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Early versus delayed dressing removal after primary closure of clean and clean-contaminated surgical wounds (Review)

Toon CD, Lusuku C, Ramamoorthy R, Davidson BR, Gurusamy KS

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[Intervention Review]

Early versus delayed dressing removal after primary closure of clean and clean-contaminated surgical wounds

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ABSTRACT

Background

Most surgical procedures involve a cut in the skin that allows the surgeon to gain access to the deeper tissues or organs. Most surgical wounds are closed fully at the end of the procedure (primary closure). The surgeon covers the closed surgical wound with either a dressing or adhesive tape. The dressing can act as a physical barrier to protect the wound until the continuity of the skin is restored (within about 48 hours) and to absorb exudate from the wound, keeping it dry and clean, and preventing bacterial contamination from the external environment. Some studies have found that the moist environment created by some dressings accelerates wound healing, although others believe that the moist environment can be a disadvantage, as excessive exudate can cause maceration (softening and deterioration) of the wound and the surrounding healthy tissue. The utility of dressing surgical wounds beyond 48 hours of surgery is, therefore, controversial.

Objectives

To evaluate the benefits and risks of removing a dressing covering a closed surgical incision site within 48 hours permanently (early dressing removal) or beyond 48 hours of surgery permanently with interim dressing changes allowed (delayed dressing removal), on surgical site infection.

Search methods

In March 2015 we searched the following electronic databases: The Cochrane Wounds Group Specialised Register; The Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library*); Database of Abstracts of Reviews of Effects (DARE) (*The Cochrane Library*); Ovid MEDLINE; Ovid MEDLINE (In-Process & Other Non-Indexed Citations); Ovid EMBASE; and EBSCO CINAHL. We also searched the references of included trials to identify further potentially-relevant trials.

Selection criteria

Two review authors independently identified studies for inclusion. We included all randomised clinical trials (RCTs) conducted with people of any age and sex, undergoing a surgical procedure, who had their wound closed and a dressing applied. We included only trials that compared early versus delayed dressing removal. We excluded trials that included people with contaminated or dirty wounds. We also excluded quasi-randomised studies, and other study designs.

Data collection and analysis

Two review authors independently extracted data on the characteristics of the trial participants, risk of bias in the trials and outcomes for each trial. We calculated risk ratios (RR) with 95% confidence intervals (CI) for binary outcomes and mean difference (MD) with 95% CI for continuous outcomes. We used RevMan 5 software to perform these calculations.

Main results

Four trials were identified for inclusion in this review. All the trials were at high risk of bias. Three trials provided information for this review. Overall, this review included 280 people undergoing planned surgery. Participants were randomised to early dressing removal (removal of the wound dressing within the 48 hours following surgery) (n = 140) or delayed dressing removal (continued dressing of the wound beyond 48 hours) (n = 140) in the three trials. There were no statistically significant differences between the early dressing removal group and delayed dressing removal group in the proportion of people who developed superficial surgical site infection within 30 days (RR 0.64; 95% CI 0.32 to 1.28), superficial wound dehiscence within 30 days (RR 2.00; 95% CI 0.19 to 21.16) or serious adverse events within 30 days (RR 0.83; 95% CI 0.28 to 2.51). No deep wound infection or deep wound dehiscence occurred in any of the participants in the trials that reported this outcome. None of the trials reported quality of life. The hospital stay was significantly shorter (MD -2.00 days; 95% CI -2.82 to -1.18) and the total cost of treatment significantly less (MD EUR -36.00; 95% CI -59.81 to -12.19) in the early dressing removal group than in the delayed dressing removal group in the only trial that reported these outcomes.

Authors' conclusions

The early removal of dressings from clean or clean contaminated surgical wounds appears to have no detrimental effect on outcomes. However, it should be noted that the point estimate supporting this statement is based on very low quality evidence from three small randomised controlled trials, and the confidence intervals around this estimate were wide. Early dressing removal may result in a significantly shorter hospital stay, and significantly reduced costs, than covering the surgical wound with wound dressings beyond the first 48 hours after surgery, according to very low quality evidence from one small randomised controlled trial. Further randomised controlled trials of low risk of bias are necessary to investigate whether dressings are necessary after 48 hours in different types of surgery and levels of contamination and investigate whether antibiotic therapy influences the outcome

PLAIN LANGUAGE SUMMARY

Early versus delayed dressing removal for people with surgical wounds

Most surgical procedures involve a cut in the skin that allows the surgeon to gain access to the deeper tissues or organs. Most surgical wounds are closed fully at the end of the procedure.The surgeon covers the closed surgical wound with either a dressing or adhesive tape.The dressing can act as a physical barrier to protect the wound until the continuity of the skin in restored (within about 48 hours). It can also absorb exudate from the wound, keeping it dry and clean, and preventing bacterial contamination from the external environment. Some studies have found that the moist environment created by some dressings accelerates wound healing, although others believe that it is a disadvantage, as excessive exudate can cause softening and deterioration of the wound and surrounding healthy tissue.

We reviewed the medical literature up to July 2013 and identified four randomised controlled trials that investigated early (permanent removal of dressings within 48 hours of surgery) versus delayed removal of dressings (permanent removal of dressings after 48 hours of surgery with interim changes of dressing allowed) in people with surgical wounds. The levels of bias across the studies were mostly high or unclear, i.e. flaws in the conduct of these trials could have resulted in the production of incorrect results. A total of 280 people undergoing planned surgery were included in this review. One-hundred and forty people had their dressings removed within 48 hours following surgery and 140 people had their wounds dressed beyond 48 hours. The choice of whether the dressing was removed early (within 48 hours) or retained for more 48 hours was made randomly by a method similar to the toss of a coin. No significant differences were reported between the two groups in terms of superficial surgical site infection (infection of the wound), superficial wound dehiscence (partial disruption of the wound that results in it reopening at the skin surface) or the number of people experiencing serious adverse events. There were no deep wound infections or complete wound dehiscence (complete disruption of wound healing, when the wound reopens completely) in the studies that reported these complications. However, the studies were not large enough to identify small differences in complication rates. None of the studies reported quality of life. Participants in the group that had early removal of dressings had significantly shorter hospital stays and incurred significantly lower treatment costs than those in the delayed removal of dressings group, but these results were based on very low quality evidence from one small randomised controlled trial. We recommend further randomised controlled trials are performed to investigate whether dressing of wounds beyond 48 hours after surgery is necessary, since the current evidence is based on very low quality evidence from three small randomised controlled trials.

SUMMARY OF FINDINGS

Summary of findings for the main comparison. Early dressing removal compared to delayed dressing removal for surgical wounds

Early dressing removal compared to delayed dressing removal for surgical wounds

Patient or population: people with surgical site infection
Settings: secondary or tertiary care
Intervention: early dressing removal
Comparison: delayed dressing removal

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Delayed dressing removal	Early dressing removal				
Superficial surgical site infection Superficial surgical site infection within 30 days of surgery Follow-up: mean 30 days	**114 per 1000**	**73 per 1000** (37 to 146)	**RR 0.64** (0.32 to 1.28)	280 (3 studies)	⊕⊖⊖⊖ **very low** [1,2,3]	
Superficial wound dehiscence Superficial wound dehiscence reported within 30 days of surgery Follow-up: mean 30 days	**11 per 1000**	**22 per 1000** (2 to 235)	**RR 2.00** (0.19 to 21.16)	180 (2 studies)	⊕⊖⊖⊖ **very low** [1,2,3]	
Serious adverse events Patients experiencing serious adverse events within 30 days of surgery Follow-up: mean 30 days	**154 per 1000**	**128 per 1000** (43 to 386)	**RR 0.83** (0.28 to 2.51)	78 (1 study)	⊕⊖⊖⊖ **very low** [1,2,3]	
Length of hospital stay Total length of hospital stay at maximal follow up	The mean length of hospital stay in the control group was **10.2 days**	The mean length of hospital stay in the intervention group was **2.00 days shorter** (2.82 to 1.18 shorter)		102 (1 study)	⊕⊕⊖⊖ **low** [1]	
Costs Costs at maximal follow-up	The mean cost in the control group was **EUR 139**	The mean cost in the intervention groups was **EUR 36.00 lower** (59.81 to 12.19 lower)		102 (1 study)	⊕⊕⊖⊖ **low** [1]	

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: confidence interval; **RR:** risk ratio

GRADE Working Group grades of evidence
High quality: further research is very unlikely to change our confidence in the estimate of effect
Moderate quality: further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate
Low quality: further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate
Very low quality: we are very uncertain about the estimate

[1] High risk of bias in all domains
[2] < 300 events in total in both groups
[3] 95% confidence interval includes both 0.75 and 1.25

BACKGROUND

Description of the condition

Most surgical procedures involve a cut in the skin that allows the surgeon to gain access to the deeper tissues or organs. Most surgical wounds are closed fully at the end of the procedure.This is called primary closure (Garcia-Gubern 2010). The various techniques for wound closure include closure using sutures, staples, adhesive tapes and tissue glue (Ahn 2011; Biancari 2010; Hasan 2009). Primary closure is essential to restore the skin barrier, which prevents infection of deeper tissues. However, it is not always possible to maintain clean conditions throughout surgery, for example, when operating on a contaminated wound (external wounds resulting from trauma) or when operating on tissues that contain contaminated material (e.g. surgery on the colon, which contains faecal material). In these situations it is sometimes best to delay closure of the wound until the wound develops good granulation tissue, and this is called secondary closure (Garcia-Gubern 2010).

