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Local 7-day patterns of on/off switching in acute bed occupancy

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Key Points

- Acute bed occupancy shows on/off switching for 7-day periods of higher bed occupancy/workload
- Bed occupancy/workload can be up to 16% higher than baseline during these 7-day periods
- Common pathogens are most likely to be the cause
- Random transmission along social networks probably limits the size of each mini-outbreak
- High bed occupancy at individual hospitals limits the calculated impact, the extra demand is simply hidden in queues waiting for admission (ambulance queues outside A&E and patients in A&E or on beds in corridors)
- Medical admissions appear to be exacerbated
- These mini-outbreaks show high spatial granularity

Introduction

The recent uncertainty regarding the ability of the Sustainability and Transformation Plans (STPs) to reduce acute bed numbers is a sad reflection of the headlock which Whitehall exerts over NHS thinking. Policy-based evidence becomes the only truth (Beeknoo and Jones 2017). Based upon 25 years of experience I can assure everyone that acute bed demand, as a reflection of intrinsic demand, is far more highly nuanced than anyone at the top will allow the NHS (and the public) to believe.

Data and methods

The following is an analysis of local bed occupancy in English hospitals as revealed by the data collected in the 2017/18 NHS winter SitRep process (NHS England 2017). In this study 7-day periods of higher occupancy are detected by comparing a moving 7-day average of occupancy in each hospital. Average occupancy for days 1-7 are compared to days 8-14, move forward one day and recalculate.

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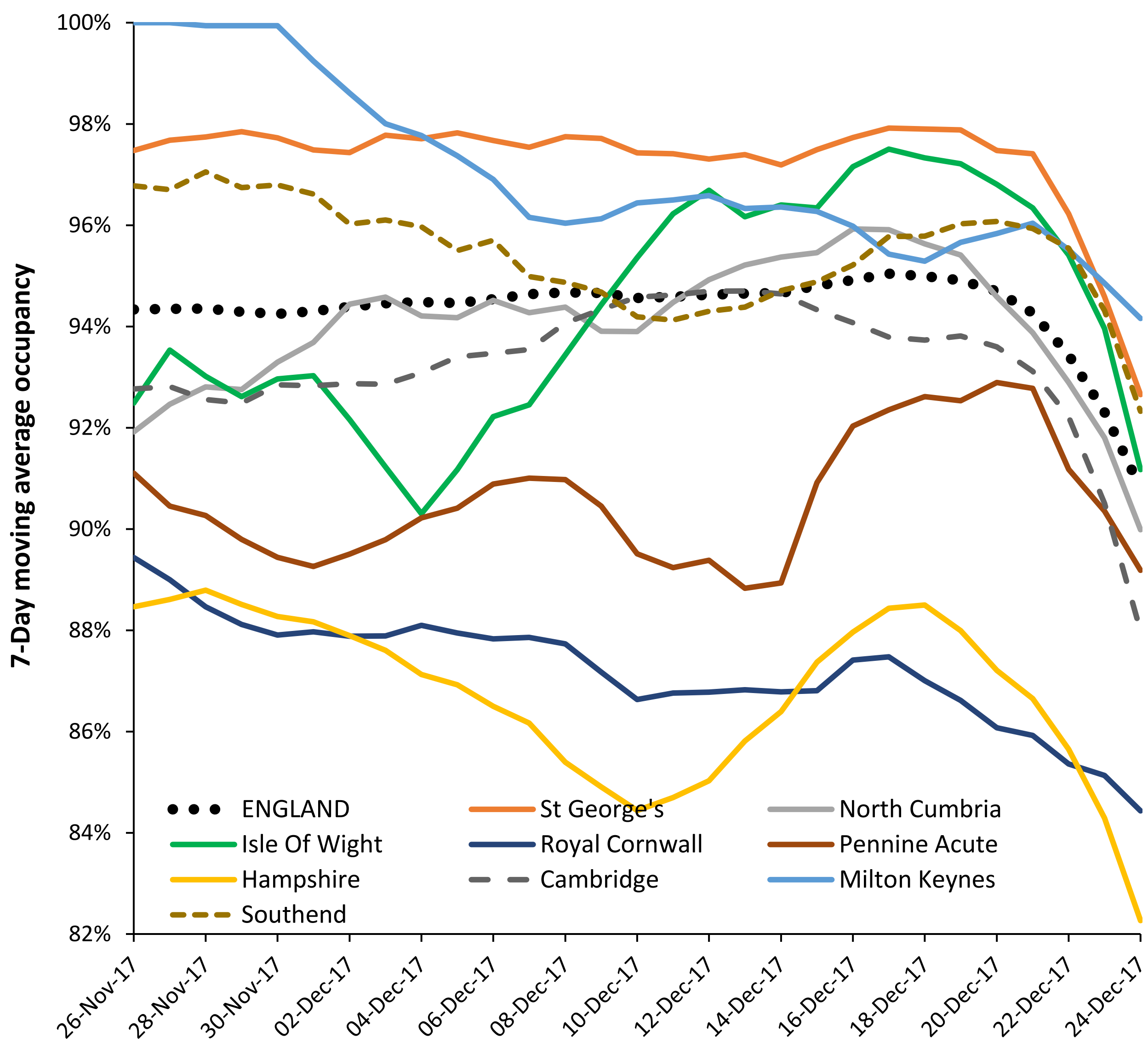
Bed occupancy shows local trends

