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Article:

Mason, S., Knowles, E. and Boyle, A. (2016) Exit block in emergency departments: a rapid evidence review. *Emergency Medicine Journal*. ISSN 1472-0205

<https://doi.org/10.1136/emered-2015-205201>

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Exit Block in Emergency Departments: A Rapid Evidence Review

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Key Words: crowding, management, emergency department management, performance improvement

Word Count: 3754

Abstract

Background

Exit block (or access block) occurs when “patients in the Emergency Department (ED) requiring inpatient care are unable to gain access to appropriate hospital beds within a reasonable time frame”. Exit block is an increasing challenge for EDs worldwide and has been recognised as a major factor in leading to departmental crowding. This paper aims to identify empirical evidence, highlighting causes, effects and strategies to limit exit block.

Methods

A computerised literature search was conducted of English language empirical evidence published between 2008 and 2014 using a combination of terms relating to exit block in the Emergency Department.

Results

233 references were identified following the computerised search. Of these, 32 empirical articles of varying scientific quality were identified as relevant and results are presented under a number of headings. The majority of studies presented data relating to the impact of exit block on departments, patients and staff. A smaller number of articles evaluated interventions designed to reduce exit block. Evidence suggests that exit block is more likely to occur in more densely populated areas and less likely in paediatric settings. Bed occupancy appears to be associated with exit block. Evidence supporting the impact of initiatives pointed towards increasing workforce and inpatient bed resources within the hospital setting to reduce block.

Conclusion

Further evidence is needed, especially within the National Health Service setting to increase the understanding around factors which cause exit block, and interventions that are shown to relieve it without compromising patient outcomes.

Background

Exit block (or access block) occurs when “patients in the Emergency Department (ED) requiring inpatient care are unable to gain access to appropriate hospital beds within a reasonable time frame”,(1) with arrival access block being identified as being a potential indicator of hospital dysfunction.(2)When exit block occurs, patients in the ED are highly likely to remain there for longer than necessary. In the UK, this usually means that patients breach the maximum four hours they are expected to spend there. Recently in the UK, performance against this target has fallen to the lowest since records began in 2004, falling to 83.0% of patients in England being seen and discharged within the four-hour window in January 2016. There is no doubt that exit block has played a huge role in the development of this situation, with hospitals already being at maximum bed capacity simply being unable to admit more patients. (3) Much of the evidence regarding exit block originates from outside the UK, particularly Australia. In 2008, Forero (4) prepared an international evidence review on access block and crowding for the Australasian College of Emergency Medicine, in which the

authors highlighted the negative impact crowding and access block had on patient mortality and staff satisfaction. With specific reference to access block, Forero (4) summarised that when there were not enough beds to meet demand, this resulted in block and suggested that by increasing the capacity within the system, i.e. by increasing bed numbers, access block could be addressed. A number of measures which were not deemed as effective in reducing exit block were also identified. These included reducing the number of low acuity ED attendances, use of an after hours general practitioner, and reducing daily elective admissions.

The aim of this rapid review is to focus solely on exit block, and to summarise recent empirical evidence, highlighting epidemiology, causes, effects and potential solutions to limit exit block alongside identifying evidence gaps.

Methodology

Search strategy

Database searches were undertaken to identify literature pertaining to exit block/access block issues in emergency medicine (secondary care setting) particularly under the broad headings of epidemiology of exit block; causes of exit block; effects of exit block and possible solutions to exit block. Specific keyword strategies using free text and, where available, thesaurus terms using Boolean operators and database-specific syntax were developed to search the electronic databases. Synonyms relating to 'exit block' and 'access block', and synonyms relating to 'patient discharge' and 'patient transfer', were combined with synonyms relating to emergency services and departments. Following on from Forero's (4) review, undertaken in 2008, the searches were limited to studies published in 2008-present, studies published in the English language. In addition we only intended to seek peer reviewed evidence, but included all types of study designs in the review. However, a search of the grey literature was not undertaken. No geographical limitations were imposed on the search strategy. Due to the likely heterogeneity of study types, a decision was taken for a narrative review of the evidence to be presented. Relevant studies were identified through electronic searches of key databases:

MEDLINE; MEDLINE in Process; Embase; Cochrane Database of Systematic Reviews (CDSR); Cochrane CENTRAL Controlled Trials Register; Database of Abstracts of Reviews of Effects (DARE); NHSEED and HTA databases (Cochrane); Cumulative Index to Nursing and Allied Health Literature (CINAHL); Science Citation Index and Social Science Citation Index (Web of Science)

Searches were undertaken in June 2014. An example of the search strategy developed for one of the main databases used in our searches can be found in appendix 1. Following the evidence search, a proportion of the results were subjected to additional screening by an Emergency Medicine Consultant to check agreement on the papers selected for review, and agree a strategy for inclusion based on discussion where discrepancies arose.

Results

The results are presented under the headings we developed our search strategy under:

