



Review

Indicators for monitoring the quality of surgical site infection prevention: a scoping review

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SUMMARY

Background: Surveillance of surgical site infection (SSI) prevention is important to detect unwarranted variations in practice that require address to avoid patient harm. Performance indicators quantify the quality of care, but the availability of such measures for clinical use across the surgical journey is unclear. The aim of this scoping review was to identify and summarise indicators (structure, process, outcome) developed and/or used to monitor the quality of SSI prevention care.

Methods: Databases and guideline repositories were searched for research, guidelines and technical documents, which specified indicators for SSI prevention in any setting and inclusive of the whole surgical journey. Screening and data extraction were performed by two independent reviewers. Narrative synthesis was based on the (Patterns, Advances, Gaps, Evidence for Practice, Research recommendations) framework, with indicators mapped to categories and subcategories.

Results: Across 77 documents, 276 indicators were identified. Most were process indicators ($N = 152$; 55.1%), followed by structure ($N = 65$; 23.6%) and outcome indicators ($N = 59$; 21.4%). Structural measures were mapped to eight subcategories, including the presence of protocols for specific care components ($N = 25$; 38.5%) and surveillance ($N = 19$; 29.2%). Process indicators were mapped to 18 subcategories, with most related to antibiotic administration ($N = 100$; 65.8%) and fewer to topics such as skin/area preparation ($N = 8$; 5.3%), hand hygiene ($N = 6$; 3.9%) and normothermia ($N = 6$; 3.9%). Most outcome measures reported SSI incidence ($N = 54$; 91.5%).

Conclusion: There is a need for standardised and validated indicators aligned across structure, process and outcome domains, which can be nuanced to specialty, procedure

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and local context. This would support organisations and clinicians globally to implement local monitoring and quality improvement mechanisms.

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Introduction

Surgical site infection (SSI) is one of the most common healthcare-associated infections [1] and surgical wound complications [2] globally. Described as an infection involving the skin, subcutaneous tissue and/or deep tissue of the surgical incision within 30 days of a surgical procedure [1] (or 90 days for some necessitating extended surveillance, e.g. breast and cardiac surgery, hip and knee prosthesis [3]), SSIs are associated with poor patient outcomes, increased hospital stay length, readmissions and in some cases mortality [4,5]. Around 2.5% (95% confidence interval [CI]: 1.5–6.7%) of people undergoing surgical procedures develop an SSI [6], with rates higher in specific specialties (e.g. general surgery 11%, 95% CI: 10–13% [7]) and low- to middle-income countries (e.g. African region 7.2%, 95% CI: 4.3–11.8% [6]). With over 300 million surgical procedures being performed annually around the world [8], SSIs represent an enormous international healthcare burden.

As a high-priority healthcare complication often preventable with appropriate care [1,9], detailed SSI-prevention guidelines have been published by several bodies [2], such as the World Health Organization [1], Centers for Disease Control and Prevention (CDC), USA [10,11] and the National Institute for Health Excellence (NICE), UK [12]. Clinical guidelines provide recommendations for practice, which are intended to optimise patient care, supporting clinical decision-making, appropriate care delivery and unwarranted variation by promoting evidence-based and effective interventions and care processes for the relevant topic [13–15]. For SSI prevention, recommendations guide the care of surgical patients and their wounds across all or some of the continuum of care from pre-operative to postoperative phases [1,11,12]. However, the adoption of guidelines into practice [14,15] and unwarranted variations in SSI prevention care are ongoing challenges [16–18].

Surveillance and local practice monitoring (or auditing) are important strategies for identifying unwarranted care variations requiring address, which guidelines and clinical standards facilitate by providing an expected or 'minimum' level of care against which practice can be measured [15,19,20]. Surveillance results can then be benchmarked and 'fed back' to organisations and clinicians to drive quality improvement as part of an ongoing cycle [21]. Underpinning this cycle of surveillance feedback improvement are performance indicators (measures or metrics), which quantify the quality of care being provided [22–25] and can be categorised as structure, process or outcome measures [26,27]. Theoretically, these categories are interlinked with appropriate system and structure supports leading to appropriate practices and processes, and in turn delivering better outcomes [26].

