WHO Surgical Site Infection Prevention Guidelines

Web Appendix 26

Summary of a systematic review on advanced dressings

1. Introduction

The term "surgical wound" used in this document refers to a wound created when an incision is made with a scalpel or other sharp cutting device and then closed in the operating room by suture, staple, adhesive tape or glue and resulting in close approximation of the skin edges. It is traditional to cover such wounds with a dressing, which acts as a physical barrier to protect the wound from contamination from the external environment until it becomes impermeable to microorganisms. The dressing can also serve to absorb exudate from the wound and keep it dry. There is a wide variety of wound dressings and the main types are described below in the Table.

Table. Classification of dressings suitable for use on primarily closed incisions*

I. Basic wound contact dressings	
Ia. Absorbent dressings and surgical absorbents	Absorbent dressings are applied directly to the wound. Surgical absorbents may be used as secondary absorbent layers in the management of heavily-exuding wounds.
Ib. Low-adherent wound contact layers	Low-adherent wound contact layers consist mainly of a fine mesh gauze impregnated with moisturizing, antibacterial or bactericidal compounds. They are either non-medicated (for example, paraffin gauze dressing) or medicated (for example, containing povidone iodine or chlorhexidine). These dressings are widely used primarily as interface layers between the wound surface and a secondary absorbent dressing, usually made of cotton gauze, to prevent it from adhering to the wound surface and causing trauma upon removal. As the dressing dries, fibrin from the wound bed causes temporary bonding of the dressing to the wound, thus permitting healing beneath it.
II. Advanced dressings	
IIa. Vapour-permeable films	Vapour-permeable films are permeable to water vapour and oxygen, but not to water or microorganisms. They are normally transparent.
IIb. Hydrocolloid dressings	Hydrocolloid dressings vary significantly in their composition and physical properties. In general, they consist of a self-adhesive gel-forming mass applied to a carrier, such as a thin polyurethane film or a foam sheet. They contain colloidal particles, such as quar, karaya, gelatic, sodium carboxymethylcellulose, gelatin and pectin, in an adhesive mass usually made of polyisobutylene. In their intact state,

	hydrocolloids are virtually impermeable to water vapour and thus they facilitate wound hydration and promote moist wound healing. By trapping wound exudates, hydrocolloids create a moist environment that softens and lifts dry eschars or causes their autolytic debridement and proteolytic digestion. They favour also granulation tissue formation and re-epithelialization.
IIc. Hydrogels or fibrous hydrocolloid dressing	Hydrogels consist of 80-90% water and insoluble cross-linked polymers, such as polyethyleneoxide, polyvinyl pyrollidone, acrylamide or carboxymethylcellulose, with hydrophilic sites that interact with aqueous solutions, absorbing and retaining significant volumes of water.
IId. Polyurethane matrix hydrocolloid dressing	Polyurethane matrix hydrocolloid dressings consist of two layers: a polyurethane gel matrix and a waterproof polyurethane top film designed to act as a bacterial barrier.
III. Antimicrobial dressings	
IIIa. Polyhexametylene biguanide (PHMB) dressing	A commonly used antiseptic. It is used in a variety of products, including wound care dressings, contact lens cleaning solutions, perioperative cleansing products and swimming pool cleaners.
IIIb. Silver-impregnated dressing	The extensive coverage that silver provides against bacteria, fungi and viruses, including nosocomial pathogens and methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant enterococci (VRE), make it a valuable adjunct in the prevention and treatment of infection. Silver has both bactericidal effects via oxidation of the cell membrane and bacteriostatic effects by inhibiting bacterial replication through damage to DNA.
IV. Negative-pressure dressings	Primarily designed to prevent exudate collection while simultaneously preventing desiccation of the wound. It has been also claimed that these dressings increase oxygen tension in the wound, decrease bacterial count, increase granulation formation and prevent shear force on the wound surface.

* modified from reference [1]

A Cochrane review [2] and its update [1] of the effect of dressings for the prevention of surgical site infection (SSI) found no evidence to suggest that one dressing type was better than others.

The United Kingdom (UK) National Institute for Health and Care Excellence (NICE) issued a clinical guideline for SSI prevention and treatment in 2008, which recommends to cover surgical incisions with an appropriate interactive dressing at the end of the procedure [3]. The 2013 evidence update of the NICE guidelines suggests that no particular dressing type emerges as the most effective in reducing the risk of SSI, although silver nylon dressings may be more effective than gauze. The update also recommends further research to confirm the effectiveness of modern

dressing types [4]. Postoperative care bundles recommend that surgical dressings be kept undisturbed for a minimum of 48 hours after surgery unless leakage occurs. However, there are currently no specific recommendations or guidelines regarding the type of surgical dressing [5-7].

The purpose of this review is to investigate the effect of advanced surgical dressings vs. standard dressings for the purpose of preventing SSI.

2. PICO question

In surgical patients, should advanced dressings vs. standard sterile wound dressings be used for the prevention of SSI?

- **P**opulation: inpatients and outpatients of any age undergoing a surgical operation (any type of procedure)
- **I**ntervention: advanced dressings (hydrocolloid, silver-containing, hydroactive or PHMB)
- **C**omparator: standard postoperative dressings
- **O**utcomes: SSI, SSI-attributable mortality

3. Methods

The following databases were searched: Medline (PubMed); Excerpta Medica Database (EMBASE); Cumulative Index to Nursing and Allied Health Literature (CINAHL); the Cochrane Central Register of Controlled Trials (CENTRAL); and the WHO Global Health Library. The time limit for the review was between 1 January 1990 and 21 May 2015. Language was restricted to English, French and Spanish. A comprehensive list of search terms was used, including Medical Subject Headings (MeSH) (Appendix 1).

Two independent reviewers screened titles and abstracts of retrieved references for potentially relevant studies. The full text of all potentially eligible articles was obtained. Two authors independently reviewed the full text articles for eligibility based on inclusion criteria. Duplicate studies were excluded.

