimate for access block was 1.121 (95% CI 1.029 - 1.222, p=0.009): the intervention was not effective in helping patients access an appropriate hospital bed in a reasonable amount of time (<8h). Age was linearly related with length of stay, with younger patients having a shorter LOS. Weekends were associated with a shorter length of stay. Trends in daily mean length of stay are shown in Figure 2.

Figure 2 Daily mean emergency department length of stay during the study period (trends obtained by locally weighted regression).

Effect on quality of care indicators

Overall, 12.0% of stays were 30-day readmissions. Most readmissions (6.1%) occurred within the first seven days. There was a trend for increasing 30-day readmissions during the study period (Figure 3). Seven-day readmissions increased in the intervention group, but not in the control group. In the intervention hospital, after the intervention, the proportion of patients leaving without being seen by a physician decreased from 10% to 5.4%.

Figure 3 Proportion of emergency department 7-day and 30-day readmissions during the study period

Table 4: Multivariable logistic regression fitted with Generalized Estimating Equations for length of stay > 4h and access block

Variable	Odds Ratio (emergency department length of stay ≥4 hours) [a]	(95% Confidence Interval)	P-value	Odds Ratio (Access block: emergency department length of stay ≥8h for hospitalized patients) [a]	(95% Confidence Interval)	P-value
Location × Period interaction	0.798	(0.762 - 0.836)	<0.0001	1.121	(1.029 - 1.222)	<0.01
7-day readmission	0.906	(0.861 - 0.953)	<0.001	0.894	(0.82 - 0.975)	0.01
Weekend day	0.896	(0.873 - 0.919)	<0.0001	0.849	(0.808 - 0.892)	<0.0001
Night	0.749	(0.724 - 0.775)	<0.0001	1.51	(1.422 - 1.604)	<0.0001
Principal Diagnosis (ICD-10 Chapter)						
Injury, poisoning	0.400	(0.375 - 0.427)	<0.0001	0.578	(0.529 - 0.632)	<0.0001
Diseases of the nervous system	1.903	(1.713 - 2.114)	<0.0001	1.266	(1.119 - 1.444)	<0.001
Skin and subcutaneous tissue	0.418	(0.377 - 0.463)	<0.0001	0.606	(0.483 - 0.761)	<0.0001
Neoplasms	1.715	(1.253 - 2.348)	0.001	2.588	(1.941 - 3.45)	<0.0001
Diseases of the circulatory system	1 (Reference)	-	-	1 (Reference)	-	-
Month: December and January (reference = other months)	1.121	(1.088 - 1.155)	<0.0001	1.324	(1.255 - 1.396)	<0.0001
Severity (PS classification)						
PS1: Outpatient with moderate treatment	1 (Reference)	-	-	-	-	-
PS2: Outpatient with major treatment	0.753	(0.725 - 0.781)	<0.0001	-	-	-
PS3: Inpatient with moderate treatment	2.584	(2.5 - 2.671)	<0.0001	1 (Reference)	-	-
PS4: Inpatient with major treatment	3.083	(2.941 - 3.231)	<0.0001	0.875	(0.832 - 0.92)	<0.0001
PS5: Patients requiring immediate treatment, not classified elsewhere	1.225	(1.064 - 1.411)	<0.01	0.783	(0.686 - 0.894)	<0.001
PS6: Patients requiring immediate intensive care/resuscitation	0.38	(0.307 - 0.47)	<0.0001	0.305	(0.23 - 0.403)	<0.0001
PS7: Died in emergency Department	0.436	(0.279 - 0.682)	<0.001	0.416	(0.251 - 0.691)	<0.001
Sex: Female (reference = male)	0.972	(0.949- 0.996)	0.02	1.032	(0.988 - 1.078)	0.16
Age (years)						
50 - 64	1.693	(1.635 - 1.753)	<0.0001	1.340	(1.248 - 1.438)	<0.0001

65 - 74	2.279	(2.182 - 2.38)	<0.0001	1.544	(1.431 - 1.665)	<0.0001
75 – 89	3.395	(3.268 - 3.527)	<0.0001	1.786	(1.677 - 1.903)	<0.0001
≥ 90	4.250	(3.979 - 4.539)	<0.0001	1.748	(1.606 - 1.903)	<0.0001
0 – 17	0.259	(0.248 - 0.270)	<0.0001	0.078	(0.064 - 0.096)	<0.0001
18 - 50	1 (Reference)	-	-	1 (Reference)	-	-

[a] Multivariable analysis adjusted for age, sex, time of the day (nighttime or daytime), time in the week (weekend day or weekday), time of the year (December and January or other months, admission diagnosis (grouped using ICD-10 chapters) and severity (using the PS classification).

Discussion

Our study showed that implementing a fast-track can decrease the mean length of stay and number of stays lasting ≥ 4 hours in the emergency department of a large general hospital. We did not observe a higher number of stays with LOS inferior to 8 hours for patients requiring hospitalization, suggesting that the length of stay for severe patients is limited by hospital-level bed availability rather than ED-related factors.

Our results are concurrent with Bucheli and Martina [40], who found that adding a supplementary ED physician shortened outpatient ED length of stay but not the LOS for patients that would be hospitalized afterwards. The extension of the emergency department could explain part of our result. However, the extension of an emergency department does not guarantee improved access to care. In a study by Han et al., the time between ambulance diversion episodes was not significantly different after extending an ED from 28 to 53 beds [41]. The difference-in-differences method is based on a hypothesis that intervention and control hospitals share common trends before the study period. In our study, the trends in both hospitals were graphically similar. Regional data also supports the hypothesis that intervention hospital and the control hospital are subject to common shocks [42]. Asplin et al. consider the emergency department as a system with 3 components :

input, throughput, output [43]. The input component includes events, diseases or other characteristics that contribute to the demand for urgent care. Throughput includes triage, room placement, diagnosis and treatment. The implementation of the fast-track can accelerate throughput for outpatients. Regarding admission diagnoses, in the multivariable analysis patients admitted for injuries (ICD-10 codes S00 to T98) and skin problems (L00 to L99) tended to have short lengths of stay, while patients admitted for neoplasms (C00 to D48) or neurologic diseases (G00 – G99) tended to have longer lengths of stay. This could be due to the necessity of consulting different specialists [44] or to delays in obtaining complementary examinations. As expected, patients that were subsequently admitted to the hospital (PS3 and PS4) had a higher LOS than outpatients. The limiting factor for ED LOS is often lack of available hospital beds. Some authors have suggested that an occupancy of 85% is a suitable target to ensure that new patients are not left without beds [45]. This seems difficult to implement under current conditions. A systematic review of 220 articles discussing strategies to prevent « access block » [36] mentions interventions to diminish the number of patients admitted to the ED, observation wards [46], and other resource management strategies. The DEED II study was a randomised controlled trial measuring the effect of a multidisciplinary geriatric management plan for patients admitted to the emergency department that returned home afterwards. The patients of the intervention group had significantly lower ED readmission rates than the other patients. There were, however, no differences in mortality or in admissions to nursing homes [47]. This type of intervention could be relevant for the hospitals in our study, where age was a major predictor of length of stay. Other solutions to prevent ED crowding are sharing optimal care processes [48], enrolling additional staff [10], or eventually redirecting patients towards other centers [9]. Causes of increased demand for urgent care include the ageing of

populations, with a higher prevalence of chronic diseases, the scarcity of primary care, and changing perceptions of what is considered urgent. Solitude is a major driver of ED consultations [49]. The efficacy of gatekeeping procedures has yet to be evaluated [50]. The patients that frequently consult in the emergency department, however, are often disadvantaged by a low socio-economic status [51] and can be considered a high-risk group regarding morbidity and mortality [52]. Prior contact with the ED could help improve communication with the patient, although an effect on the number of ED admissions remains to be established [53]. Pain is a major complaint in the ED, and patients with chronic pain could be more likely to consult [54]. Our data shows longer ED lengths of stay for patients admitted for neoplasms and diseases of the nervous system. Complex case managers targeting these subgroups could be a solution to shorten LOS [55]. Access to programmed care is crucial. Patients who cannot access programmed care will come back to the emergency department. In an Australian study, around half of patients would prefer to see a general practitioner for a similar problem than to be treated in the emergency fast-track [56]. In this regard, what is happening in emergency departments can be seen as a mirror of the dysfunctions in a healthcare system [57]. After the implementation of the fast-track, the number of patients registered in the ED increased by 7.8%. This increase was higher than in the control group. This is unlikely to be a fluctuation in epidemiological trends, but rather reflects an increased demand generated by an easier access to timely care.

Patients leaving without being seen diminished from 10% to 5.4%, similar to the proportions in studies by Combs et al [58] and Sanchez et al. [30]. In this study we evaluated 7 and 30-day readmissions [59]. The main rationale for including these indicators was to appreciate the extent by which the decrease in LOS was explained by readmissions of the same

patients. Patients coming back to the hospital within 7 days had shorter lengths of stay during the readmission: Odds Ratio for LOS ≥ 4 hours: 0.91; 95% Confidence Interval (CI) (0.86 - 0.95). One possible explanation is the availability of the patient's recent medical history, making medical assessment simpler. Seven-day readmissions increased in the intervention hospital after the implementation of the fast-track. However, because we included a readmission indicator in the multivariable model, the fast-track effect on length of stay is probably not due to close readmissions of the same patients. Emergency departments may have a role to play in preventing hospital readmissions [60]. However, recent studies show that hospital readmissions are often not avoidable, and are largely influenced by factors on which hospitals have no control, like socio-economic status [61]. Preventable readmissions algorithms (which could improve our appreciation of which readmissions are caused by hospital-related factors) [62] are being developed, however they are not widely available at the moment. We were able to control for regional trends with the inclusion of a control hospital. The intervention that took place in the intervention group was the only major change in the emergency department during this period. The control hospital did not undergo structural changes during the study period. The major limitation of our study is that the effect of implementing a fast-track was confounded with the extension and addition of staff to the ED to allow it to function effectively under increased constraints. However, the reported increase in full-time equivalents was due to the administrative transfer of staff from the mobile unit for emergencies and intensive care. Only one additional nurse was fully allocated to the ED. As the mobile unit's main activity is to intervene outside of the hospital, it is unlikely that the changes in length of stay observed in the intervention hospital are entirely explained by the increase in human resources. Moreover, because supplemental beds were added to the ED as part of the intervention,

the ratio of staff to beds decreased. Another possible shortcoming of this study is that the time to physician assessment was evaluated using data from local emergency department information systems. There could be discrepancies between hospitals in encoding the moment where the physician sees the patient. However, this is unlikely to change the difference in trends between hospitals. To conclude, our study showed an increase in short stays for low acuity patients following the implementation of the fast-track. In this regard, the fast-track consolidated the emergency department's role of compensating deficiencies in access to primary care, without favourably impacting length of stay for severe patients. Hospital-level bed availability is critical to ensure efficient healthcare for patients registered to the ED. Studies including more control hospitals and a larger array of quality of care indicators are warranted to estimate the effect of implementing a fast-track on emergency department performance and population health outcomes.

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STROBE Checklist: STROBE Checklist is provided as a Supplementary Material

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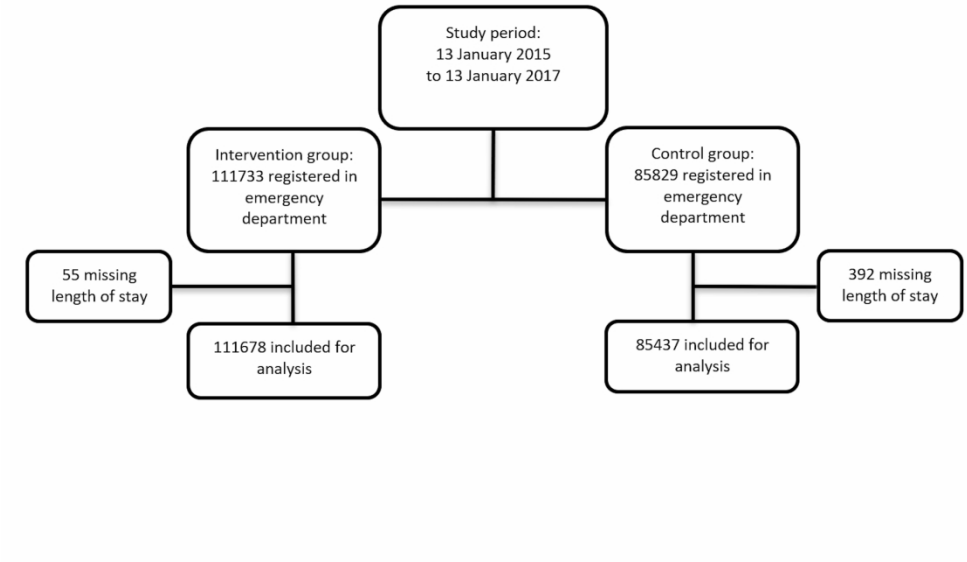
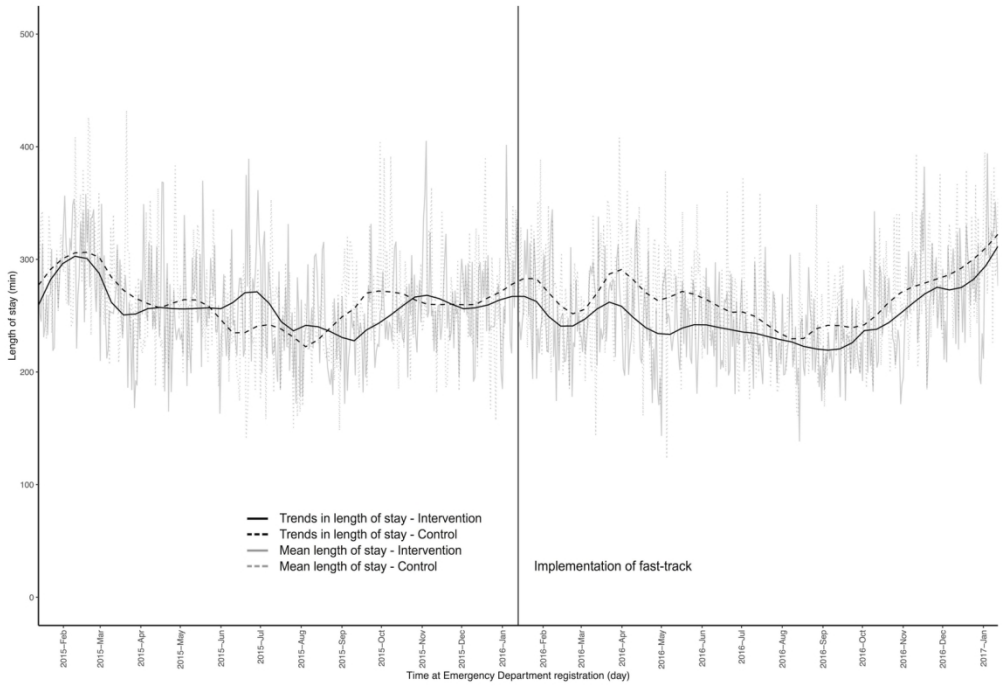


