Do prophylactic catheter washouts reduce catheter associated urinary tract infections and catheter blockage compared to standard care in adults living with long-term catheters? A systematic review with meta-analysis

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ABSTRACT

Introduction: Prophylactic catheter washouts (PCWs) are often recommended to patients with long-term catheters (LTCs) to reduce symptomatic catheter-associated urinary tract infection (S-CAUTI) and catheter blockage. This systematic review summarizes current evidence on the benefits and harms of regular PCWs for adults using LTCs.
Methods: A literature search was conducted using MEDLINE, EMBASE, CINAHL, and CENTRAL (database inception to June 2024) for randomized controlled trials (RCTs) and quasi-RCTs comparing PCWs to standard care, or different catheter washout solutions to each other. The review followed Cochrane Handbook methodology. Certainty of evidence was assessed using GRADE. Detailed protocol registered with PROSPERO (CRD42024553575).
Results: Seven RCTs were included. The review found lower S-CAUTI rates in saline washout groups (SWGs) than no washout groups (NWGs) (mean difference [MD] -0.10, 95% confidence interval [CI] -0.50–0.29; low certainty evidence; p=0.61) and lower S-CAUTI

rates in any washout groups (WG) compared to NWGs (MD -0.05, 95% CI -0.42–0.32; low certainty evidence; p=0.79). The review found reduced odds of catheter blockage in acidic washout groups (AWGs) than SWGs (odds ratio [OR] 0.51, 95% CI 0.25–1.03; very low certainty evidence; p=0.06). Airaksinen 1979 also found increased odds of greater encrustation in their NWG compared to their SWG (OR 0.62, 95% CI 0.17–2.25; very low certainty evidence; p=0.46). The review found that WGs had reduced hematuria incidence (relative risk [RR] 0.99, 95% CI 0.87–1.12; moderate certainty evidence; p=0.86) compared to NWGs. Furthermore, WGs had higher EQ-5D-5L scores than NWGs, with SWGs MD -0.056 (97.5% CI -0.022–0.134, p=0.11) and AWGs MD -0.053 (97.5% CI -0.024–0.131, p=0.12), indicating possible improvement in quality of life (QoL).
Conclusions: PCWs may have more benefits and less harms than previously thought and could improve patients' QoL. Tailoring washout solutions to patients' needs may be beneficial. International RCTs abiding by SPIRIT and CONSORT guidelines are recommended, as most outcomes were of low certainty.

INTRODUCTION

The National Institute for Health and Care Excellence (NICE) CG139[1] and Cochrane Incontinence Group[2] define long term catheters (LTCs) as catheters in situ for ≥28 days, with expected use over 6-12 months.[3] LTCs are recommended for patients with urinary issues such as intractable urinary incontinence or chronic urinary retention.[3]

As LTCs are a foreign body, they can provide a surface for bacterial colonisation and biofilm formation.[4] This can lead to encrustations, catheter blockage and/or catheter associated urinary tract infection (CAUTI), the most common problems for LTC users. Approximately 40-50% of LTC patients experience debris or encrustation,[5] which can cause catheter blockages leading to distress and increased healthcare utilisation.[3] CAUTI has an average incidence of 13.79 per 1000 hospitalised patients, and a prevalence of 9.33%[6] Gage 2024 found that the average annual cost to the NHS for management of LTC related complications totals £125 million.[7]

Catheter washouts involve injecting liquid solutions into catheters, clearing any debris and potentially preventing or treating blockages.[8] Several types of washouts are used in clinical practice: acidic solutions are meant to dissolve encrustations,[5] normal saline works as a sterile solution.[9] while antimicrobial solutions reduce biofilm formation and bacterial load.[5] Their respective clinical and cost effectiveness are currently unproven.[5,9]

However, arguably washouts can damage bladder mucosa and potentially increase CAUTI risk.[3] A 2017 Cochrane review found no high-level evidence on the effectiveness of various washout policies in preventing catheter encrustations.[5] Thus, the practice is not currently recommended in the prevention of CAUTI or catheter blockages.[5] European Association of Urology (EAU)[6] guidelines reflect this and advise avoiding routine irrigation for LTC users.[10]

In the UK, the prevalence of community LTC users is 0.14% or approximately 90,000 people.[7] Elderly people have the highest prevalence of catheterisation and, with an ageing population in the developed world, the incidence of LTC users and LTC complications are expected to rise.[11] Preventing LTC morbidity from catheter blockage and CAUTI is therefore crucial. The aim of this systematic review was to summarise the current evidence about the clinical and cost-effectiveness of prophylactic LTC washouts in preventing complications amongst LTC users.

Objectives

This systematic review summarises the evidence on the clinical and cost-effectiveness of prophylactic catheter washouts (CWs) in adults living with LTCs.
The objectives are:

1. To determine if a policy of regular, prophylactic CWs plus standard LTC care would result in a reduction of catheter blockage and CAUTI requiring intervention compared to standard LTC care alone.
2. To evaluate if a policy of regular, prophylactic CWs plus standard LTC care would be more cost-effective than the current guidelines of standard LTC care alone.

