Peer-reviewed article

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Coordination of procedural equipment and supplies for the surgical set-up in the perioperative environment: A scoping review

Abstract

Background: Defective, incorrect or missing procedural devices from the surgical set-up contribute to delay, interruption, cancellation and patient harm in the perioperative environment.

Objective: This scoping review aims to identify evidence to guide approaches to surgical set-up used by perioperative health service personnel, organisations or teams. In addition, the review aims to describe factors that hinder or support the surgical set-up, identify gaps in the literature and determine any issues impacting the quality of available evidence.

Methods: Empirical research and grey literature were retrieved from seven electronic databases. Titles and abstracts were screened before full text screening. A mixed method appraisal tool (MMAT) and quality improvement minimum quality criteria set (QI-MQCS) were used for critical appraisal. After data extraction from included studies, key concepts were synthesised, thematically analysed and reported.

Results: Forty-nine full texts were included. Evidence generated by nurses responsible for the surgical set-up is limited. The majority of studies were quality improvement studies to reduce inefficiencies through optimisation or mathematical modelling with outcomes measured in cost and time saved. There is limited evidence exploring how optimisation or mathematical modelling impacts the work of perioperative staff.

Conclusion: Technology will continue to influence work systems and processes of the surgical set-up. Implementing surgical set-up quality indicators within policy may aid waste and cost reduction of organisations. The impact of human factors upon the surgical set-up is relatively unaddressed. Nurse-led research on the surgical set-up would be valuable as nurses are key professionals contributing to delivery of, management of and policy about surgical set up.

Introduction

The effective, safe and timely management of surgical devices is fundamental to patient outcomes. Internationally, evidence suggests problems with surgical set-up processes contribute to delay, interruption or cancellation of surgery[1–3]. Problems include inadequate information regarding surgical supplies, waste from unused opened devices and superfluous, defective, incorrect or missing surgical equipment[2, 4–6].

A surgical set-up can be a dynamic, labour-intensive process fraught with complex, time sensitive challenges in a technological environment with evolving procedural techniques[7–9]. Many staff working at different times and locations contribute to surgical set-ups; these staff include technicians, medical device representatives and nurses. Confusion about equipment and procedural information has been reported with perioperative nurses being 'busy locating equipment' at the beginning of surgical lists[4, p.3]. For example, an observational study by Rappold et al.[10] in the United States of America (USA) recorded more than 4000 surgeon preference cards were unused, contributing to ineffective procurement, unused opened devices and superfluous instruments. Evidence regarding how to best approach and organise surgical set-up processes for perioperative personnel, organisations and teams would be valuable.

The aim of this review was to examine the availability of evidence to guide the surgical set-up. Primary scholarly literature was reviewed to identify and map available evidence and describe factors that hinder or support the surgical set-up. The review also aimed to identify gaps in the literature regarding the surgical set-up and to determine issues impacting the quality of available evidence.

Methods

A scoping review guided by Joanna Briggs Institute (JBI) methodology[11] was conducted and is reported according to the PRISMA-ScR (preferred reporting items for systematic reviews and meta-analyses, extension for scoping reviews)[12]. The JBI framework of population, concept and context (PCC)[13] was used with key terms defined as:

- **population** – health service personnel, organisations, groups or teams responsible for the surgical set up
- **concept** – the surgical set-up which involves timely, coordinated organisation of single-use and re-usable medical devices (RMD), biomaterials and ancillary equipment. A set-up, or case assembly, is defined as assembly of physical resources needed for a procedure and may include opening and laying out surgical set-up items within the procedural room[14]. This includes surgical instruments, single-use isolation drapes, implants and ancillary medical equipment such as laparoscopic carbon dioxide insufflation devices[15].
- **context** – the perioperative environment. The Australasian Health Facility Guidelines[14] identify the perioperative environment to be an environmentally controlled area with one or more operating rooms to support patient procedural interventions under inhalation or other anaesthetic agents.

Types of evidence

Primary studies including randomised and non-randomised controlled trials, quality improvement projects and case, case-controlled, observational and cohort studies were eligible for inclusion. Literature reviews or discussion papers were excluded. Studies focused on testing safety and efficacy of surgical devices for patient outcomes, such as trials of new surgical devices were also excluded.

Search strategy

A three-step search strategy included an initial search of Cumulative Index for Allied Health Literature (CINAHL) and Scopus identifying medical subject headings (MeSh) for key terms within titles and abstracts[16,17]. Seven electronic databases were subsequently searched using MeSh terms: CINAHL, Joanna Briggs Institute EPD (via OPD), Scopus, PubMed, Cochrane Central Register of Controlled Trials (CENTRAL). Grey literature was sought via Overton and ProQuest Dissertations and Theses Global (PQDT)™. The search strategy used for Joanna Briggs Institute EPD database is presented as Supplement 1. With a lack of access to translators, only papers in English were included. The publication timeframe was from database inception to 25 March 2023 to permit capture of trends over time. Reference lists from included sources were examined for additional relevant literature. A PRISMA-ScR flowchart is presented in Figure 1.

