(Re)defining nurse and patient roles in routine postoperative neurosurgical care: empowering autonomy and strengthening collaborative roles

Nollen, J.M.

Chapter 4
The impact of early postoperative indwelling urinary catheter removal: a systematic review

Jeanne-Marie Nollen
Laury Pijnappel
Jan W. Schoones
Wilco C. Peul
Wouter R. van Furth
Anja H. Brunsveld-Reinders
Journal of Clinical Nursing 2023

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 June 6th 2021. Studies were included that described the effect of the removal time in relation to re-catheterization, 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 Organization 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-catheterization 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 hours. Immediate- or after 1-2 day(s) removal does not lead to higher re-catheterization 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.

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 catheterization rate of approximately 12-77% (1). Indications for appropriate IDUC use include urologic surgeries, acute urinary retention, accurate measurement of urinary output in the critically ill, prolonged immobilization and comfortable end-of-life care (2). Perioperative placement during surgical procedures is common practice as they prevent bladder distention and incontinence in the anesthetized patient and facilitate the measurement of urine output during surgery (3).

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 (4). 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 (5, 6). Other complications of the IDUC include structural injuries to the urinary tract, bleeding, the creation of a false passage, and patient discomfort (7). Additionally, IDUCs are known to have a negative influence on patients' mobility and participation in daily activities (8). 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 hours after IDUC removal (9, 10). Controversy, the primary intervention for urinary retention is inserting an IDUC (11).

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 (12, 13). 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 (14). To reduce delayed removal and to empower the bedside nursing staff, literature advocates a nurse-driven protocol to remove the IDUC (15).

Several systematic reviews have been conducted on IDUC removal time concerning a specific type of surgery (16, 17) . However, to the best of our knowledge, no systematic review has been performed that compares complications after early versus 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 summarizes the evidence from randomized 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.

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-catheterization rate, ambulation time and moment of first voiding. Furthermore, the length of hospital stay in relation to IDUC removal was investigated.

Methods

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 hours or 12 hours 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) (Supplementary File 1) (18, 19).

Data collection

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 6th of June 2021.

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 Attachment 1.
Studies were eligible for inclusion if they: (a) included surgical patients aged ≥18 with an IDUC that is inserted perioperative; (b) reported on early versus late IDUC removal or a specific IDUC removal time or on the comparison between flexible duration versus fixed duration of the IDUC; (c) reported on complications post IDUC removal (occurrence of UTI, re-catheterization rate, ambulation time, moment of first voiding and length of hospital stay); (d) conducted in a hospital setting; (e) used a randomized, 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 anesthesia 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 was sent to the authors of studies with no full text available. If they did not respond, a reminder was sent after 2 weeks.

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.

Data extraction

The data of the included studies was 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 was 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-catheterization rate, ambulation time, moment of first voiding and hospital stay.

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 Organization of Care (EPOC) was used for randomized controlled trials and controlled before and after studies (20, 21). The NOS consists of three categories: (a) selection; (b) comparability; (c) and outcome. A number of stars can be awarded to each category, resulting in the conclusion: poor quality; fair quality; good quality (21). 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 (20). Differences in judgement were discussed and, if necessary, resolved through intervention of a third reviewer.