METHODS

Evidence acquisition

This systematic review was conducted according to standard methodology outlined by the Cochrane Handbook for Systematic Reviews of Interventions[12] and the PRISMA 2020 reporting guidelines.[13,14] A priori protocol was registered at PROSPERO with registration number CRD42024553575.[15]

Search strategy

MEDLINE, EMBASE, CINAHL and CENTRAL databases were searched for all relevant publications (database inception to June 2024). Detailed search strategy is included in Appendix 1. The review referred to the search strategy and reference list of a Cochrane review on a similar topic by Shepherd et. al 2017.[8]

Eligibility criteria

The identified trials were screened following the PICOS approach abiding by the PRISMA guidelines 2020;[13] Participants (P), Interventions (I), Comparator(C), Outcome (O) (Table 1).

Selection process

Two independent review authors (EW, CY) independently performed abstracts and full-texts screening using Covidence. Any disagreements were resolved by discussion or consulting a third review author (MIO).

Data collection

A standardised data extraction form was developed and piloted. One reviewer (EW) independently extracted data which was cross-checked by second review author (CY) for

accuracy. Disagreements were resolved by discussion or by consulting a third review author (MIO). Trial authors were contacted for any missing data where possible. Refer 'characteristics of included trials' for detailed information (Table 2). More detailed characteristics of included trials in Appendix 2.

Risk of bias assessment

The risk of bias for each trial was assessed independently by two review authors (EW, CY) using recommended tools in the Cochrane Handbook.[12] For parallel RCTs, the Risk of Bias tool 2 (RoB 2)[16] was used. For crossover RCTs, the RoB 2 for crossover trials[17] was used. Disagreements were resolved through discussion or by consulting a third review author (MIO).

Statistical analysis

RevMan Web (Version 5.4) was used to calculate treatment effects[18]. Dichotomous outcomes were combined using the Mantel-Haenszel method for risk ratios or odds ratios. For continuous outcomes, means and standard deviations were used to derive mean difference using the inverse variance mean difference method. Standardised mean difference was calculated if trials used different scales. A priori, a fixed effects model was used to calculate pooled estimates of treatment effects and 95% confidence intervals (CIs) for trials with comparable outcome measures.

Heterogeneity between trials was identified through visually inspecting forest plots, using a standard chi-square test for heterogeneity, and/or the I^2 statistic.[12] Where there was evidence of heterogeneity, the review examined individual trials, analysed subgroup characteristics, or used a random effects model.[14] The primary analysis was per participant (randomised). Meta-analysis was conducted when appropriate; otherwise, narrative synthesis was used.[19] Detailed methods in the PROSPERO protocol.[15]

RESULTS

Study selection

The literature search identified 2026 citations. 66 were selected for full-text screening. Abdel-Fattah 2024 was identified from other sources and included. Overall, seven RCTs and quasi-RCTs were included in the review. The study selection process is described using a PRISMA flow diagram[13,19] (Figure 1). Excluded studies with reasons are provided (Appendix 4). A summarised 'characteristics of included trials' is shown in Table 2.

Risk of bias 2 assessment

Cochrane RoB 2 tool[16] was used to assess the four parallel RCTs (Abdel-Fattah 2024, Airaksinen 1979, McNicoll 2003, Moore 2009). Cochrane RoB 2 tool for crossover trials[17] was used to assess the three crossover RCTs (Kennedy 1992, Linsenmeyer 2014, Muncie 1989). Abdel-Fattah 2024, Kennedy 1992, and Moore 2009 had three intervention arms. These were grouped into washout versus no washout groups, and/or acidic versus saline groups.

Respective Excel tools were used to answer signalling questions.[16,17] A "low", "some concerns" and "high" risk of bias for each domain was assigned using an algorithm and author judgement where appropriate. The RoB assessment tables can be found in Appendix 3.

Evidence synthesis

Primary outcomes

S-CAUTI

Abdel-Fattah 2024 and Muncie 1989 reported data on S-CAUTI rates (per 100 catheter days) for their washout and no washout groups. These are presented in a forest plot (Figure 2). Pooled analysis (Abdel-Fattah 2024, Muncie 1989) found that the S-CAUTI rate was lower in the saline washout groups compared to the no washout groups, with a mean difference of 0.10 per 100 catheter days [(95% CI -0.50-0.29); low certainty evidence]. However, this result was statistically insignificant (p=0.61). Furthermore, pooled analysis (Abdel-Fattah 2024, Muncie 1989) found lower S-CAUTI rates in the any washout (acidic or saline) groups compared to the no washout groups with a mean difference of 0.05 per 100 catheter days [(95% CI -0.42-.32); low certainty evidence] (Figure 2). This result is statistically insignificant (p=0.79). However, Abdel-Fattah 2024 reported a significantly lower S-CAUTI rate (per 1000 catheter days) in their saline group [3.71 (SD=8.45)] compared to their no washout group
[8.05 (SD=11.29)].

Airaksinen 1979 and Moore 2009 reported incidence of UTIs (Figure 2). In contrast to the S-CAUTI rate, pooled analysis found that the odds of UTI were 1.26 times higher in saline washout groups than no washout groups [(95% CI 0.44-3.60); very low certainty evidence]. This difference was not statistically significant (p=0.67)

Catheter blockage

Kennedy 1992 and Linsenmeyer 2014 reported catheter blockage incidence for their acidic and saline washout groups (Figure 2). Pooled analysis suggests that the odds of catheter blockage in acidic groups were 0.51 times that of saline groups [(95%CI 0.25-1.03); very low certainty evidence]. However, the difference was not statistically significant (p=0.06).

