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REVIEW ARTICLE

The effect of bladder catheterization on the incidence of urinary tract infection in laboring women with epidural analgesia: a meta-analysis of randomized controlled trials

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Abstract

Introduction and hypothesis There is conflicting evidence on whether intermittent catheterization (IC) is less associated with urinary tract infection (UTI) and more likely to prevent urinary retention than continuous catheterization (CC). We aimed to compare the effect of IC with that of CC on the incidence of postpartum UTI, urinary retention and hemorrhage in laboring women with epidural analgesia.

Methods Electronic searches were performed in PubMed, EMBASE and Cochrane Library from their inception to October 2018. We selected RCTs comparing IC with CC in laboring women with epidural analgesia. A meta-analysis was performed using the RevMan software, and a random-effects model was used to pool the effect size. The Grades of Recommendation, Assessment, Development and Evaluation (GRADE) approach was used to rate the quality of evidence.

Results Six RCTs ($N = 850$) were included in this review. The meta-analyses indicated that there was no significant difference between the IC and CC group in the incidence of postpartum UTI (RR = 1.25, 95% CI: 0.91 to 1.71, $P = 0.16$), postpartum urinary retention (RR = 0.76, 95% CI: 0.21 to 2.77, $P = 0.68$) and postpartum hemorrhage (RR = 1.72, 95% CI: 0.60 to 4.95, $P = 0.31$). GRADE assessment results showed that the quality of evidence was low.

Conclusions Based on the available evidence, there is no measurable difference in rates of UTI between CC and IC, not that neither stragety decreases UTI, since the included trials do not address this.

Keywords Labor · Epidural analgesia · Urinary catheter · Continuous catheterization · Intermittent catheterization · Bladder drainage

Abbreviations

IC	Intermittent catheterization
CC	Continuous catheterization
UTI	Urinary tract infection
RCT	Randomized clinical trial
RR	Risk ratio

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CI Confidence interval
GRADE Grades of Recommendation, Assessment, Development and Evaluation

Introduction

Over the last decade, the number of women who request epidural analgesia in labor has increased to 60%–80% [1, 2]. However, because of increased sympathetic and motor blockade, many laboring women with epidural analgesia cannot sense a full bladder or ambulate independently, so urinary retention is a known side effect of epidural analgesia [3–5]. In case of overt postpartum urinary retention, catheterization is considered to be required, because bladder over-distension can potentially result in long-term problems including bladder atony, detrusor instability, voiding difficulties and even kidney failure [6, 7].

At present, there are no recommended guidelines for intrapartum bladder management for women with an epidural, nor is there agreement on the most appropriate type of catheterization (intermittent versus continuous) in cases of bladder distention [8, 9]. The type of catheterization usually is determined by the physician's preference and/or institutional practice patterns. Recently, some randomized controlled trials (RCTs) [9–11] investigated the incidence of postpartum urinary tract infection (UTI) and urinary retention in laboring women with epidural analgesia; however, they reported mixed results. These heterogeneous results make it difficult to draw conclusions on the acceptability and complication rate of intermittent catheterization (IC) and continuous catheterization (CC).

The aim of the present study was to perform a systematic review and meta-analysis of RCTs to compare the effect of CC with that of IC on the incidence of postpartum UTI, urinary retention and hemorrhage in laboring women with epidural analgesia.

Methods

The systematic review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement [12] and some other reporting guidelines [13–15].

Search strategy

We searched PubMed, EMBASE and Cochrane Library from their inception until October 2018, and the last search was updated on January 2019. We used free-text terms and Mesh searches for the terms: urinary catheter*, continuous catheter*, intermittent catheter*, transurethral catheter*, intermittent self catheter*, "in–out" catheter*, bladder drainage, labor, labour, delivery and childbirth (Appendix 1). We manually screened bibliographies of the included studies as well as guidelines and review articles for additional studies.