- Epidemiology of exit block

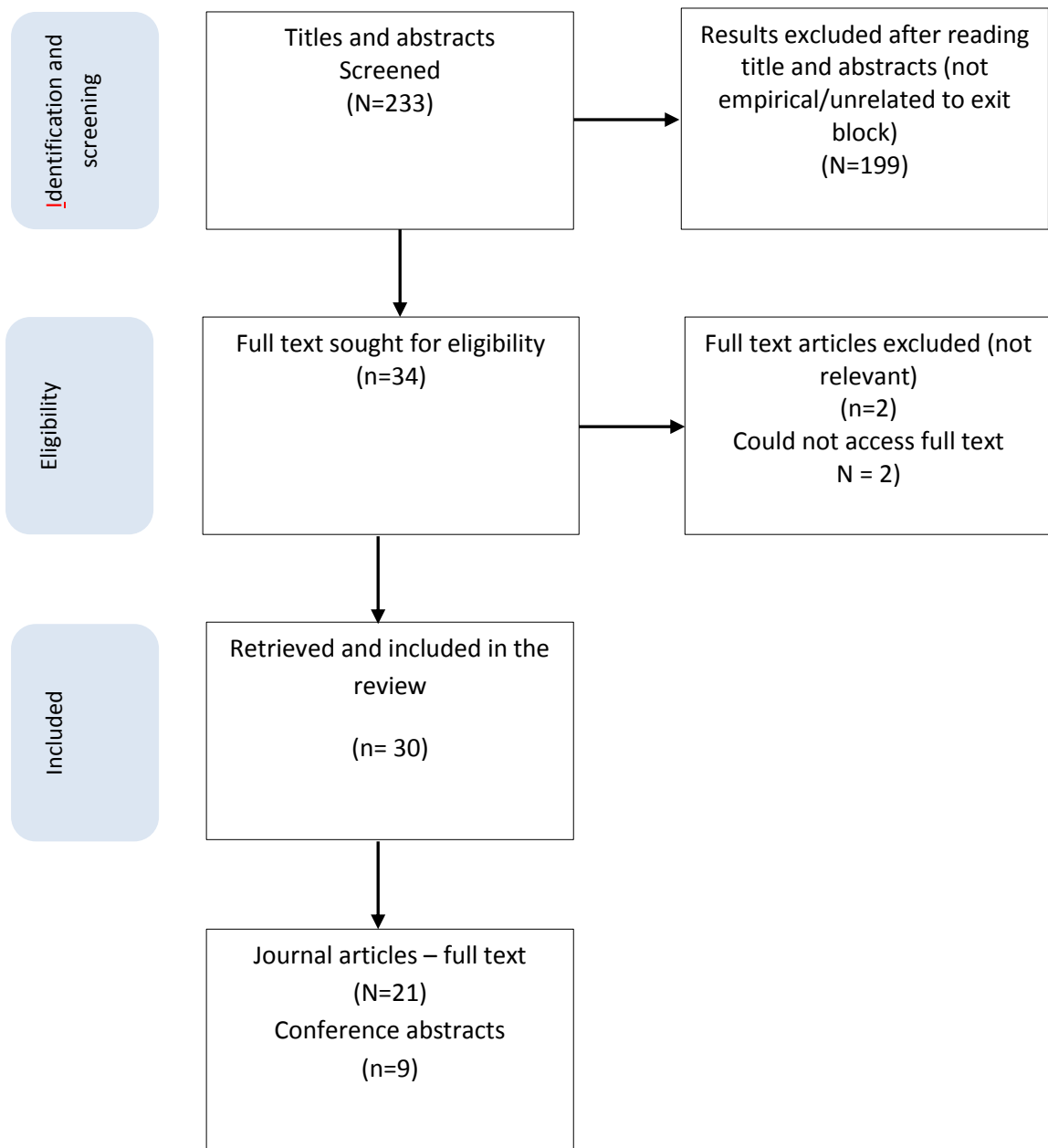
- Causes of exit block
- Effects of exit block
- Potential solutions to exit block

233 articles were identified and figure 1 outlines the PRISMA flowchart for the selection of articles to include in the review. All titles and abstracts were screened by a single researcher, with a random 23 (10%) abstracts checked by the Emergency Medicine consultant reviewer. A further 65 (28%) abstracts, which the researcher felt should be included or where there was uncertainty, were also screened by the same Emergency Medicine consultant. Following the review of titles and abstracts, 34 empirical articles were identified as relevant to the review. Full texts of all articles identified were sought. When seeking full text articles it became evident that some articles related to peer reviewed conference abstracts rather than journal articles. Some conference abstracts and journal articles originated from the same study, reporting findings from different aspects of the study. In these cases, both the conference abstract and journal article were included in the review. Two full text articles were not retrieved (abstract only), and a further two articles were identified as not relevant when the full text was obtained.

The articles were of varying scientific quality. There were no articles reporting findings from randomised controlled trials. Where statistical tests were performed, the results are shown in the summary table (Table 1). Article types (i.e. conference abstract or journal article) are also highlighted in this table.

Of the 32 relevant articles, the majority originated from Australia (n=19). The remainder originated from studies based in Ireland (n=3), USA (n=3), New Zealand (n=2), Spain (n=2), Canada (n=1), China (n=1), and Hong Kong (n=1). There were no scientific studies about exit block from the United Kingdom.

Figure 1: PRISMA flowchart



Epidemiology of Exit Block

Who gets exit block?

A prevalence study originating from Australia reported that one third of ED patients experienced block.(6) There was no evidence emerging in relation to patient characteristics and exit block. However, one study reported this in relation to ED length of stay (LOS), suggesting that higher acuity patients requiring an emergency operation or ICU admission experienced shorter LOS in the ED. The study also identified older patients, night time attendances, non-Spring visitors, and general medicine patients as having longer LOS in the ED.(13)

Where and when does exit block occur?

Two studies identified the types of hospital setting where block appeared most prevalent. Higher levels of block were more likely to occur in larger hospitals: urban settings,(9) 'major referral',(6) 'tertiary' (i.e. a major hospital which usually has a full complement of services),(12) and non-paediatric hospitals.(6,9) Other factors that have been found in a limited number of studies to increase block include increased re-attendance rates at the ED. It was felt this would add to workload and patient numbers in the ED, and therefore potentially lead to block.(11) One study found block to be worse at 09:00 hours but constant during other times of day.(12)

There was also some evidence that as the mean number of patients 'under' treatment in the ED increases, so does the likelihood of block.(6) This study did not report the underlying factors that might lead to this finding. However, Forero (4)'s review found that interventions to improve access to diagnostics and testing i.e. laboratory and radiology investigations had been shown to significantly reduce access block.

