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Michigan Appropriate Perioperative (MAP) criteria for urinary catheter use in common general and orthopaedic surgeries: results obtained using the RAND/UCLA Appropriateness Method

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ABSTRACT

Background Indwelling urinary catheters are commonly used for patients undergoing general and orthopaedic surgery. Despite infectious and non-infectious harms of urinary catheters, there is limited guidance available to surgery teams regarding appropriate perioperative catheter use.

Objective Using the RAND Corporation/University of California Los Angeles (RAND/UCLA) Appropriateness Method, we assessed the appropriateness of indwelling urinary catheter placement and different timings of catheter removal for routine general and orthopaedic surgery procedures.

Methods Two multidisciplinary panels consisting of 13 and 11 members (physicians and nurses) for general and orthopaedic surgery, respectively, reviewed the available literature regarding the impact of different perioperative catheter use strategies. Using a standardised, multiround rating process, the panels independently rated clinical scenarios (91 general surgery, 36 orthopaedic surgery) for urinary catheter placement and postoperative duration of use as appropriate (ie, benefits outweigh risks), inappropriate or of uncertain appropriateness.

Results Appropriateness of catheter use varied by procedure, accounting for procedure-specific risks as well as expected procedure time and intravenous fluids. Procedural appropriateness ratings for catheters were summarised for clinical use into three groups: (1) can perform surgery without catheter; (2) use intraoperatively only, ideally remove before leaving the operating room; and (3) use intraoperatively and keep catheter until postoperative days 1–4. Specific recommendations were provided by procedure, with postoperative day 1 being appropriate for catheter removal for first voiding trial for many procedures.

Conclusion We defined the appropriateness of indwelling urinary catheter use during and after common general and orthopaedic surgical procedures. These ratings may help reduce catheter-associated complications for patients undergoing these procedures.

INTRODUCTION

Urinary catheters (commonly known as Foley catheters) are frequently placed in patients undergoing surgical procedures. They serve to prevent bladder distention or incontinence in the anaesthetised patient, as well as facilitate the measurement of urine output during and after surgery. Yet urinary catheters are increasingly recognised as having the potential to harm patients, as illustrated in [figure 1](#).¹ Infectious harms include catheter-associated urinary tract infection² and the potential of drug-resistant infections and orthopaedic prosthetic infections. There are also non-infectious harms, such as urethral pain, trauma and mobility restrictions caused by a 1-point restraint to a urinary drainage device, which are as common as infectious complications and lengthen hospitalisations.^{3–6} Furthermore, catheter use beyond 48 hours following surgery has been associated with an increase in hospital-acquired urinary tract infections and 30-day mortality, and a decreased likelihood of discharge home.^{7 8} Unfortunately, significant variation in catheter use exists across routine surgical procedures, often varying by local training and clinician preferences.⁹

Perioperative urinary catheter use has previously been considered routine, but more recent guidelines recommend using urinary catheters only when required and removing them as soon as possible postoperatively.^{10–18} Some procedure-specific literature reviews and protocols

