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[Intervention Review]

Removal of nail polish and finger rings to prevent surgical infection

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ABSTRACT

Background

Surgical wound infections may be caused by the transfer of bacteria from the hands of surgical teams to patients during operations. Surgical scrubbing prior to surgery reduces the number of bacteria on the skin, but wearing rings and nail polish on the fingers may reduce the efficacy of scrubbing, as bacteria may remain in microscopic imperfections of nail polish and on the skin beneath rings.

Objectives

To assess the effect of the presence or absence of rings and nail polish on the hands of the surgical scrub team on postoperative wound infection rates.

Search methods

For this fifth update, we searched The Cochrane Wounds Group Specialised Register (searched 23 July 2014); The Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library*); Ovid MEDLINE; Ovid MEDLINE (In-Process & Other Non-Indexed Citations); Ovid EMBASE and EBSCO CINAHL.

Selection criteria

Randomised controlled trials (RCTs) evaluating the effect of wearing or removing finger rings and nail polish on the efficacy of the surgical scrub and postoperative wound infection rate.

Data collection and analysis

All abstracts were checked against a checklist to determine whether they fulfilled the inclusion criteria. Full reports of relevant studies were obtained. Excluded trial reports were checked by all review authors to ensure appropriate exclusion.

Main results

We identified: no new trials; no RCTs that compared wearing of rings with the removal of rings; and no trials of nail polish versus no nail polish that measured surgical infection rates.

We found one small RCT (102 scrub nurses) that evaluated the effect of nail polish on the number of bacterial colony forming units left on hands after pre-operative surgical scrubbing. Nurses had either unpolished nails, freshly-applied nail polish (less than two days old), or old nail polish (more than four days old). There were no significant differences in the number of bacteria on hands between the groups before and after surgical scrubbing.

Authors' conclusions

No trials have investigated whether wearing nail polish or finger rings affects the rate of surgical wound infection. There is insufficient evidence to determine whether wearing nail polish affects the number of bacteria on the skin post-scrub.

PLAIN LANGUAGE SUMMARY**No evidence to show whether removing nail polish and finger rings prevents wound infection after surgery**

People having surgery can get a serious wound infection from bacteria (germs) on the hands of operating theatre staff (doctors, nurses, and assistants). Theatre staff scrub their hands intensively before operations to reduce the number of bacteria on them. It may be that nail polish (varnish) and rings (jewellery) hide bacteria and reduce the effectiveness of hand scrubbing. This review could not locate any trials that investigated the effect of theatre staff wearing rings, but did find one small trial that investigated the number of bacteria before and after scrubbing on the hands of theatre staff with varnished and unvarnished nails. This trial did not identify any clear differences between the number of bacteria on varnished and unvarnished nails, but evidence from more trials is required before we can be certain that this is a true result.

BACKGROUND

It has been estimated that approximately one in ten patients in acute hospital settings have a hospital-acquired infection (HAI). In addition, an unquantifiable number of patients discharged from hospital into the community have an infection related to their hospital stay (NINSS 1999).

Analysing the cost of HAIs is complex. The cost to the patient may range from a few extra days absence from work, to considerable pain and immobility, while the social and economic burdens of lost earnings and productivity - as well as social security payments - attributable to HAIs are difficult to quantify (NINSS 1999). Deaths from HAIs are also difficult to quantify because infection may be one of several contributory factors (Wilson 1995). As previously mentioned, studies have indicated that one in ten patients in acute hospitals have an HAI, and, assuming that England has a similar mortality rate to that in the USA, it is estimated that one per cent of these patients will die as a direct result of their infection, and that HAIs will be a contributory cause in the deaths of a further three per cent (NINSS 1999). In addition, the direct and indirect cost of hospital treatment must also be considered. Patients with HAIs may require further surgery, additional nursing care, drug therapy and consumables. HAIs also increase the length of hospital stay by an average of four to ten days, and so prevent the admission of other patients needing care and treatment (Wilson 1995). It has been calculated that a ten per cent reduction in the incidence rate of HAIs in England would deliver a £93 million saving in expenditure (Plowman 1999). The National Priorities Guidance (1999/00-2001/02) emphasised the obligation of the National Health Service to ensure the continuing and effective protection of the public's health against communicable disease, including HAIs (NINSS 1999). This review of finger rings and nail polish, may contribute to the development of effective guidelines and policies on HAIs.

Surgical wound infection accounts for up to 20% of all HAIs, most of which occur because of microbial contamination of the wound during surgery (Ayliffe 1999). The incidence of surgical infection varies according to surgical site and between hospitals (NINSS 1999). Infections may derive from the resident flora or transient microbiological flora found on the hands of health care workers (Wilson 1995). Resident flora are microbes that live deep in the crevices of the skin, in hair follicles and sebaceous glands. Transient flora are microbes acquired on the surface of the skin through contact with other people, objects, or the environment (Price 1938; Wilson 1995). The composition of transient flora varies, but reflects the extent of contact with patients, their environments, and the micro-organisms that are prevalent (Wilson 1995).

Generally, it is recognised that the hands of hospital staff are the most common vehicles by which micro-organisms are transmitted between patients (Gould 1997; Kerr 1998; May 1998), although Ayliffe 1999 suggested that there was little statistical evidence to support this view. Despite this view, Ayliffe 1999 also concurred that hand washing or disinfection is the most important technique for prevention of cross-infection.