Various factors affect wound healing, such as infection or mechanical strain leading to wound dehiscence (breakdown of wound along the incision), wound infection (currently termed 'surgical site infection') or both. Three types of surgical site infections (SSIs) have been classified: they are defined as 1) superficial incisional surgical site infections that involve only the skin or subcutaneous tissue around the incision, 2) deep incisional surgical site infections that involve deep soft tissues, such as the fascia and muscles (both occurring within 30 days of procedure, or one year in the case of implants), and 3) organ/space surgical site infections that involve any part of the body (excluding the skin incision, fascia or muscle layers) that is opened or manipulated during the operative procedure (Horan 1992). The incidence of SSI varies according to the classification of surgical wounds. Surgical wounds can be classified in different ways. One accepted classification that has been adopted by the Centers for Disease Prevention and Control (CDC) is to define wounds as clean, clean-contaminated, contaminated, and dirty or infected (Garner 1986). This classification is shown in Appendix 1. The incidence of SSI can vary between 1% and 80% depending upon the types of surgery, the hospital setting (community hospital, tertiary-care hospital, etc), the classification of surgical wounds, and the method of skin closure (Biancari 2010; Broex 2009; Garner 1986). It is estimated that the presence of SSI can double the costs of surgery (Broex 2009). Some of the methods used to prevent SSI include administration of prophylactic antibiotics and dressing of wounds.

Description of the intervention

Surgeons cover closed surgical wounds using either a dressing or adhesive tape (steri-strips), or both. Wound dressings are classified in a number of ways according to their function (e.g. occlusive, absorbent), type of material (e.g. hydrocolloid, collagen) and the physical form of the dressing (e.g. ointment, film, foam) (Boateng 2008). Some dressings are designed to control the environment for wound healing, for example, to donate fluid (hydrogels), maintain hydration (hydrocolloids), or to absorb wound exudates (alginates, foams) (BNF 2011). These dressings can be either transparent (e.g. vapour-permeable films), so that the wound can be monitored without the need for frequent dressing changes, or non-transparent. Wound dressings are customarily left in place for at least 48 hours after surgery (delayed dressing removal) irrespective of the level of contamination of wounds, or other factors such as antibiotic administration.

How the intervention might work

Dressings can act as a physical barrier to protect wounds until the continuity of the skin (epithelialisation) has been achieved - this occurs within about 48 hours of surgery (Lawrence 1998) - and to absorb exudate from the wound, keeping it dry and clean with the aim of avoiding bacterial contamination from the external environment (Hutchinson 1991; Mertz 1985; Ubbink 2008). Another reason for using a dressing is to prevent contamination of the surrounding area by any wound discharge (Downie 2010), although this is mainly applicable for clean-contaminated, contaminated, and dirty or infected wounds. Some studies have found that the moist environment created by some dressings accelerates wound healing (Dyson 1988), although others believe that it is a disadvantage, as excessive exudate can cause maceration (softening and breakdown) of the wound and the surrounding healthy tissue (Cutting 2002). Ideally surgeons choose suitable dressings to ensure that the wound remains:

- free of clinical infection and excessive slough;
- free of toxic chemicals, particles or fibres;
- at the optimum temperature for healing;
- undisturbed by the need for frequent changes;
- at the optimum pH value.

As wound healing progresses, it may be appropriate to use different types of dressings (BNF 2011).

Why it is important to do this review

Dressings applied to surgical wounds at the time of surgery can either be removed early, changed regularly, or retained until the removal of sutures or strips. This may cause inconvenience to the patient and increase nursing time, with an inevitable increase in associated costs (Chrintz 1989; Dosseh 2008; Merei 2004). In simulated wounds, where dressings increase the chance of localised sweating and can reduce moisture evaporation, the resulting increased dampness potentially acts as a nidus (point at which micro-organisms enter the body) for infection (Gwosdow 1993). Thus, there are some potential disadvantages to delaying dressing removal. There has been no systematic review of early dressing removal (permanent dressing removal within 48 hours after surgery) versus delayed dressing removal (permanent dressing removal 48 hours after surgery with dressing changes allowed in the interim) for surgical wounds.

OBJECTIVES

To evaluate the benefits and risks of removing a dressing covering a closed surgical incision site within 48 hours (early dressing removal) or beyond 48 hours (delayed dressing removal) of surgery, on surgical site infection.

METHODS

Criteria for considering studies for this review

Types of studies

We included randomised clinical trials (RCTs), irrespective of their use of blinding, language of publication, publication status, date of

publication, study setting or sample size. We included cluster RCTs provided that the effect estimate, after adjusting for the cluster effect, was available. We excluded quasi-randomised studies (where the methods of allocating participants to a treatment are not strictly random, for example, based on date of birth, hospital record number, alternation) and other study designs.

Types of participants

People, of any age and sex, undergoing a surgical procedure (major, minor or day-case procedure) who had their wound closed (primary wound closure), irrespective of the material and method used for the primary closure and the location of the wound. We excluded trials that included people with contaminated or dirty (infected) wounds unless separate information was provided for the clean and clean-contaminated wounds.

Types of interventions

When wound dressings are used they are almost always applied immediately after surgery. We included trials comparing the permanent removal of the wound dressing within 48 hours after surgery (early group) with continued dressing of the wound beyond 48 hours with interim dressing changes allowed (delayed group). We made no differentiation in the type of dressing and whether the dressing applied at the time of surgery was retained or changed. Co-interventions were allowed (e.g. antibiotics, wound drainage, etc.), provided that they were used equally across all groups.

Types of outcome measures

Primary outcomes

- Surgical site infection (SSI) within 30 days of operation. We attempted to use the definition of SSI that matches the standard definition of SSI described by Horan 1992. Otherwise, we accepted the definitions used by the trial authors.
  - Superficial SSI.
  - Deep SSI.
- Wound dehiscence within 30 days of operation. Postoperative wound dehiscence is the term given to wound disruptions that result from poor wound healing; it is caused by a variety of factors, such as type of incision, infection, anaemia, diabetes, ascorbic acid deficiency, etc. (Keill 1973). Wound dehiscence is classified as:
  - superficial (dehiscence involving skin and subcutaneous tissue); or
  - deep (burst abdomen).
- Other serious adverse events within 30 days of operation, defined as any event that would increase mortality; is life-threatening; requires inpatient hospitalisation or prolongation of existing hospitalisation; results in a persistent or significant disability or incapacity; or any important medical event that might have jeopardised the person, or requires intervention to prevent it (ICH-GCP 1996). We recognised that the main role of dressings is to prevent wound-related complications, but we wanted to assess the impact of dressings in the overall context of the operation.

Secondary outcomes

- Quality of life at maximal follow-up (however defined by authors).
- Length of hospital stay at maximal follow-up.
- Time taken to return to work.
- Costs at maximal follow-up (however reported by authors).

Search methods for identification of studies

Electronic searches

For this first update we searched:

- The Cochrane Wounds Group Specialized Register (Searched 24/03/15)
- The Cochrane Central Register of Controlled Trials (CENTRAL) - The Cochrane Library 2015, Issue 2
- Ovid MEDLINE & Ovid MEDLINE - In-Process & Other Non-Indexed Citations 2013 to March 23 2015
- Ovid EMBASE - 2013 to March 23 2015
- EBSCO CINAHL - 2013 to March 24 2015

The search strategies for Ovid MEDLINE, Ovid EMBASE and EBSCO CINAHL can be found in Appendix 1. We combined the Ovid MEDLINE search with the Cochrane Highly Sensitive Search Strategy for identifying randomised trials in MEDLINE: sensitivity- and precision-maximising version (2008 revision) (Lefebvre 2011). We combined the EMBASE and CINAHL searches with the trial filters developed by the Scottish Intercollegiate Guidelines Network (SIGN 2013). We did not restrict studies with respect to language, date of publication or study setting.

We used the following search strategy in The Cochrane Central Register of Controlled Trials (CENTRAL):

#1 MeSH descriptor Bandages explode all trees
#2 (dressing* or hydrocolloid* or alginate* or hydrogel* or "foam" or "bead" or "film" or "films" or tulle or gauze or non-adherent or "non adherent" or silver or honey or matrix):ti,ab,kw
#3 (#1 OR #2)
#4 MeSH descriptor Surgical Wound Infection explode all trees
#5 MeSH descriptor Surgical Wound Dehiscence explode all trees
#6 surg* NEAR/5 infect*:ti,ab,kw
#7 surg* NEAR/5 wound*:ti,ab,kw
#8 surg* NEAR/5 site*:ti,ab,kw
#9 surg* NEAR/5 incision*:ti,ab,kw
#10 surg* NEAR/5 dehiscen*:ti,ab,kw
#11 wound* NEAR/5 infect*:ti,ab,kw
#12 wound* NEAR/5 dehiscen*: ti,ab,kw
#13 (#4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12)
#14 (#3 AND #13)

The search strategies used for the original version of this review are detailed in Appendix 3.

Searching other resources

We did not undertake any additional searches for this update.

Data collection and analysis

We performed the systematic review following instructions in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011a).

Selection of studies

We did not apply any restrictions regarding language or publication status of trial reports. Two review authors (CT and KG)

independently read the titles and abstracts of potentially-relevant reports identified by the searches, and decided which references should be retrieved in full. We sought the full text for any reference that at least one review author considered was likely to meet the inclusion criteria. Final decisions on inclusion or exclusion of studies were based on reading the full text. We also listed the excluded studies with reasons for their exclusion (Characteristics of excluded studies).

Data extraction and management

Two review authors (CT and KG) extracted the following data independently.

- Year and language of publication.
- Country of conduct of the trial.
- Year of conduct of the trial.
- Inclusion and exclusion criteria.
- Sample size.
- Anatomical location of wound.
- Type of operation (primary closure versus secondary closure; actual operation; clean or clean contaminated wound).
- Type of wound closure.
- Type of dressing (occlusive versus non-occlusive; moist versus dry; manufacturer's name; type of material).
- Co-morbidities in participants (for example, diabetes).
- Antibiotics used.
- Outcome data for primary and secondary outcomes (by group).
- Duration of follow-up.
- Number of withdrawals (by group).
- Assessment of risk of bias (as described below).

We sought further information from trial authors when sufficient information was not available in the report. In future, if multiple reports exist for a trial, we will examine all the reports for information (on this occasion there were no multiple reports for the included trials). If there is any doubt about whether the trials share the same participants - completely or partially (by identifying common authors and centres) - we plan to contact the trial authors to check whether the trial report has been duplicated, and to seek clarification for any unclear or missing information. We resolved any differences in opinion through discussion amongst the review authors.