Figure 1 presents a running 7-day average of bed occupancy for a sample of English hospitals for the 7-day period ending 26th November through to 24th December 2017. Occupancy is averaged over a 7-day period due to day-of-week patterns and generally lower midnight occupancy over the weekend. Sudden step-changes in occupancy show up as 7-day long ramps (up and down) in the trend. Note that the (average) position for the whole of England is entirely unhelpful because it implies that nothing much is happening (Jones 2016). This is the view that the Department of Health perceives as reality. Note the huge local variety.

Figure 1: Moving 7-day average acute bed occupancy for a selection of English NHS hospitals



Thursday the 21st December marks the last day of elective surgery before Christmas and provides an example of a man-made step-change in occupancy. The average ending Dec 24th compared to the 21st across England ranges from +0.5% through to -14.9% (data not shown). This range depends on the reduction in bed demand induced by the cessation of elective surgery over Christmas counterbalanced by local increases due to emergency admissions. These local increases will now be discussed.

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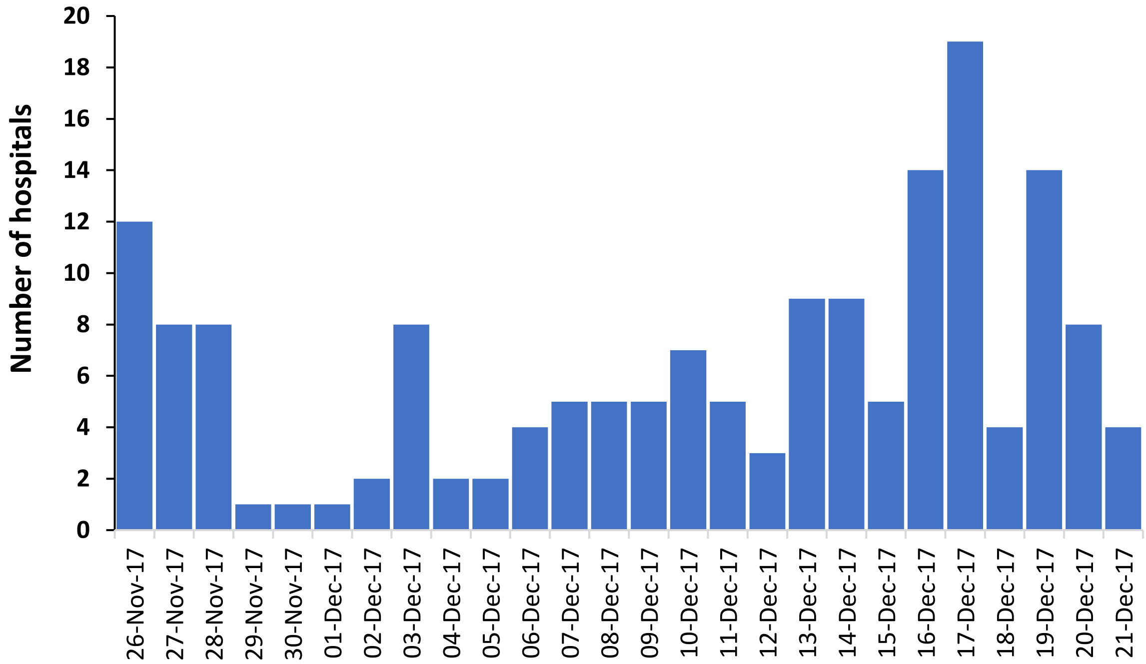
Local trends explained