Synthesis

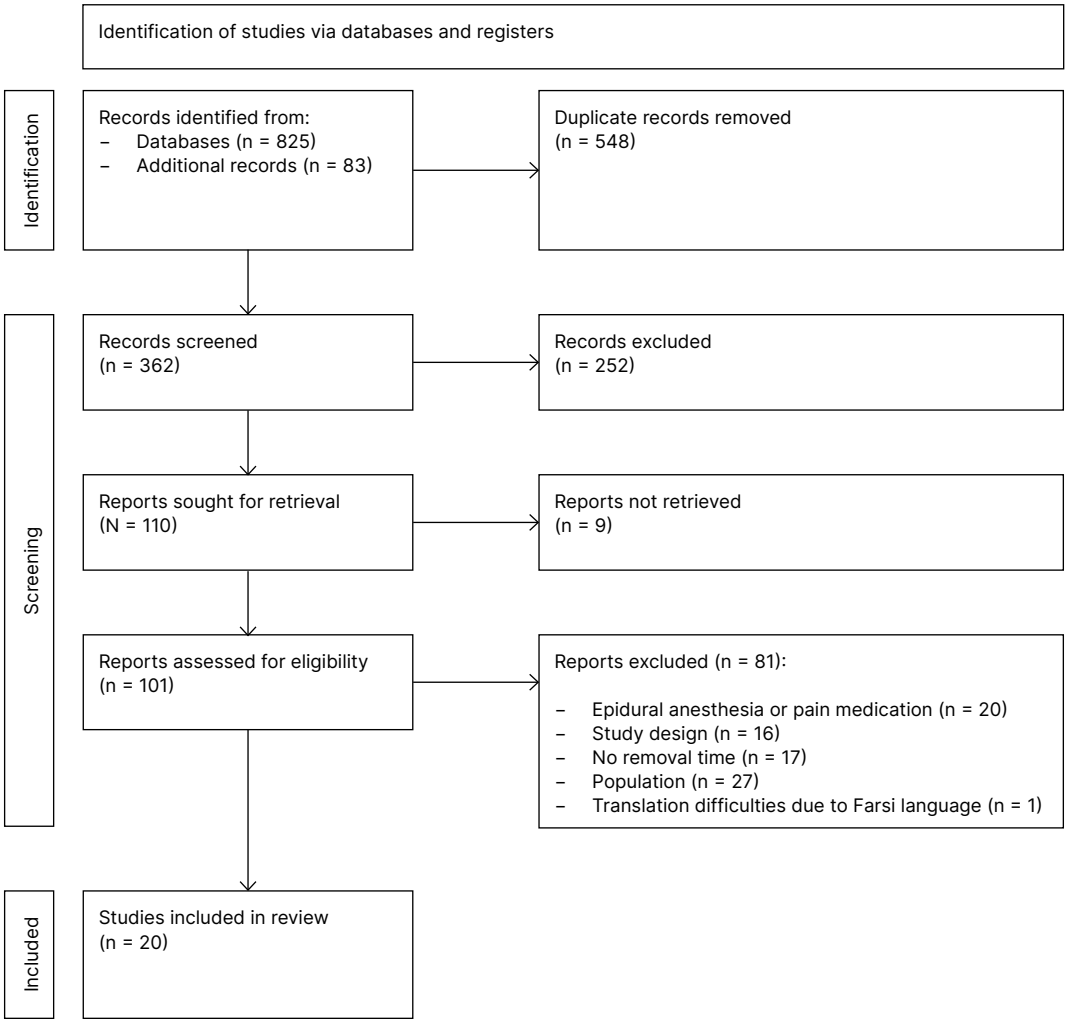
Given the heterogeneity of the target population (age, type of surgery), the variability in IDUC removal times and differences in methodological quality, performing a meta-analysis was infeasible. To summarize the overall evidence of the effectiveness of removal time of a short-term indwelling urinary catheter on the development of complications for surgical patients in hospital, a narrative descriptive synthesis was conducted. The extracted data was summarized 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.

Results

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 randomized controlled trials (22-34) and seven uncontrolled studies (35-41). Reasons for exclusion were: (a) the use of perioperative epidural anesthesia or pain medication (n= 20); (b) inappropriate study design, e.g. 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).

Figure 1: Prisma flow-chart



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 (24, 26), 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 (36). 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 (39).

Table 1. Risk of bias Cochrane Effective Practice and Organization 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 (2014)	+	+	+	+	?	?	+	+	+	7/9
Aref (2020)	+	+	+	+	?	?	+	+	+	7/9
Atilgan (2020)	+	+	+	+	?	?	+	+	−	6/9
Chai (2011)	+	+	−	+	+	+	+	+	+	8/9
Dunn (2003)	+	+	?	+	?	?	−	?	+	4/9
El-Mazny (2014)	+	+	+	+	+	?	+	+	+	8/9
Joshi (2014)	+	+	−	+	+	?	+	+	+	7/9
Liang (2009)	+	+	+	+	?	+	−	+	+	7/9
Onile (2008)	+	+	+	+	+	?	+	+	+	8/9
Ouladsahebmadarek (2012)	+	+	+	+	−	?	+	+	+	7/9
Sandberg (2019)	+	+	+	+	?	?	+	+	+	7/9
Sekhavat (2008)	+	?	+	+	?	+	+	+	+	7/9
Vallabh (2020)	+	+	+	+	?	?	+	+	+	7/9

Legend:
Green circle: Low risk of bias; yellow circle: Unclear risk of bias; Red circle: High risk of bias.
Low risk of bias: score 7 to 9. Unclear risk of bias: score 4 to 6; High risk of bias: score 0 to 3.

Table 2. Risk of Bias Newcastle-Ottawa Scale (NOS) of uncontrolled studies (*n*=7)

Author	Score selection	Score comparability	Score outcome	Conclusion
Campbell (2017)	☆☆☆	-	☆☆	Poor[1]
Dedden (2020)	☆☆☆	-	☆☆☆	Poor[1]
Duchalais (2019)	☆☆☆☆	☆	☆☆	Good[2]
Hung (2020)	☆☆☆☆	☆	☆☆	Good[2]
Karp (2018)	☆☆☆	-	☆☆	Poor[1]
Mengatto (2020)	☆☆☆☆	☆	☆☆	Good[2]
Yoo (2015)	☆☆☆	-	☆☆☆	Poor[1]

Legend:
[1]Poor quality: 0 or 1 star in selection domain OR 0 stars in comparability domain OR 0 stars or 1 stars in outcome domain.
[2]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

