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The effectiveness of meatal cleaning in the prevention of catheter-associated urinary tract infections and bacteriuria: An updated systematic review and meta-analysis

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3 1 **TITLE**
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5 2 The effectiveness of meatal cleaning in the prevention of catheter-associated urinary tract
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7 3 infections and bacteriuria: An updated systematic review and meta-analysis
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27 ABSTRACT

28 **Introduction:** Meatal cleaning prior to urinary catheterisation and post catheterisation is
29 one element of urinary catheter care which may reduce the risk of catheter-associated
30 urinary tract infections (CAUTIs) and bacteriuria. A systematic review on this topic was
31 published in 2017, with further studies undertaken since this time. We present an updated
32 systematic review on the effectiveness of antiseptic cleaning of the meatal area for the
33 prevention of CAUTIs and bacteriuria.

34 **Objective:** To determine the effectiveness of antiseptic cleaning of the meatal area for
35 preventing CAUTIs and bacteriuria.

36 **Design:** Systematic review

37 **Methods:** Electronic databases Cochrane Library, PubMed, Embase, CINAHL, Medline and
38 Academic Search Complete were searched to identify randomised controlled trials and
39 quasi-experimental studies. Odds ratios and 95% confidence intervals were calculated from
40 the proportions of patients with CAUTI and bacteriuria in the intervention and control
41 groups and compared between groups using Der Simonian and Laird random-effects
42 models. Subgroup analyses were undertaken to explore effects of aspects of study design on
43 outcomes. Heterogeneity was estimated using the I^2 statistic.

44 **Findings:** A total of 18 studies were included. Some potential benefit of using antiseptics,
45 compared to non-antiseptics for meatal cleaning to prevent bacteriuria and or CAUTI was
46 identified (OR 0.84, 95% CI 0.69-1.02; P=0.071). Some potential value of antiseptics prior to
47 urinary catheterisation in reducing the incidence of bacteriuria, compared to non-antiseptic
48 agents (OR=0.67, 95% CI 0.44-1.03; P=0.065) was also identified.

49 **Conclusion:** There is emerging evidence of the role of antiseptics prior to urinary
50 catheterisation, in reducing CAUTIs, and some potential benefit to the role of antiseptics
51 more generally in reducing bacteriuria.

52

53 **Strengths and limitations of this study**

- 54 • A summary of the latest evidence on the role of antiseptics in reducing catheter
55 associated urinary tract infections
- 56 • Provides an update to a previous review, to include new research which impact key
57 findings
- 58 • Heterogeneity of population groups is a limitation

60 INTRODUCTION

61 Indwelling or intermittent urinary catheter use can result in bacteriuria which may signify
62 either colonisation (catheter-associated asymptomatic bacteriuria) or symptomatic infection
63 (catheter-associated urinary tract infections).¹ Catheter-associated urinary tract infections
64 (CAUTIs) are a common but preventable nosocomial infection. They account for around 70-
65 80% of hospital-acquired UTIs, are associated with longer length of hospital stay and
66 increased risk of morbidity and mortality.²⁻⁵ In the UK, economic analyses of hospital
67 inpatient costs estimated that CAUTIs caused over 45,000 excess bed days, 1,467 deaths,
68 and a loss of 10,471 quality-adjusted life years (QALYs).⁶ The burden of CAUTIs for both
69 patients and health services highlight the importance of reducing these infections in
70 healthcare settings.

71
72 Various strategies for reducing the risk of CAUTIs have been proposed. These include
73 reducing unnecessary catheter use, practicing appropriate catheter insertion and
74 maintenance, and prompt removal of urinary catheters.⁷⁻⁹ A systematic review published in
75 2017 explored the effect of using different meatal (peri-urethral) cleaning agents prior to
76 urinary catheter insertion on the incidence of UTIs.¹⁰ Meatal cleaning was identified by the
77 review as one element of urinary catheter care which may reduce CAUTI risk.¹⁰ However,
78 the review also identified uncertainty in the available evidence for the effectiveness of this
79 practice. Since this publication there have been further studies published on this topic,^{11 12}
80 and the evidence base is still evolving. Moreover, some previous studies were limited by
81 bias (e.g. selection bias, non-masking of intervention).^{11 13} Given the potential importance of
82 meatal cleaning for preventing UTIs and informing clinical practice and guidelines, we
83 believed it was important to update the evidence base.¹⁰ In this paper, we present findings
84 from an updated systematic review and meta-analysis. The aim of this review is to
85 determine the effectiveness of antiseptic cleaning of the meatal area, for preventing CAUTI
86 and bacteriuria.

88 METHODS

89 A protocol was developed to guide the conduct of the systematic review and meta-analysis,
90 and we have used a reporting approach consistent with the Preferred Reporting Items for
91 Systematic Reviews and Meta-analyses (PRISMA) statement.¹⁴ The approach used for this

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3 92 update is the same as that used in the initial publication.¹⁰ Studies included in the final
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5 93 synthesis from the initial publication were combined with studies identified as part of the
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7 94 updated search strategy.
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10 96 ***Data sources and search strategy***

11 97 The electronic databases Cochrane Library, PubMed, Embase, CINAHL, Medline and
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13 98 Academic Search Complete were used to undertake the search. Search parameters were
14
15 99 adjusted to suit database requirements. A search of the databases was limited to the period
16
17 100 between 1 January 2016 and 29 February 2020. The 1st January 2016 represents the end
18
19 101 date of the search from the initial review.¹⁰ Keywords and MeSH terms used were: urinary
20
21 102 catheter and/or urinary catheterisation, urinary tract infection, meatal cleaning, periurethral
22
23 103 cleaning, antiseptic, antimicrobial, antibacterial, antibiotic, and topical intervention. Further
24
25 104 details on the search strategy are provided as supplementary material.
26
27 105

28 106 ***Study inclusion and exclusion criteria***

29 107 Included studies were randomised controlled trials (RCTs) and quasi-experimental studies
30
31 108 (pre-and post-test design, non RCTs) evaluating the use of antiseptic, antibacterial or non-
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33 109 medicated agents (such as soap and water) for cleaning the meatal, periurethral or perineal
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35 110 areas before indwelling catheter insertion or intermittent catheterisation or during routine
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37 111 meatal care. Studies were included if they involved patients requiring short- or long-term
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39 112 indwelling catheters or intermittent catheterisation in hospitals, community settings, and
40
41 113 long-term/aged care facilities. Studies were excluded if they were not published in English
42
43 114 language, focused solely on children (≤ 18 years), included patients with pre-existing UTIs, or
44
45 115 were published in grey literature (conference abstracts, editorial letters, reports and
46
47 116 guidelines). Review articles, bundle interventions, studies without available data for
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49 117 analysis, studies that did not evaluate the control or intervention agents, and studies for
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51 118 which the full-text was not available were also excluded.
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53 119

54 120 The co-primary outcome measures were the difference in rates of CAUTI and bacteriuria in
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56 121 the intervention and control groups. While we accepted the definition of CAUTI and
57
58 122 bacteriuria provided in the included studies, we also considered infection to be the outcome
59
60 123 when clinical signs or symptoms of infection were present.¹⁵

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45 125 **Study selection**

7 126 Database results were imported into Covidence for screening and selection.¹⁶ Screening of
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9 127 abstracts of articles retrieved from electronic databases for relevance to the systematic
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11 128 review aim was undertaken by one researcher (CC). Ten percent of the abstracts were cross
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13 129 checked by a second researcher (BM). No discrepancies were found. Full-text screening was
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15 130 then undertaken and assessed against the inclusion and exclusion criteria by CC. A cross
16
17 131 check of all studies deemed to meet the inclusion criteria was also undertaken by BM. A
18
19 132 manual search of the references lists of all included articles was undertaken to identify
20
21 133 additional studies. Where decisions were open to disagreement, this was resolved by
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23 134 discussion with other members of the research team (EGH and OF).

23 135

25 136 **Data extraction**

27 137 The data from included studies were extracted using the Cochrane Collaboration's data
28
29 138 collection form for RCTs and non-RCTs. Data were extracted by one researcher (CC) and
30
31 139 then checked for accuracy by a second researcher (BM). Extracted details included: age and
32
33 140 sex distribution of the study population, study duration, sample size, study setting, type of
34
35 141 intervention and duration, colony-forming unit (cfu/mL) count, bacteriuria and CAUTI rates
36
37 142 (numerator/denominator data). For studies that reported the outcome at multiple time
38
39 143 points, the outcome value closest to the end of the indwelling catheter in-situ period was
40
41 144 extracted for analysis. Attempts were made to contact the authors of included studies
42
43 145 where information was missing regarding the numerator or denominator data for
44
45 146 calculating CAUTI rates, and when clarity was needed on the type of intervention used. One
46
47 147 author was contacted regarding inaccuracies in reporting results and the author responded
48
49 148 by sending the corrected version of the study manuscript.

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51 150 **Risk of bias assessment**

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53 151 Using Covidence and following the Cochrane Collaboration's Handbook for Systematic
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55 152 Reviews of Interventions (v6., 2019), the risk of bias for studies were evaluated.¹⁷ Risk of
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57 153 bias was assessed as high, unclear or low. Risk of bias assessment was conducted
58
59 154 independently by two researchers (OF and CC) and disagreements resolved by discussion
60
61 155 with a third researcher (BM).

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Data analysis

Data analyses were undertaken using Stata Version 14 (StataCorp, College Station, TX, USA). Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated from the proportions of patients with CAUTI and bacteriuria in the intervention and control groups. The pooled ORs were calculated and compared across intervention and control groups using the DerSimonian and Laird random effects meta-analysis model which considers possible heterogeneity between the studies during analysis.¹⁸ The likelihood of clinical heterogeneity in the included studies with regards to varying meatal cleaning agents used was considered in the a-priori data synthesis strategy. Hence, the meta-analysis was stratified by the outcome and type of meatal cleaning agent used. The I^2 statistic was used to quantify between-study heterogeneity of intervention effects. Subgroup analyses were undertaken to explore effects of aspects of study methodology (antiseptic vs non-antiseptic cleaning and administration of the intervention prior to urinary catheter insertion) on the outcome. Assessment of reporting biases was by visual examination of the funnel plot. A 0.05 level of significance was used without adjustment for multiplicity (number of comparisons of meatal cleaning agents). Effect sizes and their precision, in addition to significance were considered when interpreting the results.

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RESULTS

In total, 927 articles were retrieved from electronic database searches and their abstracts were screened for relevance to the systematic review aim. After evaluating these articles against the inclusion and exclusion criteria, four studies were identified for inclusion. These four studies were added to the 14 studies included in the previous review,¹⁰ hence a total 18 studies were included in this systematic review and meta-analysis (Figure 1).

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The characteristics of the included studies are presented in Table 1. The majority of studies were RCTs (n=15). There was considerable diversity in the types of interventions (meatal cleaning agent) used and whether the intervention was applied to the meatal area during ongoing meatal care, prior to catheter insertion only or a combination of both. Of the 18 studies, two compared povidone-iodine with routine (or standard) meatal care, which involved removal of debris from the catheter during bathing;^{19 20} one compared green soap

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3 188 with routine meatal care;¹⁹ four compared an antibacterial agent (Neomycin-polymyxin B,
4 189 1% silver sulfadiazine Silvadene, 2% polynoxylin) with routine meatal care;²¹⁻²⁴ two
5 190 compared chlorhexidine (0.1% and 0.3% plus and 3% centrimide) with tap water;^{25 26} three
6 191 compared povidone-iodine with soap and water;^{13 27 28} one compared chlorhexidine (0.1%)
7 192 with saline;¹¹ one compared povidone-iodine with saline;²⁹ two compared povidone-iodine
8 193 with sterile water;^{12 30} one compared povidone-iodine with tap water;³¹ and one compared
9 194 antimicrobial cloth with chlorhexidine (2%) compared to a non-antimicrobial cloth.³²
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18 196 The term 'infection' was often referred to as the primary outcome in studies. However, the
19 197 definition of 'infection' varied and for most studies, this term was used when bacteria were
20 198 present in the urine with or without clinical symptoms. We recoded outcomes to be either
21 199 bacteriuria or infection – where the definition of infection must have included
22 200 signs/symptoms of a UTI. Two studies reported CAUTI as the only outcome, 15 studies
23 201 reported bacteriuria as the only outcome and one study reported both CAUTI and
24 202 bacteriuria as outcomes.
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32 204 ***Effect of meatal cleaning on the incidence of bacteriuria and CAUTI***

33 205 A forest plot displaying the results of random-effect meta-analyses for the effect of meatal
34 206 cleaning on the incidence of both bacteriuria and CAUTI, stratified by meatal cleaning agent
35 207 is presented in Figure 2. For the study that reported both CAUTI and bacteriuria as
36 208 outcomes,¹¹ only data for bacteriuria were included because bacteriuria was the outcome in
37 209 majority of studies.
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45 211 There was no evidence of differences in the incidence of bacteriuria or CAUTI between the
46 212 intervention and control groups when comparing the different agents: povidone-iodine vs
47 213 routine care (OR 1.19, 95% CI 0.75-1.87; P=0.46); green soap and water vs routine care (OR
48 214 1.59, 95% CI 0.85-2.96; P=0.15), chlorhexidine vs tap water (OR 1.04, 95% CI 0.59-1.83;
49 215 P=0.89); povidone-iodine vs soap and water (OR 0.88, 95% CI 0.48-1.62; P=0.69); povidone-
50 216 iodine vs saline (OR 1.13, 95% CI 0.53-2.41; P=0.76); povidone-iodine vs sterile water (OR
51 217 0.42, 95% CI 0.14-1.24; P=0.12); povidone-iodine vs tap water (OR 0.80, 95% CI 0.22-2.97;
52 218 P=0.74) and chlorhexidine vs antimicrobial cloths (OR 0.67, 95% CI 0.39-1.18; P=0.17).
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3 220 There was potential evidence of a small difference in the incidence of bacteriuria or CAUTI
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5 221 between the intervention and control groups overall (pooled OR 0.84, 95% CI 0.69-1.02;
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7 222 $P=0.071$), with the CI nearly excluding 1. This also applies to the comparison of antibacterial
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9 223 agent vs routine care (OR 0.75, 95% CI 0.55-1.01; $P=0.055$). The comparison of chlorhexidine
10
11 224 vs saline demonstrated statistical evidence of differences between the intervention and
12
13 225 control group (OR 0.40, 95% CI 0.21-0.74; $P=0.003$). Overall results showed evidence of
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15 226 heterogeneity ($I^2=13.2\%$; $P=0.296$) among the included studies.
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17 227

18 228 Separate forest plots showing the effect of meatal cleaning on the incidence of bacteriuria
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20 229 and CAUTI are presented as supplementary material (Figure S1 and Table S1, and Figure S2,
21
22 230 respectively). Sixteen studies were included in the meta-analysis evaluating the effect of
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24 231 meatal cleaning on the incidence of bacteriuria only while three studies were included in the
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26 232 meta-analysis evaluating the effect of meatal cleaning on the incidence of CAUTI only.^{11 27 32}
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28 233 Both analyses showed no evidence of differences in the incidence of bacteriuria (pooled OR
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30 234 0.84, 95% CI 0.68-1.04; $P=0.10$) and CAUTI (pooled OR 0.625, 95% CI 0.27-1.43; $P=0.27$)
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32 235 between the intervention and control groups.
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34 236

35 237 ***Effect of antiseptic vs non-antiseptic meatal cleaning prior to urinary catheterisation on***
36 238 ***the incidence of bacteriuria and CAUTI***

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38 239 Six studies explored the effect of using an antiseptic meatal cleaning agent prior to catheter
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40 240 insertion, compared to a non-antiseptic agent, on the incidence of bacteriuria (Figure 3).¹¹
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42 241^{12 25 26 28 31} There was evidence of a potential difference in the incidence of bacteriuria when
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44 242 comparing the use of antiseptic and non-antiseptic agents (pooled OR=0.67, 95% CI 0.44-
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46 243 1.03; $P=0.065$) (Figure 3). Two studies explored the effect of using an antiseptic meatal
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48 244 cleaning agent prior to catheter insertion, compared to a non-antiseptic agent, on the
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50 245 incidence of CAUTI.^{11 27} There was no evidence for a difference in the incidence of CAUTI
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52 246 when comparing the use of antiseptic and non-antiseptic agents (pooled OR=0.56, 95% CI
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54 247 0.10-3.20; $P=0.52$) (Figure S3).
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56 249 ***Risk of bias***

58 250 Results showed that the level of risk of bias varied between the included studies (Figure 4).
59
60 251 The majority of studies ($n=15$) were assessed to have a high or unclear risk of bias for

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3 252 reporting of blinding processes used in the studies. The vast majority of studies were biased
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5 253 in the categories of allocation and performance. The studies conducted by Noto et al,³² and
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7 254 Fasugba et al,¹¹ were deemed to be at lowest risk of bias.
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10 256 ***Publication bias***

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12 257 Visual inspection of the funnel plot showed no evidence of publication bias (Figure 5).
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Table 1. Characteristics of studies included in the systematic review and meta-analysis

Study author, year and design	Country	Population	Administration	Frequency of application	Outcome	Outcome definition	Intervention				Control		
							Mean age (SD)	Intervention agent	Alcohol-containing agent	Cases	Mean age (SD)	Comparator agent	Cases
Burke et al., 1981a; RCT ¹⁹	USA	Medical and surgical patients	Daily meatal care while IDC in situ	Twice daily	Bacteriuria	$\geq 10^3$ cfu/mL	NR	10% povidone-iodine Betadine solution and ointment	Yes, 25-9 as inactive ingredient	32/200	NR	Usual care; removal of debris from catheter during bathing	24/194
Burke et al., 1981a; RCT ¹⁹	USA	Medical and surgical patients	Daily meatal care while IDC in situ	Once daily	Bacteriuria	$\geq 10^3$ cfu/mL	NR	Green soap and water	Assumed yes, 30% ethyl alcohol as solution	28/228	NR	Usual care; removal of debris from catheter during bathing	18/223
Burke et al., 1983; RCT ²¹	USA	Medical and surgical patients	Daily meatal care while IDC in situ, until UTI found	Twice daily	Bacteriuria	$\geq 10^3$ cfu/mL	NR	Neomycin-polymyxin B-bacitracin ointment	No	14/21	NR	Usual care; removal of debris from catheter during bathing	16/214
Carapeti et al., 1996; RCT ²⁵	UK	General surgery patients	On IDC insertion for surgery	Once for surgery	Bacteriuria (+/- symptoms)	$> 10^5$ cfu/mL	67.5	0.3% CHG and 3% centrimide Savlon solution	Yes, 2.84% isopropyl alcohol, 0.056% benzyl benzoate and	7/74	65.3	Tap water	9/82

Study author, year and design	Country	Population	Administration	Frequency of application	Outcome	Outcome definition	Intervention				Control		
							Mean age (SD)	Intervention agent	Alcohol-containing agent	Cases	Mean age (SD)	Comparator agent	Cases
									terpineol as excipient ingredients				
Classen et al., 1991a; RCT ²²	USA	Medical and surgical patients	Daily meatal care while IDC in situ, until UTI found	Thrice daily	Bacteriuria	≥10 ³ cfu/mL	NR	Polymyxin B sulfate, neomycin sulfate, gramicidin Neosporin cream	Yes, propylene glycol as non-medicinal ingredient	26/38	NR	Routine meatal care; removal of debris from catheter during bathing	37/364
Classen et al., 1991b; RCT ²⁰	USA	Medical and surgical patients	Daily meatal care while IDC in situ, until UTI found	Once daily	Bacteriuria	≥10 ³ cfu/mL	NR	2% Lugol's Iodine povidone-iodine solution	Unclear, assumed no	14/30	NR	Routine meatal care; removal of debris from catheter during bathing	15/306
Duffy et al., 1995; RCT ²⁷	USA	Male veterans in long-term care	Pre-IC and IDC	Pre-IC, ~thrice daily	Infection	≥10 ⁵ cfu/mL + symptoms	72.6 (10.8)	10% povidone-iodine Betadine solution	Yes, parath-25-9 as inactive ingredient	26/42	70.9 (12.1)	Soap and water	21/38
Fasugba et al., 2019; RCT ¹¹	Australia	Medical and surgical patients, ICU	On IDC insertion	Once, before insertion	Infection & Bacteriuria	CAUTI: CDC/NHSN	NR	0.1% CHG solution	No	UTI: 4/94	NR	0.9% saline	UTI 13/697

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Study author, year and design	Country	Population	Administration	Frequency of application	Outcome	Outcome definition	Intervention				Control			
							Mean age (SD)	Intervention agent	Alcohol-containing agent	Cases	Mean age (SD)	Comparator agent	Cases	
						Bacteriuria: $\geq 10^5$ cfu/mL					Bacteriuria		Bacteriuria	29/697
Huth et al., 1992; quasi-RCT ²³	USA	Medical and surgical patients	Daily meatal care while IDC in situ	Twice daily	Bacteriuria	$\geq 10^3$ cfu/mL	61	1% silver sulfadiazine Silvadene cream	Yes, stearyl alcohol, isopropyl myristate and propylene glycol as vehicle ingredients	38/33	63	Usual care; removal of debris from catheter during bathing	48/364	
Ibrahim & Rashid, 2002; RCT ²⁹	Saudi Arabia	Male transurethral surgery patients	On IDC insertion, and in daily application while IDC in situ	Once daily	Bacteriuria	10^5 cfu/mL	66.7 (10.1)	Povidone-iodine solution	Unclear, assumed no	19/64	66 (10.4)	Saline	18/66	
Jeong et al., 2010; quasi-RCT ¹³	South Korea	Female ICU patients	On IDC insertion, and in daily meatal care while IDC in situ	Once daily	Bacteriuria*	CDC/NHSN	61.5 (17.3)	10% povidone-iodine solution	Unclear, assumed no	9/28	64.1 (13.3)	Soap and water	10/22	

