Hospital Bed Management Practices: A Review

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Abstract: This paper reviews current literature on the bed management role seeking to highlight developments most likely to increase efficiency. A reduction in the number of in-patient beds due in part to innovative surgical techniques is causing increased pressure on a very finite resource. This requires a greater emphasis on the bed management role and the wider hospital team. A number of studies are presented describing initiatives implemented to support bed management both operationally, procedurally and from a decision support approach. Finally, literature on people, process technology approaches in healthcare is presented, which could support a sustainable improvement in the role.

1 INTRODUCTION

The trend in Europe over the last ten years is towards a reduction in in-patient beds in hospitals. Figure 1 below illustrates the public hospital in-patient bed ownership for the larger European states between 2007 and 2015 (Eurostat, 2017).

The reduction is driven by an improvement in surgical techniques leading to a reduction in length of stay (LOS). In a report produced on the NHS (Audit-Commission, 2003), it is highlighted that even though acute beds reduced in England from 123,000 to 107,000, the number of admissions rose due to reducing length of stay. There is a cost associated with 'unoccupied' beds as reported in (Webster et al., 2011) which contributes towards bed number reductions. With an increasing population in Europe, the management of the decreasing hospital bed resource becomes more critical.

The aims of this paper are, firstly to present an overview of the areas of current bed management practice that contribute to the management of the bed resource and patient throughput, secondly, to highlight the challenges present in bed management, thirdly, to identify those areas that significantly contribute to an improvement and finally suggest a research area as a focus for providing sustainable gains in efficiency and patient satisfaction.

Section 2 discusses the issues surrounding the bed management role and its implementation and notes the contrast of elective and medical patient bed allocation and presents a high level view of the bed management process. Section 3 reviews trends in addressing the issues with a view to increasing the efficiency of patient placement, through focus on the admission and discharge elements of the process, pooling capacity and modelling and decision support systems. Section 4 identifies work on providing a people, process, technology approach and the challenges therein highlighting the success in manufacturing and software industries using these techniques. Section 5 concludes the paper.

2 BED MANAGEMENT ISSUES

The bed management role is at the forefront of efficient use of a critical but limited hospital resources and timely allocation of beds to patients admitted to hospitals can turn a stressful experience into a comforting and positive experience that will have a positive effect on patients' well being. The work of (Boaden et al., 1999) refer to papers from the early 1990s to claim that "the effective management of beds as a resource has always been an issue with the NHS".

2.1 Competing Demands

The bed management role seeks to marry the hospital bed supply with the hospital bed demand (Boaden

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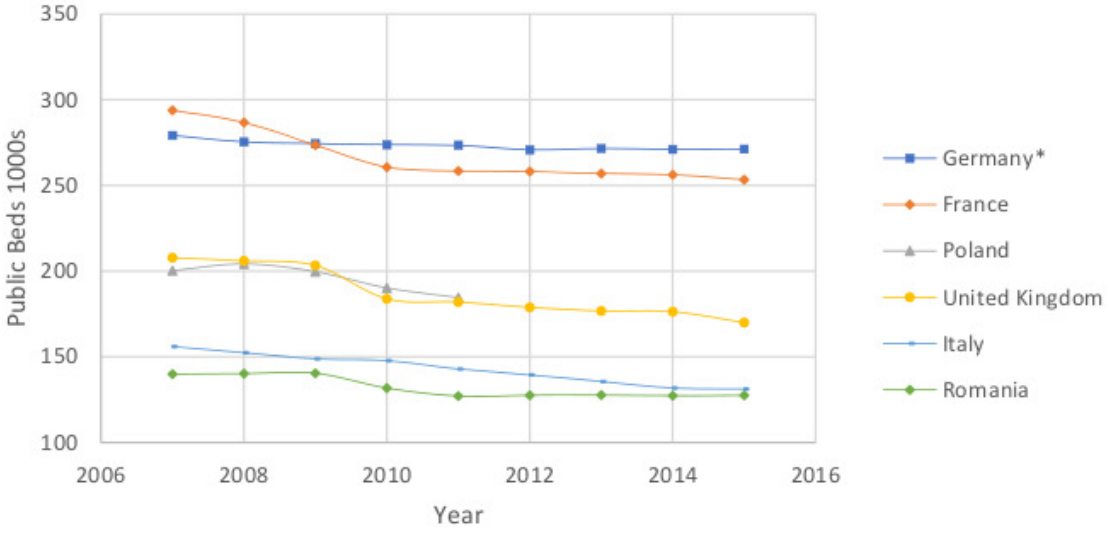


Figure 1: Changes in inpatient bed numbers for a subset of European countries.