Inclusion and exclusion criteria

Studies that met the following criteria were included:

1. Population: healthy laboring women, who requested epidural anesthesia during labor.
2. Intervention: intermittent catheterization, also known as in-out catheterization, was defined as emptying the bladder via the urethra using a catheter that is removed after the procedure, mostly at regular intervals.
3. Comparator: continuous catheterization was defined by the passage of a catheter into the urinary bladder via the urethra using an inflatable balloon or other means to retain it in position.
4. Outcomes: postpartum UTI, urinary retention and hemorrhage.
5. Study design: randomized controlled trial.

We excluded review articles, editorials, comments, meeting abstracts and non-relevant topic studies.

Literature screening and data extraction

The study selection and data extraction were performed by two researchers (LMX and HWB) independently and then cross-checked. In the event of disagreement, the two sides discussed and decided.

All the retrieved articles were imported into the EndNote X7 software, and duplicate publications were excluded. Then, the two authors evaluated the articles independently by reading the titles, abstracts and full text of the articles according to the inclusion and exclusion criteria.

According to the characteristics of the selected documents, we extracted year, country, sample, maternal age, gestational age, pregestational BMI, birth weight, antibiotics in labor, definition of bacteriuria or UTI, risk of bias and outcomes.

Quality assessment

Two authors (LMX and LHJ) independently assessed the risk of bias using the Cochrane Collaboration's tool [16]. Each study was determined as having a low, high or unclear risk of bias relating to sequence generation, allocation concealment, blinding of patients or outcome assessors, incomplete outcome data, selective outcome reporting and other sources of bias. Any disagreement was resolved via discussion among the authors.

In addition, we used the GRADE (Grades of Recommendation, Assessment, Development and Evaluation) system [17] to assess the quality of evidence associated with specific outcomes and constructed a 'Summary of findings' table. The GRADE approach is used to assess the quality of a body of evidence based on the extent to which one can be confident that an estimate of effect or association reflects the item being assessed. Assessment of the quality of evidence considers study methodological quality, directness of the evidence, heterogeneity of the data, precision of the effect estimates and risk of publication bias [18, 19].

Statistical analysis

This meta-analysis was performed using RevMan version 5.3 (Cochrane Collaboration) [20]. Dichotomous variables were evaluated using the risk ratio(RR) with 95% confidence intervals (95% CIs). Continuous variables were analyzed using mean differences (MDs) and 95% CIs. When studies reported on medians, ranges or *P* values for continuous variables, statistical algorithms were used to derive the appropriate means and standard. A random effects model was used for pooling studies. Meta-analyses of binary variables were performed using the Mantel-Haenszel method, and those of continuous variables were conducted using the inverse variance method. Heterogeneity was assessed through the Cochran Q test and I^2 statistic. We conducted subgroup analyses according to the symptoms of UTI (asymptomatic bacteriuria and symptomatic UTI). Sensitivity analysis was performed by excluding some low-quality studies [21].

Results

Literature search

The literature search yielded 1911 reports, of which 128 were excluded because of duplication; 1759 were excluded on the basis of the title or abstract being irrelevant to the topic, and 18 were excluded from the remaining 24 trials after reading the full text. Therefore, six ($N = 850$) RCTs [9–11, 22–24] were included in this systematic review. The PRISMA flow chart of literature studies for meta-analysis is illustrated in Fig. 1.

Study characteristics

The basic characteristics of the included studies were extracted and are listed in Table 1. The six studies were all published in English between 1986 and 2017, and the study samples ranged from 50 to 209 participants. Three studies [9, 22, 24] were performed in the USA, two [10, 11] in Israel and one [23] in the UK.