Assessment of risk of bias in included studies

We followed instructions in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011b). According to empirical evidence (Kjaergard 2001; Moher 1998; Schulz 1995; Wood 2008), we assessed the risk of bias of included trials based on the following risk of bias domains:

Sequence generation

- Low risk of bias: the method used was either adequate (e.g. computer-generated random numbers, table of random numbers) or unlikely to introduce confounding.
- Unclear risk of bias: there was insufficient information to assess whether the method used was likely to introduce confounding.
- High risk of bias (the method used was improper and likely to introduce confounding (e.g. quasi-randomised studies)). We excluded such studies.

Allocation concealment

- Low risk of bias: the method used was unlikely to induce bias on the final observed effect (e.g. central allocation).
- Unclear risk of bias: there was insufficient information to assess whether the method used was likely to induce bias on the estimate of effect.
- High risk of bias: the method used was likely to induce bias on the final observed effect (e.g. open random allocation schedule).

Blinding of participants and personnel

It was impossible to blind the participants, so, we classified patient-reported outcomes such as quality of life at high risk of bias, as this is a subjective outcome and a person's belief may influence the reporting of quality of life. However, it was possible to blind the healthcare providers. So, we considered outcomes that were not reported by participants as follows.

- Low risk of bias: blinding was performed adequately, or the outcome measurement was not likely to be influenced by lack of blinding.
- Unclear risk of bias: there was insufficient information to assess whether the type of blinding used was likely to induce bias on the estimate of effect.
- High risk of bias: no blinding or incomplete blinding, and the outcome or outcome measurement was likely to be influenced by lack of blinding.

Blinding of outcome assessors

- Low risk of bias: blinding was performed adequately, or the outcome measurement was not likely to be influenced by lack of blinding.
- Unclear risk of bias: there was insufficient information to assess whether the type of blinding used was likely to induce bias on the estimate of effect.
- High risk of bias: no blinding or incomplete blinding, and the outcome or the outcome measurement was likely to be influenced by lack of blinding.

Incomplete outcome data

- Low risk of bias: the underlying reasons for missing data were unlikely to make treatment effects depart from plausible values, or proper methods were employed to handle missing data.
- Unclear risk of bias: there was insufficient information to assess whether the missing data mechanism in combination with the method used to handle missing data was likely to induce bias on the estimate of effect.
- High risk of bias: the crude estimate of effect was clearly biased due to the underlying reasons for missing data, and the methods used to handle missing data were unsatisfactory (e.g. complete case estimate).

Selective outcome reporting

- Low risk of bias: the trial protocol was available and all of the trial's pre-specified outcomes that were of interest to this review

were reported; if the trial protocol was not available, all the primary outcomes in this review were reported.

- Unclear risk of bias: there was insufficient information to assess whether the magnitude and direction of the observed effect was related to selective outcome reporting.
- High risk of bias: not all of the trial's pre-specified primary outcomes were reported.

We considered trials that were classified as being at low risk of bias in all the above domains as 'low bias-risk trials'. We considered the other trials to be at unclear risk of bias (if at least one of the domains was at unclear risk of bias and none of the domains was at high risk of bias) or 'high bias-risk trials' (if at least one of the domains was at high risk of bias).

Measures of treatment effect

For dichotomous variables, we calculated the risk ratio (RR) with 95% confidence intervals (CI). For continuous variables, we calculated the mean difference (MD) with 95% CI for outcomes that could be quantified, such as hospital stay and return to work, and planned to calculate the standardised mean difference (SMD) with 95% CI for outcomes such as quality of life where different assessment scales may have been used in different studies. We also reported the results of risk difference (RD) if they were different from those of risk ratio. This is because the risk difference takes account of trials with an absence of events in both treatment groups, while risk ratio does not include such trials in the meta-analysis.

Unit of analysis issues

We included simple RCTs of parallel design. The unit of analysis was the individual person. We did not anticipate or identify any cluster-RCTs. We excluded trials of other designs, such as cross-over trials.

Dealing with missing data

We planned to perform an intention-to-treat analysis whenever possible (Newell 1992). We planned to impute data for binary outcomes using various scenarios such as best-best scenario, worst-worst scenario, best-worst scenario, and the worst-best scenario (Gurusamy 2009). In the best-best scenario, participants with missing outcome data would be considered not to have developed a complication. In the worst-worst scenario, participants with missing outcome data would be considered to have developed a complication. In the best-worst scenario, participants with missing outcome data in the intervention group would be considered not to have developed a complication, while those in the control group would be considered to have developed a complication. In the worst-best scenario, participants with missing outcome data would be considered to have developed a complication in the intervention group and not to have developed a complication in the control group.

For continuous outcomes, we planned to use the available-case analysis where intention-to-treat analysis was not possible. We planned to impute the standard deviation from P values according to instructions in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011c), and to use the median for the meta-analysis when the mean was not available. Where it was not possible to calculate the standard deviation from the P value or the confidence intervals, we planned to impute the standard deviation as the highest standard deviation in the other trials included under that outcome, fully recognising that this form of imputation decreases the weight of the study for calculation of mean differences and bias the effect estimate towards no effect in case of standardised mean difference (Higgins 2011d).

Assessment of heterogeneity

We explored heterogeneity by the Chi^2 test with the threshold for statistical significance set at P value 0.10, and measured the quantity of heterogeneity by the I^2 statistic (Higgins 2002).

Thresholds for the interpretation of the I^2 statistic can be misleading. A rough guide to interpretation is as follows (Deeks 2011).

- 0% to 40%: might not be important.
- 30% to 60%: may represent moderate heterogeneity.
- 50% to 90%: may represent substantial heterogeneity.
- 75% to 100%: represents considerable heterogeneity.

Assessment of reporting biases

If we had included at least 10 trials, we planned to use visual asymmetry on a funnel plot to explore reporting bias (Egger 1997; Macaskill 2001). We had also planned to perform the linear regression approach described by Egger 1997 to determine the funnel plot asymmetry.

Data synthesis

We performed the meta-analysis using RevMan 5 software (RevMan 2011), and followed the recommendations of The Cochrane Collaboration (Deeks 2011). We used both a random-effects model (DerSimonian 1986), and fixed-effect model (DeMets 1987), of meta-analysis. We planned to report both results where we identified discrepancy between the two models from the pooled estimates and their confidence intervals, resulting in a change in conclusions. However, we did not find any such outcomes, so have reported the results of the fixed-effect model. With regard to dichotomous outcomes, risk ratio calculations do not include trials in which no events occurred in either group in the meta-analysis, whereas risk difference calculations do. We planned to report the risk difference (RD) if the results using this association measure were different from risk ratio in terms of statistical significance. However, risk ratio is the measure that we have used to derive conclusions, since risk ratios perform better when there are differences in the control event rate (proportion of people who develop the event in the control group(s)).

Summary of findings

We have presented the 'Summary of findings for the main comparison' for all the reported primary and secondary outcomes (Schünemann 2011).

Subgroup analysis and investigation of heterogeneity

We planned to perform the following subgroup analyses in the presence of an adequate number of trials.

- Trials with low risk of bias (considered to be at low risk of bias in all the risk of bias domains) compared to trials with high or unclear risks of bias.

- Based on the type of dressing (dry, moist, occlusive, absorbent) (some types of dressings may be useful while other types of dressings may not be useful).
- Based on type of surgery (trunk versus extremities) (wound healing rates may be different in the trunk and extremities, particularly in people who have peripheral vascular diseases).
- Based on type of wound closure (sutures versus staples versus adhesive tapes). Dressings may be useful in some types of wound closure while they may not be useful in other forms.
- Based on degree of contamination (clean versus clean-contaminated). Dressings may be useful in clean-contaminated wounds because they absorb exudate, while they may not be useful in clean wounds.
- Antibiotic treatment up to 48 hours after surgery versus antibiotic treatment for more than 48 hours after surgery (i.e. continuation of antibiotic after removal of dressing in the early group). Antibiotics may eradicate bacteria, even in wounds that become contaminated, in which they may prevent infection.

However, there were not enough eligible studies in each subgroup to allow for this.

Sensitivity analysis

We performed sensitivity analysis by imputing data for dichotomous outcomes using various scenarios including best-best scenario, worst-worst scenario, best-worst scenario and worst-best scenario (Gurusamy 2009). We planned to perform a sensitivity analysis by excluding the trials in which the mean and the standard deviation were imputed.