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Study author, year and design	Country	Population	Administration	Frequency of application	Outcome	Outcome definition	Intervention			Control			
							Mean age (SD)	Intervention agent	Alcohol-containing agent	Mean age (SD)	Comparator agent	Cases	
Kara & Ozyurek, 2017; RCT ³⁰	Turkey	ICU, surgical and medical patients	On IDC insertion, and in daily meatal care while IDC in situ	Once daily	Bacteriuria	≥10 ⁵ cfu/mL	66.34 (14)	Sterile water	No	7/32	67.96 (12)	Sterile water	7/32
King et al., 1992; RCT ²⁸	USA	SCI rehabilitation inpatients	Pre-IC	Pre-IC, once per 4-6 hours	Bacteriuria	≥10 ⁴ cfu/mL with symptoms	32.8 (13.7)	Povidone-iodine solution	Unclear, assumed no	13/23	27.9 (10.3)	Castile soap wipe	15/23
Lynch et al., 1991; quasi-RCT ²⁴	UK	Male transurethral surgery patients	On IDC insertion, and in daily meatal care while IDC in situ	Once daily	Bacteriuria	>10 ⁵ cfu/mL	67 (9.7)	2% polynoxylin Anaflex spray	Yes, formaldehyde as active ingredient	6/50	68 (8.4)	No intervention	11/50
Nasiriani et al., 2009; RCT ³¹	Iran	Female gynaecological surgery patients	On IDC insertion for surgery	Once for surgery	Bacteriuria	>10 ⁵ cfu/mL	NR	Povidone-iodine solution	Unclear, assumed no	5/30	NR	Tap water	6/30
Noto et al., 2015; RCT ³²	USA	Surgical, medical and ICU patients	Daily bathing including meatal care	Once daily	Infection	CAUTI: CDC/NHSN	NR	2% CHG Cloths	No	20/488	NR	Non-antimicrobial bath cloth	32/4852

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Study author, year and design	Country	Population	Administration	Frequency of application	Outcome	Outcome definition	Intervention			Control			
							Mean age (SD)	Intervention agent	Alcohol-containing agent	Cases	Mean age (SD)	Comparator agent	Cases
Nugraha et al., 2019; RCT ¹²	Java	Surgical and medical patients; (n=4, 12.5% aged 16-20 years)	On IDC insertion	Once, before insertion	Bacteriuria	Presence of bacteriuria; (cfu/mL level NR)	NR	10% povidone-iodine solution	Unclear, assumed no	2/16	NR	Sterile water	5/16
Webster et al., 2001; RCT ²⁶	Australia	Pregnant obstetrics patients	On IDC insertion for delivery	Once for delivery	Bacteriuria	≥10 ⁶ cfu/mL	NR	0.1% CHG solution	No	20/20	NR	Tap water	18/219

Note: cfu: colony forming units; CHG: chlorhexidine gluconate; IC: intermittent catheterisation; ICU: intensive care unit; IDC: indwelling catheter; NR: not reported; RCT: randomised controlled trial; SCI: spinal cord injury; SD: standard deviation; UK: United Kingdom; USA: United States of America; UTI: urinary tract infection. Information on alcohol-containing agent ingredients assumed from research; no information on alcohol-containing agents available in included paper * Positive UTI was assessed on following criteria: fever ≥38 degrees, suprapubic pain, dysuria, urethral erythema, purulent drainage around the catheter exit, presence of bacteria, pyuria (pus ≥3/ml in unspun urine), urine culture to stand on the presence of UTI (? ≥10⁵ cfu/mL, see CDC 2015), and white blood cell (WBC) count to prove presence of infection. # Table 2 results reported in the paper were incorrect. Authors were contacted for clarification, data in the table reflect clarification from authors. + Author state based "on the CDC definition of UTI, in particular, asymptomatic bacteriuria", with a reference supporting bacteriuria, therefore bacteriuria was assumed

258 DISCUSSION

259 Findings from this systematic review suggest that broadly speaking, using antiseptics for
260 meatal cleaning may reduce the risk of bacteriuria or CAUTI. Although the odds ratios are
261 not statistically significant at a level of 0.05,³³ the results are clinically meaningful. There
262 are some specific subsets where the evidence is stronger and more consistent, for example
263 prior to urinary catheterisation. There also appears to be emerging evidence that using
264 chlorhexidine prior to urinary catheterisation may provide benefit in reducing CAUTI.
265 Preventing CAUTI is important for a number of reasons. Prevention of CAUTI is vital, not
266 only because of associated morbidity, mortality and increased length of stay in hospital,²⁻⁵
267 but because of the added threats posed by increasing antimicrobial resistance.³⁴

268
269 The meta-analysis exploring the effect of meatal cleaning in reducing the risk of bacteriuria,
270 included studies that used antiseptics for routine meatal cleaning, for example post catheter
271 insertion, as well as studies using antiseptics as part of the catheter insertion process (prior
272 to urinary catheterisation) (Figure 2). The antiseptics used in studies included in this meta-
273 analysis also varied (Table 1). When all studies were combined, the results indicated a
274 benefit of using antiseptics, in reducing the risk bacteriuria or CAUTI (pooled OR 0.84, 95%
275 CI 0.691-1.02; P=0.071). Although not statistically significant at an arbitrary level of 0.05,
276 these results have clinical implications, noting it is difficult to interpret given the
277 heterogeneity of antiseptics and timing of their use. In sub-analysis, some benefit of using
278 an antibacterial agent vs routine (standard) care was identified (OR 0.75, 95% CI 0.55-1.01;
279 P=0.055).

280
281 In studies specifically exploring the use of antiseptics prior to urinary catheterisation, a
282 meta-analysis indicated some value of antiseptics in preventing bacteriuria, compared to
283 non-antiseptic agents (pooled OR=0.67, 95% CI 0.44-1.03; P=0.065). Five of the six studies
284 included in the meta-analysis had findings in the same direction, a benefit to antiseptics
285 (Figure 3). The meta-analysis was largely influenced by two studies, indicating differing
286 results, but both using chlorhexidine 0.1%. One of these two studies, a multi-centre study
287 involving three hospitals and included all patients in each hospital, indicated a statistically
288 significant benefit when using antiseptics (chlorhexidine 0.1%).¹¹ The second study, a single
289 centre study in an obstetric population, indicated no benefit, with a non-statistically

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3 290 significant result.²⁶ For consistency, in the meta-analysis, the outcomes presented were
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5 291 bacteriuria. We also present outcomes of the same meta-analysis by type of antiseptic in
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7 292 Table S1, with chlorhexidine 0.1% versus saline being the only statistically significant finding.
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10 294 We identified two studies evaluating the use of antiseptics prior to catheterisation, with
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12 295 CAUTI as the primary outcome.^{11 27} Fasugba and colleagues found a significant reduction in
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14 296 CAUTI, associated with the use of chlorhexidine 0.1% (IRR 0.06, 95% CI 0.01-0.32,
15
16 297 $p=0.00080$).¹¹ In a follow up cost-effectiveness evaluation, the authors found that using
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18 298 chlorhexidine 0.1% was cost saving.³⁵ Duffy et al, evaluated the use of povidone-iodine prior
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20 299 to catheterisation, in participants who had indwelling catheters or were undertaking
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22 300 intermittent catheterisation.²⁷ Duffy and colleagues did not identify a benefit from using
23
24 301 povidone-iodine.²⁷ It is worth noting other important differences. The control phase
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26 302 included a clean catheterisation technique, i.e. not requiring a sterile field. The intervention
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28 303 phase, which used povidone-iodine, also included the use of a sterile procedure. The
29
30 304 average follow-up period for participants was 63 days. As time from catheter insertion
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32 305 increases, the likelihood of an infection being related to insertion practices diminishes. In
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34 306 contrast, participants in the study undertaken by Fasugba et al were followed up for 7 days
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36 307 only.¹¹

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38 309 This paper represents the latest evidence on the role of using antiseptics in people with
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40 310 urinary catheters, for the purpose of infection prevention. In turn, we hope this will inform
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42 311 local policy and practice, as well as infection control guidelines more generally. We
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44 312 acknowledge that two of the authors of this systematic review led one of the included
45
46 313 studies.¹¹ To ensure there was balance, we included two authors on this paper that had no
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48 314 involvement in this study. Based on the evidence identified in this review and after careful
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50 315 consideration of the outcomes and methods used in included studies, we believe there is
51
52 316 emerging evidence of the role of chlorhexidine 0.1% prior to urinary catheterisation, in
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54 317 reducing CAUTI, and potentially some benefit to the role of antiseptics more generally in
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56 318 reducing bacteriuria. Given the low number of included studies using CAUTI as the primary
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58 319 outcome, additional studies in this area are required, ensuring that important confounders
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60 320 are controlled for in the study design.
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5 323 **ETHICS APPROVAL**

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7 324 As this is a systematic review, ethics approval was not required.
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10 326 **CONFLICT OF INTEREST**

11
12 327 Two of the authors (BM and OF) are named on one of the studies included in this systematic
13 review. The risk of bias assessment for this study included an independent person.
14 328
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17
18 330 **FUNDING**

19 331 No funding was received for this study.
20
21 332

22
23 333 **AUTHORSHIP STATEMENT**

24
25 334 OF and BM designed the study. OF conducted the search. CC conducted the primary review
26 of the articles and data extraction. CC, OF and BM conducted the risk of bias assessment.
27 335
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29 336 OF, BM and EGH conducted the analysis. All authors had input into writing the paper,
30 provided critical review and approved the final version of the paper.
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339 REFERENCES

- 340 1. Hooton TM, Bradley SF, Cardenas DD, et al. Diagnosis, prevention, and treatment of catheter-associated urinary tract infection in adults: 2009 International Clinical Practice Guidelines from the Infectious Diseases Society of America. *Clin Infect Dis* 2010;50(5):625-63.
- 341
342
- 343 2. Lo E, Nicolle LE, Coffin SE, et al. Strategies to prevent catheter-associated urinary tract infections in acute care hospitals: 2014 update. *Infection Control & Hospital Epidemiology* 2014;35(S2):S32-S47.
- 344
345
- 346 3. Smith DR, Pouwels KB, Hopkins S, et al. Epidemiology and health-economic burden of urinary-catheter-associated infection in English NHS hospitals: a probabilistic modelling study. *Journal of Hospital Infection* 2019;103(1):44-54.
- 347
348
- 349 4. Daniels KR, Lee GC, Frei CR. Trends in catheter-associated urinary tract infections among a national cohort of hospitalized adults, 2001-2010. *American journal of infection control* 2014;42(1):17-22.
- 350
351
- 352 5. Mitchell BG, Ferguson JK, Anderson M, et al. Length of stay and mortality associated with healthcare-associated urinary tract infections: a multi-state model. *Journal of Hospital Infection* 2016;93(1):92-99.
- 353
354
- 355 6. Smith DRM, Pouwels KB, Hopkins S, et al. Epidemiology and health-economic burden of urinary-catheter-associated infection in English NHS hospitals: a probabilistic modelling study. *J Hosp Infect* 2019;103(1):44-54. doi: 10.1016/j.jhin.2019.04.010 [published Online First: 2019/05/03]
- 356
357
358
- 359 7. Meddings J, Rogers MAM, Krein SL, et al. Reducing unnecessary urinary catheter use and other strategies to prevent catheter-associated urinary tract infection: an integrative review. *BMJ Quality & Safety* 2013 doi: 10.1136/bmjqs-2012-001774
- 360
361
- 362 8. Meddings J, Saint S, Krein SL, et al. Systematic Review of Interventions to Reduce Urinary Tract Infection in Nursing Home Residents. *Journal Of Hospital Medicine* 2017;12(5):356-68. doi: 10.12788/jhm.2724
- 363
364
- 365 9. Mitchell BG, Northcote M, Cheng AC, et al. Reducing urinary catheter use using an electronic reminder system in hospitalized patients: a randomized stepped-wedge trial. *Infection Control & Hospital Epidemiology* 2019;40(4):427-31.
- 366
367
- 368 10. Fasugba O, Koerner J, Mitchell BG, et al. Systematic review and meta-analysis of the effectiveness of antiseptic agents for meatal cleaning in the prevention of catheter-associated urinary tract infections. *Journal of Hospital Infection* 2017;95(3):233-42. doi: <https://doi.org/10.1016/j.jhin.2016.10.025>
- 369
370
371
- 372 11. Fasugba O, Cheng AC, Gregory V, et al. Chlorhexidine for meatal cleaning in reducing catheter-associated urinary tract infections: a multicentre stepped-wedge randomised controlled trial. *Lancet Infect Dis* 2019;19(6):611-19. doi: 10.1016/s1473-3099(18)30736-9 [published Online First: 2019/04/17]
- 373
374
375
- 376 12. Nugraha A, Puspita T, Patimah IIN, et al. Comparison of 10% povidone iodine and sterile water as a periuretra cleansing solution before the insertion of indwelling urincathether on the occurrence of bacteria. *International Journal of Pharmaceutical Research (09752366)* 2019;11(4):810-16. doi: 10.31838/ijpr/2019.11.04.087
- 377
378
379
- 380 13. Jeong I, Park S, Jeong JS, et al. Comparison of catheter-associated urinary tract infection rates by perineal care agents in intensive care units. *Asian Nursing Research* 2010;4(3):142-50.
- 381
- 382 14. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Int J Surg* 2010;8(5):336-41.
- 383
384
- 385 15. Centers for Disease Control and Prevention. CDC/NHSN Surveillance Definitions for Specific Types of Infections, 2020.
- 386
- 387 16. Veritas Health Innovation. Covidence systematic review software. Melbourne, 2020.
- 388
- 389 17. Higgins JP, Savović J, Page MJ, et al. Assessing risk of bias in a randomized trial. *Cochrane Handbook for Systematic Reviews of Interventions* 2019:205-28.
- 389 18. DerSimonian R, Laird N. Meta-analysis in clinical trials. *Controlled clinical trials* 1986;7(3):177-88.

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2
3 390 19. Burke JP, Garibaldi RA, Britt MR, et al. Prevention of catheter-associated urinary tract infections:
4 391 efficacy of daily meatal care regimens. *The American Journal of Medicine* 1981;70(3):655-58.
5 392 20. Classen DC, Larsen RA, Burke JP, et al. Prevention of catheter-associated bacteriuria: Clinical trial
6 393 of methods to block three known pathways of infection. *American Journal of Infection*
7 394 *Control* 1991b;19(3):136-42.
8 395 21. Burke JP, Jacobson JA, Garibaldi RA, et al. Evaluation of daily meatal care with poly-antibiotic
9 396 ointment in prevention of urinary catheter-associated bacteriuria. *The Journal of Urology*
10 397 1983;129(2):331-34.
11 398 22. Classen DC, Larsen RA, Burke JP, et al. Daily meatal care for prevention of catheter-associated
12 399 bacteriuria results using frequent applications of polyantibiotic cream. *Infection Control &*
13 400 *Hospital Epidemiology* 1991;12(3):157-62.
14 401 23. Huth TS, Burke JP, Larsen RA, et al. Randomized trial of meatal care with silver sulfadiazine cream
15 402 for the prevention of catheter-associated bacteriuria. *Journal of Infectious Diseases*
16 403 1992;165(1):14-18.
17 404 24. Lynch M, MacDermott J, Byrne D, et al. Use of an antibacterial powder spray to prevent post
18 405 prostatectomy urinary infection. *Journal of the Royal Society of Medicine* 1991;84(11):667.
19 406 25. Carapeti E, Andrews S, Bentley P. Randomised study of sterile versus non-sterile urethral
20 407 catheterisation. *Annals of the Royal College of Surgeons of England* 1996;78(1):59.
21 408 26. Webster J, Hood RH, Burrige CA, et al. Water or antiseptic for periurethral cleaning before
22 409 urinary catheterization: a randomized controlled trial. *American Journal of Infection Control*
23 410 2001;29(6):389-94.
24 411 27. Duffy LM, Cleary J, Ahern S, et al. Clean intermittent catheterization: Safe, cost-effective bladder
25 412 management for male residents of VA nursing homes. *Journal of the American Geriatrics*
26 413 *Society* 1995;43(8):865-70.
27 414 28. King RB, Carlson CE, Mervine J, et al. Clean and sterile intermittent catheterization methods in
28 415 hospitalized patients with spinal cord injury. *Archives of physical medicine and rehabilitation*
29 416 1992;73(9):798-802.
30 417 29. Ibrahim A, Rashid M. Comparison of local povidone-iodine antiseptics with parenteral
31 418 antibacterial prophylaxis for prevention of infective complications of TURP: a prospective
32 419 randomized controlled study. *European urology* 2002;41(3):250-56.
33 420 30. Kara A, Ozyurek P. The Effect of Periurethral Care and Follow-Up on Bacteriuria in Patients with
34 421 Urinary Catheter: A Comparison of Three Solutions. *Journal of Clinical & Experimental*
35 422 *Investigations / Klinik ve Deneysel Arastirmalar Dergisi* 2017;8(2):54-60. doi:
36 423 10.5799/jcei.333382
37 424 31. Nasiriani K, oh re Kalani Z. Comparison of the Effect of Wa ter Vs. Povidone-Iodine Solution for P
38 425 eriu rethral Cleaning in Wo men Requiring an Indwelling Catheter Prior to Gynecologic Surg e
39 426 ry. *Urologic Nursing* 2009;29(2):119.
40 427 32. Noto MJ, Domenico HJ, Byrne DW, et al. Chlorhexidine bathing and health care-associated
41 428 infections: a randomized clinical trial. *Jama* 2015;313(4):369-78.
42 429 33. Kyriacou DN. The Enduring Evolution of the P Value. *JAMA* 2016;315(11):1113-15. doi:
43 430 10.1001/jama.2016.2152
44 431 34. Paul R. State of the Globe: Rising Antimicrobial Resistance of Pathogens in Urinary Tract
45 432 Infection. *J Glob Infect Dis* 2018;10(3):117-18. doi: 10.4103/jgid.jgid_104_17
46 433 35. Mitchell BG, Fasugba O, Cheng AC, et al. Chlorhexidine versus saline in reducing the risk of
47 434 catheter associated urinary tract infection: A cost-effectiveness analysis. *International*
48 435 *Journal of Nursing Studies* 2019;97:1-6. doi: 10.1016/j.ijnurstu.2019.04.003
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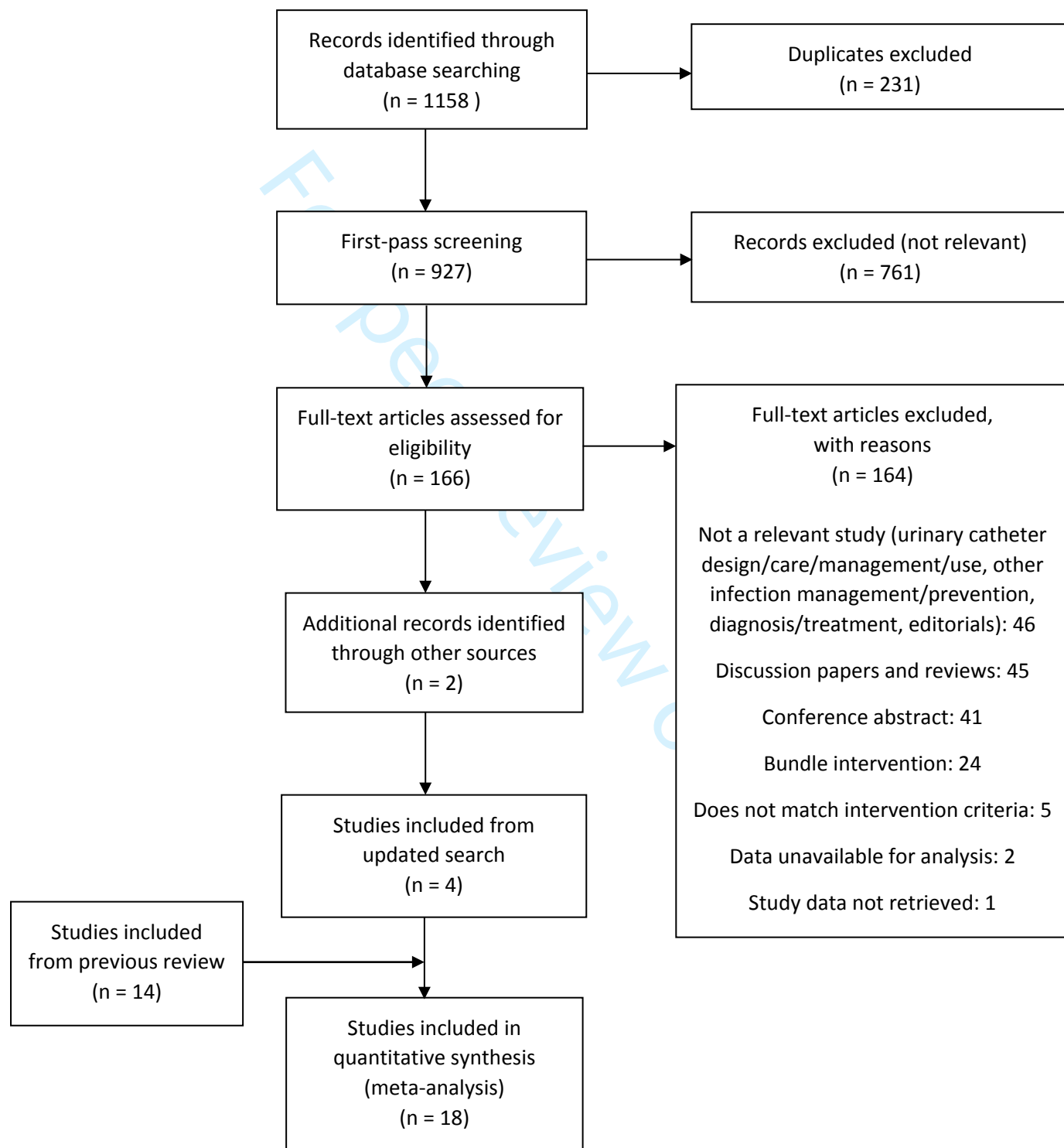


