Impact of early postoperative indwelling urinary catheter removal: a systematic review

Nollen, J.M.; Pijnappel, L.; Schoones, J.W.; Peul, W.C.; Furth, W.R. van; Brunsveld-Reinders, A.H.

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SPECIAL ISSUE REVIEW

Impact of early postoperative indwelling urinary catheter removal: A systematic review

Jeanne-Marie Nollen RN, MSc[1] | Laury Pijnappel RN, BSc[1] | Jan W. Schoones MSc[2] | Wilco C. Peul MD, PhD, MPH, MBa[1] | Wouter R. Van Furth MD, PhD[1] | Anja H. Brunsveld-Reinders RN, MSc, PhD[3]

[1]Department of Neurosurgery, Leiden University Medical Center, Leiden, The Netherlands

[2]Walaeus Library, Leiden University Medical Center, Leiden, The Netherlands

[3]Department of Quality and Patient Safety, Leiden University Medical Center, Leiden, The Netherlands

Correspondence
Jeanne-Marie Nollen, Department of neurosurgery, Leiden University Medical Center, Albinusdreef 2, 2300 RC, 9600 Leiden, The Netherlands.
Email: j.m.nollen@lumc.nl

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Abstract

Background: Indwelling urinary catheters (IDUCs) are associated with complications and early removal is therefore essential. Currently, it is unknown what the effect of a specific removal time is and what the consequences of this removal time are.

Research question: To present an overview of the available evidence to determine the effects of three postoperative IDUC removal times (after a certain number of hours, at a specific time of day and flexible removal time) on the development of complications in hospital.

Methods: PubMed, Medline, Embase, Emcare and Cochrane Central Register of Controlled Trials were searched till 6 June, 2021. Studies were included that described the effect of the removal time in relation to re-catheterisation, urinary tract infections (UTIs), ambulation time, time of first voiding and hospital stay. The quality of the studies was assessed with the Newcastle-Ottawa Scale and the Cochrane Effective Practice and Organisation of Care. A narrative descriptive analysis was performed. PRISMA guidelines were followed in reporting this review.

Results: Twenty studies were included from which 18 compared removal after a number of hours, 1 reported on a specific removal time and 1 reported on both topics. The results were contradicting regarding the hypothesis that later removal increases the incidence of UTIs. Earlier removal does not lead to a higher re-catheterisation rate while immediate removal is beneficial for reducing the time to first ambulation and shortening the hospital stay. Studies reporting on specific removal times did not find differences in outcomes. No study addressed flexible removal time.

Conclusions: There is inconclusive evidence that earlier removal results in less UTIs, despite the incidence of UTIs increasing if the IDUC is removed ≥24 h. Immediate or after 1–2 day(s) removal does not lead to higher re-catheterisation rates while immediate removal results in earlier ambulation and shorter length of hospital stay.

Implications of key findings: Nurses should focus on early IDUC removal while being aware of urinary retention.

KEYWORDS
indwelling urinary catheter, nursing, patient safety, quality of care, removal time

1 | INTRODUCTION

Indwelling urinary catheters (IDUCs) are frequently used in general hospital settings for various reasons. Literature indicates a variation in IDUC prevalence between populations and specialisms with a reported catheterisation rate of approximately 12%–77% (Shackley et al., 2017). Indications for appropriate IDUC use include urologic surgeries, acute urinary retention, accurate measurement of urinary output in the critically ill, prolonged immobilisation and comfortable end-of-life care (Gould et al., 2010). Perioperative placement during surgical procedures is common practice as they prevent bladder distention and incontinence in the anaesthetised patient and facilitate the measurement of urine output during surgery (Meddings et al., 2019).

Despite IDUCs being routinely placed during surgeries, they are associated with a broad range of infectious and non-infectious complications and impediments. Patients have a 3%–7% risk of developing a catheter-associated urinary tract infection (UTI), per extra day the IDUC remains in place (Lo et al., 2014). The consequences of a UTI are extensive and range from higher morbidity, longer hospital stay, antibiotic use, which can lead to antibiotic resistance, and extensive costs (Bhatia et al., 2010; Smith et al., 2019). Other complications of the IDUC include structural injuries to the urinary tract, bleeding, the creation of a false passage and patient discomfort (Wooller et al., 2018). Additionally, IDUCs are known to have a negative influence on patients' mobility and participation in daily activities (Saint et al., 2018). After removing the IDUC, urinary retention has been reported as a commonly occurring complication which is associated with a risk of over distension and permanent detrusor muscle damage, which can occur from 7 to 48 h after IDUC removal (Baldini et al., 2009; Rosseland et al., 2002). Controversy, the primary intervention for urinary retention is inserting an IDUC (Johansson et al., 2013).

Although the catheter insertion, removal procedures and management of the IDUC are traditionally the domain of the nursing staff, decisions regarding the removal of the IDUC often remain with the physician. However, there is no consensus among researchers regarding the responsibility of removing the IDUC (Mazzo et al., 2015; Niederhauser et al., 2018). Additionally, since there is no specific time defined for removing the IDUC postoperatively, as it depends on the policy of the hospital and the preference of the surgeon, this could lead to delayed removal (Quinn et al., 2020). To reduce delayed removal and to empower the bedside nursing staff, literature advocates a nurse-driven protocol to remove the IDUC (Schiessler et al., 2019).

Several systematic reviews have been conducted on IDUC removal time concerning a specific type of surgery (Huang et al., 2020; Menshawy et al., 2020). However, to the best of our knowledge, no systematic review has been performed that compares complications after early vs. delayed IDUC removal from a nursing perspective after a broad range of surgeries. It is unknown what the effect of a certain removal time is and what the consequences of this removal time are after non-specific surgeries. Therefore, this systematic review summarises the evidence from randomised controlled trials, controlled trials, case–control and cohort studies related to the effect of the removal time of a short-term indwelling urinary catheter on the development of complications in general surgery.

What does this paper contribute to the wider global clinical community

- The systematic review presents available evidence on early indwelling urinary catheter removal with a translation to clinical nursing practice.
- As removal time does not have a clear and distinct relation to UTIs and re-catheterisation rate, nurses should focus on early removal to reduce patient discomfort.

1.1 | Aims

This systematic review aims to empower nurses and to reduce the risk of patient-related postoperative complications by presenting a systematic literature overview to determine the effect of the postoperative removal time of a short-term indwelling urinary catheter on the development of complications for surgical patients in the hospital. Complications include frequency of UTI occurrence, re-catheterisation rate, ambulation time and moment of first voiding. Furthermore, the length of hospital stay in relation to IDUC removal was investigated.

2 | METHODS

2.1 | Systematic review

A systematic review was used in this study to provide scientific knowledge from previous studies on the clinical impact of postoperative IDUC removal. Three postoperative removal times were investigated:

1. IDUC removal after a certain number of hours postoperatively (e.g. directly after surgery, 6 h or 12 h after surgery);

2. IDUC removal at a specific time of day (e.g. 06:00, 00:00, morning, evening, night);
3. Flexible removal time.

This systematic review was conducted according to the Cochrane Review Methodology and Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) (Appendix, S1) (Higgins et al., 2019; Moher et al., 2009).

2.2 | Data collection

2.2.1 | Databases

A systematic literature search was performed in six databases: PubMed, Medline, Embase, Emcare, Web of Science and Cochrane Central Register of Controlled Trials. The date of the most recent search of the register for this review is 6 June, 2021.

2.3 | Search strategy and inclusion criteria

The search queries were formulated by three researchers using the patient/population, intervention, comparison and outcomes framework (PICO). We used the following research question: what is the effect of the postoperative removal time of a short-term indwelling urinary catheter on the development of complications for surgical patients in the hospital? Search queries included index terms and keywords from the title and abstract. The following keywords were used to develop the search queries: 'urinary catheter', 'foley catheter', 'urethral catheter', 'catheter removal', 'removal of catheter', 'time', 'timing', 'early removal', 'late removal', 'flexible removal', 'morning removal', 'evening removal', 'midnight removal', 'surgerical procedures', 'postoperative period', 'perioperative nursing', 'complications', 'adverse effects', 'retention bladder' and 'recatheterization'. No limitations were applied on publication date and language. An expert health librarian at the University hospital guided the search. The full search strategy is included in Appendix, S1.

Studies were eligible for inclusion if they (a) included surgical patients aged ≥18 with an IDUC that is inserted perioperative; (b) reported on early vs. late IDUC removal or a specific IDUC removal time or on the comparison between flexible duration vs. fixed duration of the IDUC; (c) reported on complications post IDUC removal (occurrence of UTI, re-catheterisation rate, ambulation time, moment of first voiding and length of hospital stay); (d) conducted in a hospital setting; (e) used a randomised, controlled trial design; controlled clinical trial design or a uncontrolled clinical trial design. Studies were excluded if (a) they reported on patients with abnormalities of the genitourinary system; (b) they reported on patients undergoing urological surgery; (c) they reported on patients with epidural anaesthesia or epidural pain medication (d) they reported on the use of antibiotics as a study intervention; (e) they were a systematic review; meta-analysis; individual case study; letter to the editor; conference abstract or expert opinion and (f) no full text was available. Requests for full text articles were sent to the authors of studies with no full text available. If they did not respond, a reminder was sent after 2 weeks.

2.4 | Study selection

All studies identified from the search were systematically ordered using Endnote (version 20) and Microsoft Excel (version 2016). After removing the duplicates, two researchers independently reviewed title and abstract of the studies, followed by full texts review. Disagreements were discussed and, if necessary, a third researcher was consulted. After the initial search, the reference lists and citations of all included studies were examined to identify more relevant studies.

2.5 | Data extraction

The data of the included studies were extracted in standard data extraction forms in Microsoft Excel (version 2016) by one researcher. A second researcher independently checked the extracted data. Differences were discussed between the researchers until consensus was reached. If consensus was not possible, a third researcher was consulted. The following data were collected from all included studies: first author, year of publication, country of origin, setting, study design, participant characteristics such as age and gender, type of surgery, postoperative IDUC removal time, primary and secondary outcomes. The primary outcome was the frequency of UTI occurrence. Secondary outcomes were re-catheterisation rate, ambulation time, moment of first voiding and hospital stay.