Is exit block getting worse?

Recent evidence on the prevalence of exit block (or proxies of) originates from the US, Australia and Ireland. Over a six year period in Ireland, whilst new ED attendances decreased, admission rates increased and the number of patients reported as 'boarding' *in the ED increased. Whilst the abstract is not clear, it appears the data relates to one ED in Ireland.(7) Analysis of data from all EDs in the US identified that whilst total patient care hours increased, ED length of stay decreased over a three year period (2002-5). The study also reported that admission rates decreased over time.(8) In Australia, over a four year period, there was a country-wide increase in exit block.(6) Data from the same study suggested that of those ED patients waiting for an inpatient bed, the majority experienced block.(9)

Causes of Exit Block

Can exit block be predicted?

Predicting demand for hospital care may be useful in predicting periods where an ED is likely to encounter block and therefore in determining appropriate interventions to manage block.

Retrospective data of consecutive ED presentations and inpatient admissions was utilised to develop a model designed to predict ED presentations and inpatient admissions. The model was tested and found to be effective in predicting both presentations to the ED and admissions from the ED. Forecasting of ED presentations was more accurate than admission forecasting. Admissions forecasting worsened as the time interval decreased (i.e. monthly forecasting was more accurate than hourly forecasting).(14)

Exit block and bed availability

There were a number of papers which reported on exit block and bed occupancy. A shortage of inpatient beds and reluctance of the wards to admit patients was reported as potentially being the primary reason for extremely long boarding.(13) Two studies, originating from Australia found a link between inpatient bed occupancy and block. Access block and ED LOS were significantly higher on days exhibiting higher occupancy (where admissions peak leads the discharge peak).(19) Likewise, as inpatient bed occupancy increased, so too did ED occupancy and block.(20)

Effects of Exit Block

Waiting times

A state wide study originating in Australia, found significant variation in time spent in the ED across hospitals.(15) One study found that, on average, block accounted for 60% of the total patient journey time in the ED.(16)

Two Australasian studies identified that compliance with the four hour target (a target which is standard in UK EDs) was dependant on the presence of block: ie in the absence of block, EDs were more likely to deliver care within four hours.(1,17) However, in another study non-compliance with the target appeared to rise during the afternoon at a time which the authors reported that the proportion of exit block cases typically drops.(12)

Boarding*

Boarding is a consequence of exit block. We identified boarding as the practice of holding patients in the ED after they have been referred for admission to the hospital, because no inpatient beds are available. References to 'boarding' were highlighted in a number of articles. One study reported that the greatest source of delay in ED patient flow was from the submission of an inpatient bed request to a patient exiting the ED.(18) Where there is a prolonged ED LOS, this is likely to be associated with boarding for more than 2 hours.(13)

One study reporting an increase in boarding did not associate this with an increase in ED demand, instead reporting decreases in new patient attendances, and lower acuity attendances. However, the study reported an increase in the admission rate during the data collection period.(7) In contrast, a US based study reported a decrease in boarding, evident alongside decreases in overall admission rates and ED LOS. The authors did acknowledge that measures to reduce boarding such as moving patients to inpatient corridors may have contributed to the reported decrease(8).

* 'Boarding' is defined as a patient who remains in the emergency department after the patient has been admitted to the facility, but has not been transferred to an inpatient unit. (source: ACEP Policy Statements, 2011: <http://www.acep.org/Content.aspx?id=75791>. Accessed 29.03.16)

Patient outcomes

With regard to patient outcomes, a study of those with a diagnosis of fractured neck of femur identified that patients experiencing block were more likely to experience a delay to surgery as were patients who arrived when the ED itself was experiencing block. Patients having experienced block were also more likely to go on to have a longer post-operative LOS.(2) In relation to patients with mental health care needs, one study reported that healthcare professionals perceived that block had detrimental effects on emergency mental health care.(27) Whilst block was perceived to be detrimental to patients with mental health care needs, Forero's (4) review identified that mental health service re-configuration had the potential to ease block, identifying that the co-location of psychiatric services within the ED had been shown to reduce block. Whilst there may be various reasons why the patient leaves an ED without being seen, including a long waiting time, authors inferred, in a single study, that the presence of exit block may influence this.(11) Evidence from a single site study reported ED wait time and associated mortality, finding that a delay to admission was independently adversely related to increases in mortality outcome. The authors recommended target limits of 4 and 6 h for referrals and admissions, respectively.(28)

Impact on workforce

The effects of block on the ED workforce were reported in two articles. A survey of ED consultants, registrars, and medical students suggested that reducing access block would improve the attractiveness of Emergency Medicine as a career.(24) In another study ED directors, EMT (Emergency Medical Team) directors, registrars and interns perceived that exit block was likely to negatively affect supervision and feedback given to junior doctors.(25)

Potential solutions to exit block

Changing the workforce

An increase in hospital resources, as measured by the number of nurses and doctors (in combination with the presence of inpatient beds), was shown to be associated with a significant reduction in total patient time in the ED.(15) ED staff perceived that the time interval for ED patients moving through the department to an inpatient bed was highly dependent on the availability of internal (ED staff) and external resources (hospital beds, admitting consultants, allied health professionals, porters, trolleys and ward medical equipment).(18) A study reporting the results of computer simulation modelling found that by speeding up the rate of moving admitted patients from the ED to a ward did reduce ED LOS.(23) A further study, again using modelling, suggested that an increase in the number of nurses operational overnight might speed up the transfer of patients from the ED to an inpatient bed, and could reduce block. In addition, the authors also suggested granting nurses/registrars working during early morning shifts, the authority to admit patients. Both measures were seen as having the potential to reduce block.(21)

This evidence review supports the findings of Forero's (4) earlier work in which he identified that increasing staff capacity had facilitated reduced ED LOS. Forero (4) identified increased working hours, employing care co-ordinators, community nurses, and ED nurses as being effective measures.