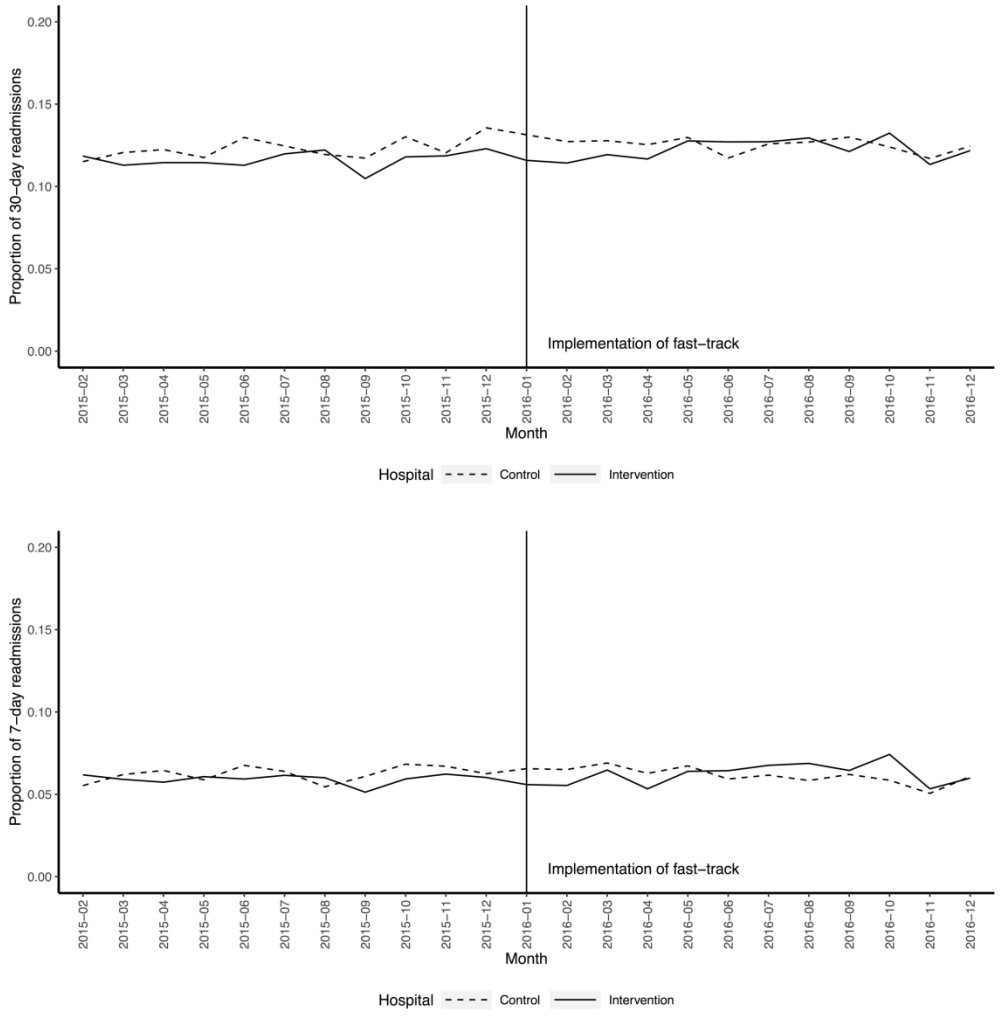
Flowchart of the study

209x148mm (300 x 300 DPI)



Daily mean emergency department length of stay during the study period, with trends obtained by locally weighted regression.

142x99mm (300 x 300 DPI)



Proportion of emergency department 7-day and 30-day readmissions during the study period

266x280mm (300 x 300 DPI)

SUPPLEMENTARY APPENDIX 1: Emergency department fast-track admission criteria

Exclusion criteria

- Dependent in everyday life

- Age > 65 years

- Pain on visual analogic scale ≥ 8/10

Triage

If the answer to all following questions is no, the patient can be managed in the fast-track

- Need to undress patient for assessment/treatment
- Patient needs to be in supine position
- Need for blood sampling
- Patient needs major wound suture

Trauma patients managed in the fast-track

- Trauma not requiring major analgesics
- Contusions and benign trauma, for patients WITHOUT anticoagulant medication
- Cranial trauma without initial loss of consciousness
- Minor wounds, except on tongue, eye, or scalp
- Abscess, minor subcutaneous tissue infection, subcutaneous foreign body
- Minor burn injuries except on face
- Wound management

Medical patients managed in the fast-track

Gastro-enterology

- Foreign body ingestion
- Constipation/diarrhea
- Acid reflux disease

Ophtalmology

- Ocular foreign body
- Conjunctivitis
- Palpebral infection

Urology

- Uncomplicated lower urinary tract infections

Oto-rhino-laryngology

- Epistaxis
- Ear pain
- Dental abscess

Dermatology

- Skin rash
- Benign skin disease without fever
- Insect bites

Others

- Urgent treatment injections

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	3
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, explain how loss to follow-up was addressed	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			N/A

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Figure 1
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	Figure 1
		(c) Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	Report numbers of outcome events or summary measures over time	8
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11
		(*b*) Report category boundaries when continuous variables were categorized	12
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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The impact of the implementation of a fast-track on emergency department length of stay and quality of care indicators in the Champagne-Ardenne region: a difference-in-differences study

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The impact of the implementation of a fast-track on emergency department length of stay and quality of care indicators in the Champagne-Ardenne region: a difference-in-differences study

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Abstract

Objectives: We aimed to evaluate the effect of the implementation of a fast-track on Emergency Department (ED) length of stay (LOS) and quality of care indicators.
Design: Difference-in-differences analysis.
Setting: Two large hospitals in the Champagne-Ardenne region, France.
Participants: Patients admitted to the emergency department between 13 January 2015 and 13 January 2017.
Intervention: Implementation of a fast-track for patients with small injuries or benign medical conditions (13 January 2016).
Primary and Secondary Outcome Measures: Proportion of patients with LOS ≥ 4h and proportion of access block situations (when patients cannot access an appropriate hospital bed within 8 hours). 7-day readmissions and 30-days readmissions.
Results: The emergency department of the intervention hospital registered 53768 stays in 2016 and 57965 in 2017 (+7.8%). During the same period, the control hospital registered 42133 and 43696 stays respectively (+3.7%). In the intervention hospital, the mean length of stay was 261 minutes before the intervention and 248 minutes after the intervention. In the control hospital, the corresponding times were 262 and 265 minutes. The difference-in-differences (DID) estimator for ED LOS ≥ 4h was 0.80; 95% confidence interval (CI) 0.76 – 0.84). The DID estimator for access block was 1.12; 95% CI 1.03 – 1.22.
There was an increase in the proportion of 30-day readmissions in the intervention hospital (from 11.4% to 12.3%). An increase was also observed in the control group (from 12.0% to 12.6%). In the intervention hospital, after the intervention, the proportion of patients leaving without being seen by a physician decreased from 10.0% to 5.4%.
Conclusions: The implementation of a fast-track was associated with a decrease in stays lasting ≥4 hours without a decrease in access block. Further studies are needed to evaluate the causes of variability in emergency department LOS and their connections to quality of care indicators.

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Keywords
Emergency Department – Length of stay – Fast-track – Hospital readmissions – Healthcare Quality

Strengths and Limitations of this study

- We measured the effect of the implementation of a fast-track on length of stay and quality of care indicators

- Regional trends were controlled for using a difference-in-differences approach

- The intervention was the only major change in the intervention hospital. No structural changes took place in the control hospital during the study period

- Further studies could include more hospitals

Introduction

The number of annual emergency department (ED) visits has doubled between 1980 and 2004 in France [1], and is still rising (+3.7% between 2014 and 2015). This phenomenon has been observed in most developed countries [2], and is a challenge for physicians and policymakers. ED crowding was defined by the American College of Emergency Physicians (ACEP) as a mismatch between the need for emergency care and the emergency department's ability to provide this care [3]. ED crowding has been associated with longer ED length of stay (LOS) [4], inadequate pain management [5], and worse patient outcomes [6]. A crowded emergency department may sometimes need to fall back on ambulance diversion, redirecting patients to nearby hospitals. Finding the best organization for EDs is therefore a public health priority with ethical implications [3]. The causes of ED crowding include increased demand from patients, epidemics, lack of trained staff, and lack of hospital beds [7]. Numerous scores have been proposed to measure ED crowding (EDWIN, NEDOCS, READI, Work Score) however their predictive power typically does not outperform simpler indicators such as bed occupancy [8,9]. Time series analysis can predict emergency department activity with a Relative Mean Absolute Performance (RMAP) of 90% [10]. A

shorter length of stay results in less complications [11,12], higher odds of survival for severe patients [13], increased patient satisfaction [14,15], and lower healthcare spending [16]. The optimization of patient flow has been studied extensively [17,18]. Numerous strategies have been proposed to regulate patient flow in the emergency department : Care Coordination Teams, whose mission involves orienting older patients towards appropriate healthcare, observation units (caring for patients up to 72h), chest pain units, home-based healthcare [19]. A common strategy is the use of fast-tracks, dedicated pathways aimed towards the fast delivery of healthcare for patients with benign medical conditions scheduled for rapid discharge. Fast-tracks have been implemented in small and larger hospitals [20]. In 2002, 58% of 17 surveyed Australian public hospitals functioned with a fast-track [19]. A Monte-Carlo simulation showed that implementing a fast-track with a dedicated nurse could shorten median waiting times up to 35% [21]. Previous studies have evaluated the effect of implementing a fast-track [22–25], however the length of these studies was short, typically less than 6 months. One 2-year study with a fast-track staffed with mid-level providers did not adjust for patient severity or regional trends [26]. The aim of this study was to assess the impact of an emergency department restructuration with the implementation of a fast-track on ED length of stay in the setting of a large hospital in France. Secondary objectives were to study predictors of ED LOS, and to assess the effect of the emergency department restructuration on 7-day readmissions, 30-day readmissions, and the proportion of patients leaving without being seen.

Methods

We conducted a difference-in-differences analysis [27,28]. This method is classically used in economics [29] and involves a control group to attempt to model the counterfactual: what

would have happened if the intervention group had continued evolving with a common trend with the control group before the intervention.

Population

The region in which the study took place is one of the least densely populated regions in France. The age structure of the region resembles the pooled age structure of the rest of the country. The intervention hospital (Troyes Hospital) was a large hospital with 442 medical beds, 127 surgical beds and 63 beds dedicated to gynaecology and obstetrics, serving an area of approximately 40 kilometres radius (25 miles). The emergency department hosted an observation unit. The control hospital (Manchester Hospital, located in Charleville-Mézières) was in the same region, and had 375 medical bed, 101 surgical beds, and 63 beds for gynaecology and obstetrics.

Patient and Public involvement

Patients were not involved in the design or analysis of this study.

Intervention

The intervention included an extension of the ED from 15 to 27 consultation rooms and the opening of a fast-track for patients with small injuries or benign medical conditions. The fast-track in the intervention hospital had 6 rooms. The fast-track is a healthcare pathway for the assessment and treatment of low severity patients, situated in a dedicated area of the emergency department. The intervention was implemented on 13 january 2016. Two ED physicians managed adult patients and paediatric traumatology in the fast-track. When ED physicians were not available, they were replaced by residents. Gynaecology and psychiatry

patients could also be managed in dedicated areas of the fast-track. Entry criteria for the fast-track were pre-defined in a protocol (Supplementary Appendix 1).

Outcomes

The main outcome was an emergency department length of stay ≥ 4 hours [30,31]. LOS was defined as the time elapsed between registration in the ED to the time the patient leaves the ED. The secondary outcome was access block, defined by the Australasian College for Emergency Medicine as the situation where patients who need hospital care cannot access an appropriate hospital bed within a reasonable delay (8 hours) [32]. We used the Patient State (PS) classification [10] presented in Table 1 to identify patients that needed to be admitted to the hospital (PS 3, 4, 5, 6 and 7). Time to physician appraisal and LOS were extracted from local hospital databases (data extracted from Resurgences© in the intervention hospital and Urqual© in the control hospital). Other quality of care indicators included the number of patients leaving without being seen [33] and the monthly proportion of 30-day and 7-day readmissions [34].

Table 1: Patient State (PS) classification for patients admitted to the emergency department

PS class	Description
PS1	Patient with moderate treatment, discharged from emergency department
PS2	Patient with major treatment, discharged from emergency department
PS3	Patient with moderate treatment, hospitalized after emergency department stay
PS4	Patient with major treatment, hospitalized after emergency department stay
PS5	Patients requiring immediate treatment, not elsewhere classified
PS6	Patients requiring immediate intensive care/resuscitation
PS7	Died in emergency Department

Statistical methods

Continuous variables were summarized with means and standard deviations. Categorical variables were presented with absolute frequencies and proportions. A descriptive analysis was carried out for LOS by period and by location. Summary statistics were provided for the waiting times of patients with selected diagnoses (pneumonia, stroke, myocardial infarction and heart failure). To facilitate modelling, length of stay was transformed into a binary variable using thresholds classically found in the litterature [31]. Separate models were fitted to study the primary outcome and access block. The effect of the intervention on the primary outcome was evaluated for all patients. The effect of the intervention on access block was evaluated in an analysis restricted to patients who needed to be hospitalized after their emergency department stay. Multiple logistic regression models were estimated with Generalized Estimating Equations [35] to account for the within-patient correlation in LOS. The difference-in-difference estimate was modelled as the coefficient of the interaction between time (before or after the intervention) and location. The indicator variable for calculating the difference-in-difference estimate was coded 1 in the "post" period for the intervention hospital, and 0 otherwise. The model was $\text{Logit}(p) = \alpha + \pi P + \gamma L + \delta D + T'\tau + X'\beta$, with p being the probability of the outcome, α the intercept, P an indicator variable for period, L an indicator variable for location, D the interaction between period and location (difference-in-differences indicator), T a vector of additional time variables (effect of being admitted during the night, the weekend or winter months) and X a vector of individual-level covariates. Age was grouped in categories relevant to clinical practice. Primary diagnosis was defined using chapters of the International Classification of Disease (10^{th} revision) to avoid problems in estimation due to sparse data. Patient severity was included in the model using the PS classification [10]. If one of the components of the PS classification was missing, PS was imputed to the most likely category based on available data in the

classification (11.9% of cases). Time variables included indicator variables for admission during the night (22:00 – 06:00), and during weekends (Saturday and Sunday). An indicator variable for December and January, where flu epidemics often occur, was included in the model. The study sample was a convenience sample with a time window constructed symmetrically around the intervention, allowing to control for seasonal effects. Statistical analyses were performed using SAS software version 9.4 (The SAS Institute Inc., Cary, NC, USA). Data management and figures were realised using R version 3.3.4 [36].

