

Rapid evidence checks are based on a simplified review method and may not be entirely exhaustive, but aim to provide a balanced assessment of what is already known about a specific problem or issue. This brief has not been peer-reviewed and should not be a substitute for individual clinical judgement, nor is it an endorsed position of NSW Health.

Resuming elective surgery – productivity and efficiency approaches

Evidence check question

What evidence is available about ways to increase productivity or efficiency in operating theatres and managing elective surgery waiting lists?

In brief

- COVID-19 has led to postponement of elective surgery in many jurisdictions. This has resulted in an immediate increase in waiting times and a significant backlog of patients.
- Both supply and demand side interventions are implemented in OECD countries to reduce waiting lists and increase productivity and efficiency in elective surgery.(1)
- Lean, and Six Sigma methods can increase productivity – and point to the importance of transformational leadership and workforce flexibility in achieving productivity gains. (2), (3, 4)
- Scenario and optimisation modelling have been used to identify and quantify potential productivity gains.(5)
- In England, a 2019 study estimated that theatre time lost to late starts, early finishes and delays between operations could have been used to perform 16.8% more operations.(6)
- A number of studies have demonstrated modest efficiency gains associated with interventions to improve start times and change-over times.(7, 8)
- An English regulator identified five key levers to improve theatre productivity:
 1. stratifying patients by risk
 2. extending clinical roles
 3. increasing throughput by explicitly measuring, communicating and managing the number of procedures per theatre session
 4. implementing enhanced and rapid recovery practices to reduce length of stay
 5. providing virtual follow-up for uncomplicated patients.(9)
- In New Zealand, one district health board introduced an incentive-based and clinically led model of care in 2012, which was associated with increases in productivity and reduced costs.(10)
- A Queensland study found that day-long sessions (as opposed to separate morning or afternoon sessions), mid-week sessions, certain specialties (e.g. neurosurgery sessions) and not scheduling long cases first were most beneficial to theatre utilisation.(11)
- Specialty approaches to improving efficiency have been adopted by the Getting it Right First Time program in the UK and estimated significant potential efficiency gains.

- In NSW an operating theatre productivity index was developed in 2014 and was piloted in four sites

Background

According to the OECD, waiting times for elective surgery in many countries have either remained unchanged or increased over the past decade. In response to COVID-19, many systems have postponed elective surgery to free up human resources and hospital beds to deal with the emergency. This postponement has resulted in an immediate increase in waiting times for patients and will result in a significant backlog of surgery that will likely take some time to be resolved. (1)

Pre-COVID-19, policy responses to waiting lists and surgery in OECD countries focused on:

- Supply side levers - improving the management and efficiency in delivery through a better use of operating theatres, increasing productivity of providers via additional sessions, activity-based payment systems, or increasing the medical workforce
- Demand side levers - clinical prioritisation tools that distinguish between patients with different severity profiles and potential health benefits, improved referral systems and coordination between primary and secondary care.

Key definitions in the literature

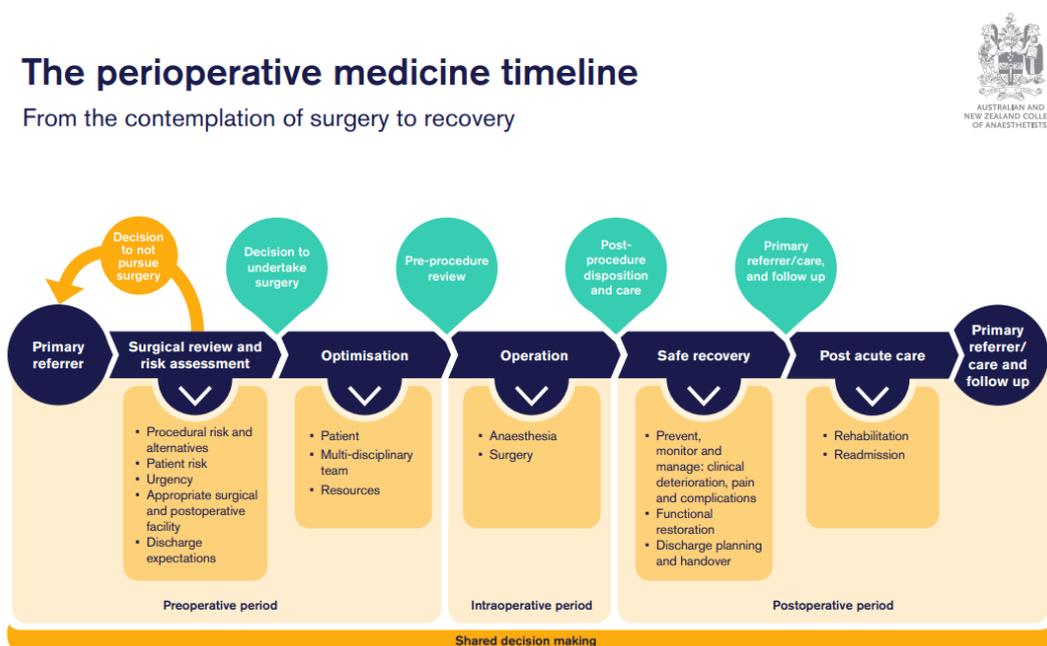
Productivity: the quantity of outputs produced per unit of input.