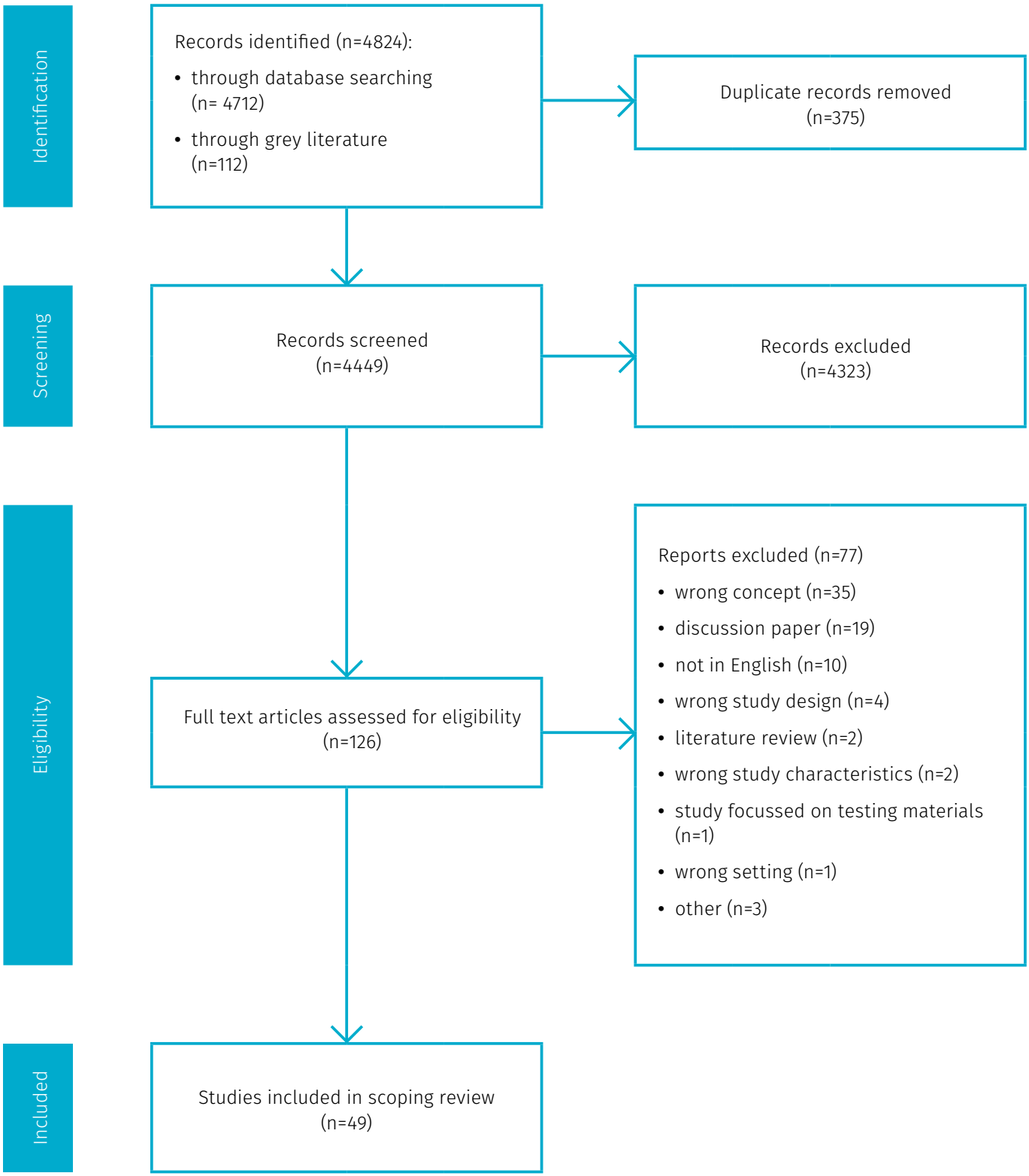

Figure 1: PRISMA flow diagram of paper selection process

Selection of evidence

Piloting of the eligibility criteria was undertaken by three reviewers (ML, JD, JM) screening three full texts followed by discussion (see Supplement 2). The eligibility criteria were rephrased for clarity prior to screening. Search results were imported to EndnoteTM and duplicates removed, then into CovidenceTM for review. Titles and abstracts were screened against the eligibility criteria by three reviewers (ML, JD, JM), then full texts were screened for eligibility by two independent reviewers (ML, JM). Disagreements were resolved through consensus. Reasons for exclusion are summarised in Figure 1.

Data charting process

An adapted JBI data extraction instrument (Supplement 3) was developed and pilot tested. Data was extracted independently from the aims of each study, and included the population, concept, context, type of evidence, citation, participants, country of origin and approaches used for the surgical set up. Factors that hinder or support a surgical set-up were also extracted from the results of each paper.

Critical appraisal

Critical appraisal was undertaken using the mixed method appraisal tool (MMAT)[18] and quality improvement minimum quality criteria set (QI-MQCS)[19] relevant to the study design. Studies were evaluated by methodology to identify trends and strengths or weaknesses.

Synthesis of results

Extracted data was synthesised into narrative and tabulated results addressing the population, concept and context outlined above. Approaches to the surgical set-up were mapped with key themes identified and narratively summarised. Factors that hinder or support the surgical set-up were thematically analysed and classified.

Results

Forty-nine papers are included in this scoping review[20–68]. Most studies were conducted in the United States of America (USA)[20–22,25–27,30–32,34–44,47,48,50,56,57,60–62,64,65,67] (n = 31).

The remainder were conducted in Europe[24,45,46,51–54,58,66] (n = 9), Singapore[29,33,63] (n = 3), Brazil[49,68] (n = 2), Canada[23,28] (n = 2), Australia[55] (n = 1) and Australia and Brazil binationally[59] (n = 1). Included studies were published over 35 years from 1986 to 2023. From 2005 the number of publications increased, with a sharp rise from 2015 (see Figure 2).

Characteristics of included studies

Supplement 4 summarises the characteristics of the included studies. Over half of included papers were quality improvement projects focused on waste minimisation[20–45] (54%, n = 26). Of these, more than three quarters aimed to eliminate inefficiencies, reduce costs and comply with the Patient Protection and Affordable Care Act[69] in the USA[20–22,25–27,30–32,34–44] (77%, 20/26).

Four mixed methods studies explored hazards or work systems responsible for re-usable medical devices, often within a human factors or failure effects model[46–49]. One mixed method study examined how physician preference card planning and communication influenced unplanned costs[50]. Nine observational studies sought to evaluate resource inefficiencies[51–59]. Four observational studies modelled the optimal number of resources needed

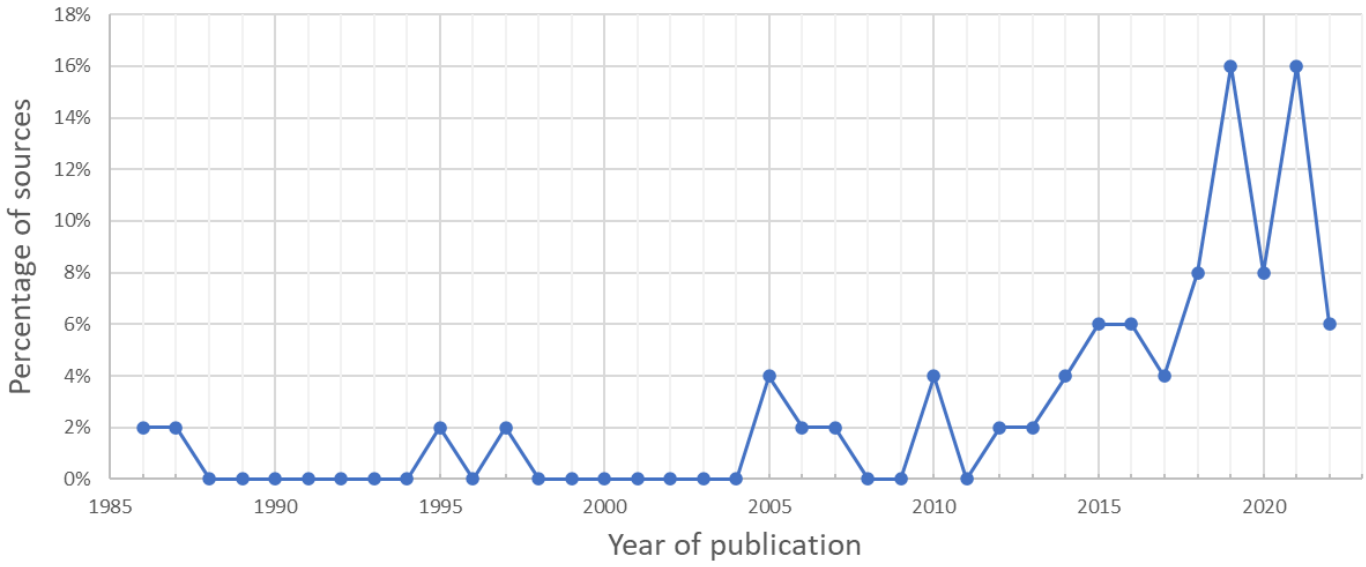

Figure 2: Distribution of published sources 1986 to 2022

to deliver surgical services[60–63]. Of three experimental studies, one compared costs between streamlined procedural and standard operating room packs[64], one compared sterility for procedural packs transported between hospital sites[65] and one analysed instrument descriptions used by nurses[66]. One qualitative study explained organisational strategies for influencing stakeholders involved in medical device procurement[67]. One case study mapped perioperative flow of instruments[68].

Factors that hinder the surgical set-up

Factors that hinder the surgical set-up are multidimensional, occurring at different times and locations throughout procedural departments. Three themes identified were waste, lack of governance and human factors.

Waste

The included studies focused on three sources of waste: medical device defects, unused opened medical devices and inefficient use of time.

Medical device defects

Eighteen types of defects were identified across seven studies[34,37,40,47,48,55,57]. The defects were classified as either sterile or non-sterile (see Table 2), according to the classification used by Palo et al.[37] where sterile defects are any problem compromising the sterile integrity of an RMD, and non-sterile defects are any problem influencing the accuracy, functionality or availability of an RMD.

