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Authors

Amanda J Snape
RN
School of Nursing and Midwifery | College of Health, Medicine and Wellbeing, University of Newcastle, Newcastle, Australia

Jed Duff
PhD, RN, FACORN
School of Nursing, Queensland University of Technology| Centre for Healthcare Transformation, Chair of Nursing | Royal Brisbane and Women's Hospital, Brisbane, Australia

Oya Gumuskaya
PhD, RN
School of Nursing and Midwifery | College of Health, Medicine and Wellbeing, University of Newcastle, Newcastle, Australia

Kerry Inder
PhD, BN, Grad Dip Clin Epid, RN
School of Nursing and Midwifery | College of Health, Medicine and Wellbeing, University of Newcastle, Newcastle, Australia

Alison Hutton
PhD
School of Nursing and Midwifery | College of Health, Medicine and Wellbeing, University of Newcastle, Newcastle, Australia

Strategies to prevent inadvertent retained surgical items: An integrative review

Abstract

Background: The surgical count process is currently the recommended strategy for preventing unintentionally retained surgical items (RSIs) in Australia. Despite this, RSIs still occur and remain an internationally recognised issue and sentinel event associated with morbidity and mortality. There are numerous new and emerging strategies to prevent inadvertent RSIs, apart from the surgical count, and many involve the use of technology. These strategies are not currently specified in *Standards for Perioperative Nursing in Australia* (the ACORN Standards).

Aim: To provide an integrative synthesis of the literature to identify current and emerging strategies for preventing RSIs during surgical procedures.

Design: An integrative review process was undertaken.

Method: The literature search was conducted in the CINAHL, ClinicalKey and Medline databases and included primary research papers of any design about RSIs and prevention strategies in humans that were published in English between 2008 and 2022. Data was extracted and developed into a table. Quality assessment was undertaken using the Mixed Method Assessment Tool (MMAT).

Findings: Based on the inclusion and exclusion criteria, 186 articles were screened and 18 studies were included following quality assessment. Data were grouped into categories according to the prevention strategies of surgical count, radiography, radiofrequency technology, barcode technology and other technologies.

Conclusions: RSIs occur despite the mandated use of the surgical count, a human-based process. The use of adjunct, technological prevention strategies is not yet feasible as more research is needed into efficacy and cost-effectiveness.

Keywords: retained surgical item, prevention, count, perioperative, safety

Background

The occurrence of unintentionally retained surgical items (RSIs) is an internationally recognised issue and in Australia RSIs are recognised as a sentinel event.[1] In the operating theatre, patient safety is the main priority for the perioperative team. RSIs occur when any foreign body, such as a surgical sponge or surgical instrument, is inadvertently left inside the patient during an operation. RSIs are referred to by a number of other terms including 'retained foreign bodies', 'retained surgical sponges' and 'retained surgical instruments'. Due to the variety of terms used, they will be referred to as RSIs for the remainder of this paper.

While the risk of RSI is present in all surgeries the risk is higher in emergency surgery and surgeries of longer duration, on patients with increased BMI (>30kg/m^2), with

unexpected events or unplanned changes, with intra-operative bleeding or with increased number of staff present.[2,3] Sponges are typically the item most often retained, followed by gauze and, less commonly, surgical instruments and needles.[4–6] RSIs of any type can have a significant impact on patients; the impacts include infection, the need for reoperation, and even death.[6] The mortality rate resulting from RSIs has been estimated to be as high as 35 per cent.[4,8] There are also significant costs associated with RSIs and the reconciliation of discrepancies in the surgical count. This can include additional operating theatre time or the use of additional resources such as radiography.[9]

Aims

To provide an integrative synthesis of the literature to identify what strategies can be used to prevent RSIs in surgical patients.

Methods

Design

This review used an integrative review design. An integrative review incorporates various study methodologies and summarises past research to draw conclusions from the body of literature on a particular topic.[10] This integrative review was conducted according to steps adapted from the framework by Whittemore and Knafl.[11] The steps were:

- identifying a problem
- establishing a research question
- searching the literature
- extracting the data
- analysing and evaluating the data
- presenting the review.

Table 1: Inclusion and exclusion criteria for the review

Inclusion criteria	papers on RSIs and prevention strategies
	primary research papers of any design
	papers published in English
	papers published between 2008 and 2022
Exclusion criteria	case reports, case studies
	animal studies

Literature search methods

The research question guiding the integrative review was 'What strategies can be used to prevent inadvertent retained surgical items in surgical patients?'