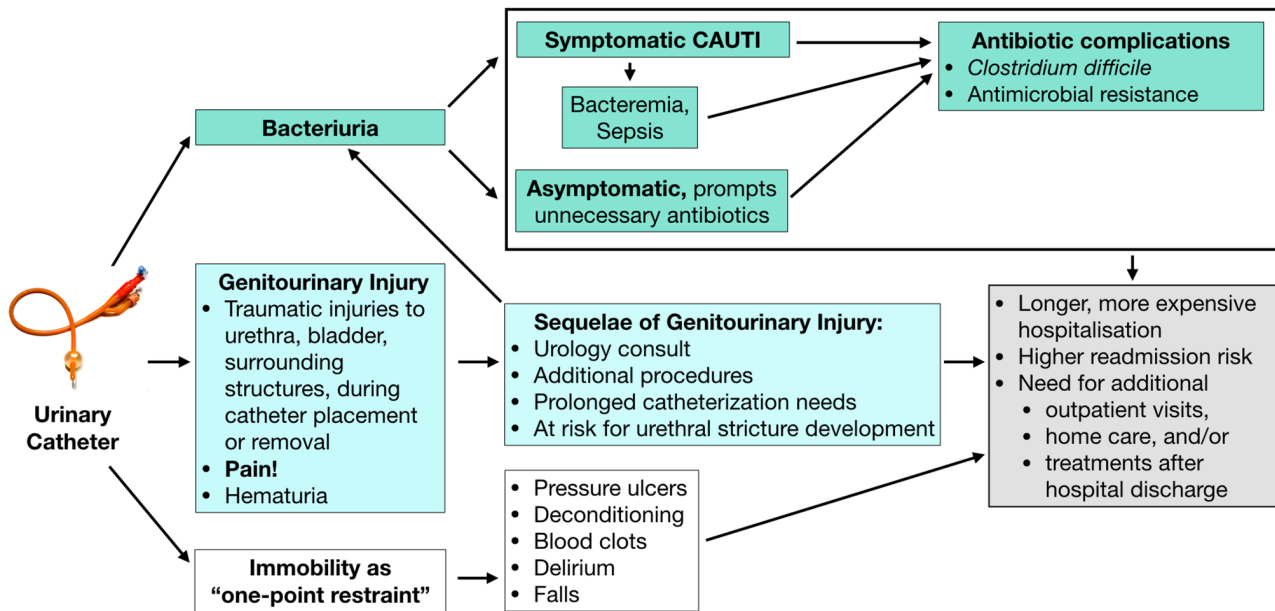


Figure 1 Infectious and non-infectious urinary catheter complications. CAUTI, catheter-associated urinary tract infection.

promoting enhanced recovery after surgery provide guidance on when a urinary catheter can be avoided or removed after brief use.^{10–18} More recently, institutions are developing guidelines for urinary catheter use based on consensus agreement among an institution's own surgeons,^{19 20} which can vary by procedure types and case complexity seen at each institution. The currently available guidelines are not defined enough to be both broadly applicable to a large variety of surgical procedures, as well as to account for procedural complexities that only some surgeons and institutions encounter (eg, complex colon surgery).

To address this gap, we applied the RAND Corporation/University of California Los Angeles (RAND/UCLA) Appropriateness Method²¹ to formally rate the appropriateness of urinary catheter placement and timing for removal across routine general and orthopaedic surgical procedures in adults, as rated by clinicians who practise in different clinical settings across the USA and informed by the available literature involving perioperative urinary catheter use. We sought to provide guidance for and promote standardisation of urinary catheter use during and after these common procedures in order to appropriately minimise catheter use and related complications, and to be applicable across many institutions — yielding the Michigan Appropriate Perioperative (MAP) criteria for urinary catheter use in common general and orthopaedic surgeries.

METHODS

The RAND/UCLA Appropriateness Method²¹ combines a review of the available scientific evidence for a given practice, in this case urinary catheterisation in the perioperative setting for specific routine procedures, with clinical judgement using multidisciplinary

panels of experienced clinicians to produce clinically relevant guidance statements regarding the practice's appropriateness. Our team previously applied this method to define appropriateness criteria for urinary catheter use in hospitalised medical patients.²²

Literature review methods

For each panel, we performed a systematic literature search in Web of Science, Cumulative Index to Nursing and Allied Health Literature, Embase, Cochrane and PubMed/MEDLINE. Searches identified studies involving procedures of interest with respect to urinary catheter use and related outcomes (eg, urinary retention, need for recatheterisation, haematuria, length of stay). Search details are provided in online supplementary appendix figures 1–2 and online supplementary appendix text 1–2. We chose common procedures for general surgery (hernia repair, bariatric procedures, appendectomy, cholecystectomy and colorectal surgery) and orthopaedic surgery (hip fracture repair, elective hip arthroplasty and elective knee arthroplasty). Our final literature searches for the general and orthopaedic surgery procedures were conducted in February and March of 2015, respectively. An expert in urinary catheter use who cares for hospitalised adults reviewed the records meeting the criteria by title, abstract and full-text review to select the final articles.

For each search, we categorised articles into groups based on relevance to perioperative catheter strategies and outcomes. The most relevant articles (group 1) reported at least one infectious or non-infectious outcome of interest for procedures with respect to specific urinary catheter strategies. We also identified key review articles that assessed perioperative catheter use for the procedures of interest. Group 2 articles

Table 1 Characteristics of the general surgery panellists for urinary catheter appropriateness panel