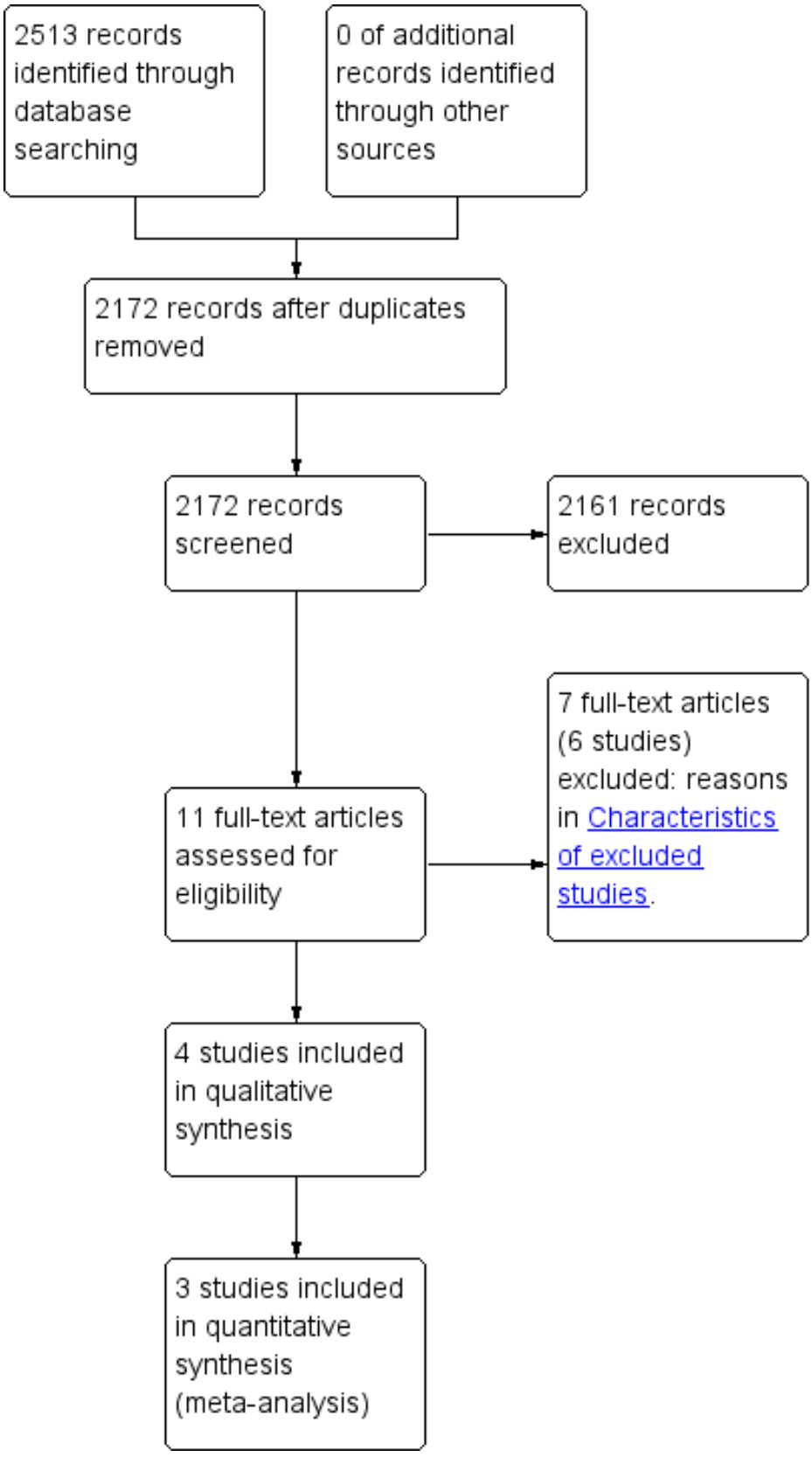
RESULTS

Description of studies

Results of the search

A total of 2513 references were identified through the searches detailed previously. We excluded 342 duplicates and 2161 irrelevant references by going through titles and abstracts, leaving eleven references for full assessment. We obtained full texts for these references. Seven references (six studies) were excluded for the reasons outlined in the Characteristics of excluded studies table. This left four trials for inclusion in this review (Ajao 1977; Dosseh 2008; Ramkumar 2006; Wipke-Tevis 1998). No further trials were identified through searching the references of the included trials. The reference flow is shown in Figure 1.

Figure 1. Reference Flow



Included studies

(See Characteristics of included studies table)

A total of 317 participants were included in this systematic review. Ten were lost to follow-up. Of the remaining participants, 147 were randomised to the early dressing removal group (removal of the wound dressing within 48 hours after surgery) and the remaining 160 participants were randomised to the delayed dressing removal group (continued dressing of the wound beyond 48 hours). The trials included a variety of surgical procedures in one trial (no details about them) (Ajao 1977); various abdominal surgeries, cervical surgeries and thoracic surgeries in another (Dosseh 2008); correction of prominent ears in a third (Ramkumar 2006); and saphenous vein-graft harvesting in patients undergoing coronary artery bypass graft surgery in the fourth (Wipke-Tevis 1998). Routine antibiotics were not used in one trial (Ajao 1977), while in another prophylactic antibiotics were used for a period not exceeding 24 hours after surgery (Dosseh 2008). No information about antibiotic use was available from the other two trials (Ramkumar 2006; Wipke-Tevis 1998). Early dressing removal was performed within 24 hours of surgery in Ramkumar 2006 and Wipke-Tevis 1998; between 24 to 36 hours in Ajao 1977; and at 48 hours in Dosseh 2008. Delayed dressing removal was performed in seven to 10 days in Ajao 1977; 10 days in Ramkumar 2006; and at suture removal in Dosseh 2008 and Wipke-Tevis 1998.

Three trials including 280 participants randomised to the early dressing removal group (140 participants) and delayed dressing removal group (140 participants) provided data for this review (Ajao 1977; Dosseh 2008; Ramkumar 2006) (Figure 1).

Excluded studies

(See Characteristics of excluded studies table for details.) Four studies were excluded for the following reasons: two studies were quasi-randomised (Chrintz 1989; Meylan 2001); one was an RCT that compared different types of dressing against no dressing (i.e. the wound was not covered with a dressing immediately after surgery) (Law 1987); one did not compare early vs delayed dressing (Springer 2013); and one was not a randomised controlled trial (Edwards 1967). We also identified a summary report about an excluded study (Chrintz 1989) and a commentary on this review (Lisy 2014).

Risk of bias in included studies

All the trials were at high risk of bias. The proportion of trials with different classifications of risk of bias is shown in Figure 2, and the classification of domains in individual trials is shown in Figure 3.

Figure 2. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies

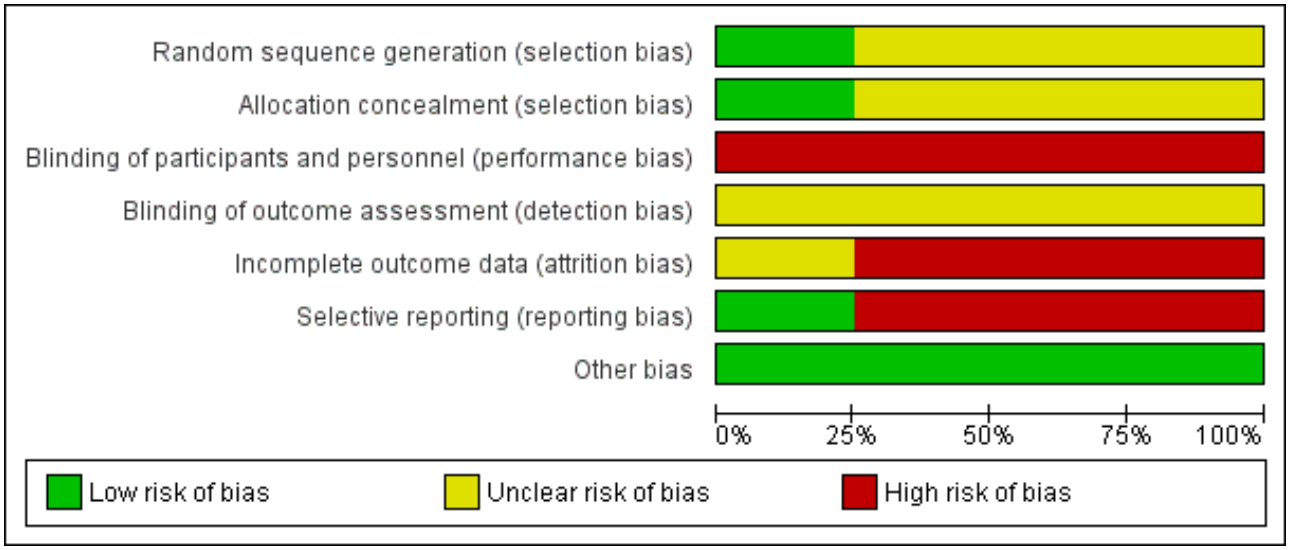
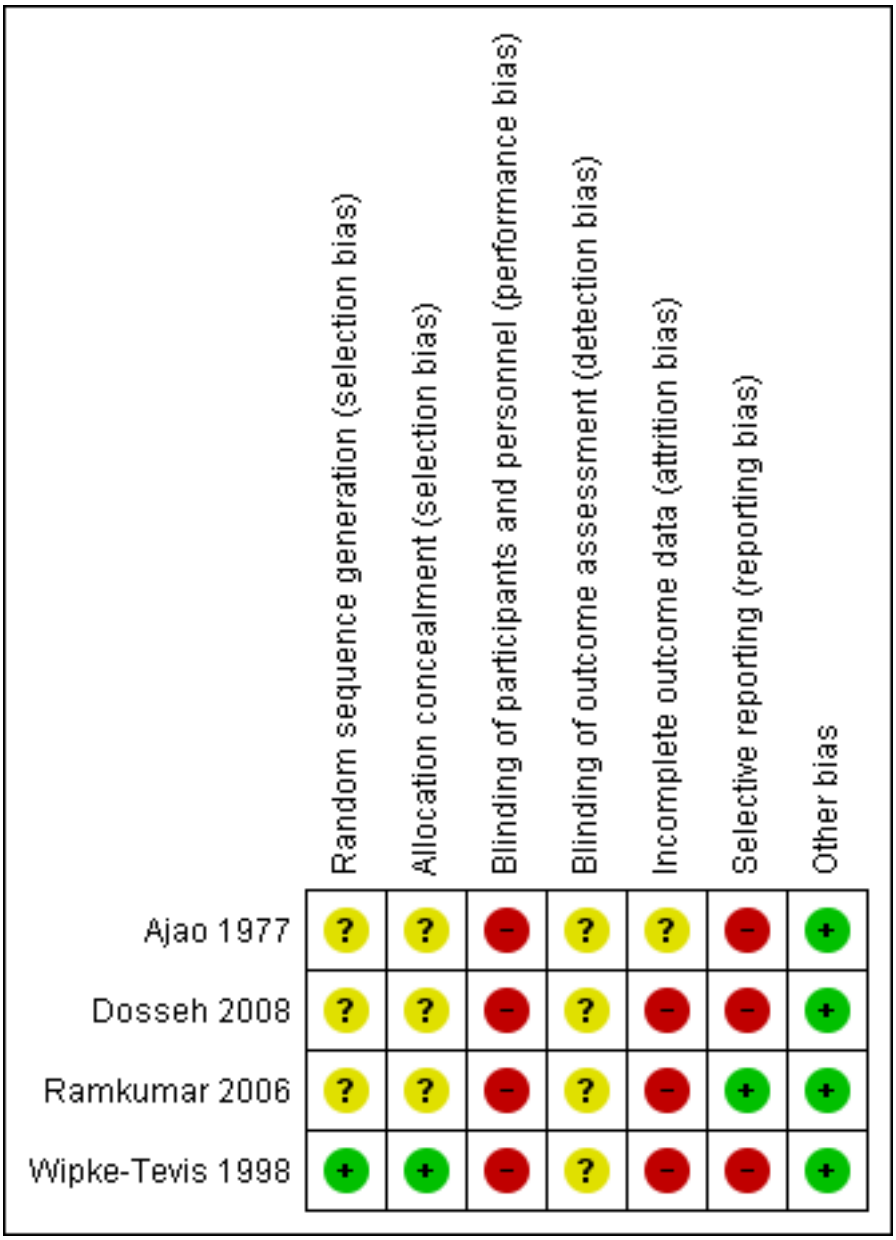


Figure 3. Risk of bias summary: review authors' judgements about each risk of bias item for each included study



Allocation

One trial had a low risk of bias due to sequence generation (Wipke-Tevis 1998), it also had a low risk of bias due to allocation concealment. The other three trials were assessed as being at unclear risk of bias.