2.6 | Methodological quality

The methodological quality of the included articles was assessed independently by two researchers using tools to assess the risk of bias. The Newcastle-Ottawa Scale (NOS) was used for uncontrolled studies and the Cochrane Effective Practice and Organisation of Care (EPOC) was used for randomised controlled trials and controlled before and after studies (EPOC, 2015; Wells et al., 2013). The NOS consists of three categories: (a) selection; (b) comparability and (c) and outcome. A number of stars can be awarded to each category, resulting in the conclusion: poor quality; fair quality; good quality (Wells et al., 2013). The EPOC tool consists of nine items that access risk of bias: (a) random sequence generation; (b) allocation concealment; (c) baseline outcome measurements similar; (d) baseline characteristics similar; (e) incomplete outcome data; (f) knowledge of the allocated interventions adequately prevented during the study; (g) protection against contamination; (h) selective outcome reporting (i) and other risks of bias. Every item was scored with low, high, or unclear risk

(EPOC, 2015). Differences in judgement were discussed and, if necessary, resolved through intervention of a third reviewer.

2.7 | Synthesis

Given the heterogeneity of the target population (age, type of surgery), the variability in IDUC removal times and differences in methodological quality, performing a meta-analysis was infeasible. To summarise the overall evidence of the effectiveness of removal time of a short-term indwelling urinary catheter on the development of complications for surgical patients in hospital, a narrative descriptive synthesis was conducted. The extracted data were summarised in a baseline characteristics table and an evidence table. These tables are comprised of either descriptive statistics or, if available, the results (mean, median, percentages, hours) related to the primary and secondary objectives.

3 | RESULTS

3.1 | Study selection

The search in the databases resulted in 825 results. The reference and citation search resulted in an additional 83 studies. After removing 546 duplicates, 362 articles remained. After screening on title and abstract, 110 articles were selected for full-text evaluation. Eight reports were not retrieved, resulting in 102 articles being assessed for eligibility. A total of 20 studies were included in this systematic review (Figure 1), including 13 randomised controlled trials (Ahmed et al., 2014; Aref, 2020; Atilgan et al., 2020; Chai & Pun, 2011; Dunn et al., 2003; El-Mazny et al., 2014; Joshi et al., 2014; Liang et al., 2009; Onile et al., 2008; Ouladsahebmadarek et al., 2012; Sandberg et al., 2019; Sekhavat et al., 2008; Vallabh-Patel et al., 2020) and seven uncontrolled studies (Campbell et al., 2017; Dedden et al., 2020; Duchalais et al., 2019; Hung et al., 2020; Karp et al., 2018; Mengatto et al., 2020; Yoo et al., 2015). Reasons for exclusion were as follows: (a) the use of perioperative epidural anaesthesia or pain medication ($n = 20$); (b) inappropriate study design, for example, systematic review, letter to the editor, conference abstract and individual case study ($n = 16$); (c) no specific removal time mentioned ($n = 17$); (d) study population did not fit the inclusion criteria ($n = 27$) and (e) not published in English or Dutch ($n = 2$).

3.2 | Methodological quality and risk of bias

The risk of bias in the controlled studies ($n = 13$), scored with the EPOC tool (Table 1), showed that eleven studies scored low risk on seven of the nine risk of bias criteria. For two studies (Atilgan et al., 2020; Dunn et al., 2003), there was an unclear risk of bias due to missing outcomes and high risks of bias that were likely to bias the results. The risk of bias of the uncontrolled studies ($n = 7$), scored with the NOS, is shown in Table 2. The quality of the majority of the included uncontrolled studies was poor, particularly due to a low score in the comparison domain due to a shortage of matching of exposed and unexposed individuals in the study design and/or a lack of correction for confounding in the analyses. One study did not perform statistical tests to measure the effectiveness of their de-implementation strategy (Dedden et al., 2020). The quality of the studies was not of influence on the aggregation. For one study, there was an unclear and high risk for missing outcomes that were likely to bias the results (Karp et al., 2018).

3.3 | Study characteristics

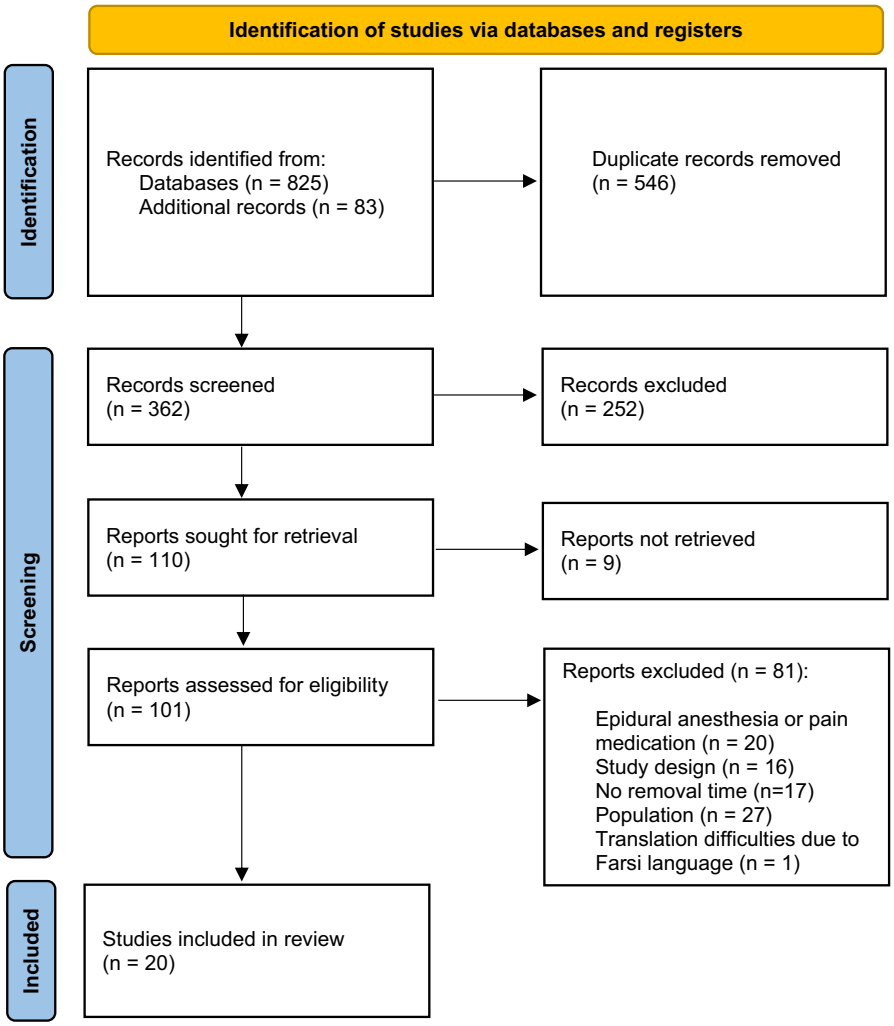
3.3.1 | Controlled studies

Thirteen of the 20 studies (65%) had a controlled design (Table 3), including 11 randomised controlled trials (55%) (Atilgan et al., 2020; Chai & Pun, 2011; Dunn et al., 2003; El-Mazny et al., 2014; Joshi et al., 2014; Liang et al., 2009; Onile et al., 2008; Ouladsahebmadarek et al., 2012; Sandberg et al., 2019; Sekhavat et al., 2008; Vallabh-Patel et al., 2020) and two cluster RCTs (10%) (Ahmed et al., 2014; Aref, 2020). Out of the 13 controlled studies, seven studies performed hysterectomies (Ahmed et al., 2014; Chai & Pun, 2011; Dedden et al., 2020; Joshi et al., 2014; Karp et al., 2018; Liang et al., 2009; Sandberg et al., 2019), three caesarean sections (Aref, 2020; El-Mazny et al., 2014; Onile et al., 2008), one study a combination of hysterectomy and a laparotomy (Ouladsahebmadarek et al., 2012), one study colporrhaphy's (Sekhavat et al., 2008), one study a sacrocolpopexy (Vallabh-Patel et al., 2020) and one study tension-free vaginal tape-procedures (Atilgan et al., 2020). Given the type of surgeries, the study population of all controlled studies were female.

In all controlled studies, IDUC removal was the intervention, however, the number of hours after which the IDUC was removed postoperatively differed between studies (Table 4). We found nine different comparisons in these studies: (1) removing the IDUC immediately after surgery vs. 24 h postoperatively (Chai & Pun, 2011; Joshi et al., 2014; Onile et al., 2008; Ouladsahebmadarek et al., 2012; Sekhavat et al., 2008), (2) immediate vs. after 6 h vs. after 24 h removal (Ahmed et al., 2014; Aref, 2020), (3) immediate vs. after 18–24 h removal (Sandberg et al., 2019), (4) after 6 h vs. 24 h removal (Atilgan et al., 2020), (5) immediate vs. after 12 h removal (El-Mazny et al., 2014), (6) 6 h vs. the morning after surgery removal (Vallabh-Patel et al., 2020), (7) immediate vs. postoperative day one removal (Dunn et al., 2003), (8) immediate vs. after 24 h vs. after >48 h removal vs. discharged with IDUC (Karp et al., 2018) and (9) no IDUC inserted vs. day one vs. day two removal (Liang et al., 2009).

The study population in five studies had a mean age of <40 years (Aref, 2020; El-Mazny et al., 2014; Onile et al., 2008; Ouladsahebmadarek et al., 2012; Sekhavat et al., 2008) and eight had a mean age >40 year (Ahmed et al., 2014; Atilgan et al., 2020; Chai & Pun, 2011; Dunn et al., 2003; Joshi et al., 2014; Liang et al., 2009; Sandberg et al., 2019; Vallabh-Patel et al., 2020).

FIGURE 1 Prisma flow-chart



3.3.2 | Uncontrolled studies

Seven of the 20 studies (35%) had an uncontrolled design (Table 3), including two cohort studies (10%) (Campbell et al., 2017; Mengatto et al., 2020), three retrospective reviews (20%) (Duchalais et al., 2019; Hung et al., 2020; Yoo et al., 2015), one retrospective analysis (5%) (Dedden et al., 2020) and one case–control study (5%) (Karp et al., 2018). Two of the seven studies performed hysterectomies (Dedden et al., 2020; Karp et al., 2018), one hysterectomies or bilateral pelvic node dissections (Campbell et al., 2017), one rectal resections (Duchalais et al., 2019), one hysterectomies or trachelectomies (Mengatto et al., 2020), one proctectomies (Hung et al., 2020) and one performed mesorectal excisions (Yoo et al., 2015). Three studies included males (Duchalais et al., 2019; Hung et al., 2020; Yoo et al., 2015). Five uncontrolled studies focused their intervention on IDUC removal after a certain number of hours postoperatively (Table 4). Comparisons were different in the included studies namely: a certain number of hours postoperatively and a specific removal time (Campbell et al., 2017), immediate removal vs. delayed removal (Dedden et al., 2020), day one or two removal vs. day three or later removal (Hung et al., 2020), four different removal times ranging from immediate removal to discharge with an IDUC (Karp et al., 2018), day one removal vs. day seven removal (Mengatto et al., 2020). Campbell et al. (2017) investigated both removal after a certain hours postoperatively (24 h, 24–48 h and 48–72 h postoperatively) and removal at a specific moment (6–12 AM vs. midnight). The intervention of the study from Duchalais et al. (2019) focused IDUC removal between 6 and 8 AM. The mean age in the six studies was >40. One study did not mentioned age (Karp et al., 2018). Not all studies reported on the operation time.