Figure 1. PRISMA flow diagram of study selection

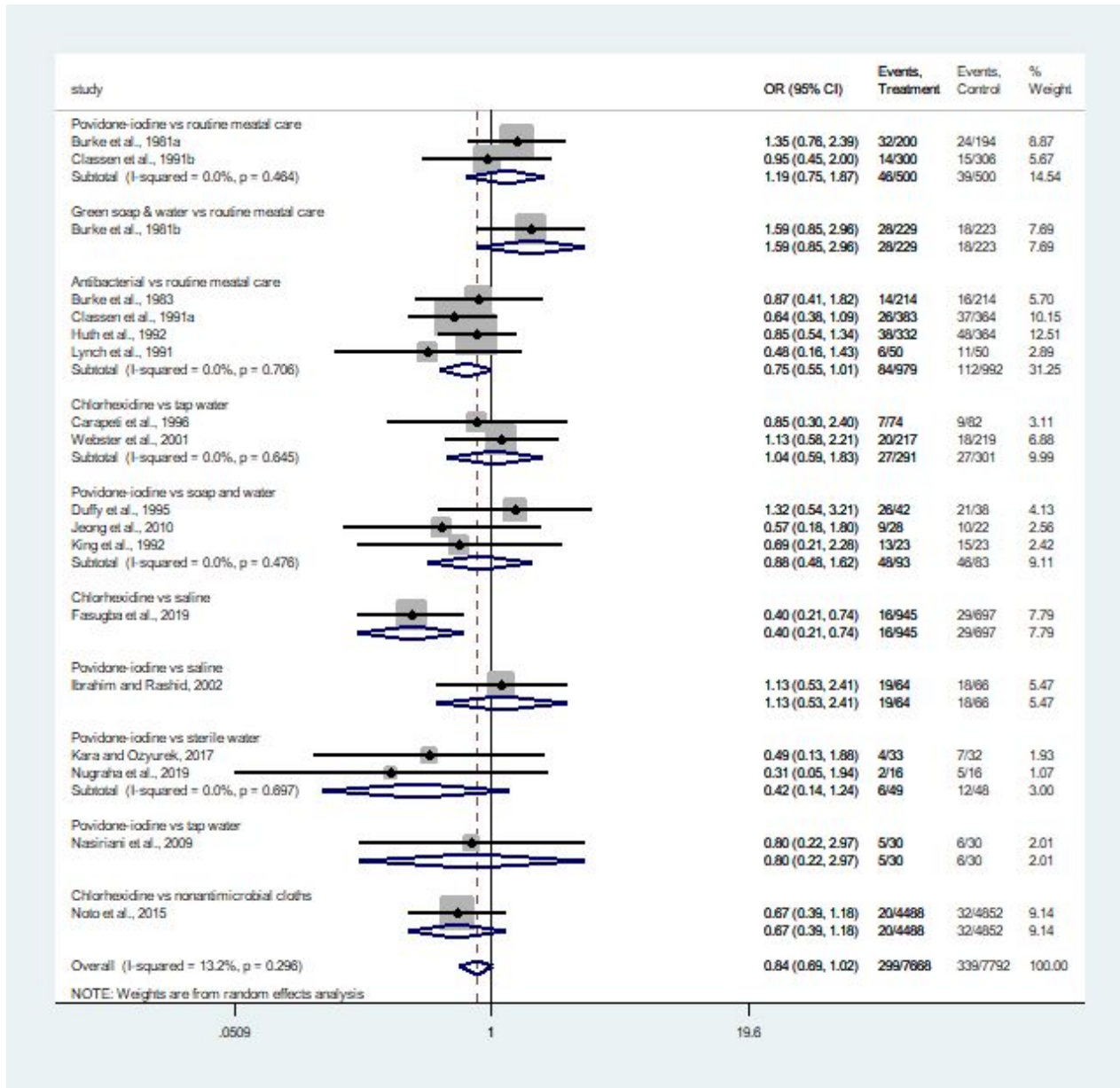


Figure 2. Forest plot displaying random-effect meta-analysis of the effect of meatal cleaning on the incidence of bacteriuria and or catheter-associated urinary tract infections (results stratified by meatal cleaning agent)

Note: Duffy et al., 1995 and Noto et al., 2015 all report CAUTI as the outcome, while Fasugba et al., 2019 report both CAUTI and bacteriuria. Bacteriuria data only from Fasugba et al., 2019 is included in this analysis.

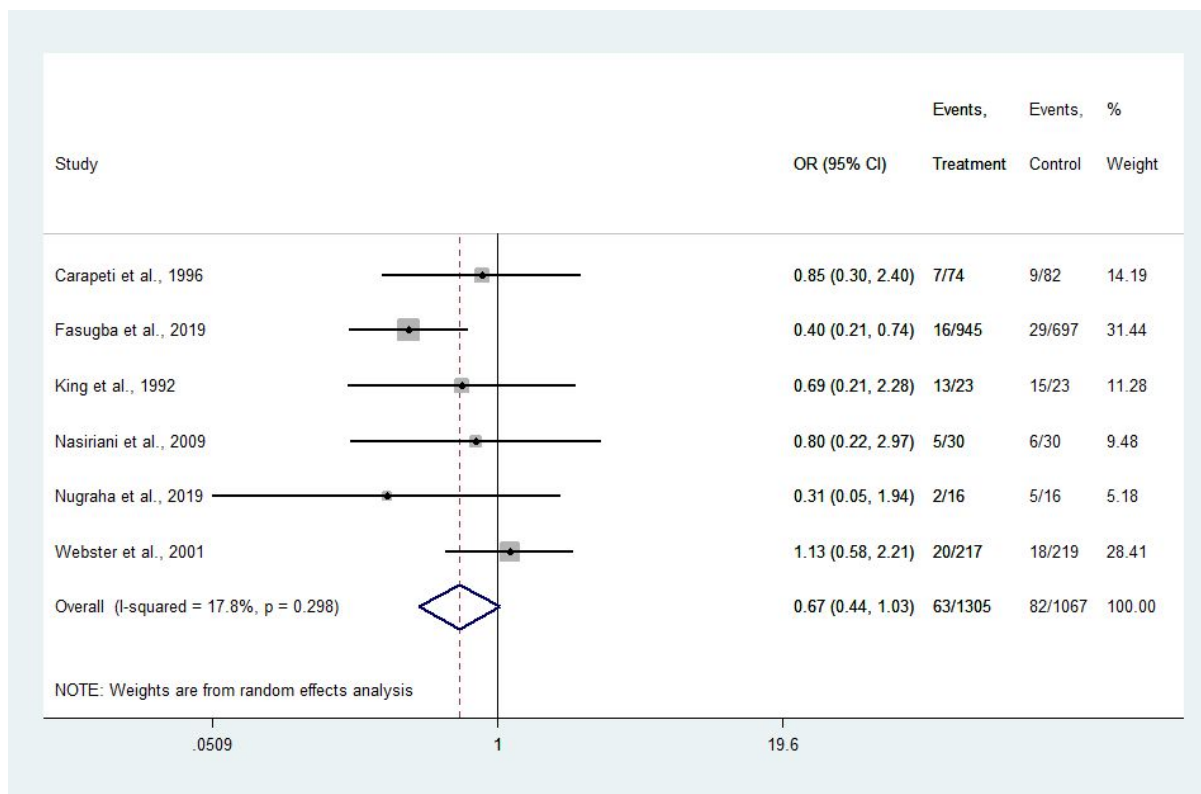


Figure 3. Random-effect meta-analysis of the effect of using an antiseptic meatal cleaning agent (povidone-iodine, chlorhexidine) vs a non-antiseptic agent (soap and water, tap water, sterile water or saline) prior to catheter insertion on the incidence of bacteriuria

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
AbdElbaky 2020	+	?	?	?	?	+	?
Burke 1981*	?	?	-	?	?	-	?
Burke 1983	?	?	-	?	-	-	?
Carapeti 1996	+	-	-	?	+	+	?
Classen 1991a	?	?	-	?	+	+	?
Classen 1991b	?	?	-	?	+	-	?
Duffy 1995	?	?	-	-	+	+	?
Fasugba 2019	+	?	+	?	+	+	+
Huth 1992	-	-	-	?	-	+	?
Ibrahim 2002	+	?	-	?	+	+	?
Jeong 2010	-	-	-	?	+	+	?
Kara 2017	?	?	?	?	+	+	+
King 1992	?	?	-	?	+	+	?
Lynch 1991	-	-	-	?	+	+	?
Nasiriani 2009	+	?	-	?	-	+	?
Noto 2015	+	-	+	+	+	+	+
Nugraha 2019	?	?	?	?	?	-	-
Webster 2001	+	+	-	+	-	+	?

Figure 4. Risk of bias assessment

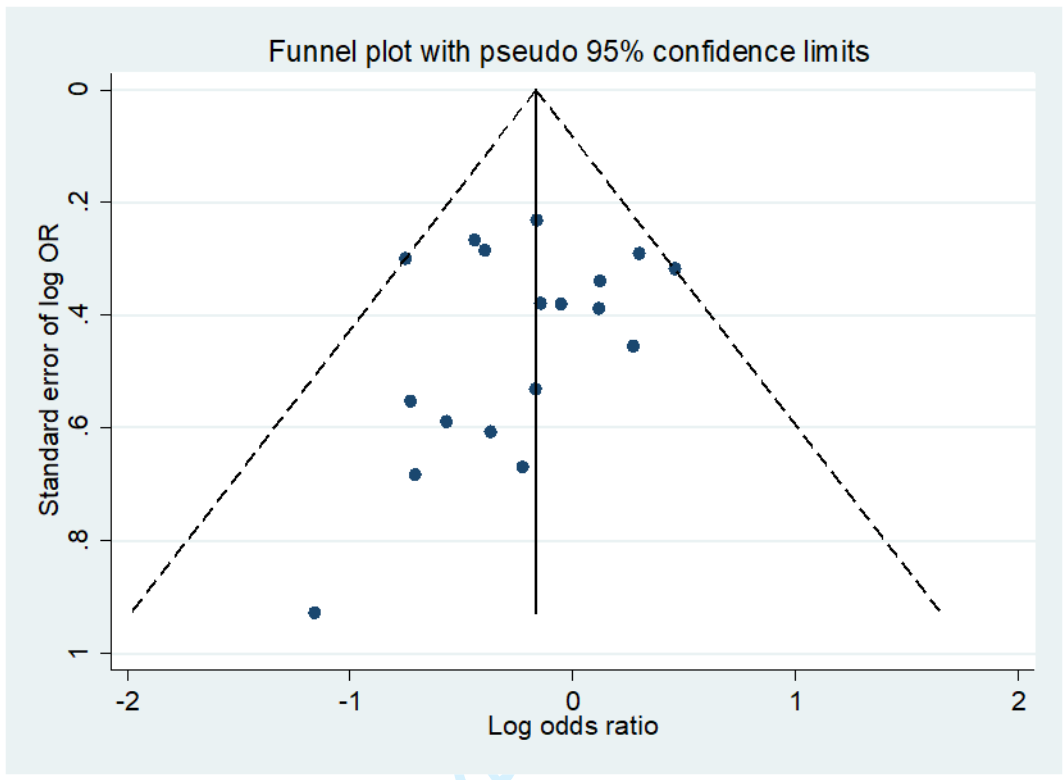


Figure 5. Funnel plot of the included studies

Peer review only

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SUPPLEMENTARY MATERIAL

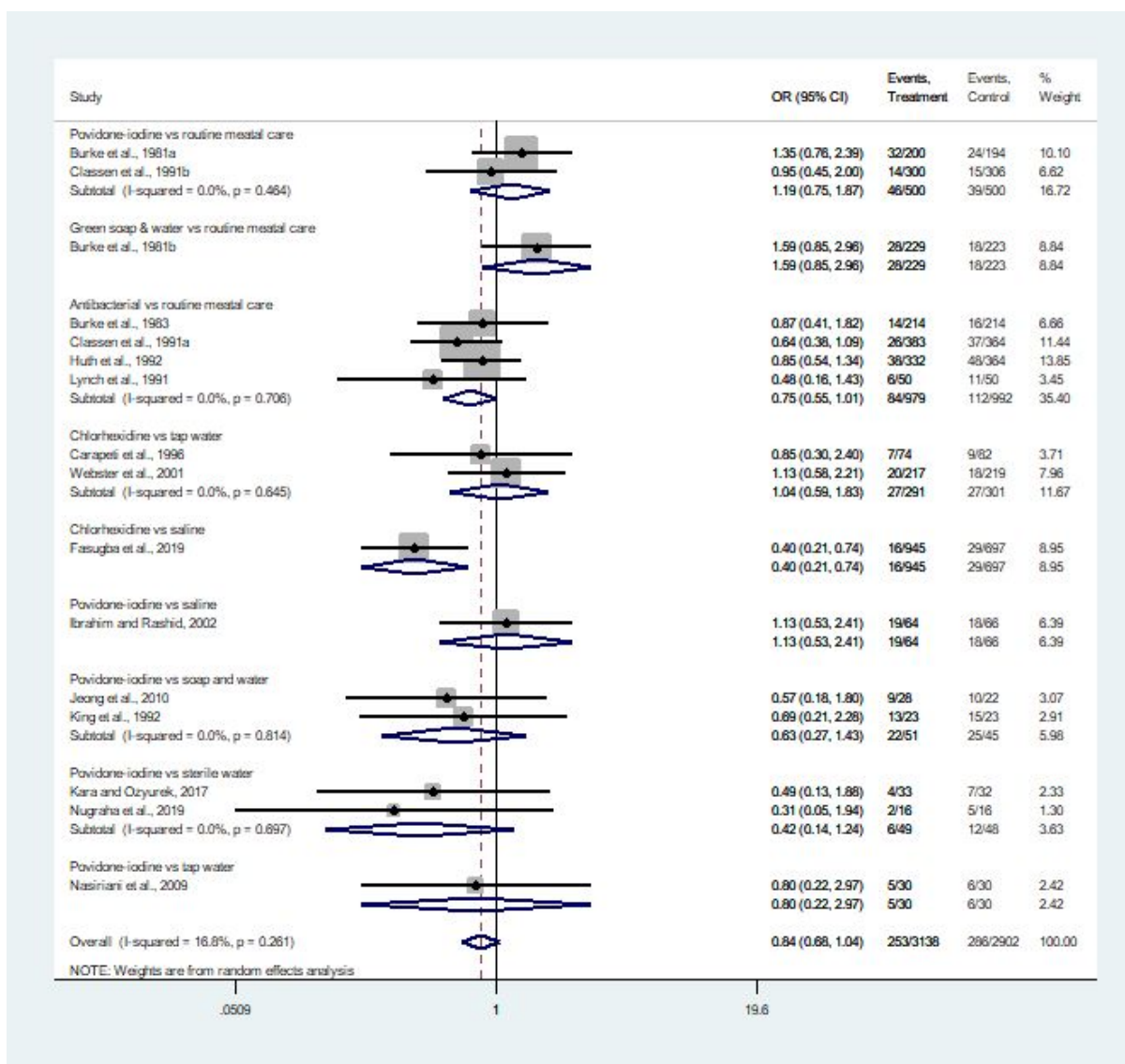


Figure S1. Forest plot displaying random-effect meta-analysis of the effect of meatal cleaning on the incidence of bacteriuria only (results stratified by meatal cleaning agent)

Table S1. Comparison of the effect of meatal cleaning on the incidence of bacteriuria only

Comparisons	P values
Povidone-iodine vs routine meatal care	0.462
Green soap and water vs routine meatal care	0.147
Antibacterial vs routine meatal care	0.055
Chlorhexidine vs tap water	0.886
Chlorhexidine vs saline	0.012
Povidone-iodine vs saline	0.760
Povidone-iodine vs soap and water	0.268
Povidone-iodine vs sterile water	0.116
Povidone-iodine vs tap water	0.739
Overall	0.105

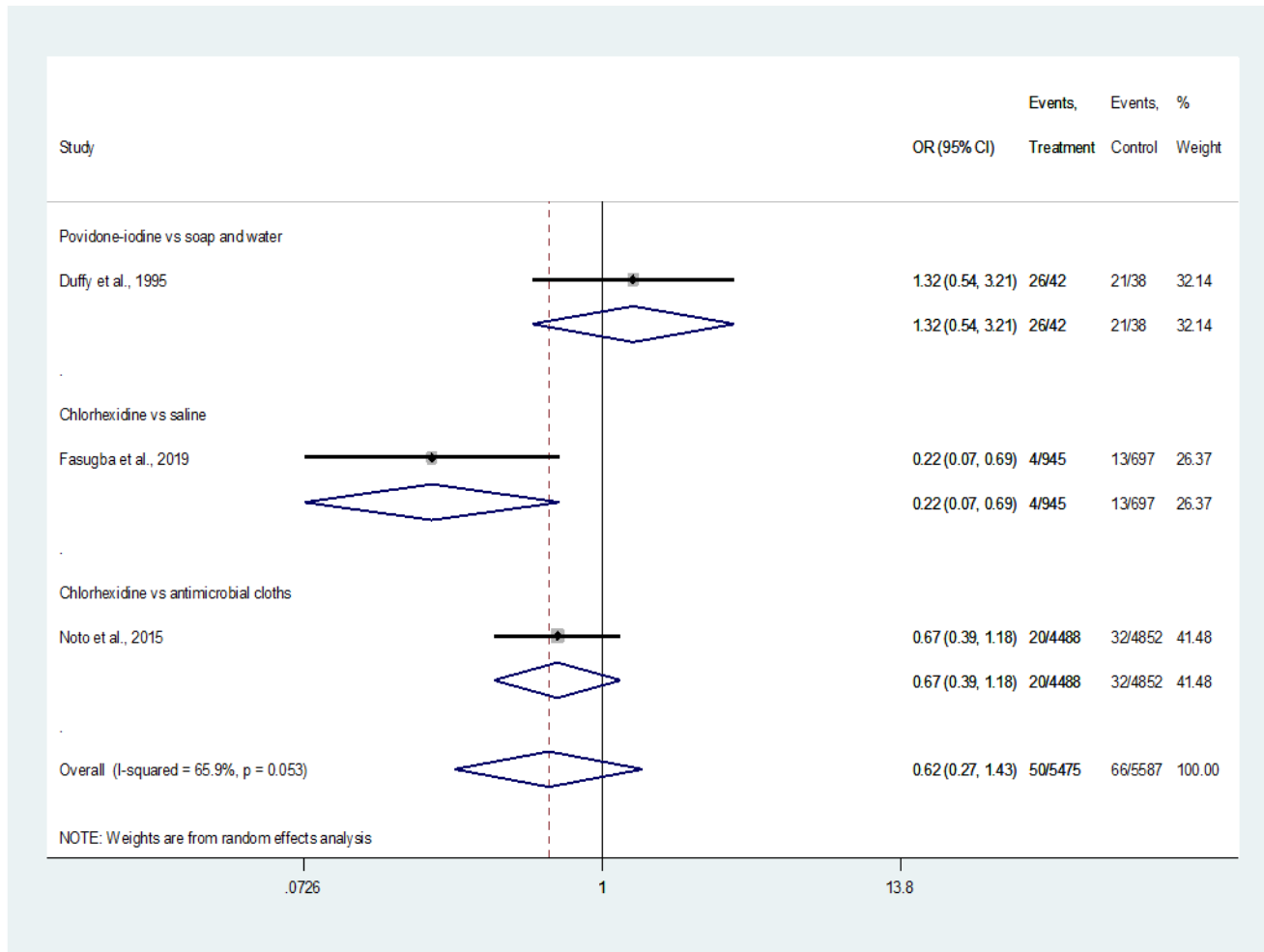


Figure S2. Forest plot displaying random-effect meta-analysis of the effect of meatal cleaning on the incidence of catheter-associated urinary tract infections only (results stratified by meatal cleaning agent)