Ethics Statement

All legal requirements for epidemiological studies were respected, and the French national commission governing the application of data privacy laws issued an approval for the project. Since the study was strictly observational, in accordance with the laws that regulate "non-interventional clinical research" in France, namely articles L.1121-1 and R.1121-2 of the Public Health Code, it did not require a written informed consent from participants or approval from an ethics committee.

Results

Between 13 January 2015 and 13 January 2017, 111733 ED stays were registered in the intervention hospital, and 85829 in the control hospital (Figure 1).

Figure 1 Flowchart

The Emergency department of the intervention hospital registered 53768 stays in 2016 and 57965 in 2017 (+7.8%). During the same period, the control hospital registered 42133 and

43696 admissions respectively (+3.7%). Regarding human ressources, in the intervention hospital, physicians increased from 11.5 to 14.5 Full-Time Equivalents (FTE), nurses from 35.3 to 36.8 FTE, and assistant nurses from 16.8 to 19.5 FTE. Mean age was higher in the control hospital (Table 2). The mean length of stay in the intervention hospital ED was 261 min (Standard Deviation 213) before the intervention and 248 min (SD 217) after the intervention. In the control group, the mean length of stay before the intervention was 262 min (SD 392) and 265 min (SD 393) after the intervention. In the intervention hospital, the proportion of patients with LOS < 4 hours changed from 55.2% to 60.6%. The proportion of patients with LOS < 4 hours was stable in the control group. Within the subgroups of patients subsequently admitted to the intervention hospital, patients consulting for pneumonia had a decrease in mean time to physician assessment after the intervention: from 128 min (SD 122.5) to 123 min (SD 123.9). Stroke patients also had decreased waiting times: from 108 (SD 111) to 90 (SD 89) minutes. The time to physician assessment remained unchanged for patients consulting for myocardial infarction and heart failure: from 110 (SD 115) before the intervention to 109 (SD 114) minutes after the intervention.

Table 2: Demographic characteristics of study population, length of stay and readmissions in the intervention and control hospitals

	Intervention			Control		
	2015-2016* mean (SD) or n (%)	2016-2017† mean (SD) or n (%)	P-value	2015-2016* mean (SD) or n (%)	2016-2017† mean (SD) or n (%)	P-value
n	53768	57965	-	42133	43696	-

Age (years): mean (SD)	40.4 (27.3)	39.8 (27.4)	<0.001‡	45.4 (25.3)	45.4 (25.2)	0.81‡
Sex*: female – n* (%)	26712 (49.7)	29235 (50.4)	0.001§	20171 (47.9)	21338 (48.8)	0.005§
Length of stay (min): mean (SD)	260.67 (212.65)	248.36 (216.96)	<0.001‡	262.78 (392.34)	265.04 (392.48)	0.40‡
7-day readmissions: *n* (%)	3177 (5.9)	3642 (6.3)	0.01§	2600 (6.2)	2689 (6.2)	0.92§
30-day readmissions: *n* (%)	6105 (11.4)	7129 (12.3)	<0.001§	5048 (12.0)	5489 (12.6)	0.01§
Patients admitted to hospital after emergency department: *n*	14795	14864	-	7530	7592	-
Length of stay (min): mean (SD)	342 (221)	367 (251)	<0.001‡	536 (532)	566 (554)	<0.001‡
Patients not admitted to hospital after emergency department						
n	38971	43100	-	34603	36104	-
Length of stay (min): mean (SD)	230 (201)	208 (188)	<0.001‡	203 (325)	201 (314)	0.51‡

SD: Standard Deviation. ICD-10: International Classification of Disease, 10th revision.
* 13/01/2015 to morning of 13/01/2016. ✝ 13/01/2016 afternoon to 13/01/2017. ‡ Student's *t* test. § χ^2 test

The exponentiated difference-in-differences estimate was 0.798 (95% CI 0.762 - 0.836, p<0.0001), therefore the intervention successfully reduced the number of ED stays with LOS ≥ 4 hours (Table 3). This coefficient can be interpreted as a ratio of odds ratios. However, the estimate for access block was 1.121 (95% CI 1.029 - 1.222, p=0.009): the intervention did not seem effective in helping the patients who needed it to access an appropriate hospital bed in a reasonable amount of time (<8h). Age was linearly related with length of stay, with younger patients having a shorter LOS. Weekends were associated with a shorter LOS. Patients admitted for injuries (ICD-10 codes S00 to T98) and skin problems (L00 to L99) tended to have a short LOS, while patients admitted for neoplasms (C00 to D48) or neurologic diseases (G00 – G99) tended to have a longer LOS. Trends in daily mean LOS are shown in Figure 2.

Figure 2 Daily mean emergency department length of stay during the study period (trends obtained by locally weighted regression).

Effect on quality of care indicators

Overall, 12.0% of stays were 30-day readmissions. Most readmissions (6.1%) occurred within the first seven days. There was a trend for increasing 30-day readmissions during the study period (Figure 3). Seven-day readmissions increased from 5.9% to 6.3% in the intervention group, and remained stable (6.2%) in the control group. In the intervention hospital, after the intervention, the proportion of patients leaving without being seen by a physician decreased from 10.0% to 5.4%.

Figure 3 Proportion of emergency department 7-day and 30-day readmissions during the study period

Table 3: Multivariable logistic regression fitted with Generalized Estimating Equations for length of stay ≥ 4h and access block.

Variable	Odds Ratio (emergency department length of stay ≥ 4 hours for all patients)*	95% Confidence Interval	Odds Ratio (Access block: emergency department length of stay ≥ 8h for hospitalized patients)*	95% Confidence Interval
Location × Period interaction	0.798	(0.762 - 0.836)	1.121	(1.029 - 1.222)
Period: after intervention (reference = before intervention)	0.967	(0.934 - 1.001)	1.097	(1.027 - 1.172)
Location: intervention hospital (reference = control hospital)	2.41	(2.317 - 2.507)	0.718	(0.672 - 0.767)
7-day readmission	0.906	(0.861 - 0.953)	0.894	(0.82 - 0.975)

Weekend day	0.896	(0.873 - 0.919)	0.849	(0.808 - 0.892)
Night	0.749	(0.724 - 0.775)	1.51	(1.422 - 1.604)
Principal Diagnosis (ICD-10 Chapter)				
Injury, poisoning	0.400	(0.375 - 0.427)	0.578	(0.529 - 0.632)
Diseases of the nervous system	1.903	(1.713 - 2.114)	1.266	(1.119 - 1.444)
Skin and subcutaneous tissue	0.418	(0.377 - 0.463)	0.606	(0.483 - 0.761)
Neoplasms	1.715	(1.253 - 2.348)	2.588	(1.941 - 3.45)
Diseases of the circulatory system	1 (Reference)	-	1 (Reference)	-
Month: December and January (reference = other months)	1.121	(1.088 - 1.155)	1.324	(1.255 - 1.396)
Severity (PS classification)				
PS1	1 (Reference)	-	-	-
PS2	0.753	(0.725 - 0.781)	-	-
PS3	2.584	(2.5 - 2.671)	1 (Reference)	-
PS4	3.083	(2.941 - 3.231)	0.875	(0.832 - 0.92)
PS5	1.225	(1.064 - 1.411)	0.783	(0.686 - 0.894)
PS6	0.38	(0.307 - 0.47)	0.305	(0.23 - 0.403)
PS7	0.436	(0.279 - 0.682)	0.416	(0.251 - 0.691)
Sex: Female (reference = male)	0.972	(0.949- 0.996)	1.032	(0.988 - 1.078)
Age (years)				
50 - 64	1.693	(1.635 - 1.753)	1.340	(1.248 - 1.438)
65 - 74	2.279	(2.182 - 2.38)	1.544	(1.431 - 1.665)
75 – 89	3.395	(3.268 - 3.527)	1.786	(1.677 - 1.903)
≥ 90	4.250	(3.979 - 4.539)	1.748	(1.606 - 1.903)
0 – 17	0.259	(0.248 - 0.270)	0.078	(0.064 - 0.096)
18 - 50	1 (Reference)	-	1 (Reference)	-

ICD-10: International Classification of Disease, 10th revision. PS: Patient State

* Multivariable analysis adjusted for age, sex, time of the day (nighttime or daytime), time in the week (weekend day or weekday), time of the year (December and January or other months, admission diagnosis (grouped using ICD-10 chapters) and severity (using the PS classification).

Discussion

Our study showed that implementing a fast-track can decrease the mean length of stay and number of stays lasting ≥ 4 hours in the emergency department of a large general hospital.

We did not observe a decrease in LOS for patients requiring hospitalization. However, the length of stay for severe patients may have been limited by hospital-level bed availability rather than ED-related factors [37]. Indeed, other studies have found that the implementation of a fast-track did not adversely affect LOS for patients subsequently admitted to the hospital [38].

The addition of new beds to the emergency department could explain part of our results. However, the addition of new beds does not guarantee improved access to care. In a study by Han et al., the time between ambulance diversion episodes was not significantly different after expanding an ED from 28 to 53 beds [39].

Asplin et al. consider the emergency department as a system with 3 components : *input, throughput,* and *output* [40]. The input component includes events, diseases or other factors that contribute to the demand for urgent care. Throughput includes triage, room placement, diagnosis and treatment. The implementation of the fast-track can accelerate throughput for patients not subsequently admitted to the hospital. The decrease in LOS can be explained by decreased crowding due to rapid patient discharge, floorplan modifications allowing faster patient transfers, or physician and nurse role adjustments [41,42]. Fast-tracks can efficiently coexist with other patient streams, such as tracks dedicated to complex ambulant patients [43]. Regarding output, the limiting factor for ED LOS is often lack of available hospital beds. Some authors have suggested that an occupancy of 85% is a suitable target to ensure that new patients are not left without beds [44]. This seems difficult to implement under current conditions. A systematic review of 220 articles discussing strategies to prevent « access block » [32] mentions interventions to diminish the number of patients admitted to the ED and observation wards [45]. Other solutions to prevent ED crowding are: sharing optimal care processes [46], enrolling additional staff [8],

or eventually redirecting patients towards other centers [7]. Causes of increased demand for urgent care include the ageing of populations, with a higher prevalence of chronic diseases, the scarcity of primary care, and changing perceptions of what is considered urgent. Solitude is a major driver of ED consultations [47]. The efficacy of gatekeeping procedures has yet to be evaluated [48]. The patients that frequently consult in the emergency department, however, are often disadvantaged by a low socio-economic status [49] and can be considered a high-risk group regarding morbidity and mortality [50]. Prior contact with the ED could help improve communication with the patient, although an effect on the number of ED admissions remains to be established [51]. Pain is a major complaint in the ED, and patients with chronic pain could be more likely to consult [52]. Access to programmed care is crucial, and patients who cannot access programmed care will come back to the emergency department. In an Australian study, around half of patients would prefer to see a general practitioner for a similar problem than to be treated in the emergency fast-track [53]. In this regard, what is happening in emergency departments can be seen as a mirror of the dysfunctions in a healthcare system [54].

After the implementation of the fast-track, the number of patients registered in the ED increased by 7.8%. This increase was higher than in the control group. This is unlikely to be a fluctuation in epidemiological trends, but rather reflects an increased demand generated by an easier access to timely care. Patients leaving without being seen diminished from 10.0% to 5.4%, similar to the proportions in studies by Combs et al [55] and Sanchez et al. [26].

Among other quality of care indicators, we evaluated emergency department 7 and 30-day readmissions [56]. The main rationale for including these indicators was to appreciate the extent by which the decrease in LOS was explained by readmissions of the same patients. Seven-day readmissions increased in the intervention hospital after the implementation of

the fast-track. Patients coming back to the hospital within 7 days had shorter lengths of stay during the readmission. One possible explanation is the availability of the patient's recent history, making medical assessment simpler. Emergency departments may have a role to play in preventing hospital readmissions [57]. However, recent studies show that hospital readmissions are often not avoidable, and are largely influenced by factors on which hospitals have no control, like socio-economic status [34,58]. As is often the case, these indicators need to be appraised in conjunction with other quality of care indicators.

We were able to control for regional trends with the inclusion of a control hospital. The intervention that took place in the intervention group was the only major change in the emergency department during this period. The control hospital did not undergo structural changes during the study period. The major limitation of our study was that the effect of implementing a fast-track was confounded with the addition of staff and new beds to the ED to allow it to function effectively under increased constraints. However, the reported increase in full-time equivalents was due to the administrative transfer of staff from the mobile unit for emergencies and intensive care. Only one additional nurse was fully allocated to the ED. As the mobile unit's main activity is to intervene outside of the hospital, it is unlikely that the changes in length of stay observed in the intervention hospital were entirely explained by the increase in human resources. Moreover, because supplemental beds were added to the ED as part of the intervention, the ratio of staff to beds decreased. Another limitation was that the time intervals were evaluated using data from local emergency department information systems. There could have been discrepancies between hospitals in encoding admission and discharge times. However, it seems unlikely that this could change the results of the study. The difference-in-differences method is based on a hypothesis that intervention and control hospitals share common trends before the study

period. In our study, the trends in both hospitals were graphically similar. Regional data supports the hypothesis that the intervention hospital and the control hospital are subject to common shocks. To conclude, our study showed an increase in short stays for low acuity patients following the implementation of the fast-track. In this regard, the fast-track consolidated the emergency department's role of compensating deficiencies in access to primary care, without favourably impacting length of stay for severe patients. Hospital-level bed availability is critical to ensure efficient healthcare for patients registered to the ED. Studies including more hospitals and a larger array of quality of care indicators are warranted to estimate the effect of implementing a fast-track on emergency department performance and population health outcomes.

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Data sharing statement: To prevent dissemination of sensitive patient data, the dataset on which this study was based was not made available to the public. Deidentified data can be obtained from the corresponding author upon reasonnable request - ORCID ID 0000-0002-8364-6506.