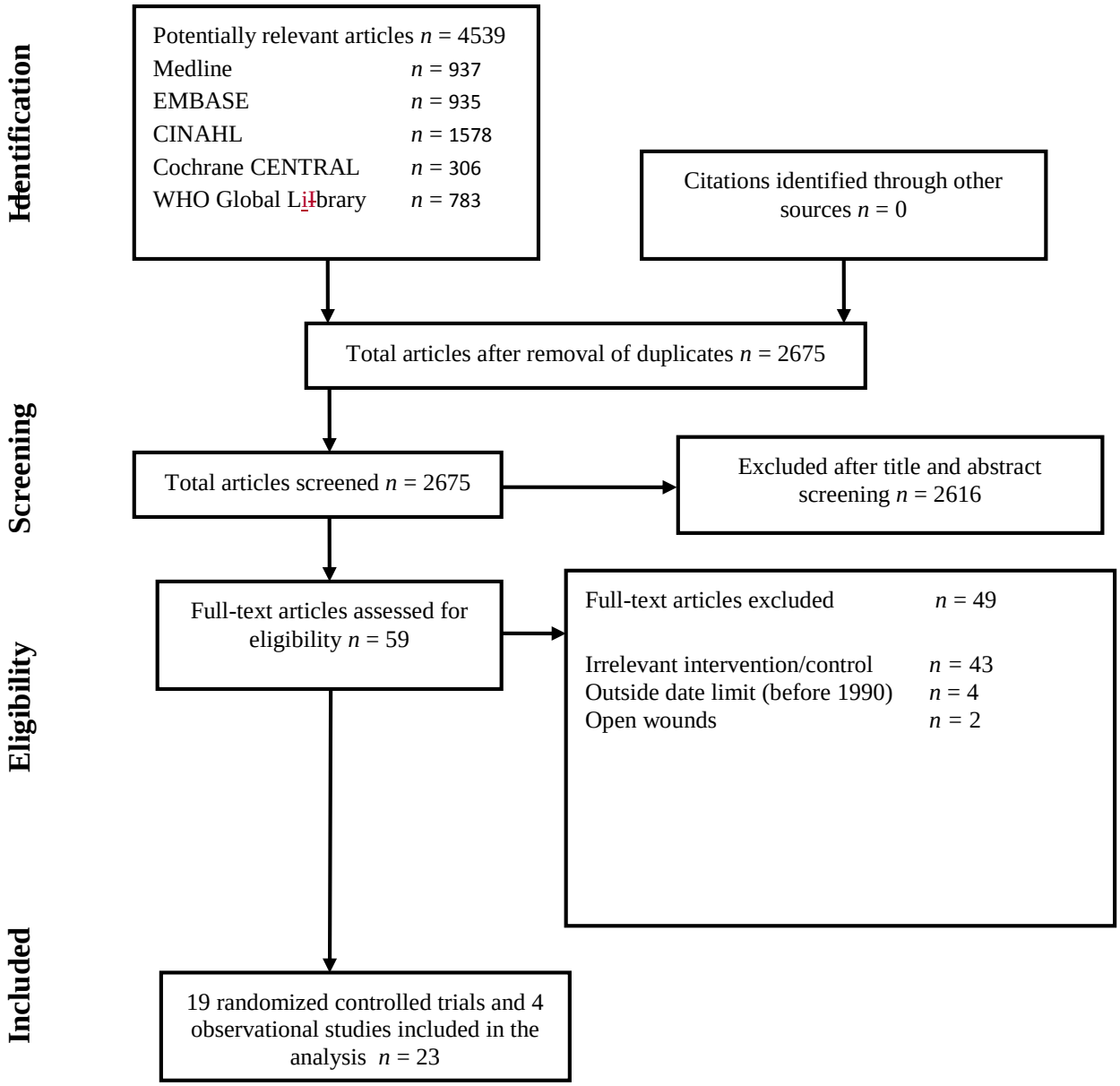
Two authors extracted data in a predefined evidence table (Appendix 2) and critically appraised the retrieved studies. Quality was assessed using the Cochrane Collaboration tool [8] to assess the risk of bias of randomized controlled trials (RCTs) (Appendix 3). Any disagreements were resolved through discussion or after consultation with the senior author, when necessary.

Meta-analyses of available comparisons were performed using Review Manager v5.3 [9] as appropriate (Appendix 4). Adjusted odds ratios (OR) with 95% confidence intervals (CI) were extracted and pooled for each comparison with a random effects model. The Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology (GRADE

Pro software, http://gradepro.org/) [10] was used to assess the quality of the body of retrieved evidence (Appendix 5).

4. Study selection

Flow chart of the study selection process



5. Summary of the findings and quality of the evidence

Ten RCTs [11-20] were identified comparing advanced and antimicrobial dressings to standard gauze or absorbent dressings for the prevention of SSI in closed surgical wounds. Included patients were adults undergoing elective orthopaedic, cardiac, sternotomy, vascular, plastic, abdominal and colorectal cancer surgical procedures.

There were variations in the interventions as some studies used hydrocolloid, hydroactive, silver- or PHMB-impregnated dressings. In addition, there were variations among studies in the definition of SSI and the duration of postoperative follow-up.

After careful appraisal of the studies, the following comparisons were performed:

1. Overall comparison of all advanced dressings vs. standard wound dressings
2. Hydrocolloid vs. standard wound dressings
3. Silver-impregnated vs. standard wound dressings
4. Hydroactive vs. standard wound dressings
5. PHMB vs. standard wound dressings

1. Overall comparison of all advanced dressings vs. standard wound dressings

The effect of advanced dressings on the SSI risk varied among the 10 RCTs [11-20]. One study [14] reported that advanced dressings may have some effect compared to standard wound dressings. Three studies [11,13,15] showed some effect of advanced dressings, but this was not statistically different. Three studies [18-20] found that advanced dressings may cause harm, but this effect was not statistically significant. Two studies [12,16] had no SSI events in the intervention or the control group.

Meta-analysis of the 10 RCTs (Appendix 4, comparison 1) showed that advanced dressings had neither benefit nor harm compared to standard dressings (OR: 0.80; 95% CI: 0.52–1.23). The overall quality of evidence of this comparison was low due to the risk of bias and imprecision (Appendix 5).