3.4 | Effects of interventions

3.4.1 | IDUC removal after a certain number of hours postoperatively (e.g. directly after surgery, 6 h after surgery, 12 h after surgery)

Nineteen studies compared IDUC removal at different times postoperatively in relation to at least one of the following complications: frequency of UTI occurrence, re-catheterisation rate, ambulation time, moment of first voiding and hospital stay (Table 5).

TABLE 1 Risk of bias Cochrane effective practice and organisation of care (EPOC) of controlled studies ($n = 13$)

	Random sequence generation	Allocation concealment	Baseline outcome measurements similar	Baseline characteristics similar	Incomplete outcome data	Knowledge of the allocated interventions adequately prevented during the study	Protection against contamination	Selective outcome reporting	Other risks of bias	Score
Ahmed et al. (2014)	+	+	+	+	?	?	+	+	+	7/9
Aref (2020)	+	+	+	+	?	?	+	+	+	7/9
Atilgan et al. (2020)	+	+	+	+	?	?	+	+	+	6/9
Chai and Pun (2011)	+	+	-	+	+	+	+	+	+	8/9
Dunn et al. (2003)	+	+	?	+	?	?	-	?	+	4/9
El-Mazny et al. (2014)	+	+	+	+	+	?	+	+	+	8/9
Joshi et al. (2014)	+	+	-	+	+	?	+	+	+	7/9
Liang et al. (2009)	+	+	+	+	?	+	-	+	+	7/9
Onile et al. (2008)	+	+	+	+	+	?	+	+	+	8/9
Ouladsahebmadarek et al. (2012)	+	+	+	+	-	?	+	+	+	7/9
Sandberg et al. (2019)	+	+	+	+	?	?	+	+	+	7/9
Sekhavat et al. (2008)	+	?	+	+	?	+	+	+	+	7/9
Vallabh-Patel et al. (2020)	+	+	+	+	?	?	+	+	+	7/9

Note: Green circle: Low risk of bias; yellow circle: Unclear risk of bias; Red circle: High risk of bias.

Low risk of bias: score 7–9. Unclear risk of bias: score 4–6; High risk of bias: score 0–3.

TABLE 2 Risk of bias Newcastle-Ottawa scale (NOS) of uncontrolled studies ($n = 7$)

Author	Score selection	Score comparability	Score outcome	Conclusion
Campbell et al. (2017)	☆☆☆	-	☆☆	Poor[a]
Dedden et al. (2020)	☆☆☆	-	☆☆☆	Poor[a]
Duchalais et al. (2019)	☆☆☆☆	☆	☆☆	Good[b]
Hung et al. (2020)	☆☆☆☆	☆	☆☆	Good[b]
Karp et al. (2018)	☆☆☆	-	☆☆	Poor[a]
Mengatto et al. (2020)	☆☆☆☆	☆	☆☆	Good[b]
Yoo et al. (2015)	☆☆☆	-	☆☆☆	Poor[a]

[a]Poor quality: 0 or 1 star in selection domain OR 0 stars in comparability domain OR 0 stars or 1 stars in outcome domain.

[b]Good quality: 3 or 4 stars in selection domain AND 1 or 2 stars in comparability domain AND 2 or 3 stars in outcome domain.

3.5 | Urinary tract infection

Seventeen studies evaluated the development of UTIs after various postoperative IDUC removal times. Seven of these seventeen studies (41%) found a positive and significant effect between late IDUC removal and the development of UTIs (Ahmed et al., 2014; Aref, 2020; Atilgan et al., 2020; El-Mazny et al., 2014; Karp et al., 2018; Liang et al., 2009; Sekhavat et al., 2008; Vallabh-Patel et al., 2020). Three studies found a statistically significant effect between the latest (2 days or 24 h postoperatively) and the fastest IDUC removal time (immediate removal, after 6 h or after 1 day) when comparing three different time points postoperatively. Two days or 24 h after surgery compared to not inserting the IDUC or removing the catheter immediately after surgery or after 6 h or after 1 day, with 14.9%, 13.4% and 18% UTIs in the latest removal groups compared with 1.4% and 4% in the earliest removal groups, respectively. (Ahmed et al., 2014; Aref, 2020; Liang et al., 2009).

Four studies found a statistically significant effect between later IDUC removal (12 h after surgery/24 h after surgery/>48 h after surgery/discharged with IDUC/morning after surgery removal) and UTIs, with 34.2%, 19.3%, 6.5% and 15% UTIs in the latest removal groups compared with 11.4%, 9.3%, 1.3% and 4.5% in the earliest removal groups, respectively (Atilgan et al., 2020; El-Mazny et al., 2014; Karp et al., 2018; Sekhavat et al., 2008). One study (6%) found a statistically significant effect between IDUC removal after 6 h and removal the morning after surgery, with 9% and 0% UTIs, respectively (Vallabh-Patel et al., 2020).

Eight studies (47%) did not report a significant effect between later removal time and UTIs (Chai & Pun, 2011; Dunn et al., 2003; Hung et al., 2020; Joshi et al., 2014; Mengatto et al., 2020; Onile et al., 2008; Ouladsahebmadarek et al., 2012; Sandberg et al., 2019). One study (6%) did not report a *p*-value (Dedden et al., 2020).

3.5.1 | Re-catheterisation

Eighteen studies evaluated the re-catheterisation rate after the various postoperative IDUC removal times. In total, five studies (28%) reported a significant result between re-catheterisation and earlier IDUC removal (Ahmed et al., 2014; Aref, 2020; Liang et al., 2009; Sekhavat et al., 2008; Vallabh-Patel et al., 2020). These studies reported a re-catheterisation rate of 16.4%–36% in their earliest removal group compared with 0–6.6% in their latest removal group. Eleven studies did not display a significant relation between re-catheterisation and earlier removal time (Atilgan et al., 2020; Chai & Pun, 2011; Dunn et al., 2003; El-Mazny et al., 2014; Hung et al., 2020; Joshi et al., 2014; Mengatto et al., 2020; Onile et al., 2008; Ouladsahebmadarek et al., 2012; Sandberg et al., 2019; Yoo et al., 2015). Two studies did not report a *p*-value: Campbell et al. (2017) found a re-catheterisation rate of 44%, however, this percentage is in relation to the whole study population. Dedden et al. (2020) reported a re-catheterisation rate of 4.6% in their early removal group compared with 2.1% in their late removal group.

3.5.2 | Ambulation time

Seven studies reported on ambulation time. Six of those studies (86%) found a statistically significant relation between earlier IDUC removal and shorter time until first ambulation (Ahmed et al., 2014; Aref, 2020; El-Mazny et al., 2014; Ouladsahebmadarek et al., 2012; Sandberg et al., 2019; Sekhavat et al., 2008). In these studies, the earliest IDUC removal group walked without the aid of assistant devices and/or nurses 1.6–3.6 times earlier (in hours) than the latest removal group. Onile et al. (2008) did not report a significant effect.

3.5.3 | First voiding

One study reported on the relation between IDUC removal and first void and found that the group with immediate removal early voided after an average of 4.8 h compared with 13.4 h in the 12 h postoperative removal group, which resulted in a statistically significant effect (El-Mazny et al., 2014).

TABLE 3 Baseline characteristics of the studies

Author (year), country	Study design	Type of sugery	Gender (*n*)	Intervention	Age in years, mean (SD or 95% CI)	Operation time in minutes, mean (SD or 95% CI)
Ahmed et al. (2014), Egypt	Cluster RCT	Uncomplicated abdominal hysterectomy	Female (221)	a. Immediate removal (0 h) b. Intermediate removal (after 6 h) c. Delayed removal (after 24 h)	a. 59.1 (8.3) b. 58.3 (6.9) c. 61.3 (0.5)	a. 95.6 (10.9) b. 96.4 (13.1) c. 98.9 (11.5)
Aref (2020), Saudi Arabia	Cluster RCT	Caesarean section	Female (221)	a. Immediate removal (0 h) b. Intermediate removal (after 6 h) c. Delayed removal (after 24 h)	a. 26.1 (4) b. 25.3 (2) c. 25.6 (3)	a. 45.36 (15.3) b. 43.91 (13.9) c. 48.48 (12.4)
Atilgan et al. (2020), Turkey	RCT	Tension-free vaginal tape	Female (70)	b. Intermediate removal (after 6 h) c. Delayed removal (after 24 h)	b. 42.8 (6.8) c. 44.6 (4.34)	b. 35.25 (21.8) c. 36.18 (23.1)
Campbell et al. (2017), Northern Ireland	Retrospective cohort study	Hysterectomy or bilateral pelvic node dissection	Female (78)	c. Delayed removal (after 24 h) d. 24–48 h after surgery e. 48–72 h after surgery	40.7 (8.74)	-
Chai and Pun (2011), Hong Kong	RCT	Total abdominal hysterectomy	Female (70)	a. Immediate removal (0 h) c. Delayed removal (after 24 h)	a. 46.4 (3.9) c. 46.4 (4.0)	a. 84.3 (2.1) c. 85.6 (0.8)
Dedden et al. (2020), Netherlands	Retrospective analysis	Laparoscopic hysterectomy	Female (242)	a. Immediate removal (0 h) f. Delayed removal	50 (12)	128 [108;164]
Duchalais et al. (2019), United States	Retrospective review	Rectal resection	Female (143) Male (274)	Removal of unirary catheter, post operative Day 1 between 6 and 8 in the morning	59 [50;68]	229 [171;301]
Dunn et al. (2003), United States	RCT	Caesarean dilvery or hysterectomy	Female (250)	a. Immediate removal (0 h) g. Removal postoperative Day 1	47 [25;72]	-
El-Mazny et al. (2014), Egypt	RCT	Elective caesarean section	Female (300)	a. Immediate removal (0 h) h. Delayed removal (after 12 h)	a. 24.5 (4.2) h. 23.8 (3.9)	-
Hung et al. (2020), United States	Retrospective review	Proctectomy	Female (1117) Male (1312)	i. Removal postoperative Day 1 or 2 j. Removal postoperative Day 3 or later	i. 52 (16.3) j. 53.5 (16.4)	i. 220 [164;291] j. 239 [178;304]
Joshi et al. (2014), India	RCT	Proctectomy	Female (70)	a. Immediate removal (0 h) c. Delayed removal (after 24 h)	a. 46.80 (6.9) c. 45.09 (6.44)	a. 97.86 (21.39) c. 107.29 (15.30)
Karp et al. (2018), United States	Retrospective case study	Hysterectomy	Female (10354)	a. Immediate removal (0 h) c. Delayed removal (after 24 h) k. Delayed removal (after >48 h) l. Discared home with indweling catheter	-	-
Liang et al. (2009), Taiwan	RCT	Hysterectomy	Female (150)	m. No IDUC g. Removal postoperative Day 1 n. Removal postoperative Day 2	m. 43.7 (3.9) g. 45.7 (3.5) n. 45.7 (5.8)	m. 142.5 (102.2) g. 143.9 (81.5) n. 154.2 (81.6)
Mengatto et al. (2020)	Cohort study	Hysterectomy or trachelectomy	Female (95)	g. Removal postoperative day 1 o. Removal postoperative Day 7	g. 40 o. 44	-
Onile et al. (2008), Nigeria	RCT	Caesarean delivery	Female (200)	a. Immediate removal (0 h) c. Delayed removal (after 24 h)	a. 31.67 (6.042) c. 32.72 (5.96)	-