Name	Title	Affiliation, at time of panel participation	Specialty
Hailey Allen, BSN, RN, CBN	Bariatric Program Assistant/Circulator, Weight Management/Surgical Services	Mercy Health Saint Mary's Hospital, Grand Rapids, Michigan	Nursing
Philip Chang, MD, FACS	Medical Director, Perioperative Services; Associate Chief Medical Officer; Section Chief, Trauma and Surgical Critical Care	University of Kentucky, Lexington, Kentucky	General surgery
E Patchen Dellinger, MD	Professor of Surgery	University of Washington, Seattle, Washington	General surgery
Daniel Eiferman, MD, FACS	Assistant Professor of Surgery, Associate Director of Surgical Intensive Care Unit	Ohio State University, Columbus, Ohio	Acute care surgery and surgical critical care
Jonathan F Finks, MD	Associate Professor of Surgery; Associate Director, Michigan Bariatric Surgery Collaborative	University of Michigan Ann Arbor, Michigan; Michigan Bariatric Surgery Collaborative, Ann Arbor, Michigan	Bariatric surgery
John L Gore, MD, MSHS, FACS	Associate Professor, Department of Urology; Adjunct Associate Professor, Department of Surgery	University of Washington, Seattle, Washington	Urology
Jon Hourigan, MD, FACS, FASCRS	Associate Professor of Surgery	University of Kentucky, Lexington, Kentucky	General surgery
Lillian Kao, MD, MS	Professor of Surgery	University of Texas Health Science Center at Houston, Houston, Texas	General surgery and critical care
Efren Manjarrez, MD, SFHM	Hospitalist	University of Miami, Miller School of Medicine, Miami, Florida	Hospitalist
Shawn Obi, DO, FACS	Chief of Surgery	Allegiance Health, Jackson, Michigan	General surgery
Amanda Stricklen, BSN, MS	Senior Project Manager for Bariatric Collaborative, Nurse	Michigan Bariatric Surgery Collaborative, Ann Arbor, Michigan	Nursing
Amber Wood, MSN, RN, CNOR, CIC	Perioperative nursing specialist	Association of periOperative Registered Nurses (AORN)	Nursing
Marilyn Woodruff, BSN, MSN, ANP-BC	Nurse practitioner specialising in bariatric and general surgery	VA Ann Arbor Healthcare System, Ann Arbor, Michigan	Bariatric and general surgery

reported relevant patient outcomes without assessing a particular type of urinary catheter strategy, such as urinary retention rates after cholecystectomy. For the orthopaedic search, we also included studies involving bladder scanner protocols in orthopaedic populations (group 3). We prepared summary tables of the group 1–3 articles, organised by procedure type, study design and type of catheter (eg, indwelling catheter, intermittent straight catheter), to provide panellists with infectious and/or non-infectious outcomes reported.

Panellist selection and rating process

For each panel (general surgery, orthopaedics) we recruited experienced, practising experts from academic, private and government organisations from across the USA to participate by sending an introductory email describing the panel and processes. Panellists included surgeons who performed the procedure of interest, perioperative nurses, a urologist and a hospitalist experienced in comanagement of these surgical patients (tables 1–2).

In Spring 2015, panellists were mailed materials that included instructions, printed literature summary tables, articles in electronic form on flash drive, printed key review articles assessing surgical outcomes with respect to urinary catheter strategies, and a round 1 scoring document (example section in figure 2). We

included clinical scenarios for panellists to rate the appropriateness of catheter placement (on a scale of 1–9) for intraoperative use and when the first voiding trial should occur after a given surgery. Catheter placement and the timing of removal were considered appropriate if ‘The expected health benefit (eg, relief of pain, reduction in anxiety, improved functional capacity) exceeds the expected negative consequences (eg, mortality, morbidity, anxiety, pain, time lost from work) by a sufficiently wide margin that the procedure is worth doing, exclusive of cost’.^{23 24} A rating of 1 indicated the harms significantly outweigh the benefits (ie, inappropriate), whereas a rating of 9 indicated the benefits significantly outweigh the harms (ie, appropriate). A central rating of 5 indicated the benefits or harms were considered equal by the participant, or that the participant was unable to make an informed rating of the clinical scenario.

The scenarios focused on adult patients undergoing routine surgery in acute care inpatient or outpatient settings. We instructed panellists to use their best clinical judgement in combination with evidence from the literature review, assuming no other relevant patient characteristics or clinical indications for a urinary catheter than provided in the scenario. Panellists were instructed to focus on the appropriateness of catheter use with respect to the surgery performed, but without

Original research

Table 2 Characteristics of the orthopaedic surgery panellists for urinary catheter appropriateness panel