Pathogenic micro-organisms are acquired in the greatest number when handling moist, heavily-contaminated substances such as body fluids. These fluids frequently contain large numbers of micro-organisms, and are a major source of the pathogens that cause HAIs. Team members within the environment of the operating

theatre are frequently, and routinely, exposed to a variety of potentially pathogenic micro-organisms during the handling body fluids, specimens and contaminated instruments. These, alongside the resident skin flora on the hands of the theatre team, put staff at risk of transmitting infection to patients, and are of particular concern at the surgical scrub stage in the surgical procedure.

Prior to surgical procedures, a particular form of hand washing - the surgical scrub - is used before putting on sterile surgical gloves. Most people use antiseptic formulations for surgical scrubbing that are highly effective in removing or destroying bacteria that might pass through punctured or damaged gloves during surgery (Ayliffe 1999). It is believed that the presence of finger rings and nail polish (also called nail varnish) may reduce the efficacy of the scrub, because an increased number of micro-organisms may be harboured in the microscopic imperfections on the surface of nail polish and on the skin beneath rings. Rings may also harbour bacteria, and rip surgical gloves. As a result, the reluctance of theatre staff to remove rings or nail polish is an issue.

There is a lack of uniformity in guidelines and policies regarding the optimum technique for scrubbing (AORN 1999), specifically scrubbing agent, duration of hand scrubbing, nail length, and whether wearing nail polish and rings on the fingers is acceptable. If we can identify evidence for an association between the removal of finger rings, and nail polish, and a subsequent reduction in the number of surgical wound infections, the potential benefit for patients could be high, whilst the cost of changing clinical practice would be comparatively low.

OBJECTIVES

To assess the effect of the presence or absence of rings and nail polish on the hands of the surgical team on postoperative wound infection rates.

METHODS

Criteria for considering studies for this review

Types of studies

Randomised controlled trials (RCTs).

Types of participants

Those members of the theatre team who scrub for invasive operative procedures: surgeons, anaesthetists, surgeon's assistants, scrub nurses, operating department practitioners, and scrubbed observers, in any country.

Types of interventions

Removal or absence of nail polish (varnish) compared with wearing nail polish.

Newly applied nail polish compared with old nail polish.

Removal or absence of finger rings compared with the wearing of finger rings.

Types of outcome measures

Primary outcomes

Incidence of surgical wound infections.

Secondary outcomes

- Numbers of micro-organisms on the hands of the surgical team after the surgical scrub.
- Numbers of micro-organisms on the hands of the surgical team after the surgical procedure.
- Patient mortality.
- Acceptability of finger ring removal to theatre team.
- Length of stay in hospital.

Search methods for identification of studies

The search methods used in the previous update of this review are shown in [Appendix 1](#)

Electronic searches

For this fifth update, the following databases were searched:

- The Cochrane Wounds Group Specialised Register (searched 23 July 2014);
- The Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2014, Issue 5);
- The NHS Economic Evaluation Database (NHS EED) (*The Cochrane Library* 2014, Issue 2);
- Ovid MEDLINE (1946 to July Week 34 2014);
- Ovid MEDLINE (In-Process & Other Non-Indexed Citations July 22, 2014);
- Ovid EMBASE (1974 to July 02, 2014);
- EBSCO CINAHL (1982 to 03 July 2014)

The following search strategy was used in CENTRAL:

- ```
#1 MeSH descriptor Handwashing explode all trees
#2 surg* NEAR/5 scrub*
#3 hand* NEAR/5 (scrub* or wash* or clean*)
#4 MeSH descriptor Nails explode all trees
#5 nail NEXT (polish or varnish)
#6 finger NEAR/5 ring*
#7 jewel*ry
#8 (#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7)
#9 MeSH descriptor Surgical Wound Infection explode all trees
#10 MeSH descriptor Surgical Wound Dehiscence explode all trees
#11 surg* NEAR/5 infection*
#12 surg* NEAR/5 wound*
#13 (postoperative or post-operative) NEAR/5 infection*
#14 (#9 OR #10 OR #11 OR #12 OR #13)
#15 (#8 AND #14)
```

The search strategies for Ovid MEDLINE, Ovid EMBASE and EBSCO CINAHL can be found in [Appendix 2](#), [Appendix 3](#) and [Appendix 4](#) respectively. The Ovid MEDLINE search was combined with the Cochrane Highly Sensitive Search Strategy for identifying randomised trials in MEDLINE: sensitivity- and precision-maximizing version (2008 revision); Ovid format ([Lefebvre 2011](#)). The EMBASE and CINAHL searches were combined with the trial filters developed by the Scottish Intercollegiate Guidelines Network ([SIGN 2011](#)). There was no restriction by language or publication status.

## Data collection and analysis

### Selection of studies

All review authors scanned the abstracts of studies identified from the electronic searches, hand searches, bibliographic searching, and manufacturers' information. We checked all abstracts against a checklist to determine whether they fulfilled the inclusion criteria. We obtained full papers of those articles that were definitely, or potentially, relevant to the review. Two authors independently checked these full papers for inclusion. Each author independently checked all the excluded abstracts and papers to ensure that exclusions were appropriate.

We used a checklist to determine inclusion criteria. In order to be included in the review a trial report had to include the following features:

- RCT trial design.
- Investigate either the presence or absence of finger rings or the presence or absence of nail polish.
- Outcome measures to include either wound infection rate, or number of bacteria on hands after hand scrubbing.