In this context, *structure indicators* represent characteristics of the setting being evaluated, including physical resources such as facilities, equipment and personnel, and the organisation's policies and procedures [26]. Unlike other forms of indicators, structure indicators are typically evaluated as

either the presence or the absence of policies and procedures, rather than proportions with a numerator and denominator [27]. As the policies and procedures of the healthcare setting supply information on the specific care that should be provided in that setting, it illuminates the role that setting-dependent policies have on outcomes such as SSIs [26]. *Process indicators* monitor and evaluate the actions involved in direct patient care (e.g. proportion of patients who *did* receive an intervention out of those who *should* have received said intervention) [26], while *outcome indicators* consider the changes in health status proposed to reflect the care provided (e.g. determination of or lack of determination of SSI within 30 days of a surgical procedure, or changes in patient knowledge, behaviour and satisfaction) [23,26].

Outcome indicators are perhaps the most widely used and known, and there are large surgical registries and surveillance mechanisms internationally that use SSI as a key metric [28,29]. However, while an outcome allows an evaluation of 'overall care', many specific factors may have contributed to its development [23,30]. Process indicators are less influenced by factors such as the method of data collection, case mix and chance, and are thus more sensitive to the quality of care being provided and more nuanced to specific care actions to inform quality improvement [23,30]. Yet, the availability of measures for monitoring structures and processes is unclear, particularly for local clinicians and organisations that are seeking easy-to-use and clinically relevant measures to inform their own quality improvement, and who may or may not use larger surveillance registries or improvement programme mechanisms.

The aim of this scoping review was to *identify and summarise indicators (structure, process and outcome) developed and/or used to monitor the quality of SSI prevention care*. Undertaking a scoping review is important because indicators for SSI prevention quality are scattered across different guidelines, specialties and health-system contexts, making it difficult to know what exists and where the gaps are. Mapping structure, process and outcome indicators in one place creates a foundation for consistent monitoring and supports the development of more standardised, evidence-informed quality frameworks. Ultimately, the findings of this synthesis provide greater understanding of SSI indicators such that health services can identify and target improvement efforts where they are most likely to impact patient care.

Methods

Design

This scoping review was conducted following Joanna Briggs Institute methodology [31], with a protocol developed *a priori* and registered on the Open Science Framework Registries (ref: 784m9). Reporting was guided by the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews checklist [32] (Supplementary 1). Consumer

reviewer involvement was reported following the Guidance for Reporting Involvement of Patients and the Public reporting checklist [33] (Supplementary 2).

Eligibility criteria

Eligibility criteria were refined based on the Population, Concept, Context (PCC) framework [34]:

- **Population (P):** Patients aged 16 years and over,
- **Concept (C):** Process, structure and outcome indicators for monitoring SSI-prevention care. For the purposes of this review examining the breadth of the literature and to identify clinically relevant indicators that can be easily applied by clinicians and local organisations, only process and outcome indicators based on a clear numerator and denominator were included [22,35]. Structure indicators with binary or categorical measures (e.g. yes/no to presence of appropriate policy) were included [27].
- **Context (C):** Indicators used in any setting, inclusive of any part of the surgical journey including pre-admission/pre-operation through to discharge and follow-up appointments.

Any quantitative and qualitative research (primary and secondary) that discussed or proposed potential or existing indicators for SSI prevention care were included. Clinical practice guidelines and other technical documents (documents outlining specific applications or standards for clinical application [36]) that specified indicators were also included. Only those documents written in English and published in the year 2000 or later (after the seminal treatment CDC guidelines [11]) were included. Documents where the full-text screening was inaccessible and grey literature were excluded.

Search strategy

An initial search was conducted with the assistance of a research librarian to develop a search strategy (Supplementary 3) based on the PCC framework and relevant document titles, abstracts and index terms. Search terms were combined and truncated, according to database specifications. Databases (Cumulative Index to Nursing and Allied Health Literature via Elton Bryson Stephens Company, Medline EBSCO, Scopus, Web of Science and Excerpta Medical Database) were systematically searched in December 2024, with searches updated in November 2025 and January/February 2026. Additional searches for clinical practice guidelines and technical documents were undertaken via guideline repositories including the International Guideline Library, NICE, Emergency Care Research Institute, ClinicalKey (Elsevier) and Guideline Central. The reference lists of included documents were also manually searched for additional, potentially relevant citations for screening.