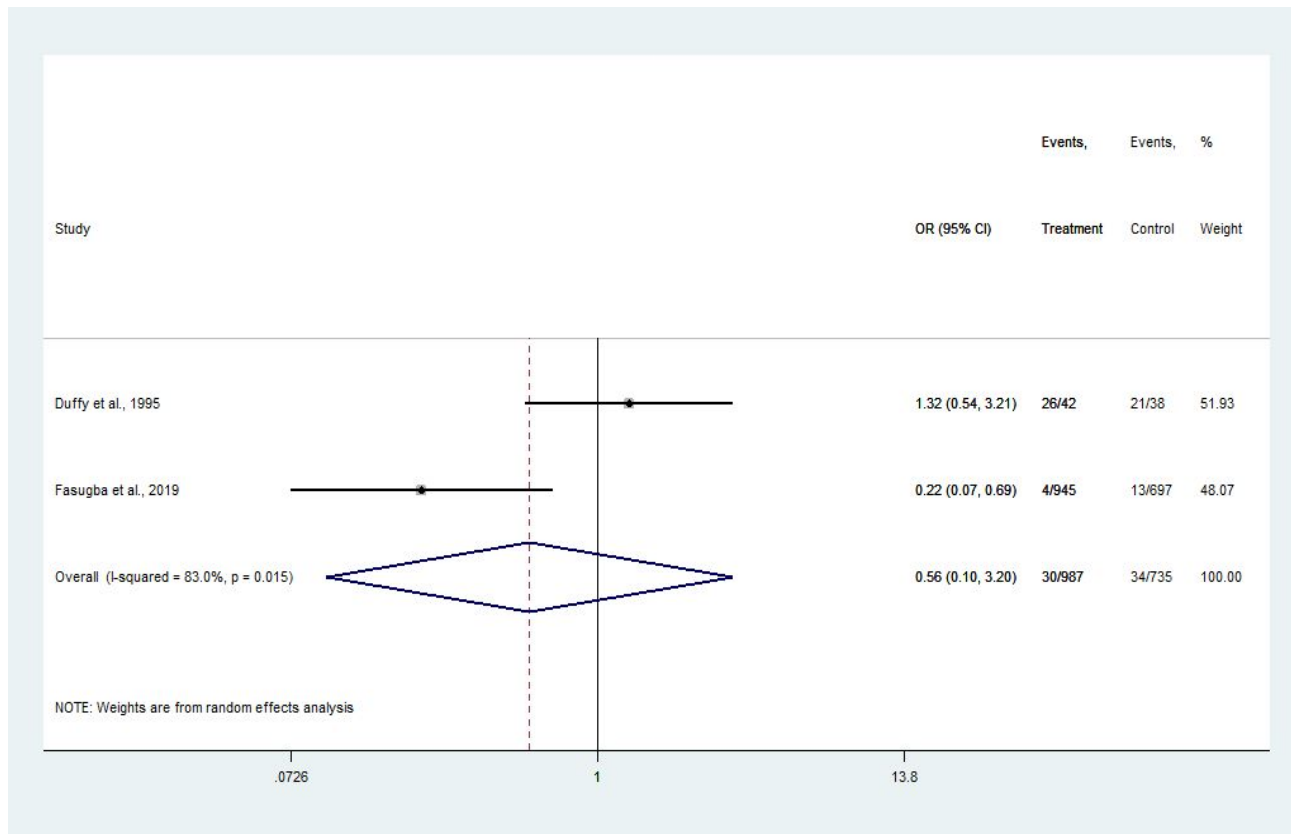


Figure S3. Random-effect meta-analysis of the effect of using an antiseptic meatal cleaning agent (povidone-iodine or chlorhexidine) vs a non-antiseptic agent (soap and water or saline) prior to catheter insertion on the incidence of catheter-associated urinary tract infections

Search strategy

#	Query	Limiters/Expanders	Last Run Via
S5	S1 AND S2 AND S3 AND S4	Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - Academic Search Complete
S4	antiseptic* OR antimicrobial OR antibacterial OR anti-infective OR disinfect OR microbicide OR antibiotic OR polyantibiotic OR sterile OR "bacitracin zinc" OR betadine OR centrimide	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - Academic Search Complete
S3	bath* OR hygiene OR cleans* OR cleaned OR cleaning OR topical OR apply OR applied OR application	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - Academic Search Complete
S2	meatal OR meatus OR perineal OR perineum OR periurethral	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - Academic Search Complete
S1	TX urinary catheter* OR TX urethral catheter* OR TX indwelling catheter* OR TX intermittent catheter	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - Academic Search Complete

#	Query	Limiters/Expanders	Last Run Via
S3	S1 AND S2	Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - Academic Search Complete
S2	bundle intervention OR bundle care	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - Academic Search Complete
S1	TX urinary tract infection OR TX meatal OR TX meatal disinfection OR TX meatal cleaning	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - Academic Search Complete

#	Query	Limiters/Expanders	Last Run Via
S6	S1 AND S2 AND S3 AND S4	Limiters - Human Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete
S5	S1 AND S2 AND S3 AND S4	Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete
S4	TX antiseptic* OR TX antimicrobial OR TX antibacterial OR TX	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete

	anti-infective OR TX disinfect* OR TX microbicide OR TX antibiotic OR TX polyantibiotic OR TX sterile OR TX chlorhexidine OR TX povidone-iodine		
S3	TX bath* OR TX hygiene OR TX cleans* OR TX cleaned OR TX cleaning OR TX topical OR TX applied OR TX apply OR TX application	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete
S2	TX meatal OR TX meatus OR TX perineal OR TX perineum OR TX periurethral	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete
S1	TX urinary catheter* OR TX urethral catheter* OR TX indwelling catheter* OR TX intermittent catheter*	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete

#	Query	Limiters/Expanders	Last Run Via
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S3	S1 AND S2	Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE Complete
S2	bundle OR bundle care OR bundle intervention	Limiters - Date of Publication: 20160101- 20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE Complete
S1	urinary catheter* OR urethral catheter* OR indwelling catheter* OR intermittent catheter* OR "urinary tract infection"	Limiters - Date of Publication: 20160101- 20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE Complete
#	Query	Limiters/Expanders	Last Run Via
S5	S1 AND S2 AND S3 AND S4	Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE Complete
S4	antiseptic* OR antimicrobial OR antibacterial OR anti-infective OR disinfect* OR microbicide OR antibiotic OR polyantibiotic OR sterile OR chlorhexidine OR povidone-iodine	Limiters - Date of Publication: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE Complete
S3	bath* OR hygiene OR cleans* OR cleaned OR cleaning OR topical OR applied OR apply OR application	Limiters - Date of Publication: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases

			Search Screen - Advanced Search Database - MEDLINE Complete
S2	meatal OR meatus OR perineal OR perineum OR periurethral	Limiters - Date of Publication: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EMBASEhost Research Databases Search Screen - Advanced Search Database - MEDLINE Complete
S1	urinary catheter* OR urethral catheter* OR indwelling catheter* OR intermittent catheter	Limiters - Date of Publication: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EMBASEhost Research Databases Search Screen - Advanced Search Database - MEDLINE Complete

	EMBASE
1	urinary catheter.mp. or urinary catheter/ or indwelling catheter/
2	meatal.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
3	meatus.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
4	perineal.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
5	perineum.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
6	periurethral.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
7	bath*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]

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8	hygiene.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
9	cleans*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
10	cleaned.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
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12	topical.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
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21	microbicide.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
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25	7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15
26	16 or 17 or 18 or 19 or 20 or 21 or 22 or 23
27	1 and 24 and 25 and 26
28	27 and 2016:2020.(sa_year).

	EMBASE
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3	indwelling catheter*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
4	intermittent catheter*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]

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5	urinary tract infection.mp. or urinary tract infection/
6	bundle care.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
7	bundle intervention.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
8	bundle.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
9	1 or 2 or 3 or 4 or 5
10	6 or 7 or 8
11	9 and 10
12	limit 11 to yr="2016 -Current"

	Cochrane Library
#1	(urinary catheter*) OR (urethral catheter*) OR (indwelling catheter*) OR (intermittent catheter*)
#2	(meatal) OR (meatus) OR (perineal) OR (perineum) OR (periurethral)
#3	(bath) OR (hygiene) OR (clean*) OR (topical) OR (appl*)
#4	(antiseptic*) OR (antimicrobial) OR (antibacterial) OR ("anti-infective") OR (disinfect*)
#5	(antibiotic) OR (polyantibiotic) OR (sterile)
#6	#1 AND #2 AND #3 AND #4 AND #5

	Cochrane Library
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#1	(urethral catheter*) OR (intermittent catheter*) OR (indwelling catheter*) OR (urinary catheter*) OR (“urinary tract infection”)		
#2	(bundle) OR (“bundle care”) OR (“bundle intervention”)		
#3	#1 AND #2		
#	Query	Limiters/Expanders	Last Run Via
S5	S1 AND S2 AND S3 AND S4	Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete
S4	TX antiseptic* OR TX antimicrobial OR TX antibacterial OR TX anti-infective OR TX disinfect* OR TX microbicide OR TX antibiotic OR TX polyantibiotic OR TX sterile OR TX chlorhexidine OR TX povidone-iodine	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete
S3	TX bath* OR TX hygiene OR TX cleans* OR TX cleaned OR TX cleaning OR TX topical OR TX applied OR TX apply OR TX application	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete
S2	TX meatal OR TX meatus OR TX perineal OR TX perineum OR TX periurethral	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete

S1	TX urinary catheter* OR TX urethral catheter* OR TX indwelling catheter* OR TX intermittent catheter*	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete
#	Query	Limiters/Expanders	Last Run Via
S3	S1 AND S2	Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete
S2	TX bundle care OR TX bundle OR TX bundle intervention	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete
S1	TX urinary catheter* OR TX urethral catheter* OR TX indwelling catheter* OR TX intermittent catheter* OR TX urinary tract infection	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete

PubMed	
Search	Query

#3	Search (((((((urinary catheter*) OR urethral catheter*) OR indwelling catheter*) OR intermittent catheter*) OR urinary tract infection) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat]))) AND (((("bundle care") OR "bundle intervention") OR bundle) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat])) Filters: Publication date from 2016/01/01 to 2020/02/29
#2	Search (("bundle care") OR "bundle intervention") OR bundle Filters: Publication date from 2016/01/01 to 2020/02/29
#1	Search (((urinary catheter*) OR urethral catheter*) OR indwelling catheter*) OR intermittent catheter*) OR urinary tract infection Filters: Publication date from 2016/01/01 to 2020/02/29

PubMed	
Search	Query
#8- searches 4 and 7	Search (((((((((((urinary catheter*) OR urethral catheter*) OR indwelling catheter*) OR intermittent catheter*) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat]))) AND (((((meatal) OR meatus) OR perineal) OR perineum) OR periurethral) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat]))) AND (((((((bath*) OR hygiene) OR cleans*) OR cleaned) OR cleaning) OR topical*) OR apply) OR applied) OR application) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat]))) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat]))) AND (((((((((((antiseptic) OR antimicrobial) OR antibacterial) OR "anti-infective") OR disinfect*) OR microbicide) OR polyantibiotic) OR sterile) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat]))) AND (((((((("bacitracin zinc") OR "polymyxin b") OR "povidone-iodine") OR betadine) OR cetrimide) OR chlorhexidine) OR savlon) OR sulfadiazine) OR sulphadiazine) OR neomycin) OR gramicidin) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat]))) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat])) Filters: Publication date from 2016/01/01 to 2020/02/29
#7- searches 5 and 6	Search (((((((((((antiseptic) OR antimicrobial) OR antibacterial) OR "anti-infective") OR disinfect*) OR microbicide) OR polyantibiotic) OR sterile) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat]))) AND (((((((("bacitracin zinc") OR "polymyxin b") OR "povidone-iodine") OR betadine) OR cetrimide) OR chlorhexidine) OR savlon) OR sulfadiazine) OR sulphadiazine) OR neomycin) OR gramicidin) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat])) Filters: Publication date from 2016/01/01 to 2020/02/29
#6	Search (((((((("bacitracin zinc") OR "polymyxin b") OR "povidone-iodine") OR betadine) OR cetrimide) OR chlorhexidine) OR savlon) OR sulfadiazine) OR sulphadiazine) OR neomycin) OR gramicidin Filters: Publication date from 2016/01/01 to 2020/02/29

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#5	Search (((((((antiseptic) OR antimicrobial) OR antibacterial) OR "anti-infective") OR disinfect*) OR microbicide) OR polyantibiotic) OR sterile Filters: Publication date from 2016/01/01 to 2020/02/29
#4- searches 1, 2 and 3	Search (((((((urinary catheter*) OR urethral catheter*) OR indwelling catheter*) OR intermittent catheter*) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat]))) AND ((((((meatal) OR meatus) OR perineal) OR perineum) OR periurethral) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat]))) AND (((((((bath*) OR hygiene) OR cleans*) OR cleaned) OR cleaning) OR topical*) OR apply) OR applied) OR application) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat])) Filters: Publication date from 2016/01/01 to 2020/02/29
#3	Search (((((((bath*) OR hygiene) OR cleans*) OR cleaned) OR cleaning) OR topical*) OR apply) OR applied) OR application Filters: Publication date from 2016/01/01 to 2020/02/29
#2	Search (((((meatal) OR meatus) OR perineal) OR perineum) OR periurethral) Filters: Publication date from 2016/01/01 to 2020/02/29
#1	Search (((urinary catheter*) OR urethral catheter*) OR indwelling catheter*) OR intermittent catheter* Filters: Publication date from 2016/01/01 to 2020/02/29

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PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and if available, provide registration information including registration number.	N/A
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5-6
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	4
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I ²) for each meta-analysis.	7



PRISMA 2009 Checklist

Page 1 of 2

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	6
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	7
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICO, follow-up period) and provide the citations.	7
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	9
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	7-9 + Supplementary
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	7-9 + Supplementary
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	Figure 4
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	Supplementary
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	16
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	17
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	17
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data, role of funders for the systematic review).	18

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

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BMJ Open

The effectiveness of meatal cleaning in the prevention of catheter-associated urinary tract infections and bacteriuria: An updated systematic review and meta-analysis

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2020-046817.R1
Article Type:	Original research
Date Submitted by the Author:	25-Mar-2021
Complete List of Authors:	Mitchell, Brett; The University of Newcastle - Central Coast Campus, School of Nursing and Midwifery Curryer, Cassie; The University of Newcastle - Central Coast Campus, School of Nursing and Midwifery Holliday, Elizabeth; The University of Newcastle, School of Medicine and Public Health Rickard, Claire; Griffith University, School of Nursing and Midwifery; Griffith University, Alliance for Vascular Access Teaching and Research (AVATAR), Menzies Health Institute Queensland Fasugba, Oyebola; Australian Catholic University, Nursing Research Institute, St Vincent's Health Network Sydney
Primary Subject Heading:	Nursing
Secondary Subject Heading:	Infectious diseases
Keywords:	Infection control < INFECTIOUS DISEASES, Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, PREVENTIVE MEDICINE, Urinary tract infections < UROLOGY

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3 1 **TITLE**
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5 2 The effectiveness of meatal cleaning in the prevention of catheter-associated urinary tract
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7 3 infections and bacteriuria: An updated systematic review and meta-analysis
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9 4

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27 **ABSTRACT**

28 **Objective:** A systematic review on meatal cleaning prior to urinary catheterisation and post
29 catheterisation and reduces the risk catheter-associated urinary tract infections (CAUTIs)
30 and bacteriuria was published in 2017, with further studies undertaken since this time. The
31 objective of this paper is to present an updated systematic review on the effectiveness of
32 antiseptic cleaning of the meatal area for the prevention of CAUTIs and bacteriuria in
33 patients who receive a urinary catheter.

34 **Design:** Systematic review

35 **Data sources:** Electronic databases Cochrane Library, PubMed, Embase, CINAHL, Medline
36 and Academic Search Complete were searched from 1 January 2016 and 29 February 2020.

37 **Eligibility criteria:** Randomised controlled trials and quasi-experimental studies evaluating
38 the use of antiseptic, antibacterial or non-medicated agents for cleaning the meatal,
39 periurethral or perineal areas before indwelling catheter insertion or intermittent
40 catheterisation or during routine meatal care.

41 **Data extraction and synthesis:** Data were extracted using the Cochrane Collaboration's data
42 collection form for RCTs and non-RCTs. Data were extracted by one researcher and then
43 checked for accuracy by a second researcher.

44 **Results:** A total of 18 studies were included. Some potential benefit of using antiseptics,
45 compared to non-antiseptics for meatal cleaning to prevent bacteriuria and or CAUTI was
46 identified (OR 0.84, 95% CI 0.69-1.02; P=0.071). Antiseptics (chlorhexidine or povidine-
47 iodine) may be of value for meatal cleaning on the incidence of CAUTI, compared to
48 comparator agents (saline, soap or antimicrobial cloths) (OR=0.65, 95% CI 0.42-0.99;
49 P=0.047).

50 **Conclusion:** There is emerging evidence of the role of some specific antiseptics
51 (chlorhexidine) prior to urinary catheterisation, in reducing CAUTIs, and some potential
52 benefit to the role of antiseptics more generally in reducing bacteriuria.

53 **PROSPERO registration number:** CRD42015023741

54 **Strengths and limitations of this study**

- 56 • A summary of the latest evidence on the role of antiseptics in reducing catheter
57 associated urinary tract infections
- 58 • Sub-group analysis to explore effects using different antiseptics

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- Heterogeneity of population groups is a limitation

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61 INTRODUCTION

62 Indwelling or intermittent urinary catheter use can result in bacteriuria which may signify
63 either colonisation (catheter-associated asymptomatic bacteriuria) or symptomatic infection
64 (catheter-associated urinary tract infections).¹ Catheter-associated urinary tract infections
65 (CAUTIs) are a common but preventable nosocomial infection. They account for around 70-
66 80% of hospital-acquired UTIs, are associated with longer length of hospital stay and
67 increased risk of morbidity and mortality.²⁻⁵ In the UK, economic analyses of hospital
68 inpatient costs estimated that CAUTIs caused over 45,000 excess bed days, 1,467 deaths,
69 and a loss of 10,471 quality-adjusted life years (QALYs).⁶ The burden of CAUTIs for both
70 patients and health services highlight the importance of reducing these infections in
71 healthcare settings.

72
73 Various strategies for reducing the risk of CAUTIs have been proposed. These include
74 reducing unnecessary catheter use, practicing appropriate catheter insertion and
75 maintenance, and prompt removal of urinary catheters.⁷⁻⁹ A systematic review published in
76 2017 explored the effect of using different meatal (peri-urethral) cleaning agents prior to
77 urinary catheter insertion on the incidence of UTIs.¹⁰ Meatal cleaning was identified by the
78 review as one element of urinary catheter care which may reduce CAUTI risk.¹⁰ However,
79 the review also identified uncertainty in the available evidence for the effectiveness of this
80 practice. Since this publication there have been further studies published on this topic,^{11 12}
81 and the evidence base is still evolving. Moreover, some previous studies were limited by
82 bias (e.g. selection bias, non-masking of intervention).^{11 13} Given the potential importance of
83 meatal cleaning for preventing UTIs and informing clinical practice and guidelines, we
84 believed it was important to update the evidence base.¹⁰ In this paper, we present findings
85 from an updated systematic review and meta-analysis. The aim of this review is to
86 determine the effectiveness of antiseptic cleaning of the meatal area, for preventing CAUTI
87 and bacteriuria.

89 METHODS

90 A protocol was developed to guide the conduct of the systematic review and meta-analysis,
91 and we have used a reporting approach consistent with the Preferred Reporting Items for
92 Systematic Reviews and Meta-analyses (PRISMA) statement.¹⁴ The methodological approach

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2
3 93 used in this systematic review is the same as that used in the initial publication,¹⁰
4
5 94 PROSPERO International Prospective Register of Systematic reviews (Registration No:
6
7 95 CRD42015023741). Studies included in the final synthesis from the initial publication were
8
9 96 combined with studies identified as part of the updated search strategy.
10
11 97

12

12 98 ***Data sources and search strategy***

13
14 99 The electronic databases Cochrane Library, PubMed, Embase, CINAHL, Medline and
15
16 100 Academic Search Complete were used to undertake the search. Search parameters were
17
18 101 adjusted to suit database requirements. A search of the databases was limited to the period
19
20 102 between 1 January 2016 and 29 February 2020. The 1st January 2016 represents the end
21
22 103 date of the search from the initial review.¹⁰ Keywords and MeSH terms used were: urinary
23
24 104 catheter and/or urinary catheterisation, urinary tract infection, meatal cleaning, periurethral
25
26 105 cleaning, antiseptic, antimicrobial, antibacterial, antibiotic, and topical intervention. Further
27
28 106 details on the search strategy are provided as supplementary material.
29
30 107

31

31 108 ***Study inclusion and exclusion criteria***

32
33 109 Included studies were randomised controlled trials (RCTs) and quasi-experimental studies
34
35 110 (pre-and post-test design, non RCTs) evaluating the use of antiseptic, antibacterial or non-
36
37 111 medicated agents (such as soap and water) for cleaning the meatal, periurethral or perineal
38
39 112 areas before indwelling catheter insertion or intermittent catheterisation or during routine
40
41 113 meatal care. Studies were included if they involved patients requiring short- or long-term
42
43 114 indwelling catheters or intermittent catheterisation in hospitals, community settings, and
44
45 115 long-term/aged care facilities. Studies were excluded if they were not published in English
46
47 116 language, focused solely on children (≤ 18 years), included patients with pre-existing UTIs, or
48
49 117 were published in grey literature (conference abstracts, editorial letters, reports and
50
51 118 guidelines). Review articles, bundle interventions, studies without available data for
52
53 119 analysis, studies that did not evaluate the control or intervention agents, and studies for
54
55 120 which the full-text was not available were also excluded.
56
57 121

58

56 122 The co-primary outcome measures were the difference in rates of CAUTI and bacteriuria in
57
58 123 the intervention and control groups. While we accepted the definition of CAUTI and
59
60

1
2
3 124 bacteriuria provided in the included studies, we also considered infection to be the outcome
4
5 125 when clinical signs or symptoms of infection were present.¹⁵
6
7 126

8 9 127 **Study selection**

10 128 Database results were imported into Covidence for screening and selection.¹⁶ Screening of
11
12 129 abstracts of articles retrieved from electronic databases for relevance to the systematic
13
14 130 review aim was undertaken by one researcher (CC). Ten percent of the abstracts were cross
15
16 131 checked by a second researcher (BM). No discrepancies were found. Full-text screening was
17
18 132 then undertaken and assessed against the inclusion and exclusion criteria by CC. A cross
19
20 133 check of all studies deemed to meet the inclusion criteria was also undertaken by BM. A
21
22 134 manual search of the references lists of all included articles was undertaken to identify
23
24 135 additional studies. Where decisions were open to disagreement, this was resolved by
25
26 136 discussion with other members of the research team (EGH and OF).
27
28 137