No new studies were identified in any of the four updates of this review.

### Data extraction and management

Two review authors independently extracted and cross-checked the following data from the trials:

- Type of theatre personnel.
- Intervention characteristics, e.g. presence or absence of nail polish or finger ring.
- Baseline comparability.
- Scrubbing solution or agents.
- Use of brushes or nail picks.
- Duration of surgical scrub.
- Technique of surgical scrub.
- Skin integrity.
- Number of postoperative infections in patients.
- Unit of randomisation and analysis.
- Other outcomes.
- Number and reason for withdrawals.

Any disagreement was resolved by discussion with the full review team. Where details were missing from trial reports, attempts were made to obtain them by contacting the trial authors. Should any studies that are published in duplicate be identified, they will be included only once.

### Assessment of risk of bias in included studies

Risk of bias was assessed using the Cochrane Collaboration tool ([Higgins 2011](#)), which addresses six domains: sequence generation, allocation concealment, blinding, incomplete outcome data, selective outcome reporting, and other issues (e.g. extreme baseline imbalance). The risk of bias information for the one included study ([Wynd 1994](#)) is presented in [Characteristics of included studies](#) (see also [Figure 1](#)).

**Figure 1. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.**

### Measures of treatment effect

Data were entered into and analysed using Cochrane RevMan software. Results were presented with 95% confidence intervals (CI). Estimates for dichotomous outcomes would be reported as relative risk (RR). Continuous data were reported as mean difference and overall effect size (with 95% CI) were calculated.

Methods of synthesising the studies will depend on their quality, design and heterogeneity.

### Assessment of heterogeneity

Both clinical and statistical heterogeneity were explored. We will assess heterogeneity between study results using the  $I^2$  statistic (Higgins 2003). This examines the percentage of total variation across studies due to heterogeneity rather than to chance. Values of  $I^2$  over 75% indicate a high level of heterogeneity. Where pooling is appropriate and in the absence of clinical and statistical heterogeneity a fixed effect model will be applied to pool data. In the presence of statistical heterogeneity (as estimated by the  $I^2$ ) a random effects model would be applied for meta-analysis. Where synthesis was inappropriate we undertook a narrative overview.

## RESULTS

### Description of studies

#### Results of the search

We found no randomised controlled trials, controlled trials, cohort, or case controlled studies, that compared the wearing of finger rings with their removal. One eligible, randomised controlled trial

(RCT) was identified that compared unpolished nails, freshly-applied polish and old, or chipped, nail polish. The following manufacturers of surgical scrubbing solutions were contacted to request reports of any trials they might know of: Seton Healthcare Group PLC (Betadine Surgical Scrub), Zeneca Ltd (Hibiscrub), Maxime Medical Europe (Chlorhexidine Gluconate 4% in detergent impregnated brushes, PCMX 3%, PVP Iodine in detergent), Diversey Lever (Alcohol gel hand rub), but no further trials were identified as a result of this effort.

The searches for the updates of this review did not identify any further relevant trials. Manufacturers have been contacted, but no further trials have been identified from their replies to date.

### Included studies

Only one eligible RCT was identified for the first publication of this review (Wynd 1994), and no new studies have been identified since. This included study was conducted in Cleveland Clinic Foundation, USA. Participants were a convenience sample of 102 scrub nurses. (The necessary sample size was estimated from previous studies.) Scrub nurses are nurses who scrub surgically, wear sterilised gloves and clothing, and work as part of the surgical scrub team. In the trial, subjects were randomly assigned to three groups: freshly-polished fingernails, chipped nail polish, or unpolished fingernails. The trialists defined fresh nail polish as having been applied to the hands within a two-day time span. Old, or chipped, nail polish was defined as either obviously chipped, or applied to the hands four days before data collection and fingernail culturing. Unpolished fingernails were fingernails that had not been polished within the four-day period before data collection and fingernail culturing.



Participants complied with instructions on fingernail preparation contained in the envelopes assigned to them, and the number of bacteria cultured from each of the groups was compared. The process of data collection and fingernail culturing was timed to take place immediately prior to surgery.

Only the dominant hands of subjects were assessed, and nails were swabbed to determine the number of bacteria on them (measured in colony forming units (CFUs)) both before and after the surgical scrub. Although numbers of CFUs were measured, postoperative wound infection rates were not reported. Logarithmic representations of numbers of bacteria are commonly used to express this type of result, since the number of bacteria on a single swab is enormous, and can number millions of CFUs. One-hundred colony-forming units are expressed as  $1 \times 10^2$  CFUs (one-hundred is equal to 10 squared (counted and recorded as  $\log_{10}$  CFUs by Wynd 1994)). Wynd 1994 estimated that there was an 80% chance of detecting a three-log reduction in the number of bacteria on the hands of nurses (at  $P < 0.05$ ). This size of effect would equate to, for example, a reduction from  $1 \times 10^6$  CFUs to  $1 \times 10^3$  CFUs, i.e. from one-million CFUs to one-thousand CFUs.

The study was carried out in the clinical area with participants who had scrubbed on a daily basis for at least two weeks before entering the study. Only the participants' dominant hands were sampled. The justification for not sampling both hands was stated as being insufficient time, though the additional time required to conduct tests on both hands by the trialists would have been minimal. Logic suggests that participants would prepare both hands as a matter of course and that the sampling of both might have produced a more valid data set, as there could be differences in between the dominant and non-dominant hand following surgical scrub.

