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Staged meta-analysis of high- versus low-quality randomised trials testing triclosan-coated sutures on surgical site infection after abdominal surgery.

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Abstract

Introduction: Conflicting meta-analyses have been published comparing the effectiveness of triclosan-coated sutures. This creates confusion amongst clinical teams, guideline committees, and policymakers about how to interpret these findings. We aimed to understand how study quality influences the results of meta-analysis on the use of triclosan sutures in patients undergoing abdominal surgery and their impact on surgical site infection.

Methods: A systematic review was performed to identify randomised controlled trials comparing triclosan-coated versus uncoated sutures for closure of the fascial layer during clean-contaminated, contaminated, and dirty abdominal surgery, published up to April 2024. We performed a sequence of pre-specified meta-analyses to understand the effects of including low-quality studies and explore potential sources of bias. We then performed a simulated meta-analysis to determine the effect of new randomised trials being added to the high-quality evidence base.

Results: From 634 studies, our final meta-analysis included 15 studies (n=11,475 patients), of which six were high-quality and nine low-quality studies. The high-quality studies included 8,937 patients from 12 countries. The low quality included 2,538 from 11 countries. The high-quality studies showed no significant difference in rates of surgical site infections (OR: 0.88, 95% CI: 0.71 - 1.09). When the low-quality studies were included, there was a significant shift in the effect to show a benefit with triclosan-coated sutures (OR: 0.67, 95% CI: 0.54 - 0.83). Meta-regression identified that increasing study quality was associated with a smaller effect size towards non-significance. Simulation showed that new studies will only marginally shift these results, and only if strongly positive.

Conclusions: This study highlights potential uncertainty around the clinical effectiveness of triclosan-coated sutures, particularly when assessed through high-quality randomised trials. While lower-quality studies suggest benefit, these effects were not replicated in more robust evidence, although geographical uncertainty and practices in different settings around the world may explain some differences. However, some caution may be needed in value-based health systems, especially if prices fluctuate, and such investment may be best suited to high-risk or expensive cases where marginal gains are important. As clinical practice continues to evolve, further well-conducted, high-quality trials (including both randomised and efficient platform observational cohort studies) may help resolve this uncertainty

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Introduction

Surgical site infection (SSI) is the most common complication after surgery worldwide, particularly common in people undergoing clean-contaminated surgery, affecting as high as one in three patients.[1] They are associated with increased morbidity and mortality, with high economic costs to both patients and healthcare systems.[2] Several patient- and operation-level risk factors are known to increase risk of developing SSI after surgery, one of which includes methods of closing the surgical wound. Multiple interventions have been identified and tested over the past decade to reduce SSI, with mixed results.[3, 4]

Triclosan-coated sutures have been suggested as a highly effective single treatment for SSI prevention.[5-9] Several guideline committees make 'moderate strength' recommendations for the use of triclosan-coated sutures, due to heterogeneity and risk of bias of included studies in their considered meta-analyses.[10-12] The Centre for Disease Control and Prevention makes a weak recommendation for their use due to low-quality evidence.[13] Our previous meta-analysis, which included only high-quality studies, showed no difference when triclosan-coated sutures were used.[14] In contrast, a recent meta-analysis including both low and high quality studies suggested a clear benefit.[15] More research is needed to understand these variabilities, why they occur, the generalisability of the evidence, and how guideline committees should interpret this evidence in the future.

Triclosan sutures are more expensive than readily available alternatives[16] and their effects on antimicrobial resistance (AMR) are uncertain. Hence, the justification for their routine use is important for healthcare expenditure and prevention of infections and subsequent AMR. Therefore, the primary aim of this study was to perform a series of pre-planned meta-analyses, using a previously developed modified Risk of Bias-2 tool,[14] to understand why these conflicting results occur and the relative size of the various evidence bases. The objectives of the systematic review are: (i) update a systematic review by study quality, using the modified Risk of Bias-2 tool,[14](ii) describe the geographical diversity of high and low quality studies; (iii) meta-analysis of high- and low-quality studies; (iv) meta-regression to understand the relationship between study quality and effect size; and (v) perform a simulated meta-analysis, building in the effects of future high-quality randomised trials.

Methods

This study was prospectively registered as a systematic review and meta-analysis (PROSPERO: CRD42024540197) and followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020.[17] There were no deviations from the registered protocol in PROSPERO.

Inclusion and exclusion criteria

This systematic review included all randomised controlled trials evaluating triclosan-coated sutures for reducing SSI in patients undergoing clean-contaminated, contaminated, and dirty abdominal surgery. Only studies including abdominal surgery were included as they are the highest risk group for SSI and reduce the risks of heterogeneity, allowing the focus of this study on methodological quality. Patients undergoing surgery for clean surgery only were excluded since the event rate in clean surgery is extremely low (as shown in previous studies)[10], there are few studies in this area,[16] and they are not the focus of the most common area for updated clinical guidance.

Studies were included according to the following criteria: (i) high- and low- quality (criteria for assessment of study quality using the modified Risk of Bias-2 tool, appendix p 3 - 4); (ii) randomised controlled trial; (iii) assessed types of sutures (i.e. coated vs uncoated); and (iv) data regarding the contamination level of surgery was extractable, relating specifically to patients undergoing clean-contaminated, contaminated, or dirty abdominal surgery. Studies were excluded if they were (i) RCTs evaluating clean surgery only or where data on contamination strata for clean-contaminated and contaminated/dirty surgery were not available not stratified analysis not performed; (ii) SSI was not a primary outcome; (iii) conference abstracts, where the full text of articles were not available, (iv) patients not undergoing abdominal surgery.