Quality assessment results

The risk of bias of the included studies is shown in Table 2. All studies were randomized. Four trials [10, 11, 22, 24] described an adequate random sequence generation process, only one trial [11] described the methods used for allocation concealment, one trial [10] described the blinding of outcome assessment, the data from all six studies [9–11, 22–24] were complete, and none of the studies reported selective outcome reporting. Overall, the quality of the included studies was

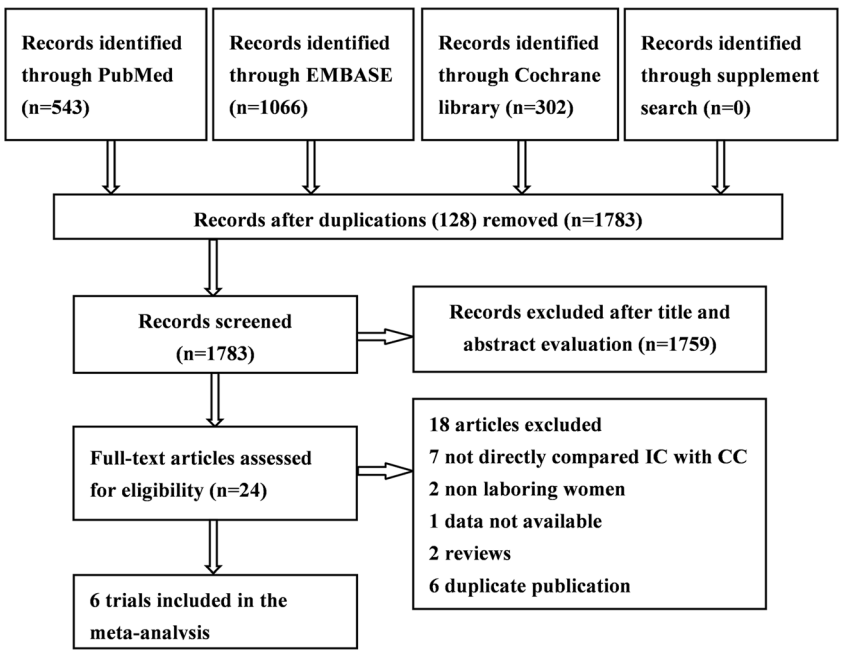

Fig. 1 Flowchart of the meta-analysis

Table 1 Characteristics and quality score of studies included in the meta-analysis

Study	Year	Country	Group	Sample	Maternal age, years	Gestational age, mean, weeks	Pregestational BMI, kg/m^2	Birth weight (g), mean	Antibiotics in labor, n (%)	Primiparous women, n (%)	Definition of bacteriuria or UTI
Millet [24]	2012	USA	IC	79	28.2 ± 5.8	NA	32.02 ± 6.8	3285.3 ± 450.4	36 (45.6)	30 (38)	CDC and IDSA definitions
			CC	67	27.1 ± 5.6	NA	32.88 ± 7.7	3347 ± 453.9	27 (40.3)	24 (35.6)	
Suleiman [11]	2017	Israel	IC	94	27.9 ± 4.5	39.9 ± 1.3	23.9 ± 4.9	3310.2 ± 423.1	26 (27.7)	NA	10^5 cfu/ml of a single organism.
			CC	90	27.0 ± 4.6	39.5 ± 1.3	23.8 ± 4.9	3264.7 ± 442.2	31 (34.4)	NA	
Wilson [9]	2015	USA	IC	68	26.16 ± 4.76	39.74 ± 1.06	NA	3445.7 ± 453.73	NA	NA	CDC, 2014 definitions
			CC	55	25.87 ± 4.66	39.77 ± 1.22	NA	3486.1 ± 445.08	NA	NA	
Rivard [22]	2012	USA	IC	66	28.7	38w 2d	NA	NA	NA	NA	NA
			CC	72	27.6	38w 2d	NA	NA	NA	NA	
Evron [10]	2008	Israel	IC	109	25 ± 4.0	40 ± 2	NA	3140 ± 450	Not used	NA	> l05 organisms/ml, at 24 and 48 h
			CC	100	26 ± 4.0	40 ± 2	NA	3129 ± 460	Not used	NA	
Kerr-wilson [23]	1986	UK	IC	25	27.0 ± 1.03	NA	NA	3100 ± 140	Not used	8(32)	> $l0^5$ organisms/ml, with or without pus cells
			CC	25	29.5 ± 0.97	NA	NA	3370 ± 140	Not used	6(24)	