Efficiency: the optimal use of resources to produce outputs of a given quality (ACI, 2015 Project scoping paper).

Productivity and efficiency in surgery are regarded to be multidimensional, to be considered along a patient journey, offering multiple opportunity points for improvement (Figure 1). (12)

Some studies have highlighted the importance of human factors. (13)

Figure 1: The peri-operative medicine timeline



Source: ANZCA

Methods

A PubMed search was done on the 14 June 2020 using the following search terms: (elective surgery[Title/Abstract] OR operating theat*[Title/Abstract]) AND (productivity[Title/Abstract] OR efficiency[Title/Abstract]) AND (2010:2020[pdat]). 188 results were retrieved.

Results

Table 1: Peer reviewed literature

Source	Summary
Peer reviewed sources	
Optimization and planning of operating theatre activities: an original definition of pathways and process modeling Barbagallo et al, 2015 (5)	The OR process (the sequence of all of the elementary steps between ‘patient ready for surgery’ to ‘patient operated upon’) was defined and modelled with special attention paid to flows, timing and resource involvement. An optimisation model was implemented and tested on real clinical data. The comparison of the results reported with real data shows that using the optimisation model allows for the scheduling of about 30% more patients than in actual practice, as well as to better exploit the OR efficiency, increasing the average operating room utilisation rate up to 20%.
Human Factors and the Safety of Surgical and Anaesthetic Care Marshall and Touzell, 2020 (13)	This review explores human factors engineering – the science of how to design processes, equipment and environments to optimise the human contributions to performance – can be used to improve safety and efficiency of surgery. Although these are often dismissed as ‘common sense’, the review explains how these solutions emerge not from healthcare but from diverse disciplines such as psychology, design and engineering.
The use of Lean and Six Sigma methodologies in surgery: A systematic review Mason et al, 2015 (4)	Systematic review included 23 studies, with 11 assessing Lean, six assessing Six Sigma and six assessing Lean Six Sigma. Outcomes were classed into six common aims: to optimise outpatient efficiency, to improve operating theatre efficiency, to decrease operative complications, to reduce ward-based harms, to reduce mortality and to limit unnecessary cost and length of stay. The majority of studies (88%) demonstrate improvement, however high levels of systematic bias and imprecision were evident.