Name	Title	Affiliation, at time of panel participation	Specialty
Hany Bedair, MD	Assistant Professor, Orthopaedic Surgery	Harvard Medical School, Boston, Massachusetts	Orthopaedic surgery
Michael B Cross, MD	Assistant Attending Orthopaedic Surgeon	Hospital for Special Surgery, New York, New York	Orthopaedic surgery
Adam Fonrouge, BS, RN	Operating Room Supervisor	Saint Joseph Hospital, Bangor, Maine	Nursing
Paul Grant, MD	Assistant Professor of Medicine; Director, Perioperative and Consultative Medicine	University of Michigan, Ann Arbor, Michigan	Hospitalist
Paul Holtom, MD	Professor of Medicine and Orthopaedics; Hospital Epidemiologist	Keck School of Medicine, University of Southern California, Los Angeles, California	Infectious diseases
Nathan Houchens, MD, FACP	Associate Staff Physician	Cleveland Clinic Hospital, Cleveland, Ohio	Hospitalist
Benjamin Miller, MD, MS	Assistant Professor; Staff Physician	University of Iowa, Iowa City, Iowa; VA Iowa City Healthcare System, Iowa City, Iowa	Orthopaedic surgery
Nicolas Noiseux, MD, MS, FRCS	Vice Chair, Clinical Affairs; Assistant Professor, Orthopaedic Surgery	University of Iowa, Iowa City, Iowa	Orthopaedic surgery
J Kellogg Parsons, MD, MHS	Associate Professor of Surgery	UC San Diego Moores Cancer Center, La Jolla, California	Urology
Thomas Scharschmidt, MD, FACS	Associate Professor	Wexner Medical Center at The Ohio State University, Columbus, Ohio	Orthopaedic surgery
Charles Washington, MSN, RN, ACNS-BC	Unit Based Educator: Medical Surgical Unit	VA Ann Arbor Healthcare System, Ann Arbor, Michigan	Nursing education

respect to catheter use specifically due to anaesthesia options of spinal or epidural anaesthesia.

After the round 1 ratings were completed, we conducted a 1-hour conference call with the panellists to clarify the clinical scenarios, aiming to reduce disagreement or uncertainty in ratings. The expert panel was then brought together for a face-to-face round 2 meeting, where preliminary scores and rating

differences were discussed for each clinical scenario. These meetings occurred in April 2015 (general surgery) and May 2015 (orthopaedics). Panellists rerated each clinical scenario after the inperson discussion. The median round 2 scores were used to classify each scenario as appropriate (panel median score of 7–9); uncertain or neutral (panel median score of 4–6); or inappropriate (panel median score of 1–3) if there

B. Colorectal Surgery: In this section we are asking you to rate the appropriateness of placing and timing of removal of Foley catheters for cases that are considered **ROUTINE** – meaning we are excluding patients who have required colorectal procedure because of an emergency such as sepsis, shock, or trauma. We are also **excluding** cases that require creation of a new urinary conduit due to involvement of the bladder or renal system. Colorectal surgery is performed for a variety of reasons including cancers of the gastrointestinal system, metastatic tumors (such as melanoma), Crohn's disease, colon polyp, colitis and diverticulitis.

Clinical Scenarios	Urinary Management Strategies					
	Appropriateness of placing a Foley routinely for OR use because of this description:	Appropriateness of removing Foley catheter in this timeframe (if had been placed for Surgery). In other words, what is the appropriateness of WAITING until the timeframe listed before removing the Foley if one had been placed?				
		Post-op day #0: End of case or in post-anaesthesia care unit	Post-op day #1	Post-op day #2:	Post-op day #3-4	Post-op day #5 or greater
B1 Colorectal procedures performed using "Open" technique (as opposed to "Laparoscopic" technique)	An overview of colon and rectal resection including a description of the common types of surgical procedures performed can be located in the "Review" articles provided on the USB drive labeled "Overview of Colon Resection," and "Overview of surgery for the treatment of primary rectal adenocarcinoma."					
a. Open ileocecectomy (removal of part of ileum of small intestine, cecum part of colon, ileocecal valve and often appendix)	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
b. Open segmental colectomy	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
c. Open right hemicolectomy	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
d. Open extended right hemicolectomy	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
e. Open transverse colectomy	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
f. Open left hemicolectomy	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
g. Open sigmoidectomy	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
h. Open subtotal colectomy (removes the entire intraperitoneal colon, not removing rectum) with end ileostomy	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
i. Open subtotal colectomy with loop ileostomy	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
j. Open subtotal colectomy with ileorectostomy	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
k. Open subtotal colectomy with ileodistal sigmoidostomy	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9

Scoring: 1=Highly inappropriate; 5=Neutral or uncertain; 9=Highly appropriate

Figure 2 Example of clinical scenarios from the round 1 rating document.

was no disagreement among the panel. If four or more panellists rated a scenario as appropriate (score of 7–9) and four or more rated it as inappropriate (score of 1–3), the scenario was rated as uncertain or neutral due to disagreement. Clinical scenario ratings from each panel were reviewed, and converted into a single, one-page, clinician-friendly table of recommendations to consider implementing to reduce catheter use.