29 138 **Data extraction**

30 139 The data from included studies were extracted using the Cochrane Collaboration's data
31
32 140 collection form for RCTs and non-RCTs. Data were extracted by one researcher (CC) and
33
34 141 then checked for accuracy by a second researcher (BM). Extracted details included: age and
35
36 142 sex distribution of the study population, study duration, sample size, study setting, type of
37
38 143 intervention and duration, colony-forming unit (cfu/mL) count, bacteriuria and CAUTI rates
39
40 144 (numerator/denominator data). For studies that reported the outcome at multiple time
41
42 145 points, the outcome value closest to the end of the indwelling catheter in-situ period was
43
44 146 extracted for analysis. Attempts were made to contact the authors of included studies
45
46 147 where information was missing regarding the numerator or denominator data for
47
48 148 calculating CAUTI rates, and when clarity was needed on the type of intervention used. One
49
50 149 author was contacted regarding inaccuracies in reporting results and the author responded
51
52 150 by sending the corrected version of the study manuscript.
53
54 151

55 152 **Risk of bias assessment**

56 153 Using Covidence and following the Cochrane Collaboration's Handbook for Systematic
57
58 154 Reviews of Interventions (v6., 2019), the risk of bias for studies were evaluated.¹⁷ Risk of
59
60 155 bias was assessed as high, unclear or low. Risk of bias assessment was conducted

1
2
3 156 independently by two researchers (OF and CC) and disagreements resolved by discussion
4
5 157 with a third researcher (BM).
6
7
8 158
9
10 159

11 160 **Data analysis**

12
13 161 Data analyses were undertaken using Stata Version 14 (StataCorp, College Station, TX, USA).
14
15 162 Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated from the proportions
16
17 163 of patients with CAUTI and bacteriuria in the intervention and control groups. The pooled
18
19 164 ORs were calculated and compared across intervention and control groups using the
20
21 165 DerSimonian and Laird random effects meta-analysis model which considers possible
22
23 166 heterogeneity between the studies during analysis.¹⁸ The likelihood of clinical heterogeneity
24
25 167 in the included studies with regards to varying meatal cleaning agents used was considered
26
27 168 in the a-priori data synthesis strategy. Hence, the meta-analysis was stratified by the
28
29 169 outcome and type of meatal cleaning agent used. The I^2 statistic was used to quantify
30
31 170 between-study heterogeneity of intervention effects. Subgroup analyses were undertaken
32
33 171 to explore effects of aspects of study methodology (antiseptic vs non-antiseptic cleaning
34
35 172 and administration of the intervention prior to urinary catheter insertion) on the outcome
36
37 173 using a fixed effect model due to the low number of studies.^{19 20} Assessment of reporting
38
39 174 biases was by visual examination of the funnel plot. A 0.05 level of significance was used
40
41 175 without adjustment for multiplicity (number of comparisons of meatal cleaning agents).
42
43 176 Effect sizes and their precision, in addition to significance were considered when
44
45 177 interpreting the results.
46

46 179 **Patient and Public Involvement**

47
48 180 No patient involved.
49
50 181

51 182 **RESULTS**

52
53 183 In total, 927 articles were retrieved from electronic database searches and their abstracts
54
55 184 were screened for relevance to the systematic review aim. After evaluating these articles
56
57 185 against the inclusion and exclusion criteria, four studies were identified for inclusion. These
58
59
60

1
2
3 186 four studies were added to the 14 studies included in the previous review,¹⁰ hence a total 18
4
5 187 studies were included in this systematic review and meta-analysis (Figure 1).
6
7 188

8
9 189 The characteristics of the included studies are presented in Table 1. The majority of studies
10
11 190 were RCTs (n=15). There was considerable diversity in the types of interventions (meatal
12
13 191 cleaning agent) used and whether the intervention was applied to the meatal area during
14
15 192 ongoing meatal care, prior to catheter insertion only or a combination of both. Of the 18
16
17 193 studies, two compared povidone-iodine with routine (or standard) meatal care, which
18
19 194 involved removal of debris from the catheter during bathing;^{21 22} one compared green soap
20
21 195 with routine meatal care;²¹ four compared an antibacterial agent (Neomycin-polymyxin B,
22
23 196 1% silver sulfadiazine Silvadene, 2% polynoxylin) with routine meatal care;²³⁻²⁶ two
24
25 197 compared chlorhexidine (0.1% and 0.3% plus and 3% centrimide) with tap water;^{27 28} three
26
27 198 compared povidone-iodine with soap and water;^{13 29 30} one compared chlorhexidine (0.1%)
28
29 199 with saline;¹¹ one compared povidone-iodine with saline;³¹ two compared povidone-iodine
30
31 200 with sterile water;^{12 32} one compared povidone-iodine with tap water;³³ and one compared
32
33 201 antimicrobial cloth with chlorhexidine (2%) compared to a non-antimicrobial cloth.³⁴
34
35 202

36 203 The term 'infection' was often referred to as the primary outcome in studies. However, the
37
38 204 definition of 'infection' varied and for most studies, this term was used when bacteria were
39
40 205 present in the urine with or without clinical symptoms. We recoded outcomes to be either
41
42 206 bacteriuria or infection – where the definition of infection must have included
43
44 207 signs/symptoms of a UTI. Two studies reported CAUTI as the only outcome, 15 studies
45
46 208 reported bacteriuria as the only outcome and one study reported both CAUTI and
47
48 209 bacteriuria as outcomes.
49
50 210

51 211 ***Effect of meatal cleaning on the incidence of bacteriuria and CAUTI***

52 212 A forest plot displaying the results of random-effect meta-analyses for the effect of meatal
53
54 213 cleaning on the incidence of both bacteriuria and CAUTI combined, stratified by meatal
55
56 214 cleaning agent is presented in Figure 2. For the study that reported both CAUTI and
57
58 215 bacteriuria as outcomes,¹¹ only data for bacteriuria were included because bacteriuria was
59
60 216 the outcome in majority of studies. There was no evidence of differences in the incidence of
217
218 219 bacteriuria or CAUTI between the intervention and control groups when comparing the

1
2
3 218 different agents: povidone-iodine vs routine care (OR 1.19, 95% CI 0.75-1.87; P=0.46); green
4
5 219 soap and water vs routine care (OR 1.59, 95% CI 0.85-2.96; P=0.15), chlorhexidine vs tap
6
7 220 water (OR 1.04, 95% CI 0.59-1.83; P=0.89); povidone-iodine vs soap and water (OR 0.88,
8
9 221 95% CI 0.48-1.62; P=0.69); povidone-iodine vs saline (OR 1.13, 95% CI 0.53-2.41; P=0.76);
10
11 222 povidone-iodine vs sterile water (OR 0.42, 95% CI 0.14-1.24; P=0.12); povidone-iodine vs tap
12
13 223 water (OR 0.80, 95% CI 0.22-2.97; P=0.74) and chlorhexidine vs antimicrobial cloths (OR
14
15 224 0.67, 95% CI 0.39-1.18; P=0.17).
16
17 225

18 226 There was potential evidence of a small difference in the incidence of bacteriuria or CAUTI
19
20 227 between the intervention and control groups overall (pooled OR 0.84, 95% CI 0.69-1.02;
21
22 228 P=0.071), with the CI nearly excluding 1. This also applies to the comparison of antibacterial
23
24 229 agent vs routine care (OR 0.75, 95% CI 0.55-1.01; P=0.055). The comparison of chlorhexidine
25
26 230 vs saline demonstrated statistical evidence of differences between the intervention and
27
28 231 control group (OR 0.40, 95% CI 0.21-0.74; P=0.003). Overall results showed evidence of
29
30 232 heterogeneity ($I^2=13.2%$; P=0.296) among the included studies.
31
32 233

33 234 Separate forest plots showing the effect of meatal cleaning on the incidence of bacteriuria
34
35 235 and CAUTI are presented as supplementary material (Figure S1 and Table S1, and Figure S2,
36
37 236 respectively). Sixteen studies were included in the meta-analysis evaluating the effect of
38
39 237 meatal cleaning on the incidence of bacteriuria only while three studies were included in the
40
41 238 meta-analysis evaluating the effect of meatal cleaning on the incidence of CAUTI only.^{11 29 34}
42
43 239 Analyses showed no statistically significant difference in the incidence of bacteriuria (pooled
44
45 240 OR 0.84, 95% CI 0.70-1.01; P=0.06), noting this was close to being statistically significant. In
46
47 241 addition, 12 of the 16 studies in this meta-analysis had findings in the same direction, a
48
49 242 benefit to antiseptics (Figure S1). In contrast, there was a statistically significant difference
50
51 243 in the effect of meatal cleaning using an antiseptic (chlorhexidine or povidine-iodine) versus
52
53 244 a comparator agents (saline, soap or antimicrobial cloths) on the incidence of CAUTI (pooled
54
55 245 OR 0.65, 95% CI 0.42-0.99; P=0.047), Figure S2.
56
57 246

58 247 ***Effect of antiseptic vs non-antiseptic meatal cleaning prior to urinary catheterisation on***
59
60 248 ***the incidence of bacteriuria***

1
2
3 249 Six studies explored the effect of using an antiseptic meatal cleaning agent prior to catheter
4
5 250 insertion, compared to a non-antiseptic agent, on the incidence of bacteriuria (Figure 3).¹¹
6
7 251^{12 27 28 30 33} There was evidence of a potential difference in the incidence of bacteriuria when
8
9 252 comparing the use of antiseptic and non-antiseptic agents (pooled OR=0.67, 95% CI 0.44-
10
11 253 1.03; P=0.065) (Figure 3).
12
13 254

14 255 ***Effect of antiseptic vs non-antiseptic meatal cleaning prior to urinary catheterisation on***
15
16 256 ***the incidence of CAUTI***

17
18 257 Two studies explored the effect of using an antiseptic meatal cleaning agent prior to
19
20 258 catheter insertion, compared to a non-antiseptic agent, on the incidence of CAUTI.^{11 29} One
21
22 259 used 10% povidone-iodine and found no difference,²⁹ while the other study used
23
24 260 chlorhexidine (0.1%) and identified a significant reduction in CAUTI¹¹ (Figure S3).
25
26 261

27 262 ***Risk of bias***

28
29 263 Results showed that the level of risk of bias varied between the included studies (Figure 4).
30
31 264 The majority of studies (n=15) were assessed to have a high or unclear risk of bias for
32
33 265 reporting of blinding processes used in the studies. The vast majority of studies were biased
34
35 266 in the categories of allocation and performance. The studies conducted by Noto et al,³⁴ and
36
37 267 Fasugba et al,¹¹ were deemed to be at lowest risk of bias.
38
39 268

40 269 ***Publication bias***

41
42 270 Visual inspection of the funnel plot showed no evidence of publication bias (Figure 5).
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Table 1. Characteristics of studies included in the systematic review and meta-analysis

Study author, year and design	Country	Population	Administration	Frequency of application	Outcome	Outcome definition	Mean age (SD)	Intervention			Cases	Control	
								Intervention agent	Alcohol-containing agent	Mean age (SD)		Comparator agent	Cases
Burke et al., 1981a; RCT ²¹	USA	Medical and surgical patients	Daily meatal care while IDC in situ	Twice daily	Bacteriuria	≥10 ³ cfu/mL	NR	10% povidone-iodine Betadine solution and ointment	Yes, parath-25-9 as inactive ingredient	32/200	NR	Usual care; removal of debris from catheter during bathing	24/194
Burke et al., 1981a; RCT ²¹	USA	Medical and surgical patients	Daily meatal care while IDC in situ	Once daily	Bacteriuria	≥10 ³ cfu/mL	NR	Green soap and water	Assumed yes, 30% ethyl alcohol as solution	28/228	NR	Usual care; removal of debris from catheter during bathing	18/223
Burke et al., 1983; RCT ²³	USA	Medical and surgical patients	Daily meatal care while IDC in situ, until UTI found	Twice daily	Bacteriuria	≥10 ³ cfu/mL	NR	Neomycin-polymyxin B-bacitracin ointment	No	14/214	NR	Usual care; removal of debris from catheter during bathing	16/214
Carapeti et al., 1996; RCT ²⁷	UK	General surgery patients	On IDC insertion for surgery	Once for surgery	Bacteriuria (+/- symptoms)	>10 ⁵ cfu/mL	67.5	0.3% CHG and 3% centrimide Savlon solution	Yes, 2.84% isopropyl alcohol, 0.056% benzyl benzoate and	7/74	65.3	Tap water	9/82

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Study author, year and design	Country	Population	Administration	Frequency of application	Outcome	Outcome definition	Mean age (SD)	Intervention			Control		
								Intervention agent	Alcohol-containing agent	Cases	Mean age (SD)	Comparator agent	Cases
									terpineol as excipient ingredients				
Classen et al., 1991a; RCT ²⁴	USA	Medical and surgical patients	Daily meatal care while IDC in situ, until UTI found	Thrice daily	Bacteriuria	$\geq 10^3$ cfu/mL	NR	Polymyxin B sulfate, neomycin sulfate, gramicidin Neosporin cream	Yes, propylene glycol as non-medicinal ingredient	26/38	NR	Routine meatal care; removal of debris from catheter during bathing	37/364
Classen et al., 1991b; RCT ²²	USA	Medical and surgical patients	Daily meatal care while IDC in situ, until UTI found	Once daily	Bacteriuria	$\geq 10^3$ cfu/mL	NR	2% Lugol's Iodine povidone-iodine solution	Unclear, assumed no	14/30	NR	Routine meatal care; removal of debris from catheter during bathing	15/306
Duffy et al., 1995; RCT ²⁹	USA	Male veterans in long-term care	Pre-IC and IDC	Pre-IC, ~thrice daily	Infection	$\geq 10^5$ cfu/mL + symptoms	72.6 (10.8)	10% povidone-iodine Betadine solution	Yes, parath-25-9 as inactive ingredient	26/42	70.9 (12.1)	Soap and water	21/38
Fasugba et al., 2019; RCT ¹¹	Australia	Medical and surgical patients, ICU	On IDC insertion	Once, before insertion	Infection & Bacteriuria	CAUTI: CDC/NHSN	NR	0.1% CHG solution	No	UTI: 4/94	NR	0.9% saline	UTI 13/697

Study author, year and design	Country	Population	Administration	Frequency of application	Outcome	Outcome definition	Intervention				Control			
							Mean age (SD)	Intervention agent	Alcohol-containing agent	Cases	Mean age (SD)	Comparator agent	Cases	
						Bacteriuria: ≥10 ⁵ cfu/mL					Bacteriuria 16/94			Bacteriuria 29/697
Huth et al., 1992; quasi-RCT ²⁵	USA	Medical and surgical patients	Daily meatal care while IDC in situ	Twice daily	Bacteriuria	≥10 ³ cfu/mL	61	1% silver sulfadiazine Silvadene cream	Yes, stearyl alcohol, isopropyl myristate and propylene glycol as vehicle ingredients	38/33	63	Usual care; removal of debris from catheter during bathing	48/364	
Ibrahim & Rashid, 2002; RCT ³¹	Saudi Arabia	Male transurethral surgery patients	On IDC insertion, and in daily application while IDC in situ	Once daily	Bacteriuria	10 ⁵ cfu/mL	66.7 (10.1)	Povidone-iodine solution	Unclear, assumed no	19/64	66 (10.4)	Saline	18/66	
Jeong et al., 2010; quasi-RCT ¹³	South Korea	Female ICU patients	On IDC insertion, and in daily meatal care while IDC in situ	Once daily	Bacteriuria*	CDC/NHSN	61.5 (17.3)	10% povidone-iodine solution	Unclear, assumed no	9/28	64.1 (13.3)	Soap and water	10/22	

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Study author, year and design	Country	Population	Administration	Frequency of application	Outcome	Outcome definition	Intervention				Control		
							Mean age (SD)	Intervention agent	Alcohol-containing agent	Cases	Mean age (SD)	Comparator agent	Cases
Kara & Ozyurek, 2017; RCT ³²	Turkey	ICU, surgical and medical patients	On IDC insertion, and in daily meatal care while IDC in situ	Once daily	Bacteriuria	$\geq 10^5$ cfu/mL	66.34 (14)	Sterile water	No	7/32	67.96 (12)	Sterile water	7/32
King et al., 1992; RCT ³⁰	USA	SCI rehabilitation inpatients	Pre-IC	Pre-IC, once per 4-6 hours	Bacteriuria	$\geq 10^4$ cfu/mL with symptoms	32.8 (13.7)	Povidone-iodine solution	Unclear, assumed no	13/23	27.9 (10.3)	Castile soap wipe	15/23
Lynch et al., 1991; quasi-RCT ²⁶	UK	Male transurethral surgery patients	On IDC insertion, and in daily meatal care while IDC in situ	Once daily	Bacteriuria	$> 10^5$ cfu/mL	67 (9.7)	2% polynoxylin Anaflex spray	Yes, formaldehyde as active ingredient	6/50	68 (8.4)	No intervention	11/50
Nasiriani et al., 2009; RCT ³³	Iran	Female gynaecological surgery patients	On IDC insertion for surgery	Once for surgery	Bacteriuria	$> 10^5$ cfu/mL	NR	Povidone-iodine solution	Unclear, assumed no	5/30	NR	Tap water	6/30
Noto et al., 2015; RCT ³⁴	USA	Surgical, medical and ICU patients	Daily bathing including meatal care	Once daily	Infection	CAUTI: CDC/NHSN	NR	2% CHG Cloths	No	20/488	NR	Non-antimicrobial bath cloth	32/4852

Study author, year and design	Country	Population	Administration	Frequency of application	Outcome	Outcome definition	Intervention			Control			
							Mean age (SD)	Intervention agent	Alcohol-containing agent	Cases	Mean age (SD)	Comparator agent	Cases
Nugraha et al., 2019; RCT ¹²	Java	Surgical and medical patients; (n=4, 12.5% aged 16-20 years)	On IDC insertion	Once, before insertion	Bacteriuria	Presence of bacteriuria; (cfu/mL level NR)	NR	10% povidone-iodine solution	Unclear, assumed no	2/16	NR	Sterile water	5/16
Webster et al., 2001; RCT ²⁸	Australia	Pregnant obstetrics patients	On IDC insertion for delivery	Once for delivery	Bacteriuria	≥10 ⁶ cfu/mL	NR	0.1% CHG solution	No	20/20	NR	Tap water	18/219

Note: cfu: colony forming units; CHG: chlorhexidine gluconate; IC: intermittent catheterisation; ICU: intensive care unit; IDC: indwelling catheter; NR: not reported; RCT: randomised controlled trial; SCI: spinal cord injury; SD: standard deviation; UK: United Kingdom; USA: United States of America; UTI: urinary tract infection. Information on alcohol-containing agent ingredients assumed from research; no information on alcohol-containing agents available in included paper * Positive UTI was assessed on following criteria: fever ≥38 degrees, suprapubic pain, dysuria, urethral erythema, purulent drainage around the catheter exit, presence of bacteria, pyuria (pus ≥3/ml in unspun urine), urine culture to stand on the presence of UTI (? ≥10⁵ cfu/mL, see CDC 2015), and white blood cell (WBC) count to prove presence of infection. # The results reported in the paper were incorrect. Authors were contacted for clarification, data in the table reflect clarification from authors. + Author state based "on the CDC definition of UTI, in particular, asymptomatic bacteriuria", with a reference supporting bacteriuria, therefore bacteriuria was assumed

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271 DISCUSSION

272 Findings from this systematic review suggest that broadly speaking, using antiseptics for
273 meatal cleaning may reduce the risk of bacteriuria or CAUTI in some instances, but
274 uncertainty remains for antiseptics as a broad group. The uncertainty is in part driven by the
275 diversity of antiseptics reviewed and variations in outcomes and populations. Although the
276 odds ratios are not statistically significant at a level of 0.05,³⁵ the results are clinically
277 meaningful for some specific subsets of antiseptics and or outcomes. For this reason, we
278 discuss some important subsets below, including limitations. The evidence appears to be
279 stronger and more consistent, for example prior to urinary catheterisation. There also
280 appears to be emerging evidence that using chlorhexidine prior to urinary catheterisation
281 may provide benefit in reducing CAUTI. Preventing CAUTI is important for a number of
282 reasons. Prevention of CAUTI is vital, not only because of associated morbidity, mortality
283 and increased length of stay in hospital,²⁻⁵ but because of the added threats posed by
284 increasing antimicrobial resistance.³⁶

285

286 **The effect of meatal cleaning in reducing the risk of bacteriuria**

287 The meta-analysis exploring the effect of meatal cleaning in reducing the risk of bacteriuria,
288 included studies that used antiseptics for routine meatal cleaning, for example post catheter
289 insertion, as well as studies using antiseptics as part of the catheter insertion process (prior
290 to urinary catheterisation) (Figure 2). The antiseptics used in studies included in this meta-
291 analysis also varied (Table 1). When all studies were combined, the results indicated a
292 potential benefit of using antiseptics, in reducing the risk bacteriuria or CAUTI (pooled OR
293 0.84, 95% CI 0.70-1.01). It is also worth noting that 13 of the 18 studies in Figure 2 had point
294 estimates less than one i.e. direction favouring antiseptics. Although not statistically
295 significant at an arbitrary level of 0.05, these results have clinical implications, noting it is
296 difficult to interpret given the heterogeneity of antiseptics and timing of their use. In sub-
297 analysis, some benefit of using an antibacterial agent vs routine (standard) care was
298 identified (OR 0.75, 95% CI 0.55-1.01). Bacteriuria as a clinical outcome is arguably of little
299 clinical relevance. However, studies to date have largely used this as the primary outcome.
300 We discuss the results related to CAUTI later in this discussion. One argument in favour
301 of bacteriuria as an outcome, is that reducing this may reduce antimicrobial use. Research

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2
3 302 has indicated the frequency of inappropriate treatment for bacteriuria. In supplementary
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5 303 material, results using a random effect model are also presented (Figure S3, S4, S5 and S6).
6
7 304

8 305 **The use of antiseptics prior to urinary catheterisation**

9
10 306 In studies specifically exploring the use of antiseptics prior to urinary catheterisation, a
11
12 307 meta-analysis indicated some value of antiseptics in preventing bacteriuria, compared to
13
14 308 non-antiseptic agents (pooled OR=0.67, 95% CI 0.44-1.03; P=0.065). Five of the six studies
15
16 309 included in the meta-analysis had findings in the same direction, a benefit to antiseptics
17
18 310 (Figure 3). The meta-analysis was largely influenced by two studies, indicating differing
19
20 311 results, but both using chlorhexidine 0.1%. One of these two studies, a multi-centre study
21
22 312 involving three hospitals and included all patients in each hospital, indicated a statistically
23
24 313 significant benefit when using antiseptics (chlorhexidine 0.1%).¹¹ The second study, a single
25
26 314 centre study in an obstetric population, indicated no benefit, with a non-statistically
27
28 315 significant result.²⁸ For consistency, in the meta-analysis, the outcomes presented were
29
30 316 bacteriuria.
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34 319 **The use of antiseptics prior to urinary catheterisation and effect on CAUTI**

35
36 320 Arguably the most important clinical outcome is CAUTI. We identified two studies evaluating
37
38 321 the use of antiseptics prior to catheterisation, with CAUTI as the primary outcome.^{11 29}
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40 322 These two studies used different antiseptics. Fasugba and colleagues found a significant
41
42 323 reduction in CAUTI, associated with the use of chlorhexidine 0.1% (IRR 0.06, 95% CI 0.01-
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44 324 0.32, <p=0.001).¹¹ In a follow up cost-effectiveness evaluation, the authors found that using
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46 325 chlorhexidine 0.1% was cost saving.³⁷ Duffy et al, evaluated the use of povidone-iodine prior
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48 326 to catheterisation, in participants who had indwelling catheters or were undertaking
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50 327 intermittent catheterisation.²⁹ Duffy and colleagues did not identify a benefit from using
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52 328 povidone-iodine.²⁹ It is worth noting other important differences. The control phase
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54 329 included a clean catheterisation technique, i.e. not requiring a sterile field. The intervention
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56 330 phase, which used povidone-iodine, also included the use of a sterile procedure. The
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58 331 average follow-up period for participants was 63 days. As time from catheter insertion
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60 332 increases, the likelihood of an infection being related to insertion practices diminishes.
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3 334 In contrast, participants in the study undertaken by Fasugba et al were followed up for 7
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5 335 days only. Further, unlike the study by Duffy and colleagues, there were no other major
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7 336 changes that could potentially confound the outcome – such as a change in the procedure.¹¹

8
9 337 The risk of bias assessment also suggests less bias in the study undertaken by Fasugba.