STROBE Checklist: STROBE Checklist is provided as a Supplementary Material

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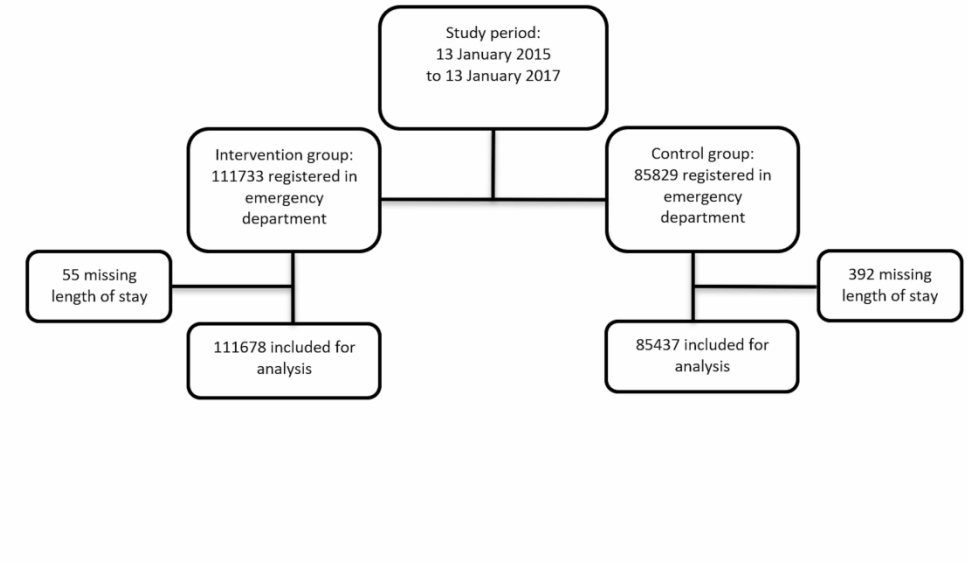
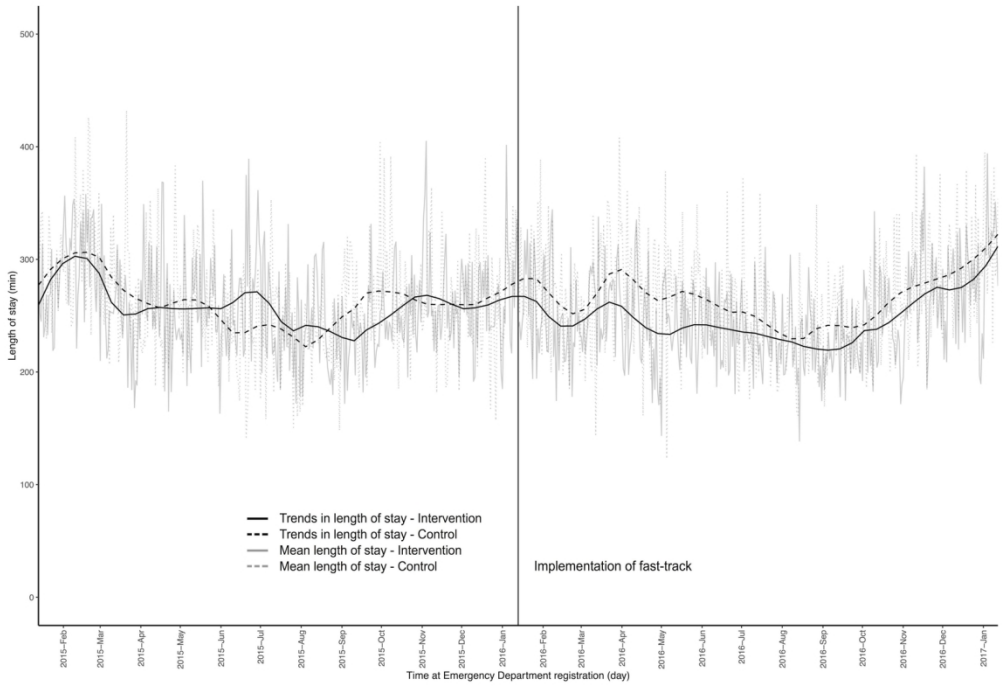


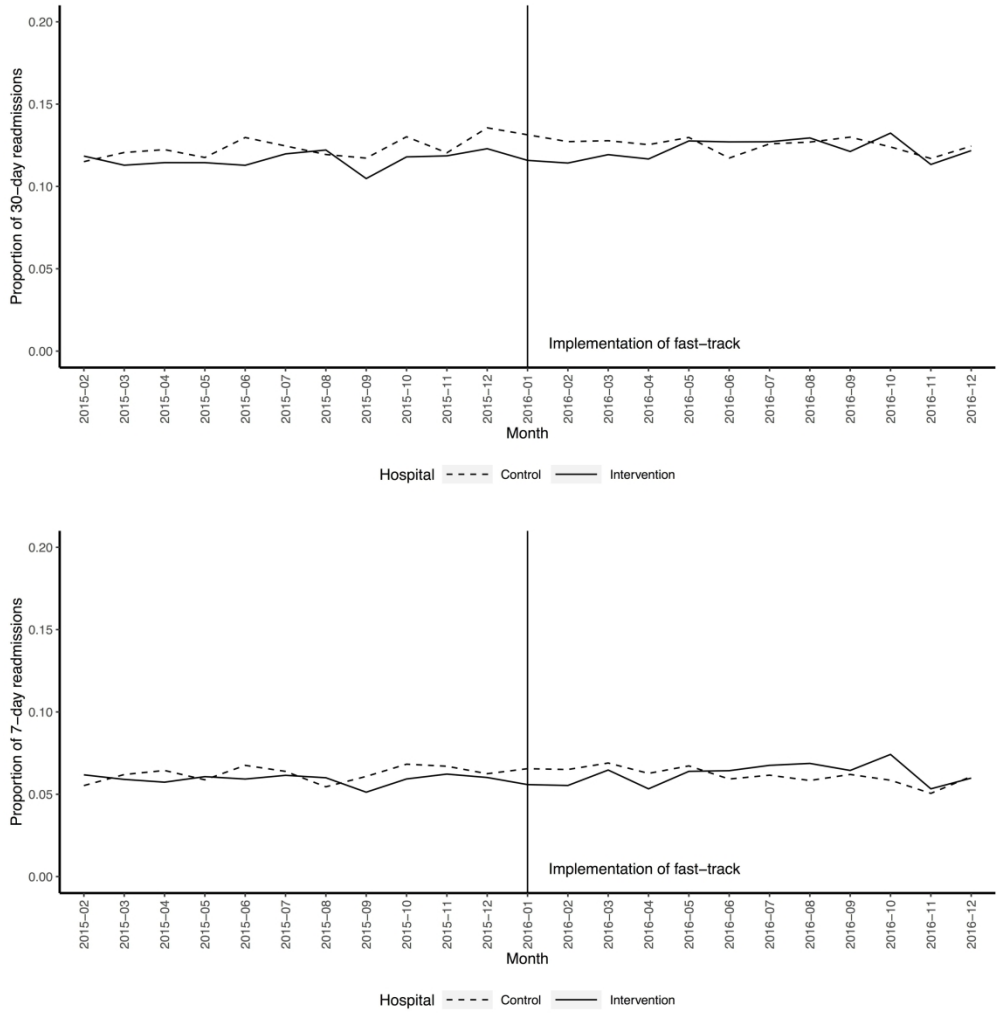
Flowchart of the study

209x148mm (300 x 300 DPI)



Daily mean emergency department length of stay during the study period, with trends obtained by locally weighted regression.

142x99mm (300 x 300 DPI)



Proportion of emergency department 7-day and 30-day readmissions during the study period

266x280mm (300 x 300 DPI)

SUPPLEMENTARY APPENDIX 1: Emergency department fast-track admission criteria

Exclusion criteria

- Disabled patients or patients with reduced autonomy
- Age > 65 years
- Pain on visual analogic scale ≥ 8/10

Triage

If the answer to all following questions is no, the patient can be managed in the fast-track:

- Need to undress the patient for assessment/treatment
- The patient needs to be in supine position
- Need for blood sampling
- The patient needs a wound suture with expected duration of > 20 min

Trauma patients managed in the fast-track

- Trauma not requiring major analgesics
- Contusions and benign trauma, for patients WITHOUT anticoagulant medication
- Cranial trauma without initial loss of consciousness
- Minor wounds, except on tongue, eye, or scalp
- Abscess, minor subcutaneous tissue infection, subcutaneous foreign body
- Minor burn injuries except on face
- Wound management

Medical patients managed in the fast-track

Gastro-enterology

- Foreign body ingestion
- Constipation/diarrhea
- Acid reflux disease

Ophtalmology

- Ocular foreign body
- Conjunctivitis
- Palpebral infection

Urology

- Uncomplicated lower urinary tract infections

Oto-rhino-laryngology

- Epistaxis
- Ear pain
- Dental abscess

Dermatology

- Skin rash
- Benign skin disease without fever
- Insect bites

Others

- Urgent local drugs administration (e.g. intracavernous phenylephrine)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	4
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, explain how loss to follow-up was addressed	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			N/A

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Fig. 1
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	Fig. 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	Fig. 1
		(c) Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	Report numbers of outcome events or summary measures over time	8
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10
		(*b*) Report category boundaries when continuous variables were categorized	5
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	6
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

The impact of the implementation of a fast-track on emergency department length of stay and quality of care indicators in the Champagne-Ardenne region: a difference-in-differences study

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Keywords:	Emergency Department, Length of stay, Fast-track, Hospital readmissions, Healthcare Quality

The impact of the implementation of a fast-track on emergency department length of stay and quality of care indicators in the Champagne-Ardenne region: a difference-in-differences study

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Abstract

Objectives: We aimed to evaluate the effect of the implementation of a fast-track on Emergency Department (ED) length of stay (LOS) and quality of care indicators.
Design: Difference-in-differences analysis.
Setting: Two large hospitals in the Champagne-Ardenne region, France.
Participants: Patients admitted to the emergency department between 13 January 2015 and 13 January 2017.
Intervention: Implementation of a fast-track for patients with small injuries or benign medical conditions (13 January 2016).
Primary and Secondary Outcome Measures: Proportion of patients with LOS ≥ 4h and proportion of access block situations (when patients cannot access an appropriate hospital bed within 8 hours). 7-day readmissions and 30-days readmissions.
Results: The emergency department of the intervention hospital registered 53768 stays in 2016 and 57965 in 2017 (+7.8%). During the same period, the control hospital registered 42133 and 43696 stays respectively (+3.7%). In the intervention hospital, the mean length of stay was 261 minutes before the intervention and 248 minutes after the intervention. In the control hospital, the corresponding times were 262 and 265 minutes. The difference-in-differences (DID) estimator for ED LOS ≥ 4h was 0.80; 95% confidence interval (CI) 0.76 – 0.84). The DID estimator for access block was 1.12; 95% CI 1.03 – 1.22.
There was an increase in the proportion of 30-day readmissions in the intervention hospital (from 11.4% to 12.3%). An increase was also observed in the control group (from 12.0% to 12.6%). In the intervention hospital, after the intervention, the proportion of patients leaving without being seen by a physician decreased from 10.0% to 5.4%.
Conclusions: The implementation of a fast-track was associated with a decrease in stays lasting ≥4 hours without a decrease in access block. Further studies are needed to evaluate the causes of variability in emergency department LOS and their connections to quality of care indicators.

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Keywords
Emergency Department – Length of stay – Fast-track – Hospital readmissions – Healthcare Quality

Strengths and Limitations of this study

- We measured the effect of the implementation of a fast-track on length of stay and quality of care indicators

- Regional trends were controlled for using a difference-in-differences approach

- The intervention was the only major change in the intervention hospital. No structural changes took place in the control hospital during the study period

- Further studies could include more hospitals

Introduction

The number of annual emergency department (ED) visits has doubled between 1980 and 2004 in France [1], and is still rising (+3.7% between 2014 and 2015). This phenomenon has been observed in most developed countries [2], and is a challenge for physicians and policymakers. ED crowding was defined by the American College of Emergency Physicians (ACEP) as a mismatch between the need for emergency care and the emergency department's ability to provide this care [3]. ED crowding has been associated with longer ED length of stay (LOS) [4], inadequate pain management [5], and worse patient outcomes [6]. A crowded emergency department may sometimes need to fall back on ambulance diversion, redirecting patients to nearby hospitals. Finding the best organization for EDs is therefore a public health priority with ethical implications [3]. The causes of ED crowding include increased demand from patients, epidemics, lack of trained staff, and lack of hospital beds [7]. Numerous scores have been proposed to measure ED crowding (EDWIN, NEDOCS, READI, Work Score) however their predictive power typically does not outperform simpler indicators such as bed occupancy [8,9]. Time series analysis can predict emergency department activity with a Relative Mean Absolute Performance (RMAP) of 90% [10]. A

shorter length of stay results in less complications [11,12], higher odds of survival for severe patients [13], increased patient satisfaction [14,15], and lower healthcare spending [16]. The optimization of patient flow has been studied extensively [17,18]. Numerous strategies have been proposed to regulate patient flow in the emergency department : Care Coordination Teams, whose mission involves orienting older patients towards appropriate healthcare, observation units (caring for patients up to 72h), chest pain units, home-based healthcare [19]. A common strategy is the use of fast-tracks, dedicated pathways aimed towards the fast delivery of healthcare for patients with benign medical conditions scheduled for rapid discharge. Fast-tracks have been implemented in small and larger hospitals [20]. In 2002, 58% of 17 surveyed Australian public hospitals functioned with a fast-track [19]. A Monte-Carlo simulation showed that implementing a fast-track with a dedicated nurse could shorten median waiting times up to 35% [21]. Previous studies have evaluated the effect of implementing a fast-track [22–25], however the length of these studies was short, typically less than 6 months. One 2-year study with a fast-track staffed with mid-level providers did not adjust for patient severity or regional trends [26]. The aim of this study was to assess the impact of an emergency department restructuration with the implementation of a fast-track on ED length of stay in the setting of a large hospital in France. Secondary objectives were to study predictors of ED LOS, and to assess the effect of the emergency department restructuration on 7-day readmissions, 30-day readmissions, and the proportion of patients leaving without being seen.

Methods

We conducted a difference-in-differences analysis [27,28]. This method is classically used in economics [29] and involves a control group to attempt to model the counterfactual: what

would have happened if the intervention group had continued evolving with a common trend with the control group before the intervention.