NA: not available; CDC: Center for Disease Control; IDSA: Infectious Disease Society of America

Table 2 The risk of bias of included studies

Study	Year	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
Millet [24]	2012	Low risk	Unclear risk	High risk	High risk	Low risk	Unclear risk	Unclear risk
Suleiman [11]	2017	Low risk	Low risk	High risk	High risk	Low risk	Unclear risk	Unclear risk
Wilson [9]	2015	Unclear risk	Unclear risk	High risk	High risk	Low risk	Unclear risk	Unclear risk
Rivard [22]	2012	Low risk	Unclear risk	High risk	High risk	Low risk	Unclear risk	Unclear risk
Evron [10]	2008	Low risk	Unclear risk	High risk	Low risk	Low risk	Unclear risk	Unclear risk
Kerr-wilson [23]	1986	Unclear risk	Unclear risk	Unclear risk	Unclear risk	Low risk	Unclear risk	Unclear risk

Table 3 Summary of findings

Intermittent catheterization compared with continuous catheterization for laboring women with epidural analgesia
Patient or population: laboring women with epidural analgesia
Setting: hospital
Intervention: intermittent catheterization
Comparison: continuous catheterization

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No. of participants (studies)	Certainty of the evidence (GRADE)
	Risk with continuous catheterization	Risk with intermittent catheterization			
Urinary tract infection (UTI)	157 per 1000	**197 per 1000** (143 to 269)	**RR 1.25** (0.91 to 1.71)	712 (5 RCTs)	⊕⊕○○ LOW
Postpartum urinary retention	26 per 1000	**20 per 1000** (6 to 73)	**RR 0.76** (0.21 to 2.77)	393 (2 RCTs)	⊕⊕○○ LOW
Postpartum hemorrhage	56 per 1000	**96 per 1000** (33 to 275)	**RR 1.72** (0.60 to 4.95)	184 (1 RCT)	⊕⊕○○ LOW

*The **risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI)

CI: confidence interval; **RR:** risk ratio; **MD:** mean difference

GRADE 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 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

low. The quality of evidence evaluated by GRADE is shown in Table 3.

The incidence of postpartum UTI

Five studies [9–11, 23, 24] evaluated the rate of UTI. We conducted subgroup analysis according to the type of UTI; overall, there was no significant difference between the IC and CC group (pooled RR = 1.25, 95% CI: 0.91 to 1.71, P = 0.164, I^2 = 0.0%), the symptomatic UTI group (pooled RR = 1.16, 95% CI: 0.81 to 1.65, P = 0.42, I^2 = 0.0%) and the asymptomatic bacteriuria group (pooled RR = 1.67, 95% CI: 0.84 to 3.30, P = 0.14, I^2 = 0.0%) (Fig. 2).

Postpartum urinary retention

Two studies [10, 11] reported postpartum urinary retention. There was no significant difference between the IC group and CC group (pooled RR = 0.76, 95% CI 0.21 to 2.77, P = 0.68, I^2 = 0.0%) (Fig. 3).

Postpartum hemorrhage

Only one study [11] reported postpartum hemorrhage. No difference was found between the IC and CC group (pooled RR = 1.72, 95% CI 0.60 to 4.95, P = 0.31) (Fig. 3).

Sensitivity analysis

We performed sensitivity analyses to assess the robustness of our results and investigate the potential source of high heterogeneity. After removing low-quality studies [9, 23] which did not report how to generate random sequences, the results were stable.

Discussion

Our systematic review and meta-analysis demonstrated no difference between the IC and CC group in the rate of postpartum UTI, urinary retention and hemorrhage for laboring women with epidural analgesia. However, the quality of evidence for the reported outcomes was low. We downgraded quality of evidence by one or two levels for serious risk of bias, inconsistency and imprecision.