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11 338
12 339 There were no report adverse events using low dose chlorhexidine prior to
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14 340 catheterisation.¹¹ Chlorhexidine prior to catheterisation is anticipated to have high
15
16 341 acceptability noting it is already used in many clinical settings. Like most antiseptics,
17
18 342 feasibility is unlikely to be an issue, given the relative ease of implementation, only requiring
19
20 343 a simple product substitution. The cost-effectiveness (& cost saving) for the use of
21
22 344 chlorhexidine 0.1% has been demonstrated and accounted for uncertainty, thus reducing
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24 345 equity issues.³⁷

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27 348 **Limitations**

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29 349 A limitation of this review is that data extraction was undertaken by one person, noting that
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31 350 a second reviewer checked data extraction for accuracy. There was considerable
32
33 351 heterogeneity in intervention and population groups, in particular those presented in Figure
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35 352 2. We acknowledge that two of the authors of this systematic review led one of the included
36
37 353 studies.¹¹ To ensure there was balance, we included three authors on this paper that had no
38
39 354 involvement in this study.

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42 357 **Conclusion**

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44 358 This paper represents the latest evidence on the role of using antiseptics in people with
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46 359 urinary catheters, for the purpose of infection prevention. In turn, we hope this will inform
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48 360 local policy and practice, as well as infection control guidelines more generally. The results
49
50 361 from this review suggest that antiseptics may be of value for meatal cleaning on the
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52 362 incidence of CAUTI, compared to non-antiseptic agents. In other areas of infection
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54 363 prevention and control, rather than a “broad brush” approach to determining the effect of
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56 364 antiseptics on a specific outcome, often individual agents are examined. For example in the
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58 365 case of prevention of surgical site infection, comparisons have been made for chlorhexidine

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3 366 versus iodophor or alcoholic versus non-alcoholic based antiseptics.^{38 39} The evidence to
4
5 367 support the role of antiseptics as a broad group in reducing bacteriuria and CAUTI is
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7 368 challenged by variations in the diversity of antiseptics and the utility of bacteriuria as an
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9 369 outcome. Based on the evidence identified in this review and after careful consideration of
10
11 370 the outcomes and methods used in included studies, we believe there is emerging but
12
13 371 limited evidence of the role of chlorhexidine 0.1% prior to urinary catheterisation, in
14
15 372 reducing CAUTI. However, we acknowledge this evidence is limited to one multi-centred
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17 373 study. Given the low number of included studies using CAUTI as the primary outcome,
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19 374 additional studies in this area are required, ensuring that important confounders are
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21 375 controlled for in the study design.
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376

377 **ETHICS APPROVAL**

378 As this is a systematic review, ethics approval was not required.

379

380 **CONFLICT OF INTEREST**

381 Dr. Mitchell reports personal fees from MSD, grants from Cardinal Health, grants from
382 Senver, outside the submitted work.

383

384

385 **FUNDING**

386 No funding was received for this study.

387

388 **DATA AVAILABILITY STATEMENT**

389 Please contact authors as required.

390

391 **AUTHORSHIP STATEMENT**

392 OF and BM designed the study. OF conducted the search. CC conducted the primary review
393 of the articles and data extraction. CC, OF, and BM conducted the risk of bias assessment.
394 OF, BM and EGH conducted the analysis. All authors (BM, OF, CC, EGH, CR) provided input
395 into the interpretation of the data, writing the paper, provided critical review and approved
396 the final version of the paper.

397

398 REFERENCES

- 399 1. Hooton TM, Bradley SF, Cardenas DD, et al. Diagnosis, prevention, and treatment of catheter-associated urinary tract infection in adults: 2009 International Clinical Practice Guidelines
400 from the Infectious Diseases Society of America. *Clin Infect Dis* 2010;50(5):625-63.
- 401 2. Lo E, Nicolle LE, Coffin SE, et al. Strategies to prevent catheter-associated urinary tract infections
402 in acute care hospitals: 2014 update. *Infection Control & Hospital Epidemiology*
403 2014;35(S2):S32-S47.
- 404 3. Smith DR, Pouwels KB, Hopkins S, et al. Epidemiology and health-economic burden of urinary-
405 catheter-associated infection in English NHS hospitals: a probabilistic modelling study.
406 *Journal of Hospital Infection* 2019;103(1):44-54.
- 407 4. Daniels KR, Lee GC, Frei CR. Trends in catheter-associated urinary tract infections among a
408 national cohort of hospitalized adults, 2001-2010. *American journal of infection control*
409 2014;42(1):17-22.
- 410 5. Mitchell BG, Ferguson JK, Anderson M, et al. Length of stay and mortality associated with
411 healthcare-associated urinary tract infections: a multi-state model. *Journal of Hospital*
412 *Infection* 2016;93(1):92-99.
- 413 6. Smith DRM, Pouwels KB, Hopkins S, et al. Epidemiology and health-economic burden of urinary-
414 catheter-associated infection in English NHS hospitals: a probabilistic modelling study. *J Hosp*
415 *Infect* 2019;103(1):44-54. doi: 10.1016/j.jhin.2019.04.010 [published Online First:
416 2019/05/03]
- 417 7. Meddings J, Rogers MAM, Krein SL, et al. Reducing unnecessary urinary catheter use and other
418 strategies to prevent catheter-associated urinary tract infection: an integrative review. *BMJ*
419 *Quality & Safety* 2013 doi: 10.1136/bmjqs-2012-001774
- 420 8. Meddings J, Saint S, Krein SL, et al. Systematic Review of Interventions to Reduce Urinary Tract
421 Infection in Nursing Home Residents. *Journal Of Hospital Medicine* 2017;12(5):356-68. doi:
422 10.12788/jhm.2724
- 423 9. Mitchell BG, Northcote M, Cheng AC, et al. Reducing urinary catheter use using an electronic
424 reminder system in hospitalized patients: a randomized stepped-wedge trial. *Infection*
425 *Control & Hospital Epidemiology* 2019;40(4):427-31.
- 426 10. Fasugba O, Koerner J, Mitchell BG, et al. Systematic review and meta-analysis of the
427 effectiveness of antiseptic agents for meatal cleaning in the prevention of catheter-
428 associated urinary tract infections. *Journal of Hospital Infection* 2017;95(3):233-42. doi:
429 <https://doi.org/10.1016/j.jhin.2016.10.025>
- 430 11. Fasugba O, Cheng AC, Gregory V, et al. Chlorhexidine for meatal cleaning in reducing catheter-
431 associated urinary tract infections: a multicentre stepped-wedge randomised controlled
432 trial. *Lancet Infect Dis* 2019;19(6):611-19. doi: 10.1016/s1473-3099(18)30736-9 [published
433 Online First: 2019/04/17]
- 434 12. Nugraha A, Puspita T, Patimah IIN, et al. Comparison of 10% povidone iodine and sterile water as
435 a periuretra cleansing solution before the insertion of indwelling urynecathetheron the
436 occurrence of bacteria. *International Journal of Pharmaceutical Research (09752366)*
437 2019;11(4):810-16. doi: 10.31838/ijpr/2019.11.04.087
- 438 13. Jeong I, Park S, Jeong JS, et al. Comparison of catheter-associated urinary tract infection rates by
439 perineal care agents in intensive care units. *Asian Nursing Research* 2010;4(3):142-50.
- 440 14. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-
441 analyses: the PRISMA statement. *Int J Surg* 2010;8(5):336-41.
- 442 15. Centers for Disease Control and Prevention. CDC/NHSN Surveillance Definitions for Specific
443 Types of Infections, 2020.
- 444 16. Veritas Health Innovation. Covidence systematic review software. Melbourne, 2020.
- 445 17. Higgins JP, Savović J, Page MJ, et al. Assessing risk of bias in a randomized trial. *Cochrane*
446 *Handbook for Systematic Reviews of Interventions* 2019:205-28.
- 447 18. DerSimonian R, Laird N. Meta-analysis in clinical trials. *Controlled clinical trials* 1986;7(3):177-88.

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2
3 449 19. Tufanaru C, Munn Z, Stephenson M, et al. Fixed or random effects meta-analysis? Common
4 450 methodological issues in systematic reviews of effectiveness. *Int J Evid Based Healthc*
5 451 2015;13(3):196-207. doi: 10.1097/xeb.000000000000065 [published Online First:
6 452 2015/09/12]
- 8 453 20. Mathes T, Kuss O. A comparison of methods for meta-analysis of a small number of studies with
9 454 binary outcomes. *Res Synth Methods* 2018;9(3):366-81. doi: 10.1002/jrsm.1296 [published
10 455 Online First: 2018/03/25]
- 11 456 21. Burke JP, Garibaldi RA, Britt MR, et al. Prevention of catheter-associated urinary tract infections:
12 457 efficacy of daily meatal care regimens. *The American Journal of Medicine* 1981;70(3):655-58.
- 13 458 22. Classen DC, Larsen RA, Burke JP, et al. Prevention of catheter-associated bacteriuria: Clinical trial
14 459 of methods to block three known pathways of infection. *American Journal of Infection
15 460 Control* 1991b;19(3):136-42.
- 17 461 23. Burke JP, Jacobson JA, Garibaldi RA, et al. Evaluation of daily meatal care with poly-antibiotic
18 462 ointment in prevention of urinary catheter-associated bacteriuria. *The Journal of Urology*
19 463 1983;129(2):331-34.
- 20 464 24. Classen DC, Larsen RA, Burke JP, et al. Daily meatal care for prevention of catheter-associated
21 465 bacteriuria results using frequent applications of polyantibiotic cream. *Infection Control &
22 466 Hospital Epidemiology* 1991;12(3):157-62.
- 23 467 25. Huth TS, Burke JP, Larsen RA, et al. Randomized trial of meatal care with silver sulfadiazine cream
24 468 for the prevention of catheter-associated bacteriuria. *Journal of Infectious Diseases*
25 469 1992;165(1):14-18.
- 27 470 26. Lynch M, MacDermott J, Byrne D, et al. Use of an antibacterial powder spray to prevent post
28 471 prostatectomy urinary infection. *Journal of the Royal Society of Medicine* 1991;84(11):667.
- 29 472 27. Carapeti E, Andrews S, Bentley P. Randomised study of sterile versus non-sterile urethral
30 473 catheterisation. *Annals of the Royal College of Surgeons of England* 1996;78(1):59.
- 31 474 28. Webster J, Hood RH, Burrige CA, et al. Water or antiseptic for periurethral cleaning before
32 475 urinary catheterization: a randomized controlled trial. *American Journal of Infection Control*
33 476 2001;29(6):389-94.
- 34 477 29. Duffy LM, Cleary J, Ahern S, et al. Clean intermittent catheterization: Safe, cost-effective bladder
35 478 management for male residents of VA nursing homes. *Journal of the American Geriatrics
36 479 Society* 1995;43(8):865-70.
- 38 480 30. King RB, Carlson CE, Mervine J, et al. Clean and sterile intermittent catheterization methods in
39 481 hospitalized patients with spinal cord injury. *Archives of physical medicine and rehabilitation*
40 482 1992;73(9):798-802.
- 41 483 31. Ibrahim A, Rashid M. Comparison of local povidone-iodine antiseptics with parenteral
42 484 antibacterial prophylaxis for prevention of infective complications of TURP: a prospective
43 485 randomized controlled study. *European urology* 2002;41(3):250-56.
- 45 486 32. Kara A, Ozyurek P. The Effect of Periurethral Care and Follow-Up on Bacteriuria in Patients with
46 487 Urinary Catheter: A Comparison of Three Solutions. *Journal of Clinical & Experimental
47 488 Investigations / Klinik ve Deneysel Arastirmalar Dergisi* 2017;8(2):54-60. doi:
48 489 10.5799/jcei.333382
- 49 490 33. Nasiriani K, oh re Kalani Z. Comparison of the Effect of Wa ter Vs. Povidone-Iodine Solution for P
50 491 eriu rethral Cleaning in Wo men Requiring an Indwelling Catheter Prior to Gynecologic Surg e
51 492 ry. *Urologic Nursing* 2009;29(2):119.
- 52 493 34. Noto MJ, Domenico HJ, Byrne DW, et al. Chlorhexidine bathing and health care-associated
53 494 infections: a randomized clinical trial. *Jama* 2015;313(4):369-78.
- 55 495 35. Kyriacou DN. The Enduring Evolution of the P Value. *JAMA* 2016;315(11):1113-15. doi:
56 496 10.1001/jama.2016.2152
- 57 497 36. Paul R. State of the Globe: Rising Antimicrobial Resistance of Pathogens in Urinary Tract
58 498 Infection. *J Glob Infect Dis* 2018;10(3):117-18. doi: 10.4103/jgid.jgid_104_17
- 59
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2
3 499 37. Mitchell BG, Fasugba O, Cheng AC, et al. Chlorhexidine versus saline in reducing the risk of
4 500 catheter associated urinary tract infection: A cost-effectiveness analysis. *International*
5 501 *Journal of Nursing Studies* 2019;97:1-6. doi: 10.1016/j.ijnurstu.2019.04.003
6 502
7 503 38. Peel TN, Watson E, Lee SJ. Randomised Controlled Trials of Alcohol-Based Surgical Site Skin
8 504 Preparation for the Prevention of Surgical Site Infections: Systematic Review and Meta-
9 505 Analysis. *J Clin Med* 2021;10(4) doi: 10.3390/jcm10040663 [published Online First:
10 506 2021/02/13]
11 507 39. Dumville JC, McFarlane E, Edwards P, et al. Preoperative skin antiseptics for preventing surgical
12 508 wound infections after clean surgery. *Cochrane Database of Systematic Reviews* 2015(4) doi:
13 509 10.1002/14651858.CD003949.pub4
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17 Figure 1. PRISMA flow diagram of study selection
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24 Figure 2. Forest plot displaying random-effect meta-analysis of the effect of meatal cleaning on the
25 incidence of bacteriuria and or catheter-associated urinary tract infections (results stratified by
26 meatal cleaning agent).
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29 Note: Duffy et al., 1995 and Noto et al., 2015 all report CAUTI as the outcome, while Fasugba et al.,
30 2019 report both CAUTI and bacteriuria. Bacteriuria data only from Fasugba et al, 2019 is included in
31 this analysis.
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40 Figure 3. Random-effect meta-analysis of the effect of using an antiseptic meatal cleaning agent
41 (povidone-iodine, chlorhexidine) vs a non-antiseptic agent (soap and water, tap water, sterile water
42 or saline) prior to catheter insertion on the incidence of bacteriuria
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52 Figure 4. Risk of bias assessment
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Figure 5. Funnel plot of the included studies

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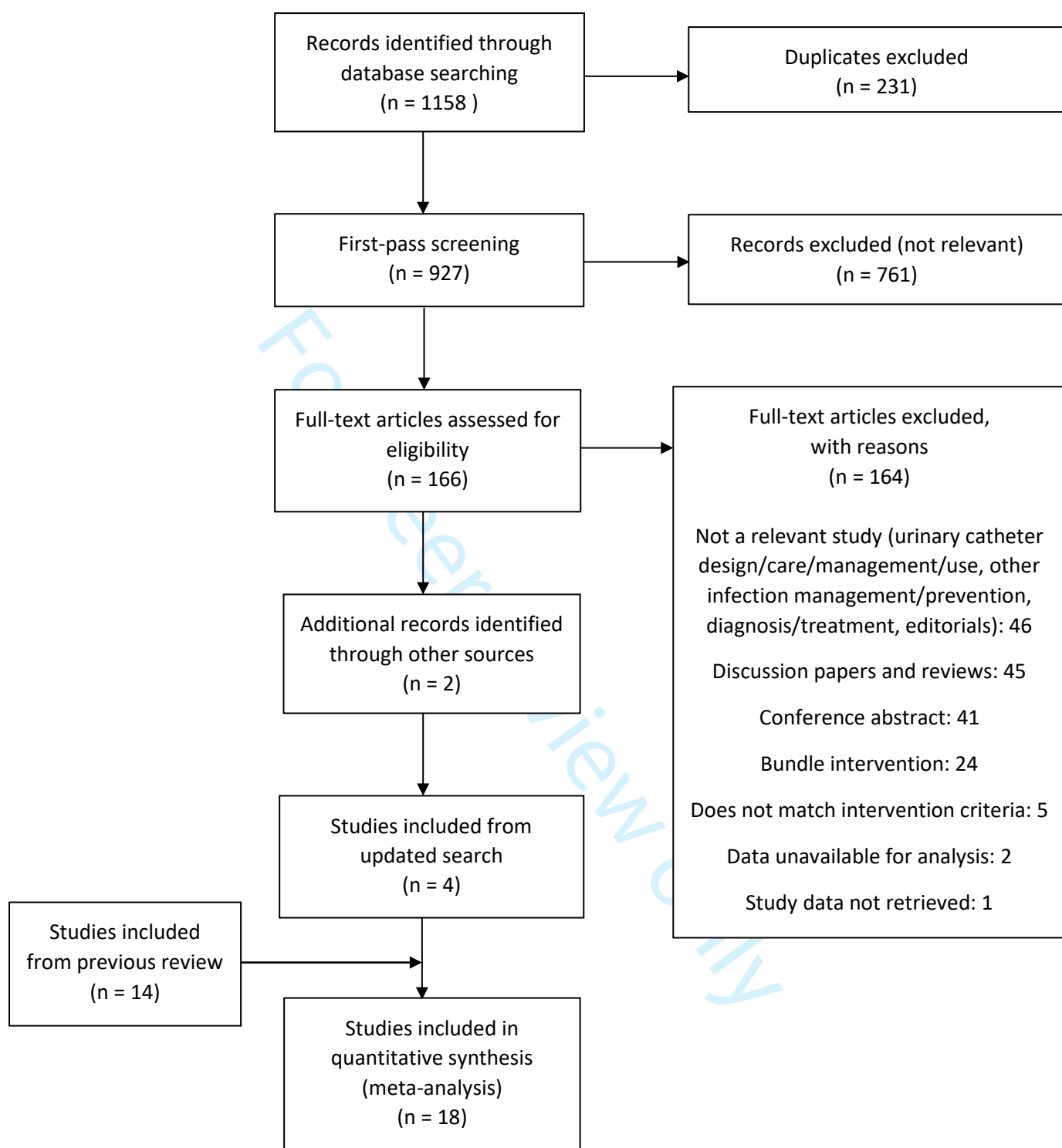


Figure 1. PRISMA flow diagram of study selection

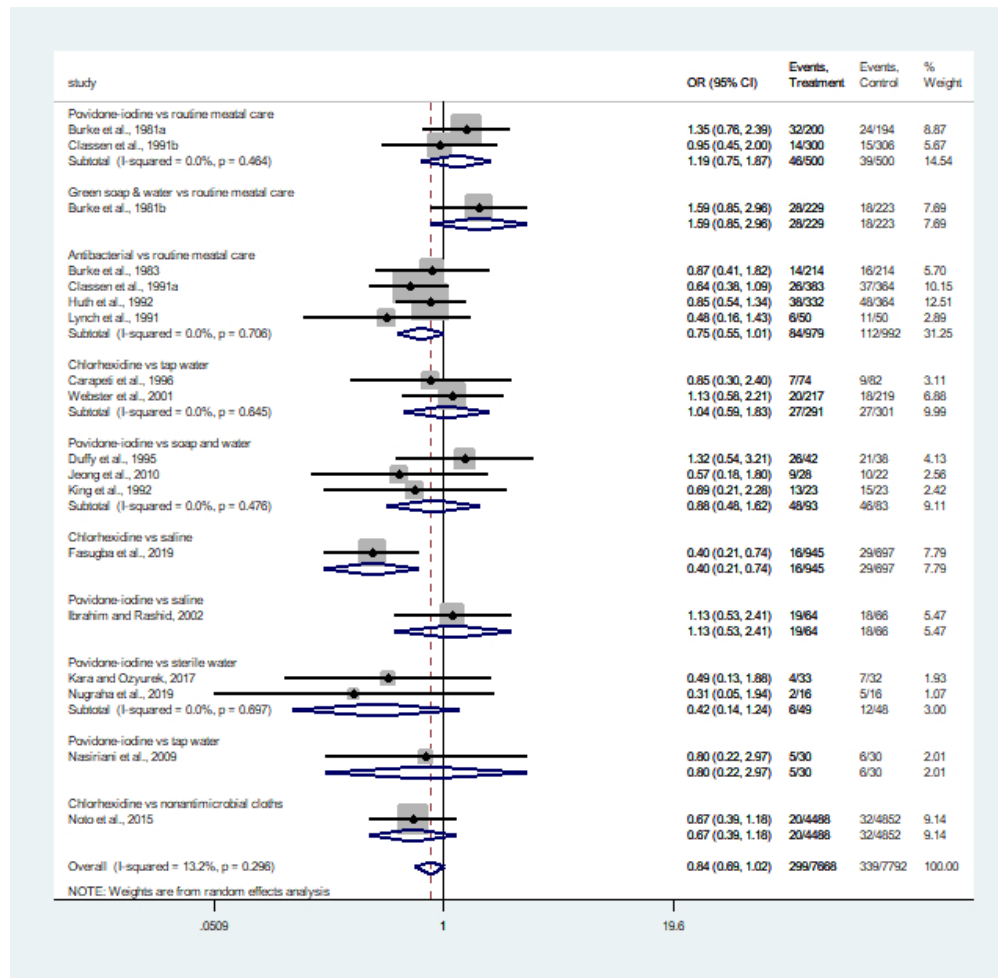


Figure 2. Forest plot displaying random-effect meta-analysis of the effect of meatal cleaning on the incidence of bacteriuria and/or catheter-associated urinary tract infections (results stratified by meatal cleaning agent)

Note: Duffy et al., 1995 and Noto et al., 2015 all report CAUTI as the outcome, while Fasugba et al., 2019 report both CAUTI and bacteriuria. Bacteriuria data only from Fasugba et al, 2019 is included in this analysis.