All participants were required to undertake a "modified surgical scrub" which consisted of a set of instructions indicating precisely how the scrub should be conducted, however, this may be different to normal operating theatre technique. Different pharmacological surgical scrubbing solutions were used by participants in the study, and standardisation in this respect would have produced results of greater consistency. The timing at which the post-scrub specimen was taken was not made explicit, and this may have had an impact upon the numbers of CFUs recorded by the trialists. Staged sampling over pre-determined periods might have produced more informative results with greater value and consistency.

A surgical scrub observation tool was developed to monitor the performance of participants conducting the modified surgical scrub. The pilot test of the observation tool was tested on ten subjects for inter-rater reliability. The Pearson product moment correlation co-efficient was used to analyse the results, but requires greater numbers of pairings than the pilot test was able to provide. In addition, although this test is appropriate for establishing correlation, it does not establish that the observers are measuring the same actions in the performance of participant scrub, and thus was not an appropriate test.

The table produced from the pilot of ten subjects indicated that nine people did not score well against the prescribed surgical scrub criteria. Despite this, Wynd 1994 stated that surgical scrub performance was not a factor affecting outcomes, though no rationale was offered for this conclusion. The trial authors also stated that vigorous hand washing and nail brushing may generally

be avoided by practitioners in an effort to protect nail polish and expensive manicures, and that this may affect outcomes. Wynd 1994 state that 30% of the nurses across all three groups had a statistically insignificant increase in numbers of CFUs following the surgical hand scrub. Increased bacterial counts following surgical scrubbing has been reported, and may be due to release of organisms from the subungual spaces, and Wynd 1994 highlighted this. The trial authors also suggested that it could result from mechanical disturbance and transfer of bacteria from hands to culture mediums.

As CFUs are a proxy measure for possible patient outcomes, the significance for patients was not made clear in the study, although Wynd 1994 assert that a three-log reduction is clinically significant. Wynd 1994 correlated nail length and bacterial counts using the Spearman correlation analysis for both pre- and post-scrub and within each of the three subject groups, and stated that no significant correlations were revealed.

No dropouts were recorded.

### Excluded studies

Six studies were retrieved in full but were not eligible for inclusion. Five were not randomised (Edel 1998; Hoffman 1985; Jacobson 1985; Nicholson-Pegg 1982; Salisbury 1997); and one did not indicate that a surgical hand scrub was performed (Baumgardner 1993). Full reasons for exclusion are given in the Characteristics of excluded studies table.

### Risk of bias in included studies

Randomisation was by sealed envelopes prepared by a biostatistician; it was not stated how the randomisation sequence had been generated. It was also unclear whether allocation was concealed. The trial report did not state whether the envelopes used were sequentially-numbered or opaque. Due to the nature of the comparison groups (freshly polished fingernails, old or chipped nail polish, or unpolished fingernails), blinding of participants was not possible; nor was it possible to blind the personnel taking the swabs. It was unclear whether the outcome assessors were blind to the comparison groups under investigation. Data were available for all randomised participants and for the pre-specified outcome (bacterial colonies) (Figure 1).

### Effects of interventions

Only one RCT comparing unpolished nails, freshly-applied polish and old or chipped nail polish was found. Wynd 1994 compared the bacterial load on the nails of 102 scrub nurses randomly assigned to unpolished nails (34 nurses), freshly-polished nails (34 nurses) or old, or chipped, polished nails (34 nurses). The mean values of the bacterial load are shown in Table 1. In the freshly-polished nails group the data obtained from the sample were skewed because one participant carried a large number of CFUs before the scrub. No indications were given about why this might have occurred. Due to large deviations in mean bacterial CFUs, median counts were examined by the trialists who reported no significant differences in pre-scrub (i.e. baseline) readings ( $P$  value 0.122) among the three groups. The median values were not, however, given in the trial report.



Comparing the mean values we found no difference between the pre-scrub bacterial loads, expressed as CFUs ([Analysis 1.1](#); [Analysis 2.1](#); [Analysis 3.1](#)).

Post-surgical scrub values of bacterial load (CFUs) are probably more important clinically than pre-scrub values as they indicate the potentially available reservoir of bacteria that can be transferred to the patient via perforations in gloves or other breaches of sterile technique.

#### **Post-scrub: unpolished nails compared with freshly-polished nails**

The trialists concluded that freshly-polished nails, compared with natural (unpolished) nails had a lower bacterial load, however, comparing the mean values, we found no statistically significant difference (154 versus 438; mean difference (MD) -284; 95% CI -692 to 124) ([Analysis 1.1](#)).

#### **Post-scrub: unpolished nails compared with chipped polished nails**

Comparing the mean colonies of CFUs, we found no statistically significant difference between the groups (895 versus 438; MD 457; 95% CI -456 to 1370) ([Analysis 2.1](#)).

#### **Post-scrub: freshly-polished nails compared with chipped polished nail**

Comparing the mean colonies of CFUs, we found no statistically significant difference between the groups (154 versus 895; MD -741; 95% CI -1582 to 100) ([Analysis 3.1](#)).