In this study, the primary outcome was UTI. It is known that bacterial infection can progress during catheterization, either directly due to insertion of the catheter or by colonization as bacteria can ascend from the meatus of the urethra along the catheter [25, 26]. The European Association of Urology 2015 guidelines on urological infection stated that IC was associated with a reduction in the incidence of bacteriuria compared with CC [27]. However, they could not make

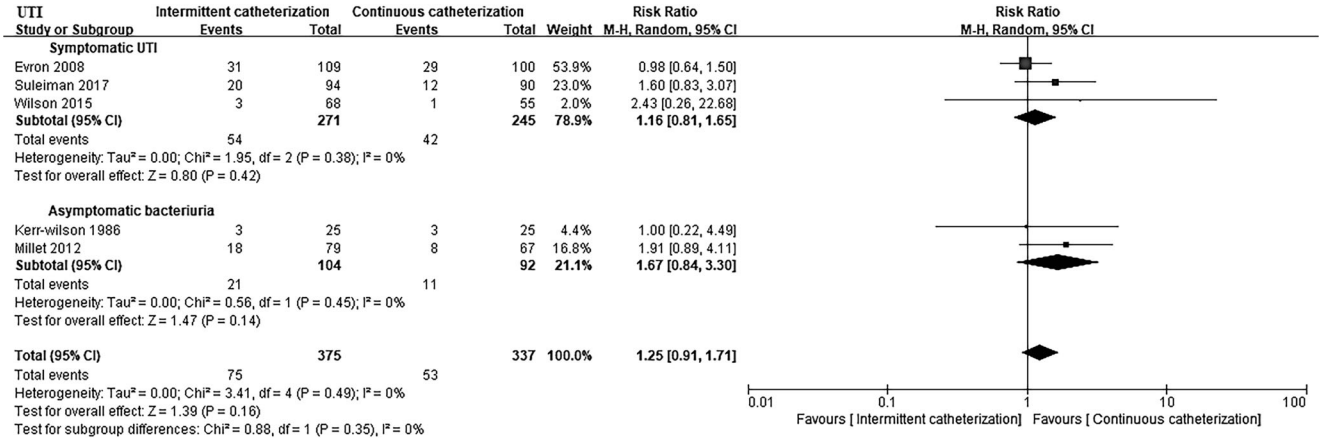

Fig. 2 Forest plot of the incidence of urinary tract infection

any recommendations for symptomatic UTI. In fact, symptomatic UTI and asymptomatic bacteriuria have different clinical outcomes, so we conducted subgroup analysis according to symptoms of UTI (asymptomatic bacteriuria and symptomatic UTI).

Our meta-analysis found that there was no difference in the incidence of UTIs between the CC and IC group. The result was consistent with a previous review [28] of catheterization options. Four RCTs examining this issue in laboring women with epidural analgesia have been published. However, the review indicated that the wide confidence interval of their meta-analysis made it difficult to say that there was truly no difference between the groups. The sample size of our review was also small, so more high-quality randomized trials are needed to determine which route is most appropriate for catheterization in laboring women with epidural analgesia.

Postpartum urinary retention was one of the most common complications in laboring women with epidural analgesia, but much of the original research did not report the complications using CC or IC. It is unclear if this is because complications did not occur or they were simply not reported. Therefore, it intuitively seems improbable to reach a more reliable conclusion. Future trials should pay more attention to reporting core outcomes (e.g., postpartum hemorrhage, postpartum urinary retention, postpartum pain, urinary continence, and so on).

Patient satisfaction and cost-effectiveness data with IC compared with CC are lacking. Only one included study [22] provided the cost-effectiveness data, and the authors concluded that the supply cost for the IC strategy was slightly less than the supply cost for a CC. Due to the limited data, we cannot draw a precise conclusion; further related studies should pay more attention to the above two outcomes.

Strengths and limitations

Strengths of this review are that all included studies were RCTs, detailed data collection and extraction were performed on all related studies, quality of evidence was assessed using the GRADE approach, and we provide detailed reporting of the results of all extracted outcomes.