Population

The region in which the study took place is one of the least densely populated regions in France. The age structure of the region resembles the pooled age structure of the rest of the country. The intervention hospital (Troyes Hospital) was a large hospital with 442 medical beds, 127 surgical beds and 63 beds dedicated to gynaecology and obstetrics, serving an area of approximately 40 kilometres radius (25 miles). The emergency department hosted an observation unit. The control hospital (Manchester Hospital, located in Charleville-Mézières) was in the same region, and had 375 medical bed, 101 surgical beds, and 63 beds for gynaecology and obstetrics.

Patient and Public involvement

Patients were not involved in the design or analysis of this study.

Intervention

The intervention included an extension of the ED from 15 to 27 consultation rooms and the opening of a fast-track for patients with small injuries or benign medical conditions. The fast-track in the intervention hospital had 6 rooms. The fast-track is a healthcare pathway for the assessment and treatment of low severity patients, situated in a dedicated area of the emergency department. The intervention was implemented on 13 january 2016. Two ED physicians managed adult patients and paediatric traumatology in the fast-track. When ED physicians were not available, they were replaced by residents. Gynaecology and psychiatry

patients could also be managed in dedicated areas of the fast-track. Entry criteria for the fast-track were pre-defined in a protocol (Supplementary Appendix 1).

Outcomes

The main outcome was an emergency department length of stay ≥ 4 hours [30,31]. LOS was defined as the time elapsed between registration in the ED to the time the patient leaves the ED. The secondary outcome was access block, defined by the Australasian College for Emergency Medicine as the situation where patients who need hospital care cannot access an appropriate hospital bed within a reasonable delay (8 hours) [32]. We used the Patient State (PS) classification [10] presented in Table 1 to identify patients that needed to be admitted to the hospital (PS 3, 4, 5, 6 and 7). Time to physician appraisal and LOS were extracted from local hospital databases (data extracted from Resurgences© in the intervention hospital and Urqual© in the control hospital). Other quality of care indicators included the number of patients leaving without being seen [33] and the monthly proportion of 30-day and 7-day readmissions [34].

Table 1: Patient State (PS) classification for patients admitted to the emergency department

PS class	Description
PS1	Patient with moderate treatment, discharged from emergency department
PS2	Patient with major treatment, discharged from emergency department
PS3	Patient with moderate treatment, hospitalized after emergency department stay
PS4	Patient with major treatment, hospitalized after emergency department stay
PS5	Patients requiring immediate treatment, not elsewhere classified
PS6	Patients requiring immediate intensive care/resuscitation
PS7	Died in emergency Department

Statistical methods

Continuous variables were summarized with means and standard deviations. Categorical variables were presented with absolute frequencies and proportions. A descriptive analysis was carried out for LOS by period and by location. Differences between the period before the intervention and the period after the intervention were compared with Student's *t* test after verifying for each group that the sample size was sufficient for the application of the Central Limit Theorem, and with the χ^2 test for categorical variables. Summary statistics were provided for the waiting times of patients with selected diagnoses (pneumonia, stroke, myocardial infarction and heart failure). To facilitate modelling, length of stay was transformed into a binary variable using thresholds classically found in the litterature [31]. Separate models were fitted to study the primary outcome and access block. The effect of the intervention on the primary outcome was evaluated for all patients. The effect of the intervention on access block was evaluated in an analysis restricted to patients who needed to be hospitalized after their emergency department stay. Multiple logistic regression models were estimated with Generalized Estimating Equations [35] to account for the within-patient correlation in LOS. The difference-in-difference estimate was modelled as the coefficient of the interaction between time (before or after the intervention) and location. The indicator variable for calculating the difference-in-difference estimate was coded 1 in the "post" period for the intervention hospital, and 0 otherwise. The model was $\text{Logit}(p) = \alpha + \pi P + \gamma L + \delta D + T'\tau + X'\beta$, with p being the probability of the outcome, α the intercept, P an indicator variable for period, L an indicator variable for location, D the interaction between period and location (difference-in-differences indicator), T a vector of additional time variables (effect of being admitted during the night, the weekend or winter months) and X a vector of individual-level covariates. Age was grouped in categories relevant to clinical practice. Primary diagnosis was defined using chapters of the International Classification of

Disease (10th revision) to avoid problems in estimation due to sparse data. Patient severity was included in the model using the PS classification [10]. If one of the components of the PS classification was missing, PS was imputed to the most likely category based on available data in the classification (11.9% of cases). Time variables included indicator variables for admission during the night (22:00 – 06:00), and during weekends (Saturday and Sunday). An indicator variable for December and January, where flu epidemics often occur, was included in the model. The study sample was a convenience sample with a time window constructed symmetrically around the intervention, allowing to control for seasonal effects. Statistical analyses were performed using SAS software version 9.4 (The SAS Institute Inc., Cary, NC, USA). Data management and figures were realised using R version 3.3.4 [36].

Ethics Statement

All legal requirements for epidemiological studies were respected, and the French national commission governing the application of data privacy laws issued an approval for the project. Since the study was strictly observational, in accordance with the laws that regulate "non-interventional clinical research" in France, namely articles L.1121-1 and R.1121-2 of the Public Health Code, it did not require a written informed consent from participants or approval from an ethics committee.

Results

Between 13 January 2015 and 13 January 2017, 111733 ED stays were registered in the intervention hospital, and 85829 in the control hospital (Figure 1).

Figure 1 Flowchart

The Emergency department of the intervention hospital registered 53768 stays in 2016 and 57965 in 2017 (+7.8%). During the same period, the control hospital registered 42133 and 43696 admissions respectively (+3.7%). Regarding human ressources, in the intervention hospital, physicians increased from 11.5 to 14.5 Full-Time Equivalents (FTE), nurses from 35.3 to 36.8 FTE, and assistant nurses from 16.8 to 19.5 FTE. Mean age was higher in the control hospital (Table 2). The mean length of stay in the intervention hospital ED was 261 min (Standard Deviation 213) before the intervention and 248 min (SD 217) after the intervention. In the control group, the mean length of stay before the intervention was 262 min (SD 392) and 265 min (SD 393) after the intervention. In the intervention hospital, the proportion of patients with LOS < 4 hours changed from 55.2% to 60.6%. The proportion of patients with LOS < 4 hours was stable in the control group. Within the subgroups of patients subsequently admitted to the intervention hospital, patients consulting for pneumonia had a decrease in mean time to physician assessment after the intervention: from 128 min (SD 122.5) to 123 min (SD 123.9). Stroke patients also had decreased waiting times: from 108 (SD 111) to 90 (SD 89) minutes. The time to physician assessment remained unchanged for patients consulting for myocardial infarction and heart failure: from 110 (SD 115) before the intervention to 109 (SD 114) minutes after the intervention.

Table 2: Demographic characteristics of study population, length of stay and readmissions in the intervention and control hospitals

	Intervention		Control	
		P-value		P-value

	2015-2016* mean (SD) or n (%)	2016-2017† mean (SD) or n (%)		2015-2016* mean (SD) or n (%)	2016-2017† mean (SD) or n (%)	
n	53768	57965	-	42133	43696	-
Age (years): mean (SD)	40.4 (27.3)	39.8 (27.4)	<0.001‡	45.4 (25.3)	45.4 (25.2)	0.81‡
Sex*: female – n* (%)	26712 (49.7)	29235 (50.4)	0.001§	20171 (47.9)	21338 (48.8)	0.005§
Length of stay (min): mean (SD)	260.67 (212.65)	248.36 (216.96)	<0.001‡	262.78 (392.34)	265.04 (392.48)	0.40‡
7-day readmissions: *n* (%)	3177 (5.9)	3642 (6.3)	0.01§	2600 (6.2)	2689 (6.2)	0.92§
30-day readmissions: *n* (%)	6105 (11.4)	7129 (12.3)	<0.001§	5048 (12.0)	5489 (12.6)	0.01§
Patients admitted to hospital after emergency department: *n*	14795	14864	-	7530	7592	-
Length of stay (min): mean (SD)	342 (221)	367 (251)	<0.001‡	536 (532)	566 (554)	<0.001‡
Patients not admitted to hospital after emergency department						
n	38971	43100	-	34603	36104	-
Length of stay (min): mean (SD)	230 (201)	208 (188)	<0.001‡	203 (325)	201 (314)	0.51‡

SD: Standard Deviation. ICD-10: International Classification of Disease, 10th revision.
* 13/01/2015 to morning of 13/01/2016. † 13/01/2016 afternoon to 13/01/2017. ‡ Student's *t* test. § χ^2 test

The exponentiated difference-in-differences estimate was 0.798 (95% CI 0.762 - 0.836, p<0.0001), therefore the intervention successfully reduced the number of ED stays with LOS ≥ 4 hours (Table 3). This coefficient can be interpreted as a ratio of odds ratios. However, the estimate for access block was 1.121 (95% CI 1.029 - 1.222, p=0.009): the intervention did not seem effective in helping the patients who needed it to access an appropriate hospital bed in a reasonable amount of time (<8h). Age was linearly related with length of stay, with younger patients having a shorter LOS. Weekends were associated with a shorter LOS. Patients admitted for injuries (ICD-10 codes S00 to T98) and skin problems (L00 to L99) tended to have a short LOS, while patients admitted for neoplasms (C00 to D48) or

neurologic diseases (G00 – G99) tended to have a longer LOS. Trends in daily mean LOS are shown in Figure 2.

Figure 2 Daily mean emergency department length of stay during the study period (trends obtained by locally weighted regression).

Effect on quality of care indicators

Overall, 12.0% of stays were 30-day readmissions. Most readmissions (6.1%) occurred within the first seven days. There was a trend for increasing 30-day readmissions during the study period (Figure 3). Seven-day readmissions increased from 5.9% to 6.3% in the intervention group, and remained stable (6.2%) in the control group. In the intervention hospital, after the intervention, the proportion of patients leaving without being seen by a physician decreased from 10.0% to 5.4%.

Figure 3 Proportion of emergency department 7-day and 30-day readmissions during the study period

Table 3: Multivariable logistic regression fitted with Generalized Estimating Equations for length of stay ≥ 4h and access block.

Variable	Odds Ratio (emergency department length of stay ≥ 4 hours for all patients) *	95% Confidence Interval	Odds Ratio (Access block: emergency department length of stay ≥ 8h for hospitalized patients) *	95% Confidence Interval
Location × Period interaction	0.798	(0.762 - 0.836)	1.121	(1.029 - 1.222)
Period: after intervention	0.967	(0.934 - 1.001)	1.097	(1.027 - 1.172)

(reference = before intervention)				
Location: intervention hospital (reference = control hospital)	2.41	(2.317 - 2.507)	0.718	(0.672 - 0.767)
7-day readmission	0.906	(0.861 - 0.953)	0.894	(0.82 - 0.975)
Weekend day	0.896	(0.873 - 0.919)	0.849	(0.808 - 0.892)
Night	0.749	(0.724 - 0.775)	1.51	(1.422 - 1.604)
Principal Diagnosis (ICD-10 Chapter)				
Injury, poisoning	0.400	(0.375 - 0.427)	0.578	(0.529 - 0.632)
Diseases of the nervous system	1.903	(1.713 - 2.114)	1.266	(1.119 - 1.444)
Skin and subcutaneous tissue	0.418	(0.377 - 0.463)	0.606	(0.483 - 0.761)
Neoplasms	1.715	(1.253 - 2.348)	2.588	(1.941 - 3.45)
Diseases of the circulatory system	1 (Reference)	-	1 (Reference)	-
Month: December and January (reference = other months)	1.121	(1.088 - 1.155)	1.324	(1.255 - 1.396)
Severity (PS classification)				
PS1	1 (Reference)	-	-	-
PS2	0.753	(0.725 - 0.781)	-	-
PS3	2.584	(2.5 - 2.671)	1 (Reference)	-
PS4	3.083	(2.941 - 3.231)	0.875	(0.832 - 0.92)
PS5	1.225	(1.064 - 1.411)	0.783	(0.686 - 0.894)
PS6	0.38	(0.307 - 0.47)	0.305	(0.23 - 0.403)
PS7	0.436	(0.279 - 0.682)	0.416	(0.251 - 0.691)
Sex: Female (reference = male)	0.972	(0.949- 0.996)	1.032	(0.988 - 1.078)
Age (years)				
50 - 64	1.693	(1.635 - 1.753)	1.340	(1.248 - 1.438)
65 - 74	2.279	(2.182 - 2.38)	1.544	(1.431 - 1.665)
75 – 89	3.395	(3.268 - 3.527)	1.786	(1.677 - 1.903)
≥ 90	4.250	(3.979 - 4.539)	1.748	(1.606 - 1.903)
0 – 17	0.259	(0.248 - 0.270)	0.078	(0.064 - 0.096)
18 - 50	1 (Reference)	-	1 (Reference)	-

ICD-10: International Classification of Disease, 10th revision. PS: Patient State

* Multivariable analysis adjusted for age, sex, time of the day (nighttime or daytime), time in the week (weekend day or weekday), time of the year (December and January or other months, admission diagnosis (grouped using ICD-10 chapters) and severity (using the PS classification).

Discussion

Our study showed that implementing a fast-track can decrease the mean length of stay and number of stays lasting ≥ 4 hours in the emergency department of a large general hospital. We did not observe a decrease in LOS for patients requiring hospitalization. However, the length of stay for severe patients may have been limited by hospital-level bed availability rather than ED-related factors [37]. Indeed, other studies have found that the implementation of a fast-track did not adversely affect LOS for patients subsequently admitted to the hospital [38].

The addition of new beds to the emergency department could explain part of our results. However, the addition of new beds does not guarantee improved access to care. In a study by Han et al., the time between ambulance diversion episodes was not significantly different after expanding an ED from 28 to 53 beds [39].