TABLE 3 (Continued)

Author (year), country	Study design	Type of sugery	Gender (*n*)	Intervention	Age in years, mean (SD or 95% CI)	Operation time in minutes, mean (SD or 95% CI)
Ouladsahebmadarek et al. (2012), Iran	RCT	Hysterectomy and laparotomy	Female (200)	a. Immediate removal (0 h) c. Delayed removal (after 24 h)	a. 37.48 (8.85) c. 39.48 (9.54)	a. 100.2 (21) c. 105.6 (22.8)
Sandberg et al. (2019), Netherlands	RCT	Hysterectomy	Female (155)	a. Immediate removal (0 h) p. Delayed removal (after 18–24 h)	a. 49.3 (10.5) p. 51.5 (11.9)	a. 116.0 (44.0) p. 105.4 (29.6)
Sekhavat et al. (2008), Iran	RCT	Colporrhaphy	Female (90)	a. Immediate removal (0 h) c. Delayed removal (after 24 h)	a. 38.9 (2.9) c. 39 (3.8)	a. <30 min: 18 (40%) 30–45 min: 22 (48.9%) >45 min: 5 (11%) c. <30 min: 20 (44.4%) 30–45 min: 21 (46.7%) > 45 min: 4 (8.9%)
Vallabh-Patel et al. (2020), United States	RCT	Robotic-assisted laparoscopic sacrocolpopexy	Female (88)	b. Intermediate removal (after 6 h) q. Morngning after sugery	b. 59.52 (8.5) q. 59.57 (11.2)	b. 202.5 [120;284] q. 192.5 [127;391]
Yoo et al. (2015), South Korea	Retrospective review	Total mesorectal excision or tumour-specific mesorectal excision	Male (102) Female (87)	g. Removal postoperative Day 1 n. Removal postoperative Day 2	a. 64.5 [36;82] n. 66.0 [27;87]	-

Abbreviations: CI, confidence interval; *n*, sample size; RCT, randomised controlled trial; SD, standard deviation.

a = immediate removal (0 h).

b = intermediate removal (6 h).

c = delayed removal (after 24 h).

d. 24–48 h after surgery.

e = 48–72 h after surgery.

f = delayed removal (unspecified).

g = removal postoperative Day 2.

h = delayed removal (12 h).

i = removal postoperative Day 1 or 2.

j = removal postoperative Day 3 or later.

k = delayed removal (>48 h).

l = discharged home with IDUC.

m = no IDUC placed during surgery.

n = removal postoperative Day 2.

o = removal postoperative Day 7.

p = delayed removal (18–24 h).

q = morning after surgery.

TABLE 4 Removal time indwelling catheter

Author (year)/ removal time	No IDUC	Hours							Days									Other	
		0	6	12	18–24	<24	24	>24	1	Morning after surgery	Day after surgery	1 or 2	2	>48	Between 1–3	>3	7	Delayed	Discharged home
Ahmed et al. (2014)		+	+				+												
Aref (2020)		+	+				+												
Atilgan et al. (2020)			+				+												
Campbell et al. (2017)						+									+				
Chai and Pun (2011)		+					+												
Dedden et al. (2020)		+																+	
Dunn et al. (2003)		+							+										
El-Mazny et al. (2014)		+		+															
Hung et al. (2020)												+				+			
Joshi et al. (2014)		+							+										
Karp et al. (2018)		+					+							+					+
Liang et al. (2009)	+								+				+						
Mengatto et al. (2020)									+								+		
Onile et al. (2008)		+					+												
Ouladsahebmadarek et al. (2012)		+					+												
Sandberg et al. (2019)		+			+														
Sekhavat et al. (2008)		+						+											
Vallabh-Patel et al. (2020)			+							+									
Yoo et al. (2015)											+		+						

Author (year)/removal time	6:00 AM	Between 6 and AM	Morning (between 6 AM and 12 AM)	22:00 PM	Midnight (00:00)
Campbell et al. (2017)			x		x
Duchalais et al. (2019)		x			

3.5.4 | Hospital stay

Eleven of the nineteen included studies reported on the length of hospital stay in relation to IDUC removal. Seven of these studies (58%) reported a statistically significant effect between earlier IDUC removal and shorter length of hospital stay (Ahmed et al., 2014; Aref, 2020; Atilgan et al., 2020; El-Mazny et al., 2014; Hung et al., 2020; Ouladsahebmadarek et al., 2012; Sekhavat et al., 2008). In these studies, the earliest IDUC removal group stayed in the hospital 0.5–2.4 days shorter than the latest removal group. No significant effect is reported by two other studies (Onile et al., 2008; Sandberg et al., 2019). One study did not report a *p*-value (Chai & Pun, 2011).

3.5.5 | IDUC removal at a specific time of day (e.g. 06:00, 00:00, morning, evening, night)

Two studies investigated IDUC removal at a specific time of day (between 06:00and 12:00 AM, midnight and between 06:00and 08:00 AM) (Table 4) in relation to UTIs, re-catheterisation and voiding dysfunction (Campbell et al., 2017; Duchalais et al., 2019). In the study from Duchalais et al. (2019), 11 (6%) of the 172 patients (41%) who required in-and-out catheterisation due to voiding problems after IDUC removal, developed a UTI ($p = .002$). In the group who did not need in-and-out catheterisation (245 patients), 2 patients (1%) developed a UTI. The IDUC was re-inserted in 14 patients. The length of the hospital stay was longer in the in-and-out catheterisation group with a mean of 4 days compared with 5 days in the non in-and-out catheterisation group ($p < .001$).

Campbell et al. (2017) described that 51 of the 78 participants had the IDUC removed in the morning between 06:00and 12:00 AM and 23 patients had IDUC removal at midnight. Voiding dysfunction was registered in 21 patients (41%) of the morning group vs. 11 (48%) of the midnight group ($p = .59$).

3.5.6 | Flexible removal

No studies were found that investigated flexible removal times.

4 | DISCUSSION

Our study sought to assess the effects of three postoperative removal times (after a certain number of hours postoperatively, at a specific time of day and flexible removal time) of an IDUC on the development of complications for surgical patients in hospitals. Prevention and early recognition of postoperative complications are a major part of the nursing profession which benefit both the medical team as well as the patient.

Of the included twenty included studies, nineteen studies investigated IDUC removal after a certain number of hours postoperative in relation to five complications. However, due to not all studies providing a precise definition of the amount of hours passed before IDUC removal (e.g. stating day 1 or day 2 after surgery), interpretation and comparison of the results was challenging. Consequently, the results from this review were inconclusive regarding the hypothesis that later IDUC removal increases the incidence of UTIs. This finding is in contrast with previous research, which assumes that patients have a 3–7% risk of developing a catheter-associated urinary tract infection, per extra day the IDUC remains in place (Lo et al., 2014). One explanation for these results could be the short duration of IDUC placement in the included studies. However, extending the duration of postoperative catheterisation for ≥24 h postoperatively did increase the incidence of UTIs compared with early removal times.

Urinary retention, defined as the inability to void in the presence of a full bladder, frequently occurs after anaesthesia, surgery and IDUC removal which requires bladder catherisation (Baldini et al., 2009). Since literature indicates that the risk of urinary retention, and subsequent catheterisation, increases when epidural or spinal anaesthesia is used during surgery, we decided to include only studies that used general anaesthetics (Brouwer et al., 2021; Hayami et al., 2019). Additionally, we excluded urological surgeries as IDUCs can be used as an intervention that is beneficial for the healing process during the postoperative period (Gould et al., 2010). Thus, in this review, we mostly included studies who performed gynaecological surgeries, which automatically results in a higher population females, thereby complicating direct generalisation to other surgical specialisms such as vascular surgery, neurosurgery and thoracic surgery. Regarding urinary retention, most studies in this review show that earlier IDUC removal, immediate removal or on day one or two, does not lead to a significantly higher re-catheterisation rate compared with later IDUC removal. This finding is of relevant for daily practice since nurses could have a tendency to leave the IDUC in place due to a fear of re-catheterisation (Ouma, 2017).

The findings of this systematic review show that early IDUC removal leads to a shorter time until first ambulation and a shorter length of hospital stay, especially when the IDUC was removed immediately after surgery. Saint et al. underlined that IDUCs are known to negatively affect patient mobility and participation in daily activities (Saint et al., 2018). Moreover, by reducing the time to ambulation a broad range of complications including thrombosis and embolisms could be prevented (Chindamo & Marques, 2019). Early ambulation is stated to be of great importance after surgical interventions due to the positive effect on patient recovery, that results in a reduced length of hospital stay and which in turn as has as substantial societal impact by limiting costs (Adogwa et al., 2017; Fleming et al., 2018). For patients, early IDUC removal is of great clinical significance as it reduces discomfort and feelings of shame that patients might experience (Bhardwaj et al., 2012). Patients can feel ashamed when others notice the IDUC as this can make them feel less competent. Additionally, the