Document selection

All citations identified were uploaded into EndNote X9™ (Clarivate™), and duplicates removed. The remaining citations were imported into Covidence™ for document selection.

Preliminary screening was conducted by one reviewer to identify documents clearly outside the review scope. Abstract and title screening, followed by full-text screening, were then performed by two independent reviewers. Any arising disagreements were resolved through discussion or with a third reviewer.

Data extraction

A data extraction tool was developed in Microsoft Excel™, including publication details (author, country, year), document characteristics (design, setting, sample, type of surgery), indicators (structure, process, outcome), based on published guideline (yes/no; name/year of guideline). The tool was piloted with the first three studies to determine whether the data produced were consistent with the review scope; alterations were made throughout piloting based on the information provided in the selected documents. Data extraction was performed by two independent reviewers extracted with any disagreements between the reviewers resolved through discussion or third reviewer consultation.

Data analysis and presentation

Synthesis, reporting and discussion of results was based on the PAGER (Patterns, Advances, Gaps, Evidence for Practice, Research recommendations [37]) framework. Document characteristics and indicators (by category: structure, process, outcome) were narratively synthesised, with indicators further mapped to subcategories (e.g. antibiotic prophylaxis) to reflect their focus. Characteristics, indicator categories and subcategories were counted in Microsoft Excel and presented as proportions (%), with extracted data summarised in tabular and diagrammatic form to underpin PAGER analysis.

Results

Document screening

Searches across sources yielded 12,085 documents for screening (Figure 1). From 823 articles screened at full text, 744 were excluded and 79 met the eligibility criteria [38–117]. Given the very large number of screened and excluded full-text articles, reasons for exclusion have not been presented in a Supplementary file but are available on request from the authors.

Document patterns

Individual study characteristics ($N = 79$) and specified indicators are presented in Supplementary 4, with a characteristics summary presented in Table I. Nearly 80% of documents were research and quality improvement articles, with only eight (10%) technical documents. The largest proportion of studies were from North America (39%), followed by Australasia (24%). The most predominant surgical specialty was orthopaedics (29%); however, around one third of studies ($N = 26$, 33%) did not address a specific area. Most documents reported one or more outcomes (67%) and process indicators (63%) but only 11 (14%) reported structure indicators. The majority (64%) also reported a guideline or policy document as the basis for the indicators