2. Hydrocolloid *vs.* standard wound dressings

Five studies [12,16,18-20] evaluated the effect of the use of hydrocolloid dressing compared to standard dressings to reduce SSI. Three studies [18-20] showed some effect of advanced dressings, but the effect estimate was not statistically different compared to standard wound dressings. Two studies [12,16] had no events in the intervention or the control group.

Meta-analysis of the 5 RCTs (Appendix 4, comparison 2) showed that hydrocolloid dressings had neither benefit nor harm in reducing SSI compared to standard dressings (OR, 1.08; 95% CI, 0.51–2.28). The overall quality of evidence of this comparison was very low due to the risk of bias and imprecision (Appendix 5).

3. Silver-impregnated vs. standard wound dressings

Four studies [11,13,14,17] assessed the effect of silver-impregnated dressings compared to standard dressings for SSI prevention. One study [14] reported that silver-impregnated dressings may have

some effect compared to standard wound dressings. Two studies [11,13] showed some effect of silver-impregnated dressings, but the effect estimate was not statistically different compared to standard wound dressings. By contrast, one study [17] found that silver-impregnated dressings may cause harm, but this effect was not statistically significant.

Meta-analysis of the 4 RCTs (Appendix 4, comparison 3) showed that silver-impregnated dressings had neither benefit nor harm compared to standard dressings (OR: 0.67; 95% CI: 0.34–1.30) in reducing SSI. The overall quality of evidence of this comparison was very low due to the risk of bias and imprecision (Appendix 5).

4. Hydroactive vs. standard wound dressings

One of the intervention arms of a study [20] evaluated the effect of the use of hydroactive dressings compared to standard wound dressings to reduce SSI. The study showed that the hydroactive dressings do not significantly reduce SSI compared to standard dressings (OR: 1.63; 95% CI: 0.57–4.66; Appendix 4, comparison 4). The quality of evidence of this study was very low due to the risk of bias and imprecision (Appendix 5).

5. PHMB vs. standard wound dressings

One study [15] examined the effect of PHMB dressings compared to standard dressings for the prevention of SSI. The study showed that PHMB dressings do not significantly reduce SSI compared to standard dressings (OR: 0.20; 95% CI: 0.02–1.76; Appendix 4, comparison 5). The quality of evidence of this study was low due to imprecision (Appendix 5).

In conclusion, the retrieved evidence can be summarized as follows:

1. Overall, a low quality of evidence shows that advanced dressings do not significantly reduce SSI compared to standard wound dressings.
2. A very low quality of evidence shows that hydrocolloid dressings do not significantly reduce SSI compared to standard dressings.
3. A very low quality of evidence shows that silver-impregnated dressings do not significantly reduce SSI compared to standard dressings.
4. A very low quality of evidence shows that hydroactive dressings do not significantly reduce SSI compared to standard dressings.
5. A low quality of evidence shows that PHMB dressings do not significantly reduce SSI compared to standard dressings.

There are many limitations to this analysis as the number of studies is small with small sample sizes. There are many factors that may contribute to bias in the included studies. For example, the nature of many different types of dressing makes blinding in these trials difficult. In addition, many commercial manufacturers of specialty dressings provide materials or financial support for clinical trials investigating the effects of the product, thus potentially contributing to the risk of bias.

6. **Other factors considered in the review**

The systematic review team identified the following other factors to be considered.

Potential harms

A potential allergy or skin irritation may develop in some patients, particularly with silver dressings. One study reported that two patients had metallic silver dressings removed due to itching [13]. This is important to consider in patients who have known allergies to metals or skin conditions. There has been also increased discussion about the possible safety concerns of ionic silver dressings and the transfer of nanoparticles to patients and health care workers [21]. Another study noted that the toxicity of silver to human cells is considerably less than to bacteria. Unlike antibiotics, resistance to silver is very rare. Instead of targeting a specific cellular process, silver ions directly interact with proteins and other organic molecules and disrupt electrolyte balances. The affinity of silver to multiple microbial molecules and structures further decreases the risks of resistance [22].

Values and preferences

There are many factors that may contribute to the preferences of surgeons and/or patients to use particular dressings. Although no difference in SSI prevention was shown in the meta-analysis of 10 RCTs, other outcomes were reported in some studies. Two RCTs included in these analyses assessed patient comfort and reported that hydrocolloid dressings were more comfortable than standard dressings [19,20]. Another study reported better cosmetic results in patients whose incisions were dressed with hydrocolloid dressings compared to incisions covered with standard dressings, despite no SSI events in either group [16].

Resource use

The cost and availability of advanced dressings may be a limitation, especially in low- and middle-income countries (LMICs). The added cost of using hydrogel, hydrocolloid or silver dressings has been investigated by several of the studies included in this review. Two studies reported fewer dressing changes for hydrogel dressings compared to standard dressings [12,19]. Although the hydrogel dressings were associated with a cost 2-5 times higher than standard dressings, they may be beneficial for patients unable to change dressings or requiring a return to the hospital for subsequent dressing changes [19]. One study also attributed increased nursing time with standard dressings, which is a consideration for hospitals with a smaller nursing staff. Similarly, another study reported higher costs for hydrocolloid compared to standard dressings [20].

Feasibility and equity

In addition to cost, it may also be difficult for some LMICs to acquire and properly use moist or metallic dressings. However, one study reported that hydrocolloid dressings were less complicated to apply [18].

7. **Key uncertainties and future research priorities**

It was emphasized that there are very few large, high-quality trials investigating different types of dressings that evaluated SSI prevention as a primary outcome. Future clinical studies should focus on generating a large sample size and attempt to create a blinded methodology. Well-designed studies conducted in LMICs are needed, as well as in the paediatric population. It was highlighted that there is a special interest in investigating the use of silver-containing dressings in orthopaedic and cardiac surgery with regard to SSI prevention. Assessment of adverse events should be considered in the trials, including the possible effects of silver nanoparticles.