Airaksinen 1979 reported on incidence of visual encrustation. In the saline washout group, 9/21 had 'little' encrustation and 12/21 had 'a lot' of encrustation. In the no washout group, 6/19 had 'little' encrustation and 13/19 had 'a lot' of encrustation. Though $p<0.05$, the trial concludes that this was not statistically significant. The review analysis found that the odds of having 'a lot' of encrustation in the saline washout group was 0.62 times that of the no washout group [(95%CI 0.17-2.25); very low certainty evidence]. The result was not statistically significant (p=0.46).

McNicoll 2003 states that catheter washouts do not reduce encrustation formation. However, this was a small trial and had only one participant in the washout group.

Moore 2009 measured mean time to first catheter change to determine washout effect on encrustation. Combining means and standard deviations from the trial's acidic and saline

groups gave a mean of 4.48 weeks (SD=2.72) for the washout group, compared to 4.55 weeks (SD=2.91) for the no washout group. This difference was not statistically significant (p=0.71).

Abdel-Fattah 2024 found that the rate of LTC blockages per 1000 catheter days was 9.96, 10.53, 20.92 in the saline, acidic and no washout group, respectively. The incidence rate ratio favours any washout group [0.62, 97.5%CI (0.26-1.49)] compared to no washout. However, these findings were not statistically significant (p=0.22).

Catheter removal or replacement

Muncie 1989 reported mean catheter replacement rate per 100 catheter days. For the saline washout period, the mean was 5.5 catheters compared to 4.7 catheters for the no washout period. The trial did not report standard deviations or if this was statistically significant. Kennedy 1992 measured mean days of catheter in-situ to determine washout effect on catheter removal or replacement (Saline: 16.3, Suby G: 14.3, Solution R: 14.2). The trial did not report standard deviations or if this was statistically significant.

McNicoll 2003 reported total catheter changes. For the one participant who had washouts, their catheter was changed 9 (SD=0) times over the 12-week trial period. For the three participants in the catheter change group, the mean was 14.3 (SD=11.2). However, catheter changes being the comparator would result in a higher mean for that group and does not clarify washouts' impact on this outcome.

Abdel-Fattah 2024 reported on routine catheter changes per month. Combining means and standard deviations from the acidic and saline groups gave a mean of 0.33 (SD=0.22) for the washout group, and 0.36 (SD=0.23) for the no washout group. This difference was not statistically significant (p=0.58).

Secondary outcomes

Washout acceptability

McNicoll 2003 gave anecdotal evidence that regular prophylactic CWs caused intrusion into patients' lives. The trial also suggests that district nurses found washout schedules impractical and difficult to adhere to.

In Abdel-Fattah 2024, incidence of pain at catheter site was low for saline (1/25), acidic (2/27) and control groups (2/26). Differences between groups were not statistically significant. The mean monthly occurrence of bladder spasms was similar between washout groups [Saline: 3.5 (SD=5.7), Acidic: 3.2 (SD=5.9)] and slightly higher in the no washout group [Standard care: 4.4 (SD=6.5)].

Abdel-Fattah 2024 also conducted a treatment satisfaction questionnaire. Scores for each theme range from 0-100, and higher scores are preferred. Both washout groups gave relatively high scores for all three questionnaire domains, suggesting high patient satisfaction (Table 3).

Furthermore, Abdel-Fattah 2024 also contained an embedded qualitative study (20) which concluded that catheter washouts were acceptable to patients and carried good compliance when given appropriate patient training. Participants in the washout groups felt

that they experienced fewer LTC complications, required less healthcare provider support and were empowered by their ability to self-manage their catheters. This effective self-management could allow for improved quality of life, reduced symptom burden and lower healthcare costs. These benefits to patient quality of life and high acceptability warrant further evaluations of prophylactic LTC washouts.

Health economic outcome

McNicoll 2003 conducted cost analysis for its four participants. The one participant in the daily washouts group costed £975.51 over the 12-week trial period. Over the same duration, the patient who changed catheters twice a week costed £197.97, the patient who changed catheters on clinical signs of blocking costed £286.66, and the patient who changed their catheter twice costed £81.48. District nurses performed all interventions.
In Abdel-Fattah 2024, 80 participants performed allocated washouts themselves, with minimal dependence on healthcare resources. Washout groups had fewer interactions with and by healthcare professionals. However, a full economic analysis was not possible due to early termination of the trial and consequently small sample size

Adverse effects of washouts

Abdel-Fattah 2024 and Moore 2009 reported incidence of haematuria, which were analysed in a forest plot (Figure 2). Moore 2009 noted microscopic haematuria for all participants regardless of washout solution and attributed this to LTC usage rather than washouts. Pooled analysis suggests that the risk of blood in the washout group is 0.99 times that of the no washout group [(95%CI 0.87-1.12); moderate certainty evidence]. This difference was not statistically significant (p=0.86).

Abdel-Fattah 2024 also recorded patient-reported blood in urine (mean days per month). This was lowest for the saline group [0.25 (SD=0.51)] and highest for the acidic group [1.8 (SD=3.8)]. The statistical significance of this is not reported. The trial also found that the rates of bleeding or discharge at the catheter site were similar between the washout and no washout group.

Kennedy 1992 reported the percentage of patients with urothelial cells in washout fluid. As proportions were consistently high across all three groups (Saline: 100%, Suby G: 86%, Solution R: 100%), differences were unlikely clinically significant. The trial also reported percentage of patients with red blood cells in washout fluid. This was higher for the Suby G period compared to the other two treatment periods to a statistically significant degree (p=0.028).

