NHS bed occupancy and surgical cancellations

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Abstract

As cost and demand for health services continue to grow, there is mounting pressure on the English National Health Service (NHS) to increase efficiency, cost-effectiveness and productivity. Over the past few decades, continual and extensive system analysis and policy changes have led to many major structural, operational and system changes within the NHS in order to achieve these goals. One of the most widespread of these changes was a major reduction in national bed numbers across most specialties including general and acute, mental health and maternity.

Streamlined treatment pathways, reductions in average length of stay, increases in day-only procedures and expansion of community and outpatient services are some of the changes commended with making these large-scale reductions in bed numbers achievable. However, despite these system changes, which were designed to reduce the demand upon hospital overnight beds, prominent organisations have raised concerns that NHS England is now operating below the minimum number of beds required to provide a safe and efficient service.

A literature review and quantitative data analysis were carried out to assess the impact of bed occupancy rate (BOR) and its relation to performance markers in aspects of patient care, patient safety and efficiency of the service, with a specific analysis of one specific performance marker: last minute surgical cancellations.

The literature suggests that high BOR is associated with poorer performance in some areas of acute care. However, in the quantitative data analysis, weak associations of low statistical significance were identified between BOR and surgical cancellations in the English NHS, suggesting that high BORs do not increase the likelihood of last minute surgical cancellations. More research is needed to determine how much of an impact, if any, BORs are having in other areas of NHS performance and safety, in particular critical and emergency care, using the results to clinically justify or denounce future plans to further reduce the NHS acute bed stock.

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Glossary of terms

NHS – Public National Health Service of the United Kingdom.

Bed occupancy rate (BOR) – A measure of occupied beds as a percentage of overall beds in a hospital.

Elective operation – Surgery which is planned and scheduled in advance as it is not classed as a clinical emergency.

LMNC cancellation – Last-minute cancellation of elective operation for non-clinical reason.

Acute bed – A hospital bed intended to accommodate patients for treatment of an illness or injury.

Day-case/day-only operation – Planned elective surgery where a patient can attend a hospital, receive their operation and be discharged home on the same day.

Inpatient – A patient who lives in hospital while under treatment.

Intensive care unit (ICU) – Specialist hospital ward where treatment and monitoring is provided for patients who are very ill.

Admission – The act of a person being placed into an inpatient bed under the care of a hospital for treatment or observation.

Readmission – The act of a patient who has been previously discharged from hospital being admitted again within a specified time frame.

Waiting list – A list of people waiting for an operation.

Referral – The act of a primary care general practitioner referring a patient to secondary care for a consultation, review or treatment for a clinical condition.

Trust – Hospital or group of hospitals under the same management (interchangeable with ‘care provider’).

Care provider – Hospital or group of hospitals under the same management (interchangeable with ‘trust’).

1 Introduction

This essay will examine the issues surrounding NHS bed numbers including a look at trends in bed numbers over time with a discussion on how and why changes have been achieved. It will look at hospital bed occupancy rate (BOR) as a way of measuring bed numbers against demand and give an account of the literature to form a discussion around BOR and its relation to performance markers in aspects of patient care, patient safety and efficiency of the service.

It will then conduct an examination of one specific performance marker: last minute surgical cancellations. An in-depth analysis of NHS England public quantitative data will be carried out to investigate if there is a relationship between BORs and the last-minute cancellation of elective operations in the NHS. This will form the basis of a critical discussion of NHS policy and practices in relation to BOR.

As cost and demand for health services continue to grow, there is mounting pressure on the National Health Service (NHS) of the United Kingdom (UK) to increase efficiency, cost-effectiveness and productivity. Over the past few decades, continual and extensive system analysis and policy changes have led to many major structural, operational and system changes within the NHS in order to achieve these goals. One of the most widespread of these changes was a major reduction in national bed numbers across most specialties including general and acute, mental health and maternity.

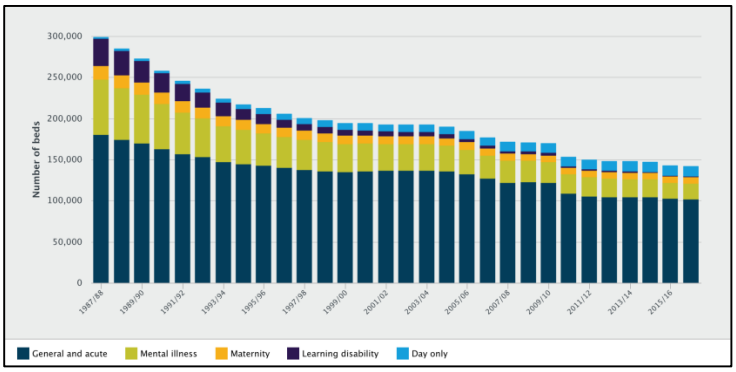
More streamlined treatment pathways, reductions in average length of stay, increases in day-only procedures and expansion of community and outpatient services are some of the changes commended with making these large-scale reductions in bed numbers achievable (King's Fund, 2017a). However, despite these system changes, which were designed to reduce the demand upon hospital overnight beds, prominent organisations such as the British Medical Association (2017) and King's Fund (2017a) have raised concerns that the NHS is now operating below the minimum number of beds required to provide a safe and efficient service.

Today, most NHS hospitals are operating above what most academic papers, healthcare bodies and the NHS themselves, have recommended to be the threshold of maximum bed occupancy rates. However, the number of beds the NHS should have is an ongoing debate with many factors to consider. This debate has led to disjointed recommendations from varying sources with no official conclusion yet reached on what is an ideal number of beds and bed occupancy rate to provide a safe and efficient health service to the UK population.

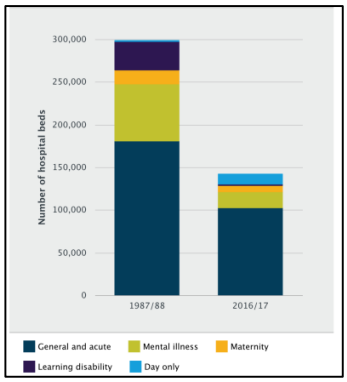
Recent high-profile media coverage has bought these issues into the public eye, with claims that longer waiting lists for elective surgery, lengthier waits in A&E and the cancellation of operations are all evidence that the NHS is suffering a "bed crisis" (Appendix). This has raised further questions about the optimum number of beds the NHS should have in order to meet demand and about whether the processes put in place to improve efficiency have been marked enough to support such large-scale bed reductions seen in the service.

1.1 The past, present and future of bed numbers in the NHS

In the period between 1987/8 and 2016/7, overall hospital bed numbers declined by 54% from approximately 299,000 to 142,000. The largest reductions have been in mental health and learning disability beds, although general and acute beds (medical and surgical inpatient hospital beds), which account for over 70% of overall beds, have decreased by 43.4% from 180,000 in 1987/8 to 102,269 in 2016/17 (King's Fund, 2017a; NHS England, 2017a).



Number of NHS beds by category, 1987/88 to 2015/16 (King's Fund, 2017).
Data source: NHS England.

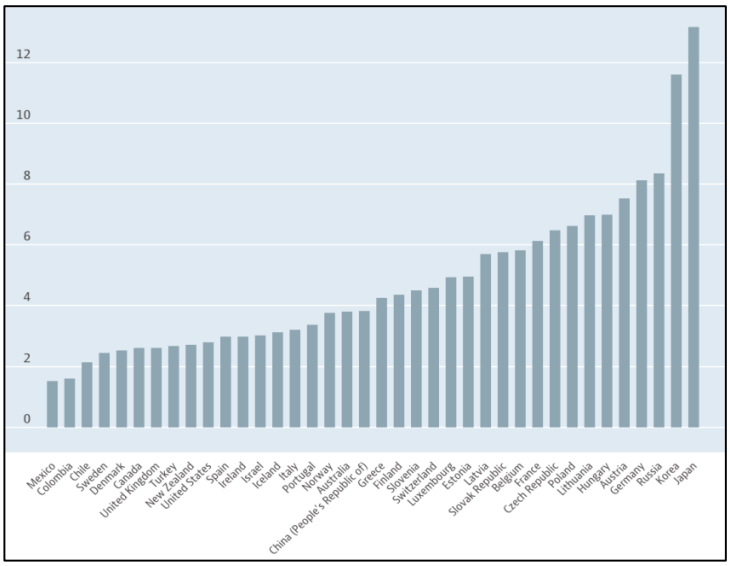


Number of NHS beds by category as a proportion of overall bed stock, 1987/88 and 2016/17 (King's Fund, 2017).
Data source: NHS England.

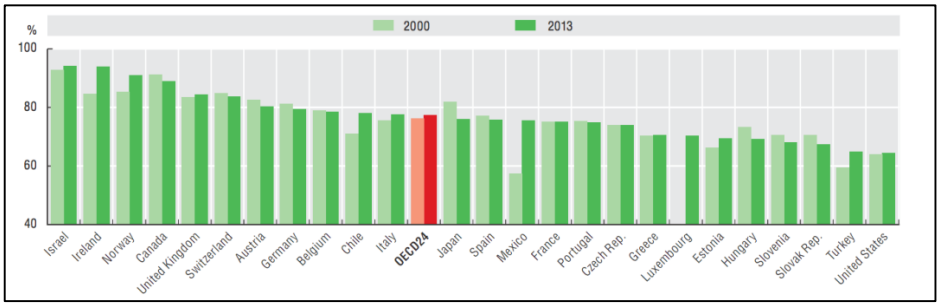
While the rate of bed reduction has slowed significantly in recent years, the future could see further reductions in bed numbers nationwide. Many "sustainability and transformation partnerships" set up across England have proposed plans to reduce the NHS's bed stock even further, including general acute beds. While exact figures remain unconfirmed, estimates are in the thousands with many of these proposals suggesting that the rate of reductions will see bed numbers fall faster than they have in recent years (NHS Improvement, 2017; King's Fund, 2017a).

1.2 How does the UK compare with other countries?

Internationally, similar scale reductions have occurred in most other advanced health systems although there are wide variations. However, among Organisation for Economic Co-operation and Development (OECD) countries, the UK has one of the lowest numbers of acute beds per 1000 population at 2.3:1000 and one of the highest average hospital bed occupancy rates (BOR) (OECD, 2015). However, Papanicolas and Jha (2017) warn that comparisons between health systems across countries can be misrepresentative. Disparities in structures of the health systems, policies, funding and supporting services such as social care for example, can make assumptions drawn from these comparisons misleading.



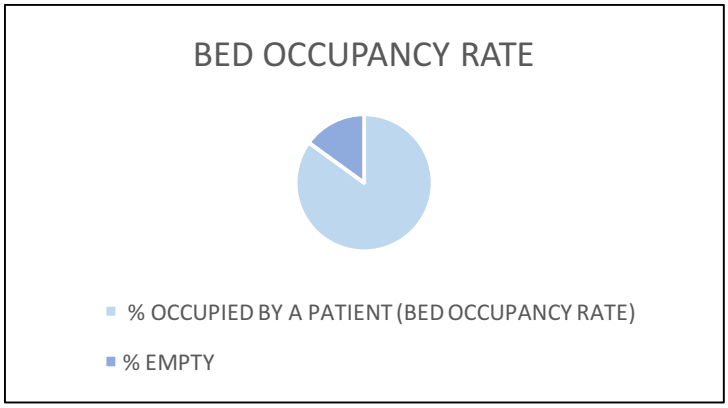
Total number of hospital beds per 1000 inhabitants in OECD countries 2015 (OECD, 2015).