Major limitations of our review were that only a few studies were available for comparison and the studies we included had a low quality of evidence and could be challenged regarding interpretation of the results. Blinding assessment of outcomes was rarely reported. In the future, we should pay more attention to reporting the blinding of the related participants.

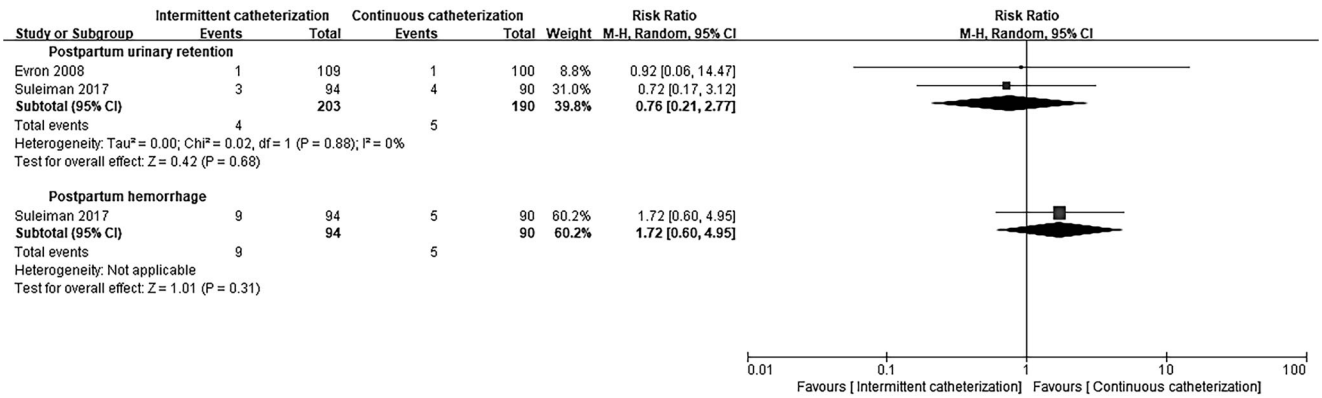

Fig. 3 Forest plot of the rate of postpartum urinary retention and hemorrhage

Conclusion

This meta-analysis found no difference between the CC and IC groups in the incidence of postpartum UTI, urinary retention and hemorrhage. Due to the low quality and small quantity of available comparative studies, more high-quality randomized trials are needed to provide stronger evidence of the acceptability and complication rates of CC and IC in laboring women with epidural analgesia.

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Compliance with ethical standards

Conflicts of interest None.

Appendix 1 Search strategy

PubMed

#1 urinary catheters[Mesh].
#2 intermittent urethral catheter*[Mesh].
#3 urinary catheters[Title/Abstract].
#4 continuous catheter*[Title/Abstract].
#5 transurethral catheter*[Title/Abstract].
#6 transurethral tube[Title/Abstract].
#7 urinary catheter*[Title/Abstract].
#8 urinary tube[Title/Abstract].
#9 urethral catheter*[Title/Abstract].
#10 urethral tube[Title/Abstract].
#11 intermittent urethral catheter*[Title/Abstract].
#12 techniques catheter*[Title/Abstract].
#13 intermittent self catheter*[Title/Abstract].
#14 clean intermittent catheter*[Title/Abstract].
#15 clean intermittent self-catheter*[Title/Abstract].
#16 "in–out" catheter*[Title/Abstract].
#17 intermittent urethral catheter*[Title/Abstract].
#18 urethral self catheter*[Title/Abstract].
#19 clean intermittent catheter*[Title/Abstract].
#20 bladder drainage[Title/Abstract].
#21 #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20.
#22 "labor, obstetric"[Mesh].
#23 labor[Title/Abstract].
#24 labour[Title/Abstract].
#25 childbirth[Title/Abstract].
#26 obstetric labor[Title/Abstract].
#27 #22 OR #23 OR #24 OR #25 OR #26 OR #27.
#28 #21 AND #27