Patient quality of life

Abdel-Fattah 2024 reported on patient quality of life using the ICIQ long-term catheterisation quality of life questionnaire (ICIQ-LTCqol) and EQ-5D-5L. The ICIQ-LTCqol assesses health-related quality of life of LTC users (Figure 3). It has two scoring themes: function and concern, and lifestyle, with higher scores being worse. These differences were not statistically significant.

The EQ-5D-5L is a generic QoL measure and higher scores demonstrate better QoL (Figure 3). Participants in both washout groups had higher scores than the no washout group, indicating a potentially better QoL. However, this result was not statistically significant.

DISCUSSION

This systematic review summarised results of seven RCTs (340 participants). We conclude that prophylactic catheter washouts did not have a statistically significant impact on S-CAUTI, catheter blockage, or catheter removal or replacement rates compared to standard LTC care alone. However, the review suggests that prophylactic CWs may have more benefits and less harms than previously thought.

Summary of main results

This review found that there was no statistically significant difference between S-CAUTI rates in the washout groups compared to no washout groups. However, a recent and relatively well-powered RCT (Abdel-Fattah 2024) reported lower S-CAUTI rates in the saline group compared to the no washout group [IRR=0.40 (0.20 to 0.80); p=0.003], suggesting that prophylactic saline washouts may prevent S-CAUTI.

This contrasts current perceptions, as the European Association of Urology Nurses (EAUN)[5] states that CWs do not prevent S-CAUTI. In addition, both the EAU[6] and the American Urological Association (AUA)[21] guidelines do not include CWs as part of their recommendations for preventing S-CAUTI. The guidelines suggest that CWs requiring breaking the sterile, closed system could increase risk of infection. However, trials that used catheter washout methods that did not require breaking the closed system (Abdel-Fattah 2024, Muncie 1989) showed a potential reduction in S-CAUTI rates.

The review also found that there was no statistically significant difference in catheter blockage between washout groups compared to no washout groups. The 7th International Consultation on Incontinence 2023 (ICI2023)[22] and the EAUN[5] guidelines both advise against utilising acidic washouts to reduce encrustations, citing lack of evidence. These are based on the 2017 Cochrane review which found insufficient evidence to conclude on the benefits or harms of catheter washouts.[8] However, EAUN[5] also reports that acidic washouts are sometimes used in practice to remove encrustations in LTC users, suggesting its efficacy against encrustations. It should also be noted that though statistically insignificant, acidic washout groups did show reduced catheter blockage compared to no washout groups. Further high powered trials could yield definitive conclusions.

As Abdel-Fattah 2024 and McNicoll 2003 differed on washout implementation and healthcare resource requirements, the review was unable to fairly evaluate the cost-effectiveness of prophylactic CWs compared to standard LTC care alone.

The review found that CWs do not cause more pain or discomfort for patients, and patients are satisfied with the procedure. CWs may even decrease the risk of some adverse effects such as haematuria and this evidence was of moderate certainty. This differs from EAUN[5] and ICI2023[22] concerns that CWs could damage bladder urothelium and cause bleeding.

The EAUN[5] also acknowledges that prophylactic catheter washouts could improve health-related QoL from a patient perspective. Abdel-Fattah 2024 echoes this, reporting that both washout groups had better overall QoL scores (EQ-5D-5L, ICIQ-LTCqol) than no washout groups. Though statistically not significant, this potential improvement in QoL deserves further investigation with a larger sample size.

This review found that prophylactic catheter washouts may have more benefits and less harms than previously thought and may improve patients' QoL. However, existing trials provide insufficient evidence and current recommendations to avoid routine irrigation in LTC users and using clinical judgement to decide on washouts still stand[6].

Our findings also suggest a potential clinical benefit in investigating the different properties of different washout solutions for patients. Patients more prone to blockage may benefit from acidic washouts, while those susceptible to S-CAUTI may be more suitable for saline washouts.

Strengths

The major strengths of this present review are that we 1) utilised robust methods as per the current edition of the Cochrane Handbook 2) based on a PRISMA-adhering protocol registered with PROSPERO a priori 3) conducted a comprehensive literature search with no language or date restriction 4) reviewed evidence based upon RCTs 5) applied RoB2 as best practice for determining the risk of bias 6) utilised GRADE for evaluating quality of evidence. It is the largest and most comprehensive review on prophylactic catheter washouts, with the inclusion of the CATHETER II trial and its embedded qualitative study.

Limitations

Outcome measures across trials were highly heterogeneous, making meta-analyses challenging.[23,25] Furthermore, some trials did not report on many of this review's outcomes of interest. The development of core outcome sets (COS) in comparing prophylactic catheter washouts would enable ease of future reviews in comparing and combining trial results as appropriate.[27]

Regarding confounders, a main concern with catheter washouts is increased risk of S-CAUTI as the sterile drainage system is often disconnected to instil the solution.[27] As the washout methodology differed between trials, comparison of results was difficult. Future trials should standardise washout methods to minimise any confounding effect.

CONCLUSIONS

This systematic review found few high-quality trials evaluating the benefits and harms of prophylactic catheter washouts and highlights the need for large scale, international RCTs.[8] However, it did reveal trends suggesting that washouts may have greater benefits and fewer harms than previously assumed, particularly in tailoring the type of prophylactic washout to patients' needs and the potential to improve the QoL for LTC patients.