Average bed occupancy rate in OECD countries 2000 and 2013 (OECD, 2015)

1.3 What are hospital bed occupancy rates?

Hospital bed occupancy rates are a measure of in-use beds as a percentage of the total number of beds available. BORs are used to identify under- or over-utilisation of available beds and as a measure of a health service or hospital's ability to provide sufficient inpatient services against demand.



While counting total hospital bed numbers in a population provides us with a rudimentary marker against other health systems or hospitals or the situation of the past, it cannot measure how changes to hospital bed numbers affect a system or individual hospital's ability to perform. Some healthcare providers are able to operate effectively with fewer beds per capita when they have more streamlined care pathways or are sufficiently supported by tertiary services such as social and primary care, while others require higher bed numbers to compensate. Therefore, a more valuable measure of whether a hospital has a sufficient number of beds is to assess what percentage are filled. Low BORs mean that many beds on wards remain empty, which could indicate a waste of resources in that area. A high BOR could indicate that there are insufficient beds to meet demand.

1.4 What is the ideal bed occupancy rate?

The question of what is the optimum BOR is complex and remains under debate. A theoretical model based on 'queuing theory' proposed by Bagust *et al* (1999) was one of the first prominent studies to suggest that 85% should be the maximum BOR in order to optimise patient safety and maintain an efficient patient flow. The theory surmised that the remaining 15% of overall beds are needed to a) withstand fluctuations and b) minimise delays in new patients reaching a ward bed without having to first wait in a queue for one to be emptied and cleaned etc.

The <85% target has been supported in the research by a variety of international studies across a range of health systems using a variety of indicators. Chris Hopson, the Chief Executive of NHS Providers, and former President of the Royal College of Surgeons (RCS), Clare Marx, have also put forward that NHS bed occupancy should not exceed 85% (National Health Executive, 2017). However, critics argue that the aim of <85% is outdated and oversimplified and that this broad-stroke target fails to take into account modern bed-management processes and the differing characteristics of individual health systems, hospitals and departments (Morton, 2011; Bain *et al*, 2010).

In 2000, the United Kingdom Department of Health (DOH) launched a national beds inquiry. It concluded that a BOR above 85% in acute care hospitals resulted in problems managing emergency and elective admissions. Immediately following the release of the bed inquiry report, UK hospitals were advised to aim for an OR of 82% in order to prevent patient backlogs in elective surgery waiting lists and A&E waiting times.

More recently, however, the National Institute for Clinical Excellence (NICE) in collaboration with the Royal College of Physicians (RCP) (2017) conducted an evidence review of hospital bed occupancy in the NHS. The report recognised that ideal BOR is likely to be variable among hospitals and health systems, "influenced by multiple variables across the whole health and social care system". The results of the evidence examined in the report suggested that high BORs were associated with a variety of adverse effects such as increased incidence of hospital acquired infections (Ahyow, 2013), emergency re-admissions (Blom, 2015), higher mortality rates (Boden, 2016; Masden, 2014; Yergens, 2015) and increases in ED waiting times (Krall, 2009). No evidence was identified to suggest that high BORs affect patient or staff satisfaction or quality of life indicators (NICE, 2017). The review concluded that "high levels of occupancy were likely to result in harm, particularly for

patients on an emergency pathway", but its recommendation that NHS hospitals aim to achieve a BOR of <90% in order to minimise risk to patients was nonetheless a significant increase from the recommendations set out in 2000. Furthermore, NHS Improvement and NHS England (2017) published a subsequent report in which it recommended NHS hospitals aim for an even higher occupancy rate of <92%, although the evidence used to arrive at this number was not cited.

Overall, the question of ideal BOR remains unclear. But with the large-scale bed reductions seen in the NHS, measuring BOR against performance indicators could be a useful gage of how much further the service can continue to cut back on beds while maintaining safety and efficiency.

2 Research question

Is there a relationship between last-minute cancellation of operations and hospital bed occupancy rates in the English NHS?

AIMS:

To investigate if there is a relationship between hospital bed occupancy rates and the last-minute cancellation of elective operations for non-clinical reasons in NHS England in 2016/17.

OBJECTIVES:

- Identify key aspects of hospital bed occupancy rates and surgical cancellations with regards to hospital care.
- Review past, present and future bed numbers, bed occupancy rates and surgical cancellation policy and practice within NHS England.
- Gather, analyse and compare publicly available data sets covering occupancy rates and surgical cancellations in NHS England in 2016/17.
- Identify trends and interpret correlations within the retrieved data.

3 Methodology

The following will outline and discuss the process of methodology applied during the research of this paper, including an identification of the limitations of the research.

Literature search

At the initial stage, a scoping search was carried out in order to gather a broad understanding of the key issues surrounding hospital bed occupancy rates. A range of sources including PubMed, Google Scholar and the Cochrane Library were used. A table of key search terms was created to facilitate the search.

The varying terminology for 'hospital bed numbers' and 'hospital bed occupancy rates' (COLUMN A) was systematically paired with a wide range of performance indicators (COLUMN B). The table below presents the results in order of quantity of papers found during the search.

<table>
<tr><th colspan="2">KEY SEARCH TERMS</th></tr>
<tr><th>COLUMN A</th><th>COLUMN B</th></tr>
<tr><td rowspan="3">➢ HOSPITAL BED OCCUPANCY RATES
➢ HOSPITAL BED OCCUPANCY
➢ HOSPITAL BED CAPACITY
➢ HOSPITAL BED NUMBERS
➢ NHS BED OCCUPANCY
➢ NHS BED NUMBERS
➢ NHS BED SHORTAGE
➢ HOSPITAL BED SHORTAGE
➢ WARD OVERCROWDING</td><td>SEARCH TERMS WITH THE MOST RESULTS:
➢ INFECTION RATES
➢ HOSPITAL ACQUIRED INFECTIONS
➢ ACCIDENT AND EMERGENCY/EMERGENCY ROOM WAITING TIMES
➢ BED BLOCKING
➢ DELAYED ADMISSION TO WARD
➢ MRSA
➢ ICU ADMISSION</td></tr>
<tr><td>SEARCH TERMS WITH A MODERATE NUMBER OF RESULTS:
➢ ICU DISCHARGE
➢ MORTALITY RATE
➢ SURGICAL WOUND INFECTIONS
➢ SURGICAL SITE INFECTIONS
➢ PREMATURE/EARLY DISCHARGE</td></tr>
<tr><td>SEARCH TERMS WITH VERY FEW OR NO RESULTS:
➢ SURGERY WAITING LISTS
➢ HOSPITAL STAFF STRESS/NURSE STRESS
➢ CANCELLED OPERATIONS/SURGERY
➢ CANCELLED ELECTIVE OPERATIONS/SURGERY
➢ DELAYED OPERATIONS/SURGERY</td></tr>
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While a number of results were found for most of the performance indicators, a gap in the literature was identified in the area of 'cancelled operations and BOR'. Therefore, a decision was made to focus this paper in this area.

A second and more specific search was conducted in order to find statistical data and policy of bed numbers, bed occupancy rates and surgical cancellations within the NHS. A new table of key terms was composed to facilitate this search. The terms from COLUMN A were systematically paired with terms from COLUMN B.

KEY SEARCH TERMS	
COLUMN A	**COLUMN B**
➢ HOSPITAL BED OCCUPANCY RATES ➢ HOSPITAL BED OCCUPANCY ➢ HOSPITAL BED NUMBERS ➢ NHS BED OCCUPANCY DATA ➢ NHS BED NUMBERS DATA ➢ NHS POLICY BED NUMBERS ➢ NHS POLICY BED OCCUPANCY ➢ DEPARTMENT OF HEALTH BED OCCUPANCY ➢ DEPARTMENT OF HEALTH BED NUMBERS	➢ CANCELLED OPERATIONS ➢ CANCELLED ELECTIVE OPERATIONS/SURGERY ➢ DELAYED OPERATIONS ➢ SURGICAL WAITING LIST ➢ NHS CANCELLED OPERATIONS ➢ NHS CANCELLED ELECTIVE OPERATIONS/SURGERY ➢ NHS DELAYED OPERATIONS ➢ NHS SURGICAL WAITING LIST ➢ NHS CANCELLED OPERATIONS POLICY

The NHS England beds data had been divided into four main bed-by-use categories; maternity, mental health, learning disabilities and general and acute. NHS England had excluded the following bed-types; critical care, residential care, beds intended solely for the use of well babies and beds commissioned by non-NHS providers. The data did not further distinguish whether the hospital beds were utilised by surgical or medical patients, nor by emergency or elective admissions.

Rationale for bed types included and excluded in the analysis

The search of the NHS England database produced the KH03 data which provided quarterly statistics on the BOR for NHS providers. The decision was made to focus the analysis for this paper exclusively on the category of 'general and acute beds'. While the data does not differentiate between beds used for surgical beds or for medical patients, we confidently excluded learning disability and mental health beds under presumption that none of these beds will be occupied by patients undergoing surgical procedures. The decision to exclude maternity beds was also justified as these are generally within a separate unit or birthing centre. Maternity beds are ring-fenced for maternity use only and are unavailable for general/acute use.

There were several justifications for these decisions: 1) surgical beds fall under the general and acute beds within NHS England data, 2) general and acute beds account for the majority (80%) of the total bed days, 3) it allows analysis to remain separate from occupancy rate percentages in non-surgical categories, which have comparatively low bed numbers within a hospital compared to general and acute, 4) separating the occupancy rates into their

individual categories of bed-by-use provides a more specific overview of the bed type of interest in this study.

Cancelled operations data

A search of the NHS England database archives produced quarterly hospital statistics for last-minute cancellations of elective operations for non-clinical reasons (LMNC cancellations). NHS England define 'last-minute' as "on the day the patient was due to arrive, after the patient has arrived in hospital or on the day of the operation or surgery". 'Non-clinical' is not defined by NHS England but a literature search revealed 'non-clinical' reasons to include (but not to be limited to) surgeon or anaesthetists being unavailable, equipment issues, nursing staff issues, prioritising emergency cases, insufficient operating theatre time, poor planning of surgery, administration error or a lack of bed (Talawah *et al*, 2018). The NHS England data did not provide specific information on individual reasons for non-clinical cancellations. It was therefore not possible to separate cancellations due to a lack of bed from the rest of the non-clinical cancellations data, and thus LMNC cancellation data is used in this analysis as a proxy for cancellation due to lack of bed availability. This is a significant limitation as it requires the assumption that the relative rates of cancellations for different non-clinical reasons remain constant. This is not possible to confirm with the data available.

This data included all planned/elective procedures including day-case operations and excluded emergency operations and minor outpatient procedures. Telephone cancellations made on the day of admission were counted as cancelled in the data but operations rescheduled within 24 hours of cancellation where the patient remained admitted in the hospital during those 24 hours were not recorded as cancellations. Operations with more than one postponement are recorded as cancellations.

Day-cases/day-only

The NHS England statistics for cancelled operations includes day case operations. These procedures do not require overnight beds, and in a similar way to maternity departments, many hospitals have separate day-case units which are set apart from the rest of the hospital's bed stock.

Analysing the effect of bed occupancy on day case work is complicated. Where hospitals have dedicated day case units distinct from the main hospital site, we would expect the impact of bed occupancy on the main site to have almost no effect on the throughput of day case work. In other hospitals, where the day-case unit may be a whole, or a part of a dedicated ward, or another area within the theatre complex, we may find the impact can vary from almost no effect to the temporary annexation of these beds to deal with general hospital workload. With the data that is available, it is not possible to make a judgement as to which effect predominates.