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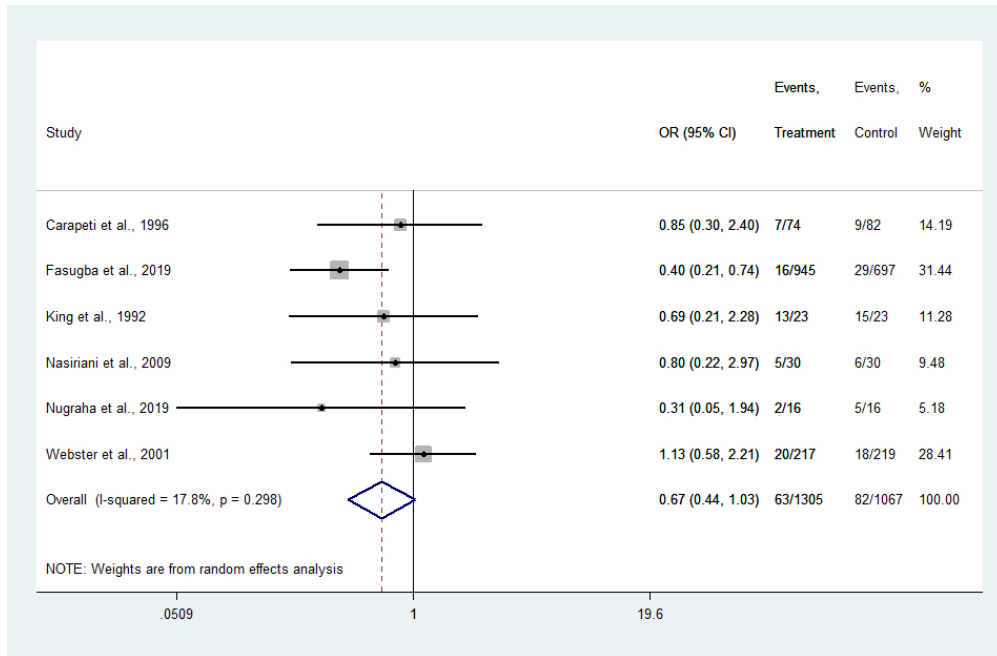


Figure 3. Random-effect meta-analysis of the effect of using an antiseptic meatal cleaning agent (povidone-iodine, chlorhexidine) vs a non-antiseptic agent (soap and water, tap water, sterile water or saline) prior to catheter insertion on the incidence of bacteriuria

335x219mm (72 x 72 DPI)

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	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
AbdElbaky 2020	+	?	?	?	?	+	?
Burke 1981*	?	?	-	?	?	-	?
Burke 1983	?	?	-	?	-	-	?
Carapeti 1996	+	-	-	?	+	+	?
Classen 1991a	?	?	-	?	+	+	?
Classen 1991b	?	?	-	?	+	-	?
Duffy 1995	?	?	-	-	+	+	?
Fasugba 2019	+	?	+	?	+	+	+
Huth 1992	-	-	-	?	-	+	?
Ibrahim 2002	+	?	-	?	+	+	?
Jeong 2010	-	-	-	?	+	+	?
Kara 2017	?	?	?	?	+	+	+
King 1992	?	?	-	?	+	+	?
Lynch 1991	-	-	-	?	+	+	?
Nasiriani 2009	+	?	-	?	-	+	?
Noto 2015	+	-	+	+	+	+	+
Nugraha 2019	?	?	?	?	?	-	-
Webster 2001	+	+	-	+	-	+	?

Figure 4. Risk of bias assessment
113x310mm (72 x 72 DPI)

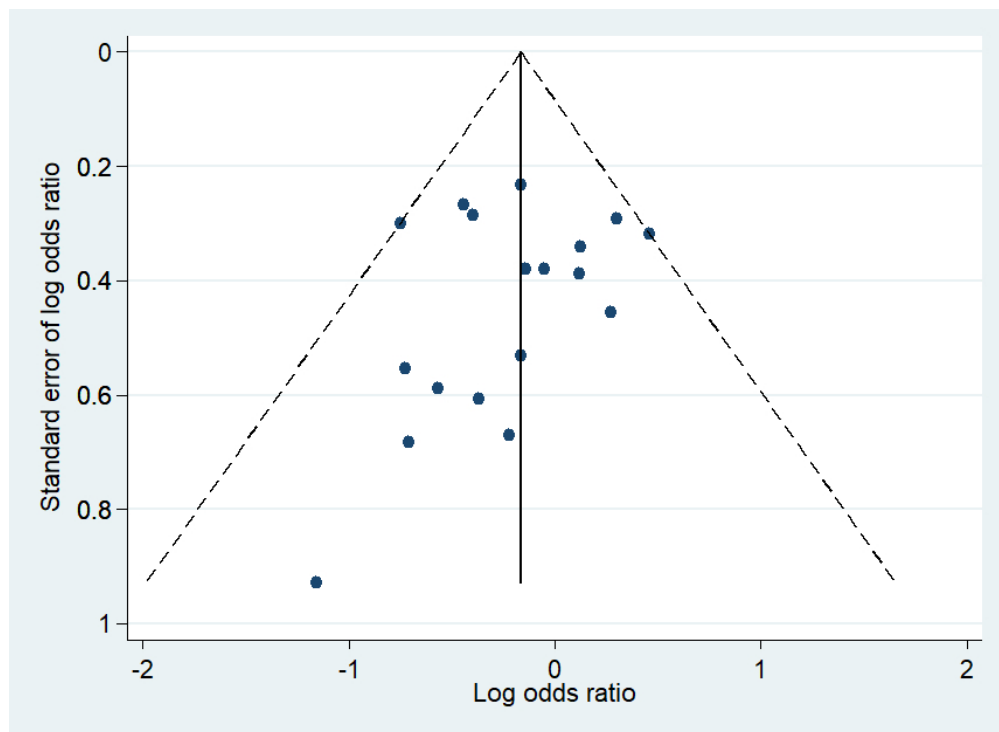


Figure 5. Funnel plot of the included studies

301x219mm (72 x 72 DPI)

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SUPPLEMENTARY MATERIAL

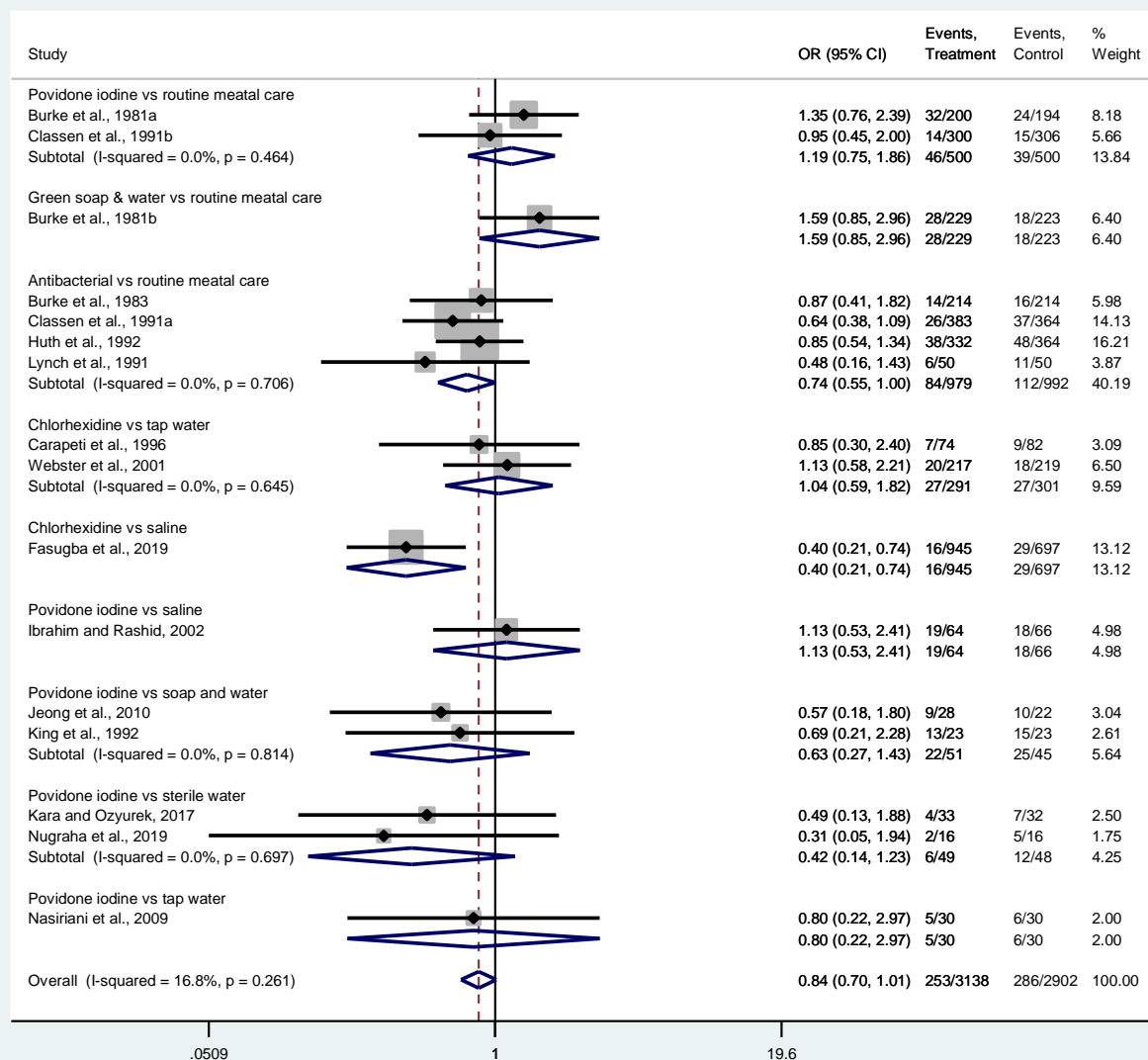


Figure S1. Forest plot displaying fixed-effect meta-analysis of the effect of meatal cleaning on the incidence of bacteriuria only (results stratified by meatal cleaning agent)

Table S1. Comparison of the effect of meatal cleaning on the incidence of bacteriuria only

Comparisons	P values (fixed effect meta-analysis)	P values (random effect meta-analysis)
Povidone-iodine vs routine meatal care	0.460	0.462
Green soap and water vs routine meatal care	0.147	0.147
Antibacterial vs routine meatal care	0.053	0.055
Chlorhexidine vs tap water	0.887	0.886
Chlorhexidine vs saline	0.003	0.012
Povidone-iodine vs saline	0.760	0.760
Povidone-iodine vs soap and water	0.268	0.268
Povidone-iodine vs sterile water	0.113	0.116
Povidone-iodine vs tap water	0.739	0.739
Overall	0.066	0.105

Note: Odds ratio and confident intervals are provided in Figure S1 (fixed effect) and S4 (random-effect). P values presented are to supplement information provided in Figure S1 and Figure S4.

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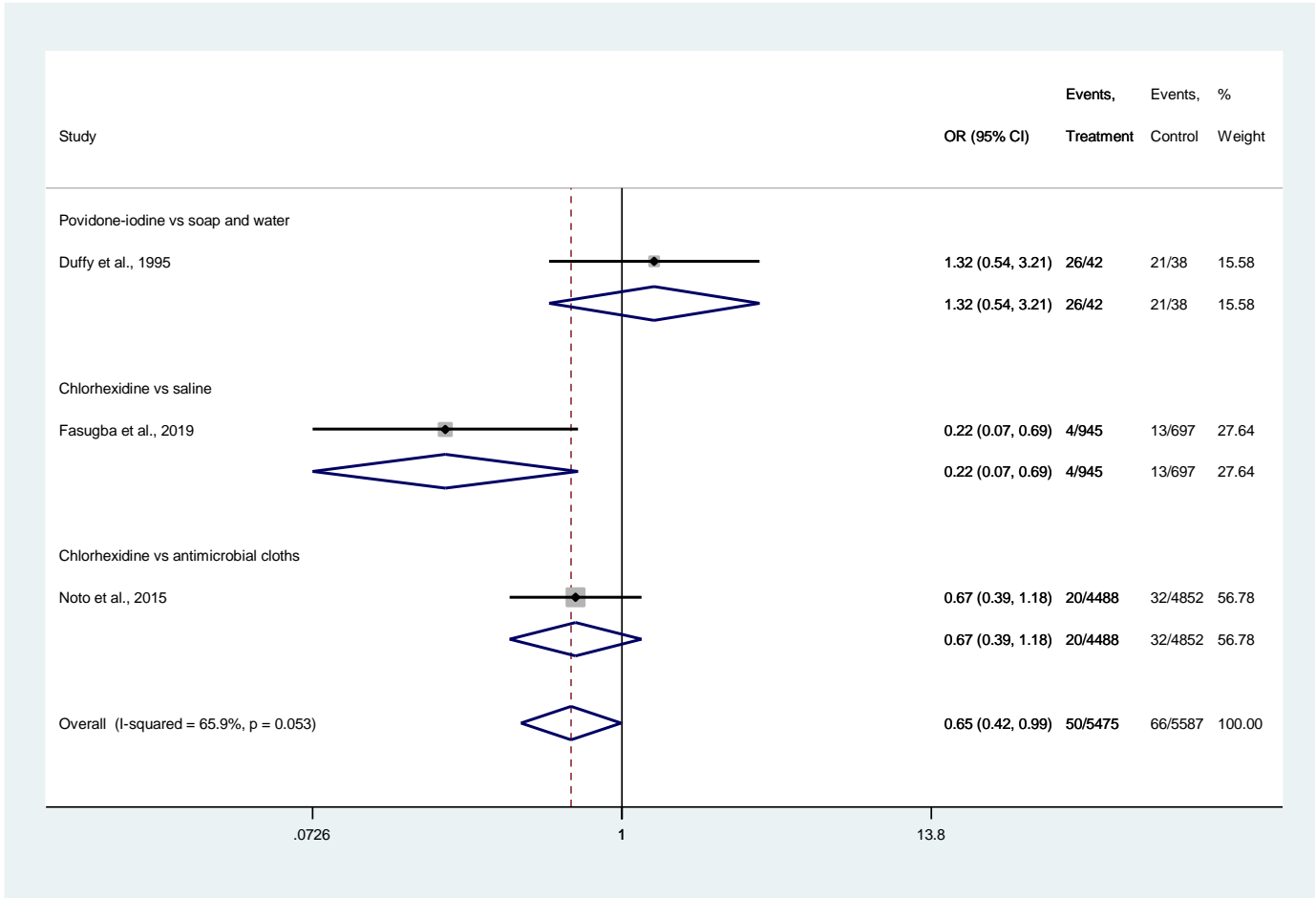


Figure S2 - Forest plot displaying fixed-effect meta-analysis of the effect of meatal cleaning on the incidence of catheter-associated urinary tract infections only (results stratified by meatal cleaning agent)

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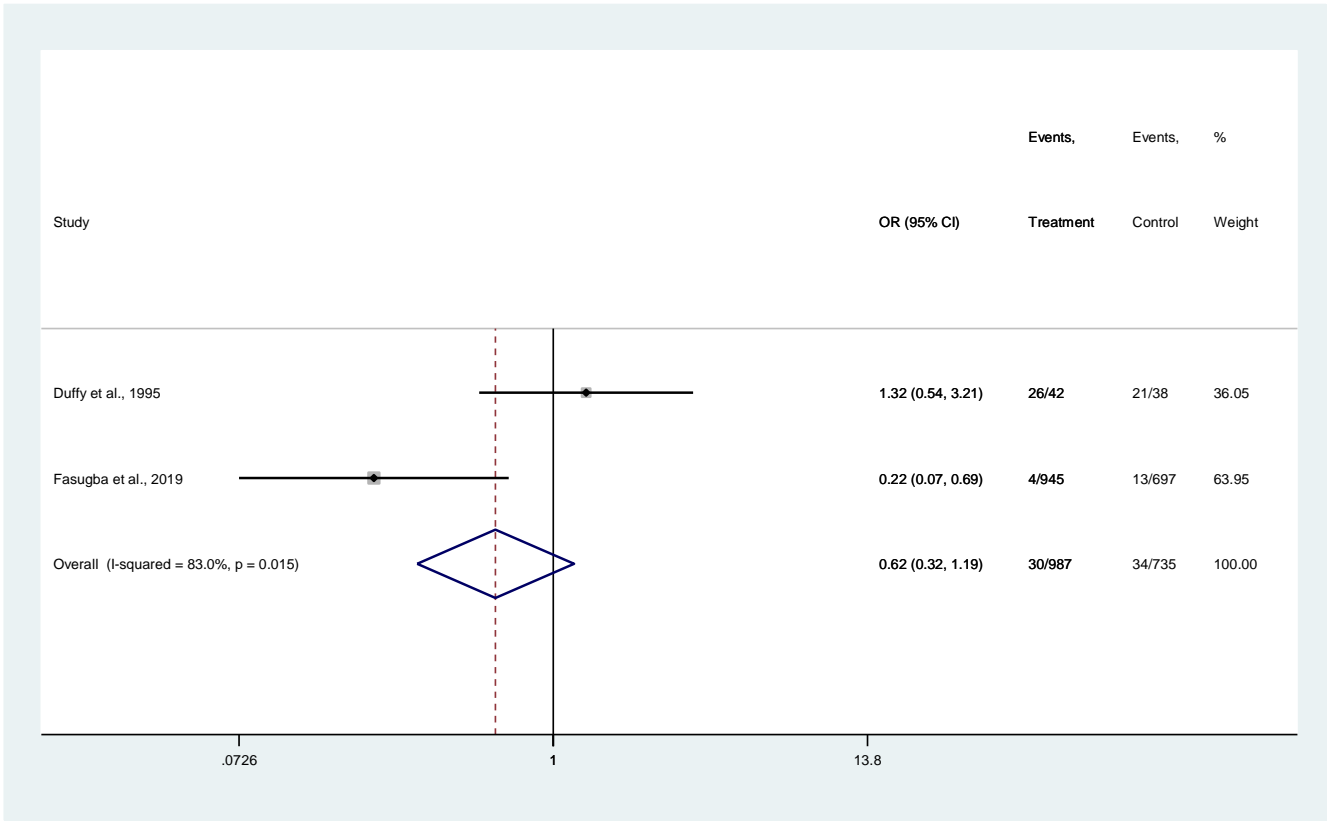


Figure S3. Fixed-effect meta-analysis of the effect of using an antiseptic meatal cleaning agent (povidone-iodine or chlorhexidine) vs a non-antiseptic agent (soap and water or saline) prior to catheter insertion on the incidence of catheter-associated urinary tract infections