TABLE 5 Removal time and complications of an IDUC

Author (year)	*n* total	Removal time (*n*)	Urinary tract infections (%)	*p* value	Recatheterisation (%)
Ahmed et al. (2014)	221	a. 0 h after surgery (73) b. 6 h after surgery (81) c. 24 h after surgery (67)	a. 1 (1.4) b. 3 (3.7) c. 10 (14.9)	.008 c. vs. a. & b.	a. 12 (16.4) b. 2 (2.5) c. 0 (0)
Aref (2020)	221	a. 0 h after surgery (73) b. 6 h after surgery (81) c. 24 h after surgery (67)	a. 1 (1.4) b. 3 (3.7) c. 9 (13.4)	.005 Difference among groups and c vs. a. & b.	a. 12 (16.4) b. 2 (2.5) c. 0 (0)
Atilgan et al. (2020)	70	b. 6 h after surgery (35) c. 24 h after surgery (35)	b. 4 (11.4) c. 12 (34.2)	.042	b. 4 (11.4) c. 0 (0)
Campbell et al. (2017)	78	c. 24 h after surgery (14) d. 24–48 h after surgery (47) e. 48–72 h after surgery (17)	-	-	34 (44%)
Chai and Pun (2011)	70	a. 0 h after surgery (35) c. 24 h after surgery (35)	a. 4 (11.4) c. 10 (28.6)	.133	a. 4 (11.4) c. 0 (0)
Dedden et al. (2020)	242	a. 0 h after surgery (194) f. Delayed removal after surgery (48)	a. 18 (9.3) f. 10 (20.8)	-	a. 9 (4.6) f. 1 (2.1)
Dunn et al. (2003)	250	a. 0 h after surgery (125) g. Postopertive day 1 (125)	a. 3 (2.4) b. 3 (2.4)	NS	a. 6 (2.4) b. 3 (2.4)
El-Mazny et al. (2014)	300	a. 0 h after surgery (150) h. 12 h after surgery (150)	a. 14 (9.3) h. 29 (19.3)	.02	a. 4 (2.7) h. 1 (0.7)
Hung et al. (2020)	2429	i.Postopertive Day 1 or 2 (1176) j. Postopertive Day 3 or later (1253)	i. 35 (2.98) j. 42 (3.35)	.680	i. 150 (12.8) j. 130 (10.4)
Joshi et al. (2014)	70	a. 0 h after surgery (35) c. 24 h after surgery (35)	a. 3 (8.5) c. 9 (22.8)	.222	a. 3 (8.5) c. 0 (0)
Karp et al. (2018)	10,354	a. 0 h after surgery (2915) c. 24 h after surgery (6297) k. >48 h after surgery (802) l. Discharged home with IDUC(340)	a. 37 (1.3) c. 130 (2.1) k. 33 (4.1) l. 22 (6.5)	<.0001	-
Liang et al. (2009)	150	m. No IDUC (50) g. Postoperative Day 1 (50) n. Postoperative Day 2 (50)	m. 2 (4) g. 3 (6) n. 9 (18)	.034	m. 17 (34) g. 6 (12) n. 5 (10)
Mengatto et al. (2020)	95	g. Postoperative Day 1 (48) o. Postoperative Day 7 (47)	g. 2 (4.2) o. 8 (14.9)	.09	g. 14 (29.2) o. 16 (34)
Onile et al. (2008)	200	a. 0 h after surgery (86) c. 24 h after surgery (89)	a. 7 (8.1) c. 10 (11.2)	.489	a. 1.2 (1) c. 0 (0)
Ouladsahebmadarek et al. (2012)	200	a. 0 h after surgery (100) c. 24 h after surgery (100)	a. 3 (3) c. 9 (9)	.074	a. 3 (3) c. 0 (0)
Sandberg et al. (2019)	155	a. 0 h after surgery (74) p. 18–24 h after surgery (81)	a. 3 (4.1) p. 8 (9.9)	.215	a. 10 (13.5) p. 0 (0)
Sekhavat et al. (2008)	90	a. 0 h after surgery (45) c. 24 h after surgery (45)	a. 2 (4.5) c. 9 (15)	.001	a. 3 (6.6) c. 11 (24.5)
Vallabh-Patel et al. (2020)	88	b. 6 h after surgery (44) q. Morning after surgery (44)	b. 4 (9) q. 0 (0)	.041	b. 16 (36) q. 2 (4.5)
Yoo et al. (2015)	189	g. Postoperative Day 1 (104) n. Postoperative Day 2 (85)	-	-	g. 5 (4.8) n. 4 (4.7)

n = sample size.
RCT = randomised controlled trial.
SD = standard deviation.
CI = confidence interval.
NS = not significant.
a = 0 h after surgery.
b = 6 h after surgery.
c = 24 h after surgery.

p value	Time of ambulation in hours (SD or 95% CI)	*p* value	First voiding in hours (SD)	*p* value	Hospital stay in days (SD or 95% CI)	*p* value
.001 a. vs. b. & c.	a. 4.1 (1.8) b. 6.8 (1.7) c. 10.3 (2.5)	.001 b. & c. vs. a.	-	-	a. 3.2 (1.6) b. 3.4 (1.5) c. 5.6 (1.2)	.001
.001 Difference among three groups and a vs. b. & c.	a. 4.1 (1.8) b. 6.8 (1.7) c. 10.3 (2.5)	.001 Difference among groups.	-	-	a. 1.9 (1.4) b. 2.4 (1.3) c. 3.9 (1.1)	.01
.069	-	-	-	-	b. 0.5 (0.14) c. 1.2 (0.21)	.043
-	-		-	-	4.2 (1.3)	-
.114	-	-	-	-	a. 3.3 (0.6) c. 3.8 (2.1)	-
-	-	-	-	-	-	-
NS	-	-	-	-	-	-
.371	a. 4.8 (1.1) h. 9.5 (1.2)	<.001	a. 4.8 (1.1) h. 13.4 (1.3)	<.001	a. 0.79 (0.1) h. 1.68 (0.47)	<.001
.076	-	-	-	-	i. 5.26 [4.0;8.0] j. 7 [4.52;10.0]	<.001
.077	-	-	-	-	-	-
-	-	-	-	-	-	-
.003	-	-	-	-	-	-
.66	-	-	-	-	-	-
.986	a. 7.82 (1.85) c. 8.72 (2.48)	.842	-	-	a. 6.8 (1.76) c. 6.9 (1.82)	.879
1	a. 15.53 (6.45) c. 24.36 (4.66)	<.0001	-	-	a. 2.2 (0.68) c. 2.7 (0.75)	<.0001
.88	a. 5.7 [0.8;23.3] p. 21.0 [1.4;29.9]	<.001	-	-	a. 1.5 [0;4] p. 1 [1;4]	.954
.008	a. 5.9 (1.7) c. 17.1 (2.4)	.01	-	-	a. 1.0 (0.13) c. 2.2 (0.20)	.003
<.001	-	-	-	-	-	-
1	-	-	-	-	-	-

(Continues)

TABLE 5 (Continued)

d. 24–48 h after surgery.
e = 48–72 h after surgery.
f = delayed removal (unspecified).
g = removal postoperative Day 2.
h = delayed removal (12 h).
i = removal postoperative Day 1 or 2.
j = removal postoperative Day 3 or later.
k = delayed removal (>48 h).
l = discharged home with IDUC.
m = no IDUC placed during surgery.
n = removal postoperative Day 2.
o = removal postoperative Day 7.
p = delayed removal (18–24 h).
q = morning after surgery.

IDUC makes patients feel dependent on nurses in simple daily tasks (Wilde, 2003).

This systematic review included only one study that reported on first voiding after IDUC removal, which revealed that the 0-h group voided significate earlier than the later removal group. While prior studies agree that difficulties regaining normal bladder function frequently occur after catheter removal, there is little known about the relation between earlier IDUC removal and urinary dysfunction. Bladder training to decrease bladder dysfunction is an intervention widely studied; however, there is no consensus whether the use of intermittent clamping before removal reduces urinary retention (Liu et al., 2015; Markopoulos et al., 2019).

In this systematic review, we included two studies who investigated IDUC removal at a specific time of day between 6 and 12 AM and at noon. However, only one study compared two specific removal times which showed no difference in voiding dysfunction between the morning and midnight group. Since this review found little evidence regarding the best IDUC removal time, future trials are required to investigate the effects of a specific removal time. Regarding flexible removing times, this review does not provide any information as there are no trials known with this research question.

In order to appreciate the finding of this systematic review, some limitations need to be considered. First, the interpretation of the results described in this systematic review is complicated due to differences in the included studies (e.g. types of surgery, removal times and mostly female population). Due to the heterogeneity of the studies, it was not possible to conduct a meta-analysis. Second, since no studies specifically addressed the comparison between flexible duration vs. fixed duration of the catheter, this could not be reviewed. Third, selection bias might have occurred as a consequence of excluding one article written in a foreign language. In this review, we had to exclude one study written in Farsi language due to translation difficulties. Fourth, only two articles included males in their study population. This could have influenced the results since females have a higher risk of UTIs (John et al., 2016). Finally, due to the exclusion criteria multiple studies with respect to urological surgeries were excluded. Therefore, this review is not representable for patients with urological conditions. A strength of this study is that the search was systematically conducted by multiple researchers and the help of a health librarian expert which ensured a critical assessment of the data. The review has been peer-reviewed by multiple researchers.

Before new removal strategies and interventions can be developed, we suggest to perform studies to acquire more insight into the consequences of flexible removing times. In addition, there is a need for studies that focus on a broader range of surgical indications with an equal distribution of sexes between the participants. Additionally, studies should evaluate the use of nurse-driven protocols that empower the nursing profession in IDUC management.

5 | CONCLUSION

This systematic review presents a literature overview to determine the effectiveness of the postoperative removal time of an IDUC on the development of complications for surgical patients in the hospital. It became clear that there is inconclusive evidence that earlier postoperative removal results in less UTIs. However, the incidence of UTIs does increase if the IDUC is removed ≥24 h postoperatively. Additionally, immediate or after 1–2 day(s) removal does not lead to higher re-catheterisation rates while immediate removal results in a shorter time until first ambulation and length of hospital stay. Therefore, based on the available evidence, removing the IDUC immediately after surgery while ensuring close monitoring of urinary retention is recommended to reduce UTIs and encourage postoperative recovery.

6 | RELEVANCE TO CLINICAL PRACTICE

This review does not provide a definite answer as to what IDUC removal time is most beneficial in relation to postoperative complications in surgical patients. However, the presented overview gives insight in the possible removal times of the IDUC in gynaecological surgeries. As evidence indicates that removal time does not have a

significant relation to UTIs and the rate of re-catheterisation, nurses should focus on early IDUC removal to increase patient comfort while being aware of the risk of urinary retention and urinary tract infections.

AUTHOR CONTRIBUTION

Jeanne-Marie Nollen involved in conceptualisation, methodology, formal analysis, investigation and writing—original draft. Laury Pijnappel performed formal analysis, investigation and visualisation. Jan Schoones involved in resources. Wilco Peul and Wouter van Furth involved in conceptualisation. Anja Brunsveld-Reinders involved in conceptualisation, formal analysis, writing—review and editing and supervision.

CONFLICT OF INTEREST

The authors report no conflict of interest.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.