Blinding

None of the trials had a low risk of bias due to an absence of blinding of participants, healthcare providers or outcome assessors.

Incomplete outcome data

None of the trials were at low risk of bias due to incomplete outcome data.

Selective reporting

Only one trial reported wound complications and serious adverse events, and was considered to be at low risk of bias for selective reporting (Ramkumar 2006).

Effects of interventions

See: **Summary of findings for the main comparison** Early dressing removal compared to delayed dressing removal for surgical wounds

The results from the meta-analysis are outlined in the Data and analyses and Summary of findings for the main comparison. Only seven outcomes were reported in the included trials.

1. Superficial surgical site infection within 30 days

Superficial surgical site infection (SSI) within 30 days of surgery was reported by Ajao 1977; Dosseh 2008 and Ramkumar 2006. Overall, 26/280 participants (9.3%) in the three trials developed SSI. There was no significant difference in the proportion of people who developed SSI between the early dressing removal group and the delayed dressing removal group (RR 0.64; 95% CI 0.32 to 1.28) (Analysis 1.1). There was no significant heterogeneity (I^2 = 0%; Chi^2 P value 0.88).

2. Deep surgical site infection within 30 days

Deep SSI was only reported by Dosseh 2008. No deep SSIs were reported in either the early or delayed dressing removal groups in this trial.

3. Superficial wound dehiscence within 30 days

Dosseh 2008 and Ramkumar 2006 presented data on superficial wound dehiscence within 30 days of surgery. Overall, 3/180 participants (1.7%) developed superficial wound dehiscence. There was no significant difference in the proportion of people who developed superficial wound dehiscence between the early and delayed dressing removal groups (RR 2.00; 95% CI 0.19 to 21.16) (Analysis 1.2). We could not assess heterogeneity, because there was no superficial wound dehiscence in either group in one trial (Dosseh 2008).

4. Deep wound dehiscence within 30 days

Deep wound dehiscence within 30 days of surgery was reported by both Dosseh 2008 and Ramkumar 2006. No deep wound dehiscences were reported in either the early or delayed dressing removal groups in these trials.

5. Serious adverse events at 30 days

Serious adverse events at 30 days after surgery were reported by only one of the included trials (Ramkumar 2006). Overall 11/78 participants (14.1%) developed serious adverse events such as skin necrosis, wound dehiscence, haematomas, SSIs, and maceration of the wound. No significant difference was noted in the proportion of people developing serious adverse events between the early dressing removal group and the delayed dressing removal group (RR 0.83; 95% CI 0.28 to 2.51) (Analysis 1.3).

6. Length of hospital stay at maximal follow-up

Length of hospital stay at maximal follow-up was reported by Dosseh 2008. The length of hospital stay was statistically significantly shorter for participants in the early dressing removal group than those in the delayed dressing removal group (MD -2.00 days; 95% CI -2.82 to -1.18) (Analysis 1.4).

7. Total costs at maximal follow-up

Only Dosseh 2008 reported total costs at maximal follow-up. Costs related to the procedure and hospitalisation were significantly lower for participants in the early dressing removal group than in the delayed dressing removal group (MD (EUR) -36.00; 95% CI -59.81 to -12.19) (Analysis 1.5).

Additional information

No differences were noted between the random-effects model and fixed-effect model. Therefore, only the fixed-effect data have been reported here. There was no change in the interpretation of results when risk difference was used for binary outcomes.

Subgroup analysis

Subgroup analysis was not performed because of the low number of trials included in this review.

Sensitivity analysis

There was no change in the results when different scenarios were used in the Dosseh 2008 trial in which three people in the delayed dressing group who did not receive dressing (patients refused to have any dressing) were excluded from the analysis (Analysis 1.6; Analysis 1.7). In the two remaining trials that reported post-randomisation drop-outs, one trial did not report the group from which they dropped-out (Ramkumar 2006), and the other trial did not report any of the outcomes of interest (Wipke-Tevis 1998), so was not included in any of the sensitivity analysis. We did not impute the mean and standard deviation for any of the trials, so we did not perform any sensitivity analysis for continuous outcomes.

Reporting bias

We did not explore reporting bias because of the presence of fewer than 10 trials in the review.

DISCUSSION

Summary of main results

This review compared the effects of early versus delayed dressing removal on a variety of outcomes, including surgical site infections (SSI), length of hospital stay and overall costs. While four trials were identified for inclusion in this review (Ajao 1977; Dosseh 2008; Ramkumar 2006; Wipke-Tevis 1998), only three trials contributed to the meta-analysis (Ajao 1977; Dosseh 2008; Ramkumar 2006). These trials included people undergoing assorted surgical procedures (Ajao 1977); abdominal, cervical or thoracic surgery (Dosseh 2008); unilateral or bilateral primary correction of prominent ears (Ramkumar 2006); and coronary artery bypass graft surgery with saphenous vein grafts (Wipke-Tevis 1998). The people in the early dressing removal group removed their dressing up to 48 hours after surgery. Those in the delayed dressing removal group continued dressing the wound beyond 48 hours. It was possible to extract data for the following outcomes: both superficial and deep SSI, both superficial and deep wound dehiscence, number of people with adverse events, length of hospital stay, and total costs. None of the trials reported quality of life or time to return to work. There were no significant differences between the groups in terms of incidence of SSIs, wound dehiscence or serious adverse events. The length of hospital stay was two days shorter and the costs were EUR 36 cheaper in the early dressing removal group than the delayed dressing removal group in the only trial that reported this outcome (Dosseh 2008). This trial included direct costs, which included the intervention and the hospitalisation in Togo. Hospital stay is likely to cost more in Western countries. For example, one additional day in hospital costs approximately GBP 250 in the United Kingdom (NHS reference costs 2012).

In the absence of evidence of a difference in complications between the two groups, the shorter hospital stay and the lower costs are likely to be due to the dressing rather than a difference in complications. However one cannot rule out differences in complications, since the trials were not powered to measure these

differences. Even if patients are discharged home with further instructions for dressings with the general practitioner (GP) or GP-nurse or a nurse who visits the home, this will involve costs. If the hospital stay is likely to be longer than 48 hours for surgical reasons (rather than for dressing the wound), dressing the wound involves time for the ward staff. So, irrespective of the setting, dressing beyond 48 hours involves resources other than the cost of the dressings. If this is not balanced by a decrease in the complications, there appears to be no evidence to support dressing surgical wounds beyond 48 hours.

Overall completeness and applicability of evidence

None of the studies reported health-related quality of life. It is important to measure the quality of life in future trials.

The findings of this review can only be applied to people with clean or clean-contaminated surgical wounds closed by primary intention. It is not clear whether or not these findings can be applied to people with accidental injuries, or for those people undergoing delayed primary closure.

Quality of the evidence

The overall quality of the evidence is low or very low as shown in Summary of findings for the main comparison. Most of the results are based on one or two trials. However, it must be pointed out that this is the best available evidence on this topic. Evidence from observational studies may be even more unreliable, since the participants in whom wound complications are not expected to develop because of various factors including co-morbidities, type of living environment, their ability to keep the wound clean, and the type of surgery performed, may influence the decision to remove the dressing early or late. Such selection bias can result in biased effect estimate.

Potential biases in the review process

Although we performed a thorough review of published literature and current trials, it is possible that some authors have conducted relevant trials in the pre-registration era and have not reported the results. There are various potential sources of heterogeneity including types of dressing, surgery, and wound closure; degree of contamination; and duration of antibiotic treatment, as mentioned in the 'Subgroup analysis and investigation of heterogeneity' section. However, heterogeneity could not be explored because of the low number of trials included in this review, so the impact of these factors on the effect estimate could not be explored.

Agreements and disagreements with other studies or reviews

This is the first review on this topic. Overall, the trials concluded that wounds can be uncovered within the first 48 hours following surgery with no ill effect. It was also concluded that when dressings were removed within the first 48 hours, people spent significantly less time in hospital and the overall cost of their treatment was significantly reduced compared to people whose wounds were covered beyond the first 48 hours following surgery. While the authors of the individual trials interpreted this to mean that there was no need for dressing beyond the first 48 hours following surgery, we interpret this information with a little more caution and conclude that there is currently no evidence for dressings beyond the first 48 hours and that dressing need not be used for more than 48 hours following surgery involving clean and clean, contaminated wounds until further research shows otherwise.

AUTHORS' CONCLUSIONS

Implications for practice

The early removal of the dressing from a clean or clean-contaminated surgical wound appears to have no detrimental effect on the patient. However, it must be noted that the point estimate that supports this conclusion is based on very low quality evidence from three small randomised controlled trials, and that the confidence intervals around this estimate were wide. Furthermore, early dressing removal may result in a significantly shorter hospital stay and significantly reduced costs than covering the surgical wound with a wound dressing beyond the first 48 hours after surgery based on very low quality evidence from one small randomised controlled trial.