Changing bed capacity

Four studies looked at the impact of increasing the number of beds in the hospital, two of which looked at the impact of increasing inpatient beds. Using data from a metropolitan hospital in Australia, one study used modelling to estimate the intensity of ward admission and its effect on block.(21) The authors identified a number of initiatives worthy of exploring, one of which was the increase of inpatient ward beds overnight, so that any potential surge in overnight admissions did not reduce bed capacity on the following morning. The second study concluded that an increase in hospital resources, including inpatient beds, was found to be associated with a significant reduction in total patient time in the ED.(15)

In contrast, the third study looked at the effects of expanding ED bed capacity from 81 beds to 122 beds, across three Australian hospitals.(22) Over a two year period, the authors reported only one outcome to improve: in-hospital mortality. Amongst other outcomes where no improvement was evident was that of ED LOS and access block. The authors concluded that in order to improve all service outcomes, a whole of system approach should be considered. A further study implemented a computer simulation model (based on an urban trauma centre) and also found that increasing number of ED beds did not reduce ED LOS.(23)

Considering patient preferences

An inevitable effect of block is that patients are 'held' somewhere in the hospital whilst awaiting an inpatient bed. One study looked at patient expectations of an acceptable waiting time, and patient preferences for where they may be held whilst awaiting a bed. The majority of patients felt that 6 hours was an acceptable time waiting for a ward bed. Most patients would prefer to wait in an ED cubicle rather than a corridor. Of patients who expressed a preference, almost three quarters would prefer to wait in a ward corridor rather than an ED corridor. However this data was collected by and ED team and may therefore include some biases.(26)

Using Service redesign

Emergency and urgent care systems are often redesigned. Whilst some redesign may have a specific objective of reducing exit block, other initiatives may have unintended consequences on exit block. Seven papers reported on the impact of implementing service redesign. Two papers in particular are worthy of a more detailed report. The first study reported findings from a hospital wide initiative which was specifically set up to improve inpatient access block. Whilst the article did not describe the specific initiatives, it described them as substitutes to traditional inpatient care. During the study period, demand increased in terms of ED presentations and inpatient admissions. However, the number of ED patients waiting for an inpatient bed decreased leading the authors to report that the initiatives had 'almost eliminated block'.(27)

A second study looked at the effectiveness of a number of initiatives implemented with a view to reducing the number of admitted patients spending more than 8 hours in the ED. Interventions included a patient quota for ED junior medical officers, abolishing radiology registrar –only approval for requesting CT scans or ultrasounds, mandatory surgical admission for radiology investigations, one way referral for inpatient teams and implemented a one hour inpatient admission rule.

Following implementation, the authors reported a reduction, by 43%, in the number of admitted patients spending more than 8 hours in the ED.(28)

Other papers reported the effects following the introduction of a single initiative. One study reported the results of a 'priority admission triage initiative'. Whilst the study stated that exit block had been reduced to zero, the study appeared descriptive and based on a relatively short data collection period.(31) Two papers reported the effect on block following the introduction of new 'units' within a hospital setting, both of which also increased bed capacity. A ten bed Medical Assessment and Planning Unit (MAPU) was set up with a view to improving patient flow amongst predominantly older patients requiring general medical care. Reductions in ED LOS and inpatient LOS were reported however, these findings did not reach statistical significance. Whilst there was an overall increase in 28 day readmissions, post implementation of MAPU, there were no differences found between the MAPU and the non MAPU group.(32) Another paper reported the effect of introducing a 16 bed 'holding unit' into the hospital system. The authors reported that the unit was effective in reducing block, despite an increase in mean ED LOS. During the study period, ED attendances increased but there was no change in admission rates.(33) It appeared that this unit was part of a raft of measures introduced to improve inpatient access block. (29) The authors did not identify whether these other measures may have impacted on the findings

One study looked at how initiatives should be implemented, comparing the merits of externally led redesign to internally led redesign in improving efficiency. The internally led redesign included the implementation of a medical assessment unit, a 23 hour elective surgical ward and new bed management processes. The internally led redesign was found to be more effective in reducing block, despite an increase in mean ED LOS. During the study period, ED attendances increased but there was no change in admission rates.(32) It appeared that this unit was part of a raft of measures introduced to improve inpatient access block. (28) The authors did not identify whether these other measures may have impacted on the findings.

A further study used computer simulation to assess the potential impact of distributing inpatient discharges across the course of the week (rather than predominantly on weekdays). The authors reported that by 'smoothing' discharges across the week, this resulted in fewer ED beds occupied by general medical inpatients and a reduction in ED LOS. The authors however, did acknowledge the need to implement additional resources if this were to be effective in practice ie increase workforce, increase the availability of hospital services such as diagnostic imaging, and require effective co-ordination with community teams to facilitate discharge.(35)

Whilst Forero (4) identified initiatives such as developing transit lounges; observation wards; holding bays; and redesigning ED facilities as effective in improving patient flow, the review noted that there was 'clear evidence that in order to improve health outcomes, the best approaches are multifaceted, multi-disciplinary, and hospital wide'.

Discussion

Overall, there was limited evidence specifically relating to the subject of exit block. Some of the evidence to emerge related to prolonged ED LOS, which we identified as a proxy for exit block. We

summarised the evidence under four main headings of epidemiology, causes, effects and solutions to exit block.