Considering the above points and also noting that day-case beds are not included in the KH03 bed occupancy data as presented by NHS England, the decision was made to assume

that a large, if not all day-case work would take place within dedicated units and thus, as a whole, be largely unaffected by overnight bed occupancy on the inpatient wards. It is recognised that this is a significant assumption and potential limitation to the analysis; however, there is no data available to measure the effect of bed occupancy on the day-case throughput of individual providers. For transparency, we analysed the data comparing cancellation rates including and excluding day-case workload to see if it made a significant difference. The reality will lie somewhere in between and is likely to vary between trusts depending upon the volume of their day-case workload, departmental organisation and a variety of other variables.

Zero bed day-cases

'Zero Bed Day Cases' (ZBDC) refers to a set of cases which are classified as ordinary admissions, but which do not involve an overnight stay, nor an additional care episode with the same provider. Whilst some of these are due to the transfer of the patient to another hospital, or the death of the patient, NHS Digital states that the "vast majority are recorded as having been discharged from hospital". These day cases are classified as 'emergency', 'elective' and 'other'. As this analysis is looking specifically at the effects of bed occupancy on elective cancellations, 'emergency' was excluded. There is no definition within NHS Digital as to what 'other' admissions refer to, so the data was analysed in 2 ways: firstly, using just 'elective' numbers, and secondly as 'non-emergency' where both 'elective' and 'other' data were combined. It became clear that when attempting to analyse the data including 'non-emergency' ZBDCs that there was a significant problem; once removing those ZBDCs labelled as 'other' in addition to the published numbers for day cases and elective ZBDCs, some Trusts seemed to have a negative number of procedures. Thus, the analysis was performed using only those ZBDCs labelled as 'elective'. It is likely that there are a number of cases that are missing using this method, but again the data is not available to confirm this assumption.

LMNC cancellations and overall elective workload

The data for LMNC cancelled operations is presented quarterly by provider by the Department of Health/NHS Statistics. However, this data only provides a raw number of cancelled procedures and is not expressed in relation to overall operating department workload (busier or larger operating departments will carry out more operations and may therefore expect to have a higher raw number of cancellations overall). Therefore, it would not be valid to compare bed occupancy rates as a percentage with this raw number of cancellations. In order to isolate the data of interest, it was necessary to recalculate these raw numbers into a percentage, thus showing cancelled elective operations as a proportion of overall elective workload.

The data for overall theatre throughput is a part of the annual Hospital Consultant Episodes (HCE) data, provided by NHS Digital (2017). The data for 2016/2017 was used for this study as although data for cancellations is available for 2017/18, the data for HCEs for 2017/2018 is not yet available at the time of writing.

Within this data, hospital admissions are classified as ‘emergency’, ‘waiting list’, ‘planned’ and ‘other admission method’. As this analysis is looking specifically at the effects of bed occupancy on elective cancellations, ‘emergency’ admissions were excluded. ‘Waiting List’ and ‘planned’ were grouped together as ‘elective admissions’ for our purposes (which is in keeping with the method that NHS Data uses to categorise admissions - an elective admission is defined as “when the decision to admit could be separated in time from the actual admission” (NHS Digital, 2017). It includes waiting list, planned and booked admissions. ‘Other admission method’ includes such things as transfer of a patient from one provider to another (which could be either elective or emergency) or the birth of a child within the Trust. With the absence of sufficient detail in this group to look for specific types of cases, these were also excluded from the analysis.

Another potential limitation is that whilst the numbers for last minute cancellations are published quarterly, the total number of procedures performed are recorded annually. There may be seasonal variability in the relationship between bed occupancy and rate of last-minute cancellations. However, the data necessary to confirm or refute this is also unavailable.

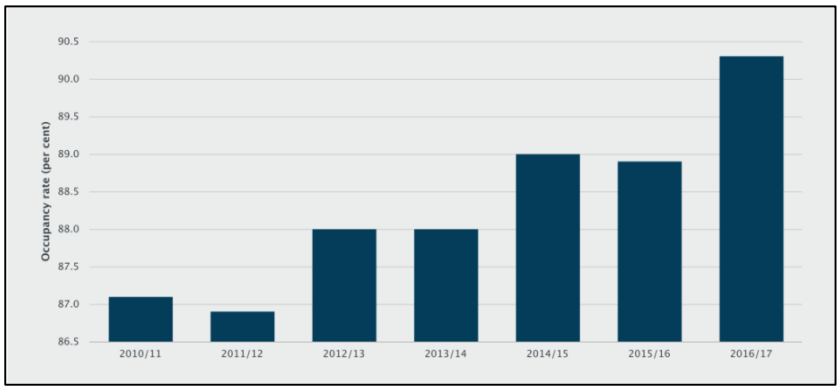
Exclusion of providers

To allow valid comparison of these data, those providers for which there was not a full set of bed occupancy and/or cancelled operations data covering the entirety of the period of interest were excluded from our analysis. This resulted in data analysis for over 150 providers, which between them represent over 90% of elective theatre work for the year in question.

4 Results

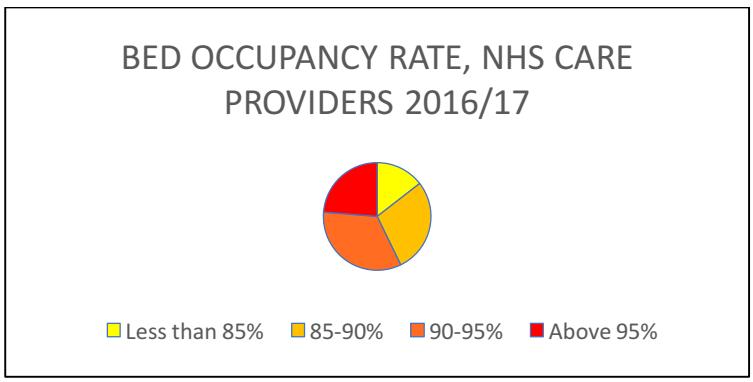
4.1 Results: NHS bed occupancy

NHS institutions are required to collect key performance data which is subsequently published online by NHS England and is available to the public. Searches on the NHS England archive database were carried out, which uncovered the KH03 data sets. KH03 data provides a quarterly summary of the average number of bed days available and occupied in each NHS health care provider institution which provides bed services. These had been calculated by NHS England to provide the quarterly figures of percentage of beds occupied (bed occupancy rate). These figures give an indication of how full to capacity or under-utilised a hospital may be.



Average NHS occupancy rate for overnight general and acute beds 2010/11 to 2016/17 (King's Fund, 2017).
Data source: NHS England.

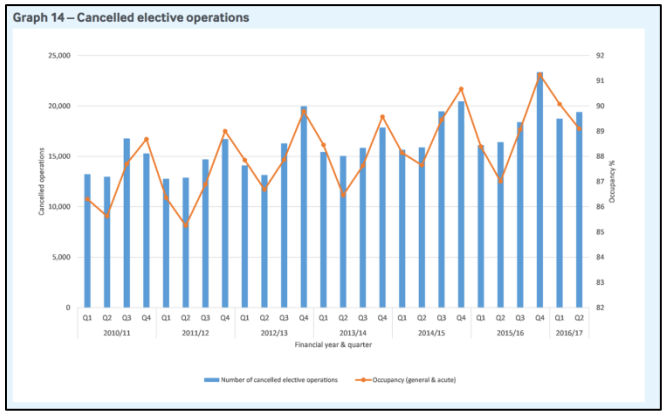
NHS-wide, average BORs have risen from 87.1% in 2010/11 to 90.3% in 2016/17. There was a 4.5% difference between the average BOR for general and acute beds during summer months (87%) and the winter months (91.5%). The data also showed wide variations in BOR between care providers. Of the 152 providers examined, only 22 (14.5%) maintained an annual BOR of under 85%. Only 65 (42.8%) providers were upholding the NICE/RCP (2017) recommendation of maintaining a BOR below 90%. 36 (23.7%) providers had average BORs of above 95%.



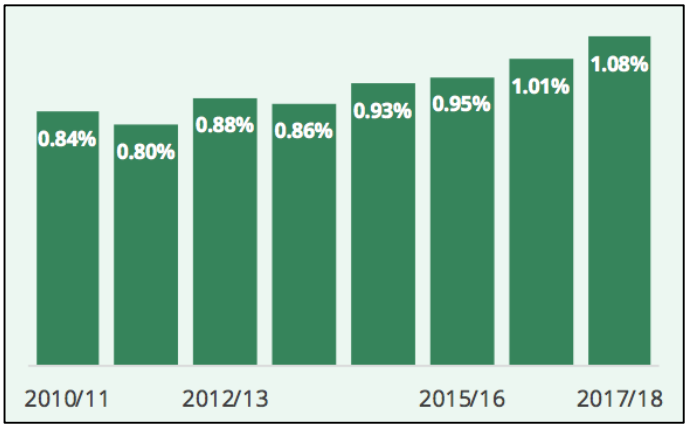
NHS care providers' bed occupancy rate averages for 2016/17.
Data source: NHS England (2017).

4.2 Results: Cancelled operations

The number of LMNC cancellations in the NHS in 2017/18 was 84,827, signifying a 5% increase from the previous year. Despite this increase, the number of cancellations as a percentage of overall elective admissions has risen at a slower rate from 1.01% in 2016/17 to 1.08% in 2017/18 (NHS England, 2017b; BMA, 2017, Baker,2018), reflecting the increase in the number of patients being treated. Between 2012/13 and 2016/17, there has been an 11% increase in elective surgery activity with more operations being performed as day-cases, increasing hospital activity without increasing the demand on inpatient overnight beds (King's Fund, 2017a).



Total number of cancelled elective operations in relation to BOR in the NHS 2010/1 to 2016/17 (BMA, 2017).
Data source: NHS England.

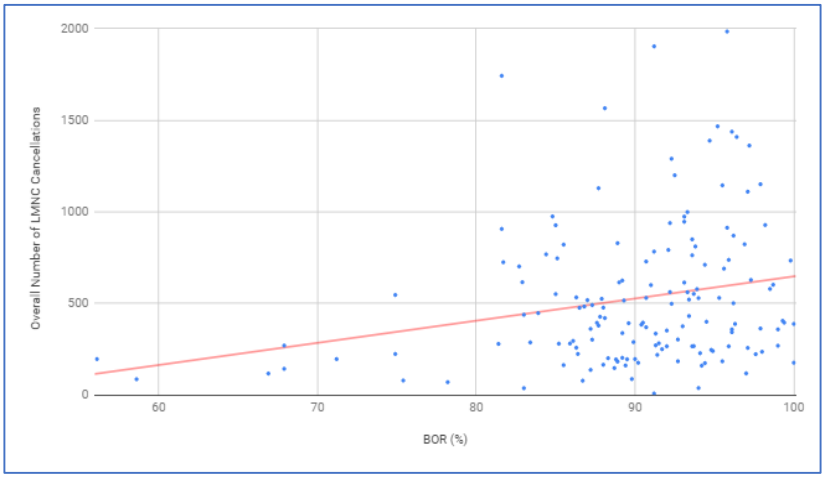


Number of elective operations cancelled at the last minute for non-clinical reasons as a percentage of all elective admissions in the NHS 2010/11 to 2017/18 (Baker, 2018).
Data source: NHS England.

4.3 Results: NHS bed occupancy rates vs surgical cancellations

In this section, KH09 BOR data was compared with NHS England LMNC cancelled operations data for the four quarters of 2016/17. All charts in this section were plotted by the author using NHS England (2017a) and NHS Digital (2017) data.