Study characteristics

Controlled studies

Thirteen of the 20 studies (65%) had a controlled design (table 3), including 11 randomized controlled trials (55%) (24-34) and two cluster RCTs (10%) (22, 23). Out of the 13 controlled studies, seven studies performed hysterectomies (22, 25, 28, 29, 32, 36, 39), three caesarean sections (23, 27, 30), one study a combination of hysterectomy and a laparotomy (31), one study colporrhaphy's (33), one study a sacrocolpopexy (34) and one study tension-free vaginal tape-procedures (24). 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 versus 24 hours postoperatively (25, 28, 30, 31, 33), (2) immediate versus after six hours versus after 24 hours removal (22, 23), (3) immediate versus after 18-24 hours removal (32), (4) after six hours versus 24 hours removal (24), (5) immediate versus after 12 hours removal (27), (6) six hours versus the morning after surgery removal (34), (7) immediate versus postoperative day one removal (26), (8) immediate versus after 24 hours versus after >48 hours removal versus discharged with IDUC (39) and (9) no IDUC inserted versus day one versus day two removal (29).
The study population in five studies had a mean age of < 40 years (23, 27, 30, 31, 33) and eight had a mean age > 40 year (22, 24-26, 28, 29, 32, 34).

Uncontrolled studies

Seven of the 20 studies (35%) had an uncontrolled design (table 3), including two cohort studies (10%) (35, 40), three retrospective reviews (20%) (37, 38, 41), one retrospective analysis (5%) (36) and one case-control study (5%) (39). Two of the seven studies performed hysterectomies (36, 39), one hysterectomies or bilateral pelvic node dissections (35), one rectal resections (37), one hysterectomies or trachelectomies (40), one proctectomies (38) and one performed mesorectal excisions (41). Three studies included males (37, 38, 41). 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 (35), immediate removal versus delayed removal (36), day one or two removal versus day three or later removal (38), four different removal times ranging from immediate removal to discharge with an IDUC (39), day one removal versus day seven removal (40). Campbell et al (2014) investigated both removal after a certain hours postoperatively (24 hours, 24-48 hours and 48-72 hours postoperatively) and removal at a specific moment (6 – 12 AM versus midnight). The intervention of the study from Duchalais (2019) focused IDUC removal between 6 and 8 AM. The mean age in the six studies was > 40. One study did not mentioned age (39). Not all studies reported on the operation time.

Table 3. Baseline characteristics of the studies

Author (year), Country	Study design	Type of Sugery	Gender (n)
Ahmed et al. (2014), Egypt	Cluster RCT	Uncomplicated abdominal hysterectomy	Female (221)
Aref (2020), Saudi Arabia	Cluster RCT	Cesarean section	Female (221)
Atilgan et al. (2020), Turkey	RCT	Tension-free vaginal tape	Female (70)
Campbell et al. (2017), Northern Ireland	Retrospective cohort study	Hysterectomy or bilateral pelvic node dissection	Female (78)
Chai et al. (2011), Hong Kong	RCT	Total abdominal hysterectomy	Female (70)
Dedden et al. (2020), Netherlands	Retrospective analysis	Laparoscopic hysterectomy	Female (242)
Duchalais et al. (2019), United States	Retrospective review	Rectal resection	Female (143) Male (274)
Dunn et al. (2003), United States	RCT	Cesarean dilvery or hysterectomy	Female (250)
El-Mazny et al. (2014), Egypt	RCT	Elective cesarean section	Female (300)
Hung et al. (2020), United States	Retrospective review	Proctectomy	Female (1117) Male (1312)
Joshi et al. (2014), India	RCT	Proctectomy	Female (70)
Karp et al. (2018), United States	Retrospective case study	Hysterectomy	Female (10 354)
Liang et al. (2009), Taiwan	RCT	Hysterectomy	Female (150)
Mengatto et al. (2020)	Cohort study	Hysterectomy or trachelectomy	Female (95)
Onile et al. (2008), Nigeria	RCT	Cesarean delivery	Female (200)
Ouladsahebmadarek et al. (2012), Iran	RCT	Hysterectomy and laparotomy	Female (200)
Sandberg et al. (2019), Netherlands	RCT	Hysterectomy	Female (155)
Sekhavat et al. (2008), Iran	RCT	Colporrhaphy	Female (90)
Vallabh et al. (2020), United States	RCT	Robotic-assisted laparoscopic sacrocolpopexy	Female (88)
Yoo et al. (2015), South Korea	Retrospective review	Total mesorectal excision or tumor-specific mesorectal excision	Male (102) Female (87)

Legend:
n = Sample size
RCT = Randomized controlled trial
SD = Standard Deviation
CI = Confidence Interval
[1]Unspecified value
[2]Median (Interquartile Range
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.