APPENDICES

Appendix 1: Search terms

Medline (through PubMed)

(((dressing[TIAB] OR hydrocolloi[TIAB] OR alginate[TIAB] OR foam[TIAB] OR bead[TIAB] OR film[TIAB] OR films[TIAB] OR tulle[TIAB] OR gauze[TIAB] OR non-adherent[TIAB] OR non adherent[TIAB] OR alginates OR hydrogels OR bandages*))) AND (((((((dressing OR hydrocolloid OR alginate OR foam OR bead OR film OR films OR tulle OR gauze OR non-adherent OR non adherent) OR (alginates OR hydrogels OR carboxymethylcellulose) OR bandages OR dressings)) AND ((((surgical wound infection) OR surgical wound dehiscence) OR "surgical site") OR ("surgical wound infection" OR surgical site infection* OR "SSI" OR "SSIs" OR surgical wound infection* OR surgical infection* OR post-operative wound infection* OR postoperative wound infection* OR wound infection* OR (("preoperative care" OR "preoperative care" OR "pre-operative care" OR "perioperative Care" OR "perioperative care" OR "peri-operative care" OR perioperative OR intraoperative OR "perioperative period" OR "intraoperative period") AND ("infection" OR infection)))) NOT ((animals) NOT human))

EMBASE

'non adherent' OR 'carboxymethylcellulose'/exp OR carboxymethylcellulose OR dressing OR 'hydrocolloid'/exp OR hydrocolloid OR 'alginate'/exp OR alginate OR 'foam'/exp OR foam OR bead OR 'film'/exp OR film OR films OR tulle OR gauze OR occlusive AND dressings OR adherent OR 'non adherent' OR 'carboxymethylcellulose'/exp OR carboxymethylcellulose OR dressing OR 'bandage'/exp OR bandage AND ('surgical site infection' OR 'wound infections' OR 'surgical infections' OR 'postoperative wound infection' OR ('postoperative care' AND 'infection') OR 'wound dehiscence') AND [embase]/lim AND [1990-2015]/py

CINAHL

((dressing OR hydrocolloid OR alginate OR foam OR bead OR film OR films OR tulle OR gauze OR non-adherent OR non adherent) OR (alginates OR hydrogels OR carboxymethylcellulose) OR bandages OR dressings)) AND ((((surgical wound infection) OR surgical wound dehiscence) OR "surgical site") OR ("surgical wound infection" OR surgical site infection* OR "SSI" OR "SSIs" OR surgical wound infection* OR surgical infection* OR post-operative wound infection* OR postoperative wound infection* OR wound infection* OR (("preoperative care" OR "preoperative care" OR "pre-operative care" OR "perioperative care" OR "perioperative care" OR "peri-operative care" OR perioperative OR intraoperative OR "perioperative period" OR "intraoperative period") AND ("infection" OR infection))))

Cochrane CENTRAL

(“wound infection” or “surgical wound infection”) AND “dressings”

WHO Global Health Library

((SSI) OR (surgical site infection) OR (surgical site infections) OR (wound infection) OR (wound infections) OR (postoperative wound infection))

TIAB: title-abstract

Appendix 2: Evidence table

Author, year, reference	Design, scope, setting, population	Objective	SSI definition	Type of surgery	Study methods	Intervention	Results (SSI)
Biffi, 2012 [11]	RCT January 2007 to December 2008 Italy Population: 68 cancer patients undergoing elective laparoscopic colorectal surgery.	To compare the efficacy of Aquacel® Ag Hydrofiber (ConvaTec Inc, Skillman, NJ, USA) dressing with a common postoperative dressing for the prevention of SSI in elective colorectal cancer surgery.	CDC criteria Follow-up: 30 days following surgery; the surgical site and patient's vital signs were assessed at least once a day during hospitalization, at discharge and at the time of follow-up evaluation.	Elective laparoscopic colorectal cancer surgery	Enrolled patients were randomized by the hospital using computer-generated randomization numbers without blocking. Exclusion criteria: history of allergy to dressing components, evidence of active infection at or adjacent to the operative site, coagulopathy, intestinal obstruction, active bowel bleeding, life expectancy less than 6 months, inability to give written informed consent or a programme of minimally invasive surgery.	C: iodine or alcohol-based swab and dry 4 x 4 gauze) I: hydrofiber dressing with ionic silver (Aquacel® Ag)	C: 11/54 I: 9/58 *P*= 0.623 Funding provided by the microbial dressing manufacturer. Authors declared no conflict of interest.

Burke, 2012 [12]	RCT 9-month period in 2009 Republic of Ireland Population: 124 patients (62 total hip replacements and 62 total knee replacements) ..	To evaluate the clinical benefits and cost effectiveness of the jubilee method compared to a standard traditional adhesive dressings...	An erythematous, indurated wound with persistent copious discharge was suggestive of a deep SSI. Follow-up: until hospital discharge (average length of stay = 9 days).	Elective total hip and total knee replacement	Patients randomized by the block randomization method to have either a jubilee or a traditional adhesive applied to the surgical wound following surgery. Exclusion criteria: patients undergoing revision surgery, on immune-suppressants, with skin conditions or those with trophic skin changes.	C: Mepore® (Mölnycke Health Care, Dunstable, UK) absorbent dressing I: hydrogel jubilee dressings	C: 0/62 I: 0/62 Relative risk: not available 95% CI: not available *P* value: not available Declaration of no conflict of interest by authors.

Dickinson Jennings, 2015 [13]	3-arm RCT Trauma centre, USA Population: 315 inpatients awaiting cardiac surgery or outpatients seen in the pre-surgical testing area before admission for surgery.	To compare wound healing, patient comfort, SSI rates and dressing factors among 3 types of dressing in patients with clean sternotomy incisions.	Superficial or deep (modified CDC) Follow-up: until hospital discharge	Sternotomy	Statistician-generated, random numbers table to assign participants to each of the 3 dressing groups. Following randomization, the principal investigator took the appropriate dressing to the operating room and communicated the dressing assignment directly to the nursing staff. Participants were not told of their group assignment until they awakened after surgery. Due to the nature of the dressings, no aspect of this study was blinded.	C: dry sterile dressing (only resistant to water) I (1): metallic silver dressing (Anticoat® Post-Op; Smith & Nephew PLC, London, UK) I (2): ionic silver dressing (Dermanet® Ag; DeRoyal Industries, Powell, TN, USA) **Interventions grouped together as silver-containing in the analysis.	C: 3/114 I (1): 2/104 I (2): 1/105 *P*: not significant between any group. Dressings provided by manufacturer.
Krieger, 2011 [14]	RCT University-based, tertiary referral hospital, USA Population: 110 patients.	To compare SSI rates among standard gauze dressings.	CDC criteria (modified to include patients placed on antibiotics for signs or symptoms of SSI). Follow-up: 30 days after surgery (via telephone).	Colorectal surgery	Patients were randomized into two different groups at the time of skin closure when a computer-generated envelope was opened indicating the dressing to be used.	C: standard gauze dressings I: silver nylon dressings	C: 18/54 I:7/55 *P*= 0.11 Multivariate analysis: *P*= 0.013 Financial support provided by the manufacturer; authors declared an independent analysis, etc.