## **DISCUSSION**

There is currently no evidence of the effect of nail polish and finger ring wearing on postoperative wound infection. A single, small study, comparing chipped and fresh nail polish with unpolished nails collected data only on the bacterial colonisation of the dominant hand and found no statistically significant differences. This trial was underpowered for detection of clinically important differences in colonisation.

## **AUTHORS' CONCLUSIONS**

### **Implications for practice**

There is insufficient trial evidence concerning the impact of no nail polish, or fresh, or chipped nail polish on bacterial density on the

finger nails of scrubbed personnel within operating theatres to draw any conclusions. There are no RCTs that assess surgical wound infection rates when surgical scrub personnel wear, or remove, finger rings or nail polish. Given the lack of evidence for either the safety or the harm that may be associated with nail polish and finger rings, health care organisations must continue to develop institutional policies based on expert opinion.

### **Implications for research**

Well-designed randomised controlled trials are needed to evaluate the effect of scrubbed personnel wearing finger rings and nail polish. Primary outcome measures should include those of clinical significance, especially surgical infection rates. Trials should be adequately powered to detect any difference in the incidence of surgical wound infection as statistically significant. In addition, trials should have adequate methods of generating the randomisation sequence, should ensure allocation is concealed and that outcome assessors are blinded. Interventions should be well defined and the acceptability of the interventions to staff should also be evaluated.

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## REFERENCES

### References to studies included in this review

#### Wynd 1994 {published data only}

Wynd CA, Samstag D, Lapp AM. Bacterial carriage on the fingernails of OR nurses. *AORN* November 1994;**60**(5):796-805.

### References to studies excluded from this review

#### Baumgardner 1993 {published data only}

Baumgardner CA, Maragos CS, Walz MJ, Larson E. Effects of nail polish on microbial growth of fingernails. *AORN* 1993;**58**(1):84-8.

#### Edel 1998 {published data only}

Edel E, Houston S, Kennedy V, LaRocco M. Impact of a 5-minute scrub on the microbial flora found on artificial, polished, or natural fingernails of operating room personnel. *Nursing Research* 1998;**47**(1):54-9.

#### Hoffman 1985 {published data only}

Hoffman PN, Cooke EM, McCarville MR, Emmerson AM. Micro-organisms isolated from skin under wedding rings worn by hospital staff. *British Medical Journal* 1985;**290**(6453):206-7.

#### Jacobson 1985 {published data only}

Jacobson G, Thiele JE, McCune JH, Farrell LD. Handwashing: ring wearing and number of microorganisms. *Nursing Research* 1985;**34**(3):186-8.

#### Nicholson-Pegg 1982 {published data only}

Nicholson-Pegg A. The wearing of wedding rings in the operating department. *National Association of Theatre Nurses News* 1982;**19**(4):19-25.

#### Salisbury 1997 {published data only}

Salisbury DM, Hutfilz P, Treen LM, Bollin GE, Gautam S. The effect of rings on microbial load of health care workers' hands. *American Journal of Infection Control* 1997;**25**(1):24-7.

### Additional references

#### AORN 1999

AORN (Association of Operating Room Nurses). Recommended practices for surgical handscrub. *AORN Journal* 1999;**69**(4):842, 845, 846, 848-50.

#### Ayliffe 1999

Ayliffe GAJ, Babb JR, Taylor LJ. Hospital acquired infection. Principles and prevention. 3rd Edition. London: Butterworth, 1999.

#### Gould 1997

Gould D. Handwashing. *Nursing Times* 1997;**93**(37 Suppl):1-2.

#### Higgins 2003

Higgins JPT, Thompson, SG, Deeks, JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ* 2003;**327**(7414):557-60.

#### Higgins 2011

Higgins JPT and Altman DG on behalf of the Cochrane Statistical Methods Group and the Cochrane Bias Methods Group (Editors). Chapter 8: Assessing risk of bias in included studies. In: Higgins JPT, Green S (editors). *Cochrane Handbook for Systematic Reviews of Interventions* Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from [www.cochrane-handbook.org](http://www.cochrane-handbook.org).

#### Kerr 1998

Kerr J. Handwashing. *Nursing Standard* 1998;**12**(51):35-42.

#### Lefebvre 2011

Lefebvre C, Manheimer E, Glanville J, on behalf of the Cochrane Information Retrieval Methods Group. Chapter 6: Searching for studies. In: Higgins JPT, Green S (editors). *Cochrane Handbook for Systematic Reviews of Interventions* Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from [www.cochrane-handbook.org](http://www.cochrane-handbook.org).

#### May 1998

May H. Now wash your hands. *Nursing Times* 1998;**94**(4):63-6.

#### NINSS 1999 [Computer program]

NINSS (Nosocomial Infection National Surveillance Scheme). Analysis of a years surveillance in English Hospitals 1997-1998. Public Health Laboratory Service [www.phls.co](http://www.phls.co), 1999.

#### Plowman 1999

Plowman R, Graves N, Griffin M, Roberts JA, Swan AV, Cookson B, et al. The socio-economic burden of hospital acquired infection. Public Health Laboratory Service 1999.

#### Price 1938

Price PB. The classification of transient and resident microbes. *Journal of Infectious Disease* 1938;**63**:301-8.

#### SIGN 2011

Scottish Intercollegiate Guidelines Network (SIGN). Search filters. <http://www.sign.ac.uk/methodology/filters.html#random> 2011.