Intervention	Age in years, mean (SD or 95% CI)	Operation time in minutes, mean (SD or 95% CI)
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)
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)
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)
c. Delayed removal (after 24 h) d. 24-48 h after surgery e. 48-72 h after surgery	40.7 (8.74)	-
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)
a. Immediate removal (0 h) f. Delayed removal	50 (12)	128 [108;164]
Removal of unirary catheter, post operative day 1 between 6 and 8 in the morning	59 [50;68]	229 [171;301]
a. Immediate removal (0 h) g. Removal postoperative day 1	47 [25;72]	-
a. Immediate removal (0 h) h. Delayed removal (after 12 h)	a. 24.5 (4.2) h. 23.8 (3.9)	-
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]
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)
a. Immediate removal (0 h) c. Delayed removal (after 24 h) k. Delayed removal (after >48h) l. Discared home with indweling catheter	-	-
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)
g. Removal postoperative day 1 o. Removal postoperative day 7	g. 40 o. 44	-
a. Immediate removal (0 h) c. Delayed removal (after 24 h)	a. 31.67 (6.042) c. 32.72 (5.96)	-
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)
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)
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%)
b. Intermediate removal (after 6 h) q. Mornging after sugery	b. 59.52 (8.5) q. 59.57 (11.2)	b. 202.5 [120;284] q. 192.5 [127;391]
g. Removal postoperative day 1 n. Removal postoperative day 2	a. 64.5 [36;82] n. 66.0 [27;87]	-

Table 4. Removal time indwelling catheter

Author (year)/ removal time	No IDUC	Hours						
		0	6	12	18-24	< 24	24	> 24
Ahmed (2014)		+	+				+	
Aref (2020)		+	+				+	
Atilgan (2020)			+				+	
Campbell (2017)						+		
Chai (2011)		+					+	
Dedden (2020)		+						
Dunn (2003)		+						
El-Mazny (2014)		+		+				
Hung (2020)								
Joshi (2014)		+						
Karp (2018)		+					+	
Liang (2009)	+							
Mengatto (2020)								
Onile (2008)		+					+	
Ouladsahebmadarek (2012)		+					+	
Sandberg (2019)		+			+			
Sekhavat (2008)		+						+
Vallabh-Patel (2020)			+					
Yoo (2015)								

Author (year)/removal time	6:00 AM	Between 6 – 8 AM
Campbell (2017)		
Duchalais (2019)		×

	Days									Other	
	1	Morning after surgery	Day after surgery	1 or 2	2	> 48	Between 1-3	> 3	7	Delayed	Discharged home
							+				
										+	
	+										
				+				+			
	+										
						+					+
	+				+						
	+								+		
		+									
			+		+						
	Morning (between 6 AM – 12 AM)				22:00 PM				Midnight (00:00)		
			×						×		

Table 5. Removal time and complications of an IDUC

Author (year)	n total	Removal time (n)	Urinary tract infections (%)	P value	Recatheter-isation (%)
Ahmed (2014)	221	a. 0h after surgery (73) b. 6h after surgery (81) c. 24h after surgery (67)	a. 1 (1.4) b. 3 (3.7) c. 10 (14.9)	0.008 c. versus a. & b.	a. 12 (16.4) b. 2 (2.5) c. 0 (0)
Aref (2020)	221	a. 0h after surgery (73) b. 6h after surgery (81) c. 24h after surgery (67)	a. 1 (1.4) b. 3 (3.7) c. 9 (13.4)	0.005 Difference among groups and c versus a. & b.	a. 12 (16.4) b. 2 (2.5) c. 0 (0)
Atilgan (2020)	70	b. 6h after surgery (35) c. 24h after surgery (35)	b. 4 (11.4) c. 12 (34.2)	0.042	b. 4 (11.4) c. 0 (0)
Campbell (2017)	78	c. 24h after surgery (14) d. 24-48h after surgery (47) e. 48-72h after surgery (17)	-	-	34 (44%)
Chai (2011)	70	a. 0h after surgery (35) c. 24h after surgery (35)	a. 4 (11.4) c. 10 (28.6)	0.133	a. 4 (11.4) c. 0 (0)
Dedden (2020)	242	a. 0h 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 (2003)	250	a. 0h 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 (2014)	300	a. 0h after surgery (150) h. 12h after surgery (150)	a. 14 (9.3) h. 29 (19.3)	0.02	a. 4 (2.7) h. 1 (0.7)
Hung (2020)	2,429	i.Postopertive day 1 or 2 (1,176) j. Postopertive day 3 or later (1,253)	i. 35 (2.98) j. 42 (3.35)	0.680	i. 150 (12.8) j. 130 (10.4)
Joshi (2014)	70	a. 0h after surgery (35) c. 24h after surgery (35)	a. 3 (8.5) c. 9 (22.8)	0.222	a. 3 (8.5) c. 0 (0)
Karp (2018)	10,354	a. 0h after surgery (2,915) c. 24h after surgery (6,297) k. >48h after surgery (802) l. Discared home with indweling catheter (340)	a. 37 (1.3) c. 130 (2.1) k. 33 (4.1) l. 22 (6.5)	< 0.0001	-
Liang (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)	0.034	m. 17 (34) g. 6 (12) n. 5 (10)
Mengatto (2020)	95	g. Postoperative day 1 (48) o. Postoperative day 7 (47)	g. 2 (4.2) o. 8 (14.9)	0.09	g. 14 (29.2) o. 16 (34)
Onile (2008)	200	a. 0h after surgery (86) c. 24h after surgery (89)	a. 7 (8.1) c. 10 (11.2)	0.489	a. 1.2 (1) c. 0 (0)
Ouladsa-heb-madarek (2012)	200	a. 0h after surgery (100) c. 24h after surgery (100)	a. 3 (3) c. 9 (9)	0.074	a. 3 (3) c. 0 (0)
Sandberg (2019)	155	a. 0h after surgery (74) p. 18-24h after surgery (81)	a. 3 (4.1) p. 8 (9.9)	0.215	a. 10 (13.5) p. 0 (0)
Sekhavat (2008)	90	a. 0h after surgery (45) c. 24h after surgery (45)	a. 2 (4.5) c. 9 (15)	0.001	a. 3 (6.6) c. 11 (24.5)
Vallabh (2020)	88	b. 6h after surgery (44) q. Morning after surgery (44)	b. 4 (9) q. 0 (0)	0.041	b. 16 (36) q. 2 (4.5)
Yoo (2015)	189	g. Postoperative day 1 (104) n. Postoperative day 2 (85)	-	-	g. 5 (4.8) n. 4 (4.7)