Martin-Trapero, 2012 [15]	Single blinded RCT Spain Population: 197 patients diagnosed with cholelithiasis.	To analyze the effectiveness of a PHMB 0.2% dressing against superficial SSI.	CDC criteria	Laparoscopic chole-cystectomy	Patients were randomized by an automatic randomization tool.	C: non-occlusive dressing I: PHMB 0.2% dressings	Superficial SSI: C: 5/101 I: 1/96 *P*=0.212 Declaration of no conflict of interest by authors.
Michie, 1994 [16]	RCT USA Population: 28 consecutive eligible patients undergoing elective surgery that would result in incision(s) not exceeding 200 mm in length each.	To compare a thin hydrocolloid occlusive dressing with a cotton gauze dressing impregnated with bismuth tribromophenate on sutured incisions after plastic and reconstructive surgery.	Not specified	Elective plastic and reconstructive surgery	Computer-generated randomization table with blocks of 4 was used to determine which dressing was applied to the right and left sides (or proximal and distal ends) of the incisions. Patients served as their own control with one half of each incision covered with an impregnated gauze and the other half covered with a thin occlusive hydrocolloid dressing.	C: impregnated-gauze (Xeroform; Covidien [Medtronic], Dubin, Ireland) I: thin occlusive hydrocolloid dressing (DuoDerm® Extra Thin CGF; ConvaTec, Skillman, NJ, USA)	C: 0/40 I: 0/40 *P*= NA Financial support from manufacturer; authors declared no conflict of interest.

Ozaki, 2015 [17]	RCT October 2010 to September 2013 USA Population: 500 adults undergoing a non-emergency surgical procedure for peripheral vascular disease involving arteries or bypass grafts.	To test the hypothesis that a silver-eluting alginate topical surgical dressing would lower wound complication rates in patients undergoing open arterial procedures in the lower extremity.	Primary endpoint – 30-day wound complication incidence based on NSIP guidelines. Follow-up: 30 days after surgery.	Open, non-emergency procedure for peripheral vascular disease involving arteries or bypass grafts.	Patients were randomized in the operating room by block design after wound closure was completed, but before any dressing was applied. Exclusion criteria: known allergy to silver or alginate, participation in another interventional clinical trial, or prior participation in the current study.	C: standard gauze dressing I: silver alginate dressing (Acticoat® Absorbent; Smith & Nephew)	C: 38/250 I: 42/250 *P*= 0.64 Bivariate OR 1.03 (95% CI: 0.70-1.52) *P*= 0.87 Multivariate OR 0.91 (95% CI: 0.61-1.37) *P*= 0.65 Financial support from manufacturer; authors declared no conflict of interest.
Shinohara, 2008 [18]	RCT November 2003 to March 2006 Japan Population: cohort of 134 consecutive patients	To compare an occlusive hydrocolloid dressing and a gauze dressing with regard to the cost and incidence of wound infection after abdominal surgery.	Pus, pyrexia, and local tenderness Follow-up: mean of 30 days in both groups.	Gastric, duodenal, pancreatic, biliary disease.	Randomization methods not described. Exclusion criteria: anal and perianal operations, and peritonitis and emergency operations.	C: standard gauze dressing I: occlusive hydrocolloid dressing: consists of an outer permeable polyurethane membrane with a thin absorbent and adhesive hydrocolloid interface.	C: 1/71 I: 1/63 *P*=0.567 Conflict of interest not addressed.

Vogt, 2007 [19]	RCT Denmark Population: 160 adults planned for vascular surgery with an expected hospitaliza-tion of 4+ days.	To compare the standard type of dry dressing, Mepore® (Mölnycke Health Care) with moist wound healing using a hydrofiber dressing, Aquacel® (ConvaTec Inc), in primary closed wounds after vascular surgery.	30-day wound complication incidence based on NSIP guidelines.	Elective vascular surgery	Patients were allocated by drawing an envelope with a corresponding number (completed by a non-involved person) in consecutive marked envelopes and opened in the operating room. Exclusion criteria: hypersensitivity to either Mepore® or Aquacel®, dementia, insufficient Danish or pregnant.	C: Mepore® standard dry dressing I: Aquacel®	C: 7/66 I: 9/70 *P*=0.68 Contribution from ConvaTec; but stated "no financial associations between the products tested and the authors".

Wynne, 2004 [20]	Setting: Melbourne, Australia Population: 737 patients undergoing cardiac surgery who required a median sternotomy incision in a major metropolitan teaching hospital from September 1999 to November 2001.	To compare dressing types (dry, hydrocolloid, hydroactive) in terms of their ability to protect against infection and promote healing, patient comfort, and cost-effectiveness.	CDC criteria Follow-up: from postoperative day 1 to day 6, daily data collection and wound assessment were conducted at 3 pm. Patients were followed up either through the outpatient department or telephone survey approximately 4 weeks after discharge from hospital.	Cardiac	Randomization was stratified equally across two operating rooms and was achieved using opaque envelopes. Patients were randomly assigned to one of 3 treatment groups by the circulating nurse on the commencement of sternal skin closure. Exclusion criteria: unable to provide written consent, immune-suppressed or under the care of one surgeon who did not wish to have his/her patient participate in the study.	C: dry absorbent (Primipore; Smith & Nephew) I (1): Hydrocolloid dressing (DuoDerm® Thin; ConvaTec Inc) I (2): hydroactive dressings (Opsite; Smith & Nephew)	C: 6/243 I (1): 6/267 I (2): 9/227 P= NS between any groups Conflict of interest not addressed

RCT: randomized controlled trial; CDC: Centers for Disease Prevention and Control; SSI: surgical site infection; CI: confidence interval; OR: odds ratio; I: intervention; C: control; PHMB: polyhexamethylene biguanide; NSIP: national surgical improvement programme; NA: not available; NS: not significant.