Implications for research

Further randomised controlled trials of low risk of bias are necessary to investigate whether dressings are necessary after 48 hours in different types of surgery and levels of contamination and investigate whether antibiotic therapy influences the outcome

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Ajao 1977

Methods	Randomised clinical trial
Participants	Country: Nigeria Number randomised: 100 Post-randomisation drop-outs: not stated Revised sample size: 100 Average age: not stated Male: female ratio: not stated Inclusion criteria: people having various surgical procedures (all operations on the trunk)
Interventions	Participants randomly assigned to 2 groups Group 1 (n = 50): early dressing removal, wound left open 24-36 h after suturing Group 2 (n = 50): delayed dressing removal, dressing left for 7-10 days unless infection suspected, when the wound was inspected and dressing reapplied
Outcomes	Wound infection
Notes	We attempted to contact the authors in Janaury 2013
Risk of bias	

Bias	Authors' judgement	Support for judgement

Ajao 1977 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	Comment: this information was not available
Allocation concealment (selection bias)	Unclear risk	Comment: this information was not available
Blinding of participants and personnel (performance bias) All outcomes	High risk	Comment: no dressing was given beyond 24-36 h after surgery in the early dressing group while the dressing was left for 7-10 days in the delayed dressing group making blinding of participants impossible
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Comment: this information was not available
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Comment: this information was not available
Selective reporting (reporting bias)	High risk	Comment: did not report some important outcomes that would generally be assessed
Other bias	Low risk	Comment: no other bias was noted

Dosseh 2008

Methods	Randomised clinical trial
Participants	Country: Togo Number randomised: 105 Post-randomisation drop-outs: 3 (2.9%) Revised sample size: 102 Average age: 36 years Male: female ratio: 67 (65.7%): 35 (34.3%) Inclusion criteria: 1. People undergoing abdominal surgery, neck surgery and thoracic surgery and having clean or clean-contaminated wounds 2. American Society of Anesthesiologists (ASA) 1 or 2 (low anaesthetic risk) 3. Could be randomised to early or delayed dressing removal 4. Participants (or their parents) should be able to understand the protocol Exclusion criteria: 1. People who did not have internal surgery (i.e. those who had surgery for skin lesions) 2. People who deviated from the protocol
Interventions	Participants randomly assigned to 2 groups Group 1 (n = 51): early dressing removal, wound left open 48 h after surgery Group 2 (n = 51): delayed dressing removal, dressing changed every 48 h until suture removal
Outcomes	Wound infection, wound dehiscence, hospital stay, and costs
Notes	We attempted to contact the authors in January 2013 Reason for post-randomisation drop-outs: participants in dressing group who opted for no dressing
Risk of bias	

Dosseh 2008 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: this information was not available
Allocation concealment (selection bias)	Unclear risk	Comment: this information was not available
Blinding of participants and personnel (performance bias) All outcomes	High risk	Comment: no dressing was given beyond 48 h after surgery in the early dressing group while the dressing was left until suture removal in the delayed dressing group making blinding of participants impossible
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Comment: this information was not available
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: there were post-randomisation drop-outs. The direction of effect was altered by imputing the data under different scenarios for superficial wound dehiscence (Analysis 1.7)
Selective reporting (reporting bias)	High risk	Comment: did not report some important outcomes that would generally be assessed
Other bias	Low risk	Comment: no other bias was noted

Ramkumar 2006

Methods	Randomised clinical trial
Participants	Country: United Kingdom Number randomised: 80 Post-randomisation drop-outs: 2 (2.5%) Revised sample size: 78 Average age: 10 years Male: female ratio: 40 (51.3%): 38 (48.7%) Inclusion criteria: children < 16 years of age undergoing a unilateral or bilateral primary correction of prominent ears Exclusion criteria: children requiring secondary revision or with any other type of congenital ear deformity
Interventions	Participants randomly assigned to 2 groups Group 1 (n = 39): early dressing removal, head bandage was removed the next day Group 2 (n = 39): delayed dressing removal, head bandage was removed after 10 days Both groups received Tubigrip bandage at night-time for 4-6 weeks
Outcomes	Wound infection and other complications
Notes	We attempted to contact the authors in January 2013 Reasons for post-randomisation drop-outs: unable to collect information (group not stated)

Risk of bias

Bias	Authors' judgement	Support for judgement

Ramkumar 2006 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	Comment: this information was not available
Allocation concealment (selection bias)	Unclear risk	Comment: this information was not available
Blinding of participants and personnel (performance bias) All outcomes	High risk	Comment: no dressing was given beyond 24 h after surgery in the early dressing group while the dressing was left for 10 days in the delayed dressing group making blinding of participants impossible
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Comment: this information was not available
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: there were post-randomisation drop-outs, and the groups to which they had been randomised could be seen
Selective reporting (reporting bias)	Low risk	Comment: all important outcomes were reported
Other bias	Low risk	Comment: no other bias was noted

Wipke-Tevis 1998

Methods	Randomised clinical trial
Participants	Country: USA Number randomised: 32 Post-randomisation drop-outs: 5 (15.6%) Revised sample size: 27 Average age: 62 years Male: female ratio: 22 (81.5%): 5 (18.5%) Inclusion criteria: people undergoing coronary artery bypass graft surgery with saphenous vein grafts Exclusion criteria: people receiving immunosuppressant medications, or undergoing intra-aortic balloon pump therapy
Interventions	Participants randomly assigned to 2 groups Group 1 (n = 7): early dressing removal, wound left open 24 h after surgery. Dry sterile dressing was used, if there was any section of the wound that continued to drain, until the discharge stopped Group 2 (n = 20): delayed dressing removal, dressing remained in place until removal of sutures. Two types of dressings were used (this again was random, so this was a 3-armed trial of early dressing removal versus delayed dressing removal with 2 different dressings). One of the delayed dressing groups received daily dressings with sterile gauze. The remaining participants in the delayed dressing group received Tegaderm dressing (frequency of change not stated)
Outcomes	None of the outcomes of interest for this review were reported
Notes	We attempted to contact the authors in January 2013. Authors replied with information regarding risk of bias assessment Reason for post-randomisation drop-outs: incomplete data (group not stated)
Risk of bias	

Wipke-Tevis 1998 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "A table of random numbers out of the back of a statistics book was utilized" (author replies)
Allocation concealment (selection bias)	Low risk	Quote: "Each potential subject was given an ID number and a sequence was placed in an opaque envelope" (author replies)
Blinding of participants and personnel (performance bias) All outcomes	High risk	Comment: no dressing was given beyond 24 h after surgery in the early dressing group while the dressing was left until suture removal in the delayed dressing group making blinding of participants impossible
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Comment: this information was not available
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: there were post-randomisation drop-outs, and the groups to which they had been randomised could be seen
Selective reporting (reporting bias)	High risk	Comment: did not report some important outcomes that would generally be assessed
Other bias	Low risk	Comment: no other bias was noted

Abbreviations
< = less than
h = hour(s)

Characteristics of excluded studies *[ordered by study ID]*

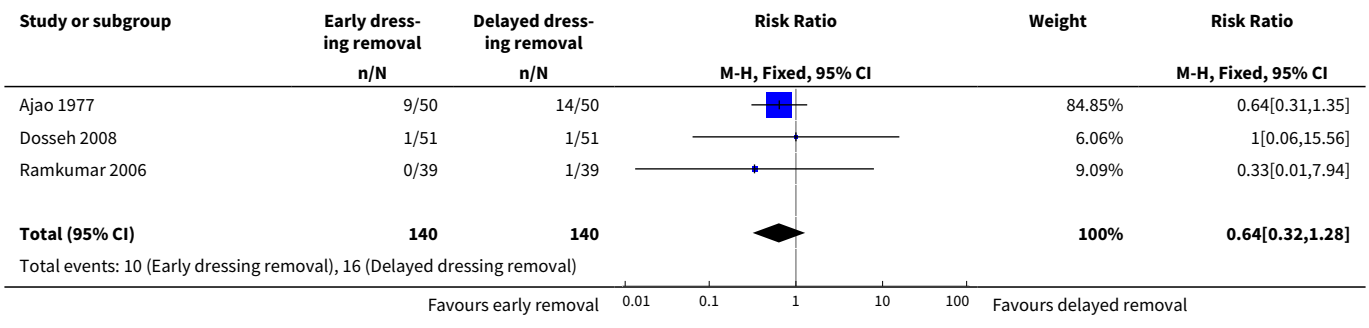
Study	Reason for exclusion
Chrintz 1989	Quasi-randomised study
Edwards 1967	Not a randomised trial
Law 1987	Comparison of different dressings and no dressings
Lisy 2014	Commentary on the current Cochrane review
Meylan 2001	Quasi-randomised study
Springer 2013	Study not comparing early versus delayed dressing removal

DATA AND ANALYSES

Comparison 1. Early versus delayed dressing removal

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Superficial surgical site infection within 30 days	3	280	Risk Ratio (M-H, Fixed, 95% CI)	0.64 [0.32, 1.28]
2 Superficial wound dehiscence within 30 days	2	180	Risk Ratio (M-H, Fixed, 95% CI)	2.0 [0.19, 21.16]
3 Patients with serious adverse events at 30 days	1		Risk Ratio (M-H, Fixed, 95% CI)	Subtotals only
4 Length of hospital stay at maximal follow-up	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
5 Costs at maximal follow-up	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
6 Superficial surgical site infection within 30 days (sensitivity analysis)	3		Risk Ratio (M-H, Fixed, 95% CI)	Subtotals only
6.1 Best-best scenario	3	283	Risk Ratio (M-H, Fixed, 95% CI)	0.64 [0.32, 1.28]
6.2 Worst-worst scenario	3	283	Risk Ratio (M-H, Fixed, 95% CI)	0.54 [0.27, 1.07]
6.3 Best-worst scenario	3	283	Risk Ratio (M-H, Fixed, 95% CI)	0.54 [0.27, 1.07]
6.4 Worst-best scenario	3	283	Risk Ratio (M-H, Fixed, 95% CI)	0.64 [0.32, 1.28]
7 Superficial wound dehiscence within 30 days (sensitivity analysis)	2		Risk Ratio (M-H, Fixed, 95% CI)	Subtotals only
7.1 Best-best scenario	2	183	Risk Ratio (M-H, Fixed, 95% CI)	2.0 [0.19, 21.16]
7.2 Worst-worst scenario	2	183	Risk Ratio (M-H, Fixed, 95% CI)	0.57 [0.12, 2.66]
7.3 Best-worst scenario	2	183	Risk Ratio (M-H, Fixed, 95% CI)	0.57 [0.12, 2.66]
7.4 Worst-best scenario	2	183	Risk Ratio (M-H, Fixed, 95% CI)	2.0 [0.19, 21.16]

Analysis 1.1. Comparison 1 Early versus delayed dressing removal, Outcome 1 Superficial surgical site infection within 30 days.