Legend:
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.
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.

	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**
	0.001 a. versus b. & c.	a. 4.1 (1.8) b. 6.8 (1.7) c. 10.3 (2.5)	0.001 b. & c. versus a.	-	-	a. 3.2 (1.6) b. 3.4 (1.5) c. 5.6 (1.2)	0.001
	0.001 Difference among three groups and a versus b. & c.	a. 4.1 (1.8) b. 6.8 (1.7) c. 10.3 (2.5)	0.001 Difference among groups.	-	-	a. 1.9 (1.4) b. 2.4 (1.3) c. 3.9 (1.1)	0.01
		0.069	-	-	-	-	b. 0.5 (0.14) c. 1.2 (0.21)
	-	-		-	-	4.2 (1.3)	-
	0.114	-	-	-	-	a. 3.3 (0.6) c. 3.8 (2.1)	-
	-	-	-	-	-	-	-
	NS	-	-	-	-	-	-
	0.371	a. 4.8 (1.1)	h. 9.5 (1.2)	<0.001	a. 4.8 (1.1)	h. 13.4 (1.3)	<0.001
	0.076	-	-	-	-	i. 5.26 [4.0;8.0] j. 7 [4.52;10.0]	<0.001
	0.077	-	-	-	-	-	-
	-	-	-	-	-	-	-
	0.003	-	-	-	-	-	-
	0.66	-	-	-	-	-	-
	0.986	a. 7.82 (1.85) c. 8.72 (2.48)	0.842	-	-	a. 6.8 (1.76) c. 6.9 (1.82)	0.879
	1	a. 15.53 (6.45) c. 24.36 (4.66)	<0.0001	-	-	a. 2.2 (0.68) c. 2.7 (0.75)	<0.0001
	0.88	a. 5.7 [0.8;23.3] p. 21.0 [1.4;29.9]	<0.001	-	-	a. 1.5 [0;4] p. 1 [1;4]	0.954
	0.008	a. 5.9 (1.7) c. 17.1 (2.4)	0.01	-	-	a. 1.0 (0.13) c. 2.2 (0.20)	0.003
	<0.001	-	-	-	-	-	-
	1	-	-	-	-	-	-

Effects of interventions

IDUC removal after a certain number of hours postoperatively (e.g. directly after surgery, 6 hours after surgery, 12 hours 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-catheterization rate, ambulation time, moment of first voiding and hospital stay (table 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 (22-24, 27, 29, 33, 34, 39). Three studies found a statistically significant effect between the latest (two days or 24 hours postoperatively) and the fastest IDUC removal time (immediate removal, after six hours or after one day) when comparing three different time points postoperatively. Two days or 24 hours after surgery compared to not inserting the IDUC or removing the catheter immediately after surgery or after six hours or after one day, with 14.9%, 13.4% and 18% UTIs in the latest removal groups compared to 1.4% and 4% in the earliest removal groups, respectively. (22, 23, 29).

Four studies found a statistically significant effect between later IDUC removal (12 hours after surgery/24 hours after surgery/>48 hours 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 to 11.4%, 9.3%, 1.3% and 4.5% in the earliest removal groups, respectively (24, 27, 33, 39). One study (6%) found a statistically significant effect between IDUC removal after six hours and removal the morning after surgery, with 9% and 0% UTIs, respectively (34).

Eight studies (47%) did not report a significant effect between later removal time and UTIs (25, 26, 28, 30-32, 38, 40). One study (6%) did not report a P-value (36).

Re-catheterization

Eighteen studies evaluated the re-catheterization rate after the various postoperative IDUC removal times. In total, five studies (28%) reported a significant result between re-catheterization and earlier IDUC removal (22, 23, 29, 33, 34). These studies reported a re-catheterization rate of 16.4 – 36% in their earliest removal group compared to 0 – 6.6% in their latest removal group. Eleven studies did not display a significant relation between re-catheterization and earlier removal time (24-28, 30-32, 38, 40, 41). Two studies did not report a P-value: Campbell et al (2017) found a re-catheterization rate of 44%, however, this percentage is in relation to the whole study population. Dedden et al (2020) reported a re-catheterization rate of 4.6% in their early removal group compared to 2.1% in their late removal group.