Appendix 3: Risk of bias assessment of the included studies

RCT, author, year, reference	Sequence generation	Allocation concealment	Participants and personnel blinded	Outcome assessors blinded	Incomplete outcome data	Selective outcome reporting	Other sources of bias
Biffi, 2012 [11]	LOW	LOW	LOW	LOW	LOW	LOW	UNCLEAR*
Burke, 2012 [12]	LOW	UNCLEAR	UNCLEAR	UNCLEAR	LOW	UNCLEAR	LOW
Dickinson-Jennings, 2015 [13]	LOW	UNCLEAR	HIGH	HIGH	UNCLEAR	LOW	UNCLEAR*
Krieger, 2011 [14]	LOW	LOW	HIGH	UNCLEAR	LOW	LOW	UNCLEAR*
Martin-Trapero, 2012 [15]	LOW	LOW	LOW	UNCLEAR	LOW	LOW	LOW
Michie, 1994 [16]	LOW	UNCLEAR	UNCLEAR	UNCLEAR	LOW	LOW	UNCLEAR*
Ozaki, 2015 [17]	LOW	UNCLEAR	UNCLEAR	UNCLEAR	LOW	LOW	UNCLEAR*
Shinohara, 2008 [18]	UNCLEAR	LOW	UNCLEAR	UNCLEAR	LOW	LOW	UNCLEAR
Vogt, 2007 [19]	LOW	LOW	UNCLEAR	UNCLEAR	UNCLEAR	LOW	LOW*
Wynne, 2004 [20]	LOW	LOW	HIGH	HIGH	LOW	LOW	UNCLEAR

* Financial support, compensation or products given to research group from dressing manufacturer.

RCT: randomized controlled trial

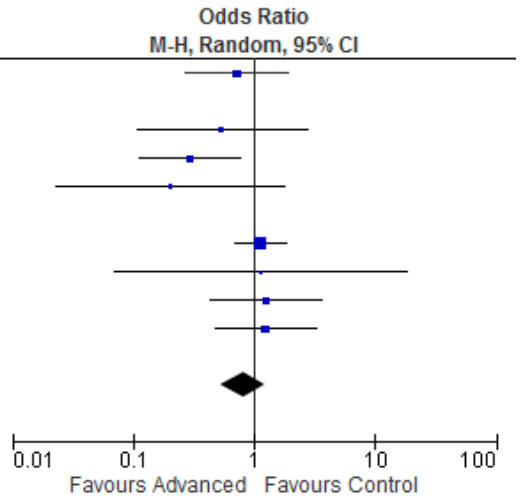
Appendix 4: Comparisons

Comparison 1: All advanced dressings vs. standard wound dressings

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Odds Ratio M-H, Random, 95% CI
Biffi	9	58	11	54	14.2%	0.72 [0.27, 1.90]
Burke	0	62	0	62		Not estimable
Dickinson Jennings	3	209	3	114	6.2%	0.54 [0.11, 2.71]
Krieger	7	55	18	54	14.2%	0.29 [0.11, 0.77]
Martin-Trapero	1	96	5	101	3.6%	0.20 [0.02, 1.76]
Michie	0	40	0	40		Not estimable
Ozaki	42	250	38	250	32.4%	1.13 [0.70, 1.82]
Shinohara	1	63	1	71	2.2%	1.13 [0.07, 18.43]
Vogt	9	70	7	66	12.7%	1.24 [0.43, 3.56]
Wynne	15	494	6	243	14.5%	1.24 [0.47, 3.23]
Total (95% CI)		**1397**		**1055**	**100.0%**	**0.80 [0.52, 1.23]**
Total events	87		89			

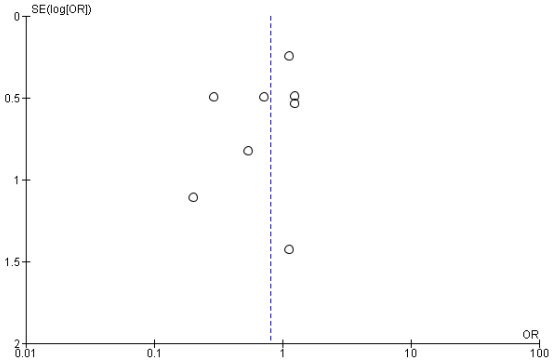
Heterogeneity: Tau² = 0.09; Chi² = 9.20, df = 7 (P = 0.24); I² = 24%

Test for overall effect: Z = 1.00 (P = 0.32)