Source	Summary
Peer reviewed sources	
	<p>Two sections were of particular relevance:</p> <p>To optimise outpatient efficiency and experience</p> <p>Two studies described a one-stop pre-operative clinic before cholecystectomy and cataract surgery and were able to significantly reduce the mean waiting time for surgery, mean hospital visits per patient and clinician time per patient (p = <0.001). One study focused on a paediatric surgery clinic aiming to reduce exam room time per patient, increase the number of patients seen in four hours, improve patient experience survey scores and increase the proportion of clinician's time with the patient.</p> <p>To improve operating theatre efficiency</p> <p>Five studies aimed to improve operating theatre start times but only two were able to demonstrate a significant improvement and a further study showed improvement of 25–30% without statistical analysis performed. Four studies assessed theatre turnaround, turnover and throughput times. A decrease in turnaround time was seen with statistical significance in two studies and without statistical analysis performed by two, with decreases of 32-36% and 25-43%. Turnover time (from exit of one patient to entry of the next) was decreased in two studies by 24 and 30%. Throughput time (from patient entry to exit of the theatre) was significantly decreased by 20% after an intervention by Schwarz et al,2011.</p>
<p>Increasing Productivity, Reducing Cost and Improving Quality in Elective Surgery in New Zealand: The Waitemata District Health Board Joint Arthroplasty Pilot</p> <p>Cullen et al, 2012 (10)</p>	<p>A retrospective matched cohort study of hip and knee replacements investigating a pilot for an incentive-based and clinically led model of care for total hip and knee arthroplasties. Participating surgeons and anaesthetists were responsible for increasing surgical throughput. The pilot aimed to increase productivity, reduce cost and increase quality for patients. Total inpatient event costs were 12% and 17% lower for hip and knee replacements, respectively, at the pilot site compared with NSH. Significant reduction in operation length (39% hip, 36% knee) and length of stay (38% hip, 39% knee) were found in the pilot groups compared with NSH.</p> <p>The main features of the model were:</p> <ol style="list-style-type: none"> 1. Specific surgeon – anaesthetist teams performed the operating lists and were accountable for driving the overall theatre throughput.

Source	Summary
Peer reviewed sources	
	<ol style="list-style-type: none"> 2. Surgeons and anaesthetists were contracted using a template for consultant-led clinical care for the entire patient episode. 3. No junior medical staff participated in the care of the patients either in the pre-admission workup, operating or postoperative care. 4. Nurses were upskilled as the main theatre assistants in the pilot operating rooms. 5. There was a dedicated allocation of surgical beds to receive patients post-surgery. 6. Patients with similar procedures were cohorted on theatre lists and then in the same four-bed room on the ward. This allowed surgeons to streamline theatre practice and patients to support and even compete with each other in their recovery.
<p>Analysis of Operating Theatre Utilisation to Drive Efficiency and Productivity Improvements</p> <p>Thorburn et al, 2014 (11)</p>	<p>Surgical data from participating Queensland public hospitals were analysed to examine the effects of session type, session specialty, scheduling the longest case first and day of the week on theatre utilisation. It was found that day-long sessions (as opposed to separate morning or afternoon sessions), mid-week sessions, certain specialties (e.g. neurosurgery sessions) and not doing the longest case first were most beneficial to theatre utilisation.</p>
<p>Improving Flow in the OR</p> <p>Blouin-Delisle et al, 2018 (3)</p>	<p>Reports on two similar Lean projects were performed in the surgery departments of two hospitals in Québec. For the first, wasted time in the recovery ward was reduced by 62 minutes (68% reduction). For the second, time passed in the recovery ward was reduced by 6 minutes (29% reduction).</p>
<p>Rational Performance Metrics for Operating Theatres, Principles of Efficiency, and How to Achieve It</p> <p>Charlesworth and Pandit, 2020</p>	<p>A narrative review of literature on the efficiency and productivity of elective NHS operating lists. Achieving efficiency requires appropriate scheduling using specific procedure mean (or median) times and their associated variance to calculate the probability they can be completed on time. The case mix may be adjusted to yield better time management.</p>