ORCID

Jeanne-Marie Nollen https://orcid.org/0000-0002-1241-5380

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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APPENDIX

SEARCH STRATEGY

Database	Search strategy	Number of references	Number of unique references
a. PubMed (Totaal d.d. 23-7-2021)	**(**(('Urinary Catheters'[majr] OR 'Urinary Catheters'[ti] OR 'Urinary Catheter'[ti] OR 'Ureteral Catheter'[ti] OR 'Ureteral Catheters'[ti] OR 'Urethral Catheter'[ti] OR 'Urethral Catheters'[ti] OR 'urinary tract catheter'[ti] OR 'urinary tract catheters'[ti] OR 'foley catheter'[ti] OR 'foley catheters'[ti] OR 'folley catheter'[ti] OR ('urinary'[ti] AND ('catheter'[ti] OR 'catheters'[ti])))) AND ('Device Removal'[Mesh] OR 'catheter removal'[tw] OR 'removal of catheter'[tw] OR 'removing catheters'[tw] OR 'removal'[tw] OR 'remov*'[tw] OR 'removal practice'[tw] OR 'removal practices'[tw]) AND ('Time'[Mesh] OR 'Time Factors'[mesh] OR 'timing'[tw] OR 'time'[tw] OR 'evening'[tw] OR 'morning'[tw] OR 'midnight'[tw] OR 'night'[tw] OR 'early removal'[tw] OR 'earlier removal'[tw] OR 'early catheter removal'[tw] OR 'earlier catheter removal'[tw] OR 'early urinary catheter removal'[tw] OR 'earlier urinary catheter removal'[tw] OR 'late removal'[tw] OR 'late catheter removal'[tw] OR 'late urinary catheter removal'[tw] OR 'early foley catheter removal'[tw] OR 'late foley catheter removal'[tw] OR 'After-Hours Care'[Mesh] OR 'Night Care'[Mesh] OR 'Day Care, Medical'[Mesh]) AND ('Surgical Procedures, Operative'[Mesh] OR 'surgery'[Subheading] OR 'Surgical*'[tw] OR 'surgery'[tw] OR 'Postoperative Period'[Mesh] OR 'Postoperative Care'[Mesh] OR 'Perioperative Period'[Mesh] OR 'Perioperative Care'[Mesh] OR 'Perioperative Nursing'[Mesh] OR 'Intraoperative Period'[Mesh] OR 'Intraoperative Care'[Mesh] OR 'acute care'[tw]) AND ('complications'[Subheading] OR 'complications'[tw] OR 'complication'[tw] OR 'Postoperative Complications'[Mesh] OR 'Intraoperative Complications'[Mesh] OR 'Urinary Catheters/adverse effects'[mesh] OR 'postdischarge problems'[tw] OR 'post discharge problems'[tw] OR 'postdischarge adverse'[tw] OR 'post discharge adverse'[tw] OR 'adverse effects'[subheading] OR 'retention bladder'[tw] OR 'Urinary Retention'[Mesh] OR 'urinary retention'[tw] OR 'recatheterisation'[tw] OR 'recatheterization'[tw] OR 'recatheter*'[tw]) NOT ('Animals'[mesh] NOT 'Humans'[mesh])) **OR** (('Urinary Catheters'[Mesh] OR 'Urinary Catheters'[tw] OR 'Urinary Catheter'[tw] OR 'Ureteral Catheter'[tw] OR 'Ureteral Catheters'[tw] OR Urethral Catheter'[tw] OR 'Urethral Catheters'[tw] OR 'urinary tract catheter'[tw] OR 'urinary tract catheters'[tw] OR 'foley catheter'[tw] OR 'foley catheters'[tw] OR 'folley catheter'[tw] OR ('urinary'[tw] AND ('catheter'[tw] OR 'catheters'[tw])))) AND ('Device Removal'[majr] OR 'catheter removal'[ti] OR 'removal of catheter'[ti] OR 'removing catheters'[ti] OR 'removal'[ti] OR 'remov*'[ti] OR 'removal practice'[ti] OR 'removal practices'[ti]) AND ('Time'[Mesh] OR 'Time Factors'[mesh] OR 'timing'[tw] OR 'time'[tw] OR 'evening'[tw] OR 'morning'[tw] OR 'midnight'[tw] OR 'night'[tw] OR 'early removal'[tw] OR 'earlier removal'[tw] OR 'early catheter removal'[tw] OR 'earlier catheter removal'[tw] OR 'early urinary catheter removal'[tw] OR 'earlier urinary catheter removal'[tw] OR 'late removal'[tw] OR 'late catheter removal'[tw] OR 'late urinary catheter removal'[tw] OR 'early foley catheter removal'[tw] OR 'late foley catheter removal'[tw] OR 'After-Hours Care'[Mesh] OR 'Night Care'[Mesh] OR 'Day Care, Medical'[Mesh]) AND ('Surgical Procedures, Operative'[Mesh] OR 'surgery'[Subheading] OR 'Surgical*'[tw] OR 'surgery'[tw] OR 'Postoperative Period'[Mesh] OR 'Postoperative Care'[Mesh] OR 'Perioperative Period'[Mesh] OR 'Perioperative Care'[Mesh] OR 'Perioperative Nursing'[Mesh] OR 'Intraoperative Period'[Mesh] OR 'Intraoperative Care'[Mesh] OR 'acute care'[tw]) AND ('complications'[Subheading] OR 'complications'[tw] OR 'complication'[tw] OR 'Postoperative Complications'[Mesh] OR 'Intraoperative Complications'[Mesh] OR 'Urinary Catheters/adverse effects'[mesh] OR 'postdischarge problems'[tw] OR 'post discharge problems'[tw] OR 'postdischarge adverse'[tw] OR 'post discharge adverse'[tw] OR 'adverse effects'[subheading] OR 'retention bladder'[tw] OR 'Urinary Retention'[Mesh] OR 'urinary retention'[tw] OR 'recatheterisation'[tw] OR 'recatheterization'[tw] OR 'recatheter*'[tw]) NOT ('Animals'[mesh] NOT 'Humans'[mesh]))**)**	228	228

Database	Search strategy	Number of references	Number of unique references
b. MEDLINE via OVID (Totaal d.d. 5-3-2021)	**(**(((exp *'Urinary Catheters'/OR 'Urinary Catheters'.ti OR 'Urinary Catheter'.ti OR 'Ureteral Catheter'.ti OR 'Ureteral Catheters'.ti OR 'Urethral Catheter'.ti OR 'Urethral Catheters'.ti OR 'urinary tract catheter'.ti OR 'urinary tract catheters'.ti OR 'foley catheter'.ti OR 'foley catheters'.ti OR 'folley catheter'.ti OR ('urinary'.ti AND ['catheter'.ti OR 'catheters'.ti])) AND (exp 'Device Removal'/OR 'catheter removal'.mp OR 'removal of catheter'.mp OR 'removing catheters'.mp OR 'removal'.mp OR 'remov*'.mp OR 'removal practice'.mp OR 'removal practices'.mp) AND (exp 'Time'/OR exp 'Time Factors'/OR 'timing'.mp OR 'time'.mp OR 'evening'.mp OR 'morning'.mp OR 'midnight'.mp OR 'night'.mp OR 'early removal'.mp OR 'earlier removal'.mp OR 'early catheter removal'.mp OR 'earlier catheter removal'.mp OR 'early urinary catheter removal'.mp OR 'earlier urinary catheter removal'.mp OR 'late removal'.mp OR 'late catheter removal'.mp OR 'late urinary catheter removal'.mp OR 'early foley catheter removal'.mp OR 'late foley catheter removal'.mp OR exp 'After-Hours Care'/OR exp 'Night Care'/OR exp 'Day Care, Medical'/) AND (exp 'Surgical Procedures, Operative'/OR 'su'.fs OR 'Surgical*'.mp OR 'surgery'.mp OR exp 'Postoperative Period'/OR exp 'Postoperative Care'/OR exp 'Perioperative Period'/OR exp 'Perioperative Care'/OR exp 'Perioperative Nursing'/OR exp 'Intraoperative Period'/OR exp 'Intraoperative Care'/OR 'acute care'.mp) AND ('co'.fs OR 'complications'.mp OR 'complication'.mp OR exp 'Postoperative Complications'/OR exp 'Intraoperative Complications'/OR exp 'Urinary Catheters'/ae OR 'postdischarge problems'.mp OR 'post discharge problems'.mp OR 'postdischarge adverse'.mp OR 'post discharge adverse'.mp OR 'ae'.fs OR 'retention bladder'.mp OR exp 'Urinary Retention'/OR 'urinary retention'.mp OR 'recatheterisation'.mp OR 'recatheterization'.mp OR 'recatheter*'.mp) NOT (exp 'Animals'/NOT exp 'Humans'/)) **OR** ((exp 'Urinary Catheters'/OR 'Urinary Catheters'.mp OR 'Urinary Catheter'.mp OR 'Ureteral Catheter'.mp OR 'Ureteral Catheters'.mp OR 'Urethral Catheter'.mp OR 'Urethral Catheters'.mp OR 'urinary tract catheter'.mp OR 'urinary tract catheters'.mp OR 'foley catheter'.mp OR 'foley catheters'.mp OR 'folley catheter'.mp OR ('urinary'.mp AND ['catheter'.mp OR 'catheters'.mp])) AND (exp *'Device Removal'/OR 'catheter removal'.ti OR 'removal of catheter'.ti OR 'removing catheters'.ti OR 'removal'.ti OR 'remov*'.ti OR 'removal practice'.ti OR 'removal practices'.ti) AND (exp 'Time'/OR exp 'Time Factors'/OR 'timing'.mp OR 'time'.mp OR 'evening'.mp OR 'morning'.mp OR 'midnight'.mp OR 'night'.mp OR 'early removal'.mp OR 'earlier removal'.mp OR 'early catheter removal'.mp OR 'earlier catheter removal'.mp OR 'early urinary catheter removal'.mp OR 'earlier urinary catheter removal'.mp OR 'late removal'.mp OR 'late catheter removal'.mp OR 'late urinary catheter removal'.mp OR 'early foley catheter removal'.mp OR 'late foley catheter removal'.mp OR exp 'After-Hours Care'/OR exp 'Night Care'/OR exp 'Day Care, Medical'/) AND (exp 'Surgical Procedures, Operative'/OR 'su'.fs OR 'Surgical*'.mp OR 'surgery'.mp OR exp 'Postoperative Period'/OR exp 'Postoperative Care'/OR exp 'Perioperative Period'/OR exp 'Perioperative Care'/OR exp 'Perioperative Nursing'/OR exp 'Intraoperative Period'/OR exp 'Intraoperative Care'/OR 'acute care'.mp) AND ('co'.fs OR 'complications'.mp OR 'complication'.mp OR exp 'Postoperative Complications'/OR exp 'Intraoperative Complications'/OR exp 'Urinary Catheters'/ae OR 'postdischarge problems'.mp OR 'post discharge problems'.mp OR 'postdischarge adverse'.mp OR 'post discharge adverse'.mp OR 'ae'.fs OR 'retention bladder'.mp OR exp 'Urinary Retention'/OR 'urinary retention'.mp OR 'recatheterisation'.mp OR 'recatheterization'.mp OR 'recatheter*'.mp) NOT (exp 'Animals'/NOT exp 'Humans'/))**)**	218	1