Systematic search strategy

A systematic search was performed using data

sources such as Medline, Embase, CINAHL, PsycINFO, CENTRAL, clinicaltrials.gov, and International Clinical Trials Registry Platform from inception to 30th April 2024 by two authors (SK, TA). In addition, the reference lists of included studies were explored for any potentially relevant studies for inclusion. A summary of the search terms used for the systematic review is presented in the appendix (p 5).

Study selection and data extraction

Three authors (SK, TA, and RA) extracted the data; any discrepancies were discussed with all authors together, and any conflict was resolved by discussion with the senior author (AB). The type of data extracted included the number of centres, number of patients, interventions used, SSI rates by each intervention, and degree of contamination. Duplicates were excluded.

Defining study quality

Surgical trials have specific challenges to the design and conduct, especially for SSI. Therefore, they warrant careful assessment using appropriate quality assessment tools. Previously, we developed a modified Risk of Bias-2 (RoB-2) tool that comprises domains with quality assessment criteria specific to SSI trials, including definitions and outcome reporting.[14] Details of the development of this modified RoB-2 tool have been described previously. Briefly, these domains contain ten areas of bias, which were mapped out to the Cochrane RoB-2 tool, in which SSI-specific quality criteria were included where possible. Of the ten domains, one was new (quality assurance of outcome assessment), and nine were adapted from different aspects of the Cochrane tool through a four-stage process. From these ten, eight were prioritised as essential and taken forward into the final adapted SSI-specific RoB-2 tool. The eight essential key domains are listed in the appendix (p 3 - 4; Table S1). Two domains were classed as desirable, which were blinding of surgeons and blinding of patients, because they were non-discriminatory towards a high-quality or low-quality assessment. To be deemed high-quality, all eight essential domains need to be at low risk of bias. Therefore, we used this tool to perform quality assessment of the included studies from the systematic review. The quality of each study was assessed by two independent reviewers (SKK, and TA) and any disagreements were discussed with a third reviewer (AB).

Statistical analysis

A random-effects estimate of the pooled odds of each outcome was generated with use of the hybrid Mantel-Haenszel methods. The rates of SSIs reported in the RCTs in the articles were used directly in the quantitative meta-analysis. Funnel plots were used to visually assess publication bias of included studies. Heterogeneity between studies was assessed using the I^2 value to determine the degree of variation not attributable to chance alone. I^2 values were considered to represent low, moderate, and high degrees of heterogeneity where values were <25%, 25–75%, and >75%, respectively. Funnel plot asymmetry was assessed using the Egger test. A random-effects meta-regression model was used to assess the effect of study quality (based on the SSI-specific RoB-2 tool) on the effect size estimates. Meta-regressions are like simple regressions, in which an outcome variable is predicted from one or more explanatory variables using a linear model. To further test the robustness of our findings and assess the impact of different clinical scenarios. These simulations were designed to model various assumptions about the distribution of surgical outcomes and to evaluate how our meta-regression model performed under different hypothetical conditions. To simulate the effects of a new high-quality studies, we created the following pre-specified scenarios, all based around a high quality randomised trial: (i) a trial with 1,500 patients in each arm with no reduction, 0%, 10%, 20%, 30%, and 40% reduction in SSI; and (ii) a trial with 500 patients in each arm with no reduction, 0%, 10%, 20%, 30%, and 40% reduction in SSI. Statistical significance was considered when $p<0.05$. Data analysis was undertaken using R Foundation Statistical software, using packages such as meta[18] (R 3.2.1).

Role of the funding source

SK was funded by the NIHR Doctoral Research Fellowship (NIHR303288). The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

Study characteristics

Of the 634 studies identified from the systematic literature search, 594 studies were excluded following screening of the title and abstract. From the remaining 29 studies for full text review, 14 were excluded due to several reasons, including non-randomised study designs (n=2), SSI was not the primary outcome (n=4), unclear type of sutures used (n=2). Reasons for the excluded studies are presented in the appendix (p 6 - 7). The final 15 studies were included comparing coated and uncoated sutures. A summary of the flow diagram is presented in Figure 1.

To understand how the present systematic reviews compare to previously published studies, nine systematic reviews were identified, including 27 studies. From these 27 studies, the present systematic review only includes 11 studies. The remaining 16 studies were excluded because three were conference abstracts, ten included clean surgery and data were unable to be separated out, one was not a randomised controlled trial, one did not include any patients with abdominal surgery, and one did not include SSI as a primary outcome. Further, this present review included four studies not included in previous systematic reviews. A summary of the studies is presented in the appendix (p 8).

Characteristics of low and high-quality studies

Following quality appraisal of the included studies in the systematic review, six were identified as high quality and nine were identified as low quality. High-quality studies were more likely to have larger studies compared to low-quality studies (median: 935 vs 198, p=0.013) (Table 1). A summary of the bias between the different conduct and reporting domains are presented in Table 2A and 2B, respectively. A summary of bias within blinding of surgeons in the included studies are presented in the appendix (p 9). Within low-quality studies, common reasons for high-risk of bias were within the conduct domains of random sequence generation (n=5), blinding of patients (n=5), lack of outcome definitions (n=5) and allocation concealment (n=4). The most common reason within the reporting domain is the lack of protocol registration (n=9). Baseline study and patient characteristics are presented in Table 3 and appendix (p 10 - 11)

Meta-analysis of studies

Low-quality studies: Nine RCTs were identified as low-quality studies comparing coated and uncoated sutures, comprising 2,538 patients. In the overall analysis, there were no significant differences in rates of SSI between coated and uncoated sutures (OR: 0.57, 95% CI: 0.42 - 0.78, Figure 2).