The databases CINAHL (Cumulative Index to Nursing and Allied Health Literature), ClinicalKey and Medline were used to search for literature. Final search terms for both databases were: retained surgical item OR RSI AND prevent AND surgical count OR count process AND safety. The reference lists of articles identified in initial searches were also manually searched to ensure a wide search for primary studies.

Inclusion and exclusion criteria

Table 1 shows the inclusion and exclusion criteria for the literature review. Primary research papers of any design about RSIs and prevention strategies in humans that were published in English between 2008 and 2022 were included. This 14-year search period was chosen as it was initially a 10-year period from when the review was first conceived in 2018. A 10-year span was deemed sufficient to include a wide body of the most recent evidence, including technological advances. Case reports, case studies and animal studies were excluded.

Data extraction

Guided by research aims and inclusion criteria, the titles and abstracts of all articles were reviewed for relevance. Following this, a full-text review of all articles identified as suitable was undertaken for data extraction. Data were extracted and summarised according to author, year of publication and country of origin; aim; design, sample and setting; key findings, and study limitations. (See supplementary material for a table of the characteristic data extracted.)

Data evaluation

This review used the Mixed Methods Appraisal Tool (MMAT) to evaluate the quality of the evidence.[12] The MMAT is a critical appraisal tool which covers five categories of study design – qualitative, descriptive, non-randomised, randomised controlled trials and mixed methods. Papers were appraised as per instructions given in the MMAT user guide.[12] Each study was subject to two preliminary screening questions related to the research question clarity and appropriateness of data collection methods. Papers could be screened out if receiving a 'no' or 'can't tell' answer to one or both questions, indicating further appraisal was not feasible or appropriate. Next, each study was classified by design type, and the appropriate set of five questions