Chart 1

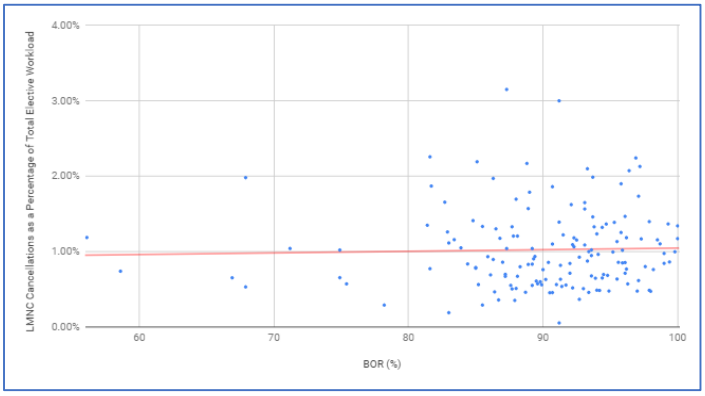


Number of elective operations cancelled at the last minute for non-clinical reasons vs percentage bed occupancy.

Chart 1 collates the raw numbers of last-minute, non-clinical cancellations of elective procedures across all four quarters of 2016/17, and plots them against average bed occupancy for the same period.

Whilst there does seem to be a general trend suggesting that increased bed occupancy is associated with higher numbers of last-minute cancellations, the data does not take into account the overall surgical theatre throughput of each provider, as the number of procedures performed by different providers varies enormously. This chart also shows that the vast majority of providers are operating with BORs above 85% although wide variations between providers are apparent.

Chart 2

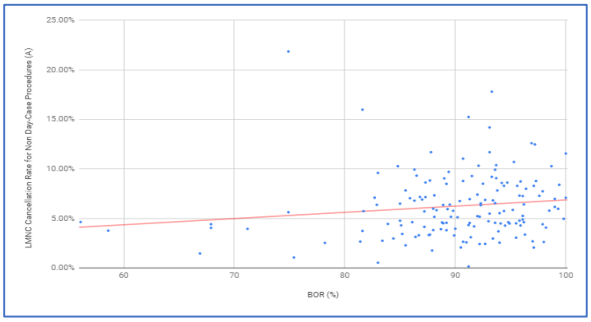


Percentage of elective operations cancelled at the last minute for non-clinical reasons vs percentage bed occupancy.

In order to provide comparable data for analysis, the total number of non-emergency procedures was obtained from NHS Digital Hospital Episode Statistics for 2016/17, which allowed a conversion of these reported numbers into a percentage of annual elective workload. This percentage was then plotted against bed occupancy rates in chart 2 above. Whilst again there is a suggestion that higher occupancy rates result in higher cancellation rates, it appears very weak; the trend line is almost horizontal.

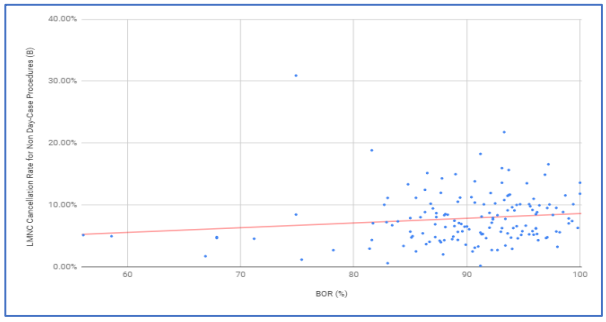
It was expected that the high numbers of non-inpatient/day-case operations that were included in this data set were diluting the number of inpatient LMNC cancellations.

Chart 3



Percentage of elective non-day-case operations cancelled at the last minute for non-clinical reasons vs percentage bed occupancy, including "zero-bed-day-cases".

Chart 4



Percentage of elective operations cancelled at the last minute for non-clinical reasons vs percentage bed occupancy, excluding "zero-bed-day-cases".

Charts 3 and 4 show an estimate of the relationship between bed occupancy rates and the rate of cancellation of non-day-case operations. For this estimate (A), the number of day cases was subtracted from the total number of procedures to estimate the number of 'non-day-cases' both with and without "zero bed day-case" category included in the absence of its definition by NHS England.

The results excluding day-case operations show a slightly stronger correlation between BOR and LMNC cancellations when day-case procedures were excluded. As BOR increased, LMNC cancellations increased by 1-3%.

Chart 5

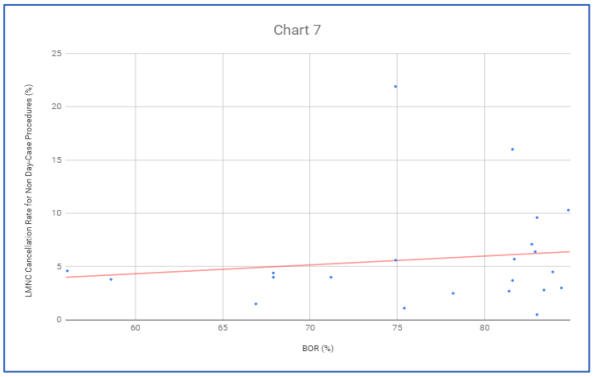


Chart 6

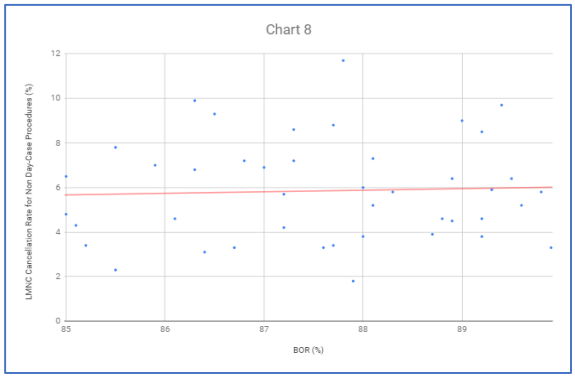


Chart 7

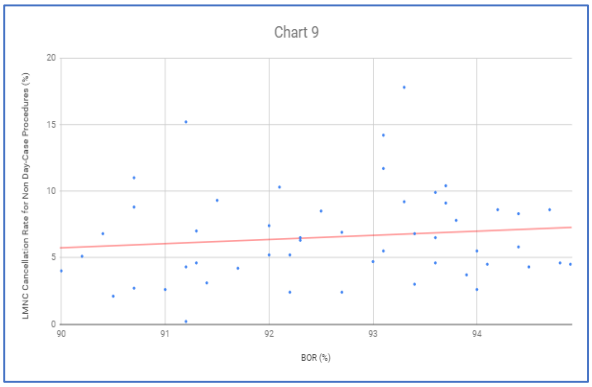
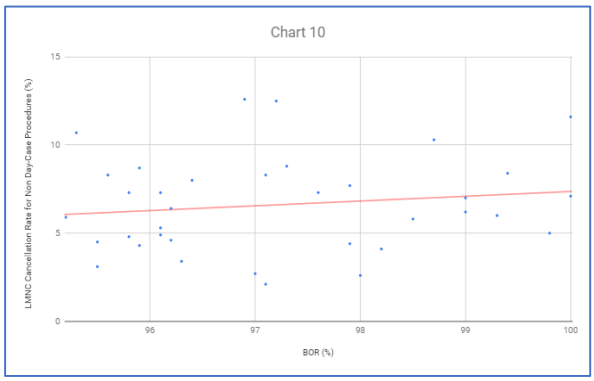
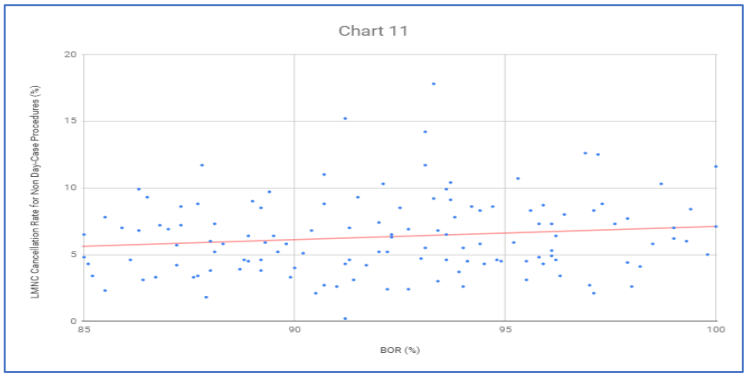


Chart 8



Charts 5, 6, 7 and 8 separate providers who into four categories; those with BORs 0-85%, 85-90%, 90-95% and 95-100%, plotted against percentage of non-day-case elective LMNC cancellations.

Chart 9



This chart combines the data of Charts 8, 9 and 10 and shows the relationship between LMNC cancellations and bed occupancy for all providers with a reported BOR greater than the recommended 85%. The results show that the likelihood of LMNC cancellations does increase as BOR rises in all four categories, although it is a weak association and not statistically significant (*p* value = 0.4-0.9).

5 Discussion and analysis

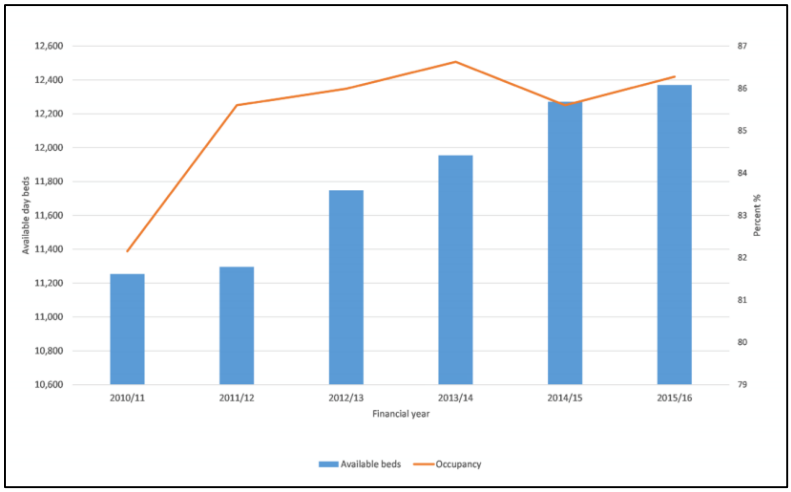
5.1 Discussion: How NHS bed numbers have been reduced while demand has increased

As previously discussed, the NHS, along with most advanced health systems worldwide, has managed to achieve large scale reductions in bed numbers over the past few decades with the aim of reducing costs. These reductions have been made despite growing demand on services and higher numbers of patients being treated in the system (King's Fund, 2017b).

There are many and varying factors which may have collectively and individually enabled these reductions within different health systems, such as policy and system changes. However, several key developments have played a major role in enabling bed reductions in the NHS, specifically by optimising bed use.

Increased day-only activity

The number of operations performed as day-cases has significantly increased in the last decade. Day-case or day-only operations describe care episodes in which a patient is admitted (often to a day-case unit rather than a ward), receives their operation or procedure and returns home on the same day without an overnight inpatient stay. Clinical innovations and improved recovery protocols mean that more patients than ever are able to access treatment and be discharged on the same day as a day-case.