The review has shown that there is evidence to suggest that exit block is more likely to occur in more densely populated areas and less likely in paediatric settings. High levels of bed occupancy appear to be associated with a greater degree of exit block. Evidence supporting the impact of initiatives pointed towards increasing workforce and inpatient bed resources within the hospital setting to reduce block, reinforcing the view expressed in Forero's (4) earlier review. However, there was no strong evidence in support of individual initiatives which had been implemented to alleviate exit block. Where successes had been identified, these appeared to be a part of a raft of measures and it was difficult to isolate any specific intervention which had been most effective. The main findings from the review are summarised in Box 1. However it must be acknowledged that solutions to exit block in the ED may cause adverse pressures elsewhere in the hospital system.

There are limitations to undertaking a rapid review such as this one. We were limited in the time that could be allocated to extracting information ie we did not include a search of the grey literature or extend the search to non-English language articles. We also used a single reviewer to initially screen articles, which can lead to errors. However the reviewer was experienced in emergency care research, and we further attempted to mitigate this by using an emergency medicine consultant to screen over a third of the selected abstracts.

Further evidence is needed, especially within the National Health Service (NHS) setting to increase the understanding around factors which cause exit block, and interventions that are shown to relieve it without compromising patient outcomes.

Box 1: Summary of findings

Features of Exit Block

- Limited and mixed evidence relating to increasing prevalence of exit block
- Exit block may be more likely to occur in densely populated areas and less likely in paediatric settings
- Mixed evidence regarding compliance with four hour standards and exit block. Boarding in the ED is a direct result of exit block.
- When hospital bed occupancy is high, so too is block. Evidence suggests that increasing inpatient beds reduces patient time in the ED, but increasing the number of ED beds does not reduce block.
- When waiting for an inpatient bed, patients prefer to wait in an ED cubicle rather than a corridor (either in the ED or at their ward destination if no ED cubicle available).
- Experiencing block has been shown to lead to adverse patient outcomes amongst certain groups and may have a negative impact on mortality.
- Exit block has been said to impact both negatively and positively on training opportunities for doctors. It may also reduce the attractiveness of emergency medicine as a career.

Possible solutions to exit block

- Increasing staff numbers both within the ED, and the wider hospital.
- Facilitating the movement of patients promptly once a bed is available.
- Increasing inpatient bed capacity.
- Implementing system wide change supported by the whole organisation, rather than single initiatives.

Further Recommendations

There is a clear evidence gap regarding exit block in general and especially in research originating from the United Kingdom. Research into the causes and effects of exit block within an NHS context is needed. Many healthcare organisations will be attempting to deal with exit block and initiatives should be evaluated robustly.

Table 1: Summary of empirical literature

Author, Year, Country of data, [Article type] (reference number)	Methods	Research question/outcomes	Main findings (relevant to this review)
Richardson, 2009,	Retrospective descriptive cohort study of patients	To determine arrival access block occupancy at	Arrival access block occupancy predicted patient access block ($p < 0.001$)

<p>Australia [journal article] (2)</p>	<p>aged 50+ with an ED diagnosis of fractured neck of femur in one tertiary setting during 2 year period</p>	<p>the start of the hour in which the patient presented in ED, and start of surgery more than 24 h after arrival without a documented reason for delay</p>	<p>Patient access block was associated with delay to surgery (p=0.006) Patient access block was associated with longer post-operative LOS (p=0.009)</p>
<p>Richardson, 2009, Australia [journal article] (6)</p>	<p>National survey of EDs at six time points between 2004 and 2008</p>	<p>Changes in prevalence of access block</p>	<p>One third of patients experienced 'block' Access block increased by 27% (P=0.025). Mean number under treatment increased by 38% (P<0.00001) Number of patients waiting to see a doctor increased by 31% (P<0.01) Non-paediatric major referral hospitals experienced greatest access block</p>
<p>Gilligan, 2012, Ireland [conference abstract] (7)</p>	<p>Routine data collected on 330,326 patient attendances between January 2004 to December 2010</p>	<p>To assess the effect of the following initiatives: 1) Increase in fee to attend ED for self-referred patients 2) Incentivising of minor injury and illness units 3) Increase in OOH GP cover 4) Development of Hospital in the Home and Community Intervention Teams</p>	<p>Regression analysis indicated: Reduction in new patient attendances (p =0.03) Reduction in lower acuity attendances (p<0.0001) Triage category orange (2) and yellow (3) annual increases of 492 patients (p<0.0001) and 918 patients (p<0.0001), respectively. Self-referrals reduced (p=0.008) Increased admission rate (p<0.0001) GP referrals increased annually by 659 patients (p=0.007) but admission rates for GP-referred patients did not show any statistically significant change (p=0.38) Number of patients 'boarding' increased (p<0.001)</p>
<p>Carr, 2010, USA [journal article] (8)</p>	<p>2003–2005 National Hospital Ambulatory Medical Care Survey (all US EDs) comprising of 44.3 million ED admissions</p>	<p>To estimate the time patients spent boarding in EDs</p>	<p>Boarding time decreased over time: 2003: estimated 11.3–17.1% of total patient-care hours 2004: 5.9–15.3% of patient-care hours 2005: 2.8–12.0% of patient-care hours Total patient care hours increased* Overall admission rates decreased (13.9% to 12.3%)* Intensive care admission rates increased (1.3% to 2.0%)* Mean EDLOS decreased (5.4 hours to 4.6 hours)*</p>