Sterile defects were less frequent than non-sterile defects; the incidence of sterile defects ranged from two per cent[21] to six per cent[37] while the incidence of non-sterile defects ranged from 10.9 per cent[48] to 52.0 per cent[37]. Missing instruments was the most problematic non-sterile defect, with incidence ranging from 17.6 per cent[48] to 77 per cent[37]. One observational study[57] reported that the incidence of missing, broken or unplanned instruments or tray errors was higher (49%) when trays had over 40 instruments compared to when trays had less than 40 instruments (13%).

Unused opened medical devices

In a study of 23 commonly used orthopaedic instrument trays, Cichos et al.[22] reported low instrument utilisation resulting in waste – 23 per cent (n = 182/792) of all opened RMD were used. Across the studies, the incidence of unused opened RMDs for total knee arthroplasties varied from 13.0 per cent[57] to 54.5 per cent[32] (n = 47/87). Harris[62] reported that 70748 instruments were opened and not used annually in a level three trauma centre with eight procedural rooms servicing 6000 procedures. A quality improvement project by Levine[31] found unused opened medical devices also included prosthetics, with 400 unused opened orthopaedic implants resulting in $425000 lost over three years. An observational study by Chasseigne et al.[54] identified nurses' perceptions about why medical devices in the operating room were opened and unused; reasons included anticipation of surgeon needs (33%, 52/152), wrong choice or unsuitable supplies (20%, n=30/152) and aseptic mistakes (18%, n=27/152).

Inefficient use of time

A work sampling study by Ikuma[56] reported that, for 12 knee arthroplasties observed, 68 per cent (124/182 minutes) of surgical time was dedicated to preparing instruments, preparing the operating room and clean-up, compared to 54 per cent (100/182 minutes) dedicated to performing the procedure. However, authors noted the researcher was not always present when instrument preparation commenced, so instrument preparation time may be longer than reported[56]. An observational study by Chasseigne et al.[54] identified unintentional absence of the circulating nurse for up to one quarter of procedural time. Reasons for absences included

Table 2: Sterile and non-sterile re-usable medical device defects[34,37,40,47,48,55,57]

Sterile defects	Non-sterile defects
bioburden (microscopic or foreign body)	broken
contamination	damaged
instrument not disassembled	expired
missing chemical indicator	incorrect
non-bioburden debris (e.g. pen)	incorrect device pulled for set-up
	malfunctioning
	mislabelled
	mismatched instrument/set
	misplaced
	missing
	paperwork/turnover issue
	wrong storage location

additional surgeon demands (30%, n = 16/53), surgical set-up incompleteness (25%, n = 13/53), new supplies required (23%, n = 12/53), defects (19%, n = 10/53) and implant size error (4%, n = 2/53). Of 49 procedures observed by Stockert and Langerman[57] the surgeon was idle during non-operative time for 29 per cent of procedures (n = 14) due to instrument errors, with each interruption lasting eight minutes on average.

Lack of governance

The included studies highlighted a lack of governance for the surgical set-up. A health care failure model and effects analysis at two hospital sites by Guédon et al.[46] reported up to 172 hazards in the delivery of loaned orthopaedic instruments. One quarter of hazards (26%, n = 41/158) were not managed; rather, organisations reportedly accepted that adverse events may occur, with up to 31 per cent (n = 49/158) deemed high risk.[46] High risk hazards included incomplete pre-operative information in digital planning systems.[46] Only one per cent (n = 1/172) to five per cent (n = 8/158) of hazards were controlled in the delivery of loaned orthopaedic instruments across both hospitals.[46]

A cross-sectional study undertaken in Australia and Brazil by Tripple et al.[59] identified loaned devices did not conform to a recommended arrival time of 48 hours prior to surgery due to high loan turnover among health services, with approximately 63 per cent (n = 141/221) of loan devices arriving less than 24 hours prior to surgery. Alfred et al.[48] identified that the absence of instrument descriptions and photographs during sterile reprocessing resulted in incorrect or omitted instruments from trays. A quality improvement project by Prephan[40] identified instrument availability was reduced in the absence of repair and maintenance schedules.

Four studies reported routine purchasing, with no systematic data analysis to inform decision-making, encouraged excess quantities and wastage from expiration or obsolescence[22–24, 42]. Similarly, Levine et al.[31] found no records of inventory for orthopaedic implants, with unused opened implants costing $25 000 a month. A quality improvement project to standardise surgeon pick lists by Simon et al.[41] found duplicated products: five comparable laparoscopic clip appliers were stocked from three manufacturers, despite no clear clinical benefit of similar products. Del Carmen et al.[24] identified the need to address items being out of stock, stock mismatch and urgent restocking using technological inventory systems. A study modelling surgical instrument distribution for ad hoc orders[63] found that even when inventory systems were available, pre-procedural time constraints inhibited the documentation of last-minute device changes.

Human factors

Various human factors were observed to influence the surgical set-up, with themes of unaddressed communication issues and ineffective collaboration. A quality improvement project to improve instrument availability[40] identified skilled labour shortages coupled with inadequate orientation led to performance deficits for sterilisation technicians. A hazard analysis for delivery of orthopaedic loaned devices by Guédon et al.[46] found instruments were occasionally double booked suggesting a lack of multidisciplinary communication.

Two studies[48,66] reported that intra-operative comprehension of instruments decreased when nurses were temporarily assigned or unfamiliar with the surgery, or when one instrument had multiple names. Nonetheless, an observational study by Chasseigne et al.[54] reported nurses occasionally opened medical devices out of 'comfort' rather than patient need (12%, n=18/152). A quality improvement study by Nilsen[36] to determine appropriate operating theatre inventory identified that low surgical device supply generated employee stress, with staff hiding surgical cameras for fear of not having the device ready. A vicious cycle of camera unavailability persisted with impact on patients re-scheduled to an earlier start, although the exact impact was not clearly defined.

Factors that support the surgical set-up

The included studies primarily focused on optimisation – increasing procedural efficiency and reducing cost through standardisation, patient matched devices and eliminating unused medical devices[32,41,51]. One study reported initiatives to support technicians responsible for the surgical set-up included training for bioburden inspection, testing device functionality, instrument tray completeness and sterilisation processes[48]. There were no initiatives supporting professional development of perioperative nurses.

Optimisation

Twenty-one studies focused on optimisation of medical device use through eliminating unused devices, patient matched devices or standardisation, primarily in orthopaedics[20,22,32,43,45,51,52] (n = 7), otolaryngology[23,28,38,42,57] (n = 5) and various other specialities[25–27, 30, 39, 41, 44, 49, 64] (n = 9). Interventions included

reducing the volume[20–23,25,27,28,32,38,39,42–45,49,51,52] (n=17) and weight[20–22,25,27,38] (n = 6) of devices on trays, with outcomes measured in time[20,21,23,25,27,28,32,35,41,42,44,45,51,52] (n = 14) and costs saved[20–22,25–28,30,32,38,39,41,42,49,51,52,64] (n = 17).

Eliminating unused devices and patient matched devices

Substantial cost savings were often achieved through eliminating unused intstruments. For example, a 30 per cent reduction (n = 31616/106959) in unused opened medical devices for total knee arthroplasty saved on average USD$191434 ($18653–$364216) annually[32]. An observational cohort study[51] estimating the economic value of patient matched instrumentation saved 20 minutes per knee arthroplasty, or 7000 minutes annually, thereby increasing service capacity.