How do we explain the other undulations in average occupancy in Figure 1? The point at which different hospitals achieve maximum 7-day average occupancy is shown in Figure 2 and is spread across the entire period. Variations in weather are unlikely to explain these differences, however, my own unpublished analysis shows that 7-day periods of higher medical admissions appear to lie behind these curious trends. These 7-day periods arise from small-area spread of agent(s) creating infectious-like patterns in both admissions and deaths. With over 1,400 known human pathogens (Woolhouse and Gowtage-Sequeria 2005) there are plenty of potential candidates. Basically, the pathogen acts to exacerbate existing conditions leading to a surge in medical admissions.

Figure 2: Number of English hospitals showing a 7-day period of maximum bed occupancy between 26th November and 24th December



For example, asthma is exacerbated by a range of common lung infections (Pelaia et al 2006). Why admissions and bed occupancy on this occasion remain high for around 7-days remains a mystery. However, the spread of the infectious agent through the social networks in the hospital catchment population then determines the exact shape of the moving 7-day average for each hospital as was observed in Figure 1. In this study comparing 7-day averages largely avoids distortion due to the more long-term seasonal cycles.

Spatial granularity

The fact that infectious outbreaks can be highly granular (Caudron et al 2014, Bansal et al 2016) explains the wide range in the date for the maximum occupancy observed in Figure 2. This granularity is further illustrated in Figure 3 where the spatial co-ordinates for each hospital are used to plot the hospitals associated with an early (7-day period ending at 26-27th November) and late (16-18th December) 7-day period of maximum occupancy. The pathogen(s) involved must be among the more common types because the spatial spread between hospitals is wide both within and between both outbreaks. Once again national data entirely misses the point!

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Figure 3: Location of English hospitals experiencing a 7-day period of highest average occupancy between 20-22nd November or 16-18th December

Maximum amplitude

The work of Caudron et al (2014) demonstrated that the magnitude of a local infectious outbreak will depend on chance events in person to person contacts in the social networks surrounding each hospital. The maximum increase observed for the whole of England was only + 0.5% which gives an entirely misleading view of the local reality.

However, a key factor likely to influence the calculated maximum amplitude is the fact that so many NHS hospitals operate at very high average occupancy, i.e. maximum occupancy is constrained to 100%. This possibility is investigated in Fig. 4 where the calculated maximum percentage increase declines as average occupancy increases. The surge in extra demand is simply hidden in queues waiting for admission, i.e. ambulance queues outside A&E and patients in A&E or on beds in corridors.

Since this study only encompasses a 35-day snapshot it is highly likely that the potential maximum amplitude has been greatly underestimated for most hospitals/locations. Also, the maximum increase in occupancy may have been constrained by compensating reductions in elective surgery.