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Peer reviewed sources	
<p>Strategies to Improve Start Time in the Operating Theatre: A Systematic Review</p> <p>Halim et al, 2018 (14)</p>	<p>A systematic review, which included 14 articles, assessing the effect of interventions on theatre start time. Financial incentives, educational approaches, system-based techniques, communication, the 'golden patient' initiative and 'the productive operating theatre' scheme have all been shown to improve start time. However, questions remain over which is the most effective, the longevity of their effects and whether the results can be extrapolated beyond the context in which they were studied.</p>
<p>Improving the Productivity of Elective Surgery Through a New 'Package of Care'</p> <p>Ashton et al, 2012 (15)</p>	<p>A district health board (DHB) in New Zealand introduced a 'package of care' (POC) in which incentive-based, risk-sharing contracts were developed collaboratively between DHB managers, surgeons and anaesthetists. Analysis indicates that, after controlling for age, case mix and complexity, the POC resulted in shorter theatre times, shorter lengths of stay and lower average inpatient event costs compared with standard care at the public hospital. An unintended consequence could be that the POC may encourage throughput of less complex cases at the expense of more complex cases.</p> <p>[see also Cullen et al, 2012]</p>
<p>Improving Operating Theatre Efficiency: An Intervention to Significantly Reduce Changeover Time</p> <p>Soliman et al, 2013 (8)</p>	<p>A two-phase prospective cohort study was undertaken over four weeks at a single institution, which included 42 patients. There was a reduction in overall case changeover times demonstrated with the utilisation of a structured intervention, with the surgical registrar actively involved in the patient's operative journey - from 27.7min to 15.7min.</p>
<p>Improving theatre turnaround time</p> <p>Fletcher et al, 2017</p>	<p>A quality improvement project to improve orthopaedic theatre turnaround without compromising patient safety. The process mapped at all stages, from application of dressing to knife to skin on the next patient, in order to identify potential areas for improvement. Mean turnaround time almost halved from 66.5 minutes in July to 36.8 minutes.</p>

Source	Summary
Peer reviewed sources	
<p>Policy strategies to reduce waiting times for elective surgery: A scoping review and evidence synthesis</p> <p>Bachelet et al, 2019 (12)</p>	<p>A scoping review on interventions to reduce waiting times for elective surgery, which focused on:</p> <ul style="list-style-type: none"> • Increased funding • Surgical pathways and restructuring of the referral process • Score-based prioritisation strategies • Policies to induce the take-up of private health insurance. <p>Evidence suggests that interventions should be multidimensional, with prioritisation strategies that incorporate equity criteria, together with quality management improvements of the surgical pathways and the use of operating rooms, as well as improvements in the planning of the surgical schedule. The findings support the need for supplemental funds to bolster an increased hospital productive capacity, including infrastructure but also human resources. Some interventions included setting up hospital annexes or special wards devoted exclusively to resolving low complexity surgeries. A dedicated operating room for emergency or semi-emergency surgeries to ensure that the operating rooms dedicated to the elective procedures can work unhindered. In countries where access guarantees have been incorporated, this macro-regulatory measure has been associated with reduced waiting times for patients covered by prioritised conditions, but only to the extent that additional funds have been allocated.</p>
<p>A Surgeon-Led Model to Improve Operating Theatre Change-Over Time and Overall Efficiency: A Randomised Controlled Trial</p> <p>Mizumoto et al, 2016 (7)</p>	<p>A single-blinded, randomised controlled intervention study comparing a surgeon-led, team-based model of strategies versus routine patient change-over. Model was trialled by a single surgeon. The primary outcome was the difference in change-over times compared with four other surgeons who were blinded and served as control. 1265 patients were randomised into five general surgical lists that included all major and minor cases. The median number of operative cases were 214 per surgeon, with an overall median change over time of 17.9 ± 3.7 min. Surgeon A in the intervention group had a median change-over time of 12.1 ± 5.4 min (p < 0.001), translating to a 58% reduction in median change-over time between the intervention and control groups.</p>

Table 2: Grey literature

Source	Summary
Grey literature	
<p>Helping NHS providers improve productivity in elective care</p> <p>Monitor (NHS), 2015 (16)</p>	<p>NHS trusts could achieve 13% to 20% productivity gains from today’s spending on elective ophthalmology and orthopaedic care if they all adopt the nine good practices reviewed in this report.</p> <p>Focusing on five of these will realise most of the potential productivity gain in elective care available to NHS hospitals:</p> <ul style="list-style-type: none"> • stratifying patients by risk and creating low-complexity pathways for lower risk patients • extending clinical roles to enable lower-grade staff to undertake routine tasks in theatre or outpatients usually performed by consultants • increasing throughput in theatres by explicitly measuring, communicating and managing the number of procedures per theatre session • implementing enhanced and rapid recovery practices to reduce length of stay • providing virtual follow-up for uncomplicated patients.