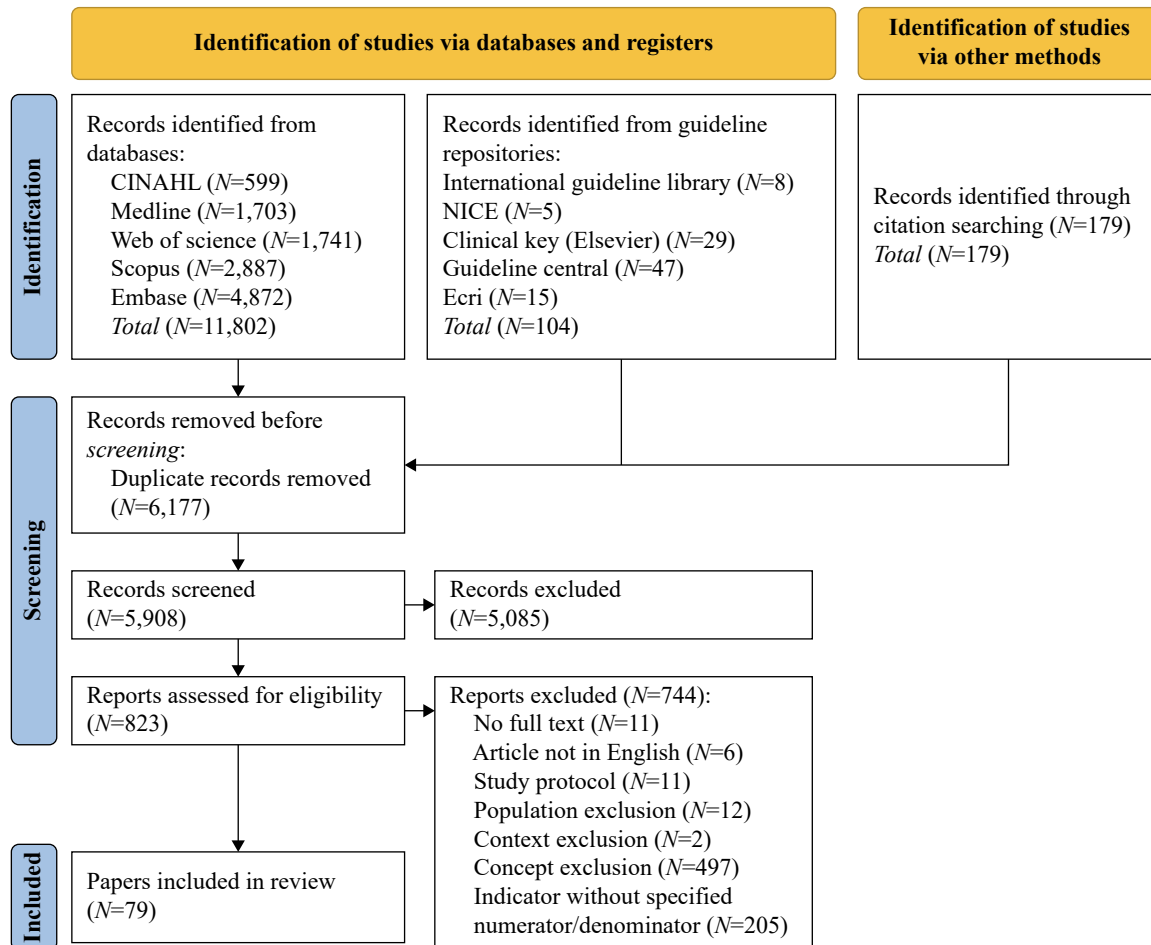


Figure 1. Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) flow diagram [127].

reported, from which the American Society of Health-System Pharmacists (20%), CDC (16%) and National Surgical Quality Improvement Project (14%) were the most cited organisations.

Indicators

There were 280 indicators reported across the 79 documents. While the largest proportion of documents reported outcome indicators (Table I), the sum of indicators described was highest for process indicators (55%), followed by structure indicators (23%) and outcome indicators (22%) (Figure 2).

Indicators were mapped to 27 subcategories (Table II), but within subcategories, there was high heterogeneity in phrasing, terminology, specifications and level of complexity (e.g. broad, general indicator vs highly specified; see Supplementary 4).

Structure indicators

Across the 11 documents reporting structure indicators [38,39,54,63–65,68,82,105,106,113], 65 structure indicators were mapped to eight subcategories (Table II); presence of protocols for specific components of SSI prevention (e.g. *presence of a protocol for antibiotic use or thrombosis prophylaxis*) was the most observed (39%) but additional topics of

interest were the presence of surveillance structures (29%) and access to specific resources (12%).

Process indicators

Across 50 documents reporting 154 process indicators [38,42–48,50–52,54,55,57,60–66,69,70,72,74,76–79,81–86,88–92,96,97,100,103,104,106,107,109,114,115], there were 18 subcategories (Table II). The vast majority of indicators were related to antibiotic administration (total $N = 101$; 66%), with far fewer mapped to other areas of care including skin/area preparation (6%), hand hygiene (4%), normothermia (4%) and completion of protocols/checklists (4%).

Outcome indicators

The overwhelming majority of outcome indicators from 53 documents [39,40,41,43,47,49,51,53,54,56–59,61,62,64,65,67,69,71,73,75,76,78–86,90–99,101,103,104,106,108–117] were variations of rates and proportions of SSI development (92%). A further five were specified by documents as outcome indicators related to sepsis (3%), infection with a specific micro-organism (2%), normothermia (2%) and generalised medical care-associated infection (2%).