High-quality studies: Six RCTs were identified as high-quality studies comparing coated and uncoated sutures, comprising 8,937 patients. In the overall analysis, there were no significant differences in rates of SSI between coated and uncoated sutures (OR: 0.88, 95% CI: 0.71 - 1.09, Figure 2).

Overall studies: When all studies were combined, both high- and low-quality studies (n=11,475), there was a significant difference in rates of SSI between coated and uncoated sutures (OR: 0.72, 95% CI: 0.59 - 0.87, Figure 2). A summary of the funnel plot for publication bias for overall studies, high-quality, and low-quality only is presented in the appendix (p 12 - 13).

Meta-regression of study quality: A meta-regression was performed to identify the relationship between study quality and effect size. With increasing study quality, the observed clinical effect in these trials was approaching non-significance (Figure 3).

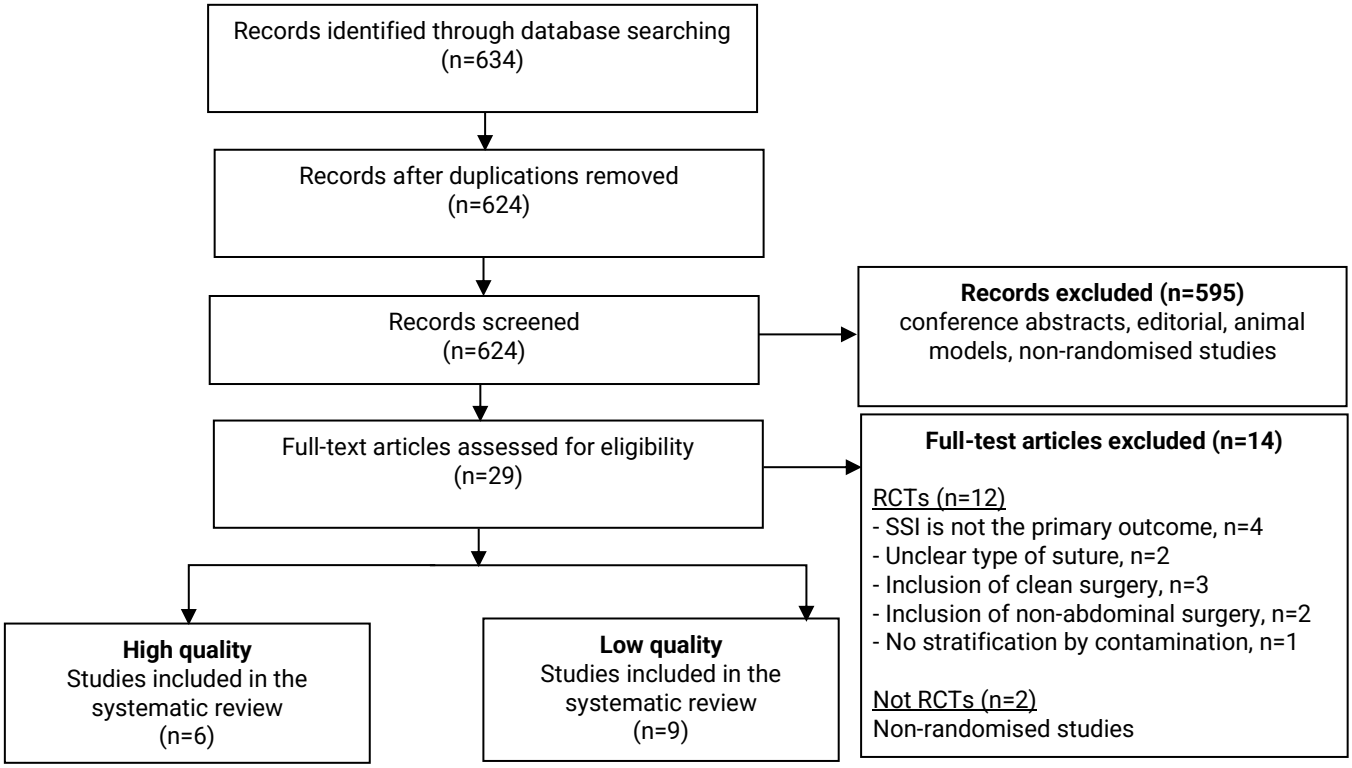
Simulation and forecasting of future trials

Scenarios developed across no effect and different sizes of clinical reduction demonstrated no significant impact on overall study findings for high-quality studies (Figure 4). Sensitivity analyses were performed for a smaller high-quality study of similar scenarios, which identified similar findings (appendix p 14).

Discussion

This study highlights potential uncertainty around the clinical effectiveness of triclosan-coated sutures, particularly when assessed through high-quality randomised trials. While lower-quality studies suggest benefit, these effects were not replicated in more robust evidence, although geographical uncertainty and practices in different settings around the world may explain some differences. However, some caution may be needed in value-based health systems, especially if prices fluctuate. As clinical practice continues to evolve, further well-conducted,

Figure 1. PRISMA flow chart of included studies in the systematic review and meta-analysis



high-quality trials (including both randomised and efficient platform observational cohort studies on surgical site infection) may help resolve this uncertainty.

This systematic review has some unique features compared to existing literature: (i) combining high quality randomised trials created a large patient group than in the low quality trials; (ii) these high quality trials had geographically diverse data, with 50% from high income countries; and (iii) that increasing study quality was more likely to lead to a neutral effect size. We demonstrated that adding low-quality studies, which were systematically more likely to have a positive effect, created an overall positive effect, which is a biased and fragile result. Our simulation suggests that small studies are unlikely to change these findings soon and should be avoided. However, as new evidence emerges, an updated evidence synthesis that robustly tests effects should be published to guide decision makers on cost expenditure.