Asplin et al. consider the emergency department as a system with 3 components : *input, throughput,* and *output* [40]. The input component includes events, diseases or other factors that contribute to the demand for urgent care. Throughput includes triage, room placement, diagnosis and treatment. The implementation of the fast-track can accelerate throughput for patients not subsequently admitted to the hospital. The decrease in LOS can be explained by decreased crowding due to rapid patient discharge, floorplan modifications allowing faster patient transfers, or physician and nurse role adjustments [41,42]. Fast-tracks can efficiently coexist with other patient streams, such as tracks dedicated to complex ambulant patients [43]. Regarding output, the limiting factor for ED LOS is often lack of available hospital beds. Some authors have suggested that an occupancy of 85% is a suitable target to ensure that new patients are not left without beds [44]. This seems difficult to implement under current conditions. A systematic review of 220 articles

discussing strategies to prevent « access block » [32] mentions interventions to diminish the number of patients admitted to the ED and observation wards [45]. Other solutions to prevent ED crowding are: sharing optimal care processes [46], enrolling additional staff [8], or eventually redirecting patients towards other centers [7]. Causes of increased demand for urgent care include the ageing of populations, with a higher prevalence of chronic diseases, the scarcity of primary care, and changing perceptions of what is considered urgent. Solitude is a major driver of ED consultations [47]. The efficacy of gatekeeping procedures has yet to be evaluated [48]. The patients that frequently consult in the emergency department, however, are often disadvantaged by a low socio-economic status [49] and can be considered a high-risk group regarding morbidity and mortality [50]. Prior contact with the ED could help improve communication with the patient, although an effect on the number of ED admissions remains to be established [51]. Pain is a major complaint in the ED, and patients with chronic pain could be more likely to consult [52]. Access to programmed care is crucial, and patients who cannot access programmed care will come back to the emergency department. In an Australian study, around half of patients would prefer to see a general practitioner for a similar problem than to be treated in the emergency fast-track [53]. In this regard, what is happening in emergency departments can be seen as a mirror of the dysfunctions in a healthcare system [54].

After the implementation of the fast-track, the number of patients registered in the ED increased by 7.8%. This increase was higher than in the control group. This is unlikely to be a fluctuation in epidemiological trends, but rather reflects an increased demand generated by an easier access to timely care. Patients leaving without being seen diminished from 10.0% to 5.4%, similar to the proportions in studies by Combs et al [55] and Sanchez et al. [26].

Among other quality of care indicators, we evaluated emergency department 7 and 30-day readmissions [56]. The main rationale for including these indicators was to appreciate the extent by which the decrease in LOS was explained by readmissions of the same patients. Seven-day readmissions increased in the intervention hospital after the implementation of the fast-track. Patients coming back to the hospital within 7 days had shorter lengths of stay during the readmission. One possible explanation is the availability of the patient's recent history, making medical assessment simpler. Emergency departments may have a role to play in preventing hospital readmissions [57]. However, recent studies show that hospital readmissions are often not avoidable, and are largely influenced by factors on which hospitals have no control, like socio-economic status [34,58]. As is often the case, these indicators need to be appraised in conjunction with other quality of care indicators.

We were able to control for regional trends with the inclusion of a control hospital. The intervention that took place in the intervention group was the only major change in the emergency department during this period. The control hospital did not undergo structural changes during the study period. The major limitation of our study was that the effect of implementing a fast-track was confounded with the addition of staff and new beds to the ED to allow it to function effectively under increased constraints. However, the reported increase in full-time equivalents was due to the administrative transfer of staff from the mobile unit for emergencies and intensive care. Only one additional nurse was fully allocated to the ED. As the mobile unit's main activity is to intervene outside of the hospital, it is unlikely that the changes in length of stay observed in the intervention hospital were entirely explained by the increase in human resources. Moreover, because supplemental beds were added to the ED as part of the intervention, the ratio of staff to beds decreased. Another limitation was that the time intervals were evaluated using data from local

emergency department information systems. A simple imputation was carried out for one of the variables (the PS classification), using the most likely result based on available scores if a component of the classification was missing. However, the risk of misclassification was minimal, as the incomplete scores were sufficient to decide if the patient required hospitalization in all cases. We could not carry out multiple imputation because of the size of the data. There could have been discrepancies between hospitals in encoding admission and discharge times. However, it seems unlikely that this could change the results of the study. The difference-in-differences method is based on a hypothesis that intervention and control hospitals share common trends before the study period. The control hospital was included because it was in the same region and was of the same size as the intervention hospital, however there were differences regarding the functioning of their emergency departments. Stays in the intervention hospital were more likely to last ≥ 4 hours than in the control hospital as is shown by the location-specific Odds Ratios. The common shocks condition is violated during peak days in either one of the hospitals. However, the aim of the difference-in-differences analysis was to demonstrate that no major changes affected the region, as was demonstrated by the stability of the number of patients and length of stay in the control hospital. To conclude, our study showed an increase in short stays for low acuity patients following the implementation of the fast-track. In this regard, the fast-track consolidated the emergency department's role of compensating deficiencies in access to primary care, without favourably impacting length of stay for severe patients. Hospital-level bed availability is critical to ensure efficient healthcare for patients registered to the ED. Studies including more hospitals and a larger array of quality of care indicators are warranted to estimate the effect of implementing a fast-track on emergency department performance and population health outcomes.

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Author contributions: JC, DL, AD, LK and SS designed the study. SS, DL, XF, AC contributed to the acquisition of data. JC conducted the statistical analysis. JC, XF, AD, AC, DL, LK and SS contributed to drafting the article or revising it critically for important intellectual content. All authors read and approved the final manuscript.

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Data sharing statement: To prevent dissemination of sensitive patient data, the dataset on which this study was based was not made available to the public. Deidentified data can be obtained from the corresponding author upon reasonnable request - ORCID ID 0000-0002-8364-6506.

STROBE Checklist: STROBE Checklist is provided as a Supplementary Material

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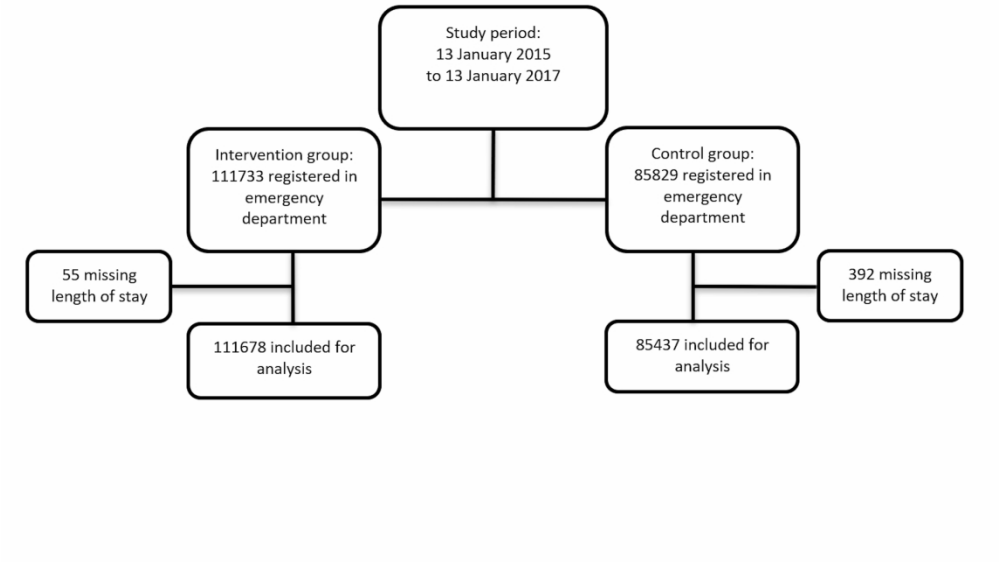
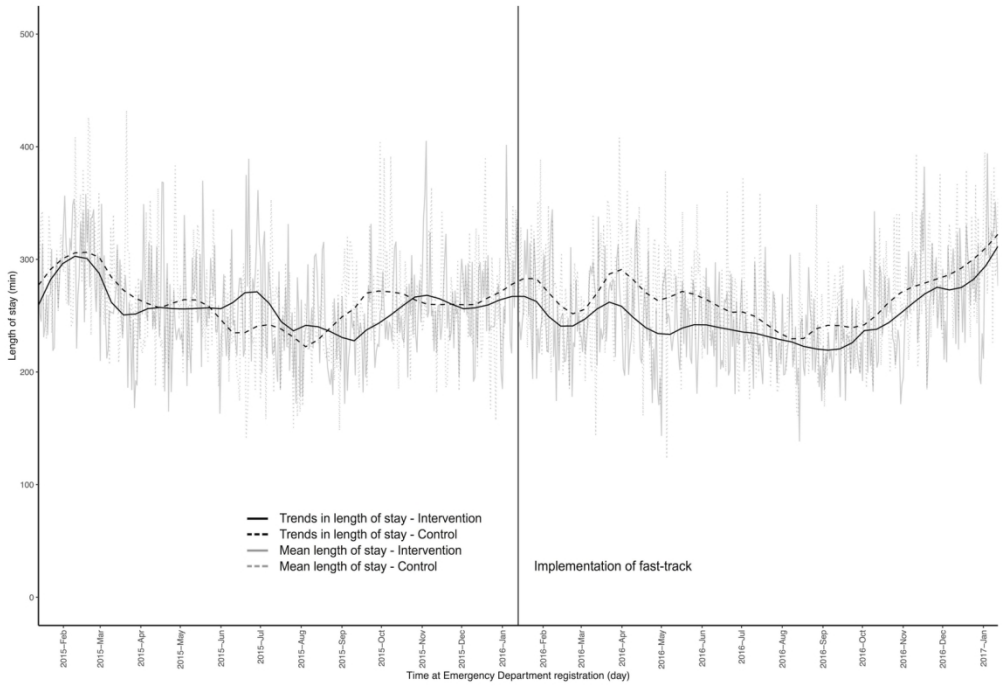


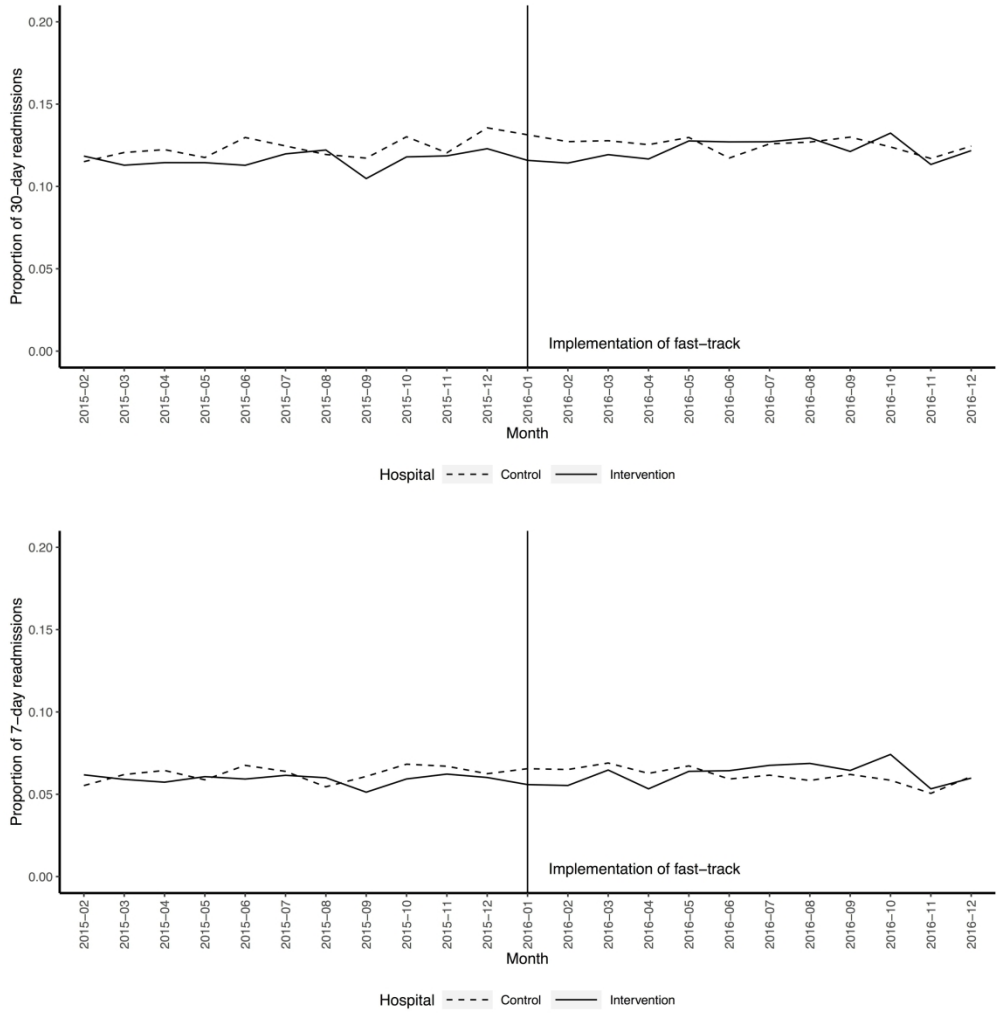
Flowchart of the study

209x148mm (300 x 300 DPI)



Daily mean emergency department length of stay during the study period, with trends obtained by locally weighted regression.

142x99mm (300 x 300 DPI)



Proportion of emergency department 7-day and 30-day readmissions during the study period

266x280mm (300 x 300 DPI)

SUPPLEMENTARY APPENDIX 1: Emergency department fast-track admission criteria

Exclusion criteria

- Disabled patients or patients with reduced autonomy
- Age > 65 years
- Pain on visual analogic scale ≥ 8/10

Triage

If the answer to all following questions is no, the patient can be managed in the fast-track:

- Need to undress the patient for assessment/treatment
- The patient needs to be in supine position
- Need for blood sampling
- The patient needs a wound suture with expected duration of > 20 min

Trauma patients managed in the fast-track

- Trauma not requiring major analgesics
- Contusions and benign trauma, for patients WITHOUT anticoagulant medication
- Cranial trauma without initial loss of consciousness
- Minor wounds, except on tongue, eye, or scalp
- Abscess, minor subcutaneous tissue infection, subcutaneous foreign body
- Minor burn injuries except on face
- Wound management

Medical patients managed in the fast-track

Gastro-enterology

- Foreign body ingestion
- Constipation/diarrhea
- Acid reflux disease

Ophtalmology

- Ocular foreign body
- Conjunctivitis
- Palpebral infection

Urology

- Uncomplicated lower urinary tract infections

Oto-rhino-laryngology

- Epistaxis
- Ear pain
- Dental abscess

Dermatology

- Skin rash
- Benign skin disease without fever
- Insect bites

Others

- Urgent local drugs administration (e.g. intracavernous phenylephrine)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	4
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, explain how loss to follow-up was addressed	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			N/A

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Fig. 1
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	Fig. 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	Fig. 1
		(c) Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	Report numbers of outcome events or summary measures over time	8
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10
		(*b*) Report category boundaries when continuous variables were categorized	5
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	6
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

The impact of the implementation of a fast-track on emergency department length of stay and quality of care indicators in the Champagne-Ardenne region: a before-after study

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Secondary Subject Heading:	Public health
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The impact of the implementation of a fast-track on emergency department length of stay and quality of care indicators in the Champagne-Ardenne region: a before-after study

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Abstract

Objectives: We aimed to evaluate the effect of the implementation of a fast-track on Emergency Department (ED) length of stay (LOS) and quality of care indicators.
Design: Adjusted before-after analysis.
Setting: A large hospital in the Champagne-Ardenne region, France.
Participants: Patients admitted to the emergency department between 13 January 2015 and 13 January 2017.
Intervention: Implementation of a fast-track for patients with small injuries or benign medical conditions (13 January 2016).
Primary and Secondary Outcome Measures: Proportion of patients with LOS ≥ 4h and proportion of access block situations (when patients cannot access an appropriate hospital bed within 8 hours). 7-day readmissions and 30-days readmissions.
Results: The emergency department of the intervention hospital registered 53768 stays in 2016 and 57965 in 2017 (+7.8%). In the intervention hospital, the median length of stay was 215 minutes before the intervention and 186 minutes after the intervention. The exponentiated before-after estimator for ED LOS ≥ 4h was 0.79; 95% confidence interval (CI) 0.77– 0.81. The exponentiated before-after estimator for access block was 1.19; 95% CI 1.13 – 1.25. There was an increase in the proportion of 30-day readmissions in the intervention hospital (from 11.4% to 12.3%). After the intervention, the proportion of patients leaving without being seen by a physician decreased from 10.0% to 5.4%.
Conclusions: The implementation of a fast-track was associated with a decrease in stays lasting ≥4 hours without a decrease in access block. Further studies are needed to evaluate the causes of variability in emergency department LOS and their connections to quality of care indicators.