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 (22, 23, 27, 31-33). 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.

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 hours compared to 13.4 hours in the 12 hours postoperative removal group, which resulted in a statistically significant effect (27).

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 (22-24, 27, 31, 33, 38). 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 (30, 32). One study did not report a P-value (25).

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 06:00 – 12:00 AM, midnight and between 06:00 – 08:00 AM) (table 4) in relation to UTIs, re-catheterisation and voiding dysfunction (35, 37). In the study from Duchalais et al (2019), 11 (6%) of the 172 patients (41%) who required in-and-out catheterization due to voiding problems after IDUC removal, developed a UTI (p = 0,002). In the group who did not need in-and-out catheterization (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 catheterization group with a mean of 4 days compared to 5 days in the non in-and-out catheterization group (p < 0.001).

Campbell et al (2017) described that 51 of the 78 participants had the IDUC removed in the morning between 06:00 – 12:00 AM and 23 patients had IDUC removal at midnight. Voiding dysfunction was registered in 21 patients (41%) of the morning group versus 11 (48%) of the midnight group (p = 0.59).

Flexible removal.
No studies were found that investigated flexible removal times.

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 (4). One explanation for these results could be the short duration of IDUC placement in the included studies. However, extending the duration of postoperative catheterization for ≥ 24 hours postoperatively did increase the incidence of UTIs compared to early removal times.

Urinary retention, defined as the inability to void in the presence of a full bladder, frequently occurs after anesthesia, surgery and IDUC removal which requires bladder catheterization (9). Since literature indicates that the risk of urinary retention, and subsequent catheterization, increases when epidural or spinal anesthesia is used during surgery, we decided to include only studies that used general anesthetics (42, 43). Additionally, we excluded urological surgeries as IDUCs can be used as an intervention that is beneficial for the healing process during the postoperative period (2). Thus, in this review, we mostly included studies who performed gynecological surgeries, which automatically results in a higher population females, thereby complicating direct generalization 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-catheterization rate compared to 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-catheterization (44).

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 (8). Moreover, by reducing the time to ambulation a broad range of complications including thrombosis and embolisms could be prevented (45). 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 (46, 47). For patients, early IDUC removal is of great clinical significance as it reduces discomfort and feelings of shame that patients might experience (48). Patients can feel ashamed when others notice the IDUC as this can make them feel less competent. Additionally, the IDUC makes patients feel dependent on nurses in simple daily tasks (49).

This systematic review included only one study that reported on first voiding after IDUC removal, which revealed that the 0-hour 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 (50, 51).
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 versus 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 (52). 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.

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 hours postoperatively. Additionally, immediate- or after 1-2 day(s) removal does not lead to higher re-catheterization 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.

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 gynecological surgeries. As evidence indicates that removal time does not have a significant relation to UTIs and the rate of re-catheterization, nurses should focus on early IDUC removal to increase patient comfort while being aware of the risk of urinary retention and urinary tract infections.

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-catheterization rate, nurses should focus on early removal to reduce patient discomfort.