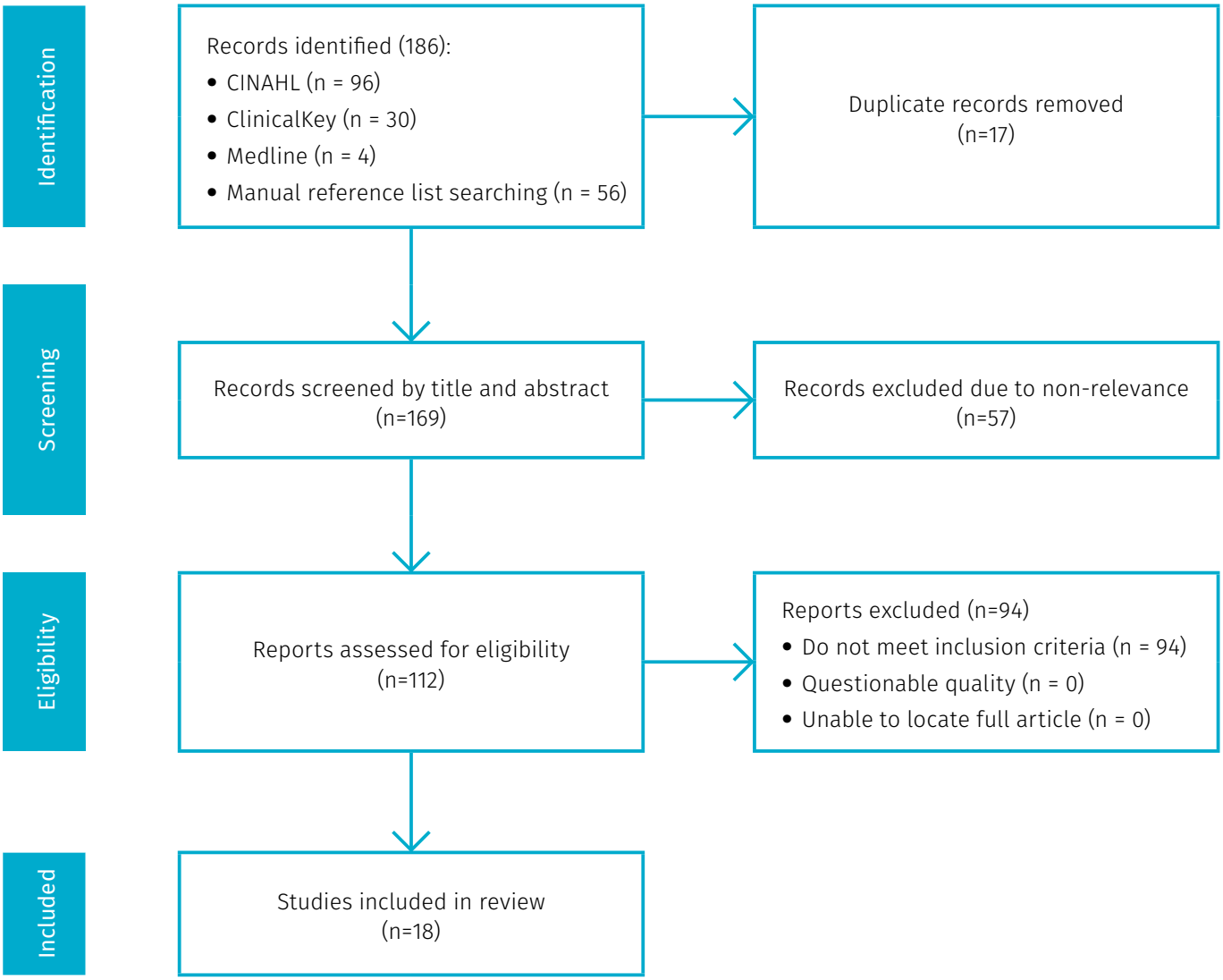

Figure 2: PRISMA flow diagram of paper selection process

was answered. These questions varied depending upon study design, with twenty-five separate questions in total. Notes on any perceived flaws which existed in the study were made. (Please see supplementary material for the quality appraisal table.)

Data synthesis

As per Whittemore and Knafl,[11] the included studies were synthesised using thematic analysis to distinguish themes, differences and commonalities. Patterns were able to be identified and data could be grouped into categories dependent upon which preventative strategy they examined. These categories allowed the literature to be organised and compared accordingly.

Selection process

The first search identified 186 articles from three databases and other resources. CINAHL and ClinicalKey yielded the most results based on the search criteria. Of the 186 articles identified, 17 duplicates were removed. The titles and abstracts of 169 articles were screened and 57 were excluded due to non-relevance. The full texts of the remaining 112 articles were then assessed and a further 94 were excluded for not meeting inclusion criteria. This resulted in 18 studies being included in the final review, 16 from the United States of America (USA),[2,3,5,6,9,13–23] one from Brazil[7] and one from Australia.[24] This is represented in Figure 2 as the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram.[25]

Discussion of findings

The 18 included studies were grouped into categories based on the preventative strategy they examined. The categories identified were surgical count, radiography, radiofrequency (RF) technology, barcode technology and other technologies such as computerised tomography (CT), fluoroscopy and ultrasound. This type of categorisation method allowed for the extracted data to be synthesised.

A preventative strategy suggested by *Standards for Perioperative Nursing in Australia* (the ACORN Standards)[26] is a two-person counting process for all items to be used in the surgical procedure including surgical instruments, sharps, absorbent items and other items at risk of being retained.[14,15,17,27] Multiple studies have found that the count process is time consuming and only partially effective. Adjunct technologies such as radiography, RF technology, barcoding technology, CT, fluoroscopy and ultrasound can and are being used to minimise the incidence of RSIs.

Surgical count

The surgical count or manual count is perhaps the oldest and most common strategy used to prevent RSIs.[20] The ACORN Standards[26] suggests the two-person counting process. Surgical counts warrant the undivided attention of those counting and have a high cognitive demand.[16] Although the surgical count is identified as the most common preventative strategy, it is also highlighted as being time consuming and only partially effective; although the error rate is low, it is inherent. This is due to the count process being a manual, person-led exercise.[6] One study found 90 per cent of RSI events were associated with some type of individual or team error.[19]

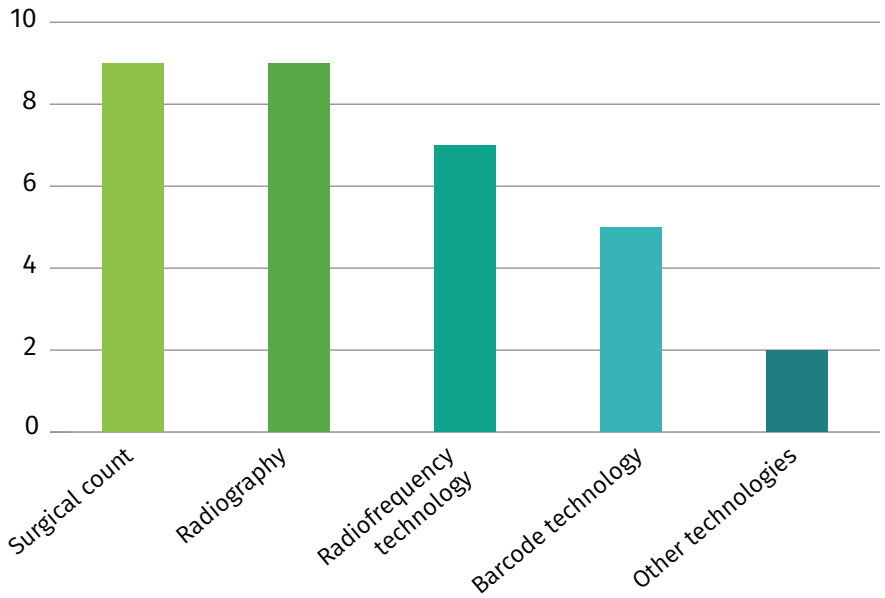

Figure 2: Number of papers reporting on RSI prevention strategies
Note: Some papers discuss multiple prevention strategies.