Source	Summary																								
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	<p>Figure 1: Nine levers to improve productivity across the elective care pathway</p> <p>Optimised care pathway</p> <table border="1"> <thead> <tr> <th>First specialist input</th> <th>Outpatient care</th> <th>Inpatient pre-operative care</th> <th>Surgery</th> <th>Inpatient post-operative care</th> <th>Follow-up post discharge</th> </tr> </thead> <tbody> <tr> <td> <ol style="list-style-type: none"> 1 Stratification of patients by risk and alignment of resources to risk </td> <td> <ol style="list-style-type: none"> 2 Streamlined diagnostics, outpatients and pre-assessment </td> <td> <ol style="list-style-type: none"> 3 Day of surgery admission </td> <td> <ol style="list-style-type: none"> 4 Specialisation and extended roles within team 5 Optimised scheduling and management 6 Surgical teams supported to use theatres efficiently </td> <td> <ol style="list-style-type: none"> 7 Standardisation of ward care and enhanced recovery 8 Proactive management of infections and readmissions </td> <td> <ol style="list-style-type: none"> 9 Nurse/AHP-led and virtual follow-up for routine patients and alignment of follow-up intensity to patient risk profile </td> </tr> <tr> <td colspan="6">Sources of efficiency - examples</td> </tr> <tr> <td> <ul style="list-style-type: none"> • Reduced number of pre-assessment appointments • Reduced cost of staff undertaking appointments </td> <td> <ul style="list-style-type: none"> • Reduced number of outpatients appointments • Higher volume of appointments per staff member and per clinic </td> <td> <ul style="list-style-type: none"> • Reduced number of days/time in hospital preop </td> <td> <ul style="list-style-type: none"> • Increased number of patients per hour • Reduced postop infection • Increased theatre utilisation, reduced cost of theatre and staff </td> <td> <ul style="list-style-type: none"> • Reduced number of days/time in hospital postop • Reduced readmissions </td> <td> <ul style="list-style-type: none"> • Reduced number of follow-up outpatient appointments • Lower staff costs per follow up appointment </td> </tr> </tbody> </table> <p>Supporting conditions to improve productivity include:</p> <ul style="list-style-type: none"> • Standardised pathways and protocols. These clarify which tasks should be done and by whom, so individuals can be held to account for particular tasks. Standardisation also helps identify opportunities to extend roles. 	First specialist input	Outpatient care	Inpatient pre-operative care	Surgery	Inpatient post-operative care	Follow-up post discharge	<ol style="list-style-type: none"> 1 Stratification of patients by risk and alignment of resources to risk 	<ol style="list-style-type: none"> 2 Streamlined diagnostics, outpatients and pre-assessment 	<ol style="list-style-type: none"> 3 Day of surgery admission 	<ol style="list-style-type: none"> 4 Specialisation and extended roles within team 5 Optimised scheduling and management 6 Surgical teams supported to use theatres efficiently 	<ol style="list-style-type: none"> 7 Standardisation of ward care and enhanced recovery 8 Proactive management of infections and readmissions 	<ol style="list-style-type: none"> 9 Nurse/AHP-led and virtual follow-up for routine patients and alignment of follow-up intensity to patient risk profile 	Sources of efficiency - examples						<ul style="list-style-type: none"> • Reduced number of pre-assessment appointments • Reduced cost of staff undertaking appointments 	<ul style="list-style-type: none"> • Reduced number of outpatients appointments • Higher volume of appointments per staff member and per clinic 	<ul style="list-style-type: none"> • Reduced number of days/time in hospital preop 	<ul style="list-style-type: none"> • Increased number of patients per hour • Reduced postop infection • Increased theatre utilisation, reduced cost of theatre and staff 	<ul style="list-style-type: none"> • Reduced number of days/time in hospital postop • Reduced readmissions 	<ul style="list-style-type: none"> • Reduced number of follow-up outpatient appointments • Lower staff costs per follow up appointment
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	<ul style="list-style-type: none"> • Effective performance management systems to support active, real time analysis and provide evidence for performance review discussions. • Visible leaders accountable for continuous improvement from board to ward. • Adapted staff contracts supporting implementation of a good practice care pathway. Extended or specialist roles for junior staff to include routine work currently performed by consultant surgeons or anaesthetists. • Efforts to engage patient and families in their own care.
<p>Operating Theatre Efficiency Guidelines Agency for Clinical Innovation, 2014</p>	<p>Three main sections:</p> <ol style="list-style-type: none"> 1. Operating theatre (OT) metrics <ul style="list-style-type: none"> • Provides an overview of the range of metrics that may be relevant for monitoring efficiency and productivity of the OT at the hospital, local health district (LHD) and SST/Ministry levels. • Includes recommendations on the metrics that should be consistently utilised across NSW. 2. Whole of surgery <ul style="list-style-type: none"> • Provide recommendations on processes that can be employed by clinical and executive leadership, managers and staff to enhance OT efficiency while maintaining a high standard of care. 3. OT costing <ul style="list-style-type: none"> • Provides tools to enable accurate and consistent costing of OT activity at the hospital level.
<p>The Productive Operating Theatre Clinical Excellence Queensland</p>	<p>Drawing on Lean principles applied to clinical service redesign, which sought to achieve:</p> <ul style="list-style-type: none"> • Increased productivity due to improved utilisation of theatre lists, reduced delays within scheduled sessions, less overruns and late starts.