References

1. Shackley DC, Whytock C, Parry G, Clarke L, Vincent C, Harrison A, et al. Variation in the prevalence of urinary catheters: a profile of National Health Service patients in England. BMJ Open. 2017;7(6):e013842.
2. Gould C, Umscheid C, Agarwal R, Kuntz G, Pegues D. Guideline for prevention of catheter-associated urinary tract infections 2009. Infect Control Hosp Epidemiol. 2010;31:319-26.
3. Meddings J, Skolarus TA, Fowler KE, Bernstein SJ, Dimick JB, Mann JD, et al. Michigan Appropriate Perioperative (MAP) criteria for urinary catheter use in common general and orthopaedic surgeries: results obtained using the RAND/UCLA Appropriateness Method. BMJ Qual Saf. 2019;28(1):56-66.
4. Lo E, Nicolle LE, Coffin SE, Gould C, Maragakis LL, Meddings J, et al. Strategies to prevent catheter-associated urinary tract infections in acute care hospitals: 2014 update. Infect Control Hosp Epidemiol. 2014;35(5):464-79.
5. Smith DRM, Pouwels KB, Hopkins S, Naylor NR, Smieszek T, Robotham JV. Epidemiology and health-economic burden of urinary-catheter-associated infection in English NHS hospitals: a probabilistic modelling study. J Hosp Infect. 2019;103(1):44-54.
6. Bhatia N, Daga MK, Garg S, Prakash SK. Urinary catheterization in medical wards. J Glob Infect Dis. 2010;2(2):83-90.
7. Wooller KR, Backman C, Gupta S, Jennings A, Hasimja-Saraqini D, Forster AJ. A pre and post intervention study to reduce unnecessary urinary catheter use on general internal medicine wards of a large academic health science center. BMC Health Serv Res. 2018;18(1):642.
8. Saint S, Trautner BW, Fowler KE, Colozzi J, Ratz D, Lescinskas E, et al. A multicenter study of patient-reported infectious and noninfectious complications associated with indwelling urethral catheters. JAMA Intern Med. 2018;178(8):1078-85.
9. Baldini G, Bagry H, Aprikian A, Carli F, Warner DS, Warner MA. Postoperative urinary retention: anesthetic and perioperative considerations. Anesthesiology. 2009;110(5):1139-57.
10. Rosseland L, Stubhaug A, Breivik H. Detecting postoperative urinary retention with an ultrasound scanner. Acta Anaesthesiol Scand. 2002;46(3):279-82.
11. Johansson RM, Malmvall BE, Andersson-Gäre B, Larsson B, Erlandsson I, Sund-Levander M, et al. Guidelines for preventing urinary retention and bladder damage during hospital care. J Clin Nurs. 2013;22(3-4):347-55.
12. Mazzo A, Bardivia CB, Jorge BM, Souza Júnior VD, Fumincelli L, Mendes I. Urinary catheterization delay: clinical practice. Enferm Glob. 2015;14(38):60-8.
13. Niederhauser A, Züllig S, Marschall J, Schwappach DJ. Nurses' and physicians' perceptions of indwelling urinary catheter practices and culture in their institutions. J Patient Saf. 2018;16(2):e82-e89.
14. Quinn M, Ameling JM, Forman J, Krein SL, Manojlovich M, Fowler KE, et al. Persistent barriers to timely catheter removal identified from clinical observations and interviews. Jt Comm J Qual Patient Saf. 2020;46(2):99-108.
15. Schiessler MM, Darwin LM, Phipps AR, Hegemann LR, Heybrock BS, Macfadyen AJ. Don't have a doubt, get the catheter out: a nurse-driven CAUTI prevention protocol. Pediatr Qual Saf. 2019;4(4):e203.
16. Huang H, Dong L, Gu L. The timing of urinary catheter removal after gynecologic surgery: a meta-analysis of randomized controlled trials. Medicine (Baltimore). 2020;99(2):e18710.
17. Menshawy A, Ghanem E, Menshawy E, Masoud AT, El-Sharkawy M, Taher A, et al. Early versus delayed removal of indwelling urinary catheter after elective cesarean delivery: systematic review and meta-analysis of randomized controlled trials. J Matern Fetal Neonatal Med. 2020;33(16):2818-25.
18. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med. 2009;6(7):e1000097.
19. Higgins JP, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, et al. Cochrane handbook for systematic reviews of interventions. Chichester: John Wiley & Sons; 2019.
20. EPOC. EPOC taxonomy 2015. Oslo: Norwegian Institute of Public Health; 2015.
21. Wells GA, Shea B, O'Connell D, Peterson J, Welch V, Losos M, Tugwell P. The Newcastle-Ottawa scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. Ottawa: Ottawa Hospital Research Institute; 2013.
22. Ahmed MR, Atwa KA, Metwally L. Timing of urinary catheter removal after uncomplicated total abdominal hysterectomy: a prospective randomized trial. Eur J Obstet Gynecol Reprod Biol. 2014;176:60-3.
23. Aref NK. Does timing of urinary catheter removal after elective cesarean section affect postoperative morbidity? A prospective randomized trial. J Matern Fetal Neonatal Med. 2020;33(18):3141-6.
24. Atilgan AE, Aydin F, Altuntas SL. When should we remove urinary catheter after TVT procedure? SN Compr Clin Med. 2020;2(9):1676-9.
25. Chai J, Patel TC. A prospective randomized trial to compare immediate and 24-hour delayed catheter removal following total abdominal hysterectomy. Acta Obstet Gynecol Scand. 2011;90(5):478-82.
26. Dunn TS, Shlay J, Forshner D. Are in-dwelling catheters necessary for 24 hours after hysterectomy? Am J Obstet Gynecol. 2003;189(2):435-7.
27. El-Mazny A, El-Sherbini M, Hassan AA. A prospective randomized clinical trial comparing immediate versus delayed removal of urinary catheter following elective cesarean section. Eur J Obstet Gynecol Reprod Biol. 2014;181:111-4.
28. Joshi BN, Chopra S, Taneja N. A prospective randomized controlled comparison of immediate versus late removal of urinary catheter after abdominal hysterectomy. J Midlife Health. 2014;5(2):68-71.
29. Liang CC, Lee CL, Chang TC, Chang YL, Wang CJ, Soong YK. Postoperative urinary outcomes in catheterized and non-catheterized patients undergoing laparoscopic-assisted vaginal hysterectomy: a randomized controlled trial. Int Urogynecol J Pelvic Floor Dysfunct. 2009;20(3):295-300.