Advances

The greatest advance in documents publishing indicators has been observed between 2010 and 2019 across all

TABLE I
Document characteristics (*N* = 79)

Publication year (%)		Type of document (%)		Geographical region (%)		Surgical specialty		Indicator category reported (%)		Based on guideline or policy document and organisation (%) ^a	
2000–2009	14 (17.7)	Research/QI	61 (77.2)	North America	31 (39.2)	Orthopaedic	23 (29.1)	Structure	11 (13.9)	Yes	51 (64.5)
2010–2019	36 (45.6)	Review/theory	10 (12.7)	Australasia	19 (24.1)	General	20 (25.3)	Process	50 (63.3)	ASHP	10 (19.6)
2020–	29 (36.7)	Technical/report	8 (10.1)	Europe	18 (22.8)	Gynaecological/Obstetrics	18 (22.8)	Outcome	53 (67.1)	CDC	8 (15.7)
				Africa	5 (6.3)	Colorectal	17 (21.5)			NSQIP	7 (13.7)
				South America	3 (3.8)	Cardiothoracic	14 (17.7)			WHO	5 (9.8)
				Multinational	3 (3.8)	Vascular	7 (8.9)			SCIP	4 (7.8)
						Buco maxillofacial	4 (5.1)			SaLTS	3 (5.9)
						Neurosurgery	4 (5.1)			NICE	2 (3.9)
						Ophthalmic	4 (5.1)			IDSA	2 (3.9)
						Major	3 (3.8)			ASBS	2 (3.9)
						Dermatologic	1 (1.3)			IPWG	2 (3.9)
						Plastic	1 (1.3)			Other	23 (45.1)
						Not specified	26 (32.9)				

QI, quality improvement; ASHP, American Society of Health-System Pharmacists; CDC, Centers for Disease Control and Prevention; NSQIP, National Surgical Quality Improvement Project; WHO, World Health Organization; SCIP, Surgical Care Improvement Project; SaLTS, Saving Lives Through Safe Surgery; NICE, National Institute for Health and Care Excellence; IDSA, Infectious Diseases Society of America, ASBS, American Society of Breast Surgeons, IPWG, Infection Prevention Working Group.

Note: Where percentages exceed 100%, documents may fall into multiple categories/counts.

Note: Some documents report multiple categories of indicators.

^a Guideline/document year within organisation cited may vary. **Regions:** North America, USA; South America, Brazil, Columbia; Europe, Sweden, Spain, France, The Netherlands, Germany and Italy; Australasia, China, Thailand, Taiwan, Korea, Saudi Arabia, Israel, India, Japan and Australia; Africa, South Africa, Ethiopia.

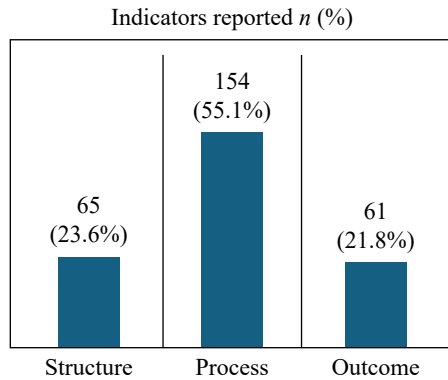


Figure 2. Indicators reported (%).

categories, with notable continued progress for process and outcome indicators post-2020 (Figure 3).

Discussion

To our knowledge, this is the first synthesis of quality indicators for SSI prevention, and against the review aim, the results provide a foundation for harmonised quality monitoring for SSI prevention. Indicators were identified across all categories (structure, process, outcome), with increases over time, suggesting there is growing clinical recognition of the link between these domains of healthcare quality [26]. Of further note was that over 50% were process indicators, while there were fewer outcome indicators (22%). This result initially appears surprising given that outcome indicators are well known and used, but is likely due to the many different components of care reflected in process measures across the surgical journey vs SSI as a single outcome [118,119]. This is a promising result given that process indicators are more sensitive to the quality of specific actions of care and thus better placed to inform quality improvement [23,30]. However, the

content of the measures was highly variable, even when targeted at the same outcome or process of care, and there were fewer structural indicators with gaps in clinical governance surveillance across the surgical journey.

Structure indicators are critical to ensuring the quality of policies and resources, which in turn govern and support the appropriateness of the clinical care provided [26]. We identified 65 structural measures across eight subcategories such as surveillance and resources, but there were far more process measures across 14 subcategories, with themes varying widely between structure and process categories. Given that supporting structures underpin clinical decision-making, it could be contended that for each process of care (and its measure), there should also be a supporting structure (and its corresponding measure). Without these governance frameworks, there may be a lack of clinical awareness of appropriate practice, which may result in suboptimal or even harmful care [120]. Some of the documents identified in this review, such as the one offered by the NICE (UK) [38], offer clear and broad SSI quality indicators – with both structure and process measures presented against important components of care across the surgical journey. Yet, most documents did not take this approach, potentially compounding a lack of awareness of structural measures and their importance for supporting appropriate clinical care. We searched multiple databases and repositories and underwent a lengthy process to identify the included indicators, which were fragmented across sources. For organisations and busy clinicians, it would be difficult to find any consistent indicators, particularly for structural measures, which may be lost among the historic and emerging predominance of outcome and process measures, respectively. This suggests the development of structural measures, aligned with those designed for processes of care, requires an increased focus.