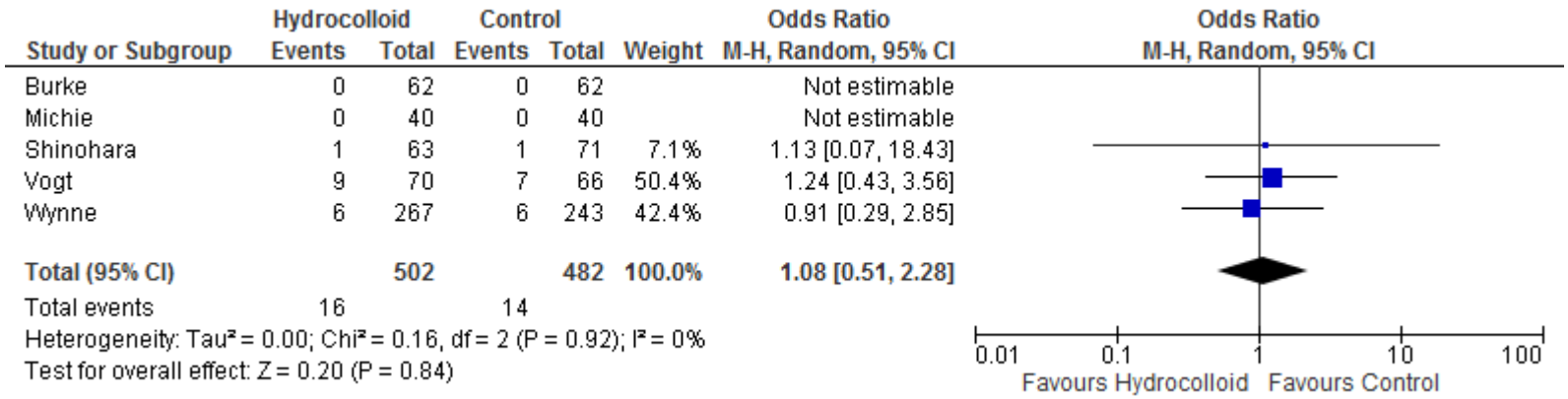


M-H: Mantel-Haenszel (test), CI: confidence interval.

Funnel plot 1: Overall comparison of all advanced dressings vs. standard wound dressings

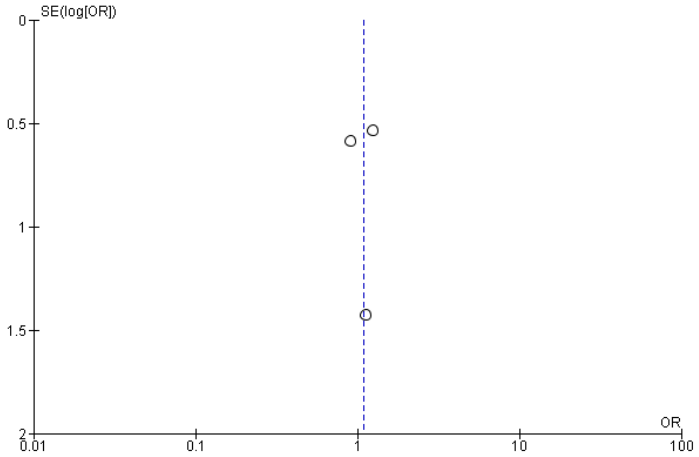


Comparison 2: Hydrocolloid vs. standard wound dressings



M-H: Mantel-Haenszel (test), CI: confidence interval

Funnel plot 2: Hydrocolloid vs. standard wound dressings

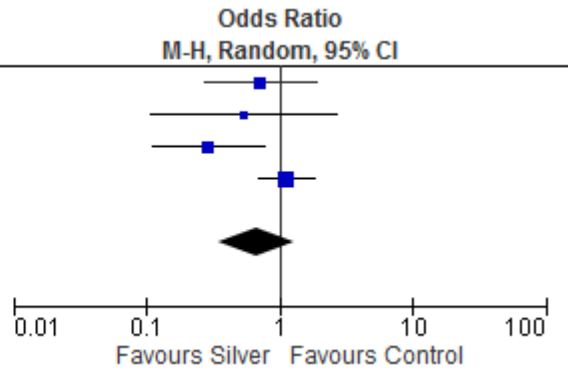


Comparison 3: Silver-impregnated vs. standard wound dressings

Study or Subgroup	Silver Events	Silver Total	Control Events	Control Total	Weight	Odds Ratio M-H, Random, 95% CI
Biffi	9	58	11	54	24.1%	0.72 [0.27, 1.90]
Dickinson Jennings	3	209	3	114	12.6%	0.54 [0.11, 2.71]
Krieger	7	55	18	54	24.0%	0.29 [0.11, 0.77]
Ozaki	42	250	38	250	39.3%	1.13 [0.70, 1.82]
Total (95% CI)		**572**		**472**	**100.0%**	**0.67 [0.34, 1.30]**
Total events	61		70			

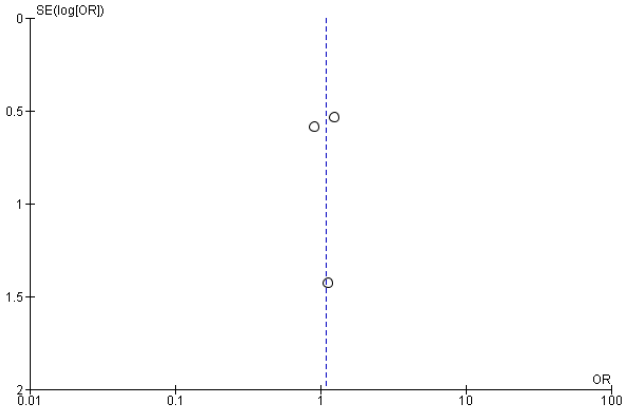
Heterogeneity: Tau² = 0.23; Chi² = 6.35, df = 3 (P = 0.10); I² = 53%

Test for overall effect: Z = 1.20 (P = 0.23)