30. Onile TG, Orji EO, Ogunniyi SO. A prospective randomized clinical trial of urethral catheter removal following elective cesarean delivery. Int J Gynaecol Obstet. 2008;102(3):267-70.
31. Ouladsahebmadarek E, Jafari-Shobeiri M. A randomized clinical trial to compare immediate versus delayed removal of Foley catheter following abdominal hysterectomy and laparotomy. Pak J Med Sci. 2012;28(3):380-3.
32. Sandberg EM, van Meir CA, Kok HS, van Geloven N, Gludovacz K, Kolkman W, et al. Immediate versus delayed removal of urinary catheter after laparoscopic hysterectomy: a randomized controlled trial. BJOG. 2019;126(6):804-13.
33. Sekhavat L, Farajkhoda T, Davar R. The effect of early removal of indwelling urinary catheter on postoperative urinary complications in anterior colporrhaphy surgery. Aust N Z J Obstet Gynaecol. 2008;48(3):348-52.
34. Vallabh-Patel V, Salamon C. Indwelling versus immediate removal of transurethral catheter after robotic sacrocolpopexy: a randomized clinical trial. Female Pelvic Med Reconstr Surg. 2020;26(10):617-21.
35. Campbell P, Addley S, Dobbs S, Harley I, Nagar H. Early catheter removal following laparoscopic radical hysterectomy for cervical cancer: assessment of a new bladder care protocol. J Obstet Gynaecol. 2017;37(7):970-2.
36. Dedden SJ, Dijkema MM, Geomini P, Maas JW, Bongers MY. Immediate catheter removal after laparoscopic hysterectomy: a retrospective analysis. Eur J Obstet Gynecol Reprod Biol. 2020;250:76-9.
37. Duchalais E, Larson DW, Machairas N, Mathis KL, Dozois EJ, Kelley SR. Outcomes of early removal of urinary catheter following rectal resection for cancer. Ann Surg Oncol. 2019;26(1):79-85.
38. Hung LY, Jia X, Steele SR, Valente MA, Holubar SD, Gorgun E. Outcomes after early versus delayed urinary bladder catheter removal after proctectomy for benign and malignant disease in 2,429 patients: an observational cohort study. Surg Infect (Larchmt). 2020;21(7):580-7.
39. Karp NE, Kamdar NS, Fore AM, Morgan DM. Length of catheter use after hysterectomy as a risk factor for urinary tract infection. Female Pelvic Med Reconstr Surg. 2018;24(6):430-4.
40. Mengatto MF, Castro BG, Nobrega L, Vieira MA, Andrade CE, Tsunoda AT, et al. Early removal of indwelling urinary catheter after radical surgery for early-stage cervical cancer: a cohort study. J Surg Oncol. 2020;122(7):1498-505.
41. Yoo BE, Kim BH, Kim HJ, Kim G, Kim JG, Cho HM. Early removal of the urinary catheter after total or tumor-specific mesorectal excision for rectal cancer is safe. Dis Colon Rectum. 2015;58(7):686-91.
42. Hayami S, Ueno M, Kawai M, Kuriyama T, Kawamata T, Yamaue H. Optimal timing of removal of epidural and urethral catheters to avoid postoperative urinary retention undergoing abdominal surgery. Dig Surg. 2019;36(3):261-5.
43. Brouwer TA, van Roon EN, Rosier PF, Kalkman CJ, Veeger N. Postoperative urinary retention: risk factors, bladder filling rate and time to catheterization: an observational study as part of a randomized controlled trial. Perioper Med (Lond). 2021;10(1):2.
44. Ouma E. Implementation of a nurse-driven educational intervention for prompt removal of urinary catheters in the neuro ICU. Unpublished manuscript. 2017.
45. Chindamo MC, Marques MA. Role of ambulation to prevent venous thromboembolism in medical patients: where do we stand? J Vasc Bras. 2019;18:e20180107.
46. Adogwa O, Elsamadicy AA, Fialkoff J, Cheng J, Karikari IO, Bagley C. Early ambulation decreases length of hospital stay, perioperative complications, and improves functional outcomes in elderly patients undergoing surgery for correction of adult degenerative scoliosis. Spine (Phila Pa 1976). 2017;42(18):1420-5.
47. Fleming LM, Zhao X, DeVore AD, Heidenreich PA, Yancy CW, Fonarow GC, et al. Early ambulation among hospitalized heart failure patients is associated with reduced length of stay and 30-day readmissions. Circ Heart Fail. 2018;11(4):e004634.
48. Bhardwaj R, Pickard R, Carrick-Sen D, Brittain K. Patients' perspectives on timing of urinary catheter removal after surgery. Br J Nurs. 2012;21(18):S4-S9.
49. Wilde MH. Life with an indwelling urinary catheter: the dialectic of stigma and acceptance. Qual Health Res. 2003;13(9):1189-204.
50. Markopoulos G, Kitridis D, Tsikopoulos K, Georgiannos D, Bisbinas I. Bladder training prior to urinary catheter removal in total joint arthroplasty: a randomized controlled trial. Int J Nurs Stud. 2019;89:14-7.
51. Liu YS, Wei S, Elliott M. The effects of a catheter clamping protocol on bladder function in neurosurgical patients: a controlled trial. Int J Nurs Pract. 2015;21(1):29-36.
52. John AS, Mboto CI, Agbo B. A review on the prevalence and predisposing factors responsible for urinary tract infection among adults. Eur J Exp Biol. 2016;6(4):7-11.

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

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

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

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

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

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