Of note, the RAND/UCLA Appropriateness Method is designed to rate the appropriateness of a therapy (in this case, perioperative urinary catheter use) with respect to specific clinical settings. We applied this method to rate the appropriateness of placing a urinary catheter for use during the surgery, as well as the appropriateness of different timings for removal of the urinary catheter for the first voiding attempt. This method deliberately does not require consensus, because it recognises and allows for differences in clinical practice for which variation is acceptable, particularly when the medical literature does not clearly demonstrate one superior strategy of care. Therefore, for some procedures, the recommendations that are provided yield a single recommendation for catheter avoidance or use. However, in other procedures, more than one strategy of care was assessed as appropriate. For example, it may be appropriate to remove a catheter for a specific procedure either on the day of surgery or on the morning after surgery. Thus, this method yields both recommendations for the soonest a catheter could be removed for the first trial of urination without a catheter, as well as guidance for when two strategies of catheter removal are both appropriate, which allows the catheter use criteria to be applied to medical charts to assess appropriate use.

RESULTS

General surgery procedures

General surgery literature summary highlights

Forty-five group 1 studies^{25–68} (online supplementary appendix table 1) including 18 randomised controlled trials (RCTs) and 1 systematic review¹³ involving catheter use in colorectal surgery were identified. The procedures studied included colorectal surgery,^{34–57} bariatric procedures,^{25–27} cholecystectomy,^{28–33} herniorrhaphy^{58–66} and other abdominal surgery types.^{56 67 68} Surgical approaches included laparoscopic and open procedures of varying levels of complexity, surgery for malignant and benign diagnoses, ‘fast track’ or enhanced recovery after surgery protocols, and surgeries with varied anaesthesia type. Many group 1 studies (online supplementary appendix table 1) using protocols with catheter avoidance or early postoperative catheter removal studies reported equivalent or fewer episodes of retention, recatheterisation or infection; however, several cohort studies reporting catheter use rates did not include a control group.

General surgery panel findings

The final detailed ratings of urinary catheter appropriateness for each of the 91 general surgery clinical scenarios for routine procedures are provided in online supplementary appendix table 2. Table 3 provides the overall summary of perioperative urinary catheter use recommendations, categorising the procedures into three categories: (A) procedures for which indwelling urinary catheter placement should be avoided, (B) procedures to consider removing indwelling urinary catheters before leaving the operating room (OR), and (C) procedures in which urinary catheter use in the OR and until at least postoperative day 1 is appropriate, with guidance on when the first trial of void is appropriate. For a few procedures, as explained above in the Methods section, the RAND/UCLA Appropriateness Method assessed two different timings of the first trial of void as appropriate, such as removal at the end of the case or on postoperative day 1. In these cases, the procedures are listed in table 3 in the earliest trial of void timing (category A, B or C) that was deemed appropriate, with a footnote indicating when later first trials of void were also felt to be appropriate. There was less confidence in removing catheters on postoperative day 0 for some procedures if no postoperative bladder scanner was available as reflected in several median scores compared with appropriate ratings with available bladder scanner. By discussion it was clear that bladder scanner availability and use were now common; table 3 reflects the panel’s recommendations assuming a bladder scanner is available to use in the postoperative setting.

Routine catheter placement was rated inappropriate for laparoscopic cholecystectomy, open appendectomy, laparoscopic appendectomy without a suprapubic port, open repair of reducible hernias (inguinal, femoral, umbilical, epigastric), and most laparoscopic repairs of reducible hernias of the same types if the patient voided preoperatively. One exception was laparoscopic reducible inguinal or femoral hernia repair by a totally extraperitoneal approach, for which there was some uncertainty on appropriateness of not using a catheter if the patient voided preoperatively; however, there was agreement on routine catheter placement for use in the OR as appropriate if the patient had not voided, with the recommendation to remove after the procedure, ideally before leaving the OR.