252 Analysis using a random effects model

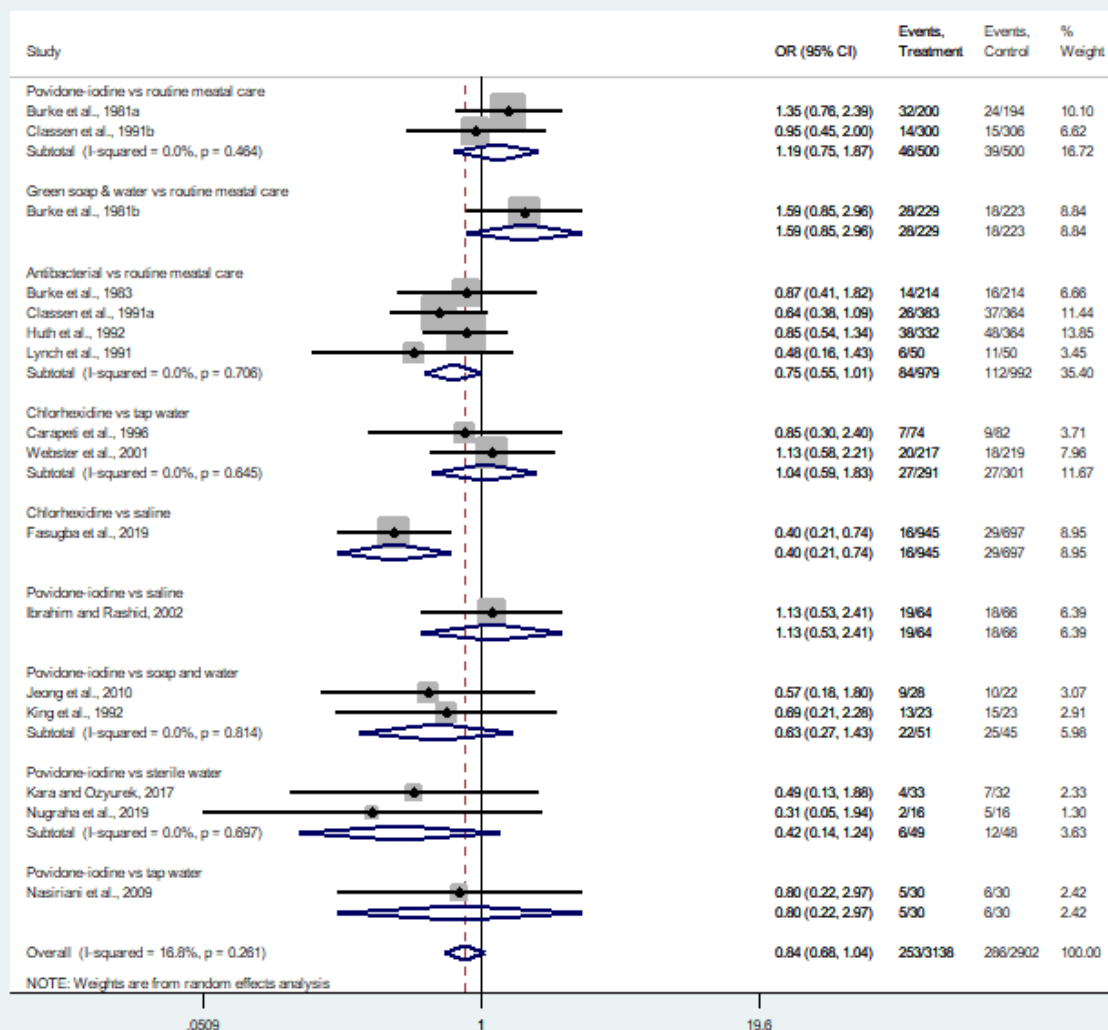


Figure S4. Forest plot displaying random-effect meta-analysis of the effect of meatal cleaning on the incidence of bacteriuria only (results stratified by meatal cleaning agent)

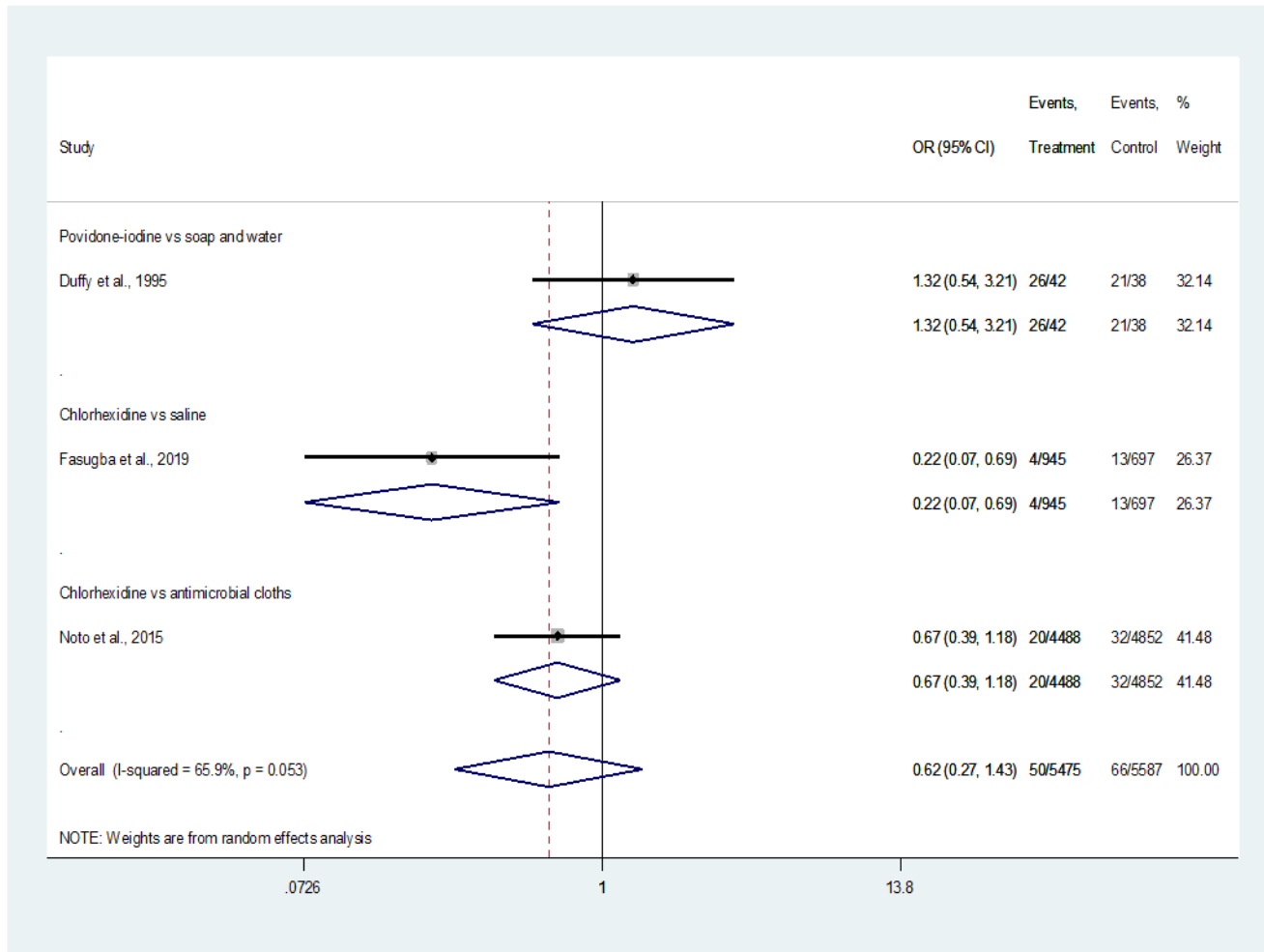


Figure S5. Forest plot displaying random-effect meta-analysis of the effect of meatal cleaning on the incidence of catheter-associated urinary tract infections only (results stratified by meatal cleaning agent)

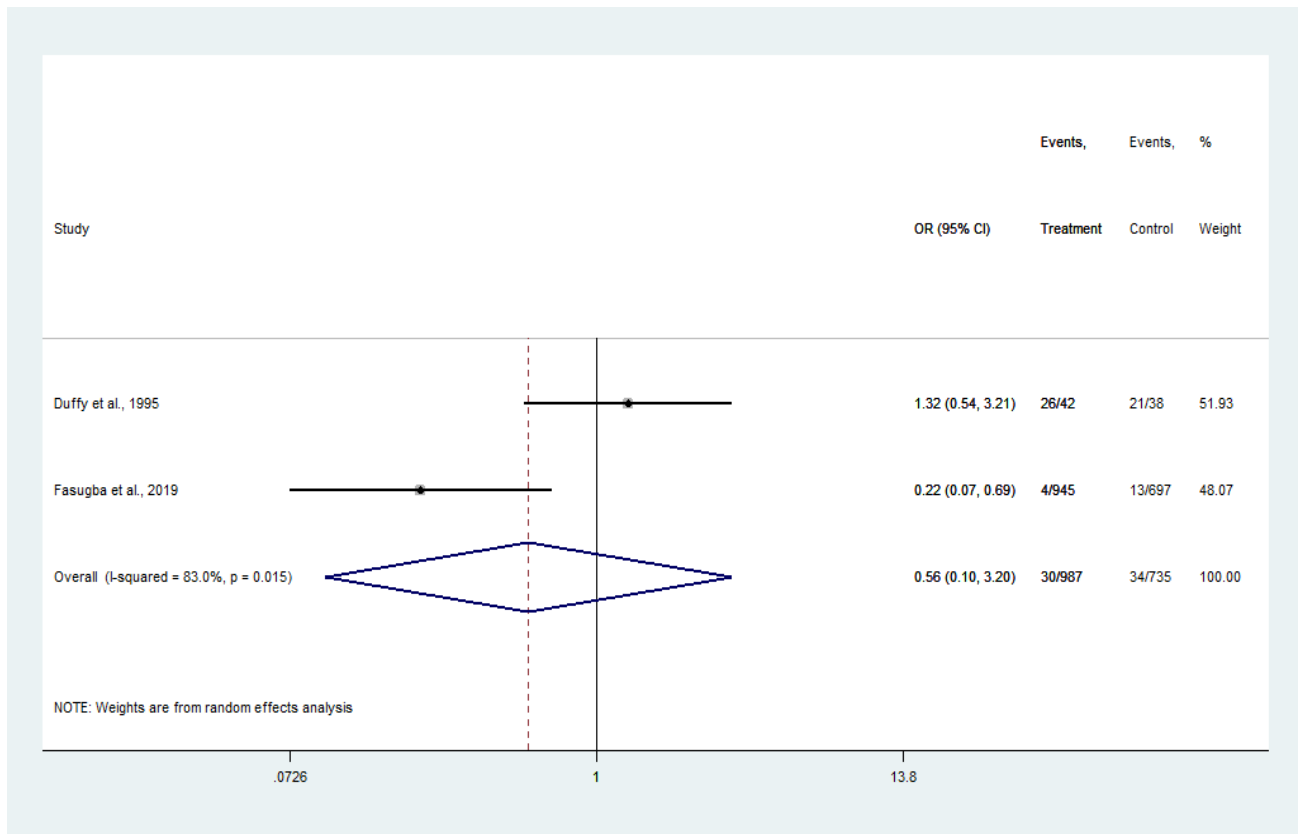


Figure S6. Random-effect meta-analysis of the effect of using an antiseptic meatal cleaning agent (povidone-iodine or chlorhexidine) vs a non-antiseptic agent (soap and water or saline) prior to catheter insertion on the incidence of catheter-associated urinary tract infections

Search strategy

#	Query	Limiters/Expanders	Last Run Via
S5	S1 AND S2 AND S3 AND S4	Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - Academic Search Complete
S4	antiseptic* OR antimicrobial OR antibacterial OR anti-infective OR disinfect OR microbicide OR antibiotic OR polyantibiotic OR sterile OR "bacitracin zinc" OR betadine OR centrimide	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - Academic Search Complete
S3	bath* OR hygiene OR cleans* OR cleaned OR cleaning OR topical OR apply OR applied OR application	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - Academic Search Complete
S2	meatal OR meatus OR perineal OR perineum OR periurethral	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - Academic Search Complete
S1	TX urinary catheter* OR TX urethral catheter* OR TX indwelling catheter* OR TX intermittent catheter	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - Academic Search Complete

#	Query	Limiters/Expanders	Last Run Via
S3	S1 AND S2	Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - Academic Search Complete
S2	bundle intervention OR bundle care	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - Academic Search Complete
S1	TX urinary tract infection OR TX meatal OR TX meatal disinfection OR TX meatal cleaning	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - Academic Search Complete

#	Query	Limiters/Expanders	Last Run Via
S6	S1 AND S2 AND S3 AND S4	Limiters - Human Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete
S5	S1 AND S2 AND S3 AND S4	Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete
S4	TX antiseptic* OR TX antimicrobial OR TX antibacterial OR TX	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete

	anti-infective OR TX disinfect* OR TX microbicide OR TX antibiotic OR TX polyantibiotic OR TX sterile OR TX chlorhexidine OR TX povidone-iodine		
S3	TX bath* OR TX hygiene OR TX cleans* OR TX cleaned OR TX cleaning OR TX topical OR TX applied OR TX apply OR TX application	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete
S2	TX meatal OR TX meatus OR TX perineal OR TX perineum OR TX periurethral	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete
S1	TX urinary catheter* OR TX urethral catheter* OR TX indwelling catheter* OR TX intermittent catheter*	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete

#	Query	Limiters/Expanders	Last Run Via
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S3	S1 AND S2	Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE Complete
S2	bundle OR bundle care OR bundle intervention	Limiters - Date of Publication: 20160101- 20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE Complete
S1	urinary catheter* OR urethral catheter* OR indwelling catheter* OR intermittent catheter* OR "urinary tract infection"	Limiters - Date of Publication: 20160101- 20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE Complete
#	Query	Limiters/Expanders	Last Run Via
S5	S1 AND S2 AND S3 AND S4	Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE Complete
S4	antiseptic* OR antimicrobial OR antibacterial OR anti-infective OR disinfect* OR microbicide OR antibiotic OR polyantibiotic OR sterile OR chlorhexidine OR povidone-iodine	Limiters - Date of Publication: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE Complete
S3	bath* OR hygiene OR cleans* OR cleaned OR cleaning OR topical OR applied OR apply OR application	Limiters - Date of Publication: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases

			Search Screen - Advanced Search Database - MEDLINE Complete
S2	meatal OR meatus OR perineal OR perineum OR periurethral	Limiters - Date of Publication: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EMBASEhost Research Databases Search Screen - Advanced Search Database - MEDLINE Complete
S1	urinary catheter* OR urethral catheter* OR indwelling catheter* OR intermittent catheter	Limiters - Date of Publication: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EMBASEhost Research Databases Search Screen - Advanced Search Database - MEDLINE Complete

	EMBASE
1	urinary catheter.mp. or urinary catheter/ or indwelling catheter/
2	meatal.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
3	meatus.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
4	perineal.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
5	perineum.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
6	periurethral.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
7	bath*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]

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8	hygiene.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
9	cleans*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
10	cleaned.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
11	cleaning.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
12	topical.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
13	applied.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
14	apply.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
15	application.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
16	antiseptic*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
17	antimicrobial.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
18	antibacterial.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
19	anti-infective.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]

20	disinfect*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
21	microbicide.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
22	antibiotic.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
23	polyantibiotic.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
24	2 or 3 or 4 or 5 or 6
25	7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15
26	16 or 17 or 18 or 19 or 20 or 21 or 22 or 23
27	1 and 24 and 25 and 26
28	27 and 2016:2020.(sa_year).

	EMBASE
1	urinary catheter*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
2	urethral catheter*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
3	indwelling catheter*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
4	intermittent catheter*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]

5	urinary tract infection.mp. or urinary tract infection/
6	bundle care.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
7	bundle intervention.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
8	bundle.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
9	1 or 2 or 3 or 4 or 5
10	6 or 7 or 8
11	9 and 10
12	limit 11 to yr="2016 -Current"

	Cochrane Library
#1	(urinary catheter*) OR (urethral catheter*) OR (indwelling catheter*) OR (intermittent catheter*)
#2	(meatal) OR (meatus) OR (perineal) OR (perineum) OR (periurethral)
#3	(bath) OR (hygiene) OR (clean*) OR (topical) OR (appl*)
#4	(antiseptic*) OR (antimicrobial) OR (antibacterial) OR ("anti-infective") OR (disinfect*)
#5	(antibiotic) OR (polyantibiotic) OR (sterile)
#6	#1 AND #2 AND #3 AND #4 AND #5

	Cochrane Library
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#1	(urethral catheter*) OR (intermittent catheter*) OR (indwelling catheter*) OR (urinary catheter*) OR (“urinary tract infection”)		
#2	(bundle) OR (“bundle care”) OR (“bundle intervention”)		
#3	#1 AND #2		
#	Query	Limiters/Expanders	Last Run Via
S5	S1 AND S2 AND S3 AND S4	Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete
S4	TX antiseptic* OR TX antimicrobial OR TX antibacterial OR TX anti-infective OR TX disinfect* OR TX microbicide OR TX antibiotic OR TX polyantibiotic OR TX sterile OR TX chlorhexidine OR TX povidone-iodine	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete
S3	TX bath* OR TX hygiene OR TX cleans* OR TX cleaned OR TX cleaning OR TX topical OR TX applied OR TX apply OR TX application	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete
S2	TX meatal OR TX meatus OR TX perineal OR TX perineum OR TX periurethral	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete

S1	TX urinary catheter* OR TX urethral catheter* OR TX indwelling catheter* OR TX intermittent catheter*	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete
#	Query	Limiters/Expanders	Last Run Via
S3	S1 AND S2	Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete
S2	TX bundle care OR TX bundle OR TX bundle intervention	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete
S1	TX urinary catheter* OR TX urethral catheter* OR TX indwelling catheter* OR TX intermittent catheter* OR TX urinary tract infection	Limiters - Published Date: 20160101-20200231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete

PubMed	
Search	Query

#3	Search (((((((urinary catheter*) OR urethral catheter*) OR indwelling catheter*) OR intermittent catheter*) OR urinary tract infection) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat]))) AND (((("bundle care") OR "bundle intervention") OR bundle) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat])) Filters: Publication date from 2016/01/01 to 2020/02/29
#2	Search (("bundle care") OR "bundle intervention") OR bundle Filters: Publication date from 2016/01/01 to 2020/02/29
#1	Search (((urinary catheter*) OR urethral catheter*) OR indwelling catheter*) OR intermittent catheter*) OR urinary tract infection Filters: Publication date from 2016/01/01 to 2020/02/29

PubMed	
Search	Query
#8- searches 4 and 7	Search (((((((((((urinary catheter*) OR urethral catheter*) OR indwelling catheter*) OR intermittent catheter*) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat]))) AND (((((meatal) OR meatus) OR perineal) OR perineum) OR periurethral) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat]))) AND (((((((bath*) OR hygiene) OR cleans*) OR cleaned) OR cleaning) OR topical*) OR apply) OR applied) OR application) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat]))) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat]))) AND (((((((((((antiseptic) OR antimicrobial) OR antibacterial) OR "anti-infective") OR disinfect*) OR microbicide) OR polyantibiotic) OR sterile) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat]))) AND (((((((("bacitracin zinc") OR "polymyxin b") OR "povidone-iodine") OR betadine) OR cetrimide) OR chlorhexidine) OR savlon) OR sulfadiazine) OR sulphadiazine) OR neomycin) OR gramicidin) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat]))) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat])) Filters: Publication date from 2016/01/01 to 2020/02/29
#7- searches 5 and 6	Search (((((((((((antiseptic) OR antimicrobial) OR antibacterial) OR "anti-infective") OR disinfect*) OR microbicide) OR polyantibiotic) OR sterile) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat]))) AND (((((((("bacitracin zinc") OR "polymyxin b") OR "povidone-iodine") OR betadine) OR cetrimide) OR chlorhexidine) OR savlon) OR sulfadiazine) OR sulphadiazine) OR neomycin) OR gramicidin) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat])) Filters: Publication date from 2016/01/01 to 2020/02/29
#6	Search (((((((("bacitracin zinc") OR "polymyxin b") OR "povidone-iodine") OR betadine) OR cetrimide) OR chlorhexidine) OR savlon) OR sulfadiazine) OR sulphadiazine) OR neomycin) OR gramicidin Filters: Publication date from 2016/01/01 to 2020/02/29

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http://bmjopen-2020-046817 on 8 June 2021
http://bmjopen.bmj.com/ on April 20, 2024 by guest. Protected by copyright.

#5	Search (((((((antiseptic) OR antimicrobial) OR antibacterial) OR "anti-infective") OR disinfect*) OR microbicide) OR (polyantibiotic) OR sterile Filters: Publication date from 2016/01/01 to 2020/02/29
#4- searches 1, 2 and 3	Search (((((((urinary catheter*) OR urethral catheter*) OR indwelling catheter*) OR intermittent catheter*) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat]))) AND ((((((meatal) OR meatus) OR perineal) OR perineum) OR periurethral) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat]))) AND (((((((bath*) OR hygiene) OR cleans*) OR cleaned) OR cleaning) OR topical*) OR apply) OR applied) OR application) AND ("2016/01/01"[PDat] : "2020/02/29"[PDat])) Filters: Publication date from 2016/01/01 to 2020/02/29
#3	Search (((((((bath*) OR hygiene) OR cleans*) OR cleaned) OR cleaning) OR topical*) OR apply) OR applied) OR application Filters: Publication date from 2016/01/01 to 2020/02/29
#2	Search (((((meatal) OR meatus) OR perineal) OR perineum) OR periurethral) Filters: Publication date from 2016/01/01 to 2020/02/29
#1	Search (((urinary catheter*) OR urethral catheter*) OR indwelling catheter*) OR intermittent catheter* Filters: Publication date from 2016/01/01 to 2020/02/29

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PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and if available, provide registration information including registration number.	N/A
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5-6
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	4
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I ²) for each meta-analysis.	7



PRISMA 2009 Checklist

Page 1 of 2

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	6
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	7
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICO, follow-up period) and provide the citations.	7
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	9
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	7-9 + Supplementary
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	7-9 + Supplementary
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	Figure 4
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	Supplementary
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	16
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	17
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	17
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data, role of funders for the systematic review).	18

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

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