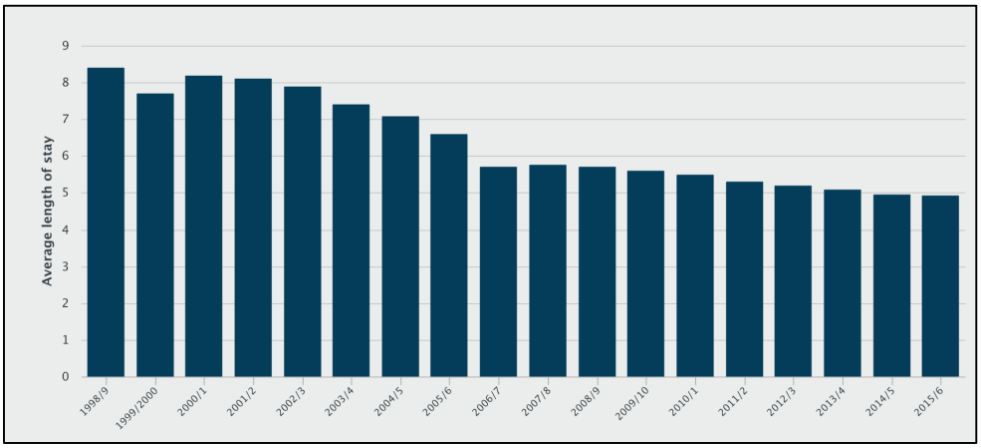
The total number of NHS beds for day-only procedures 2010/11 to 2015/16 (BMA. 2017).

In contrast to the huge decreases in overnight inpatient hospital beds, the number of day-only beds has risen from just 2,000 in 1987/8 to 12,463 in 2016/17, an increase of 520% (BMA, 2017; King's Fund, 2017). Although day-only beds account for just 12% of hospital

beds, approximately 82% of elective operations in the NHS are now carried out as a day-case procedure (NHS Digital, 2017). This means that the NHS is able to perform more operations to keep up with the rise in demand without increasing the burden on overnight acute beds.

Reductions in average length of stay

Patients are spending less time in hospital. Advancements in medical care and care pathways mean that recovery from illness or surgery is now much faster, with patients being able to be discharged home sooner than was possible in the past (Alderwick *et al*, 2015; King's Fund, 2017a).

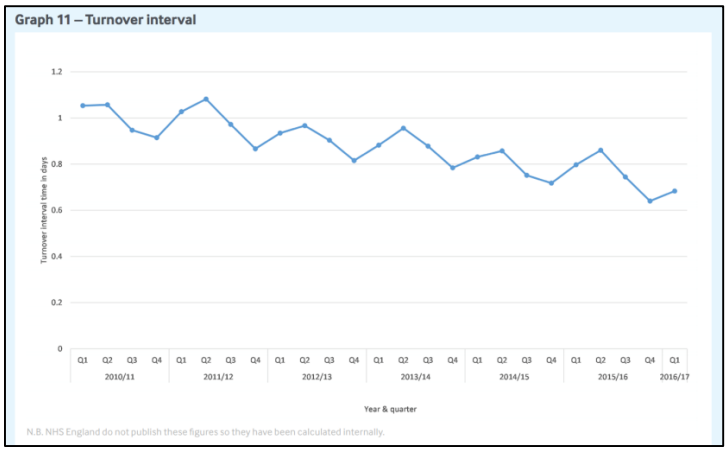


Average length of stay across the NHS 1988/89 to 2015/16 (King's Fund, 2017).
Data source: NHS England.

In 1998/9, the average length of a stay in hospital in the NHS was 8.4 days, by 2015/16 this had fallen by 40% to 4.9 days (King's Fund, 2017a). This means that the NHS is able to treat a larger number of patients overall, despite reducing the number of beds it has available, by shortening patients' average care episode.

Reduced average turnover-interval time

The turnover interval is the time between a patient being discharged or transferred from a ward bed and the next patient being admitted into it. Average turnover interval time has decreased over the years from 1.6 days in 2005/06 to 1.1 days in 2015/15. However, variations between hospitals are wide, with some able to achieve an average turnover time of under 4 hours (BMA, 2017; Nuffield Trust, 2016).



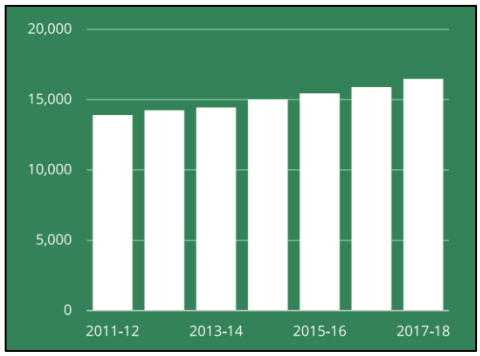
Average turnover interval time in NHS 2010/11 to 2016/17 (BMA, 2017).
Data source: NHS England.

Efficiency during this period is key to utilising bed stock potential, but there are often avoidable delays. Differing quality and availability of supporting services and external factors upon which discharges reliant, such as social care and transport arrangements, bed cleaning services and clinical staffing can all affect the efficiency of bed turnovers.

5.2 Discussion: What causes bed pressures in the NHS

In the UK, demand for hospital services is continuing to grow while bed numbers have fallen. Emergency admissions have risen by 16% and waiting lists for treatment have more than doubled in 5 years. There are many issues contributing to this. Below are several of the key factors which place pressure on hospital bed-demand within the NHS.

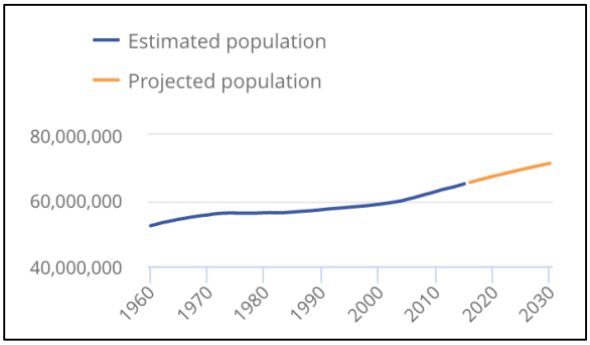
Emergency NHS admissions average per day increase 2011/12 to 2017/18 (Baker, 2018).
Data source: NHS England.



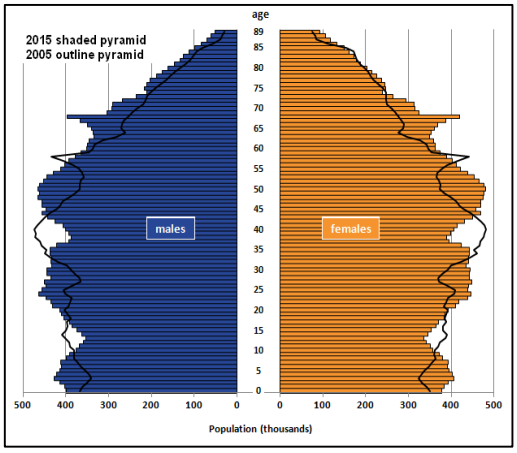
Number of people on NHS waiting list for elective treatment 2008 to 2018 (Baker, 2018).
Data source: NHS England.

Population

A growing population, which reached 65.6 million in 2016, is projected to continue to rise to 74 million by 2039. Immigration continues to exceed emigration and the number of births exceeds the number of deaths (ONS, 2017). Furthermore, the ONS (2017) predicts a continued rise in the over 65 population from 18% in 2016 to 23.9% by 2039. This increase in the elderly population is both evidence of and dependent upon the health service's ability to treat long-term and later-life health conditions which would not have been possible in the past. However, the rising prevalence of patients with long-term health conditions contributes significantly to the burden on health services. The elderly are the highest consumers of hospital bed stock, many of whom have multiple, complex health conditions and longer-term care requirements which significantly increase both their likelihood of hospital admission and the length of their stay (BMA, 2017).



UK population growth 1960 to 2015, with predicted forecast 2015 to 2030 (Office of National Statistics, 2017).

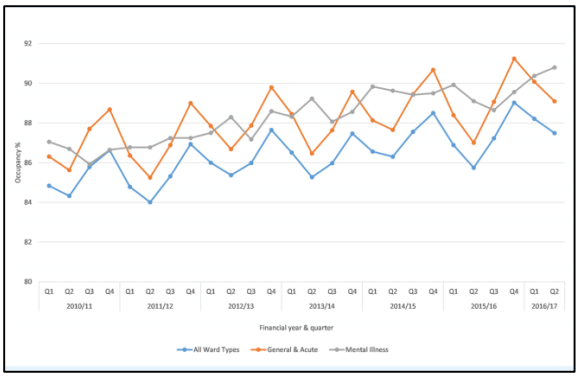


UK population age distribution by sex 2005 and 2015 illustrating both a population increase in both sexes and an increase in the older population (Office of National Statistics, 2017).

Time, day and season

The BMA (2017) argue that a health service should have sufficient resources to cope with demand not only at regular or low levels but also during these peak highs. Despite this, NHS hospitals are burdened with repeated annual bed shortages during winter months, which are defined by high occupancy rates (NHS England, 2017a).

Time of the year, day of the week and even time of day are shown to affect the demand for hospital beds. Seasonal pressures during winter months increase emergency admissions due to winter illnesses and cold weather exacerbating existing health conditions. As seen in Fig.7, the fourth quarters (January to March) have consistently higher rates of occupancy each year, with the warmer second quarters (July to September) bearing the lowest rates. Over the span of a week, Mondays bear the most admissions, while weekends see much fewer discharges than seen during weekdays (BMA, 2017).



Average NHS bed occupancy increase by bed category 2010/11 to 2016/17 showing seasonal fluctuations (British Medical Association, 2017).
Data source: NHS England.

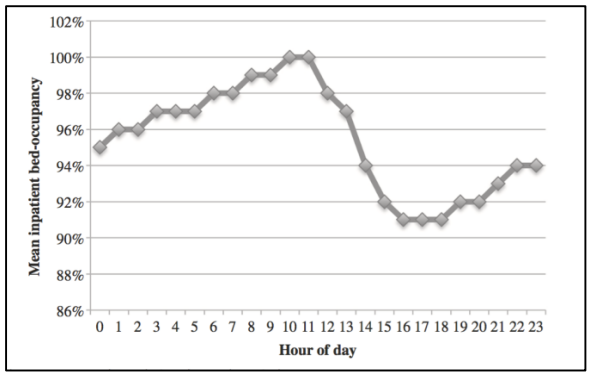


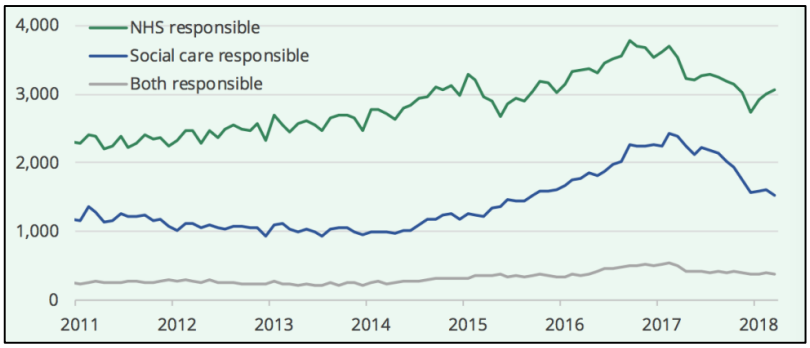
Illustration of 24-hour cycle of bed occupancy fluctuation in one NHS hospital (Blom *et al*, 2015).

In a 24-hour period, demand on beds will follow a regular pattern, experiencing peak highs and lows. Most new arrivals occur in the morning while most discharges occur in the afternoon, and very few patients are discharged overnight. Therefore, occupancy rates reach their peak in the afternoon (BMA, 2017). This is significant as daily bed occupancy rates are recorded at midnight within NHS data, leading to an underestimation of the pressure on beds.

Transfers of care

Transfer of care describes the process of reallocating a patient to a care setting appropriate to their latest need, such as, for example, discharging a patient from a ward to their home or an external care facility. Delays at this stage can be problematic to patient flow, causing backlogs known as 'bed blocking'. Delayed transfers of care can often mean that patients are occupying beds that they either do not need or which are inappropriate for their needs.