Database	Search strategy	Number of references	Number of unique references
c. Embase (Totaal d.d. 5-3-2021)	(((exp *'Urinary Catheter'/OR 'Urinary Catheters'.ti OR 'Urinary Catheter'.ti OR 'Ureteral Catheter'.ti OR 'Ureteral Catheters'.ti OR 'Urethral Catheter'.ti OR 'Urethral Catheters'.ti OR 'urinary tract catheter'.ti OR 'urinary tract catheters'.ti OR 'foley catheter'.ti OR 'foley catheters'.ti OR 'folley catheter'.ti OR ('urinary'.ti AND ['catheter'.ti OR 'catheters'.ti])) AND (exp *'Device Removal'/OR 'catheter removal'.ti,ab OR 'removal of catheter'.ti,ab OR 'removing catheters'.ti,ab OR 'removal'.ti,ab OR 'remov*'.ti,ab OR 'removal practice'.ti,ab OR 'removal practices'.ti,ab) AND (exp *'Time'/OR exp *'Time Factor'/OR 'timing'.ti,ab OR 'time'.ti,ab OR 'evening'.ti,ab OR 'morning'.ti,ab OR 'midnight'.ti,ab OR 'night'.ti,ab OR 'early removal'.ti,ab OR 'earlier removal'.ti,ab OR 'early catheter removal'.ti,ab OR 'earlier catheter removal'.ti,ab OR 'early urinary catheter removal'.ti,ab OR 'earlier urinary catheter removal'.ti,ab OR 'late removal'.ti,ab OR 'late catheter removal'.ti,ab OR 'late urinary catheter removal'.ti,ab OR 'early foley catheter removal'.ti,ab OR 'late foley catheter removal'.ti,ab OR exp *'Out-of-Hours Care'/OR exp *'Night Care'/OR exp *'Day Care'/) AND (exp *'Surgery'/OR 'su'.fs OR 'Surgical*'.ti,ab OR 'surgery'.ti,ab OR exp *'Postoperative Period'/OR exp *'Postoperative Care'/OR exp *'Perioperative Period'/OR exp *'Perioperative Care'/OR exp *'Perioperative Nursing'/OR exp *'Intraoperative Period'/OR exp *'Intraoperative Care'/OR 'acute care'.ti,ab) AND ('co'.fs OR 'complications'.ti,ab OR 'complication'.ti,ab OR exp *'Postoperative Complication'/OR exp *'Peroperative Complication'/OR exp *'Urinary Catheter'/am OR exp *'Urinary Catheter'/ae OR 'postdischarge problems'.ti,ab OR 'post discharge problems'.ti,ab OR 'postdischarge adverse'.ti,ab OR 'post discharge adverse'.ti,ab OR 'ae'.fs OR 'retention bladder'.ti,ab OR exp *'Urine Retention'/OR 'urinary retention'.ti,ab OR 'recatheterisation'.ti,ab OR 'recatheterization'.ti,ab OR 'recatheter*'.ti,ab) NOT (exp 'Animals'/ NOT exp 'Humans'/)) OR ((exp *'Urinary Catheter'/OR 'Urinary Catheters'.ti,ab OR 'Urinary Catheter'.ti,ab OR 'Ureteral Catheter'.ti,ab OR 'Ureteral Catheters'.ti,ab OR 'Urethral Catheter'.ti,ab OR 'Urethral Catheters'.ti,ab OR 'urinary tract catheter'.ti,ab OR 'urinary tract catheters'.ti,ab OR 'foley catheter'.ti,ab OR 'foley catheters'.ti,ab OR 'folley catheter'.ti,ab OR ('urinary'.ti,ab AND ['catheter'.ti,ab OR 'catheters'.ti,ab])) AND (exp *'Device Removal'/ OR 'catheter removal'.ti OR 'removal of catheter'.ti OR 'removing catheters'.ti OR 'removal'.ti OR 'remov*'.ti OR 'removal practice'.ti OR 'removal practices'.ti) AND (exp *'Time'/OR exp *'Time Factor'/OR 'timing'.ti,ab OR 'time'.ti,ab OR 'evening'.ti,ab OR 'morning'.ti,ab OR 'midnight'.ti,ab OR 'night'.ti,ab OR 'early removal'.ti,ab OR 'earlier removal'.ti,ab OR 'early catheter removal'.ti,ab OR 'earlier catheter removal'.ti,ab OR 'early urinary catheter removal'.ti,ab OR 'earlier urinary catheter removal'.ti,ab OR 'late removal'.ti,ab OR 'late catheter removal'.ti,ab OR 'late urinary catheter removal'.ti,ab OR 'early foley catheter removal'.ti,ab OR 'late foley catheter removal'.ti,ab OR exp *'Out-of-Hours Care'/OR exp *'Night Care'/OR exp *'Day Care'/) AND (exp *'Surgery'/OR 'su'.fs OR 'Surgical*'.ti,ab OR 'surgery'.ti,ab OR exp *'Postoperative Period'/OR exp *'Postoperative Care'/OR exp *'Perioperative Period'/OR exp *'Perioperative Care'/OR exp *'Perioperative Nursing'/OR exp *'Intraoperative Period'/OR exp *'Intraoperative Care'/OR 'acute care'.ti,ab) AND ('co'.fs OR 'complications'.ti,ab OR 'complication'.ti,ab OR exp *'Postoperative Complication'/OR exp *'Peroperative Complication'/OR exp *'Urinary Catheter'/am OR exp *'Urinary Catheter'/ae OR 'postdischarge problems'.ti,ab OR 'post discharge problems'.ti,ab OR 'postdischarge adverse'.ti,ab OR 'post discharge adverse'.ti,ab OR 'ae'.fs OR 'retention bladder'.ti,ab OR exp *'Urine Retention'/OR 'urinary retention'.ti,ab OR 'recatheterisation'.ti,ab OR 'recatheterization'.ti,ab OR 'recatheter*'.ti,ab) NOT (exp 'Animals'/NOT exp 'Humans'/))) • NOT conference review.pt • NOT (conference review or conference abstract).pt • AND (conference abstract).pt	187	56

Database	Search strategy	Number of references	Number of unique references
d. Web of Science (Totaal d.d. 5-3-2021)	((ti = ('Urinary Catheter' OR 'Urinary Catheters' OR 'Urinary Catheter' OR 'Ureteral Catheter' OR 'Ureteral Catheters' OR 'Urethral Catheter' OR 'Urethral Catheters' OR 'urinary tract catheter' OR 'urinary tract catheters' OR 'foley catheter' OR 'foley catheters' OR 'folley catheter' OR ('urinary' AND ['catheter' OR 'catheters'])) AND ts = ('Device Removal' OR 'catheter removal' OR 'removal of catheter' OR 'removing catheters' OR 'removal' OR 'remov*' OR 'removal practice' OR 'removal practices') AND ts = ('Time' OR 'Time Factor' OR 'timing' OR 'time' OR 'evening' OR 'morning' OR 'midnight' OR 'night' OR 'early removal' OR 'earlier removal' OR 'early catheter removal' OR 'earlier catheter removal' OR 'early urinary catheter removal' OR 'earlier urinary catheter removal' OR 'late removal' OR 'late catheter removal' OR 'late urinary catheter removal' OR 'early foley catheter removal' OR 'late foley catheter removal' OR 'Out-of-Hours Care' OR 'Night Care' OR 'Day Care') AND ts = ('Surgery' OR 'Surgical*' OR 'surgery' OR 'Postoperative Period' OR 'Postoperative Care' OR 'Perioperative Period' OR 'Perioperative Care' OR 'Perioperative Nursing' OR 'Intraoperative Period' OR 'Intraoperative Care' OR 'acute care') AND ts = ('complications' OR 'complication' OR 'Postoperative Complication' OR 'Peroperative Complication' OR 'postdischarge problems' OR 'post discharge problems' OR 'postdischarge adverse' OR 'post discharge adverse' OR 'retention bladder' OR 'Urine Retention' OR 'urinary retention' OR 'recatheterisation' OR 'recatheterization' OR 'recatheter*')) OR (ts = ('Urinary Catheter' OR 'Urinary Catheters' OR 'Urinary Catheter' OR 'Ureteral Catheter' OR 'Ureteral Catheters' OR 'Urethral Catheter' OR 'Urethral Catheters' OR 'urinary tract catheter' OR 'urinary tract catheters' OR 'foley catheter' OR 'foley catheters' OR 'folley catheter' OR ('urinary' AND ['catheter' OR 'catheters'])) AND ti = ('Device Removal' OR 'catheter removal' OR 'removal of catheter' OR 'removing catheters' OR 'removal' OR 'remov*' OR 'removal practice' OR 'removal practices') AND ts = ('Time' OR 'Time Factor' OR 'timing' OR 'time' OR 'evening' OR 'morning' OR 'midnight' OR 'night' OR 'early removal' OR 'earlier removal' OR 'early catheter removal' OR 'earlier catheter removal' OR 'early urinary catheter removal' OR 'earlier urinary catheter removal' OR 'late removal' OR 'late catheter removal' OR 'late urinary catheter removal' OR 'early foley catheter removal' OR 'late foley catheter removal' OR 'Out-of-Hours Care' OR 'Night Care' OR 'Day Care') AND ts = ('Surgery' OR 'Surgical*' OR 'surgery' OR 'Postoperative Period' OR 'Postoperative Care' OR 'Perioperative Period' OR 'Perioperative Care' OR 'Perioperative Nursing' OR 'Intraoperative Period' OR 'Intraoperative Care' OR 'acute care') AND ts = ('complications' OR 'complication' OR 'Postoperative Complication' OR 'Peroperative Complication' OR 'postdischarge problems' OR 'post discharge problems' OR 'postdischarge adverse' OR 'post discharge adverse' OR 'retention bladder' OR 'Urine Retention' OR 'urinary retention' OR 'recatheterisation' OR 'recatheterization' OR 'recatheter*'))) NOT ti = ('veterinary' OR 'rabbit' OR 'rabbits' OR 'animal' OR 'animals' OR 'mouse' OR 'mice' OR 'rodent' OR 'rodents' OR 'rat' OR 'rats' OR 'pig' OR 'pigs' OR 'porcine' OR 'horse' OR 'horses' OR 'equine' OR 'cow' OR 'cows' OR 'bovine' OR 'goat' OR 'goats' OR 'sheep' OR 'ovine' OR 'canine' OR 'dog' OR 'dogs' OR 'feline' OR 'cat' OR 'cats')	88	9