EMBASE

#1 'urinary catheters'/exp.
#2 'intermittent urethral catheter*'[Mesh].
#3 'urinary catheters': ti,ab,kw.
#4 'continuous catheter*': ti,ab,kw.
#5 'transurethral catheter*': ti,ab,kw.
#6 'transurethral tube': ti,ab,kw.
#7 'urinary catheter*': ti,ab,kw.
#8 'urinary tube': ti,ab,kw.
#9 'urethral catheter*': ti,ab,kw.
#10 'urethral tube': ti,ab,kw.
#11 'intermittent urethral catheter*': ti,ab,kw.
#12 'techniques catheter*': ti,ab,kw.
#13 'intermittent self catheter*': ti,ab,kw.
#14 'clean intermittent catheter*': ti,ab,kw.
#15 'clean intermittent self-catheter*': ti,ab,kw.
#16 'in–out catheter*': ti,ab,kw.
#17 'intermittent urethral catheter*': ti,ab,kw.
#18 'urethral self catheter*': ti,ab,kw.
#19 'clean intermittent catheter*': ti,ab,kw.
#20 'bladder drainage': ti,ab,kw.
#21 #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20.
#22 'labor, obstetric'/exp.
#23 'labor': ti,ab,kw.
#24 'labour': ti,ab,kw.
#25 'childbirth': ti,ab,kw.
#26 'obstetric labor': ti,ab,kw.
#27 #22 OR #23 OR #24 OR #25 OR #26 OR #27.
#28 #21 AND #27

Cochrane library

#1 "urinary catheters"[Mesh]).
#2 "intermittent urethral catheter*"[Mesh].
#3 urinary catheters: ti,ab,kw.
#4 continuous catheter*: ti,ab,kw.
#5 transurethral catheter*: ti,ab,kw.
#6 transurethral tube: ti,ab,kw.
#7 urinary catheter*: ti,ab,kw.
#8 urinary tube: ti,ab,kw.
#9 urethral catheter*: ti,ab,kw.
#10 urethral tube: ti,ab,kw.
#11 intermittent urethral catheter*: ti,ab,kw.
#12 techniques catheter*: ti,ab,kw.
#13 intermittent self catheter*: ti,ab,kw.
#14 clean intermittent catheter*: ti,ab,kw.
#15 clean intermittent self-catheter*: ti,ab,kw.
#16 "in–out" catheter*: ti,ab,kw.
#17 intermittent urethral catheter*: ti,ab,kw.
#18 urethral self catheter*: ti,ab,kw.

#19 clean intermittent catheter*: ti,ab,kw.
#20 bladder drainage: ti,ab,kw.
#21 #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20.
#22 "labor, obstetric"[Mesh].
#23 labor: ti,ab,kw.
#24 labour: ti,ab,kw.
#25 childbirth: ti,ab,kw.
#26 obstetric labor: ti,ab,kw.
#27 #22 OR #23 OR #24 OR #25 OR #26 OR #27.
#28 #21 AND #27

Appendix 2

Table 4 Characteristics of excluded studies

Study	Reason for exclusion
Blease 2016 [1]	Review
Pollard 2012 [2]	Review
Basbug 2018 [3]	Not directly comparing IC with CC
Edwards 2015 [4]	Not directly comparing IC with CC
Sharma 2014 [5]	Not directly comparing IC with CC
EI-Mazny 2014 [6]	Not directly comparing IC with CC
Onile 2008 [7]	Not directly comparing IC with CC
Musselwhite 2007 [8]	Not directly comparing IC with CC
Liang 2002 [9]	Not directly comparing IC with CC
Mulder 2017 [10]	Non-laboring women with epidural analgesia
Moulton 2017 [11]	Non-laboring women with epidural analgesia
Hang 2014 [12]	Data not available
Suleiman 2017 [13]	Duplicate publication
Salim 2016 [14]	Duplicate publication
Rivard 2012 [15]	Duplicate publication
Schewe 2009 [16]	Duplicate publication
Ostertag 1986 [17]	Duplicate publication
Kerr-Wilson 1986 [18]	Duplicate publication

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