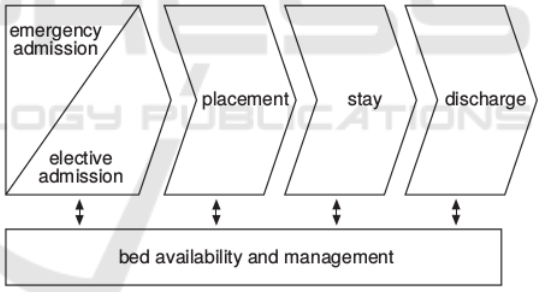
et al., 1999). At the top level, two competing demand streams exist, elective patients and medical emergency patients. The admission of the elective patient would appear to be more controlled as in most instances the procedures are well defined and in the case of private patients, is funded by standard insurance packages with set times defined for individual procedures. Elective day-case patients similar to elective surgical patients are considered well defined and generally have dedicated bed resource allocated. However, (Ortiga et al., 2012) states that numerous case studies indicate elective admissions cause the greatest variation as they are more unpredictable and this is supported by (Allder et al., 2010a). In (Sant et al., 2015) it is shown that the Day Care Unit in a focus hospital had 3.9% of patients who were not discharged as planned. In contrast (Allder et al., 2010a) states that the vast majority of emergency patients require a very short LOS.

2.2 Other Considerations

The report (Audit-Commission, 2003) covers a range of issues that affect the placing of patients in beds in a hospital, such as, speed of admission, admitting a patient to an appropriate ward, providing single sex wards, isolation requirements, avoiding cancellation of elective surgical procedures due to restrictions on beds. This is not an exhaustive list but servers to illustrate the breath of issues faced by the bed management role. Fundamentally the bed management role is to make the best use of existing beds.

2.3 Process

Figure 2 below, provided in (Boaden et al., 1999), but reproduced from an earlier Audit Commission report, illustrates a high level view of the bed management process.



Source: Audit Commission, (1992)

Figure 2: The bed management process (Boaden et al., 1999).

The bed resource is constrained until a patient exits the process through discharge and the bed they occupied is made available for the next patient. When emergency admissions are high, such as in the winter period there is a motivation to reduce the number of elective procedures as suggested in (Audit-Commission, 2003; Proudlove et al., 2003; Ortiga et al., 2012). This is particularly true in public hospitals where public perception of long emergency room waiting times can create pressure to address this issue. This also has impact in terms of the waiting list times being extended. An exploration of this issue (Proudlove et al., 2003) highlights the bed management role in maintaining a stock of beds but raises

the point that due to the routine hours of the hospital in general and the bed management presence in particular, capacity can decrease due to out of hours admissions.
Many papers (Allder et al., 2010a; Allder et al., 2010b; Zhu, 2011; Wertheimer et al., 2014; Patel et al., 2017) raise the issue of patients being admitted at a time prior to the normal patient discharge time occurring. This gives rise to an apparent shortage of beds. This further impacts the patient experience, in that they are provided with temporary accommodation only to be moved again to their final destination. This creates an air of uncertainty for them which can cause distress or angst and impacts their recovery time and hence LOS. This can exacerbate bed shortages.

3 BED MANAGEMENT TRENDS

Figure 2 provides a simple linear view of the patient journey in terms of the bed management process. Within the bed management role there is most scope to affect change in the admission or discharge areas.

3.1 Addressing Discharge

Discharge is a common process element to target. Some of the studies mentioned above (Wertheimer et al., 2014; Patel et al., 2017; Cho et al., 2017) and others (Mustafa and Mahgoub, 2016; Zhu, 2011; Webber-Maybank and Luton, 2009) suggest tackling this problem by focussing on early discharge. Other sources (Petitgout, 2015) suggest a dedicated discharge planning function as as a solution. However in their study (Mabire et al., 2018) on nursing discharge planning, it is shown that for older patients, being discharged to home, there is an increase in length of stay without additional benefits to the patient. They also added that nursing discharge planning is a complex intervention and difficult to evaluate. In (NHS, 2004), it is highlighted that 80% of discharges are 'simple' discharges and that the focus should be on completing these in a timely fashion for best efficiency. The report also suggests that the focus on discharge should begin immediately with a discharge date set within twenty-four hours of the patients' arrival in hospital. Another area of improvement it suggests is extending discharges as a seven-day activity. This is also echoed in other reports (Audit-Commission, 2003; Allder et al., 2010a) where its impact is illustrated by the LOS of a patient being correlated to the day of admission.