Dreyfus et al.[50] observed a curvilinear relationship between planning items needed for surgery and unplanned costs. Over two years, revisions to physician preference cards initially increased unplanned costs; however, unplanned costs dramatically fell after the sixth revision of physician preference cards[50]. A $5.83 billion waste reduction was achieved in this same study when physician preference cards were revised nine times over two years, with cost savings plateauing at 11 preference card revisions over the same timeframe[50].

Less frequently, studies assessed staff satisfaction when instruments were reduced or eliminated[28,42,44,45,54]. Through surveys, Wannemuehler et al.[42] identified that most scrub nurses (93.75%, n = 16) expressed satisfaction with the reduction of adenotonsillectomy instruments and, as a result, no longer needed to search through dozens of unused devices on instrument trays[42]. In their study of optimised otolaryngology surgical trays, Fu et al.[28] reported that eleven (92%) participants achieved enhanced set-up efficiency without impacting education, patient safety or operating time. An optimisation pre-post satisfaction survey by Toor et al.[44] identified that the percentage of staff members who reported that 'inventory configuration is unacceptable, and I am significantly concerned that it can affect clinical operations' fell from 48 per cent (n = 29/60) before optimisation to 3.3 per cent (n = 2/60) after optimisation[44, p.6]. Staff satisfaction surveys were conducted as part of larger studies conducted by Howard[64] and Capra et al.[20] but no results were reported.

Chasseigne et al.[54] found that waste prevention could be improved through effective communication between surgeons, instrument nurses and circulating nurses at the beginning of and during a procedure, followed by knowledge of surgical techniques.

Standardisation

Six studies explored medical device standardisation, with joint cost savings for hospitals and surgeons, in addition to vendor competitive bargaining[26,29,31,37,41,67]. Montgomery and Schneller's qualitative study[67] of physician behaviour and countering suppliers' power in purchasing devices defined models of standardisation, with methods and mechanisms to achieve standardisation. A quality improvement study by Goh et al.[29], focussed on instrument management within the sterile stock unit, found eliminating different vendors offering the same products decreased variability and duplication, resulting in a reduction from 75 general surgery sets to 45, saving S$64000 per year while maintaining timely supply for surgery.

Staff professional development

Six studies implemented professional development opportunities for technicians responsible for the surgical set-up[29,33,35,37,48,63]. Strategies included preceptorship, training, orientation, formal education and in-service education[29,33,48]. Palo et al.[37] found technician cross-rotation, orientation and competency assessments aided reduction of non-sterile defects by 56 per cent (46.8 to 26.5 defects per 1000 cases). Staff redistribution informed by workload analysis as reported in a study by Lum et al.[33] reduced reprocessing time by five per cent (267 min/day from 89 procedures) and sterile stock room replenishment time by 29 per cent (254 minutes to 180 minutes).

Job redesign included reassignment of tasks – including delivery of instruments to operating rooms, packing, storing, decontamination and sterilisation – from nurses to technicians[33,70]. Task reassignment was proposed to enable nurses to spend more time with patients in the operating room[33,63]. Ngu[35] used weekly meetings to aid pre-operative planning for assigning preference cards, implants and medical devices to surgical cases. Goh et al.[29] found that supporting staff through successful implementation of instrument management systems increased workplace safety.

Critical appraisal of literature

Supplement 5 summarises critical appraisal of studies. Weaknesses apparent in observational studies[51–57,60–62,70] (n = 13) included limited use of reporting guidelines, unclear study design and unknown risk of non-response bias (limited response or dropout rates, and reporting of reasons for non-participation). Only six of the 26

quality improvement projects were reported according to the SQUIRE guidelines[20,23,28,37,39,71]. Patient health-related outcomes among quality improvement projects were rarely measured, despite four studies[26,27,31,32] describing patient safety and quality as a priority.

Gaps in evidence

This scoping review identified a lack of available evidence from the perspective of perioperative nurses despite their being key professionals responsible for the surgical set-up. Studies primarily reported attempts to reduce medical device waste through optimisation or mathematical modelling to support efficiency and cost reduction[20,25,51,60]; there was limited evaluation of impact on the perioperative environment, personnel responsible for the surgical set-up (including registered nurses) and patient outcomes. No studies examined organisational behaviours of perioperative team members responsible for the surgical set-up.

Discussion

This scoping review explored available evidence focused on the surgical set-up. Most included studies were organisational quality improvement projects, with outcomes of procedural efficiency measured by time and cost savings. Strategies to optimise procedural devices include elimination, standardisation and customised patient devices[72–74]. Enhancing efficiency also included mathematical modelling to predict how many people or devices are needed for surgery[60–62,75]. The review revealed the scarcity of primary research studies focusing on outcomes related to the surgical set-up, such as patient outcomes. The volume of quality improvement projects versus the lack of primary research identifies research opportunities, particularly from the perspective of intra-operative nursing as these specialties perform key roles in surgical set up processes[5,76].

An increasing volume of papers from 2005 onwards focused on waste management. This may reflect the importance of surgical set-up problems or the improvement in access to data over time, with the introduction of advanced tracking and monitoring systems[77,78]. As the complexity and diversity of procedural care evolves, solutions involving automation are increasingly common in health services. Despite numerous benefits, technology in the perioperative environment is known to negatively influence workflow[79]. Impacts to workflow include additional job demands for nurses who are also expected to be abreast of technology and troubleshooting[79–81].

The increase in technology and specialised procedures, for example patient positioning during robotic surgery, has transformed routine nursing care into a highly technical, complex and arduous responsibility[81]. Mastery of surgical set-up technology is stressful and can adversely impact the health, well-being and professional efficacy of nurses[81,82], and this impact is worthy of consideration by management. As technology and artificial intelligence continue to evolve, exploring how technology influences the work involved in a surgical set-up will require ongoing investigation as well as policy and practice reform.

A number of studies in this review implemented professional development for sterilisation technicians about the pre- and post-procedural phase[33,37,47,48,59]. However, there was limited focus on education for intra-operative nurses and other perioperative professionals. Evidence-based educational approaches are crucial for patient care and safety. Intra-operative nurses learning new technologies 'on the job' and during real time surgery is reported to cause nurses to experience fear and anxiety about harming the patient[82].

Schuessler et al.[81] recommend universally standardised training and certification for professionals involved in robotic surgeries, rather than the duration and content of education being determined by individual hospitals resulting in education of varying quality. Evidence-based methods of teaching and learning for perioperative nurses include a range of self-directed online training, high fidelity simulation, team-focused training and practice operations involving animal cadavers[83,84].

As evidenced by the focus on waste found in this scoping review, governance of the surgical set-up simply cannot keep pace with technology. The variation in physician experience and skill that influences device preferences combined with unpredictability of procedures makes it difficult to create and standardise protocols[10]. Effective governance is also made more challenging by fiscal and time constraints[10]. Subsequently, perioperative departments harbour excessive, outdated and obsolete medical devices with limited systematic organisation, and this results in waste.

A lack of governance may also be influenced by perioperative efficiency measures, such as theatre utilisation representing patient intra-operative time[85]. It is unclear if theatre utilisation metrics are reliable or useful to nurse managers, given that a number of quality improvement projects included in

this review attempted to reduce intra-operative waste. The findings from this review suggest that there is a lack of efficiency measures that reflect contemporary intra-operative challenges for nursing.

Incorporating quality indicators within health service policy may be the first step in aiding governance reform for the surgical set-up. By doing so, health services can effectively streamline surgical set-up processes and optimise resources to reduce waste and costs. Examples of quality indicators for the surgical set-up include the availability and usability rates of devices and equipment[86]. Surgeon preference cards used to prepare surgical set-ups are often unreliable, with instruments added intra-operatively due to patient anatomy, contamination or error. Efforts to enhance the reliability of surgeon preference cards include frequent revision based on actual surgical requirements[25].