Future research should adhere to SPIRIT[23] and CONSORT[25] guidelines to address previous methodological and reporting limitations and ensure adequately powered trials.[26] Developing a standardised core outcome set would enable better data comparison and

synthesis.[23,27] Qualitative and economic evaluations should also be included for a holistic assessment.[20,28]

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FIGURES AND TABLES

Figure 1. PRISMA flowchart. PRISMA: preferred reporting items for systematic reviews and meta-analysis.

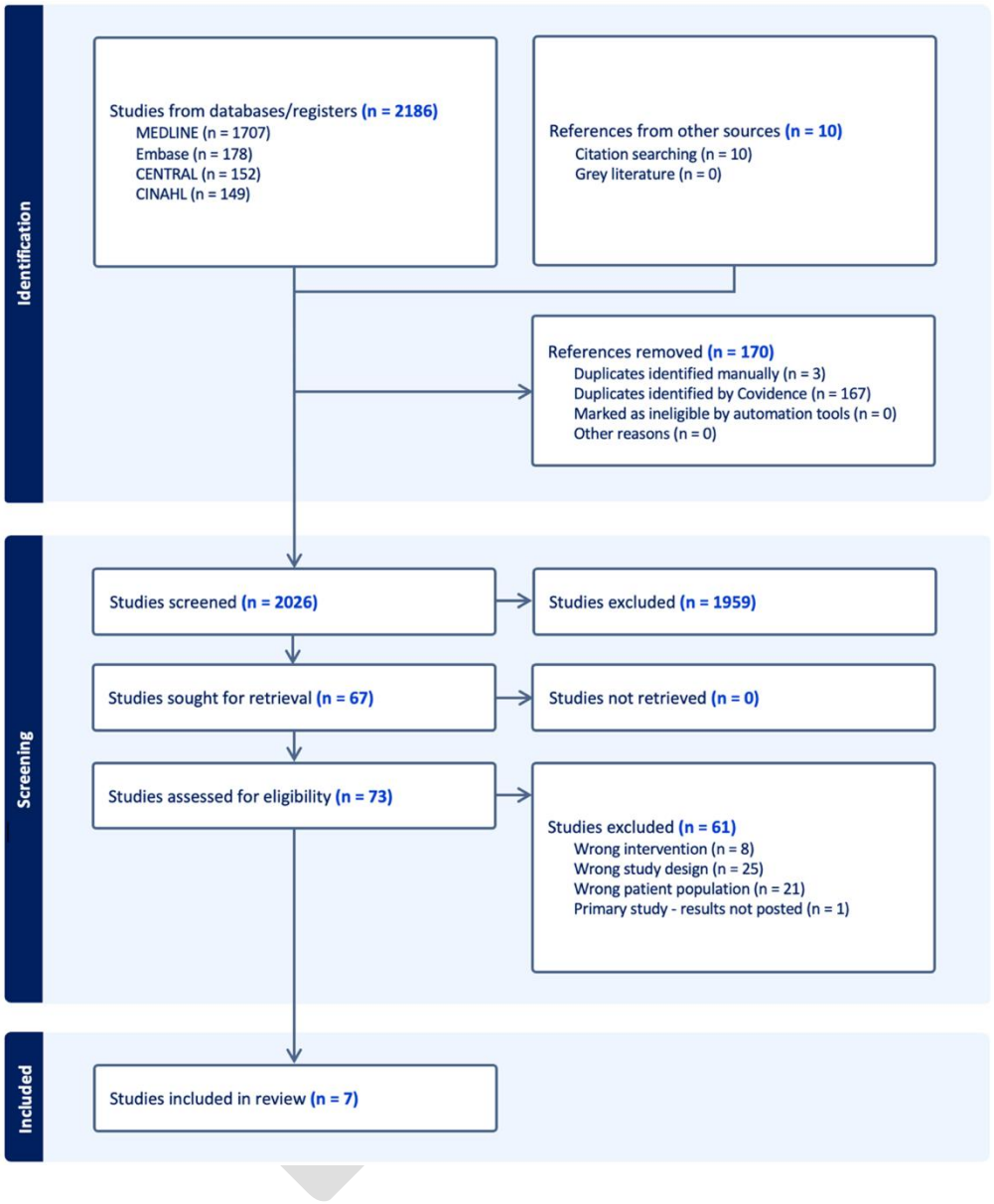


Figure 2. Forest plot analysis.