			* p value <0.001
Richardson, 2011, Australia [conference abstract] (9) Linked to reference (5)	All EDs in Australia were surveyed at one point in 2009	To describe point prevalence of access block	Of those waiting for beds, 73% experienced block. Situation best in paediatric, worst in urban district hospitals. Differences observed between States
Jones, 2011, New Zealand [journal article] (10) Linked to article (36)	National survey of EDs at two points in 2010	To identify ED occupancy and compliance with 'shorter stays' in ED target	In tertiary and secondary hospitals, respectively, access block was seen in 64% versus 23% (P=0.05). No hospital with access block met the 'shorter stays' target, compared with 60% without access block (P=0.001).
Hossain, 2012, USA [journal article] (11)	National Hospital Ambulatory Medical Care Survey (NHAMCS) during the period from 29 December 2003 to 26 December 2004.	Identification of possible causes of inefficient coordination performance and coordination quality resulting in access blocks	30% of patients waiting longer than the average wait time (19 mins) to see a physician The number of patients re-attending the ED may impact on access block. The presence of access block may influence the number of patients leaving the ED without being seen.
Khanna, 2013, Australia [journal article] (12)	Retrospective data analysis of 5 years of ED data from 30 public hospitals in Queensland from 2007-2011	To describe: 1)Cases of NEAT (national emergency access target – i.e. 4 hour target) non-compliance 2)Access block (defined as patient waiting to be admitted for >8 hours)	Linear dependence between block and NEAT non-compliance was positive 0.40-0.73 – the strongest association was between admitted patients in larger hospitals Block worse at 09:00 hours but otherwise fairly constant 4 hour non-compliance found to rise between 13.00 hours and 17.00 hours, a period when the proportion of block cases typically drops.
Ye, 2012, China [journal article] (13)	Retrospective study of high acuity patients in a tertiary hospital in 2010	To investigate prolonged EDLOS and associated factors for high-acuity patients	Most significant factor associated with prolonged LOS was boarding for more than 2 h (OR, 4.29; 95% CI, 4.03–4.57). Patients requiring emergency operation or ICU admission had a shorter EDLOS (OR, 0.56 and 0.76; 95% CI, 0.53–0.60 and 0.71–0.81, respectively). Older patients, night shift arrivals, non-spring visitors, general internal medicine patients and patients leaving without receiving advanced therapy had longer LOS (statistically significant)
Boyle, 2011,	5 year retrospective analysis (2 dissimilar	To develop and validate a predictive model to	Forecast accuracy worsened as time interval decreased:

<p>Australia [journal article] (14)</p>	<p>hospitals, consecutive hospital presentations to the ED – 2002-2007)</p> <p>Validated in 27 further hospitals within the same state (2005-2009)</p>	<p>inform on volume of ED presentations and admissions</p> <p>To establish mean average percentage error (MAPE) between forecast and observed data</p>	<ul style="list-style-type: none"> • Monthly admissions; 2% MAPE • Daily admissions; 11% MAPE • 4 hourly admissions; 38% MAPE • Hourly admissions; 50% MAPE <p>ED presentations forecasts more accurate than admissions forecasts:</p> <ul style="list-style-type: none"> • Daily presentations; 7% MAPE <p>During validation, forecasts for urban facilities were generally more accurate than for regional forecasts (accuracy related to sample size)</p>
<p>Harris, 2010, Australia [journal article] (15)</p>	<p>Retrospective observational study of all patients presenting to 38 public hospital EDs in Victoria, in 2005/2006 (one year)</p>	<p>To quantify the determinants of the duration of time spent in an ED for patients who need admission to hospital.</p> <p>Elasticity of patient care time (defined as the time in the ED from first being seen by a treating doctor to admission)</p>	<p>Mean patient care time was 396 min (95% CI 395 to 398).</p> <p>Reduced time in ED was associated with the number of nurses (elasticity= 2.38%; 95% CI 2.31 to 2.45); the number of inpatient beds (elasticity= 2.99%; 95% CI, 2.89 to 3.08); the number of doctors (elasticity=-0.235%; 95% CI 0.232 to 0.237).</p>
<p>Gilligan, 2010, Ireland [journal article requested but not retrieved. Review based on abstract only] (16)</p>	<p>Observational study of all ED attendances between August 2006 and February 2007 in one (?) ED.</p>	<p>To determine the timeliness of the delivery of care to patients requiring admission through the ED</p> <p>Impact of the referral process on the total time spent in the ED</p>	<p>Mean total time in the ED for the 4092 (58.7%) medical patients was 21h 16min (standard deviation 12h 24min) as compared with 14h 28min (standard deviation 10h 46min) for the 2852 (40.9%) surgical admissions (P<0.001).</p> <p>The referral process accounted for an average of 16.6% of the patient journey through the ED while access block accounted for an average of 59.6%.</p>
<p>Nagree, 2011, Australia [conference abstract] (17)</p>	<p>Retrospective observational study using ED routine data</p>	<p>To identify factors influencing compliance with four hour target</p>	<p>Compliance with target dependent on patients being sent to the ward within 4 hours (p<0.001) and presence of block (p < 0.001)</p>
<p>Martin, 2011, Australia [journal article] (18)</p>	<p>Mixed methods: i) workshop with ED staff ii) observation in ED iii) focus group</p>	<p>To identify bottle-necks that contribute to over crowding</p>	<p>The greatest source of delay in patient flow was the waiting time from a bed request to exit from the ED for hospital admission. The mean for this interval was 2 h 59 min.</p> <p>Workshop participants identified these time intervals: bed request to bed available, and bed request to exiting the ED for admission, as highly dependent on the availability of internal (ED staff) and external resources (hospital beds, admitting consultants, allied health professionals, porters, trolleys and ward medical</p>