3.2 Discharge Initiatives

Three very similar studies are discussed (Wertheimer et al., 2014; Patel et al., 2017; Mustafa and Mahgoub, 2016) that apply interventions to the discharge process to bring about earlier discharge. All signify the importance of teamwork and the role of the multidisciplinary team in discharge. Figure 3 illustrates the broad roles that are involved in treating a patient, for both elective and emergency patients (NAO, 2000).

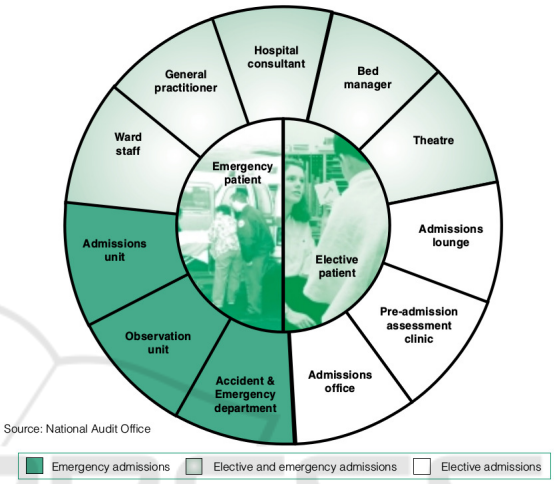


Figure 3: The roles involved in patient treatment (NAO, 2000).

A study (Wertheimer et al., 2014) states that all the stakeholders and staff involved in the launch of an initiative to increase the discharges before noon (DBN) were invited to a kick-off meeting. This was implemented to educate everyone involved in the importance of the issue and the plan for improvement. The focus was on it being a multi-disciplinary team responsibility to achieve discharges. Two separate areas were involved in the initiative and competition was fostered between the two areas towards achieving the goal. The main tools were a checklist and a website using automated emails to provide updates. Daily meetings were used to focus on the current day's discharges, plan the following day's discharges and keep everybody apprised of performance. The paper reports that there was an increase in the number of discharges before noon with an earlier average discharge time over a 13-month period after the intervention. A further outcome was a reduction in the average LOS and unexpectedly a reduction in the number of 30-Day re-admissions. The latter was not considered statistically significant. These two factors were very positive as there was concern that attempts to keep patients an extra day to help achieve the discharge before noon may occur. The other concern was that

patients could be discharged before they were fully ready to be discharged resulting in them requiring hospitalisation again due to early discharge. The figures proved this not to be the case.
A further study (Mustafa and Mahgoub, 2016), had a similar outcome and improvement rate to the study above (increase from 7% to 34% versus an improvement above from 11% to 38%). A multi-disciplinary discharge team was formed to study the problem. A list of possible causes was drawn and a Pareto chart compiled to highlight the major sources of delay. A number of Plan-Do-Study-Act (PDSA) cycles were conducted over a 26-month period. It was noted in the report that sustainability was a challenge due to the requirement for regular feedback which was time consuming. The suggestion was that with automation, this feedback would become easier and thus more sustainable. There was no report of LOS improvement but the report did state that it did not degrade.
(Patel et al., 2017) followed the same pattern. As in (Mustafa and Mahgoub, 2016), a multi-disciplinary team was established to identify the key reasons for delayed discharge. Each quality improvement initiative contained an education, process change and audit and feedback element using PDSA cycles. The DBN rate increased from 10.4% before the intervention to 19.7% after 24-months. DBN to skilled nursing facilities had a more dramatic change from a baseline rate of 14% to 33.2% after 24-months. The average LOS (from 5.88 to 5.60) and 30-Day readmission rate (17.5% to 17.0%) remained relatively stable over the period of the intervention. The report commented on the challenges of sustaining the improvements in an academic environment with rapid staff turn-over, the commitment of resource to regular meetings and creation of audit tools and feedback mechanisms.

3.3 Addressing Admission & Discharge

An approach applying interventions in both the admissions and discharge areas of the bed management process is reported in (Ortiga et al., 2012). The primary intervention mechanism at admission was the change to admitting patients on the same day of surgery for a large percentage of patients. This had an obvious reduction in LOS due to the elimination of the pre-surgery stay for these patients. The interventions at the discharge area were similar to those reported above. The elective patient LOS reduced from 4.85 days prior to intervention and 4.54 days two years later. The global LOS reduced from 8.56 days to 7.93 days over the same period excluding day surgery patients.

3.4 Communication

Technology has a role to play in bed management and real-time information through the use of technology can aid decision making (Roswo et al., 2003). This report provides case studies on the implementation of technology to assist in the bed management role. A key benefit stated in the report is the ability to make information available enterprise wide allowing for quick decision making and feedback. Infosys, an IT consultancy company promote combining technology with process engineering to provide a solution to the complexity of the bed management role in their (Balaji and Brownlee, 2009) report. Technology is referred to in a general way with an emphasis on process engineering. A further industrial report on process engineering aimed at increasing patient throughout is presented in (Kobis and Kennedy, 2006). This is more a high-level view but does emphasise both a process viewpoint and the need for a organisational resolve to succeed.