#### Wilson 1995

Wilson J. Infection control in clinical practice. London: Balliere Tindall, 1995.

## CHARACTERISTICS OF STUDIES

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

## Wynd 1994

|               |                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Methods       | RCT with three arms using natural nails as a control. Randomised using envelopes. Convenience sample, i.e. only dominant hand tested.                                                                                                                                                                                                                                                                |
| Participants  | 102 placed randomly in 3 groups of 34. Circulating and scrub nurses. No attempt to standardise nail length. Surgical scrub observation test based on a modified hand scrub protocol applied to attempt to standardise procedure. The process of data collection and fingernail culturing was timed to take place immediately prior to surgery.                                                       |
| Interventions | Group 1: fresh nail polish applied within 2 days.<br>Group 2: chipped nail polish applied 4 days before data collection.<br>Group 3: natural nails that had been unpolished during the previous 4 days.                                                                                                                                                                                              |
| Outcomes      | Nails swabbed for CFUs pre- and post-surgical scrub, using sterile cotton-tipped applicators.                                                                                                                                                                                                                                                                                                        |
| Notes         | Wynd used the Wilcoxon rank sum test because the data were not normally distributed.<br>Multiple pairwise (Dunn procedure) for median counts.<br>Spearman's correlation analysis was used to analyse correlation between bacterial load and nail length.<br>Pearson's product moment correlation coefficient was used to analyse agreement between data in the pilot test on scrub observation tool. |

### Risk of bias

| Bias                                                                            | Authors' judgement | Support for judgement                                                                                                                                      |
|---------------------------------------------------------------------------------|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Random sequence generation (selection bias)                                     | Unclear risk       | Exact randomisation procedure not reported: "random assignment was accomplished with a randomisation scheme using envelopes prepared by biostatisticians". |
| Allocation concealment (selection bias)                                         | Unclear risk       | See above - not reported                                                                                                                                   |
| Blinding (performance bias and detection bias)<br>Blinding of outcome assessors | Unclear risk       | "Cultures were sent to the microbiology laboratory for incubation and analysis".                                                                           |
| Incomplete outcome data (attrition bias)<br>All outcomes                        | Low risk           | Study data available for all recruited participants (no attrition).                                                                                        |
| Selective reporting (reporting bias)                                            | Low risk           | Pre-specified outcomes reported.                                                                                                                           |
| Other bias                                                                      | Low risk           | "...median counts were examined and revealed no significant differences among the three groups' pre-scrub readings..."                                     |

### Abbreviations

CFUs = colony forming units

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



## Comparison 2. 02 Unpolished nails versus chipped polished nails

| Outcome or subgroup title                        | No. of studies | No. of participants | Statistical method                  | Effect size         |
|--------------------------------------------------|----------------|---------------------|-------------------------------------|---------------------|
| 1 Average number of colonies of various bacteria | 1              |                     | Mean Difference (IV, Fixed, 95% CI) | Totals not selected |
| 1.1 01 Pre-scrub                                 | 1              |                     | Mean Difference (IV, Fixed, 95% CI) | 0.0 [0.0, 0.0]      |
| 1.2 02 Post-scrub                                | 1              |                     | Mean Difference (IV, Fixed, 95% CI) | 0.0 [0.0, 0.0]      |

### Analysis 2.1. Comparison 2 02 Unpolished nails versus chipped polished nails, Outcome 1 Average number of colonies of various bacteria.

| Study or subgroup                                                                             | Chipped polish |               | Natural nail |                | Mean Difference<br>Fixed, 95% CI                                                   | Mean Difference<br>Fixed, 95% CI |
|-----------------------------------------------------------------------------------------------|----------------|---------------|--------------|----------------|------------------------------------------------------------------------------------|----------------------------------|
|                                                                                               | N              | Mean(SD)      | N            | Mean(SD)       |                                                                                    |                                  |
| <b>2.1.1 01 Pre-scrub</b>                                                                     |                |               |              |                |                                                                                    |                                  |
| Wynd 1994                                                                                     | 34             | 273.8 (452.6) | 34           | 626.5 (2016.2) | | -352.65[-1047.24,341.94]         |
| <b>2.1.2 02 Post-scrub</b>                                                                    |                |               |              |                |                                                                                    |                                  |
| Wynd 1994                                                                                     | 34             | 895 (2465.6)  | 34           | 437.9 (1136.7) | | 457.06[-455.53,1369.65]          |
| Chipped nails better      -1000      -500      0      500      1000      Natural nails better |                |               |              |                |                                                                                    |                                  |

## Comparison 3. 03 Freshly-polished nails versus chipped polished nails

| Outcome or subgroup title                        | No. of studies | No. of participants | Statistical method                  | Effect size         |
|--------------------------------------------------|----------------|---------------------|-------------------------------------|---------------------|
| 1 Average number of colonies of various bacteria | 1              |                     | Mean Difference (IV, Fixed, 95% CI) | Totals not selected |
| 1.1 01 Pre-scrub                                 | 1              |                     | Mean Difference (IV, Fixed, 95% CI) | 0.0 [0.0, 0.0]      |
| 1.2 02 Post-scrub                                | 1              |                     | Mean Difference (IV, Fixed, 95% CI) | 0.0 [0.0, 0.0]      |

### Analysis 3.1. Comparison 3 03 Freshly-polished nails versus chipped polished nails, Outcome 1 Average number of colonies of various bacteria.