Almost all previously published systematic reviews have shown positive effects of triclosan-coated sutures, which is directly attributable to the inclusion of low-quality trials. In doing so, we have adopted thepreviously developed modified Risk of Bias-2 to understand the quality of the included studies. Manyof these reviews included low-to-moderate quality studies, leading to inconsistent and biased previously developed modified Risk of Bias-2 to understand the quality of the included studies. Manyof these reviews included low-to-moderate quality studies, leading to inconsistent and biased conclusions. For instance, only six of 11 meta-analyses considering coated sutures included a quality assessment.[15-19]

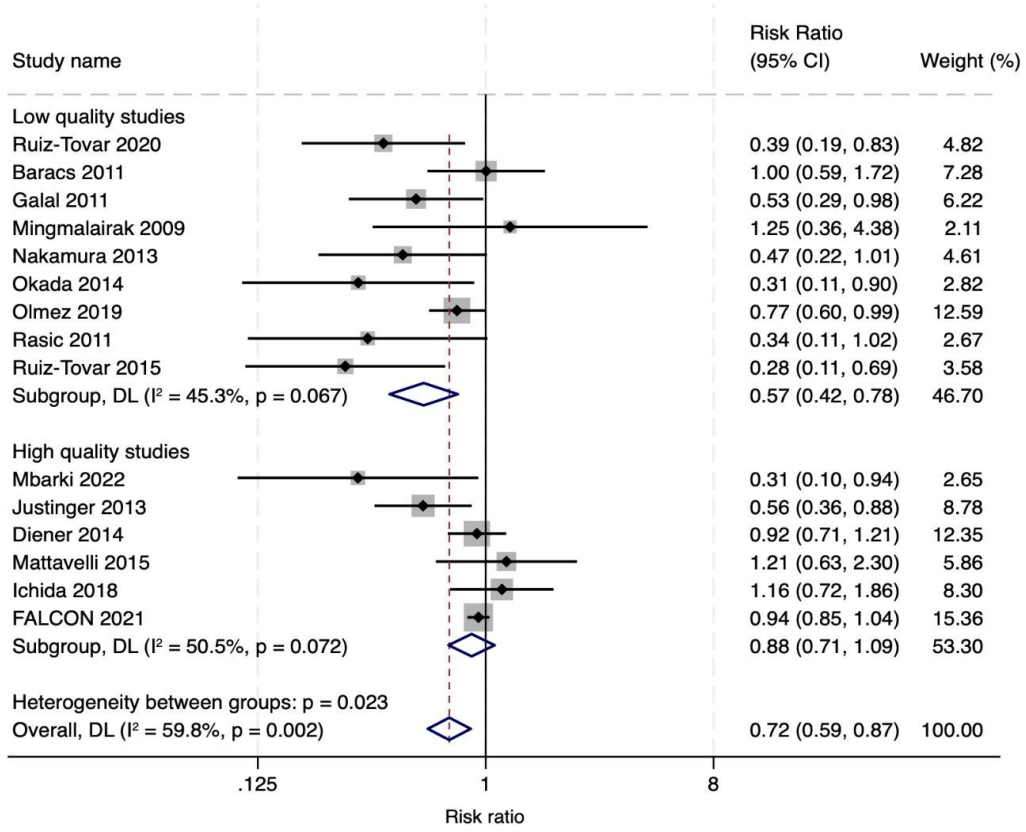
Using this modified risk of bias tool to assess SSI trials for quality, we have rigorously assessed the quality of the included studies. This ensures that findings of the study can be based on high-quality trials. This methodological rigour sets our review apart from earlier ones, which often included studies without thorough quality assessments, thereby potentially overestimating the benefits of triclosan-coated sutures.

Table 1: Summary of study characteristics by quality of included studies in systematic review

	All studies (n=15 studies)	High quality (n=6 studies)	Low quality (n=9 studies)	p-value
Country income				
HIC	10 (66.7)	4 (66.7)	6 (66.7)	0.329
UMIC	2 (13.3)	0 (0.0)	2 (22.2)	
LMIC	3 (20.0)	2 (33.3)	1 (11.1)	
Patients, n	318 (191 - 831)	935 (453 - 1142)	198 (139 - 385)	0.013
Study findings				
No difference	8 (53.3)	4 (66.7)	4 (44.4)	0.751
Positive	7 (46.7)	2 (33.3)	5 (55.6)	
Scale of study				
Multiple centres	5 (33.3)	2 (33.3)	3 (25.0)	0.435
Multiple countries	1 (6.7)	1 (16.7)	0 (0.0)	
Single centre	9 (60.0)	3 (50.0)	6 (66.7)	
Centres, n	1.0 (1.0 to 4.0)	1.0 (1.0 to 24.0)	1.0 (1.0 to 1.8)	0.370