Four laparoscopic bariatric procedures (Roux-en-Y gastric bypass, adjustable gastric banding, sleeve gastrectomy, biliopancreatic diversion with duodenal switch) were discussed as sufficiently common to permit the rating of urinary catheter appropriateness. Routine urinary catheter use in the OR was inappropriate for adjustable gastric banding, of uncertain appropriateness for sleeve gastrectomy, appropriate for Roux-en-Y gastric bypass, and appropriate for biliopancreatic diversion with duodenal switch. For all four procedures, waiting until postoperative day 2 to

Table 3 Summary of perioperative urinary catheter use recommendations*

A. Avoid placing indwelling urinary catheters for these routine procedures: these are procedures for which it is considered inappropriate to place a catheter for the procedure, as the catheter risk is considered to outweigh the benefits for the patient. †‡

General surgery	Orthopaedic surgery
<ul style="list-style-type: none"> ▶ Laparoscopic cholecystectomy ▶ Open appendectomy ▶ Laparoscopic appendectomy without suprapubic port ▶ Open reducible inguinal, femoral, umbilical or epigastric hernia repair ▶ Laparoscopic reducible inguinal or femoral hernia repair by TAPP if bladder emptied before surgery ▶ Laparoscopic reducible umbilical or epigastric hernia repair ▶ Laparoscopic adjustable gastric banding 	<ul style="list-style-type: none"> ▶ Unilateral total knee arthroplasty ▶ Unilateral/bilateral unicompartmental knee arthroplasty ▶ Unilateral osteotomy for unicompartmental or non-inflammatory knee disease ▶ Revision knee arthroplasty, to last ≤2 hours ▶ Unilateral (not revision) total prosthetic hip replacement (total hip arthroplasty) ▶ Unilateral closed reduction percutaneous pinning for femoral neck fracture

B. Procedures to consider removing indwelling urinary catheter before leaving the OR

General surgery	Orthopaedic surgery
<ul style="list-style-type: none"> ▶ Laparoscopic reducible inguinal or femoral hernia by TEP approach ▶ Laparoscopic Roux-en-Y gastric bypass§ ▶ Laparoscopic sleeve gastrectomy§ ▶ Open or laparoscopic ileocectomy, hemicolectomy (right, transverse or left) or sigmoidectomy§ ▶ Laparoscopic subtotal colectomy§ 	<ul style="list-style-type: none"> ▶ Bilateral total knee arthroplasty§ ▶ Revision knee arthroplasty, to last >2 hours§ ▶ Unilateral partial prosthetic hip replacement§ ▶ Unilateral open reduction and internal fixation for hip fracture§ ▶ Unilateral total prosthetic replacement for hip fracture§ ▶ Bilateral total hip replacement/arthroplasty§ ▶ Revision prosthetic hip replacement§

C. Procedures in which urinary catheter use in the OR and until at least postoperative day 1 is appropriate, with the timing for the first trial of void detailed below by procedure

General surgery	Orthopaedic surgery
<ul style="list-style-type: none"> ▶ Laparoscopic biliopancreatic diversion with duodenal switch (postoperative day 1)¶ ▶ Open subtotal colectomy (postoperative day 1) ▶ Open or laparoscopic rectal resection of the upper one-third of the rectum§ (postoperative day 1) ▶ Laparoscopic low anterior resection (postoperative day 1)** ▶ Open abdominal perineal resection (postoperative day 2)†† ▶ Open or laparoscopic total proctocolectomy‡‡ 	<ul style="list-style-type: none"> ▶ See section B for procedures§ in which removal on postoperative day 1 is also appropriate. It is inappropriate to wait until postoperative day 2 or later to remove catheters after routine hip or knee arthroplasty procedures, including hip fracture repair.

*These are recommendations for perioperative urinary catheter use for patients without another indication for urinary catheter use (eg, not needed to address a medical indication such as critical illness for which hourly urine output is being used to guide therapy such as vasopressors). For all procedures, using a postoperative protocol to monitor and address urinary retention symptoms is recommended; bladder scanners are increasingly common tools to verify retention in patients with symptoms to avoid unnecessary catheterisations.

†Routine urinary catheter use is not appropriate for these procedures when less than 2 hours of OR time and less than 2 L of intravenous fluids anticipated in the OR. Experts indicated that routine catheter use during the OR case could be appropriate for procedures >3 hours in duration or with >3 L of intraoperative fluids.

‡Patients are recommended to void before surgery. If concerned about postvoid residual, use of bladder scanner protocol with intermittent straight catheter as needed before surgery is an appropriate alternative to routine indwelling catheter use in patients with urinary retention.

§For these procedures, it was assessed also as clinically appropriate to remove catheter on postoperative day 1.

¶For this procedure, there was uncertainty about appropriateness of routinely removing on the same day of surgery; therefore, it could be clinically appropriate to remove earlier than postoperative day 1 by surgeon's discretion.