Of the process indicators identified, over 60% were related to antibiotic administration, while far fewer (eight or less) were focused on other actions of clinical care, such as skin/area preparation, hand hygiene and normothermia. The

TABLE II
Indicator subcategories N (%)

Structure indicators (N = 65)		Process indicators (N = 154) (%)		Outcome indicators (N = 61) (%)	
Protocol	25 (38.5)	Antibiotics (<i>general administration n 28, timing n 29, cessation n 22, choice n 19, dose 3</i>)	101 (65.6)	SSI incidence	56 (91.8)
Surveillance	19 (29.2)	Skin/area preparation	9 (5.8)	Postoperative sepsis	2 (3.3)
Resources	8 (12.3)	Hand hygiene	6 (3.9)	Infection due to medical care (generic)	1 (1.6)
Communication	4 (6.2)	Normothermia	6 (3.9)	MRSA infection	1 (1.6)
Staffing	4 (6.2)	Protocols/checklists	6 (3.9)	Normothermia	1 (1.6)
Cost	2 (3.1)	Glucose	5 (3.2)		
Training	2 (3.1)	Hair removal	5 (3.2)		
Staffing/cost	1 (1.5)	Surgical attire	5 (3.2)		
		Dressing	4 (2.6)		
		Patient education	2 (1.3)		
		Wound care	2 (1.3)		
		Irrigation	1 (0.6)		
		Oxygen	1 (0.6)		
		Suture	1 (0.6)		

Acronyms: MRSA, methicillin-resistant *Staphylococcus aureus*; SSI, surgical site infection.

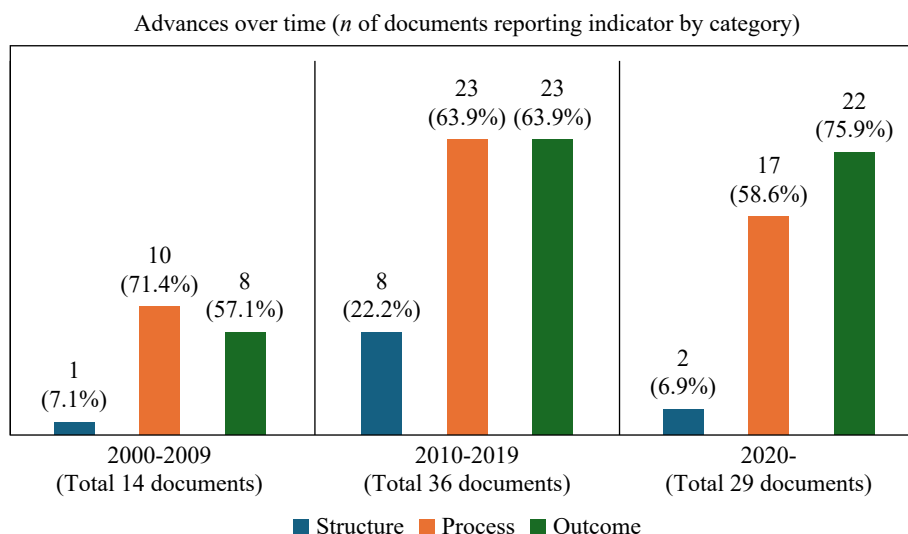


Figure 3. Advances over time – number of documents reporting indicators by category (structure, process, outcome).

surgical journey is multi-faceted and requires multi-disciplinary input, as reflected in Enhanced Recovery After Surgery (ERAS®) pathways shown to reduce complications and hospital length of stay [121,122]. Yet, our results indicate many components of care and disciplines are not supported by quality measures (e.g. components of ERAS related to SSI such as haemoglobin A1C screening, alcohol and smoking cessation and minimisation of drain use and invasiveness [123,124]). Furthermore, where process measures were available for sub-categories of care, they were highly heterogeneous. This may be expected in part, given that many indicators were specific to specialties or procedures, while others were broader and more 'generic' for application to different contexts. However, this level of variation is confusing for clinicians and institutions seeking to monitor their local practice. Internationally standardised process indicators, which are aligned with all facets of the surgical continuum of care from pre-operation to post-operation and discharge and which can be nuanced to specialty and procedure, are urgently needed to facilitate meaningful local monitoring and improvement.