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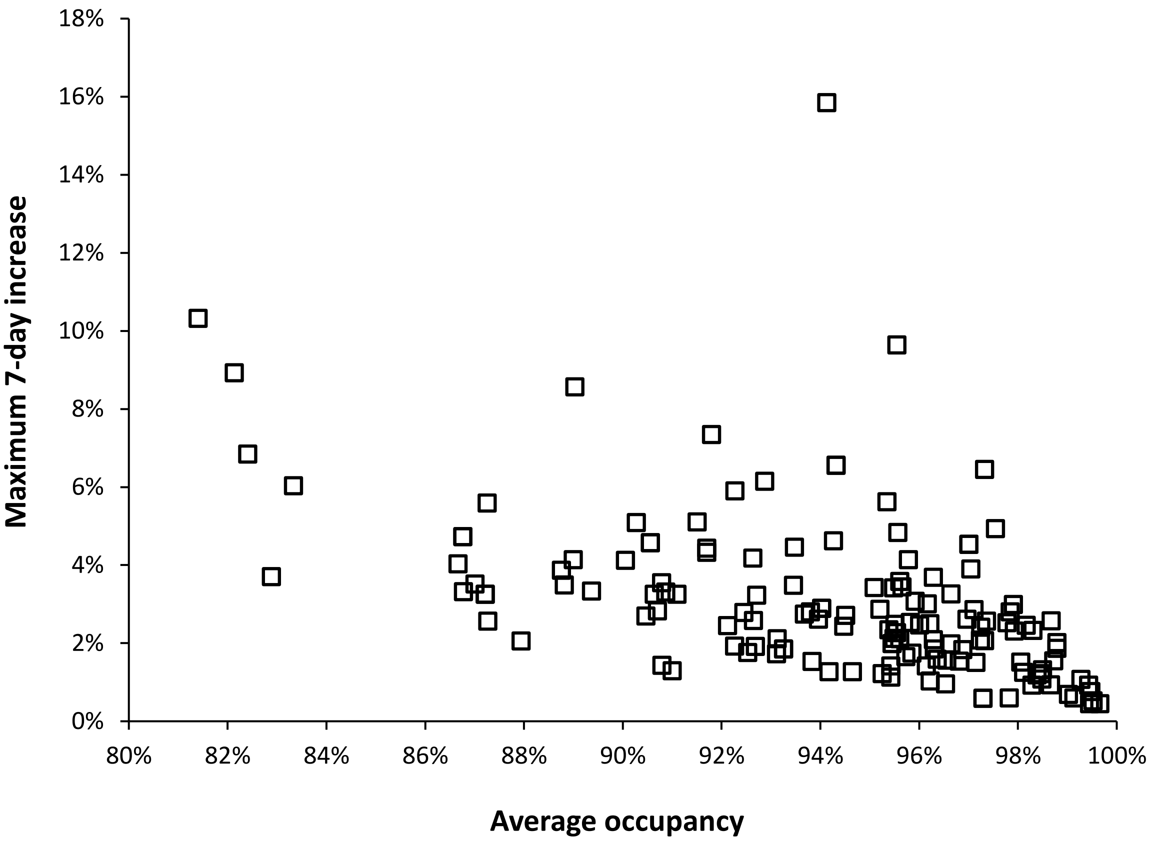
Figure 4: Effect of average occupancy on maximum 7-day increase



Implications to the STPs

To understand the implications to the STPs for bed occupancy substitute community-based workload which is undergoing periods of on/off switching from low- to high-work intensity. These 7-day periods of high occupancy, and hence workload, can be up to 16% higher than the baseline (Fig. 4). During the high intensity phase the community and social care resources become overwhelmed and acute admission becomes the default.

Hence STPs based on annual averages, equivalent to the (misleading) England-average view held by the Department of Health and others, suffer from serious overestimation of the ability of community-based resources to reduce the acute bed requirement (and total costs).

Wider Context

These 7-day high patterns appear to sit within other patterns of 28-days and 365-days high. The 28-day patterns will be investigated in the March edition of BJHCM, while the 365-day patterns have been extensively documented (2017a-l). The truth is that running an acute hospital and associated primary and social care is vastly complex. We need to employ Big Data, Neural Networks, Wavelet analysis and other approaches; however, this needs to be done on behalf of the ***whole*** NHS rather than simplistic notions that each organisation can do it all themselves. It is time the NHS was allowed to grow up.

Conclusions

The insistence by Whitehall that NHS thinking is constrained to a policy-based framework has led to a dearth of research into real-world behaviour of NHS demand and costs (Jones 2012). This has been re-enforced by the big management consultancy organisations who know that they must provide answers consistent with policy or else risk losing future work. Hence the somewhat policy-based 'fairy tale' answers around bed reductions embedded in many STPs.

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