Study or subgroup	Early dressing removal n/N	Delayed dressing removal n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
Heterogeneity: Tau²=0; Chi²=0.26, df=2(P=0.88); I²=0%					
Test for overall effect: Z=1.27(P=0.2)					

Favours early removal 0.01 0.1 1 10 100 Favours delayed removal

Analysis 1.2. Comparison 1 Early versus delayed dressing removal, Outcome 2 Superficial wound dehiscence within 30 days.

Study or subgroup	Early dressing removal n/N	Delayed dressing removal n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
Dosseh 2008	0/51	0/51			Not estimable
Ramkumar 2006	2/39	1/39		100%	2[0.19,21.16]
Total (95% CI)	**90**	**90**		**100%**	**2[0.19,21.16]**
Total events: 2 (Early dressing removal), 1 (Delayed dressing removal)					
Heterogeneity: Not applicable					
Test for overall effect: Z=0.58(P=0.56)					

Favours early removal 0.01 0.1 1 10 100 Favours delayed removal

Analysis 1.3. Comparison 1 Early versus delayed dressing removal, Outcome 3 Patients with serious adverse events at 30 days.

Study or subgroup	Early dressing removal n/N	Delayed dressing removal n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
Ramkumar 2006	5/39	6/39		0%	0.83[0.28,2.51]

Favours early removal 0.2 0.5 1 2 5 Favours delayed removal

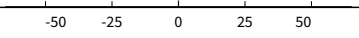
Analysis 1.4. Comparison 1 Early versus delayed dressing removal, Outcome 4 Length of hospital stay at maximal follow-up.

Study or subgroup	Early dressing removal N	Early dressing removal Mean(SD)	Delayed dressing removal N	Delayed dressing removal Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
Dosseh 2008	51	8.2 (2.2)	51	10.2 (2)		0%	-2[-2.82,-1.18]

Favours early removal -2 -1 0 1 2 Favours delayed removal

Analysis 1.5. Comparison 1 Early versus delayed dressing removal, Outcome 5 Costs at maximal follow-up.

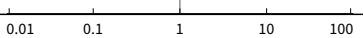
Study or subgroup	Early dressing removal N	Early dressing removal Mean(SD)	Delayed dressing removal N	Delayed dressing removal Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
Dosseh 2008	51	103 (40)	51	139 (77)		0%	-36[-59.81,-12.19]



Favours early removal — Favours delayed removal

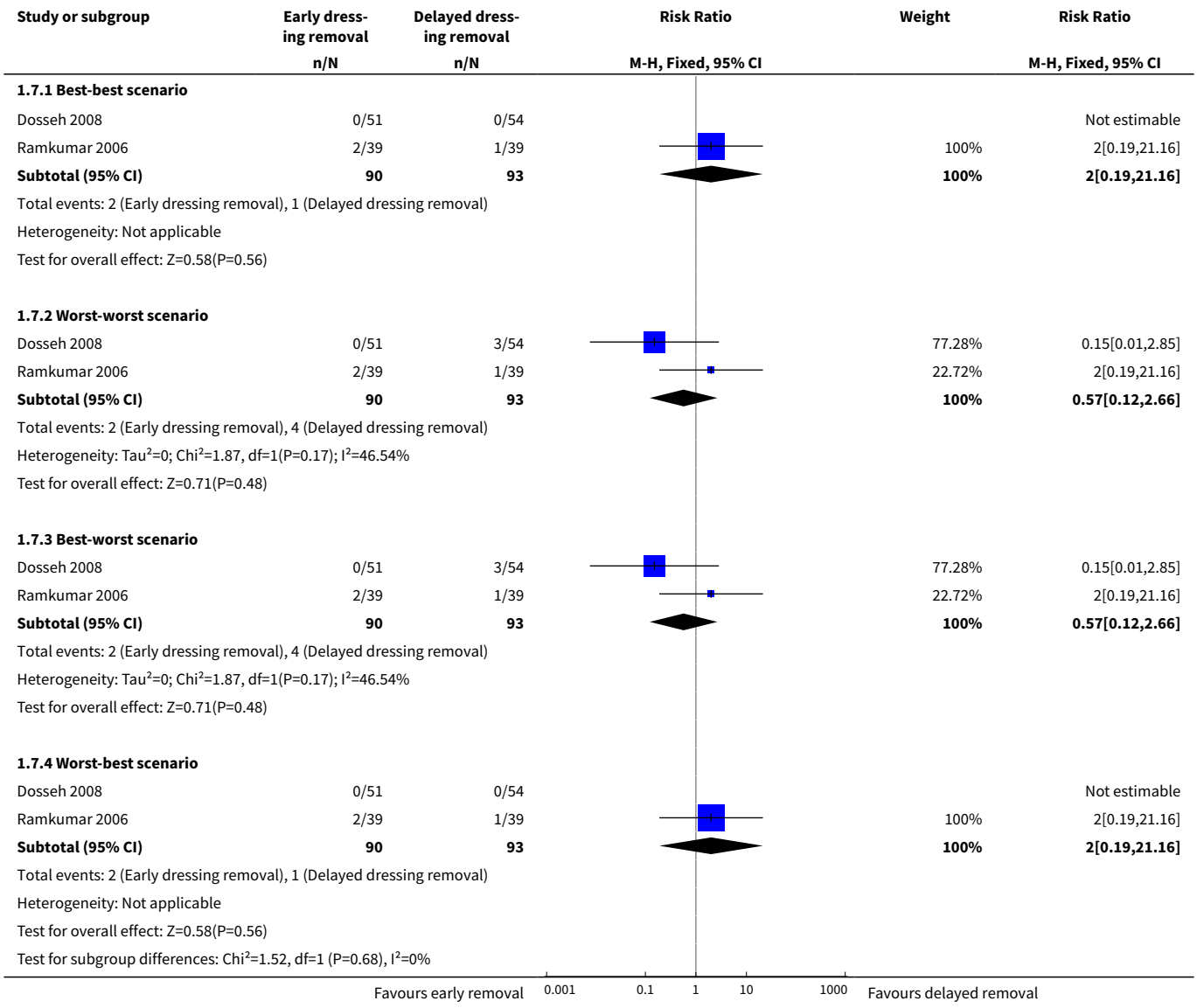
Analysis 1.6. Comparison 1 Early versus delayed dressing removal, Outcome 6 Superficial surgical site infection within 30 days (sensitivity analysis).

Study or subgroup	Early dressing removal n/N	Delayed dressing removal n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
1.6.1 Best-best scenario					
Ajao 1977	9/50	14/50		85%	0.64[0.31,1.35]
Dosseh 2008	1/51	1/54		5.9%	1.06[0.07,16.48]
Ramkumar 2006	0/39	1/39		9.11%	0.33[0.01,7.94]
Subtotal (95% CI)	**140**	**143**		**100%**	**0.64[0.32,1.28]**
Total events: 10 (Early dressing removal), 16 (Delayed dressing removal)					
Heterogeneity: Tau^2=0; Chi^2=0.29, df=2(P=0.86); I^2=0%					
Test for overall effect: Z=1.26(P=0.21)					
1.6.2 Worst-worst scenario					
Ajao 1977	9/50	14/50		72.22%	0.64[0.31,1.35]
Dosseh 2008	1/51	4/54		20.04%	0.26[0.03,2.29]
Ramkumar 2006	0/39	1/39		7.74%	0.33[0.01,7.94]
Subtotal (95% CI)	**140**	**143**		**100%**	**0.54[0.27,1.07]**
Total events: 10 (Early dressing removal), 19 (Delayed dressing removal)					
Heterogeneity: Tau^2=0; Chi^2=0.72, df=2(P=0.7); I^2=0%					
Test for overall effect: Z=1.75(P=0.08)					
1.6.3 Best-worst scenario					
Ajao 1977	9/50	14/50		72.22%	0.64[0.31,1.35]
Dosseh 2008	1/51	4/54		20.04%	0.26[0.03,2.29]
Ramkumar 2006	0/39	1/39		7.74%	0.33[0.01,7.94]
Subtotal (95% CI)	**140**	**143**		**100%**	**0.54[0.27,1.07]**
Total events: 10 (Early dressing removal), 19 (Delayed dressing removal)					
Heterogeneity: Tau^2=0; Chi^2=0.72, df=2(P=0.7); I^2=0%					
Test for overall effect: Z=1.75(P=0.08)					
1.6.4 Worst-best scenario					
Ajao 1977	9/50	14/50		85%	0.64[0.31,1.35]
Dosseh 2008	1/51	1/54		5.9%	1.06[0.07,16.48]
Ramkumar 2006	0/39	1/39		9.11%	0.33[0.01,7.94]
Subtotal (95% CI)	**140**	**143**		**100%**	**0.64[0.32,1.28]**
Total events: 10 (Early dressing removal), 16 (Delayed dressing removal)					
Heterogeneity: Tau^2=0; Chi^2=0.29, df=2(P=0.86); I^2=0%					
Test for overall effect: Z=1.26(P=0.21)					
Test for subgroup differences: Chi^2=0.21, df=1 (P=0.98), I^2=0%					



Favours early removal — Favours delayed removal

Analysis 1.7. Comparison 1 Early versus delayed dressing removal, Outcome 7 Superficial wound dehiscence within 30 days (sensitivity analysis).