There is also evidence to suggest that the more times the surgical count is performed, the higher the incidence of a possible error.[5] This can be due to variability in practice.[5] Although policies and frameworks exist to guide practice, they are open to interpretation and variability in practice can occur.[14] In Edel's study,[14] participants reported recording the surgical count on both the instrument count sheet available at the facility, as well as scrap paper. Specific count practices varied as well with some nurses counting sponges by separating them and placing them on the table and others just fanning them apart. Although there are guidelines by which institutions must operate, it is the responsibility of each facility to decide on policies for standardised practice and to measure compliance with those policies.[6,14] A study by Freitas et al.[7] in São Paulo also highlighted that a range of procedures and customisation of practices occurred in the operating theatre, even within the same hospital.

Discrepancies in the count should never be dismissed as just human error, but rather should prompt a thorough search and reconciliation process.[15] Although incorrect surgical counts are often an indicator for RSIs, RSIs may still occur with a correct surgical count. Some studies stated this occurred in 62 to 88 per cent of RSIs.[2,19]

The surgical count is a person-led approach, making it inexpensive to carry out, but it is prone to errors. Despite the lack of supporting evidence it is currently the most widely used strategy to prevent RSIs.

Radiography

Radiography, such as X-ray, is often used as a strategy to detect RSIs either intra-operatively or post-operatively, and as a routine investigation, as per policy, or to investigate suspected RSI.

Although RSIs can sometimes be identified by an incorrect count, this is not true in all cases. Some studies suggest routine X-rays be implemented as an important

safety measure in preventing RSIs.[17] However, routine X-rays to prevent RSIs could be costly.[17] One study by Primiano et al.[9] estimated the cost of intra-operative radiographs to resolve discrepant counts to be US$226 per procedure.

Although X-rays may be taken to assist in identifying RSIs, there are cases in which the item is not identified or detected upon X-ray interpretation.[19] X-rays taken intra-operatively and post-operatively should be reviewed by a radiologist, but the radiologist must also know what the RSI is and what it looks like.[9]

Radiography as a strategy for preventing RSIs can be harmful as it exposes the patient to unnecessary radiation.[2] This is true in low-risk surgical procedures when an X-ray may still be performed to rule out RSIs as per a facility's routine X-ray policy.[2] In addition, radiography is not as effective in patients with obesity and usually requires multiple images.[2] In some institutions, it is policy for X-rays to be taken when the count is discrepant.[20] However, intra-operative radiography is suboptimal and one study found it failed to identify 33 per cent of RSIs which were later found.[20] This includes small items such as needles.[23]

Radiography is a popular strategy used to prevent RSIs and is often used as an adjunct to the surgical count. Depending upon hospital or health service organisation policy, radiographs may be taken on a routine basis, when there is a count discrepancy or when there is suspicion of an RSI. Radiographs are an effective way to quickly visualise if there is an RSI in a body cavity but they require trained staff to interpret the images and incur a cost to use the equipment.

Radiofrequency technology

Radiofrequency (RF) technology is an emerging strategy to prevent RSIs. RF technology includes both radiofrequency identification and detection systems.

A radiofrequency identification (RFID) system uses unique radiofrequency tags sewn into pockets of surgical sponges, allowing sponges to be differentiated and counted. This system consists of a scanning bucket with a wand attached into which the sponges are placed and automatically counted to find any missing sponges to reconcile the count.[2]

A radiofrequency detection system (RFDS) is a system made up of three components: radiofrequency tags which are sewn into a pocket in surgical sponges, a handheld wand or mat that contains the antennae and detection system, and a computer console which emits a visual and audio signal when a sponge has been detected.[20] An RFDS does not count sponges or distinguish between types of sponge, but rather alerts the user of the presence of a sponge in relation to the detection unit.[20]

