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Burden, duration and costs of hospital bed closures due to acute gastroenteritis in England per winter, 2010/11–2015/16

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SUMMARY

Background: Bed closures due to acute gastroenteritis put hospitals under pressure each winter. In England, the National Health Service (NHS) has monitored the winter situation for all acute trusts since 2010/11.

Aim: To estimate the burden, duration and costs of hospital bed closures due to acute gastroenteritis in winter.

Methods: A retrospective analysis of routinely collected time-series data of bed closures due to diarrhoea and vomiting was conducted for the winters 2010/11 to 2015/16. Two key issues were addressed by imputing non-randomly missing values at provider level, and filtering observations to a range of dates recorded in all six winters. The lowest and highest values imputed were taken to represent the best- and worst-case scenarios. Bed-days were costed using NHS reference costs, and potential staff absence costs were based on previous studies.

Findings: In the best-to-worst case, a median of 88,000–113,000 beds were closed due to gastroenteritis each winter. Of these, 19.6–20.4% were unoccupied. On average, 80% of providers were affected, and had closed beds for a median of 15–21 days each winter. Hospital costs of closed beds were £5.7–£7.5 million, which increased to £6.9–£10.0 million when including staff absence costs due to illness.

Conclusions: The median number of hospital beds closed due to acute gastroenteritis per winter was equivalent to all general and acute hospital beds in England being unavailable for a median of 0.88–1.12 days. Costs for hospitals are high but vary with closures each winter.

Introduction

In healthcare settings, acute gastroenteritis (i.e. diarrhoea and vomiting) is a common source of disruption for routine care due to the sudden onset of symptoms, and the potential for enteric pathogens to cause outbreaks of an infectious nature

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[1]. In 2004, hospital outbreaks of acute gastroenteritis were estimated to cost the National Health Service (NHS) in England £115 million annually [2]. The main elements contributing to this cost were a decrease in the supply of available beds (when 'closed' due to acute gastroenteritis, i.e. these beds were unavailable for admissions) and staff absence due to illness. Between 2009 and 2011, Public Health England recorded a mean of 15,000 bed-days lost and 3400 cases among staff per year from voluntarily reported hospital outbreaks (primarily norovirus) [3]. This underestimates the national burden given regional variation in reporting, leading to an estimated under-ascertainment of approximately 20% [4].

Due to increased demand each winter, the impact of reduced numbers of available beds in hospitals is greater than in the rest of the year. In England, the NHS has been monitoring the performance of all acute hospital trusts each winter since 2010/11, which includes mandatory reporting of any bed closed due to diarrhoea and vomiting on weekdays [5]. These compulsory reports allow for a comprehensive overview of the impact of all causes of acute (infectious and non-infectious) gastroenteritis on bed-days lost nationwide for six winters across seven years.

This study aimed to provide updated estimates for the burden, duration and costs of all forms of acute gastroenteritis affecting the availability of hospital beds in England during winter. In addition to investigating the duration of closure, this study also explored whether the outbreak duration of infectious gastroenteritis could be traced in the data by following conventional definitions for outbreaks of norovirus [6–8], which has become the key enteric pathogen across all ages worldwide, particularly in countries that have introduced rotavirus vaccination (such as the USA) [9,10]. This study also compared estimates across winters in order to provide insights into variation across the whole hospital system.

Methods

Data

Using NHS England's winter situation reports for 2010/11 to 2015/16, all available records of occupied and unoccupied beds closed due to diarrhoea and vomiting, and the total number of general and acute beds available (including escalation beds but excluding maternity and mental health beds) were obtained [5]. Records were only available at the level of trusts, which may contain multiple hospitals and/or wards within a hospital. Bed figures were reported on weekdays alone (reflecting the number for the previous day), and figures for weekends and bank holidays reflect the last day of that respective period [5]. Suspected errors in reporting or miscoding encountered in the data were treated as missing values ($N = 0.54\%$; see Discussion).

Statistical analysis

Two key issues in the data were addressed for a reliable comparison across winters. First, one-third of values were missing due to weekends and bank holidays. To account for this, values were imputed at provider-level through last observation carried forward (LOCF) and next-observation carried backward (NOCB). Therefore, records for Thursdays were carried forwards to inform the missing values for Fridays and Saturdays (with LOCF), and records for Sundays were carried backwards to impute values for Saturdays and Fridays (i.e. NOCB). To avoid biasing results systematically upwards when closed beds were recorded before but not after the missing values (and vice versa), the lowest value imputed with either LOCF or NOCB was considered as the conservative best-case scenario. Similarly, the highest value imputed with either imputation strategy was considered as the worst-case scenario.

Second, recording lengths and periods are determined flexibly by NHS officials each winter, and varied from 13 to 21 weeks between November and March. The analysis was restricted to an overlapping range of dates recorded in all six winters (30th November–20th February; i.e. 83 days or nearly 12 weeks) after imputing missing values.

Descriptive statistics are provided using the median and interquartile range (IQR) to highlight variation between winters. Pearson's correlation coefficient was calculated to investigate the relationship between the number of unoccupied and occupied beds closed per day. To visualize any trend across winters, locally weighted regression curves across all winters, and linear regression curves interrupted between the winters of 2012/13 and 2013/14 were fitted to the time-series of all beds closed (with highest imputations). Data (with lowest imputations) were also scaled to the highest daily number per winter using the unadjusted periods (between 13 and 21 weeks) to identify within-winter variations.

Quantifying the duration of bed closures

The number of consecutive days of bed closures was counted per provider in the imputed datasets to analyse the duration of bed closures.

In order to explore whether outbreaks of infectious gastroenteritis could be traced in the data, conventional definitions for outbreaks of norovirus as the key enteric pathogen were followed (i.e. more than one case for more than one day; symptom onset within ±48 h) [6–8]. First, records of isolated occurrences of one bed closed for one day and no other closures within ±48 h were removed. Next, bed closures reported within ±48 h were grouped and analysed as part of one sustained outbreak. In scenario analyses, sequences with beds being closed on the first or last day of recording were removed, as well as sequences with beds being closed on the second (to last) day to account for the ±48-h period. Given that the removal of censored durations biases results when excluding the longest-lasting closures, this study also explored inclusion of the duration of outbreaks truncated to the overlapping range of dates from the raw data, where possible, and only removed the remaining censored outbreaks (i.e. for those two winters that defined the start and end date of the filtered range of dates; see Appendix A, online supplementary material).

Cost analysis

The financial costs of acute gastroenteritis from the perspective of hospitals was estimated based on the number of unoccupied bed closures and staff absence costs.

Financial costs for hospitals arise from revenue losses of closed (unoccupied) beds as no (additional) patients can be treated in these beds. Occupied bed closures do not represent a financial loss for hospitals in the same sense; this is discussed further in the Discussion.