There were 1.98 million blocked bed days due to delayed transfers of care in the NHS in 2017/18, a 43% increase since 2012/13. Though 2017/18 saw a promising decline, thousands of beds are blocked each day by patients experiencing delays caused by both the discharging hospital and social care services. Most delays are caused by waits for continued care packages and nursing home or housing arrangements, while a large number of delays are due to the choice of the patient or their family and failures at hospital level to complete discharge assessments (Baker, 2018).



Total number of daily delayed transfers due to NHS and social care reasons in the NHS 2011 to 2018 (Baker, 2018). Data source: NHS England.

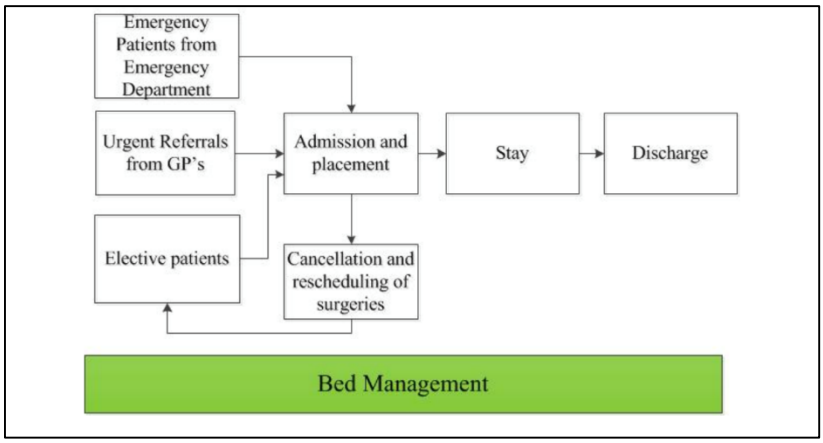
Reason for delay	Total delayed days
Awaiting care package in own home	96,046
Awaiting further non-acute NHS care	81,655
Awaiting nursing home placement or availability	61,558
Awaiting completion of assessment	56,166
Awaiting residential home placement or availability	52,605
Patient or family choice	49,893
Housing – patients not covered by NHS & Community Care Act	15,625
Awaiting public funding	14,222
Awaiting community equipment and adaptations	11,575
Disputes	4,299

Total number of NHS delayed days by reason in 2016/17. Where a patient is fit for discharge but they remain occupying a bed due to another reason (Baker, 2018).
Data source: NHS England.

5.3 Discussion: Explaining variation in bed occupancy rates

As discussed, pressures upon beds during winter months and at certain times of the day or week cause a pattern of fluctuations in BOR that is easy to predict (NHS England, 2017). However, the causes of the wide variations in BOR between NHS care providers are more complex to unravel.

BORs are determined by patient flow into and out of the hospital. Flow into the hospital is in itself determined by 'demand'. That is, how many people will require an inpatient bed and how long will they need it for. The number and type of inpatient admissions and patients' length of stay are the two key sources of variability which can affect BOR. These can be widely variable between hospitals taking into account a range of issues including the local population and policy, system and operational processes. These issues come with varying levels of potential predictability and control which can be both useful and problematic for planning.



Simple illustration of patient flow through a hospital (Porudlove *et al,* 2003)

Patient admission flows into hospital beds occur by one of two routes: emergency admissions (A&E admissions, urgent primary care referrals, other urgent hospital referrals) and elective bookings (planned surgical and non-surgical procedures). Of these, elective bookings are generally the only in-flow that can be controlled and planned ahead of time. Emergency admissions, urgent referrals and intra-hospital transfers have a reduced scope for control.

1) EMERGENCY ADMISSIONS

The number and type of emergency admissions will vary between hospitals. Emergency admissions increase demand on the available bed stock, leaving fewer beds available to accommodate elective workload, increasing potential for LMNC cancellations.

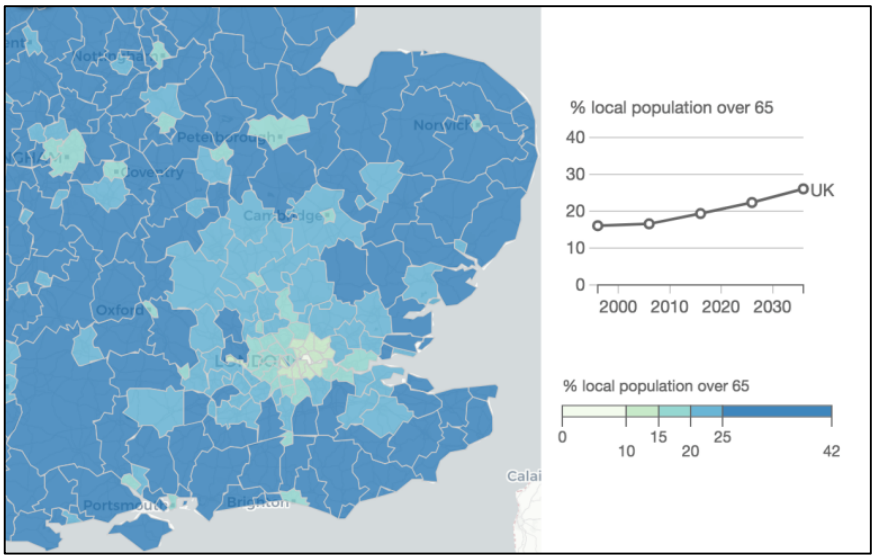
Aside from unpredictable major, multi-casualty events, it should be possible to (with some scope for flexibility) predict emergency inflow and put bed-planning policy in place to accommodate emergency admissions without affecting elective workload when bed numbers are sufficient. However, many NHS hospitals report extreme bed pressures in certain time periods such as winter months when emergency admissions are at their highest, while others seem more equipped to weather the storm. Understanding the particulars of emergency patient inflows in individual hospitals is essential for bed-planning that is prepared for these predictable fluctuations in demand.

Emergency admission variables fall into three main categories: community, hospital and seasonal factors:

- **Population factors**

The average age of the population which the hospital serves will be an indicator of admission rates. An older population is likely to accumulate more hospital admissions due to having more complex care needs. As a population, they are more likely to have multiple co-morbidities, be poly-pharmaceutical and are less likely to be eligible for day-only procedures (Wittenberg *et al*, 2017; National Audit Office, 2016).

The image below shows the predicted UK age distribution in south-east England by 2030, illustrating an unequal age distribution. Hospitals serving areas with older populations may experience different demands than those serving younger populations.



Projected 2030 geographical/age population distribution in south-east England (Office for National Statistics, 2017).

Socioeconomic factors can also affect admission rates due to lower levels of general health in lower socio-economic populations. Higher rates of smoking, obesity and alcohol-related illness are more prevalent in these communities, increasing the risk of emergency hospital admission (Asaria *et al*, 2016; Purdy, 2010).

Stronger integrated primary health care services within a community may help to reduce hospital admissions if they are better able to manage patients with complex needs or urgent requirements (Deeny *et al*, 2017; Purdy, 2017). However, hospitals serving lower socioeconomic areas and/or populations with higher rates of elderly persons should plan bed management policies to allow for higher rates of emergency admissions and longer average lengths of stay.

- **Internal/hospital factors**

The types of speciality services covered by a hospital can affect its admission rates. For example, a major trauma centre will have a higher emergency admission rate than one which has a minor injury unit alone where patients have lower-level needs and can be discharged home on the same day. The ED capacity of a hospital (how many emergency cases it sees) will directly determine the percentage rate of its emergency admissions compared to its planned elective admissions, which in-turn affects the level of predictability it will have over its patient in-flows.

- **Environmental factors**

As previously discussed, season and time of year are shown to affect admission rates. Winter months have the highest levels of admission due to circulation of ‘winter-bugs’ and cold weather exacerbating health conditions in vulnerable populations. While additional bed pressures are experienced by most providers during winter months, some hospitals are likely to experience this more acutely than others due to some of the aforementioned population and hospital factors affecting their annual average BOR.

2) LENGTH OF STAY

Average length of stay affects patient flow out of the hospital and plays a vital role in freeing up beds for new admissions. As with patient in-flow, this can also vary between hospitals as a result of a variety of causes adding additional pressures on bed stock.

- **Population factors**

As with population determinants of emergency admissions, older and unhealthier patients will have more complex care needs than younger, healthier individuals (Wittenberg *et al*, 2017; National Audit Office, 2016). These patients are likely to require lengthier stays in hospital and more bed day losses will occur delays with these patient groups while continuing care packages are arranged.

- **Internal/hospital factors**

Internal hospital factors are a major contributor to patients' length of stay and are largely influenced by local policy, practices and system processes. Delays caused while waiting for discharge decisions if senior clinical staff are unavailable are common, as are waiting for results of laboratory tests. Low staffing levels and sub-optimum care practices on wards can increase rates of infection and pressure ulcers, significantly increasing some patients' need to stay in hospital. Conversely, some hospitals may foster a culture of "prompt" discharge due to excessive bed pressures and there is research to suggest that this has led to patients being discharged prematurely which is linked to increased rates of re-admission (Blom *et al*, 2015).

5.4 Discussion: Do bed occupancy rates affect patient care?

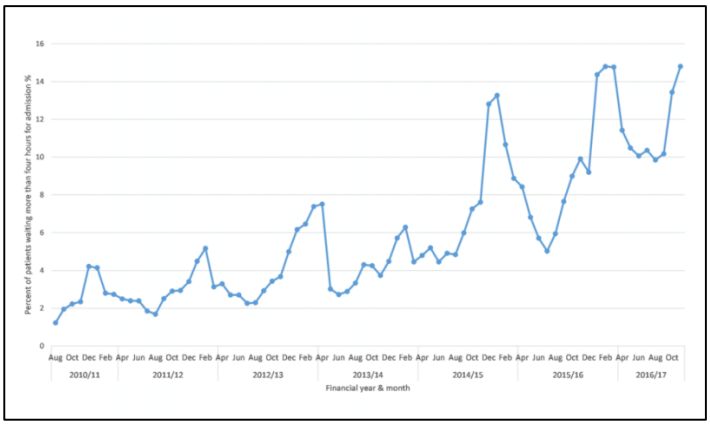
Infection

There is evidence within the literature to support a link hospital acquired infection (HAI) rates with BOR. A systematic review by Kaier *et al* (2012) of hospitals in Germany found that 75% of studies reported positive associations between BOR and HAIs.

Another multi-centre study in the Mediterranean region by Borg *et al* (2008) revealed a significant correlation between BOR and the incidence of MRSA infections. The study observed that while minor fluctuations in BOR were not seen to influence infection rates, significant overcrowding during times of high BOR triggered increases in MRSA infections. This may reflect pressures on nurse levels during times of heavy workload, which has been shown to reduce compliance with infection control practices such as hand hygiene (Kaier, 2010).

Emergency department

In the NHS, the number of patients waiting on a trolley in the ED for more than four hours after the decision to admit to a ward has been made has increased by 10.2%, from highs of 4.2% in 2010/11 to highs of 14.4% in 2015/16. In the same period, average BOR of general and acute beds increased by 2.6%, from winter highs of 88.8% in 2010/11 to winter highs of 91.4% in 2015/16 (BMA, 2017). However, if assumptions can be drawn from other studies, these patients may be at increased risk of mortality and receive poorer standards of care.



Percentage of patients waiting for more than four hours on a trolley to be admitted to a ward after being assessed in the ED in the NHS 2010/11 to 2016/17 (BMA, 2017).
Data source: NHS England.