The issue of heterogeneity was not isolated to one indicator category; similar heterogeneity was observed for outcome indicators. While the vast majority (>90%) were focused on SSI incidence, there were large variations in their terminology and complexity. This discordance in SSI outcome measures and subsequent benchmarking has also been noted between broader surgical surveillance programmes [28], with similar discrepancies between surgeon perspectives vs patient report and surveillance systems [125,126]. Evidently, there is a need for standardised indicators within all categories, developed with appropriate methodology and validation to ensure accurate and reliable measurement [22,35], even for outcome measures that are heavily used across research and surveillance systems. With alignment across structures, processes and outcomes, these indicators could be integrated into innovative approaches to audit and feedback, to holistically improve the quality of SSI prevention. For consumers, this would be an important step to safer surgeries and fewer infections, because hospitals would have a clearer, standardised set of indicators to

ensure the quality of their care through every stage of their surgical journey.

Strengths and limitations

We recognise that while this review has strengths, there are also some inherent limitations. In undertaking this review, we followed rigorous and validated methods for scoping reviews, with a comprehensive strategy and extensive search performed. Despite over 6000 citations being screened, and over 70 documents included, there is always a possibility that other relevant documents may not have been identified. Nonetheless, this review has presented the breadth of the literature and emphasised the need for harmonised indicators for local monitoring.

We set out to include process and outcome indicators based on a numerator and denominator. This was intended to identify clinically relevant indicators, which can be easily applied by clinicians and local organisations. Nonetheless, this means that indicators that are subject to risk adjustment or use other approaches (e.g. continuous data-based indicators) were not included in this review. Clearly, the exclusion of indicators that require risk adjustment does not capture more complex or system-level measures that some organisations rely on for robust quality monitoring. Thus, these findings reflect what indicators are most commonly practised for frontline use, but not the full spectrum of potentially useful SSI-prevention indicators.

Finally, this review was focused on SSI alone, but SSI forms only one of a range of surgical site complications [2]. While we considered including all surgical site complications in this review, the breadth of the literature meant this was infeasible. There may be further indicators for surgical wounds, which apply to SSI and complications more broadly, and monitoring all surgical wound care for complication prevention together would reduce the burden associated with surveillance.

The results of this review provide an initial source of internationally used indicators for monitoring care quality in practice. Synthesis within and across the domains of structure,

process and outcome means surveillance is more sensitive to which specific components of practice may be impacting patient safety. While this is important evidence for practice, it highlights significant gaps in the literature. There is an urgent need for standardised and validated quality indicators across domains, which can be nuanced to specialty, procedure and local context, to support organisations and clinicians around the world to implement local monitoring and quality improvement mechanisms. Following development with stakeholders including clinicians and patients, these indicators can be embedded in practice and innovative approaches to the surveillance and quality improvement cycle. Further rigorous research is required to develop these indicators against contemporary clinical practice guidelines and ERAS pathways.

CRedit authorship contribution statement

J. Lovegrove: Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **J. Marshall:** Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis. **N. Kuruppu:** Writing – review & editing, Investigation. **L. Shinnars:** Writing – review & editing, Investigation. **J. Carlini:** Writing – review & editing, Validation, Methodology. **J. Colquhoun:** Writing – review & editing, Validation, Methodology. **R. Liang:** Writing – review & editing, Validation, Methodology. **S.M. Havers:** Writing – review & editing, Validation. **B.M. Gillespie:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Investigation, Conceptualization.

Ethical approval

Not required.

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Conflict of interest statement

J.L. declares an investigator-initiated grant received by an affiliated university (The University of Queensland) from Becton, Dickinson and Company, unrelated to this project.

J.M., N.K., L.S., J.S., J.Ca., J.Co., R.L., S.M.H. and B.M.G. declare no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jhin.2026.09.005>.

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