3.5 Modelling

Another approach is to implement modelling to help with decision making and decision support systems. One such approach is detailed in (Teraiya and Makwana, 2015) which applies a mathematical model, on an assumption of a Poisson probability distribution rate arrival of patients. The approach was to gather data over a period and apply the data to the model to predict the arrival rate of patients and their LOS to help with accommodating them.
A similar approach was adopted (Griffiths et al., 2013), for an CCU, to increase throughput, smooth daily bed occupancy, predict occupancy levels over the coming days and identify staffing levels to better manage costs. This approach again used historic data as an input to the model.
In (Matos and Rodrigues, 2011), the paper promotes modelling annual data for prediction and augmenting the modelling with information technology systems to provide hospital personnel with the information necessary to increase resource effectiveness. Another study (Baru, 2015) creates a decision support simulation model and uses hospital data to test a number of hypotheses and compare actual and simulated LOS and used statistical techniques to validate the model.
A slightly different approach is taken in (Schmidt et al., 2013) for a decision support system for bed management, where cost factors include ward occupancy, change of ward occupancy assignment delay and an affinity cost that allows an administrator to define a cost. A simulation was created from ac-

tual hospital data and the output compared to the actual assignment. One of the limitations noted is that the software looked at only one resource, bed capacity, whereas in reality multiple other resources would need to be factored in as part of the placement planning.

The concept of modelling is taken a step further in (Bolt and Sparks, 2013) where a surveillance tree methodology is used to predict changes in presentations in hospital emergency rooms to allow implementation of the management of the change. The surveillance tree methodology is shown to be more robust in unknown sub-populations over an exponentially weighted moving average (EWMA) model for a similar population.

Modelling is also used to manage the allocation of beds in clinical specialisations in a hospital. A multi-attribute value theory model is proposed in (Tsai and Lin, 2014) to improve the quality of patient-bed assignment in terms of ward specialisation compliance. This too is the subject of a proposed model by (Lee et al., 2017) to partition clinic services in the hospital to provide an efficient means of allocating beds to the medical specialisations. They address the issue of how many specialisations to form, the number of beds to allocate to each specialisation and how to partition services amongst the specialisations using a two stage framework. The method provide balanced models for the trade-off between pooling capacity and focused care using a initial clustering of services while the subsequent stage performs optimisation of the feasible solutions returned by the initial stage.

4 PEOPLE, PROCESS & TECHNOLOGY

In the previous sections, a number of initiatives have been highlighted with regard to improving patient throughput in hospitals, in an environment of reducing bed numbers. The sustainability of such issues was reported as challenging due to the commitment and effort required to keep the initiatives going while performing a primary role in caring for patients.

A argument is put forward (Sherer et al., 2017) that implementing coordination in healthcare is more difficult due to the many external influences including payment and regulatory mechanisms, privacy constraints and the level of professional control amongst others.

The report introduces the control theory interdependence types of 'pooled', 'sequential' and 'reciprocal', in order of complexity and the associated coordination mechanisms of 'standardisation', 'plan' and 'mutual adjustment'. The report goes on to state that while care monitoring is achievable at the pooled level, for care coordination a reciprocal level of interdependence needs to be achieved. This is only achieved through a very high level of information sharing.

A comparison in this report, between industry's successful coordination re-engineering and the additional challenges associated with implementation in healthcare is echoed in (Husby, 2012). In this second study, the adoption of the 'lean' concept used so successfully in manufacturing and software is promoted using hoshin. The paper states that the adoption of the lean techniques has potential to facilitate coordination in the healthcare environment but needs significant capabilities and management to achieve success. The study proffers a practical approach for undertaking a hoshin initiative. It also underpins the criticality of improving coordination in people process technology as increased technology deployment is driving increasing health costs without a matched impact in care.

5 CONCLUSION

This paper has examined bed management and shown it to be a key area to increase patient throughput thus making a scarce resource available to more people. The trend for decreasing bed numbers, with increasing population can only serve to increase pressure on the bed resource. An increased efficiency can help to counter this pressure.

There is a constant application of initiatives to work towards a more efficient use of bed resource but the effort of sustaining them is an issue.

This paper's contribution is to highlight the need for sustainable solutions in addressing bed management. It further suggests, a holistic approach to looking at people, processes and technology to create greater coordination in the healthcare sector as successfully applied in manufacturing and software could be the key to providing the sustainability required to maximise efficiency of the bed resource.

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