**For open low anterior resection, removal before postoperative day 3 is appropriate, but there was uncertainty for whether removal was more appropriate on postoperative day 1 compared to postoperative day 2.

††For laparoscopic abdominal perineal resection, removal by postoperative day 4 is appropriate, but there was uncertainty for whether a particular day within the range of postoperative days 1–4 was more appropriate than others.

‡‡For open or laparoscopic total proctocolectomy with or without ileal pouch anal anastomosis, removal by postoperative day 4 is appropriate, but there was uncertainty for whether a particular day within the range of postoperative days 1–4 was more appropriate than others.

OR, operating room; TAPP, transabdominal preperitoneal; TEP, totally extraperitoneal.

remove the catheter for the first voiding trial if a catheter had been placed was inappropriate.

Catheter placement in the OR was rated highly appropriate for all routine colorectal procedures queried. For higher colorectal resections (ie, open or laparoscopic ileocectomy, hemicolectomy, transverse colectomy, or sigmoidectomy), the time of catheter removal for the first voiding trial using a postoperative bladder scan protocol was rated as appropriate as early as postoperative day 0 (such as at the end of the case in the OR) or postoperative day 1, with waiting until postoperative day 2 or later rated as inappropriate. As summarised

in table 3 and detailed in online supplementary appendix table 2, there was substantial variation in opinion regarding timing of catheter removal for some of the more complex lower colorectal procedures (eg, laparoscopic abdominal perineal resection), yet high agreement catheters should be removed for all of these procedures for the first trial of void by postoperative day 4. For one procedure, total proctocolectomy, the panellists agreed that removal for the first trial of void by postoperative day 4 was appropriate, but could not agree on a particular day within the range of postoperative days 1–4 as being more appropriate than others.

Panellists were also asked if a suprapubic port in laparoscopic surgery impacted the appropriateness of perioperative urinary drainage strategies. Panellists indicated it was appropriate to have the patient void preoperatively with the option of bladder scanning without placing an indwelling urinary catheter routinely, but were undecided about the appropriateness of routine indwelling urinary catheter placement in this setting. Discussion revealed this practice was highly influenced by how the surgeon trained and if the surgeon had experienced any bladder complications with suprapubic port procedures.

Orthopaedic procedures

Orthopaedic procedure literature summary

Twenty group 1 studies^{68–87} (online supplementary appendix table 3) including eight RCTs and one narrative review⁸⁸ involving catheter use in joint replacement were identified. Most articles include both total hip and knee arthroplasty procedures, including both hip fracture and elective hip arthroplasty. Catheter strategies studied included performing surgery without indwelling catheters, removing catheters in the OR, removing early on postoperative day 1 or removal within 48 hours, with several studies involving spinal anaesthesia protocols. Many, but not all, studies demonstrated that avoiding or reducing catheter use was not associated with higher rates of adverse outcomes, including three studies^{69 75 79} supporting the avoidance of routine indwelling catheter use in patients receiving low-dose spinal analgesia.

Orthopaedic surgery panel findings

The final detailed ratings of urinary catheter appropriateness for each of the 36 orthopaedic surgery clinical scenarios are provided in online supplementary appendix table 4. Table 3 provides the overall summary of the perioperative urinary catheter use recommendations, categorising these routine hip and knee procedures into the same three categories used to categorise the general surgery procedures, as described above. In general, many common hip and knee procedures were assessed as appropriate to be performed without catheters, with other longer procedures appropriate to have a catheter placed but removed shortly after the surgery (such as before leaving the OR) or on postoperative day 1. Waiting until postoperative day 2 or later was assessed as inappropriate for routine knee or hip arthroplasty procedures, including repair of hip fracture.

For knee arthroplasty including unilateral, total or unicompartmental, or revision ≤ 2 hours, avoiding routine indwelling urinary catheter placement was recommended given it was appropriate to simply empty the bladder preoperatively by voiding or bladder scan with one intermittent straight catheterisation. Routine catheter placement was of uncertain appropriateness for bilateral total knee arthroplasty, meaning it could

be used at the surgeon's discretion. If placed, removal was appropriate on either the day of surgery or postoperative day 1.

For elective unilateral prosthetic hip replacement without hip fracture, routine indwelling urinary catheter use is not recommended. However, routine catheter use was recommended for bilateral or revision hip arthroplasty with expected duration of >2 hours. Panellists were undecided regarding routine catheter placement for revisions lasting 2 hours or less. If a catheter was placed for any of these hip procedures, removal was recommended on postoperative day 0 or 1, as detailed in table 3.