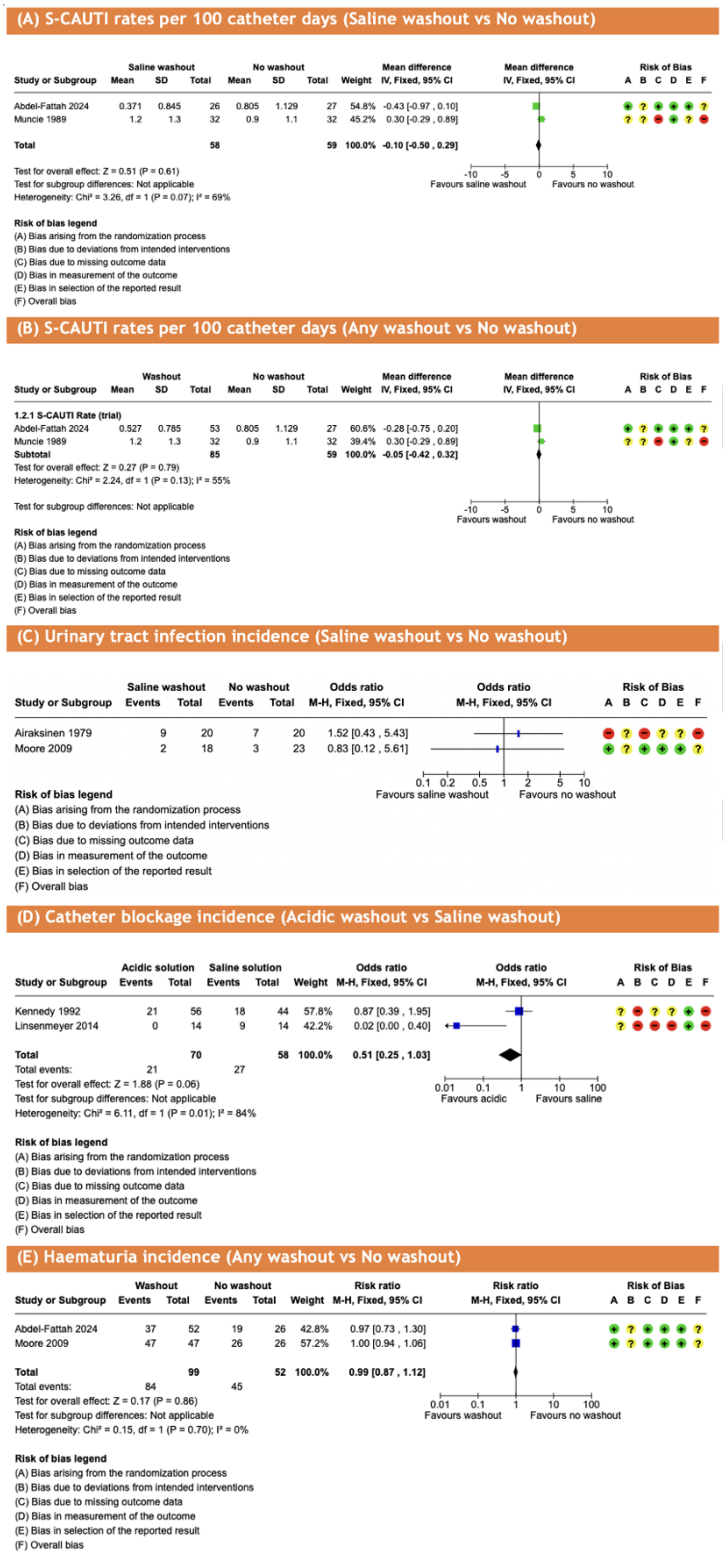
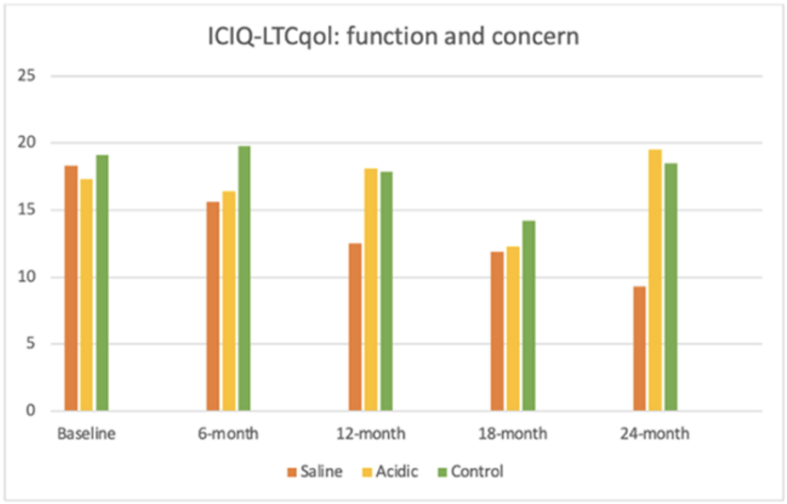
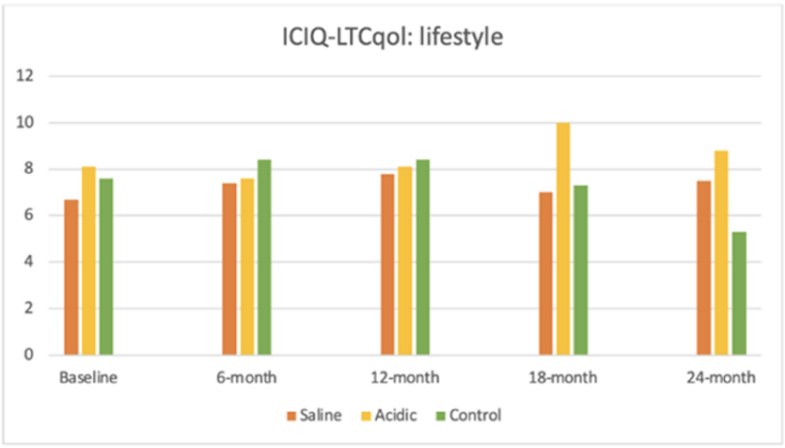