APPENDICES

Appendix 1. Classification of surgical wounds

Clean wound

- Uninfected operative wounds
- No inflammation is encountered
- Respiratory, alimentary, genital or uninfected urinary tracts are not entered
- Primarily closed

(Continued)

Clean-contaminated wound

- Respiratory, alimentary, genital or urinary tract is entered under controlled conditions
- Without unusual contamination
- No evidence of infection or major break in sterile technique is encountered

Contaminated wound

- Open, fresh accidental wounds or operations with major breaks in sterile technique or gross spillage from the gastrointestinal tract or incisions in which acute, non-purulent inflammation is encountered

Dirty wound

- Old traumatic wounds with retained devitalised tissue or those that involve existing clinical infection or perforated viscera (i.e. the organisms causing postoperative infection were present in the operative field before the operation)

Appendix 2. Search strategies for Ovid MEDLINE, Ovid EMBASE and EBSCO CINAHL

Ovid MEDLINE

1 exp Bandages/ (9807)
2 (dressing* or hydrocolloid* or alginate* or hydrogel* or foam or bead or film or films or tulle or gauze or non-adherent or non adherent or silver or honey or matrix).tw. (240450)
3 or/1-2 (246412)
4 exp Surgical Wound Infection/ (11510)
5 exp Surgical Wound Dehiscence/ (2940)
6 (surg* adj5 infect*).tw. (10880)
7 (surg* adj5 wound*).tw. (5622)
8 (surg* adj5 site*).tw. (7971)
9 (surg* adj5 incision*).tw. (4199)
10 (surg* adj5 dehiscen*).tw. (369)
11 (wound* adj5 infect*).tw. (12760)
12 (wound* adj5 dehiscen*).tw. (1771)
13 or/4-12 (42204)
14 3 and 13 (2416)
15 randomized controlled trial.pt. (238104)
16 controlled clinical trial.pt. (39335)
17 randomized.ab. (193802)
18 placebo.ab. (90703)
19 clinical trials as topic.sh. (79028)
20 randomly.ab. (133232)
21 trial.ti. (71766)
22 or/15-21 (538944)
23 (animals not (humans and animals)).sh. (1600596)
24 22 not 23 (490866)
25 14 and 24 (338)

Ovid EMBASE

1 exp "bandages and dressings"/ (19981)
2 (dressing* or hydrocolloid* or alginate* or hydrogel* or foam or bead or film or films or tulle or gauze or non-adherent or non adherent or silver or honey or matrix).tw. (338426)
3 or/1-2 (352047)
4 exp surgical infection/ (14084)
5 exp wound dehiscence/ (6698)
6 (surg* adj5 infect*).tw. (16176)
7 (surg* adj5 wound*).tw. (7956)
8 (surg* adj5 site*).tw. (11964)
9 (surg* adj5 incision*).tw. (6371)

10 (surg* adj5 dehiscen*).tw. (513)
11 (wound* adj5 infect*).tw. (18470)
12 (wound* adj5 dehiscen*).tw. (2527)
13 or/4-12 (62660)
14 3 and 13 (3718)
15 Randomized controlled trials/ (22561)
16 Single-Blind Method/ (15215)
17 Double-Blind Method/ (84665)
18 Crossover Procedure/ (31187)
19 (random$ or factorial$ or crossover$ or cross over$ or cross-over$ or placebo$ or assign$ or allocat$ or volunteer$).ti,ab. (918967)
20 (doubl$ adj blind$).ti,ab. (88438)
21 (singl$ adj blind$).ti,ab. (9428)
22 or/15-21 (951325)
23 animal/ (716482)
24 human/ (8445003)
25 23 not 24 (478203)
26 22 not 25 (919579)
27 14 and 26 (506)

EBSCO CINAHL

S15 S3 and S14
S14 S4 or S5 or S6 or S7 or S8 or S9 or S10 or S11 or S12 or S13
S13 TI wound* N5 dehiscen* or AB wound* N5 dehiscen*
S12 TI wound* N5 infection* or AB wound* N5 infection*
S11 TI surg* N5 dehiscen* or AB surg* N5 dehiscen*
S10 TI surg* N5 incision* or AB surg* N5 incision*
S9 TI surg* N5 site* or AB surg* N5 site*
S8 TI surg* N5 wound* or AB surg* N5 wound*
S7 TI surg* N5 infection* or AB surg* N5 infection*
S6 (MH "Surgical Wound")
S5 (MH "Surgical Wound Dehiscence")
S4 (MH "Surgical Wound Infection")
S3 S1 and S2
S2 TI (dressing* or hydrocolloid* or alginat* or hydrogel or foam* or bead or gauze or tulle or film or films or gauze or non-adherent or non adherent * or silver or honey or matrix) or AB (dressing* or hydrocolloid* or alginat* or hydrogel or foam* or bead or gauze or tulle or film or films or gauze or non-adherent or non adherent * or silver or honey or matrix)
S1 (MH "Bandages and Dressings+")

Trial registries (mRCT and ICTRP)

early AND dressing

Appendix 3. Search strategy for original review

In July 2013 we searched the following electronic databases to identify reports of relevant randomised clinical trials:

- Cochrane Wounds Group Specialised Register (searched 11 July 2013);
- The Cochrane Central Register of Controlled Trials (CENTRAL) (2013, Issue 6);
- Database of Abstracts of Reviews of Effects (DARE) (2013, Issue 6);
- Ovid MEDLINE (1948 to July Week 1 2013);
- Ovid MEDLINE (In-Process & Other Non-Indexed Citations, 10 July 2013);
- Ovid EMBASE (1980 to 2013 Week 27);
- EBSCO CINAHL (1982 to 5 July 2013)

The search strategies for Ovid MEDLINE, Ovid EMBASE and EBSCO CINAHL can be found in Appendix 1. We combined the Ovid MEDLINE search with the Cochrane Highly Sensitive Search Strategy for identifying randomised trials in MEDLINE: sensitivity- and precision-maximising version (2008 revision) (Lefebvre 2011). We combined the EMBASE and CINAHL searches with the trial filters developed by the Scottish Intercollegiate Guidelines Network (SIGN 2013). We did not restrict studies with respect to language, date of publication or study setting.

We searched the *meta*Register of Controlled Trials (mRCT) (http://www.controlled-trials.com/mrct/) and ICTRP (International Clinical Trials Registry Platform) portal maintained by the World Health Organization (http://apps.who.int/trialsearch/). The meta-register includes the

ISRCTN Register and NIH ClinicalTrials.gov Register among other registers. The ICTRP portal includes these trial registers along with trial registry data from a number of countries.

We searched the references of included trials to identify additional relevant trials. We contacted the suture manufacturers Johnson and Johnson, and 3M about any trials that they had conducted.

WHAT'S NEW

Date	Event	Description
25 March 2015	New citation required but conclusions have not changed	New author added. No change to conclusions.
25 March 2015	New search has been performed	fist update, new search, no new trials identified.

CONTRIBUTIONS OF AUTHORS

Protocol

Rajarajan Ramamoorthy developed the protocol, completed the first draft of the protocol, performed part of the writing or editing, made an intellectual contribution, and approved the final version prior to submission.¬
Brian Davidson conceived the review question, secured funding, made an intellectual contribution, advised on the protocol, and approved the final version prior to submission.¬
Kurinchi Gurusamy conceived the review question, developed the protocol, co-ordinated protocol development, secured funding, performed part of the writing or editing of the protocol, made an intellectual contribution, advised on the protocol, and approved the final version prior to submission.

Review

Clare Toon developed the review, completed the first draft, performed part of the writing or editing of the review, made an intellectual contribution and approved the final version prior to submission.
Rajarajan Ramamoorthy made an intellectual contribution and approved the final version prior to submission.¬
Brian Davidson conceived the review question, secured funding, made an intellectual contribution, advised on the review and approved the final version prior to submission.¬
Kurinchi Gurusamy developed the review, co-ordinated review development, secured funding, performed part of the writing or editing of the review, made an intellectual contribution, advised on the review, approved the final version prior to submission, and is guarantor of the review.

Update

Kurinchi Gurusamy screened the search results, assessed full text articles, edited and approved the final updated review version prior to submission, and is guarantor of the review.
Charnelle Lusuku screened the search results, retrieved articles for assessment and edited the updated review.

Contributions of editorial base

Nicky Cullum: edited the protocol; advised on methodology, interpretation and protocol content. Approved the final protocol prior to submission.
Joan Webster, Editor: approved the final review prior to submission.
Sally Bell-Syer: co-ordinated the editorial process. Advised on methodology, interpretation and content. Edited the protocol,review and updated review.
Ruth Foxlee: designed the search strategy and edited the search methods section.
Rachel Richardson: edited the review.

DECLARATIONS OF INTEREST

Clare D Toon: none known
Charnelle Lusuku: none known
Rajarajan Ramamoorthy: none known
Brian R Davidson: none known
Kurinchi Selvan Gurusamy: none known

SOURCES OF SUPPORT

Internal sources

- No sources of support supplied

External sources

- National Institute for Health Research (NIHR - UK Government organisation for health research), UK.

  NIHR provides financial support for K Gurusamy for completing the review
- NIHR / Department of Health (England), (Cochrane Wounds Group), UK.

INDEX TERMS

Medical Subject Headings (MeSH)

*Bandages [adverse effects] [statistics & numerical data]; *Surgical Wound Infection [epidemiology]; *Wound Closure Techniques; *Wound Healing; Early Medical Intervention; Hospital Costs; Length of Stay; Randomized Controlled Trials as Topic; Surgical Wound Dehiscence [epidemiology]; Time Factors

MeSH check words

Humans