			equipment).
Khanna, 2013, Australia [journal article] (19)	Inpatient admission and discharge information and ED presentation data for 23 public hospitals in Queensland between 1/10/2007 and 31/3/2010. Data sourced from the Hospital Based Corporate Information System (HBCIS) and ED Information System (EDIS) databases	Assessing the impact of inpatient discharge timing on ED flow parameters (i.e. access block and LOS)	*During category 5 days there was an average of 229 cases of access block per day, 60 cases a day higher than on category 1 days. Mean access block reported on category 5 days was 18, 22 and 16 cases a day higher than that on category 1 days for groups 1, 2, and 3 respectively. *Days were classified on a sliding scale from 1 to 5 where 1=discharge peak leads admission peak, and 5=admission peak leads discharge peak.
Richardson, 2010, Australia [conference abstract] (20)	Retrospective descriptive study over 26 weeks (from 31 March 2008) in a mixed tertiary ED.	To quantify any relationship between inpatient bed occupancy (OCC) and subsequent measures of care in ED	Linear, significant increase in daily ED occupancy from 24.5 (95% CI 22.7– 26.3) at OCC 430–439 to 33.6 (31.7– 35.4) at OCC 500–509 Over the same OCC interval, probability of access block increased from 40.3% (34.4– 46.5) to 60.6% (53.6–67.1) and LWBS increased from 6.9% (5.6–8.6) to 12.1% (10.2– 14.3).
Luo, 2012, Australia [journal article] (21)	Simulation modelling using 12 months data of all admissions to a ward primarily admitting emergency patients in a metropolitan hospital	Estimating the intensity of ward admission and its effects in ED access block	Model suggests: 1.Adding more night shift nurses may speed up transfer of patients into speciality wards 2.Granted early morning shift nurses and registrars the authority to admit 3.Allocating additional overnight flexible beds to accommodate potential surge
Crilly, 2014, Australia [journal article] (22)	Retrospective comparative cohort study on data collected between 2006-2008	To identify predictors of admission and describe outcomes for patient who arrived by ambulance in 3 EDs before and after opening 41 additional ED beds	1/3 presentations via ambulance and 40.3% required admission The only outcome measure to improve was in-hospital mortality based on patient's last admission (decreased by 1.5%) Proportion of patients offloaded within 30mins increased by 4% Proportion of patients seen within ATS recommended time frame increased 39% from 44% Median time to see a doctor increased 39% from 44% Median time to see a doctor increased by 4mins EDLOS for patients increased by 65mins (admitted patients), and by 21mins (non-admitted patients) Proportion admitted increased by 4% Access block increased by 11% All findings p<0.001

Khare, 2009, USA [journal article] (23)	A computer simulation model drawing on data from an urban, academic, tertiary care, Level I trauma centre ED visit data for February 2006 as the base case, which included 5,751 total ED visits	To compare the effect of two operational interventions on EDLOS: 1. Increasing the number of ED beds 2. Increasing the rate at which admitted patients leave the ED.	With a constant ED departure rate at the base case and increasing ED beds, there was an increase in mean LOS from 240 to 247 mins (95% CI 0.8 to 12.6 mins). When keeping the number of beds constant at the base case and increasing the rate at which admitted patients depart the ED to their inpatient bed, the mean overall EDLOS decreased from 240 to 218 mins (95% CI 16.8 to 26.2 mins).
Celenza, 2012, Australia [conference abstract] (24)	Survey of ED consultants, registrars and medical students	Attitudes to emergency medicine as a career	Less access block would improve attractiveness of emergency medicine
Jelinek, 2010, Australia [journal article] (25)	Semi-structured telephone surveys sought quantitative and qualitative data from ED Directors, Directors of Emergency Medicine Training, registrars and interns	To describe the adequacy of supervision of junior medical staff in EDs and perceived feedback provided	Block likely to negatively affect supervision and feedback given to junior doctors
Bartlett, 2009, Australia [journal article] (26)	Prospective cross-sectional survey of 400 patients. Information collected between 08:00 22:00 7/7 over 4/52 period	To identify patient preference for waiting location whilst waiting for an inpatient bed.	Most patients preferred to wait in ED cubicle 53.8% (95% CI 48.7 to 58.7) versus 2.5% (CI 1.3 to 4.7%) in an ED corridor, 13.5% (CI 10.4 to 17.3%) in a ward corridor and 30.2% (CI 25.8 to 35.0%) with no preference. When no ED cubicle available 46.2% patients had no preference for corridor location (CI 41.3-51.3%). Of those with a preference, 72.1% preferred to wait in a ward corridor (95% CI 65.5–77.8%) and 27.9% preferred the ED corridor (95% CI 22.1–34.5%). 57% felt that 6 hours was an acceptable amount of time waiting for a ward bed.
Jelinek, 2011, Australia [journal article requested but not retrieved. Review based on abstract only] (27)	36 semi-structured interviews undertaken with emergency medicine doctors and nurses	Perceived barriers faced by emergency clinicians in utilising mental health legislation in EDs.	Access block has detrimental effects on emergency mental health care as it does in other areas of emergency medicine.
Plunket, 2011, Ireland	Single centre study of all patients admitted as medical emergencies by the	Impact of ED wait time on 30-day in hospital mortality	Adjusting for all outcome predictors, including comorbidity and illness severity, both door-to-team and team-to-ward