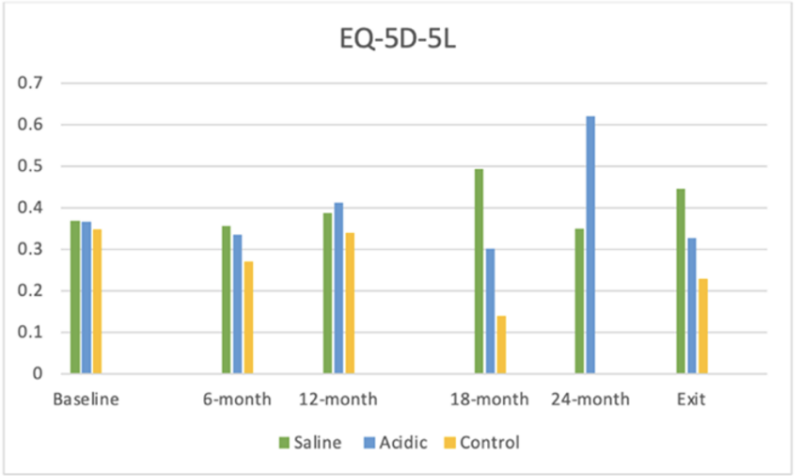
Figure 3. Quality of life questionnaire bar charts.



A: ICIQ-LTCqol scores for function and concern from baseline to 24 months (Abdel-Fattah 2024).



B: ICIQ-LTCqol scores for lifestyle from baseline to 24 months (Abdel-Fattah 2024).



C: EQ-5D-5L scores from baseline to exit (Abdel-Fattah 2024).

Figure 4. Grade assessment for certainty of evidence.

Outcomes	Anticipated absolute effects (95% CI)		Relative effect (95% CI)	No. of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with no washout	Risk with saline washout				
S-CAUTI rate (per 100 catheter days)	0	MD 0.1 lower (-0.50 to 0.29)	-	117 (2 RCTs)	⨁⨁◯◯ Low [a, b]	[k]
UTI incidence (per 100)	23	28 (12 to 52)	OR 1.26 (0.44 to 3.60)	81 (2 RCTs)	⨁◯◯◯ Very low [c,d]	[k]
Visual encrustation (per 100)	68	57 (27 to 83)	OR 0.62 (0.17 to 2.25)	40 (1 RCT)	⨁◯◯◯ Very low [e,f]	[k]

Outcomes	Anticipated absolute effects (95% CI)		Relative effect (95% CI)	No. of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with no washout	Risk with any washout				
S-CAUTI rate (per 100 catheter days)	0	MD 0.05 lower (-0.42 to 0.32)	-	144 (2 RCTs)	⨁⨁◯◯ Low [a,g]	[k]
Haematuria incidence (per 100)	87	86 (75-97)	RR 0.99 (0.87 to 1.12)	151 (2 RCTs)	⨁⨁⨁◯ Moderate [h]	[k]

Outcomes	Anticipated absolute effects (95% CI)		Relative effect (95% CI)	No. of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with saline washout	Risk with acidic washout				
Catheter blockage	47	31 (18 to 47)	OR 0.51 (0.25 to 1.03)	128 (2 RCTs)	⨁◯◯◯ Very low [i,j]	[k]

CI: confidence interval; MD: mean difference; OR: odds ratio; RR: risk ratio

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

a Downgraded by one level for study design: Evidence comes from 2 trials. Sequence generation is unclear in one trial and allocation concealment is unclear in both trials.
b Downgraded by one level for inconsistency: I^2 = 69%
c Downgraded by two levels for study design: Evidence comes from 2 trials. Both trials contributing to the meta-analysis were judged to be at high/unclear risk of bias for many domains.
d Downgraded by two levels for imprecision: 95% confidence interval varied from 0.44 to 3.60 and crosses line of no effect.
e Downgraded by two levels for study design: Evidence comes from a single trial which was judged to be high and unclear risk.
f Downgraded by one level for imprecision: 95% confidence interval varied from 0.17 to 2.25 and crosses line of no effect.
g Downgraded by one level for imprecision: 95% confidence interval varied from -0.42 to 0.32 and crosses line of no effect.
h Downgraded by one level for study design: Evidence comes from 2 trials. Allocation concealment is unclear in both trials.
i Downgraded by two levels for study design: Evidence comes from 2 trials. Sequence generation is unclear in both trials and allocation concealment is high in both trials.
j Downgraded by one level for inconsistency: I^2 = 84%
Publication bias undetected: funnel plot unable to be generated as there are less than 10 trials in the meta-analysis.

Table 1. PICOS		
P	Population	Inclusion criteria: • Adults aged ≥18 years. • Catheter in situ for ≥28 days with no plan for discontinuation at time of recruitment. • All types and routes of LTC. • Able to perform catheter washouts and/or complete trial documentation or have a carer to assist them.
		Exclusion criteria: • Intermittent self-catheterisation. • Pregnant or considering pregnancy. • Spinal cord injury at or above T6 (risk of autonomic dysreflexia). • Ongoing S-CAUTI, bladder cancer, bladder stones. • Visible haematuria. • Allergies to washout solution.
I	Interventions	Prophylactic catheter washouts included: • Acidic solution. • Antiseptic/antibiotic/antimicrobial solution. • Saline solution.
C	Comparators	Control group: • Standard care alone. • Any solution mentioned above against another.
O	Outcomes	Primary outcome was objective measures of S-CAUTI and catheter blockage • S-CAUTI rates. • Rate of catheter blockage or obstruction. • Catheter removal rates due to blockage or infection.
		Secondary outcomes: • Washout acceptability measures. • Health economic outcomes. • Measures of complications or adverse effects of washouts. • Health status or psychological health e.g., quality of life.
S	Study design	Inclusion criteria • Randomised controlled trials (RCT). • Quasi-randomised controlled trial (quasi-RCT) and crossover trials comparing outcomes.
		Exclusion criteria • Non-RCTs; cohort studies (prospective, retrospective); case reports; single-arm case series; on-going clinical trials; editorials; letters.