| Study or subgroup                                                                 | Fresh nail polish |                | Chipped polish |            | Mean Difference<br>Fixed, 95% CI                                                     | Mean Difference<br>Fixed, 95% CI |
|-----------------------------------------------------------------------------------|-------------------|----------------|----------------|------------|--------------------------------------------------------------------------------------|----------------------------------|
|                                                                                   | N                 | Mean(SD)       | N              | Mean(SD)   |                                                                                      |                                  |
| <b>3.1.1 01 Pre-scrub</b>                                                         |                   |                |                |            |                                                                                      |                                  |
| Wynd 1994                                                                         | 34                | 20838 (120006) | 34             | 274 (453)  | | 20564[-19774.03,60902.03]        |
| <b>3.1.2 02 Post-scrub</b>                                                        |                   |                |                |            |                                                                                      |                                  |
| Wynd 1994                                                                         | 34                | 154 (428)      | 34             | 895 (2466) | | -741[-1582.29,100.29]            |
| Favours fresh      -1000      -500      0      500      1000      Favours chipped |                   |                |                |            |                                                                                      |                                  |

## ADDITIONAL TABLES

**Table 1. Summary data from Wynd 1994**

| Pre/post-scrubbing | Nail condition     | Mean number of CFUs | Standard deviation |
|--------------------|--------------------|---------------------|--------------------|
| Pre-scrub          | Freshly-polished   | 20838               | 120006             |
| Pre-scrub          | Unpolished         | 626                 | 2016               |
| Pre-scrub          | Chipped/old polish | 274                 | 453                |
| Post-scrub         | Freshly-polished   | 154                 | 428                |
| Post-scrub         | Unpolished         | 438                 | 1137               |
| Post-scrub         | Chipped/old polish | 895                 | 2466               |

## APPENDICES

### Appendix 1. Search methods for the fourth update of this review in 2012

For this fourth update, the following databases were searched:

- The Cochrane Wounds Group Specialised Register (searched 27 January 2012);
- The Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2012, Issue 1);
- Ovid MEDLINE (2010 to January Week 2 2012);
- Ovid MEDLINE (In-Process & Other Non-Indexed Citations, January 26, 2012);
- Ovid EMBASE (2010 to 2012 Week 03);EBSCO CINAHL (2010 to January 6 2012)..

The following search strategy was used in CENTRAL:

- #1 MeSH descriptor Handwashing explode all trees
- #2 surg\* NEAR/5 scrub\*
- #3 hand\* NEAR/5 (scrub\* or wash\* or clean\*)
- #4 MeSH descriptor Nails explode all trees
- #5 nail NEXT (polish or varnish)
- #6 finger NEAR/5 ring\*
- #7 jewel\*ry
- #8 (#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7)
- #9 MeSH descriptor Surgical Wound Infection explode all trees
- #10 MeSH descriptor Surgical Wound Dehiscence explode all trees
- #11 surg\* NEAR/5 infection\*
- #12 surg\* NEAR/5 wound\*
- #13 (postoperative or post-operative) NEAR/5 infection\*
- #14 (#9 OR #10 OR #11 OR #12 OR #13)
- #15 (#8 AND #14)

The search strategies for Ovid MEDLINE, Ovid EMBASE and EBSCO CINAHL can be found in [Appendix 2](#), [Appendix 3](#) and [Appendix 4](#) respectively. The Ovid MEDLINE search was combined with the Cochrane Highly Sensitive Search Strategy for identifying randomised trials in MEDLINE: sensitivity- and precision-maximizing version (2008 revision); Ovid format. The EMBASE and CINAHL searches were combined with the trial filters developed by the Scottish Intercollegiate Guidelines Network. There was no restriction by language or publication status.

## Appendix 2. Ovid MEDLINE

```

1 exp Handwashing/
2 (surg$ adj5 scrub$).mp.
3 (hand$ adj5 (scrub$ or wash$ or clean$)).mp.
4 exp Nails/
5 (nail adj (polish or varnish)).mp.
6 (finger adj5 ring$).mp.
7 jewel?ry.mp.
8 or/1-7
9 exp Surgical Wound Infection/
10 exp Surgical Wound Dehiscence/
11 (surg$ adj5 infection$).mp.
12 (surg$ adj5 wound$).mp.
13 ((postoperative or post-operative) adj5 infection$).mp.
14 or/9-13
15 8 and 14
16 randomized controlled trial.pt.
17 controlled clinical trial.pt.
18 intervention studies/
19 experiment$.tw.
20 (time adj series).tw.
21 (pre test or pretest or posttest or post test).tw.
22 random allocation/
23 impact.tw.
24 intervention?.tw.
25 chang$.tw.
26 evaluation studies/
27 evaluat$.tw.
28 effect?.tw.
29 comparative study.pt.
30 or/16-29
31 animal/
32 human/
33 31 not 32
34 30 not 33
35 15 and 34

```

## Appendix 3. Ovid EMBASE

```

1 exp Hand Washing/
2 (surg$ adj5 scrub$).mp.
3 (hand$ adj5 (scrub$ or wash$ or clean$)).mp.
4 exp Finger Nail/
5 (nail adj (polish or varnish)).mp.
6 exp jewelry/
7 jewel?ry.mp.
8 (finger adj5 ring$).mp.
9 or/1-8
10 exp Surgical Infection/
11 exp Wound Dehiscence/
12 (surg$ adj5 infection$).mp.
13 (surg$ adj5 wound$).mp.
14 ((postoperative or post-operative) adj5 infection$).mp.
15 or/10-14
16 9 and 15
17 Randomized controlled trial/
18 random$.tw.
19 experiment$.tw.
20 (time adj series).tw.
21 (pre test or pretest or post test or posttest).tw.
22 impact.tw.
23 intervention?.tw.