**The data presented for patients and centres are medians.*

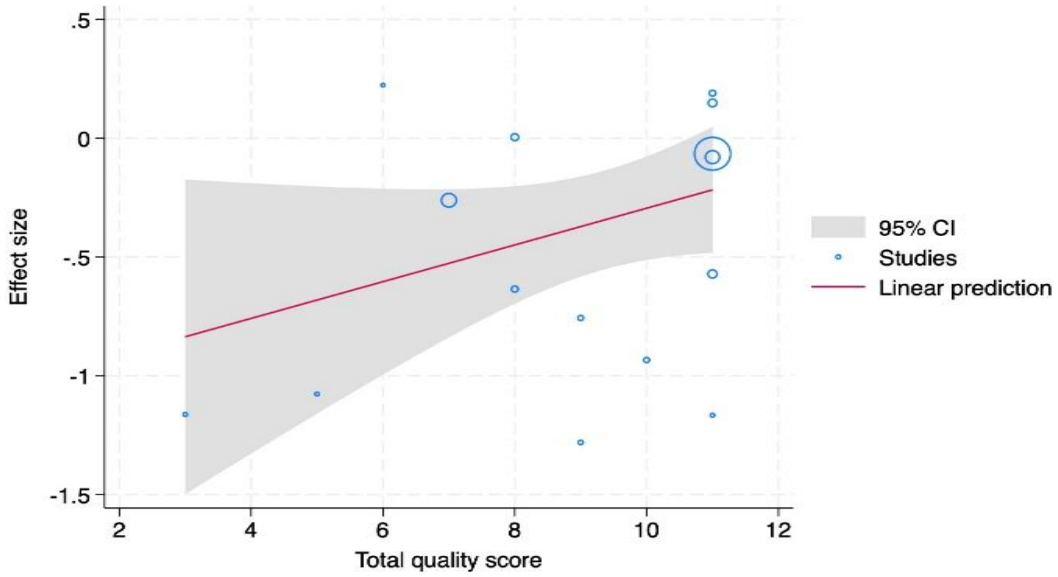
Figure 2. Summary forest plots of meta-analysis comparing suture types (triclosan coated vs uncoated) on surgical site infections in randomised controlled trials, stratified by low quality studies only and high quality only, with pooled analysis



**DL refers to Der-Simonian Low which is normally indicating the heterogeneity of the meta-analysis for overall, low-quality and high-quality studies*

This systematic review has several limitations to address. First, this study did not include studies including clean surgery only, unlike previous systematic reviews. However, the benefits of clean surgery, where infection rates are low, may be marginal at best and are beyond the scope of this paper. Second, the modified definitions of low risk of bias may have led to the exclusion of some studies that were conducted well but poorly reported. Without pre-published protocols, it can prove impossible to tell the difference, and by focusing on proven high-quality trials, we can be sure of a more reliable conclusion. Third, the inclusion of sites from diverse settings (including low and middle-income countries) without control for other factors may have contributed to the null effects seen in high-quality

Figure 3. Meta-regression of the relationship between study quality and observed clinical effect on all the included studies in the systematic review.



**The total score is the sum of all the domains based on the quality. *Within the revised Risk of Bias-2, each domain was scored as 0 as low quality and 1 as high quality.*

Figure 4. Simulations of an ongoing high-quality trial on overall meta-analysis findings including 1500 patients in each arm (A) No effect (B) 10% reduction (C) 20% reduction (D) 30% reduction (E) 40% reduction