A study by Bagust (1999) examined the effects of increased BOR on the probability of the hospital being unable to accommodate new admissions (access block). The results showed that with a BOR of <85% the probability was 0%, at 90% it became 1% and above 100% BOR, the probability of being unable to admit new arrivals increased to 19%.

Forero *et al* (2010) reviewed the effects of access block and ED overcrowding in Australian ED departments. The study found that ED overcrowding caused by access block and other

factors such as high volumes of ED attendees increased mortality rates by 20-30% (Fatovich, 2005; Richardson 2006; Sprivulis, 2006). Increased numbers of patients experiencing delays in a transfer to ICU from the ED (Chalfin *et al*, 2007), delays in receiving treatment (Cordell, 2002), delays in pain management (Hwang et al, 2006) and increased numbers of patients leaving the ED without waiting for treatment (Mohsin *et al*, 2007) were all found to be positively associated with bed blocking and high ED patient volume.
Conversely, Blom *et al* (2016) and Blom *et al* (2014) found that high BOR within several Swedish hospitals did not influence ED staff to turn away patients, discharge them early from the ED or increase the rate of patients returning to the ED within 72 hours of discharge. However, a multi-centre study in Singapore found that BOR was positively associated with 3-day unplanned return to the ED in some hospitals, while in others, no association was found (Sun *et al*, 2015). This may reveal that local factors are influencing some ED clinicians to lower ward admissions during times of high BOR. These may include pressures from hospital management, local policy, ED staff autonomy or population factors.

These studies suggest that while factors restricting patient flow and increased ED overcrowding seem to adversely affect care, ED clinician behaviour is less affected by BOR pressures. Decisions to admit patients to a ward, in the majority of cases, remain clinically-founded decisions, centred on patient need. It therefore seems that the period following a clinical decision to admit a patient and prior to them reaching an appropriate ward is when risk increases. During times of high BOR, this period is likely to be extended.

Intensive care

While critical care beds such as those on intensive care units (ICUs) are counted separately in NHS bed numbers and BOR data, the availability of non-critical care hospital beds in a hospital often impacts these units. Ward-able patients often become “bed-blockers” on ICUs due to a lack of ward beds to discharge patients from the unit into.

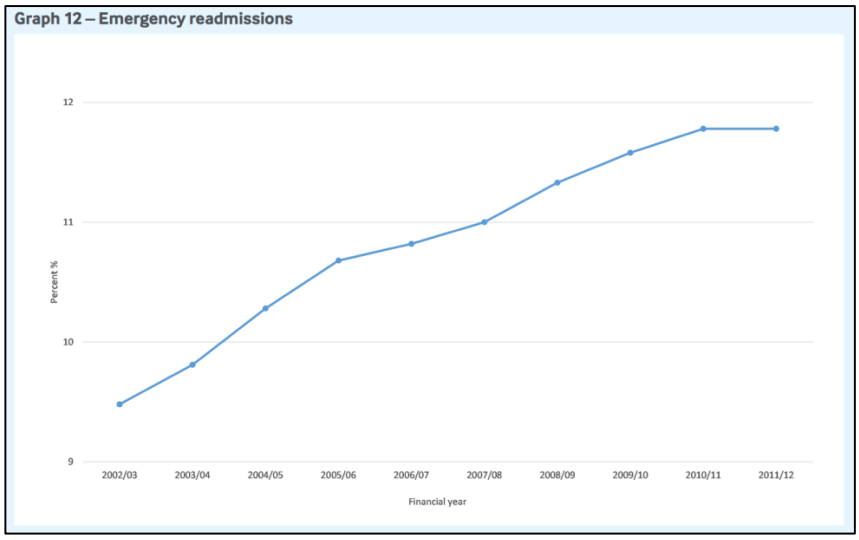
Studies have shown that high BORs in both the ICU and other wards can have a negative impact upon the care received by critically ill patients requiring ICU admission (Crusch, 2009; Robert *et al*, 2011; Talawah *et al,* 2018). Robert *et al* (2011) investigated the adverse effects of patients experiencing a refused or delayed admission onto an ICU due to a lack of beds in 10 ICUs in France. They found that the proportion of patients refused ICU admission due to a full unit ranged from 1-61% (median 31%). Patients who were admitted onto the ICU immediately experienced a referral to admission time of between 2-1200 minutes (median 80). Patients who had a delayed referral to admission time due to waiting for another patient to be downgraded onto a ward to create space experienced much longer delays of between 18-1,545 minutes (median 195). Patients who required a second referral to secure them a place in ICU experienced long delays between 90-6,130 minutes (median 309). The study concluded that patients experiencing a delayed admission onto an ICU due to a shortage of beds had a significantly higher risk of early mortality when compared to patients who were admitted immediately.

The findings presented by Robert *et al* (2015) are supported by Lange *et al* (2018) and Mathews *et al* (2018), who assert that factors delaying patient flow into the ICU adversely

affect patient outcomes. High numbers of “bed-blocking” patients on ICUs who are fit for a general-acute ward may affect ICU patient flow during times of high BOR.

Emergency readmission

30-day emergency readmission rates in the NHS increased from 9.4% in 2002/03 to 11.8% in 2011/12 when the NHS stopped publishing data (Data.gov, 2014 (BMA)). During the same period, the number of general and acute beds available fell by 22.6% (King’s Fund, 2017a).



Percentage of emergency readmissions occurring within 30 days of discharge from a hospital in the NHS 2002/03 to 2011/12 (BMA, 2017).
Data source: data.gov.uk

There is research to support the hypothesis that high BORs are associated with increased rates of 30-day readmission. A Swedish study found that patients who were discharged home during high levels of bed occupancy were more likely to need readmitting within 30 days (Blom *et al*, 2015). This suggests that pressures upon hospital staff to free-up ward beds during times of high occupancy can lead to patients being released from hospital care prematurely, adversely affecting their health. This is in contrast to the previously discussed Blom *et al* (2014) and (2016) studies in which high BOR did not affect ED clinician decision-making. This may reflect the direct pressures clinicians working on the wards are specifically under to discharge patients who are perceived to be fit enough to make space for emergency admissions and that ED clinicians experienced less pressure to turn patients away.

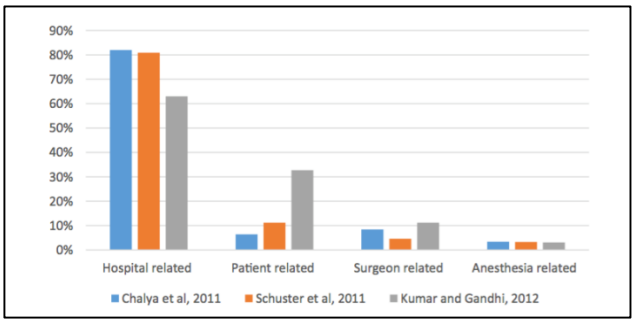
5.5 Discussion: Cancelled operations

As average BOR has risen across the NHS, so too has the number of LMNC cancelled elective operations (NHS England, 2017a). This may suggest that high BORs are responsible for many of these cancellations as elective procedures are postponed in favour of admitting emergency patients with a greater clinical need. However, more patients are also being treated overall, in-line with increased demand. Therefore, the increase in LMNC cancellations could be a reflection of this increased workload rather than as a result of high BOR.

In 2017/18, thousands of additional operations were cancelled in advance, although data was not available to confirm precise figures. In January 2018, Health Secretary Jeremy Hunt (2018) made a public apology to patients who had had their operation cancelled during the year's "winter bed-crisis". This followed the decision to postpone in advance thousands of elective operations to free-up beds for emergency admissions which were expected to reach peak highs over the winter months. These events and the subsequent media coverage prompted public concern over the system's ability to cope with growing demand and reduced resources, as well as concern from prominent medical bodies (BMA, 2018; RCS, 2017; King's Fund, 2017a).

Why are operations cancelled?

In a literature review which examined causes of elective surgery cancellations in three international hospitals, Talawah *et al* (2018) separated reasons for cancellation into three categories: patient reasons (non-attendance, unfit for surgery, non-compliance with pre-operative instructions), surgeon or anaesthesia-related (inadequate pre-assessment, specialist unavailable) and hospital-related reasons (lack of beds, equipment issues, staffing issues, prioritising emergency cases, insufficient OR time, poor planning of surgery).



Reason categories for cancelling elective operations in three separate studies (Talawah *et al*, 2018).

Due to the ability to control the inflow of elective admissions, during periods of high demand on beds elective surgery may be cancelled to create bed space for emergency admissions. During these times, decisions which prioritise certain patients over others inevitably must be made. While the forces behind the decisions causing these limited resources are primarily organisational, financial or political, decisions about which patients

to prioritise are made by clinicians and should be primarily based upon clinical need. Emergency admissions often outweigh elective admissions in terms of clinical priority, although certain elective admissions including those on cancer pathways may be considered to take precedent over some lower-risk emergency procedures due to their time-critical nature. These decisions can be extremely difficult for practitioners when decisions have to be made to cancel patients who may suffer negative consequences as a result of delaying their surgery.

How are patients affected when their operation is cancelled?

While some patients may suffer personal inconveniences associated with cancelling and re-arranging their surgery, for others the consequences are less mild. Patients who are suffering pain and discomfort including anxiety and depression as a result of their condition may find postponement of their treatment extremely distressing.

Magnussun *et al* (2011) found that surgical cancellations were associated with clinical complications in cardiac patients and strongly associated with inferior long-term wellbeing although the study was representative of only a small sample size with patient self-reported complications. Another study by Dadas and Eti-aslan (2004) examined the consequences of cancelled surgery upon patients and their families in Turkey. Extreme negative responses were recorded including increased anxiety and depression, feelings of helplessness, anger, crying, increased length of stay in hospital and stress over financial losses. This is supported by Magnussun *et al* (2011) who found that cancelled patients reported anxiety about prolonged absence from work and reorganising of postoperative care arrangements. While the specific causes of the last-minute cancellation will undoubtedly produce differences in severity of the emotional response, Ivarsson *et al* (2002) found that cancellations made for organisational reasons resulted in higher rates of psychological distress.

5.6 Analysis: Is there a relationship between bed occupancy rates and cancelled operations in the NHS?

Unexpectedly, just one academic paper was identified which highlighted a relationship between bed occupancy rates and surgical cancellations in the literature search. This gap in research is in contrast to the high-profile media coverage which claims that cancelled elective surgery is the direct consequence of NHS bed shortages. This highlights the question of the source of these assertions in the media with very little research directed in this specific area. Despite this, these assertions continue to contribute to the discourse of a struggling health service.

Data analysis: BOR vs LMNC cancellations

In the initial stage of the analysis (Chart 1), the data demonstrated a strong positive correlation between BOR and the number of LMNC cancellations in the NHS in 2016/17. These findings alone may have been enough to instigate the media attention the NHS "bed crisis" has received in relation to cancelled elective operations. However, further investigation has uncovered a more complex picture.

When BOR was measured against LMNC cancellations as a percentage of overall elective workload (excluding day-only procedures) (Chart 2), it showed almost no association. This suggests that elective surgery cancellation rates remain minimally affected by high BORs. One likely explanation to this finding is the inclusion of day-only operations in this data. As previously discussed, 82% of elective workload is now performed as day-only operations, which do not require the use of an overnight ward bed and would therefore be very minimally affected by bed pressures on inpatient wards. This would result in much fewer cancellations as a result of bed shortages. It is therefore reasonable to assume that any cancellation data which includes these cases in such a high percentage (82%), would have much lower rates of LMNC cancellations.