To begin the discussion of catheter use in patients with hip fracture, we first queried the appropriateness of placing an indwelling urinary catheter at the time of presentation to the emergency department in patients with hip fracture with uncontrolled pain. Indwelling urinary catheter placement was rated as inappropriate for male patients given the option of external 'condom' urinary catheters, and was 'uncertain' by neutral scores for female patients, though this is in the context of most clinicians not yet experienced with the more recently developed female external catheters to collect urine in women who cannot be easily turned. Voicing concern for prosthetic joint infection from urinary catheter-associated bacteriuria or infection, the orthopaedic panel also rated the use of indwelling urinary catheters as inappropriate in the postoperative hip surgery patient with incontinence, regardless of whether the wound was draining or not, either before or after removal of the occlusive dressing.

For unilateral closed reduction percutaneous pinning for femoral neck fracture, the panel ratings indicated that routine indwelling urinary catheter placement for OR use could be avoided, as having the patient void preoperatively or use of bladder scanner and a straight catheter to empty the bladder was appropriate. For other types of hip fracture repairs (open reduction and internal fixation, partial or total prosthetic hip arthroplasty), the panellists were uncertain about appropriateness for routine initial placement for OR use; if placed, catheter removal was appropriate on postoperative day 0 or 1.

CONCLUSIONS

We used the RAND/UCLA Appropriateness Method which combines a detailed review of the literature as well as multidisciplinary clinical expertise to inform a formal multi-round rating method to determine appropriateness of placing indwelling urinary catheters for use in the OR for common general surgery and orthopaedic procedures, as well as appropriateness of the postoperative timing of urinary catheter removal, producing the Michigan Appropriate Perioperative (MAP) criteria for urinary catheter use.

Although we anticipate that several of the general surgical procedures, particularly when performed in

the ambulatory setting, are becoming more commonly performed without urinary catheters, we expect that the panel's recommendations to avoid catheter use in other common procedures such as several laparoscopic procedures (eg, bariatric, cholecystectomy, appendectomy) have the potential to change care for many patients as there remains tremendous variation in practice between surgeons. We also believe that the panel's agreement that first voiding trials are appropriate on postoperative day 1, for even many complex colorectal procedures (eg, laparoscopic low anterior resection), and that it was inappropriate to wait more than 4 days postoperatively for a first voiding trial, will lead to more standardisation of early voiding trials for patients receiving these procedures, leading to fewer catheter-associated complications.

The literature and clinical experts were clear that the risk of infection from the urinary catheter needs to be taken very seriously for orthopaedic procedures, given the high morbidity of prosthetic joint infection. We anticipate the recommendations for reducing urinary catheter use in patients with hip fractures may change practice for many patients, both on surgical and medical services.

Our study has several limitations. Though our panels were diverse with broad representation from across the USA—and with significant clinical experience in the procedures evaluated—not every panellist performed every procedure type (or in the case of nurses, cared for every postoperative surgery patient type) that was described in the clinical scenarios for each panel. However, there was significant discussion at the inperson round 2 meeting to allow panellists to query each other's expertise to inform their own rating of the clinical scenario, as well as the option of rating the catheter appropriateness as uncertain if outside their area of expertise.

Limitations notwithstanding, we believe these MAP criteria for urinary catheter use will inform expectations and interventions at the service/unit level, as well as large-scale interventions to avoid placement and support prompt removal of urinary catheters in surgical patients. In combination with the Ann Arbor Criteria for Appropriate Urinary Catheter Use in Hospitalised Medical Patients,²² these perioperative criteria are anticipated to improve the confidence of clinicians to know when catheters can be safely avoided for routine surgical procedures.

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Contributors JM and KEF had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: JM, TAS, KEF, SJB, JD, SS. Acquisition of data: JM, KEF, TAS, SJB, JDM. Analysis and/or interpretation of data: JM, KEF, SJB, JD, SS. Drafting of the manuscript: JM, KEF, JDM. Critical revision of the manuscript for important intellectual content: all authors. Statistical analysis: KEF. Obtaining funding: JM, SS. Study supervision: JM, TAS, SS.

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Competing interests JM has reported receiving honoraria for lectures and teaching related to prevention and value-based purchasing policies involving catheter-associated urinary tract infection and hospital-acquired pressure ulcers. SS has reported receiving honoraria for lectures and teaching related to prevention of catheter-associated urinary tract infection, and is on the medical advisory boards of Doximity and Jvion.

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