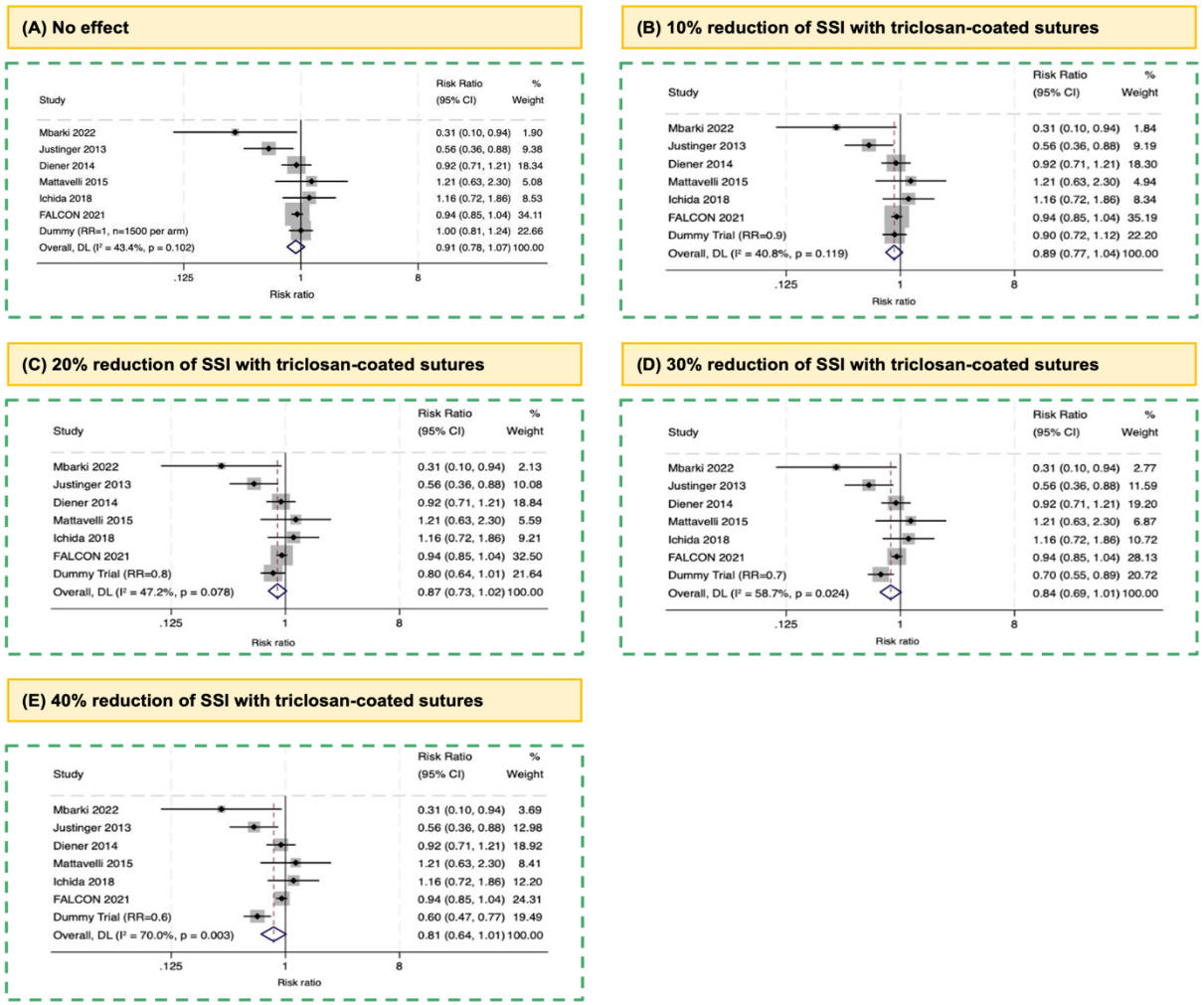


Table 2A: Evaluation of quality of included randomised trials, assessed using the modified Cochrane risk of bias tool, showing trial conduct domains and types of bias essential to trials in SSI. *Abbreviations: ITT: Intention to treat, PP: Per protocol*

	Random sequence generation	**Allocation concealment**	**Blinding - patients**	**Blinding - outcome assessors**	**Incomplete outcome data**	
	Selection	Selection	Performance	Detection	Attrition	Loss to follow-up
Low quality						
Mingmalairak 2009	High: Suture by random table	High: unclear allocation methodology	Unclear: No description of blinding of patients	Unclear: No description of blinding of outcome assessors	Low: ITT analysis, complete reporting of protocol deviations and lost to follow up	0%
Baracs 2011	Low: Computer generated 1:1 randomisation	High: unclear allocation methodology	Unclear: No description of blinding of patients	Unclear: No description of blinding of outcome assessors	Low: Complete reporting of protocol deviations and lost to follow up	0%
Galal 2011	Low: Computer generated 1:1 randomisation	Low: Sealed pack for dispensing one of the suture packs at a time	Low	Low: Blinded assessor, pre-set criteria	High: Incomplete reporting, Multicentre study but only reported from a single centre	Unknown
Rasic 2011	Low: Computer generated 1:1 randomisation	Low: Sealed, opaque, numbered envelopes	Unclear: No description of blinding of patients	Unclear: No description of blinding of outcome assessors	Low: ITT analysis, complete reporting of protocol deviations and lost to follow up	0%
Nakamura 2013	High: Envelope randomisation	High: unclear allocation methodology	High: No blinding of patients	Low: Blinded assessor, pre-set criteria	Low: ITT analysis, complete reporting of protocol deviations and lost to follow up	0%
Okada 2014	Unclear: No description of randomisation	High: Control and Study groups operated on in different years	High: No blinding of patients	Unclear: No description of blinding of outcome assessors	Low: complete reporting of protocol deviations and lost to follow up	0%
Ruiz-Tovar 2015	High: Performed by surgeon in theatres	High: unclear allocation methodology	Unclear: No description of blinding of patients	Low: Blinded assessor, pre-set criteria	Low: ITT analysis, complete reporting of protocol deviations and lost to follow up	0%
Olmez 2019	Low: Computer generated 1:1 randomisation	High: unclear allocation methodology	Unclear: No description of blinding of patients	Low: Blinded assessor, pre-set criteria	Low: ITT analysis, complete reporting of protocol deviations and lost to follow up	0%
Ruiz-Tovar 2020	High: Random number table	High: unclear allocation methodology	Low	Low: Blinded assessor, using pre-set criteria	Low: ITT analysis, complete reporting of protocol deviations and lost to follow up	0%
High quality						
Justinger 2013	Low: Randomisation into mixed block sizes	Low: Mixed block sizes ranged from 50-100 patients	Low	Low: Blinded assessor, using pre-set criteria	Low: PP analysis, complete reporting of protocol deviations and lost to follow up	0%
Diener 2014	Low: Central web-based permuted block randomisation	Low: Permuted block randomisation, 1:1 allocation ratio, block size 4	Low	Low: Blinded assessor, using pre-set criteria	Low: Modified ITT analysis, complete reporting of protocol deviations and lost to follow up	0%
Mattavelli 2015	Low: Computer generated 1:1 randomisation	Low: Sealed, opaque, numbered envelopes	Low	Low: Blinded assessor, pre-set criteria	Low: PP analysis, complete reporting of protocol deviations and lost to follow up	7%
Ichida 2018	Low: Permuted block randomisation 1:1 allocation ratio	Low: Sealed, opaque, sequential envelopes, with a block size of 2	Low	Low: Blinded assessor, pre-set criteria	Low: Modified ITT analysis, complete reporting of protocol deviations and lost to follow up	0%
FALCON 2021*	Low: Centralised computer randomisation	Low: Computerised stratified randomisation just before operation	Low	Low: Blinded outcome assessor trained on pre-set criteria	Low: ITT analysis, complete reporting of protocol deviations and lost to follow up	10%
Mbarki 2022	Low: Computer generated 1:1 block randomisation	Low: Sealed, opaque, numbered envelopes	Low	Low Blinded assessor, pre-set criteria	Low: ITT analysis, complete reporting of protocol deviations and lost to follow up	6%