Without policy change, waste and inefficiencies will likely continue to impact patient outcomes such as surgical cancellations[87] and delays in emergency surgical operating lists[88]. Lost time caused by medical device waste has a knock-on effect of delaying surgery for other patients; waiting for instrument availability is a logistic factor known to influence the queue of surgical cases[88]. These delays reportedly lead to conflict between theatre managers and surgeons[88]; however, the impact on patient outcomes is not often measured.

Studies included in this scoping review suggested that unaddressed communication failures impact surgical set-up processes[27,50,54]. Although surgical devices are prescribed in advance, it has been argued that theatre nurses need more support and surgeons have passive involvement in surgical set-up processes[5,89]. Over-supply by perioperative services results in underutilisation. The volume of time and energy that perioperative nurses subsequently spend counting and managing complex medical devices is acknowledged within limited primary research[56,90]. Procedural interruptions arising from surgical set-up problems are a distraction to the surgical team and raise concerns for patient safety[1,91]. Apart from fixing excessive volume of surgical devices through optimisation downstream, there is limited research focused on proactively improving communication and collaboration between stakeholders to identify and effectively coordinate the surgical devices actually needed.

Chasseigne et al.[54] suggested that unused opened devices were mostly preventable through effective communication about the surgical set-up. Potential causes of perioperative communication failure include inadequate pre-operative preparation, lack of personnel and disruptive behaviours including the perception that nurses serve as 'secretaries and problem solvers for the whole team'[92, p. e4]. Addressing communication failures and the perception of nurses as secretaries will require a comprehensive approach to improve medical, nursing and relevant stakeholder collaboration and ensure necessary procedural devices are identified and planned in advance. Collaborative approaches must consider potential variations and unforeseen circumstance to minimise errors and omissions.

Limitations

The scoping review only included studies written in English language and therefore may be limited in generalisability in countries where English is not the first language.

Conclusions

Fixing the issue of surgical set-up waste through optimisation is a short-term solution to a complex and evolving long-term problem. Most research into the surgical set-up comprises quality improvement studies, with limited primary research available. Mathematical modelling to predict the optimal number of resources to deliver a service may be helpful from a limited management perspective; however, it does not resolve unaddressed human factors, such as communication and collaboration for the surgical set up. Addressing challenges through proactive engagement could foster a culture of effective teamwork among health care providers working towards productive and efficient surgical set-up processes and ultimately improved safety and quality of procedural care.

Declaration of conflicting interests

The authors have declared no competing interests with respect to the research, authorship and publication of this article.

References

1. Gillespie BM, Chaboyer W, Fairweather N. Interruptions and miscommunications in surgery: An observational study [Internet]. AORN J. 2012[cited 2023 Dec 1];95(5):576–90. DOI: 10:1016/j.aorn.2012.02.012
2. Efthymiou CA, Cale AR. Implications of equipment failure occurring during surgery [Internet]. Ann R Coll Surg Engl. 2022[cited 2023 Dec 1];104(9):678–84. DOI: 10.1308/rcsann.2021.0345
3. Thomasson BG, Fuller D, Mansour J, Marburger R, Pukenas E. Efficacy of surgical safety checklist: Assessing orthopaedic surgical implant readiness [Internet]. Healthc (Amst). 2016[cited 2023 Dec 1];4(4):307– 11. DOI: 10.1016/j.hjdsi.2016.01.005