Database	Search strategy	Number of references	Number of unique references
e. Cochrane (Totaal d.d. 5-3-2021)	((‘Urinary Catheter’ OR ‘Urinary Catheters’ OR ‘Urinary Catheter’ OR ‘Ureteral Catheter’ OR ‘Ureteral Catheters’ OR ‘Urethral Catheter’ OR ‘Urethral Catheters’ OR ‘urinary tract catheter’ OR ‘urinary tract catheters’ OR ‘foley catheter’ OR ‘foley catheters’ OR ‘folley catheter’ OR (‘urinary’ AND [‘catheter’ OR ‘catheters’])):ti AND (‘Device Removal’ OR ‘catheter removal’ OR ‘removal of catheter’ OR ‘removing catheters’ OR ‘removal’ OR ‘remov*’ OR ‘removal practice’ OR ‘removal practices’):ti,ab,kw AND (‘Time’ OR ‘Time Factor’ OR ‘timing’ OR ‘time’ OR ‘evening’ OR ‘morning’ OR ‘midnight’ OR ‘night’ OR ‘early removal’ OR ‘earlier removal’ OR ‘early catheter removal’ OR ‘earlier catheter removal’ OR ‘early urinary catheter removal’ OR ‘earlier urinary catheter removal’ OR ‘late removal’ OR ‘late catheter removal’ OR ‘late urinary catheter removal’ OR ‘early foley catheter removal’ OR ‘late foley catheter removal’ OR ‘Out of Hours Care’ OR ‘Night Care’ OR ‘Day Care’):ti,ab,kw AND (‘Surgery’ OR ‘Surgical*’ OR ‘surgery’ OR ‘Postoperative Period’ OR ‘Postoperative Care’ OR ‘Perioperative Period’ OR ‘Perioperative Care’ OR ‘Perioperative Nursing’ OR ‘Intraoperative Period’ OR ‘Intraoperative Care’ OR ‘acute care’):ti,ab,kw AND (‘complications’ OR ‘complication’ OR ‘Postoperative Complication’ OR ‘Peroperative Complication’ OR ‘postdischarge problems’ OR ‘post discharge problems’ OR ‘postdischarge adverse’ OR ‘post discharge adverse’ OR ‘retention bladder’ OR ‘Urine Retention’ OR ‘urinary retention’ OR ‘recatheterisation’ OR ‘recatheterization’ OR ‘recatheter*’):ti,ab,kw) OR ((‘Urinary Catheter’ OR ‘Urinary Catheters’ OR ‘Urinary Catheter’ OR ‘Ureteral Catheter’ OR ‘Ureteral Catheters’ OR ‘Urethral Catheter’ OR ‘Urethral Catheters’ OR ‘urinary tract catheter’ OR ‘urinary tract catheters’ OR ‘foley catheter’ OR ‘foley catheters’ OR ‘folley catheter’ OR (‘urinary’ AND [‘catheter’ OR ‘catheters’])):ti,ab,kw AND (‘Device Removal’ OR ‘catheter removal’ OR ‘removal of catheter’ OR ‘removing catheters’ OR ‘removal’ OR ‘remov*’ OR ‘removal practice’ OR ‘removal practices’):ti AND (‘Time’ OR ‘Time Factor’ OR ‘timing’ OR ‘time’ OR ‘evening’ OR ‘morning’ OR ‘midnight’ OR ‘night’ OR ‘early removal’ OR ‘earlier removal’ OR ‘early catheter removal’ OR ‘earlier catheter removal’ OR ‘early urinary catheter removal’ OR ‘earlier urinary catheter removal’ OR ‘late removal’ OR ‘late catheter removal’ OR ‘late urinary catheter removal’ OR ‘early foley catheter removal’ OR ‘late foley catheter removal’ OR ‘Out of Hours Care’ OR ‘Night Care’ OR ‘Day Care’):ti,ab,kw AND (‘Surgery’ OR ‘Surgical*’ OR ‘surgery’ OR ‘Postoperative Period’ OR ‘Postoperative Care’ OR ‘Perioperative Period’ OR ‘Perioperative Care’ OR ‘Perioperative Nursing’ OR ‘Intraoperative Period’ OR ‘Intraoperative Care’ OR ‘acute care’):ti,ab,kw AND (‘complications’ OR ‘complication’ OR ‘Postoperative Complication’ OR ‘Peroperative Complication’ OR ‘postdischarge problems’ OR ‘post discharge problems’ OR ‘postdischarge adverse’ OR ‘post discharge adverse’ OR ‘retention bladder’ OR ‘Urine Retention’ OR ‘urinary retention’ OR ‘recatheterisation’ OR ‘recatheterization’ OR ‘recatheter*’):ti,ab,kw)\	78	17

Database	Search strategy	Number of references	Number of unique references
f. Emcare (Totaal d.d. 5-3-2021)	(((exp *'Urinary Catheter'/OR 'Urinary Catheters'.ti OR 'Urinary Catheter'.ti OR 'Ureteral Catheter'.ti OR 'Ureteral Catheters'.ti OR 'Urethral Catheter'.ti OR 'Urethral Catheters'.ti OR 'urinary tract catheter'.ti OR 'urinary tract catheters'.ti OR 'foley catheter'.ti OR 'foley catheters'.ti OR 'folley catheter'.ti OR ('urinary'.ti AND ['catheter'.ti OR 'catheters'.ti])) AND (exp *'Device Removal'/OR 'catheter removal'.ti,ab OR 'removal of catheter'.ti,ab OR 'removing catheters'.ti,ab OR 'removal'.ti,ab OR 'remov*'.ti,ab OR 'removal practice'.ti,ab OR 'removal practices'.ti,ab) AND (exp *'Time'/OR exp *'Time Factor'/OR 'timing'.ti,ab OR 'time'.ti,ab OR 'evening'.ti,ab OR 'morning'.ti,ab OR 'midnight'.ti,ab OR 'night'.ti,ab OR 'early removal'.ti,ab OR 'earlier removal'.ti,ab OR 'early catheter removal'.ti,ab OR 'earlier catheter removal'.ti,ab OR 'early urinary catheter removal'.ti,ab OR 'earlier urinary catheter removal'.ti,ab OR 'late removal'.ti,ab OR 'late catheter removal'.ti,ab OR 'late urinary catheter removal'.ti,ab OR 'early foley catheter removal'.ti,ab OR 'late foley catheter removal'.ti,ab OR exp *'Out-of-Hours Care'/OR exp *'Night Care'/ OR exp *'Day Care'/) AND (exp *'Surgery'/OR 'Surgical*'.ti,ab OR 'surgery'.ti,ab OR exp *'Postoperative Period'/OR exp *'Postoperative Care'/OR exp *'Perioperative Period'/OR exp *'Perioperative Care'/OR exp *'Perioperative Nursing'/OR exp *'Intraoperative Period'/OR exp *'Intraoperative Care'/ OR 'acute care'.ti,ab) AND ('complications'.ti,ab OR 'complication'.ti,ab OR exp *'Postoperative Complication'/OR exp *'Peroperative Complication'/ OR 'postdischarge problems'.ti,ab OR 'post discharge problems'.ti,ab OR 'postdischarge adverse'.ti,ab OR 'post discharge adverse'.ti,ab OR 'retention bladder'.ti,ab OR exp *'Urine Retention'/OR 'urinary retention'.ti,ab OR 'recatheterisation'.ti,ab OR 'recatheterization'.ti,ab OR 'recatheter*'.ti,ab) NOT (exp 'Animals'/NOT exp 'Humans'/)) OR ((exp *'Urinary Catheter'/OR 'Urinary Catheters'.ti,ab OR 'Urinary Catheter'.ti,ab OR 'Ureteral Catheter'.ti,ab OR 'Ureteral Catheters'.ti,ab OR 'Urethral Catheter'.ti,ab OR 'Urethral Catheters'.ti,ab OR 'urinary tract catheter'.ti,ab OR 'urinary tract catheters'.ti,ab OR 'foley catheter'.ti,ab OR 'foley catheters'.ti,ab OR 'folley catheter'.ti,ab OR ('urinary'.ti,ab AND ['catheter'.ti,ab OR 'catheters'.ti,ab])) AND (exp *'Device Removal'/ OR 'catheter removal'.ti OR 'removal of catheter'.ti OR 'removing catheters'.ti OR 'removal'.ti OR 'remov*'.ti OR 'removal practice'.ti OR 'removal practices'.ti) AND (exp *'Time'/OR exp *'Time Factor'/OR 'timing'.ti,ab OR 'time'.ti,ab OR 'evening'.ti,ab OR 'morning'.ti,ab OR 'midnight'.ti,ab OR 'night'.ti,ab OR 'early removal'.ti,ab OR 'earlier removal'.ti,ab OR 'early catheter removal'.ti,ab OR 'earlier catheter removal'.ti,ab OR 'early urinary catheter removal'.ti,ab OR 'earlier urinary catheter removal'.ti,ab OR 'late removal'.ti,ab OR 'late catheter removal'.ti,ab OR 'late urinary catheter removal'.ti,ab OR 'early foley catheter removal'.ti,ab OR 'late foley catheter removal'.ti,ab OR exp *'Out-of-Hours Care'/OR exp *'Night Care'/OR exp *'Day Care'/) AND (exp *'Surgery'/ OR 'Surgical*'.ti,ab OR 'surgery'.ti,ab OR exp *'Postoperative Period'/OR exp *'Postoperative Care'/OR exp *'Perioperative Period'/OR exp *'Perioperative Care'/OR exp *'Perioperative Nursing'/OR exp *'Intraoperative Period'/ OR exp *'Intraoperative Care'/OR 'acute care'.ti,ab) AND ('complications'.ti,ab OR 'complication'.ti,ab OR exp *'Postoperative Complication'/OR exp *'Peroperative Complication'/OR 'postdischarge problems'.ti,ab OR 'post discharge problems'.ti,ab OR 'postdischarge adverse'.ti,ab OR 'post discharge adverse'.ti,ab OR 'retention bladder'.ti,ab OR exp *'Urine Retention'/OR 'urinary retention'.ti,ab OR 'recatheterisation'.ti,ab OR 'recatheterization".ti,ab OR "recatheter*'.ti,ab) NOT (exp 'Animals'/NOT exp 'Humans'/)))	26	1
g. Additional records (Totaal d.d. 23-7-2021)	The reference and citation search	83	50
Total		908	362