RF technology has been found to improve patient safety and is a highly accurate way to mitigate common risk factors in the operating theatre such as distraction, multitasking and time pressures.[2,20] One study found the use of RF technology was associated with 68 per cent fewer reports of near misses of RSIs and unresolved miscounts.[9] A study focusing specifically on RFDS found that it had a level of accuracy which far surpassed the surgical count and was more useful than intra-operative radiography.[2] RF technology was also found to reduce time spent searching to resolve a miscount.[9] When using RFDS, the RF wand was found to be more useful than an RF mat in patients with a high BMI. This was due to the RF mat being narrow and the abdominal cavity exceeding the width of the mat, causing false negative detections.[21]

RF technology is an emerging strategy that has been investigated in some settings for the prevention of RSIs. It has been trialled alongside the surgical count to promote more accurate results.[27] This technology allows for real-time detection of RSIs.[18] However, as RF technology is relatively new its implementation as a strategy would require equipment and education and training for staff which would result in significant cost.[9]

Barcode technology

Barcode technology is a preventative strategy which makes it easier to locate and catalogue surgical items.[23] It is similar to RF technology in that each sponge or surgical instrument has a unique data-matrix code affixed to it which can be scanned to track when the item is in use.[13,20] Items can be counted in and out, and the system prevents the double-scanning of a single item.[13,15] Potential drawbacks of barcode technology are that background scanning can occur when surgical items are in the vicinity but not intended to be counted and disruption may occur if attempting to scan items out when the scanner is set to scan items in.[15]

In terms of effectiveness, a randomised controlled trial by Greenberg et al.[15] found that discrepancies in sponge counts were detected more often using barcode technology compared to the manual surgical count. In a study by Regenbogen et al.[17] barcode technology was predicted to be cost-effective in comparison to X-rays. However, the use of

barcode scanning technology was found to be more time consuming than a manual count.[16]

Barcode technology is an emerging strategy for the prevention of RSIs. Studies that have been conducted have assessed it, alongside the surgical count, as an adjunct technology.

Other technologies (CT scans, fluoroscopy, ultrasound)

Other modalities used to prevent or identify RSIs include CT scans, fluoroscopy and ultrasound. In a study by Stawicki et al.[19] CT scans were ordered and performed due to suspicion or symptoms of RSIs in 24 out of 71 studied cases. RSIs were detected via CT scans in two cases. CT scanning can also be used post-operatively to assess for RSIs, even after a negative intra-operative radiograph.[23] Fluoroscopy and ultrasound were also used to detect the presence of RSIs in three cases.[19] Further research into these technologies is needed before they are used in the operating theatre.[19]

Implications for perioperative nursing practice or research

This review indicates there are emerging prevention strategies to prevent RSIs, many of which rely on technology. However, these technologies are still being trialled and assessed for cost-effectiveness, therefore the surgical count remains the most common and cost-effective prevention strategy for RSIs. Despite the inherent risk of error and its time-consuming nature, this strategy is still recommended by the ACORN Standards.

The results of this review do not constitute a final recommendation, and there is no alternative strategy to the surgical count at this point in time. Further research into emerging preventative strategies must be undertaken before they can be integrated into clinical practice.

Limitations

This review has several limitations. Some articles may have been missed despite a thorough and systematic search. Papers written in languages other than English were omitted but may include relevant findings. Only one randomised controlled trial was identified and included, but more quantitative studies of this design may have changed the conclusions of this review. The quality of included studies was assessed by one individual and despite using a validated tool such as MMAT, subjectivity was not able to be controlled.

Conclusion

This integrative review has provided an overview of the recent literature on current and emerging RSI prevention strategies. It is evident that, despite the mandated used of the surgical count, RSIs continue to occur. Although there are emerging technological prevention strategies that exist, they are still in the developmental phase. There is currently not enough research to support their use as a prevention strategy alongside, or instead of, the surgical count.

RSIs continue to be reported as a sentinel event both nationally and internationally. The surgical count is the most utilised strategy to prevent RSIs but presents an inherent error rate, mainly due to human error. This review highlights the error margin which can occur when the manual count is used as the primary RSI prevention strategy.

There are several new and developing technologies which are being tested for use in conjunction with or instead of the surgical count. This includes radiography, RF technology, barcode technology CT scans, fluoroscopy and ultrasound.

Future research into risk factors would be valuable, including the development of a risk assessment tool to pre-operatively assess the risk associated with a particular patient having a particular procedure. This could take into consideration those risk factors commonly associated with RSIs such as high BMI (>30kg/m^2), long length of surgery and increased number of team members involved. Highlighting these risk factors pre-operatively could ensure adequate prevention strategies are implemented to prevent the occurrence of RSIs. This type of tool would ensure unnecessary strategies, such as routine radiographs, were not implemented in low risk cases but that effective adjunct strategies were used in high-risk cases.

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