Table 2B: Evaluation of quality of included randomised trials, assessed using the modified Cochrane risk of bias tool, showing the reporting domains and types of bias essential to trials in SSI

	Reporting				
	Selective reporting	Outcome definition	Follow up period pre-defined	Follow up / post discharge surveillance plan	Protocol registration
Low quality					
Mingmalairak 2009	Low: SSI primary outcome	High: Outcome not predefined	Low: 30-day pre-defined	Low: Face-to-face	High: Not registered
Baracs 2011	Low: SSI primary outcome	High: Outcome not predefined	Low: 30-day pre-defined	Low: Face-to-face	Complete: NCT01123616
Galal 2011	Low: SSI primary outcome	Low: CDC	Low: 30-day pre-defined	Low: Face-to-face	High: Not registered
Rasic 2011	Low: SSI primary outcome	High: Outcome not predefined	High: No pre-defined follow-up	High: reliance on ad-hoc re-admissions or notes-only reviews	High: Not registered
Nakamura 2013	Low: SSI primary outcome	Low: CDC	Low: 30-day pre-defined	Low: Face-to-face	High: Not registered
Okada 2014	Low: SSI primary outcome	Low: CDC	Low: 30-day pre-defined	Low: Face-to-face	High: Not registered
Ruiz-Tovar 2015	Low: SSI primary outcome	Low: CDC	Low: 30-day pre-defined	Low: Face-to-face	High: Not registered
Olmez 2019	Low: SSI primary outcome	High: Outcome not predefined	Low: 30-day pre-defined	Low: Face-to-face	High: Not registered
Ruiz-Tovar 2020	Low: SSI primary outcome	Low: CDC	Low: 30-day pre-defined	Low: Face-to-face	Complete: NCT03763279
High quality					
Justinger 2013	Low: SSI primary outcome	Low: CDC	Low: 14-days	Low: Face-to-face	Complete: NCT00998907
Diener 2014	Low: SSI primary outcome	Low: CDC	Low: 30-day pre-defined	Low: Face-to-face	Complete: DRKS00000390
Mattavelli 2015	Low: SSI primary outcome	Low: CDC	Low: 30-day pre-defined	Low: Face-to-face	Complete: NCT01869257
Ichida 2018	Low: SSI primary outcome	Low: CDC	Low: Daily up to 30-day pre-defined	Low: Face-to-face	Complete: UMIN000013054
FALCON 2021*	Low: SSI primary outcome	Low: CDC	Low: 30-day pre-defined	Low: Mixed - telephone and face-to-face	Complete: NCT01602380
Mbarki 2022	Low: SSI primary outcome	Low: CDC	Low: 30-day pre-defined	Low: Face-to-face	Complete: NCT05330650

**Abbreviations: CDC Centre for disease control, SSI: Surgical site infection, EMR: Electronic medical records*

trials. Finally, although we have used a validated tool to assess study quality, the present classification with this tool may impact the overall study findings. Findings from the present systematic review have significant implications for clinical practice and policy. Given the higher cost of these sutures and the unknown impact on antimicrobial resistance, some caution may be needed around routine use.[19, 20] Guideline committees of the future and policymakers may consider prioritising high-quality evidence when making recommendations. These findings also highlight the need for regular assessments of clinical guidelines as new high-quality evidence becomes available.

This study helps point to future research. New trials should be very large in number, efficient, and reported quickly, and meta-analyses of new evidence should be published quickly. Platform cohort studies, which are efficient and can address multiple hypotheses at once, may also add to this evidence base without the cost and duration needed for randomised trials. Future meta-analyses should take into account the different quality of evidence as demonstrated here and present a balanced overview of evidence. There is a need for research that explores the long-term impacts of triclosan-coated sutures on AMR, as this remains unproven.[20]

Table 3. Study characteristics of included high- and low-quality randomised controlled trials. Figures are n(%)

	Study Period	Centres	Surgery Type	Patients	Preoperative Antibiotic	SSI rate	Clean-contaminated	Contaminated or Dirty	Follow-up, days
Low quality									
Mingmalairak 2009	Aug 2006-Mar 2007	Single	Appendicectomy	100	100 (100)	9 (9)	100 (100)	0 (0)	30
Baracs 2011	Dec 2009 - Nov 2010	Multiple	Colorectal	385	NR	47 (12)	100 (100)	0 (0)	30
Galal 2011	NR	Single	Mixed	214	214 (100)	38 (18)	143 (67)	71 (33)	30
Rasic 2011	Sept 2008-Sept 2009	Single	Colorectal	184	184 (100)	16 (9)	184 (100)	0 (0)	NR
Nakamura 2013	April 2009 - March 2011	Single	Colorectal	410	410 (100)	28 (7)	NR	NR	30
Okada 2014	Dec 2005 - Feb 2012	Single	HPB	198	198 (100)	20 (10)	NR	NR	30
Ruiz-Tovar 2015	Nov 2007 - Nov 2013	Multiple	Colorectal	102	102 (100)	23 (23)	0 (0)	102 (100)	60
Olmez 2019	June 2013 - June 2014	Single	Mixed	806	806 (100)	183 (23)	651 (81)	155 (19)	30
Ruiz-Tovar 2020	Nov 2007 - Nov 2013	Single	Mixed	139	139 (100)	23 (17)	0	139 (100)	30
High quality									
Justinger 2013	Sep 2009 - Sep 2011	Single	Mixed	856	NR	73 (9)	790 (92)	66 (8)	14
Diener 2014	Apr 2010 - Oct 2012	Multiple	Mixed	1185	238 (20)	183 (15)	880 (74)	23 (2)	30
Mattavelli 2015	Jan 2010 - Mar 2013	Multiple	Colorectal	281	237 (84)	33 (12)	281 (100)	0 (0)	30
Ichida 2018	Mar 2014 - Mar 2017	Single	Mixed	1023	173 (17)	65 (6)	990 (97)	14 (1)	30
FALCON 2021*	Nov 2018 - July 2020	Multiple	Mixed	5788	5234 (99)	1163 (22)	3091 (53)	2697 (47)	30
Mbarki 2022	Nov 2020 - June 2021	Single	Obstetrics	318	318 (100)	17(5)	318 (100)	0 (0)	30