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Keywords
Emergency Department – Length of stay – Fast-track – Hospital readmissions – Healthcare Quality

Strengths and Limitations of this study

- We measured the effect of the implementation of a fast-track on length of stay and quality of care indicators

- We controlled for potential confounders (primary diagnosis, severity …) with a multivariable analysis by logistic regression. The uncertainty induced by missing values was accounted for by pooling estimates from multiple imputations

- The intervention was the only major change in the hospital under study

- Further studies could include more hospitals

Introduction

The number of annual emergency department (ED) visits has doubled between 1980 and 2004 in France [1], and is still rising (+3.7% between 2014 and 2015). This phenomenon has been observed in most developed countries [2], and is a challenge for physicians and policymakers. ED crowding was defined by the American College of Emergency Physicians (ACEP) as a mismatch between the need for emergency care and the emergency department's ability to provide this care [3]. ED crowding has been associated with longer ED length of stay (LOS) [4], inadequate pain management [5], and worse patient outcomes [6]. A crowded emergency department may sometimes need to fall back on ambulance diversion, redirecting patients to nearby hospitals. Finding the best organization for EDs is therefore a public health priority with ethical implications [3]. The causes of ED crowding include increased demand from patients, epidemics, lack of trained staff, and lack of hospital beds [7]. Numerous scores have been proposed to measure ED crowding (EDWIN, NEDOCS, READI, Work Score) however their predictive power typically does not outperform simpler indicators such as bed occupancy [8,9]. Time series analysis can predict emergency department activity with a Relative Mean Absolute Performance (RMAP) of 90% [10]. A shorter length of stay results in less complications [11,12], higher odds of survival for severe

patients [13], increased patient satisfaction [14,15], and lower healthcare spending [16]. The optimization of patient flow has been studied extensively [17,18]. Numerous strategies have been proposed to regulate patient flow in the emergency department : Care Coordination Teams, whose mission involves orienting older patients towards appropriate healthcare, observation units (caring for patients up to 72h), chest pain units, home-based healthcare [19]. A common strategy is the use of fast-tracks, dedicated pathways aimed towards the fast delivery of healthcare for patients with benign medical conditions scheduled for rapid discharge. Fast-tracks have been implemented in small and larger hospitals [20]. In 2002, 58% of 17 surveyed Australian public hospitals functioned with a fast-track [19]. A Monte-Carlo simulation showed that implementing a fast-track with a dedicated nurse could shorten median waiting times up to 35% [21]. Previous studies have evaluated the effect of implementing a fast-track [22–25], however the length of these studies was short, typically less than 6 months. One 2-year study with a fast-track staffed with mid-level providers did not adjust for patient severity [26]. The aim of this study was to assess the impact of an emergency department restructuration with the implementation of a fast-track on ED length of stay in the setting of a large hospital in France. Secondary objectives were to study predictors of ED LOS, and to assess the effect of the emergency department restructuration on 7-day readmissions, 30-day readmissions, and the proportion of patients leaving without being seen.

Methods

We conducted a before-after analysis with adjustment on confounders.

Population

The region in which the study took place is one of the least densely populated regions in France. The age structure of the region resembles the pooled age structure of the rest of the country. The intervention hospital (Troyes Hospital) was a large hospital with 442 medical beds, 127 surgical beds and 63 beds dedicated to gynaecology and obstetrics, serving an area of approximately 40 kilometres radius (25 miles). The emergency department hosted an observation unit.

Patient and Public involvement

Patients were not involved in the design or analysis of this study.

Intervention

The intervention included an extension of the ED from 15 to 27 consultation rooms and the opening of a fast-track for patients with small injuries or benign medical conditions. The fast-track in the intervention hospital had 6 rooms. The fast-track is a healthcare pathway for the assessment and treatment of low severity patients, situated in a dedicated area of the emergency department. The intervention was implemented on 13 january 2016. Two ED physicians managed adult patients and paediatric traumatology in the fast-track. When ED physicians were not available, they were replaced by residents. Gynaecology and psychiatry patients could also be managed in dedicated areas of the fast-track. Entry criteria for the fast-track were pre-defined in a protocol (Supplementary Appendix 1).

Outcomes

The main outcome was an emergency department length of stay ≥ 4 hours [27,28]. LOS was defined as the time elapsed between registration in the ED to the time the patient leaves

the ED. The secondary outcome was access block, defined by the Australasian College for Emergency Medicine as the situation where patients who need hospital care cannot access an appropriate hospital bed within a reasonable delay (8 hours) [29]. We used the Patient State (PS) classification [10] presented in Table 1 to identify patients that needed to be admitted to the hospital (PS 3, 4, 5, 6 and 7). Time to physician appraisal and LOS were extracted from local hospital databases (data extracted from Resurgences© in the intervention hospital). Other quality of care indicators included the number of patients leaving without being seen [30] and the monthly proportion of 30-day and 7-day readmissions [31].

Table 1: Patient State (PS) classification for patients admitted to the emergency department

PS class	Description
PS1	Patient with moderate treatment, discharged from emergency department
PS2	Patient with major treatment, discharged from emergency department
PS3	Patient with moderate treatment, hospitalized after emergency department stay
PS4	Patient with major treatment, hospitalized after emergency department stay
PS5	Patients requiring immediate treatment, not elsewhere classified
PS6	Patients requiring immediate intensive care/resuscitation
PS7	Died in emergency Department

Statistical methods

Continuous variables were summarized with means and standard deviations or medians and the interquartile range. Categorical variables were presented with absolute frequencies and proportions. A descriptive analysis was carried out for LOS by period. Differences between the period before the intervention and the period after the intervention were compared with Student's *t* test or with the Mann-Whitney *U* test for asymetrically distributed variables, and with the χ^2 test for categorical variables. Summary statistics were provided

for the waiting times of patients with selected diagnoses (pneumonia, stroke, myocardial infarction and heart failure). To facilitate modelling, length of stay was transformed into a binary variable using thresholds classically found in the litterature [28]. Separate models were fitted to study the primary outcome and access block. The effect of the intervention on the primary outcome was evaluated for all patients. The effect of the intervention on access block was evaluated in an analysis restricted to patients who needed to be hospitalized after their emergency department stay. Multivariable logistic regression models were estimated to adjust for confounders. The model was $\text{Logit}(p) = \alpha + \pi P + T'\tau + X'\beta$, with p being the probability of the outcome, α the intercept, P an indicator variable for period, T a vector of additional time variables (effect of being admitted during the night, the weekend or winter months) and X a vector of individual-level covariates. Age was grouped in categories relevant to clinical practice. Primary diagnosis was defined using chapters of the International Classification of Disease (10^{th} revision) to avoid problems in estimation due to sparse data. Patient severity was included in the model using the PS classification [10]. Time variables included indicator variables for admission during the night (22:00 – 06:00), and during weekends (Saturday and Sunday). An indicator variable for December and January, where flu epidemics often occur, was included in the model. The study sample was a convenience sample with a time window constructed symmetrically around the intervention, allowing to control for seasonal effects. The proportion of patients leaving without being seen was a secondary outcome. Due to the paucity of information on these patients, it was not included as an dependent variable for multivariable analysis. Statistical analyses, data management and figures were realised using R version 3.5.3 (www.r-project.org) [32].

Ethics Statement

All legal requirements for epidemiological studies were respected, and the French national commission governing the application of data privacy laws issued an approval for the project. Since the study was strictly observational, in accordance with the laws that regulate "non-interventional clinical research" in France, namely articles L.1121-1 and R.1121-2 of the Public Health Code, it did not require a written informed consent from participants or approval from an ethics committee.

Results

Between 13 January 2015 and 13 January 2017, 111733 ED stays were registered in the intervention hospital (Figure 1).

Figure 1 Flowchart

53768 stays in 2016 and 57965 in 2017 (+7.8%). Regarding human ressources, physicians increased from 11.5 to 14.5 Full-Time Equivalents (FTE), nurses from 35.3 to 36.8 FTE, and assistant nurses from 16.8 to 19.5 FTE. The median length of stay was 215 min (interquartile range Q1 – Q3 : 111 - 361) before the intervention and 186 min (98 - 340) after the intervention (Table 2). The proportion of patients with LOS < 4 hours changed from 55.2% to 60.6%. Within the subgroups of patients subsequently admitted to the hospital, patients consulting for pneumonia had a decrease in median time to physician assessment after the intervention: from 87 min (41 - 173) to 79 min (36 - 165). Stroke patients also had decreased median waiting times: from 77 (34 - 155) to 62 (33 - 132) minutes. The time to physician assessment remained unchanged for patients consulting for myocardial infarction and heart

failure: from 61 (31 - 149) before the intervention to 63 (30 - 150) minutes after the intervention.

Table 2: Demographic characteristics of study population, length of stay and readmissions in the intervention hospital

	Intervention		P-value
	2015-2016*	2016-2017†	
	mean (SD), median (Q1 – Q3) or n (%)	mean (SD), median (Q1 – Q3) or n (%)	
n	53768	57965	-
Age (years): mean (SD)	40.4 (27.3)	39.8 (27.4)	<0.001‡
Sex*: female* – *n* (%)	26712 (49.7)	29235 (50.4)	0.01§
Length of stay (min): median (Q1 - Q3)	215 (111 - 361)	186 (98 - 340)	<0.001‡
7-day readmissions: *n (%)*	3177 (5.9)	3642 (6.3)	0.01§
30-day readmissions: *n* (%)	6105 (11.4)	7129 (12.3)	<0.001§
Patients admitted to hospital after emergency department: *n*	14795	14864	-
Length of stay (min): median (Q1 - Q3)	316 (181 - 465)	333 (187 - 490)	<0.001‡
Patients not admitted to hospital after emergency department			
n	38971	43100	-
Length of stay (min): median (Q1 - Q3)	185 (97 - 310)	155 (86 - 272)	<0.001‡

SD: Standard Deviation. Q1 – Q3: Interquartile range
* 13/01/2015 to morning of 13/01/2016. † 13/01/2016 afternoon to 13/01/2017. ‡ Mann-Whitney *U* test. § χ^2 test

The exponentiated before-after estimator was 0.788 (95% CI 0.767 - 0.810, p<0.0001), therefore the intervention successfully reduced the number of ED stays with LOS ≥ 4 hours (Table 3). However, the estimate for access block was 1.188 (95% CI 1.126 - 1.253, p<0.001): the intervention did not seem effective in helping the patients who needed it to access an

appropriate hospital bed in a reasonable amount of time (<8h). In 4.8 % of cases, none of the scores that constituted the PS classification were present. These cases were essentially patients who left the emergency department without being seen. Age was linearly related with length of stay, with younger patients having a shorter LOS. Weekends were associated with a shorter LOS. Patients admitted for injuries (ICD-10 codes S00 to T98) and skin problems (L00 to L99) tended to have a short LOS, while patients admitted for neurologic diseases (G00 – G99) tended to have a longer LOS. Trends in daily median LOS are shown in Figure 2.

Figure 2 Daily median emergency department length of stay during the study period (trends obtained by locally weighted regression).

Effect on quality of care indicators

Overall, 12.0% of stays were 30-day readmissions. Most readmissions (6.1%) occurred within the first seven days. There was a trend for increasing 30-day readmissions during the study period (Figure 3). Seven-day readmissions increased from 5.9% to 6.3% in the intervention group. After the intervention, the proportion of patients leaving without being seen by a physician decreased from 10.0% to 5.4%.

Figure 3 Proportion of emergency department 7-day and 30-day readmissions during the study period

Table 3: Multivariable logistic regression for length of stay ≥ 4h and access block.