4. Fruhen L, Carpini J, Parker S, Leung Y, Flemming AFS. Perceived barriers to multiprofessional team briefings in operating theatres: A qualitative study [Internet]. BMJ Open. 2020[cited 2023 Dec 1];10(2):e032351. DOI: 10.1136/bmjopen-2019-032351
5. Tase A, Ni MZ, Buckle PW, Hanna GB. Current status of medical device malfunction reporting: Using end-user experience to identify current problems [Internet]. BMJ Open Quality. 2022[cited 2023 Dec 1];11(2):e001849. DOI: 10.1136/bmjoq-2022-001849
6. Rigante L, Mouous W, Vries Jd, Grotenhuis JA, Boogaarts HD. Operating room waste: Disposable supply utilization in neurointerventional procedures [Internet]. Acta Neurochir (Wien). 2017[cited 2023 Dec 1];159(12):2337–2340. DOI: 10.1007/s00701-017-3366-y
7. Hussain M, Siddharth V, Arya S. ABC, VED and lead time analysis in the surgical store of a public sector tertiary care hospital in Delhi [Internet]. Indian J Public Health. 2019[cited 2023 Dec 1];63(3):194–8. DOI: 10.4103/ijph.IJPH_282_18
8. Wachs JP, Frenkel B, Dori D. Operation room tool handling and miscommunication scenarios: An object–process methodology conceptual model [Internet]. Artif Intell Med. 2014[cited 2023 Dec 1];62(3):153– 163. DOI: 10.1016/j.artmed.2014.10.006
9. Li Y-T, Jacob M, Akingba G, Wachs JP. A cyber-physical management system for delivering and monitoring surgical instruments in the OR [Internet]. Surg Innov. 2013[cited 2023 Dec 1];20(4):377–84. DOI: 10.1177/1553350612459109
10. Rappold J, Van Roo B, Di Martinelly C, Riane F. An inventory optimization model to support operating room schedules. Supply chain forum [Internet]. 2011[cited 2023 Dec 1];12(1):56–69. DOI: 10.1080/16258312.2011.11517254
11. Wolters Kluwer Health. JBI EPB database [Internet]. Alphen aan den Rijn: Wolters Kluwer Health; 2022 [updated 2024 May 8, cited 2023 Dec 1]. Available from: ospguides.ovid.com/OSPguides/jbidb.htm
12. Tricco A, Lillie E, Zarin W, O'Brien K, Colquhoun H, Levac D et al. PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation [Internet]. Ann Intern Med. 2018[cited 2023 Dec 1];169(7):467–73. DOI: 10.7326/M18-0850
13. Joanna Briggs Institute (JBI). JBI Manual for evidence synthesis: 10.2.2 Developing the title and question [Internet]. Adelaide: JBI; 2024 [cited 2023 Dec 1]. Available from: jbi-global-wiki.refined.site/space/MANUAL/355862667/10.2.2+Developing+ the +title+and+question
14. Australasian Health Infrastructure Alliance (AHIA). Australasian Health Facility Guidelines: Part B – Health Facility Briefing and Planning, 0520 – Operating Unit [Internet]. North Sydney: AHIA; 2016 [cited 2021 March 17]. Available from: aushfg-prod-com-au.s3.amazonaws.com/HPU_B.0520_5_0.pdf
15. McCarthy J. Sutures, needles and instruments. In: Rothrock J, McEwen D, editors. Alexander's care of the patient in surgery. 15th ed. St. Louis: Elsevier Mosby; 2015. pp. 186–210.
16. Joanna Briggs Institute (JBI). JBI Manual for evidence synthesis: 10.2.5 Search strategy [Internet]. Adelaide: JBI; 2024 [cited 2023 Dec 1]. Available from: jbi-global-wiki.refined.site/space/MANUAL/355862729/10.2.5+Search+Strategy
17. National Library of Medicine. MeSH [Internet]. Bethesda: National Library of Medicine; 2021 [cited 2023 Dec 1]. Available from: www.ncbi.nlm.nih.gov/mesh/
18. Hong QN, Pluye P, Fàbregues S, Bartlett G, Boardman F, Cargo M et al. Mixed Method Appraisal Tool (MMAT) Version 2018 [Internet]. Montreal: McGill University; 2018 [cited 2023 Dec 1]. Available from: http://mixedmethodsappraisaltoolpublic.pbworks.com/w/file/fetch/127916259/MMAT_2018_criteria- manual_2018-08-01_ENG.pdf
19. Hempel S, Shekelle PG, Liu JL, Sherwood Danz M, Foy R, Lim Y-W et al. Development of the quality improvement minimum quality criteria set (QI-MQCS): A tool for critical appraisal of quality improvement intervention publications [Internet]. BMJ Qual Saf. 2015[cited 2023 Dec 1];24(12):796–804. DOI: 10.1136/bmjqs-2014-003151
20. Capra R, Bini SA, Bowden DE, Etter K, Callahan M, Smith RT et al. Implementing a perioperative efficiency initiative for orthopedic surgery instrumentation at an academic center: A comparative before-and-after study [Internet]. Medicine. 2019[cited 2023 Mar 25];98(7):e14338. DOI: 10.1097/MD.0000000000014338
21. Cichos KH, Linsky PL, Wei B, Minnich DJ, Cerfolio RJ. Cost savings of standardization of thoracic surgical instruments: The process of lean [Internet]. Ann Thorac Surg. 2017[cited 2023 Mar 25];104(6):1889–95. DOI: 10.1016/j.athoracsur.2017.06.064
22. Cichos KH, Hyde ZB, Mabry SE, Ghanem ES, Brabston EW, Hayes LW et al. Optimization of orthopedic surgical instrument trays: Lean principles to reduce fixed operating room expenses [Internet]. J Arthroplasty. 2019[cited 2023 Mar 25];34(12):2834–40. DOI: 10.1016/j.arth.2019.07.040
23. Crosby L, Lortie E, Rotenberg B, Sowerby L. Surgical instrument optimization to reduce instrument processing and operating room setup time [Internet]. Otolaryngol Head Neck Surg. 2020[cited 2023 Mar 25];162(2):215–19. DOI: 10.1177/0194599819885635
24. Del Carmen León-Araujo M, Gómez-Inhiesto E, Acaiturri-Ayesta MT. Implementation and evaluation of a RFID smart cabinet to improve traceability and the efficient consumption of high-cost medical supplies in a large hospital [Internet]. J Med Syst. 2019[cited 2023 Mar 25];43(6):178. DOI: 10.1007/s10916-019-1269-6
25. Dyas AR, Lovell KM, Balentine CJ, Wang TN, Porterfield JR, Chen H, Lindeman BM. Reducing cost and improving operating room efficiency: Examination of surgical instrument processing [Internet]. J Surg Res. 2018[cited 2023 Mar 25];229:15–9. DOI: 10.1016/j.jss.2018.03.038
26. Eiferman D, Bhakta A, Khan S. Implementation of a shared-savings program for surgical supplies decreases inventory cost [Internet]. Surgery. 2015[cited 2023 Mar 25];158(4):996–1000,discussion 1000–2[cited 2023 Mar 25]. DOI: 10.1016/j.surg.2015.06.010
27. Friend TH, Paula A, Klemm J, Rosa M, Levine W. Improving operating room efficiency via reduction and standardization of video-assisted thoracoscopic surgery instrumentation [Internet]. J Med Syst. 2018[cited 2023 Mar 25];42(7):1–1. DOI: 10.1007/s10916-018-0976-8
28. Fu TS, Msallak H, Namavarian A, Chiodo A, Elmasri W, Hubbard B et al. Surgical tray optimization: A quality improvement initiative that reduces operating room costs [Internet]. J Med Syst. 2021[cited 2023 Mar 25];45(8):1–8. DOI: 10.1007/s10916-021-01753-4
29. Goh MM, Tan AB, Leong MH. Bar code-based management to enhance efficiency of a sterile supply unit in Singapore [Internet]. AORN J. 2016[cited 2023 Mar 25];103(4):407–13. DOI: 10.1016/j.aorn.2016.01.018
30. Kirk NJ. Customized suture packs: A method for containing costs [Internet]. AORN J. 1986[cited 2023 Mar 25];43(3):655, 658–63. DOI: 10.1016/S0001-2092(07)65036-4
31. Levine DB, Cole BJ, Rodeo SA. Cost awareness and cost containment at the Hospital for Special Surgery: Strategies and total hip replacement cost centers. Clin Orthop Relat Res. 1995;311(311):117–24.

