In a high volume orthopaedic unit, managing natural variability and utilising the theory of constraints improves surgical throughput.

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Introduction

This project involved hip and knee replacement patients at the Royal Bournemouth Hospital. Throughput of surgical cases is determined by the number of operations you can perform each day and the number of beds available for patients following surgery. Modelling using length of stay data indicated that we had enough beds and so we used the Theory of Constraints (TOC) to optimise surgical throughput. The TOC process is outlined below.

Intervention

Put simply, the system was required to complete 1350 joint replacements per year through 2 operating theatres. Having established this, we identified the system constraint using TOC methodology. The constraint is the element of the system that prevented additional throughput from occurring. Our analysis revealed that the constraint in our setting was the surgeon. We then designed an operating template that subordinated everything to the constraint. A staggered operating model in which the surgeon moved between two operating theatres to perform 6 hip and knee replacements in succession each day was introduced.

Results

The model has been used in over 2000 patients, and 28 different surgeons and 48 anaesthetists have worked within the model. We found that for all surgeons this has improved their productivity, as well as reducing the variability in the time required to complete each individual case. The staggered model and predictable nature of the model has also had benefits to the nursing and rehabilitation staff on the ward. Admissions to theatre and returns from theatre are now equally staggered throughout the day. This smoothing of flow is a central principle of lean and has made the delivery of care much easier on the ward and requires less staff.

Key message

The TOC is a useful model for analysing complex systems where one step determines the rate of the process. Within our context the constraint was the surgeon. By subordinating all processes to utilise the surgeons' time maximally we optimised surgical throughput.

The operating theatre room	The anaesthetist
<p>This is traditionally seen as the constrained resource. High utilisation is perceived as good because it is seen to infer higher throughput (even though it does not measure it).</p> <p>Utilising theatre session time effectively is a good idea but this is principally to make the best use of staff time rather than the physical resource of the operating room. If the physical resource was the constraint we could extend the hours of surgery because most theatres only have planned surgery for 8 hours in every 24.</p>	<p>To perform surgery you need an anaesthetist. Anaesthetists are able to anaesthetise patients for a variety of surgical procedures and as such, individual anaesthetists are relatively flexible in the surgical cases that they cover.</p> <p>Anaesthetists do not have their own surgical practice, and are not linked to individual patients.</p>
Theatre staff	The surgeon is the constraint
<p>Theatre staffs need to be trained in the relevant procedure to help assist a surgeon or an anaesthetist but within a department there will be many staff that has equivalent skills.</p> <p>They are not the constraint because increasing theatre staff numbers would not increase throughput.</p>	<p>Surgeons specialise in a particular type/area of surgery and so there are relatively less surgeons capable of performing the procedure (compared to anaesthetists and theatre staff).</p> <p>Surgeons have limited operating time each week. The surgeon is also linked to the case because the patient will be under their overall care, and as such, they must complete or supervise their surgery.</p>

Calculating how to maximise throughput at the constraint (surgeon) Constraint \$ = throughput/unit of constraint time	
<p>Assumptions</p> <p>Procedure time – 110 minutes.</p> <p>Procedure time is made up of 60 minutes surgical time, 35 minutes anaesthetic time, and 15 minutes additional time (we apportion 5 minutes at the start of the case and 10 minutes at the end).</p> <p>To clean theatres it takes 20 minutes in between cases. All theatre sessions start on time.</p>	
<p>Traditional Model</p> <p>One surgeon and one anaesthetist performing 3 joint replacements in a session through one theatre</p>	<p>New model</p> <p>One surgeon and two anaesthetists performing 6 joint replacements in a session through two theatres</p>
<p>Constraint \$ =</p> <p>3/(35+5+60+10+20+35+5+60+10+20+35+5+60+10)</p>	<p>Constraint \$ =</p> <p>6/(35+5+60+10+60+10+60+10+60+10+60+10+60+10+60+10)</p>
<p>Constraint \$ = 0.0081</p>	<p>Constraint \$ = 0.013</p>
Result = the new model increases throughput at the constraint (surgeon) by 60%	