In the next stage of the analysis, BOR data was measured against LMNC cancellation data, this time with the exclusion of day-only operations (Charts 3 and 4). Unexpectedly, the results showed only a slightly stronger positive association between the two variables. This analysis suggests that those trusts with the highest BORs may expect last minute cancellations of elective surgery rates of up to 3% higher than those with lower BORs for patient groups requiring an overnight inpatient ward stay. Most providers should expect a 1-3% increase in elective inpatient LMNC cancellations as BORs increase.

Next, BOR data was divided into four categories; those with BORs 0-85%, 85-90%, 90-95% and 95-100%. These were plotted against percentage of non-day-case elective LMNC cancellations to investigate if the association between BOR and LMNC cancellations grew stronger as BOR increased. Again unexpectedly, the association was weak, with only a slight increase in association as BOR increased.

While the data did show a positive association between BOR and LMNC cancellations for patients requiring an inpatient stay, the association was weaker than expected. Therefore, it is reasonable to surmise that there are factors in place which are either counteracting and

managing the increased demand on hospitals with high BORs, which are helping to limit elective cancellations. With the benefit of the research undertaken in the previous sections of this assignment, several key factors align with the results which may provide an explanation.

Bed management: When is efficiency not efficient?

Average length of stay and turnover interval time have both reduced significantly over time in the NHS. This suggests that hospital/bed managers are becoming increasingly aware of the vital role of bed-use efficiency in maximising their bed stock. Putting it simply, the less time a bed is taken by a patient who may not need it or is stood empty waiting to be cleaned and issued to the next patient, the more use you can get from it. With this in mind, during times of high demand, when BOR is high, hospital/bed management teams may be focusing additional efforts into discharging ward patients and to reduce the turnover interval time in order to minimise the need to turn away elective admissions.

Unfortunately, however, the benefits of "maximising efficiency" in this way may be limited to the short-term. As has been demonstrated, average length of stay has decreased in the NHS but over the same period the rate of 30-day emergency readmissions has increased. While there may be other factors to consider which require further statistical analysis, these findings suggest that in some cases, patients may be being discharged from hospital too early while elective cases continue to be admitted. The aforementioned Swedish study by Blom *et al* (2015), which showed that higher rates of 30-day emergency readmission occurred when there was a high BOR at the time of discharge, would certainly support this hypothesis. Unfortunately, while the NHS continue to collect 30-day emergency readmission data, it has not been published since 2011/12 (Data.gov, 2014). This fact alone indicates it is worthy of investigation.

Furthermore, while the rate of LMNC cancellations has remained steady over time, the rate of ED trolley waits over 4 hours has increased. These findings could suggest that elective admissions are in some cases being prioritised over emergency ED admissions although further research in this area would be required to scrutinise this hypothesis. NHS-specific research in both these areas would be beneficial.

In the short-term, freeing up ward beds to make space for elective admissions may seem like an efficiency saving but if many of these patients are requiring readmission within 30-days, the overall burden on the health service increases. Overall admission rates rise and more costs are incurred by the hospital by having to provide additional bed-days and lengthier treatments for conditions which could and should have been treated in one care episode.

Some studies have found that some patients experience distress and inconvenience as a result of having their elective surgery cancelled and others may be forced to endure prolonged pain and discomfort (Dadas and Eti-aslan, 2004). However, the clinical consensus would normally be that emergency admissions should be prioritised over most elective cases with few exceptions including some cancer and cardiac cases, or other cases where the delay may seriously compromise the patient's safety or outcome. Therefore, if the

conclusions drawn from this data are accurate, elective patients may be being prioritised over emergency admissions and patients already in ward beds are being moved out of hospital too early in order to avoid LMNC cancellations.

Are 'payment by results' (PbR) remuneration methods influencing patient prioritisation during times of high BOR?

In order to deduce the factors which may be influencing efficiency drives and the clinical decisions they depend upon, it may be useful to look at the remuneration methods within NHS secondary care. Secondary acute care facilities in England are paid for the work they carry out via a case-based system, otherwise referred to as the 'Payment by Results (PbR). With PbR, care providers are reimbursed by commissioners for each care episode they provide for a patient. Tariffs for different types of surgery are pre-set and vary greatly. For example, Mrs X is admitted for elective hip replacement surgery and is expected to stay in hospital for the standard 3 nights post-operatively. The hospital providing the service will receive £5323 to cover the cost of her care. If Mrs X is a fit patient, she may recover sooner than expected and be discharged home early. In which case, the hospital will still receive £5323 and will have saved on the cost of her care. However, if Mrs X develops a complication and needs to remain in the hospital bed for longer, the hospital will still receive the £5323, plus an additional £400 for every day she remains as an inpatient. In this case, the hospital may lose money on this care episode.

It is important to understand the characteristics of healthcare payment methods in influencing provider behaviour (Kazungu *et al*, 2018). A great deal of research exists, which supports that physician behaviour is influenced by the remuneration method they receive for their work. However, much less research has looked at how health system funding structures affect care providers' culture and in turn, what effect this has on clinical practice and decision-making. While NHS physicians are paid via the salary method, NHS providers are remunerated for their elective work with standardised case-based or PbR payments.

Features of a case-based payment system

- Fixed tariffs for care episodes mean that providers are incentivised to reduce costs risking a decline in quality.
- Providers are incentivised to increase activity.
- 'Supplier-induced demand' may stimulate unnecessary activity.
- High administration costs.

(Nuffield Trust, 2017)

In their review of NHS payment systems, The Nuffield Trust (2017) states that case-based payment methods hold the risk that providers may be incentivised to reduce costs. One way

of reducing the cost of a care episode would be to reduce a patient's length of stay. Furthermore, they state that providers are likely to be incentivised to increase activity to maximise their income.
In their literature review, Kazungu *et al*, (2018) found that ensuring the payment rate is adequate to cover the cost of care was a vital factor in successful provider payment methods. The tariff of approximately £400 which is reimbursed to providers for additional inpatient days on top of a care episode payment is far below what a provider would stand to lose from cancelling an elective operation. It could therefore be argued that the PbR system in the NHS may be influencing providers to not only save on care by fostering a culture of premature discharge but also to maximise their income by prioritising profitable elective work.

What is the role of the independent sector in managing elective NHS workload?

In 2003, the NHS controversially introduced independent sector treatment centres (ISTCs) to help reduce waiting times for elective procedures. They are owned and run by private companies but provide services exclusively to NHS patients (King's Fund, 2009). Since then, the independent sector has developed an increasingly larger role in the NHS. NHS providers are now permitted to offer patients the option of having their operation in a private facility in order to reduce waiting lists. In 2016/17, the Department of Health spent £9 billion on subcontracting work to the independent sector (Department of Health, 2017). Of this, £381 million was paid to carry out elective operations in private facilities. This was a 59% increase from the previous year, indicating a significant upsurge in independent sector involvement in managing NHS workload (NHS Improvement, 2017).

Furthermore, providers who fail to rebook cancelled patients within 28-days are now obliged to pay for it to be carried out at a hospital of the patient's choice. NHS England data has shown a rise in the number of these cases. In the fourth quarter of 2017/18, 11.6% of patients who had their operation cancelled did not receive their second booking within 28-days. This is an increase of 3.8% compared to the same quarter in 2016/17 (NHS England, 2018).

In the NHS England data, it was not possible to ascertain whether NHS patients who have their operation subcontracted to the independent sector remain in the data as part of the elective 'consultant episodes' of the NHS provider they are under the care of. If they are included, the data may be skewed to show that the NHS is capable of managing increased elective workload despite bed reductions. However, this data suggests that it is the likely reality that the independent sector is being relied heavily and increasingly upon to manage the rising elective workload due to lack of capacity within the NHS.

The NHS has been outsourcing services to the private sector for many years to reduce waiting times. However, with the budget allocated to these subcontracting services increasing each year, buying these services instead of investing to increase the capacity of the NHS itself seems like a wasteful use of budget. Furthermore, while the private companies are able to 'cream skim' fitter patients, who are easier to save on cost, many

argue that the NHS is increasingly becoming an emergency service, providing care for the more unwell, complex patients who are often less profitable in budget terms (The Health Foundation, 2017). Outsourcing well patients to the private sector could be denying NHS providers the opportunity to make profits on less-complex cases in a PbR system.

6 Conclusions and recommendations for policy and research

The NHS has lost almost 30,000 acute beds since 2010. BOR continues to increase beyond the recommended limit in the majority of NHS providers, although wide variation exists between time periods and hospitals. Many factors were highlighted to explain these variations. Conflicting research exists to provide a definitive answer to the question of ideal BOR in the NHS, although there is strong evidence to suggests that BOR above 85-90% is linked to poorer care.

Despite widespread media reporting of large-scale cancellations of operations due to a lack of available beds, minimal research evidence was found to support an association between high BOR and higher rates of surgical cancellations in the NHS. According to this analysis, LMNC cancellation rates did not significantly increase, even at very high levels of bed occupancy. Various system and process changes such as the upward trend towards day-case operations have made bed reductions possible and improved bed-use efficiency may have enabled providers to operate on higher BORs. However, more controversially, the NHS has also seen significant and increasing outsourcing of elective work to the independent sector, which indicates a lack of capacity in the NHS system to cope with the growing demand.

It was also highlighted that while there have been positive drives towards efficiency, which would help to limit LMNC cancellations, these may have resulted in poorer performance in other areas. Efficiency measures to create beds for elective patients are potentially mis-prioritising new elective admissions over emergency admissions (reflected in stark increases ED trolley waits) and patients being discharged prematurely (resulting in higher 30-day emergency readmissions), while elective cancellation rates remain stable even at times of very high bed occupancy. More NHS-specific research is needed to investigate relationships between higher a BOR and emergency re-admissions, ED trolley waits, HCAI rates and ICU admission delays.

There is evidence to suggest that the PbR system results in conflicts between clinical decision-making and management priorities. Providers are incentivised to maximise the number of patients treated while reducing cost. This may have led to a culture where financial pressures take precedence over clinical decisions, resulting in elective cases taking priority. Furthermore, a worrying lack of transparency was found on the independent sector's involvement in NHS workload. A review of the current climate of outsourcing and the PbR system and their influence upon clinical processes is urgently needed.

It would seem that the current one-size-fits-all approach is not appropriate for BOR standards. More research is needed in order to better understand BOR nuances and develop more suitable recommendations based upon individual hospital factors. Services delivered, population, environment, local policy and processes and supporting services may all affect a hospital's ability to operate at a higher occupancy rate without compromising on safety, care quality and efficiency.

While the NHS has well established data collection processes in place, a lack of clarity in the data presentation causes weaknesses in any analyses drawn from it. Some data is presented quarterly, some annually; clarity of definition of terms is poor and important data such as 30-day readmission rates has been unpublished for 5 years without justification. Furthermore, NHS BOR data is collected at midnight, when highest occupancy rates are experienced at midday. This snapshot alone is likely to be underestimating the true levels of BOR at their peak. These issues must be addressed in the interest of transparency. Presently, the NHS is running services above the current recommended parameters with no processes in place to measure the effect it is having upon safety and efficiency.

Nationwide increases in BOR along with growing demand strongly suggest that the NHS has reached a tipping point in reducing its bed capacity. While it seems that, at present, there remain just enough acute beds to manage elective workload at high BOR with minimal effect upon LMNC cancellations in the NHS, there are other important clinical indications to favour lower BORs. It is therefore paramount that any future decisions to further reduce acute beds in the NHS be clinically-consulted, evidence-based decisions.

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8 Appendix

The popular media discourse on NHS bed numbers 2016 to 2019.