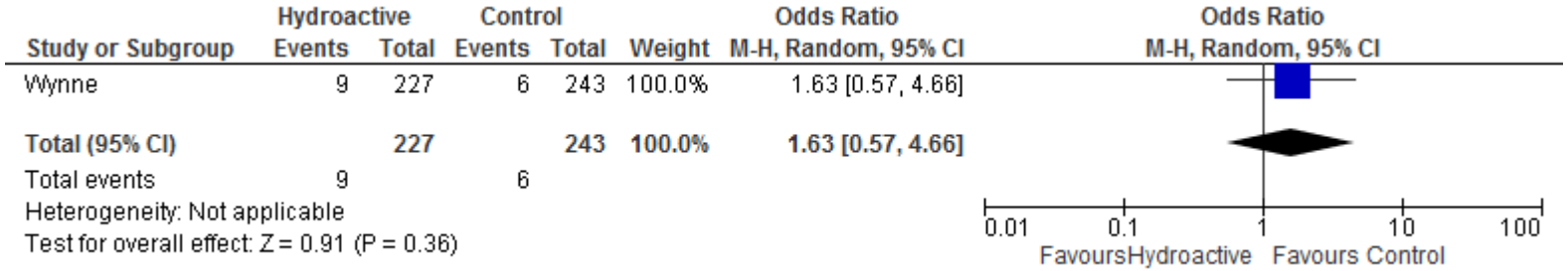


M-H: Mantel-Haenszel (test), CI: confidence interval

Funnel plot 3: Silver-impregnated vs. standard wound dressings

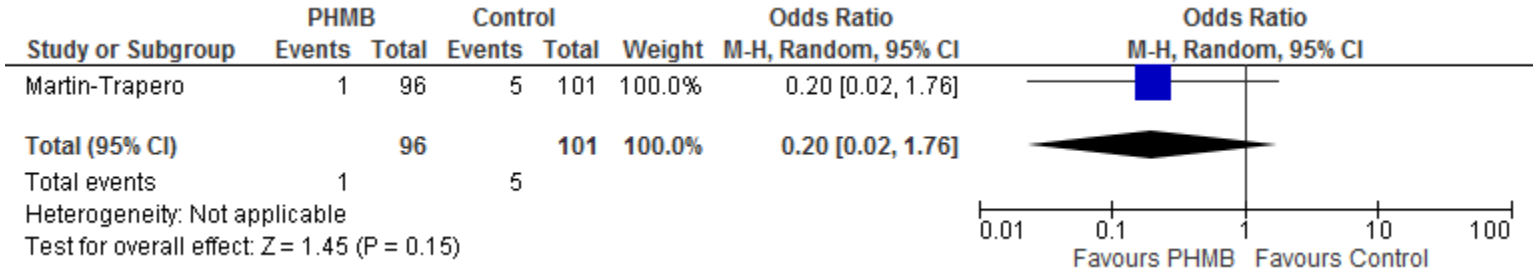


Comparison 4: Hydroactive vs. standard wound dressings



M-H: Mantel-Haenszel (test), CI: confidence interval

Comparison 5: PHMB vs. standard wound dressings



M-H: Mantel-Haenszel (test), CI: confidence interval

Appendix 6: GRADE Tables

Comparison 1: All advanced dressings vs. standard wound dressings for SSI prevention

Quality assessment							№ of patients		Effect		Quality
№ of studies	**Study design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Advanced dressings**	**Standard dressings**	**Relative (95% CI)**	**Absolute (95% CI)**	
Surgical site infection											
10	RCTs	serious [1]	not serious	not serious	serious [2]	none	87/1397 (6.2%)	89/1055 (8.4%)	**OR: 0.80** (0.52 to 1.23)	**16 fewer per 1000** (from 17 more to 39 fewer)	⨁⨁◯◯ LOW

1. Risk of detection bias
2. Optimal information size not met

SSI: surgical site infection; RCT: randomized controlled trial; CI: confidence interval; OR: odds ratio

Comparison 2: Hydrocolloid vs. standard wound dressings

Quality assessment							№ of patients		Effect		Quality
№ of studies	**Study design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Hydrocolloid**	**Standard dressings**	**Relative (95% CI)**	**Absolute (95% CI)**	
Surgical site infection											
5	RCTs	serious [1]	not serious	not serious	very serious [2]	none	16/502 (3.2%)	14/482 (2.9%)	**OR: 1.08** (0.51 to 2.28)	**2 more per 1000** (from 14 fewer to 35 more)	⨁◯◯◯ VERY LOW

1. Risk of detection bias and other possible bias (2 of 5 RCTs: financial support, compensation or products given to research group from dressing manufacturer)
2. Optimal information size not met and CI fails to exclude both appreciable benefit and harm (RR and RRR of 25%)

RCT: randomized controlled trial; CI: confidence interval; OR: odds ratio; RR: relative risk; RRR: relative risk reduction

Comparison 3: Silver-impregnated vs. standard wound dressings

Quality assessment							№ of patients		Effect		Quality
№ of studies	**Study design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Silver-containing**	**Standard dressings**	**Relative (95% CI)**	**Absolute (95% CI)**	
Surgical site infection											
4	RCTs	serious [1]	not serious	not serious	very serious [2]	none	61/572 (10.7%)	70/472 (14.8%)	**OR: 0.67** (0.34 to 1.30)	**44 fewer per 1000** (from 36 more to 92 fewer)	⊕◯◯◯ VERY LOW

1. Risk of performance bias, detection bias and other possible bias (4 of 4 RCTs: financial support, compensation or products given to research group from dressings manufacturer)
2. Optimal information size not met and CI fails to exclude both appreciable benefit and harm (RR and RRR of 25%)

RCT: randomized controlled trial; CI: confidence interval; OR: odds ratio; RR: relative risk; RRR: relative risk reduction

Comparison 4: Hydroactive vs. standard wound dressings

Quality assessment							№ of patients		Effect		Quality
№ of studies	**Study design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Hydroactive**	**Standard dressings**	**Relative (95% CI)**	**Absolute (95% CI)**	
Surgical site infection											
1	RCTs	serious [1]	not serious	not serious	very serious [2]	none	7/227 (3.1%)	6/243 (2.5%)	**OR: 1.63** (0.57 to 4.66)	**15 more per 1000** (from 10 fewer to 81 more)	⊕◯◯◯ VERY LOW

1. Risk of detection bias
2. Optimal information size not met and CI fails to exclude both appreciable benefit and harm (RR and RRR of 25%)

RCT: randomized controlled trial; CI: confidence interval; OR: odds ratio; RR: relative risk; RRR: relative risk reduction

Comparison 5: PHMB vs. standard wound dressings

Quality assessment							№ of patients		Effect		Quality
№ of studies	**Study design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**PHMB**	**Standard**	**Relative (95% CI)**	**Absolute (95% CI)**	
Surgical site infection											
1	RCT	not serious	not serious	not serious	very serious [1]	none	1/96 (1.0%)	5/101 (5.0%)	**OR: 0.20** (0.02 to 1.76)	**39 fewer per 1000** (from 34 more to 48 fewer)	⨁⨁◯◯ LOW [1]

1. Optimal information size not met and CI fails to exclude both appreciable benefit and harm (RR and RRR of 25%)

PHMB: polyhexamethylene biguanide; CI: confidence interval; RCT: randomized controlled trial; OR: odds ratio; RR: relative risk; RRR: relative risk reduction

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