<p>[journal article]</p> <p>(28)</p>	<p>ED between 2002 and 2008</p>		<p>times were independent predictors of death within 30 days with respective odds ratios of 1.13 (95% CI 1.07-1.18), and 1.07 (95% CI 1.02 1.13).</p>
<p>Corbella, 2011, Spain</p> <p>[conference abstract]</p> <p>(29)</p> <p>Derived from same study as (33)</p>	<p>Observational study set in 900-bed tertiary care, university-affiliated, public centre for adults (4461 consecutive days – 1998-2010)</p>	<p>Evaluation of effect of a set of hospital wide operation management strategies for improving inpatient access block</p> <p>Comparisons between pre, during, and post implementation of initiatives</p>	<p>Number of patients waiting at 08:00*:</p> <ul style="list-style-type: none"> • Baseline 8.8 (95%CI 8.4 to 9.2) • During intervention 5.2 (95%CI 4.9 to 5.5) • Follow-up 4.2 (95%CI 4.0 to 4.5) <p>Number of ED visits increased (baseline, intervention, follow-up respectively: 296.6, 322, 338)*</p> <p>Inpatient admissions increased (33.9, 32.7, 35.3)*</p> <p>Scheduled conventional hospital admissions increased (37.4, 44.6, 54.4)*</p> <p>Scheduled 23h-surgery admissions increased (0.1, 3.5, 13.4)*</p> <p>Hospital-in-home admissions increased (0, 1.8, 2.2)*</p> <p>Average number of hospital beds, inpatient LOS, hospital occupancy rates decreased*</p> <p>*P value p<0.0001</p>
<p>Mah, 2012, Australia</p> <p>[conference abstract]</p> <p>(30)</p>	<p>Single ED in Australia</p>	<p>To reduce by 50% the number of admitted patients with ED processing time >8 hours by implementing various strategies over a 6 month period.</p> <p>Interventions included patient quotas for ED junior medical officers, 321 (Jonah), abolish radiology registrar approval for requesting CT scans or ultrasounds, mandatory surgical admission for radiology investigations, one way referral for inpatient team and implemented one hour inpatient admission rule.</p>	<p>Reduced, by 43%, the number of admitted patients with ED processing time >8 hours.</p> <p>Requires senior permanent staff to enforce the implementation of various strategies to sustain these levels.</p>
<p>Lau, 2011, Hong Kong</p> <p>[conference abstract]</p>	<p>Retrospective review of all medical admissions</p>	<p>To identify changes in access block (defined as ≥five patients pending medical admission for ≥four hours) following introduction of PAT (Priority admission triage – to stratify patients in</p>	<p>Access block reduced after PAT was introduced from 5 days in a month to zero days</p>

(31)		terms of clinical severity))	
Brand, 2010, Australia [journal article] (32)	Before and after cohort study between 2003 and 2004.	Evaluation of the impact of a Medical Assessment and Planning Unit (MAPU) on LOS and EDLOS	<p>Median LOS (IQR):</p> <ul style="list-style-type: none"> • MAPU 2.0 days (1.2 to 3.0) • Non-MAPU 3.6 days (1.0 to 8.9) • General medicine 3.9 days (1.68.0) <p>*not statistically significant</p> <p>EDLOS for admitted patients:</p> <ul style="list-style-type: none"> • MAPU 10.3h • Non-MAPU 13.2h <p>*not statistically significant</p> <p>Mortality:</p> <ul style="list-style-type: none"> • MAPU 3.2% • Non-MAPU 7.6% <p>P<0.001</p> <p>Note – overall increase in 28 day hospital readmission after implementation of MAPU but no significant difference between groups.</p>
Gomez-Vaquero, 2009, Spain [journal article] (33) Derived from same study as (29)	Observational, prospective data analysis of all ED admissions in one hospital Retrospective data analysis used as a comparison	Comparison of pre and post opening of a 16-bed Holding Unit (HU) to reduce access block and attendance pressure in the ED	<p>3.1% increase in ED presentations Number of urgent admission/day – no real change (31.5 pre and 31.6 post HU)</p> <p>Mean number of patients waiting for a bed decreased by 55.6% (a mean difference of -5.1 patients, CI -5.9 to 4.3)</p> <p>Number of elective admissions increased from 13942 to 14779</p> <p>Number of cancelled elective admissions fell from 869 to 511</p> <p>Mean EDLOS increased by 6.9% from 3.89 hours to 4.16 hours</p> <p>*One mention in text regarding p-value- unsure what it refers to P value set at 0.05 in other part of the paper</p>
Scott, 2011, Australia [journal article] (34)	Comparative before-after study involving five tertiary hospitals in Queensland, using 3.5 years of data (12 months pre and 24 months post).	Changes in access block following hospital wide redesign. Comparing externally led redesign over 6 months within two hospitals, comprising ward-based innovations, and internally led redesign over 25 months in one hospital which implemented medical assessment and planning unit, 23 hr elective surgical ward and new bed management processes.	<p>Internally led redesign saw two decreases in access block outside control limits during the intervention period, resulting in a decrease from a baseline average of 55% to a post intervention average of 22%.</p> <p>Internally compared with externally led redesign led to superior and sustained improvements in ED access block</p>
Wong, 2010,	Simulation modelling study from an academic	To evaluate the daily number of ED beds	Good agreement between model simulations and historical data for

<p>Canada</p> <p>[journal article]</p> <p>(35)</p>	<p>care hospital in Toronto. Historical data from the general internal medicine (GIM) department between 15 January and 15 December for two years (2005 and 2006) was obtained.</p>	<p>occupied by inpatients after evenly distributing inpatient discharges over the course of the week</p>	<p>both ED and ward censuses and their respective LOS.</p> <p>When discharges were smoothed across the 7 days, the number of ED beds occupied by GIM patients decreased by approximately 27% (from 7.4 patients to 5.4 patients), and EDLOS for GIM patients decreased by approximately 31% (from 24 hours to 17 hours).</p> <p>The model also demonstrated that patients occupying hospital beds who no longer require acute care have a considerable impact on ED and ward beds</p>
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Contributorship

SM, EK and AB designed the study. EK undertook the searches and data extraction, checked by SM. SM, AM and EK wrote, reviewed and revised the manuscript.

Funding

This study was funded by the Royal College of Emergency Medicine, UK

Competing Interests

None

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