32. Lonner JH, Goh GS, Sommer K, Niggeman G, Levicoff EA, Vernace JV et al. Minimizing surgical instrument burden increases operating room efficiency and reduces perioperative costs in total joint arthroplasty [Internet]. J Arthroplasty. 2021[cited 2023 Mar 25];36(6):1857–63. DOI: 10.1016/j.arth.2021.01.041
33. Lum B, Png HM, Yap HL, Tan C, Sun B, Law YH. Streamlining workflows and redesigning job roles in the theatre sterile surgical unit [Internet]. BMJ Open Qual. 2019[cited 2023 Mar 25];8(3):e000583. DOI: 10.1136/bmjoq-2018-000583
34. Mullaney K. Improving the process of supplying instruments to the operating room using the lean rapid cycle improvement process [Internet]. Perioper Nurs Clin. 2010[cited 2023 Mar 25];5(4):479–87. DOI: 10.1016/j.cpen.2010.09.001
35. Ngu JC. Improving OR efficiency in a university medical center arthroplastic surgery service [Internet]. AORN J. 2010[cited 2023 Mar 25];92(4):425–35. DOI: 10.1016/j.aorn.2009.12.033
36. Nilsen EV. Managing equipment and instruments in the operating room [Internet]. AORN J. 2005[cited 2023 Mar 25];81(2):349–52, 355–58. DOI: 10.1016/S0001-2092(06)60417-1
37. Palo RJ, Bumpers QD, Mohsenian Y. Improvement initiative to ensure quality instrumentation in the OR [Internet]. Pediatr Qual Saf. 2021[cited 2023 Mar 25];6(1):e371. DOI: 10.1097/pq9.0000000000000371
38. Penn E, Yasso SF, Wei JL. Reducing disposable equipment waste for tonsillectomy and adenotonsillectomy cases [Internet]. Otolaryngol Head Neck Surg. 2012[cited 2023 Mar 25];147(4):615–18. DOI: 10.1177/0194599812450681
39. Pesigan P, Chen H, Bajaj AA, Gill HS. Cost savings in urology operating rooms by editing surgeon preference cards [Internet]. Qual Manag Health Care. 2021[cited 2023 Mar 25];30(2):135–7. DOI: 10.1097/QMH.0000000000000311
40. Prephan L. Surgical instrument availability [Internet]. AORN J. 2005[cited 2023 Mar 25];81(5):1015. DOI: 10.1016/S0001-2092(06)60467-5
41. Simon KL, Frelich MJ, Gould JC. Picking apart surgical pick lists: Reducing variation to decrease surgical costs [Internet]. Am J Surg. 2018[cited 2023 Mar 25];215(1):19–22. DOI: 10.1016/j.amjsurg.2017.06.024
42. Wannemuehler TJ, Elghouche AN, Kokoska MS, Deig CR, Matt BH. Impact of lean on surgical instrument reduction: Less is more [Internet]. Laryngoscope. 2015[cited 2023 Mar 25];125(12):2810–15. DOI: 10.1002/lary.25407
43. Hemingway MW, Vieira A, Salvucci M. Streamlining instrumentation through collaboration [Internet]. AORN J. 2022[cited 2023 Mar 25];116(4):335–9. DOI: 10.1002/aorn.13789
44. Toor J, Du JT, Koyle M, Abbas A, Shah A, Bassi G et al. Inventory optimization in the perioperative care department using Kotter's change model [Internet]. Jt Comm J Qual Pat Saf. 2022[cited 2023 Mar 25];48(1):5–11. DOI: 10.1016/j.jcjq.2021.09.011
45. Ribes-Iborra J, Segarra B, Cortés-Tronch V, Quintana J, Galvain T, Muehlendyck C et al. Improving perioperative management of surgical sets for trauma surgeries: The 4S approach [Internet]. BMC Health Serv Res. 2022[cited 2023 Mar 25];22(1):1298. DOI: 10.1186/s12913-022-08671-2
46. Guédon A, Wauben L, Eijk A, Vernooij A, Meeuwsen F, Elst M et al. Where are my instruments? Hazards in delivery of surgical instruments [Internet]. Surg Endosc. 2016[cited 2023 Mar 25];30(7):2728–35. DOI: 10.1007/s00464-015- 4537-7
47. Alfred M, Catchpole K, Huffer E, Fredendall L, Taaffe KM. Work systems analysis of sterile processing: Decontamination [Internet]. BMJ Qual Saf. 2020[cited 2023 Mar 25];29(4):320–8. DOI: 10.1136/bmjqs-2019-009422
48. Alfred M, Catchpole K, Huffer E, Fredendall L, Taaffe KM. Work systems analysis of sterile processing: Assembly [Internet]. BMJ Qual Saf. 2021[cited 2023 Mar 25];30(4):271–82. DOI: 10.1136/bmjqs-2019-010740
49. Schneider D, Magalhães AMM, Glanzner CH, Thomé E, Oliveira JLC, Anzanello MJ. Management of ophthalmic surgical instruments and processes optimization: Mixed method study [Internet]. Rev Gaucha Enferm. 2020[cited 2023 Mar 25];41:e20190111. DOI: 10.1590/1983-1447.2020.20190111
50. Dreyfus D, Nair A, Rosales C. The impact of planning and communication on unplanned costs in surgical episodes of care: Implications for reducing waste in hospital operating rooms [Internet]. J Oper Manag. 2020[cited 2023 Mar 25];66(1-2):91–111. DOI: 10.1002/joom.1070
51. Tibesku CO, Hofer P, Portegies W, Ruys CJM, Fennema P. Benefits of using customized instrumentation in total knee arthroplasty: Results from an activity-based costing model [Internet]. Arch Orthop Trauma Surg. 2013[cited 2023 Mar 25];133(3):405–11. DOI: 10.1007/s00402-012-1667-4
52. Moerenhout K, Allami B, Gkagkalis G, Guyen O, Jolles BM. Advantages of patient-specific cutting guides with disposable instrumentation in total knee arthroplasty: A case control study [Internet]. J Orthop Surg Res. 2021[cited 2023 Mar 25];16(1):1–6. DOI: 10.1186/s13018-021-02310-y
53. Igesund U, Overvag G, Rasmussen G, Rekvig O. Mapping of procedures for set-up of instruments in the sterile field for surgery [Internet]. Sykepleien Forskning. 2019[cited 2023 Mar 25]:e–78413. DOI: 10.4220/Sykepleienf.2019.78413en
54. Chasseigne V, ALeguelinel-Blache G, Nguyen TL, Tayrac Rd, Prudhomme M, Kinowski JM et al. Assessing the costs of disposable and reusable supplies wasted during surgeries [Internet]. Int J Surg. 2018[cited 2023 Mar 25];53:18–23. DOI: 10.1016/j.ijsu.2018.02.004
55. Halton K, Graves N, Hall L. Opportunity cost of unavailable surgical instruments in Australian hospitals [Internet]. ANZ J Surg. 2014[cited 2023 Mar 25];84(12):905–6. DOI: 10.1111/ans.12822
56. Ikuma L, Nahmens I, Ahmad A, Gudipudi Y, Dasa V. Resource evaluation framework for total knee arthroplasty [Internet]. Int J Health Care Qual Assur. 2020[cited 2023 Mar 25];33(2):189–98. DOI: 10.1108/IJHCQA-04-2019-0081
57. Stockert EW, Langerman A. Assessing the magnitude and costs of intraoperative inefficiencies attributable to surgical instrument trays [Internet]. J Am Coll Surg. 2014[cited 2023 Mar 25];219(4):646–55. DOI: 10.1016/j.jamcollsurg.2014.06.019
58. Ventimiglia E, Smyth N, Doizi S, Jiménez Godínez A, Barghouthy Y, Corrales Acosta MA et al. Can the introduction of single-use flexible ureteroscopes increase the longevity of reusable flexible ureteroscopes at a high volume centre? [Internet]. World J Urol. 2022[cited 2023 Mar 25];40(1):251–6. DOI: 10.1007/s00345-021-03808-0
59. Tipple AFV, Costa DdM, Lopes LKdO, Veloso TR, Pereira LA, Hu H et al. Reprocessing of loaned surgical instruments/implants in Australia and Brazil: A survey of those at the coalface [Internet]. Infect Dis Health. 2022[cited 2023 Mar 25];27(1):23–30. DOI: 10.1016/j.idh.2021.09.003
60. Diamant A, Milner J, Quereshy F, Xu B. Inventory management of reusable surgical supplies. Health care management science [Internet]. 2017[cited 2023 Mar 25];21(3):439–459. DOI: 10.1007/210729-017-9397-3

61. Goldberg TD, Maltry JA, Ahuja M, Inzana JA. Logistical and economic advantages of sterile-packed, single-use instruments for total knee arthroplasty [Internet]. J Arthroplasty. 2019[cited 2023 Mar 25];34(9):1876– 1876. DOI: 10.1016/j.arth.2019.03.011

62. Harris SP. Optimizing operating room scheduling considering instrument sterilization processing [Internet]. PhD thesis. Bozeman: Montana State University; 2019 [cited 2023 Mar 25]. Available from: scholarworks.montana.edu/items/a00a0219-9a9a-4a3b-9fd5-cb6e27c6a807

63. Kumar A, Shim SJ. Simulating staffing needs for surgical instrument distribution in hospitals [Internet]. J Med Syst. 2006[cited 2023 Mar 25];30(5):363–369. DOI: 10.1007/s10916-006-9018-z

64. Howard TJ, Stines CP, O'Connor JA, Schuster WS, Wiebke EA. Cost-effective supply use in permanent central venous catheter operations. Am Surg. 1997;63(5):441–445.