Table 2. Characteristics of included trials

Trial ID	Trial setting	Trial duration	Design	No. of patients randomised	Trial arms	Dose and frequency	Primary outcome
Airaksinen 1979	Finland. Hospital and home care.	6 months	Parallel RCT	40	Arm 1: Saline washout + silicath catheter. Arm 2: Saline washout + silastic catheter Arm 3: No washout + silicath catheter Arm 4: No washout + silastic catheter	Arm 1 and 2: Every 2 weeks, 10ml or 20mL saline[a].	Bacteriuria rates, symptomatic UTI rates, visual encrustation rates, rate of catheter obstruction/blockage.
Muncie 1989	United States of America (USA). Hospital and medical centre.	24 weeks – 10 weeks per phase	Crossover RCT	44	Arm 1: Saline Arm 2: No washout	Saline: 30mL, 1x a day for 10 weeks	The incidence of catheter obstructions and febrile episodes and bacteriuria (4 most prevalent organisms in each phase)
Kennedy 1992	United Kingdom (UK). Three geriatric hospitals.	12 weeks – 1 week run-in saline, 3 x 3 weeks with each solution, 1 week normal saline	Crossover RCT	25	Arm 1: Saline Arm 2: Suby G[b] Arm 3: Solution R[c]	Saline: 100mL, 2x a week for 3 weeks. Suby G: 100mL, 3.23% citric acid, 2x a week for 3 weeks. Solution R: 100mL, 6% citric	Catheter blockage, Degree of visual encrustation, Type and volume of crystals observed in washout fluid.

		washout				acid, 2x a week for 3 weeks.	
McNicoll 2003	United Kingdom (UK). Community.	12 weeks	Parallel RCT	11	Arm 1: Acidic Arm 2: Catheter change	Acidic: Daily instillation, volume and type not stated. Catheter changes: 1 patient had catheter changed 2x a week, 1 patient had catheter changed on signs of blocking, 1 patient had catheter changed at start and end of study.	Catheter replacements, time, and cost resources.
Moore 2009	Canada. Long-term care setting or received home care.	8 weeks	Parallel RCT	73	Arm 1: Saline Arm 2: Contisol[d] (acidic) Arm 3: Standard care (no washout)	Saline: 50mL, 1x a week for 8 weeks Contisol acidic): 50mL, 1x a week for 8 weeks.	Mean time to first catheter change, Measurement of cross-sectional catheter lumen (abandoned as method did not prove useful)
Linsenmeyer 2014	United States of America (USA)	8 weeks – Part 1 was 2 weeks, Part 2 was 2 weeks	Crossover RCT	67	Arm 1: Auriclosene (acidic)	Part 1: 2x25mL 0.2% Auriclosene, 3x a week for 2 weeks.	Mean % encrustation 'catheter patency' (95% CI), Percent of catheters removed for clinical blockage,

		and Part 3 was 4 weeks			Arm 2: Saline	Part 2: 2x25mL Auriclosene, 3x a week for 2 weeks. Part 3: 2x25mL Auriclosene, 2x a week for 4 weeks. Control for all parts was normal saline.	Percent of removed catheters that have 100% encrustation.
Abdel-Fattah 2024	United Kingdom (UK). Community-based study	12-24 months (varied due to early closure of study)	Parallel RCT	80	Arm 1: Saline Arm 2: Acidic Arm 3: Standard care (no washout)	Saline: 100mL of 0.9% NaCl, 2x a week Acidic: 2x30mL of 3.23% citric acid, 1x a week No washout: Standard care alone	LTC blockages (/1000 catheter days) requiring treatment. The S-CAUTI rate (/1000 catheter days).

[a]The trial did not report how these volumes were distributed among the study arms. [b]Suby G washout (citric acid 3.23%, light magnesium oxide 0.38%, sodium bicarbonate 0.7%, and disodium edetate 0.01%). [c]Solution R washout (citric acid 6%, gluconolactone 0.6%, light magnesium carbonate 2.8%, disodium edetate 0.01%). [d]Contisol (citric acid 3.23%, light magnesium oxide 0.38%, sodium bicarbonate 0.7%, and disodium edetate 0.01%).

Table 3. TQSM scores Abdel-Fattah						
	Saline [mean (SD)]			**Acidic [mean (SD)]**		
	6 months (n=17)	**24 months (n=2)**	**Change**	**6 months (n=18)**	**24 months (n=3)**	**Change**
Effectiveness	67.0 (27.9)	83.3 (23.6)	16.3	67.6 (31.3)	77.8 (25.5)	10.2
Convenience	82.0 (15.3)	91.7 (3.9)	9.7	73.8 (23.3)	74.1 (8.5)	0.3
Overall satisfaction	76.1 (22.7)	75 (15.2)	-1.1	78.2 (27.7)[a]	69.0 (28.9)	-9.2

[a]Number of participants was N=17.

Table 4. GRADE assessment

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