Source	Summary
Grey literature	
	<ul style="list-style-type: none"> • Financial savings attributed to better management of stock, reduced amounts of stock held and better rotation and ordering practices. • Increased staff morale and lower sick leave levels. • Improved patient experience. • Improved team performance. • Increased surgical activity.
<p>Victorian Public Hospital Operating Efficiency</p> <p>Victorian Auditor-General’s Office, October 2017</p>	<p>This report concluded that operating theatres are an under-utilised resource. More could be done with existing resources to achieve reduced elective surgery wait times and shorter waiting lists. Operating theatres are sitting idle for significant periods of time within planned surgical sessions because of late starts and early finishes.</p> <p>Health services need to focus more management attention on factors within their control and collect better performance data. Current funding arrangements and patient preferences present barriers to health services optimising their operating theatre efficiency.</p> <p>The Department of Health and Human Services (DHHS), as the system manager of the health sector, needs to reconsider how it funds health services to ensure that hospitals are encouraged to fully utilise operating theatres. There are opportunities for DHHS and health services to improve operating theatre efficiency and access to surgery for patients.</p>
<p>Managing operating theatre efficiency for elective surgery</p> <p>NSW Auditor-General, 2013</p>	<p>Operating theatres in NSW can be managed more efficiently and there is potential for higher volumes of elective surgeries to be conducted at current funding and resourcing levels.</p> <p>NSW Health is not meeting its three key elective surgery efficiency targets for theatre utilisation, cancellations on day of surgery and first case starting on time. There is wide variation against these efficiency targets between local health districts and hospitals across NSW.</p> <p>Managers do not have all the information they need to manage operating theatre efficiency.</p>



Source	Summary
Grey literature	
<p>Operating theatres: opportunities to reduce waiting lists</p> <p>NHS Improvement, 2019</p>	<p>A report based on data from 92 NHS trusts found significant variation in theatre productivity across trusts and specialties. A third of operating lists started 30+ minutes late and 38% finished 30+ minutes early. Over the course of a year, more than 111,000 operations finished 60+ minutes early. Day lists comprising three four-hour sessions were particularly likely to finish early. The study estimated that theatre time lost to late starts, early finishes and delays between operations could potentially have been used to undertake 16.8% more operations across the group as a whole.</p> <p>Areas to improve productivity varied across sites but include:</p> <ul style="list-style-type: none"> • assessment of bed availability and its effect on patient flow • effective scheduling and making sure theatre lists are always ‘fully’ booked • streamlining admission processes to ensure availability of both the surgical team and the patient allows a prompt theatre start • working with the whole surgical team to <ul style="list-style-type: none"> ○ understand the reasons for surgery cancellations and thereby minimise cancellations on the day ○ streamline admission processes to ensure that the whole surgical team and patients are available for a prompt theatre start ○ minimise the gaps between cases • including surgeons and anaesthetists in their organisation’s leadership team for theatre improvement programs.

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