65. Greene VW, Klapes NA, Langholz AC, Reier D. Interhospital transportation. monitoring sterility of instrument packs [Internet]. AORN J. 1987[cited 2023 Mar 25];45(6):1420–1421,1424–1425,1427. DOI: 10.1016/S0001-2092(07)70321-6

66. Glaser B, Schellenberg T, Koch L, Hofer M, Modemann S, Dubach P, Neumuth T. Not these scissors, the other scissors: A multi-center study comparing surgical instrument descriptions used by scrub nurses [Internet]. Int Conf E-Health Netw, Appl Serv, HealthCom. 2015[cited 2023 Mar 25]:32–36. DOI: 10.1109/HealthCom.2015.7454469

67. Montgomery K, Schneller ES. Hospitals' strategies for orchestrating selection of physician preference items [Internet]. The Milbank Q. 2007[cited 2023 Mar 25];85(2):307–335. DOI: 10.1111/j.1468-0009.2007.00489.x

68. Guimaraes MFL, Ramos Freire EM, Martins da Silva D, dos Santos Pereira M, Alves M. Process mapping: Video-assisted surgery instrument flow [Internet]. Online Braz J Nurs. 2016[cited 2023 Mar 25];10(3):1162–1169. Available from: https://periodicos.ufpe.br/revistas/index.php/revistaenfermagem/article/view/11071/12502

69. Patient Protection and Affordable Care Act 2010 [Internet]. Washington DC: US Government Printing Office; 2010 [cited 2023 Dec 1]. Available from: www.govinfo.gov/app/details/STATUTE-124/STATUTE-124-Pg119

70. Kumar R, Gandhi R. Reasons for cancellation of operation on the day of intended surgery in a multidisciplinary 500 bedded hospital [Internet]. J Anaesthesiol Clin Pharmacol. 2012[cited 2023 Dec 1];28(1):66–69. DOI: 10.4103/0970-9185.92442

71. Ogrinc G, Davies L, Goodman D, Batalden P, Davidoff F, Stevens D. SQUIRE 2.0 (Standards for QUality Improvement Reporting Excellence): Revised publication guidelines from a detailed consensus process [Internet]. BMJ Qual Saf. 2016[cited 2023 Dec 1];25(12):986–992. DOI: 10.1136/bmjqs-2015-004411

72. Dahake SW, Kuthe AM, Chawla J, Mawale MB. Rapid prototyping assisted fabrication of customized surgical guides in mandibular distraction osteogenesis: A case report [Internet]. Rapid Prototyp J. 2017[cited 2023 Dec 1];23(3):602–610. DOI: 10.1108/RPJ-09-2015-0129

73. Hill I, Olivere L, Helmkamp J, Le E, Hill W, Wahlstedt J et al. Measuring intraoperative surgical instrument use with radio-frequency identification [Internet]. JAMIA open. 2022[cited 2023 Dec 1];5(1):ooac003–ooac003. DOI: 10.1093/jamiaopen/ooac003

74. Kim SH, Kim HY, Lee SH, Yang K, Park BS, Choi BH, Jung HJ. Reducing supply cost by standardization of surgical equipment in laparoscopic appendectomy [Internet]. Qual Manag Health Care. 2021[cited 2023 Dec 1];30(4):259– 266. DOI: 10.1097/QMH.0000000000000315

75. Vedula SS, Hager GD. Surgical data science: The new knowledge domain [Internet]. Innov Surg Sci. 2017[cited 2023 Dec 1];2(3):109–121. DOI: 10.1515/iss-2017-0004

76. Leinonen T, Leino-Kilpi H. Research in peri-operative nursing care [Internet]. J Clin Nurs. 1999[cited 2023 Dec 1];8(2):123– 138. DOI: 10.1046/j.1365-2702.1999.00239.x

77. Poirrier A-L, Mertens D, Herman D, Camby S, Scholtes B, Scholtes F. Weight and cost of unused operating room supplies [Internet]. Am J Surg. 2022[cited 2023 Dec 1];224(4):1174–1175. DOI: 10.1016/j.amjsurg.2022.05.030

78. Mathis MR, Dubovoy TZ, Caldwell MD, Engoren MC. Making sense of big data to improve perioperative care: Learning health systems and the multicenter perioperative outcomes group [Internet]. J Cardiothorac Vasc Anesth. 2020[cited 2023 Dec 1];34(3):582–585. DOI: 10.1053/j.jvca.2019.11.012

79. Suriaga A. Nurse caring: From robotic surgeries to health care robots [Internet]. Int J Hum Caring. 2019[cited 2023 Dec 1];23(2):178–184. DOI: 10.20467/1091-5710.23.2.178

80. Kang MJ, De Gagne JC, Kang HS. Perioperative nurses' work experience with robotic surgery: A focus group study [Internet]. Comput Inform Nurs. 2016[cited 2023 Dec 1];34(4):152–158. DOI: 10.1097/CIN.0000000000000224

81. Schuessler Z, Stiles AS, Mancuso P. Perceptions and experiences of perioperative nurses and nurse anaesthetists in robotic-assisted surgery [Internet]. J Clin Nurs. 2020[cited 2023 Dec 1];29(1–2):60–74. DOI: 10.1111/jocn.15053

82. Uslu Y, Altınbaş Y, Özercan T, Giersbergen MY. The process of nurse adaptation to robotic surgery: A qualitative study [Internet]. Int J Med Robot. 2019[cited 2023 Dec 1];15(4):e1996. DOI: 10.1002/rcs.1996

83. Sharma VJ, Barton C, Page S, Ganesh JS, Patel N, Pirone F et al. Cardiac surgery simulation: A low-cost feasible option in an Australasian setting [Internet]. ANZ J Surg. 2021[cited 2023 Dec 1];91(10):2042–2046. DOI: 10.1111/ans.17077

84. Peñataro-Pintado E, Díaz-Agea JL, Castillo I, Leal-Costa C, Ramos-Morcillo AJ, Ruzafa-Martínez M, Rodríguez-Higueras E. Self-learning methodology in simulated environments (Maes©) as a learning tool in perioperative nursing: An evidence-based practice model for acquiring clinical safety competencies [Internet]. Int J Environ Res Public Health. 2021[cited 2023 Dec 1];18(15):7893. DOI: 10.3390/ijerph18157893

85. Donham R, Mazzei W, Jones R. Association of Anesthesia Clinical Directors' procedural times glossary: Glossary of times used for scheduling and monitoring of diagnostic and therapeutic procedures. Am J Anesth. 1996;23(5S):3–12.

86. Wu Q, Huang L-H, Xing M-Y, Feng Z-X, Shao L-W, Zhang M-Y et al. Establishing nursing-sensitive quality indicators for the operating room: A cross-sectional Delphi survey conducted in China [Internet]. Aust Crit Care. 2017[cited 2023 Dec 1];30(1):44–52. DOI: 10.1016/j.aucc.2016.04.003

87. Naderi-Boldaji V, Banifatemi M, Zandi R, Eghbal MH, Nematollahi M, Sahmeddini MA. Incidence and root causes of surgery cancellations at an academic medical center in Iran: A retrospective cohort study on 29 978 elective surgical cases [Internet]. Patient Saf Surg. 2023[cited 2023 Dec 1];17(1):1–24. DOI: 10.1186/s13037-023-00377-6

88. Fitzgerald A, Yong W. Beyond clinical priority: What matters when making operational decisions about emergency surgical queues? [Internet]. Aust Health Rev. 2017[cited 2023 Dec 1];41(4):384–393. DOI: 10.1071/AH16009

89. Harvey LFB, Smith KA, Curlin H. Improving operative room costs and efficiency through review of surgeon preference cards [Internet]. J Minim Invasive Gynecol. 2016[cited 2023 Dec 1];23(7):S37– S37. DOI: 10.1016/j.jmig.2016.08.097

90. Warwick VR, Gillespie BM, McMurray A, Clark-Burg KG. Undertaking the surgical count: An observational study [Internet]. Journal of Perioperative Nursing. 2021[cited 2023 Dec 1];34(3):e-3–e-14. DOI: 10.26550/2209-1092.1089

91. Asimah Ackah V, Adzo Kwashie A. Exploring the sources of stress among operating theatre nurses in a Ghanaian teaching hospital [Internet]. International Journal of Africa Nursing Sciences. 2023[cited 2023 Dec 1];18:100540. DOI: 10.1016/j.ijans.2023.100540

92. Işık I, Gümüşkaya O, Şen S, Arslan Özkan H. The elephant in the room: Nurses' views of communication failure and recommendations for improvement in perioperative care [Internet]. AORN J. 2020[cited 2023 Dec 1];111(1):e1– e15. DOI: 10.1002/aorn.1289