```



24 chang\$.tw.  
25 evaluat\$.tw.  
26 effect?.tw.  
27 compar\$.tw.  
28 (controlled adj study).tw.  
29 or/17-28  
30 16 and 29

#### Appendix 4. EBSCO CINAHL

S33 S18 and S31  
S32 S18 and S31  
S31 S19 or S20 or S21 or S22 or S23 or S24 or S25 or S26 or S27 or S28 or S29 or S30  
S30 (MH "Quasi-Experimental Studies+")  
S29 (MH "Pretest-Posttest Design+")  
S28 TI effect\* or AB effect\*  
S27 TI evaluat\* or AB evaluat\*  
S26 TI intervention\* or AB intervention\*  
S25 TI impact or AB impact  
S24 TI time series or AB time series  
S23 TI experiment\* or AB experiment\*  
S22 (MH "Comparative Studies")  
S21 TI random\* or AB random\*  
S20 TI control\* or AB control\*  
S19 (MH "Clinical Trials+")  
S18 S8 and S17  
S17 S9 or S10 or S11 or S12 or S13 or S14 or S15 or S16  
S16 TI ( jewelry or jewelry ) or AB ( jewelry or jewelry )  
S15 TI finger\* N5 ring\* or AB finger\* N5 ring\*  
S14 TI ( nail polish\* or nail varnish\* ) or AB ( nail polish\* or nail varnish\* )  
S13 (MH "Nails")  
S12 TI ( hand\* N5 scrub\* or hand\* N5 wash\* or hand\* N5 clean\* ) or AB ( hand\* N5 scrub\* or hand\* N5 wash\* or hand\* N5 clean\* )  
S11 TI surg\* N5 scrub\* or AB surg\* N5 scrub\*  
S10 (MH "Surgical Scrubbing")  
S9 (MH "Handwashing+")  
S8 S1 or S2 or S3 or S4 or S5 or S6 or S7  
S7 TI ( postoperative\* N5 infection\* OR post-operative\* N5 infection\* ) or AB ( postoperative\* N5 infection\* OR post-operative\* N5 infection\* )  
S6 TI wound\* N5 infection\* or AB wound\* N5 infection\*  
S5 TI surg\* N5 wound\* or AB surg\* N5 wound\*  
S4 TI surg\* N5 infection\* or AB surg\* N5 infection\*  
S3 (MH "Infection Control+")  
S2 (MH "Surgical Wound Dehiscence")  
S1 (MH "Surgical Wound Infection")

#### WHAT'S NEW

| Date         | Event                                                  | Description                                           |
|--------------|--------------------------------------------------------|-------------------------------------------------------|
| 24 July 2014 | New search has been performed                          | Fifth update, new searches, no new studies identified |
| 24 July 2014 | New citation required but conclusions have not changed | No change to conclusions                              |

#### HISTORY

Protocol first published: Issue 1, 2001  
Review first published: Issue 1, 2002

| Date             | Event                                                  | Description                                                                                                                                                                                                 |
|------------------|--------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 28 March 2012    | New citation required but conclusions have not changed | No new studies were identified for inclusion, and the review authors' conclusions remain unchanged.                                                                                                         |
| 23 March 2012    | New search has been performed                          | Fourth update of review: new searches performed in January 2012.                                                                                                                                            |
| 21 May 2010      | New search has been performed                          | Third update of review: new searches performed in January 2010 and a risk of bias assessment completed. No new studies were identified for inclusion, and the review authors' conclusions remain unchanged. |
| 25 April 2008    | New search has been performed                          | Second update of review: new searches performed in March 2008. Fourteen citations were screened but no new studies were identified for inclusion. The reviewers' conclusions remained unchanged.            |
| 25 April 2008    | New search has been performed                          | Converted to new review format.                                                                                                                                                                             |
| 25 November 2003 | New search has been performed                          | First update of review, new searches undertaken, no new studies added, conclusions unchanged.                                                                                                               |
| 16 November 2001 | New citation required and conclusions have changed     | Substantive amendment. First publication of review.                                                                                                                                                         |

## CONTRIBUTIONS OF AUTHORS

VAA: Initiated the review, checked retrieved papers for inclusion, extracted data, drafted protocol, review and undertook the updates.  
RT: Checked retrieved papers for inclusion, extracted data, drafted protocol and review.

## DECLARATIONS OF INTEREST

None known.

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### External sources

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## INDEX TERMS

### Medical Subject Headings (MeSH)

\*Hand Disinfection; Bacteria [isolation & purification]; Colony Count, Microbial; Cosmetics [\*adverse effects]; General Surgery; Hand [\*microbiology]; Jewelry [\*microbiology]; Lacquer [\*microbiology]; Nails [\*microbiology]; Nursing Staff; Operating Room Technicians; Randomized Controlled Trials as Topic; Surgical Wound Infection [\*prevention & control]

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**MeSH check words**

Humans