**Abbreviations: HIC: high income countries, HPB: Hepatopancreaticobiliary, LMIC: low-middle income countries, NR: Not reported, SSI: surgical site infection. *Only study in the review including centres from low-middle income countries*

Declarations

Ethics approval and consent to participate: Ethical approval was not applicable for this study, as this was a scoping review of existing literature and did not involve direct contact with human subjects.

Data sharing: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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References

1. GlobalSurg Collaborative. Surgical site infection after gastrointestinal surgery in high-income, middle-income, and low-income countries: a prospective, international, multicentre cohort study. *Lancet Infect Dis* 2018;18(5): 516-525.
2. Monahan M, Jowett S, Pinkney T, Brocklehurst P, Morton DG, Abdali Z, Roberts TE. Surgical site infection and costs in low- and middle-income countries: A systematic review of the economic burden. *PLoS One* 2020;15(6): e0232960.
3. De Simone B, Sartelli M, Coccolini F, Ball CG, Brambillasca P, Chiarugi M, Campanile FC et al. Intraoperative surgical site infection control and prevention: a position paper and future addendum to WSES intra-abdominal infections guidelines. *World J Emerg Surg* 2020;15(1): 10.
4. Wolfhagen N, Boldingh QJJ, Boermeester MA, de Jonge SW. Perioperative care bundles for the prevention of surgical-site infections: meta-analysis. *Br J Surg* 2022;109(10): 933-942.
5. de Jonge SW, Atema JJ, Solomkin JS, Boermeester MA. Meta-analysis and trial sequential analysis of triclosan-coated sutures for the prevention of surgical-site infection. *Br J Surg* 2017;104(2): e118-e133.
6. Guo J, Pan LH, Li YX, Yang XD, Li LQ, Zhang CY, Zhong JH. Efficacy of triclosan-coated sutures for reducing risk of surgical site infection in adults: a meta-analysis of randomized clinical trials. *J Surg Res* 2016;201(1): 105-117.
7. Edmiston CE, Jr., Daoud FC, Leaper D. Is there an evidence-based argument for embracing an antimicrobial (triclosan)-coated suture technology to reduce the risk for surgical-site infections?: A meta-analysis. *Surgery* 2013;154(1): 89-100.
8. Wang ZX, Jiang CP, Cao Y, Ding YT. Systematic review and meta-analysis of triclosan-coated sutures for the prevention of surgical-site infection. *Br J Surg* 2013;100(4): 465-473.
9. Chang WK, Srinivasa S, Morton R, Hill AG. Triclosan-impregnated sutures to decrease surgical site infections: systematic review and meta-analysis of randomized trials. *Ann Surg* 2012;255(5): 854-859.
10. Leaper D, Rochon M, Pinkney T, Edmiston CE. Guidelines for the prevention of surgical site infection: an update from NICE. *Infect Prev Pract* 2019;1(3-4): 100026.

11. Leaper DJ, Edmiston CE. World Health Organization: global guidelines for the prevention of surgical site infection. *J Hosp Infect* 2017;95(2): 135-136.
12. Calderwood MS, Anderson DJ, Bratzler DW, Dellinger EP, Garcia-Houchins S, Maragakis LL et al. Strategies to prevent surgical site infections in acute-care hospitals: 2022 Update. *Infect Control Hosp Epidemiol* 2023;44(5): 695-720.
13. Berrios-Torres SI, Umscheid CA, Bratzler DW, Leas B, Stone EC, Kelz RR et al. Healthcare Infection Control Practices Advisory C. Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017. *JAMA Surg* 2017;152(8): 784-791.
14. National Institute of Health Research Unit on Global S. Alcoholic chlorhexidine skin preparation or triclosan-coated sutures to reduce surgical site infection: a systematic review and meta-analysis of high-quality randomised controlled trials. *Lancet Infect Dis* 2022;22(8): 1242-1251.
15. Otto-Lambertz C, Decker L, Adams A, Yagdiran A, Eysel P. Can triclosan-coated sutures reduce the postoperative rate of wound infection? Data from a systematic review and meta-analysis. *Surgery* 2023;174(3): 638-646.
16. Edwards M, Graziadio S, Shore J, Schmitz ND, Galvain T, Danker WA, Kocaman M, Pournaras DJ, Bowley DM, Hardy KJ. Plus Sutures for preventing surgical site infection: a systematic review of clinical outcomes with economic and environmental models. *BMC Surg* 2023;23(1): 300.
17. Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, Shekelle P, Stewart LA, Group P-P. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Syst Rev* 2015;4(1):
18. Shim SR, Kim SJ. Intervention meta-analysis: application and practice using R software. *Epidemiol Health* 2019;41: e2019008.
19. Ranjbar R, Alam M. Antimicrobial Resistance Collaborators (2022). Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. *Evid Based Nurs* 2023.
20. Antimicrobial Resistance C. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. *Lancet* 2022;399(10325): 629-655.