Variable	Odds Ratio (emergency department length of stay ≥ 4 hours for all patients) *	95% Confidence Interval	Odds Ratio (Access block: emergency department length of stay ≥ 8h for hospitalized patients) *	95% Confidence Interval
Period: after intervention (reference = before intervention)	0.788	(0.767 - 0.810)	1.188	(1.126 - 1.253)
7-day readmission	0.833	(0.786 - 0.882)	0.867	(0.773 - 0.973)
8 – 30 days readmission	0.974	(0.918 – 1.033)	0.938	0.849 – 1.037
Weekend day	0.936	(0.908 - 0.966)	0.761	(0.714 - 0.811)
Night	0.594	(0.572 - 0.618)	0.878	(0.811 - 0.950)
Principal Diagnosis (ICD-10 Chapter)				
Injury, poisoning	0.559	(0.508 - 0.616)	0.641	(0.568 - 0.723)
Diseases of the nervous system	2.113	(1.846 – 2.419)	1.269	(1.065 - 1.511)
Skin and subcutaneous tissue	0.466	(0.404 - 0.537)	0.573	(0.413 - 0.795)
Neoplasms	1.175	(0.843 – 1.637)	2.098	(1.486 - 2.963)
Diseases of the circulatory system	1 (Reference)	-	1 (Reference)	-
Month: December and January (reference = other months)	1.159	(1.118 - 1.202)	1.49	(1.390 - 1.597)
Severity (PS classification)				
PS1	1 (Reference)	-	-	-
PS2	1.890	(1.668 - 2.142)	-	-
PS3	2.234	(2.157 – 2.313)	1 (Reference)	-
PS4	1.669	(1.560 - 1.785)	0.804	(0.747 - 0.865)
PS5	0.470	(0.395 - 0.560)	0.397	(0.316 - 0.499)
PS6	0.336	(0.268 - 0.420)	0.246	(0.176 - 0.344)
PS7	0.315	(0.201 - 0.492)	0.333	(0.175 - 0.637)
Sex: Female (reference = male)	0.994	(0.966 – 1.022)	1.072	(1.014 - 1.134)
Age (years)				
50 - 64	1.611	(1.547 - 1.679)	1.387	(1.271- 1.514)
65 - 74	2.152	(2.041 – 2.269)	1.681	(1.532 - 1.846)
75 – 89	3.367	(3.210 – 3.532)	2.025	(1.873 - 2.189)
≥ 90	4.330	(3.970 - 4.721)	2.117	(1.906 - 2.352)
0 – 17	0.292	(0.280 – 0.304)	0.099	(0.082 - 0.120)
18 - 50	1 (Reference)	-	1 (Reference)	-

ICD-10: International Classification of Disease, 10th revision. PS: Patient State

* Multivariable analysis adjusted for age, sex, time of the day (nighttime or daytime), time in the week (weekend day or weekday), time of the year (December and January or other months, admission diagnosis (grouped using ICD-10 chapters) and severity (using the PS classification).

Discussion

Our study showed that implementing a fast-track can decrease the median length of stay and number of stays lasting ≥ 4 hours in the emergency department of a large general hospital. We did not observe a decrease in LOS for patients requiring hospitalization. However, the length of stay for severe patients may have been limited by hospital-level bed availability rather than ED-related factors [33]. Indeed, other studies have found that the implementation of a fast-track did not adversely affect LOS for patients subsequently admitted to the hospital [34].

The addition of new beds to the emergency department could explain part of our results. However, the addition of new beds does not guarantee improved access to care. In a study by Han et al., the time between ambulance diversion episodes was not significantly different after expanding an ED from 28 to 53 beds [35].

Asplin et al. consider the emergency department as a system with 3 components : *input, throughput,* and *output* [36]. The input component includes events, diseases or other factors that contribute to the demand for urgent care. Throughput includes triage, room placement, diagnosis and treatment. The implementation of the fast-track can accelerate throughput for patients not subsequently admitted to the hospital. The decrease in LOS can be explained by decreased crowding due to rapid patient discharge, floorplan modifications allowing faster patient transfers, or physician and nurse role adjustments [37,38]. Fast-tracks can efficiently coexist with other patient streams, such as tracks dedicated to

complex ambulant patients [39]. Regarding output, the limiting factor for ED LOS is often lack of available hospital beds. Some authors have suggested that an occupancy of 85% is a suitable target to ensure that new patients are not left without beds [40]. This seems difficult to implement under current conditions. A systematic review of 220 articles discussing strategies to prevent « access block » [29] mentions interventions to diminish the number of patients admitted to the ED and observation wards [41]. Other solutions to prevent ED crowding are: sharing optimal care processes [42], enrolling additional staff [8], or eventually redirecting patients towards other centers [7]. Causes of increased demand for urgent care include the ageing of populations, with a higher prevalence of chronic diseases, the scarcity of primary care, and changing perceptions of what is considered urgent. Solitude is a major driver of ED consultations [43]. The efficacy of gatekeeping procedures has yet to be evaluated [44]. The patients that frequently consult in the emergency department, however, are often disadvantaged by a low socio-economic status [45] and can be considered a high-risk group regarding morbidity and mortality [46]. Prior contact with the ED could help improve communication with the patient, although an effect on the number of ED admissions remains to be established [47]. Pain is a major complaint in the ED, and patients with chronic pain could be more likely to consult [48]. Access to programmed care is crucial, and patients who cannot access programmed care will come back to the emergency department. In an Australian study, around half of patients would prefer to see a general practitioner for a similar problem than to be treated in the emergency fast-track [49]. In this regard, what is happening in emergency departments can be seen as a mirror of the dysfunctions in a healthcare system [50].

After the implementation of the fast-track, the number of patients registered in the ED increased by 7.8%. This is unlikely to be a fluctuation in epidemiological trends, but rather

reflects an increased demand generated by an easier access to timely care. Patients leaving without being seen diminished from 10.0% to 5.4%, similar to the proportions in studies by Combs et al [51] and Sanchez et al. [26].

Among other quality of care indicators, we evaluated emergency department 7 and 30-day readmissions [52]. The main rationale for including these indicators was to appreciate the extent by which the decrease in LOS was explained by readmissions of the same patients. Seven-day readmissions increased after the implementation of the fast-track. Patients coming back to the hospital within 7 days had shorter lengths of stay during the readmission. One possible explanation is the availability of the patient's recent history, making medical assessment simpler. Emergency departments may have a role to play in preventing hospital readmissions [53]. However, recent studies show that hospital readmissions are often not avoidable, and are largely influenced by factors on which hospitals have no control, like socio-economic status [31,54]. As is often the case, these indicators need to be appraised in conjunction with other quality of care indicators.

The intervention was the only major change in the emergency department during this period. The major limitation of our study was that the effect of implementing a fast-track was confounded with the addition of staff and new beds to the ED to allow it to function effectively under increased constraints. However, the reported increase in full-time equivalents was due to the administrative transfer of staff from the mobile unit for emergencies and intensive care. Only one additional nurse was fully allocated to the ED. As the mobile unit's main activity is to intervene outside of the hospital, it is unlikely that the observed changes in length of stay were entirely explained by the increase in human resources. Moreover, because supplemental beds were added to the ED as part of the intervention, the ratio of staff to beds decreased. A multiple imputation was carried out to

account for the uncertainty induced by missing PS severity scores, with m = 20 imputations. Patients who left without being seen were kept in the imputation model. As these patients were more frequent in the period before the intervention, and their length of stay was shorter than the rest of the population (median 156 min), the efficacy of the intervention regarding length of stay could be underestimated. To conclude, our study showed an increase in short stays for low acuity patients following the implementation of the fast-track. In this regard, the fast-track consolidated the emergency department's role of compensating deficiencies in access to primary care, without favourably impacting length of stay for severe patients. Hospital-level bed availability is critical to ensure efficient healthcare for patients registered to the ED. Studies including more hospitals and a larger array of quality of care indicators are warranted to estimate the effect of implementing a fast-track on emergency department performance and population health outcomes.

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obtained from the corresponding author upon reasonnable request - ORCID ID 0000-0002-8364-6506.

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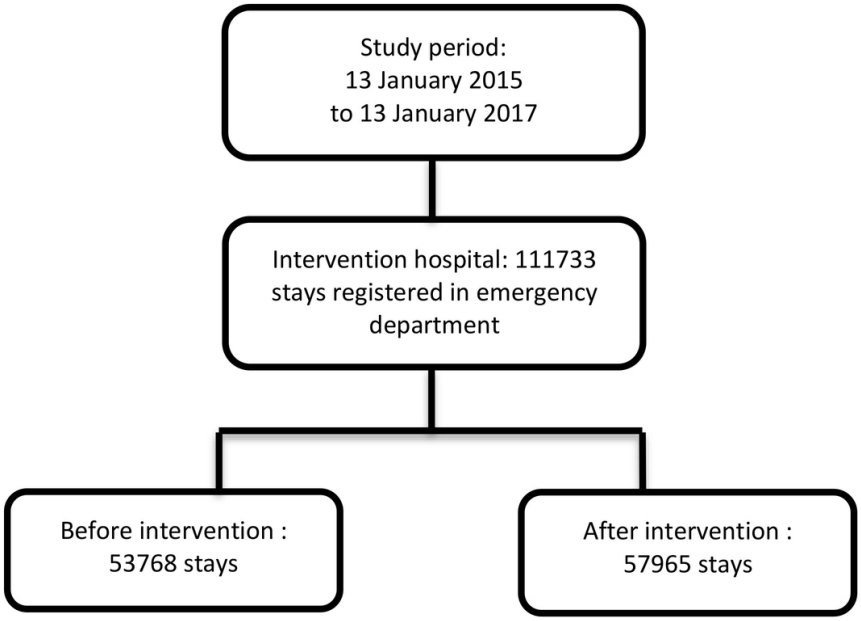
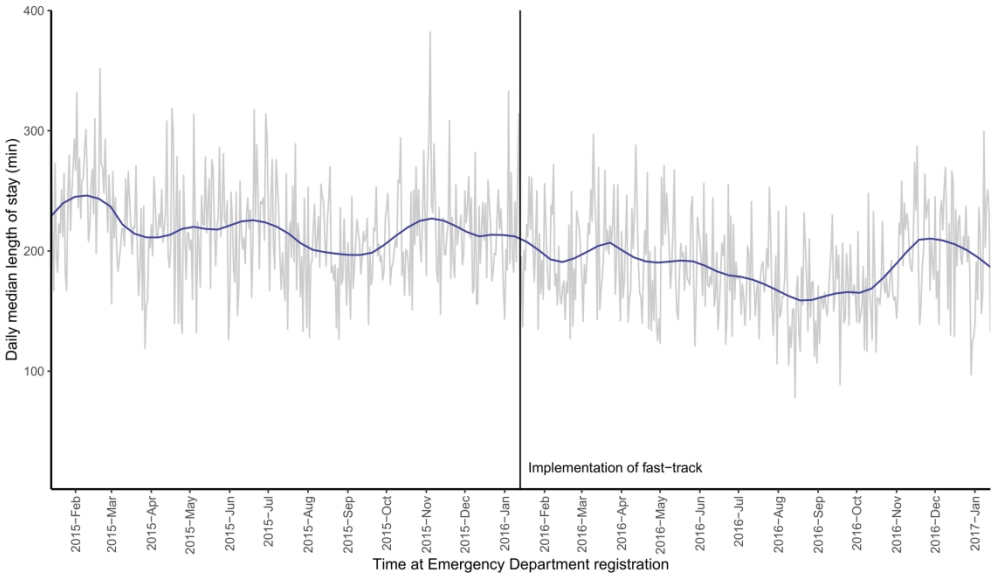


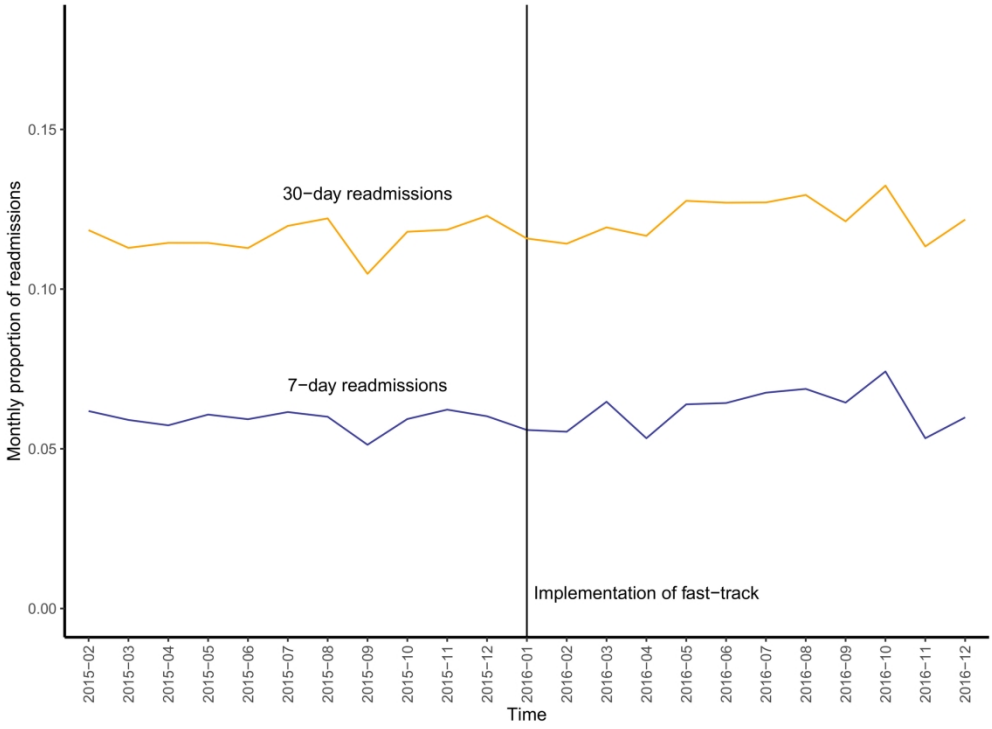
Flowchart

104x77mm (300 x 300 DPI)



Daily median emergency department length of stay during the study period (trends obtained by locally weighted regression).

254x152mm (300 x 300 DPI)



Proportion of emergency department 7-day and 30-day readmissions during the study period

215x165mm (300 x 300 DPI)

SUPPLEMENTARY APPENDIX 1: Emergency department fast-track admission criteria

Exclusion criteria

- Disabled patients or patients with reduced autonomy
- Age > 65 years
- Pain on visual analogic scale ≥ 8/10

Triage

If the answer to all following questions is no, the patient can be managed in the fast-track:

- Need to undress the patient for assessment/treatment
- The patient needs to be in supine position
- Need for blood sampling
- The patient needs a wound suture with expected duration of > 20 min

Trauma patients managed in the fast-track

- Trauma not requiring major analgesics
- Contusions and benign trauma, for patients WITHOUT anticoagulant medication
- Cranial trauma without initial loss of consciousness
- Minor wounds, except on tongue, eye, or scalp
- Abscess, minor subcutaneous tissue infection, subcutaneous foreign body
- Minor burn injuries except on face
- Wound management

Medical patients managed in the fast-track

Gastro-enterology

- Foreign body ingestion
- Constipation/diarrhea
- Acid reflux disease

Ophtalmology

- Ocular foreign body
- Conjunctivitis
- Palpebral infection

Urology

- Uncomplicated lower urinary tract infections

Oto-rhino-laryngology

- Epistaxis
- Ear pain
- Dental abscess

Dermatology

- Skin rash
- Benign skin disease without fever
- Insect bites

Others

- Urgent local drugs administration (e.g. intracavernous phenylephrine)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	4
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, explain how loss to follow-up was addressed	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			N/A

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Fig. 1
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	Fig. 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	Fig. 1
		(c) Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	Report numbers of outcome events or summary measures over time	8
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10
		(*b*) Report category boundaries when continuous variables were categorized	5
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	6
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.