

Supplementary Online Content

Chrouser K, Fowler KE, Mann JD, et al. Urinary retention evaluation and catheterization algorithm for adult inpatients. *JAMA Netw Open*. 2024;7(7):e2422281. doi:10.1001/jamanetworkopen.2024.22281

eTable 1. Articles Yielded by Systematic Search Provided to the RAND/UCLA Appropriateness Panel Members

eTable 2. Cochairs and Panelists for the RAND/UCLA Appropriateness Panel

eTable 3 Representative Questions From the Pilot-Tested, Semistructured, Role-Specific Interview Guide

eTable 4. Appropriateness Ratings for Monitoring of Urinary Retention After Catheter Removal

eTable 5. Presumptive Treatment of Urinary Retention After Catheter Removal When a Bladder Scanner Is Unavailable

eTable 6. Appropriateness Ratings for Treatment of Urinary Retention Based on Bladder Scan Volume

eTable 7. Appropriateness Ratings for Transitioning From Intermittent to Indwelling Catheter for Urinary Retention

eTable 8. Preoperative Strategies to Predict or Prevent Postoperative Urinary Retention

eFigure 1. Overview of Multimethod Approach Applied to Generate Final Algorithm

eFigure 2. Early Retention Algorithm Drafts

eFigure 3: Final Urinary Retention Evaluation and Catheterization Algorithm (URECA)

This supplementary material has been provided by the authors to give readers additional information about their work.

eTable 1. Articles yielded by the systematic search that were provided to the RAND/UCLA Appropriateness Panel members

Article Category	References
<p>“A” articles that specifically tested a feature of urinary retention protocol, such as accuracy of a bladder scanner to assess bladder volumes</p>	<ol style="list-style-type: none"> 1. Pedersen JF, Bartrum RJ, Grytter C. Residual urine determination by ultrasonic scanning. <i>Am J Roentgenol Radium Ther Nucl Med</i>. Oct 1975;125(2):474-478. 2. Ravichandran G, Fellows GJ. The accuracy of a hand-held real time ultrasound scanner for estimating bladder volume. <i>British journal of urology</i>. 1983;55(1):25-27. 3. Rosseland LA, Stubhaug A, Breivik H. Detecting postoperative urinary retention with an ultrasound scanner. <i>Acta Anaesthesiologica Scandinavica</i>. 2002;46(3):279-282. 4. Wilson M. Ultrasound assessment of bladder volume: is it valid after delivery? <i>The Australian & New Zealand journal of obstetrics & gynaecology</i>. 2003;43(6):453-456. 5. Crouch N, O'Brien P, O'Sullivan C, Cutner A. Intrapartum ultrasound estimation of total bladder volume. <i>BJOG : an international journal of obstetrics and gynaecology</i>. 2004;111(2):103-108. 6. Rosseland LA, Bentsen G, Hopp E, Refsum S, Breivik H. Monitoring urinary bladder volume and detecting post-operative urinary retention in children with an ultrasound scanner. <i>Acta anaesthesiologica Scandinavica</i>. 2005;49(10):1456-1459. 7. Cederkvist HR, Rosseland LA. Reliability of an automatic ultrasound system for detecting postpartum urinary retention after vaginal birth. <i>Acta obstetricia et gynecologica Scandinavica</i>. 2007;86(10):1251-1255. 8. Park YH, Ku JH, Oh S-J. Accuracy of post-void residual urine volume measurement using a portable ultrasound bladder scanner with real-time pre-scan imaging. <i>Neurourology and urodynamics</i>. 2011;30(3):335-338.

Article Category	References
<p>“B” articles that did not specifically test a urinary retention protocol as part of the intervention but included a detailed urinary retention protocol for review. These “B” articles are included to demonstrate the variety of urinary retention protocols in use.</p>	<ol style="list-style-type: none"> 1. Moore DA, Edwards K. Using a portable bladder scan to reduce the incidence of nosocomial urinary tract infections. <i>MEDSURG Nursing</i>. 1997;6(1):39-43. 2. Luger TJ, Garoscio I, Rehder P, Oberladstatter J, Voelckel W. Management of temporary urinary retention after arthroscopic knee surgery in low-dose spinal anesthesia: development of a simple algorithm. <i>Arch Orthop Trauma Surg</i>. Jun 2008;128(6):607-612. 3. Boyer DR, Steltzer N, Larrabee JH. Using the best evidence to change practice. Implementation of an evidence-based bladder scanner protocol. <i>Journal of Nursing Care Quality</i>. 2009 Jan-Mar 2009;24(1):10-16. 4. Brouwer T, Kalkman C, Moons C. Post operative urinary retention: Can we do better? <i>European Journal of Anaesthesiology</i>. 2009;26:19. 5. Shadle B, Barbaro C, Waxman K, Connor S, Von Dollen K. Predictors of postoperative urinary retention. <i>American Surgeon</i>. 2009;75(10):922-924. 6. Balderi T, Mistraletti G, D'Angelo E, Carli F. Incidence of postoperative urinary retention (POUR) after joint arthroplasty and management using ultrasound-guided bladder catheterization. <i>Minerva Anestesiologica</i>. 2011;77(11):1051-1057. 7. Cutright J. The effect of the bladder scanner policy on the number of urinary catheters inserted. <i>Journal of wound, ostomy, and continence nursing : official publication of The Wound, Ostomy and Continence Nurses Society / WOCN</i>. 2011;38(1):71-76. 8. Mateu N, Perez N, Tantina S, Benavent R. Avoiding urinary catheterisation in acute geriatric service at the granollers general hospital using a bladder scan. <i>European Geriatric Medicine</i>. 2011;2:S195. 9. Kim HJ, Chun MH, Han EY, Yi JH, Kim DK. The utility of a bladder scan protocol using a portable ultrasonographic device in subacute stroke patients. <i>Disability and rehabilitation</i>. 2012;34(6):486-490. 10. Rhyne L, Potter T, Headrick JR. Is It safe to remove urinary catheters in general thoracic surgery patients receiving thoracic epidural analgesia within the first 24 hours? <i>Chest</i>. 2012;142(4). 11. Uberoi V, Calixte N, Orlando R, Lerner L. A strategy to reduce Foley days, post-operative urinary retention, and catheter-associated urinary tract infections. <i>Journal of Urology</i>. 2012;187(4):e111-e112. 12. Zaouter C, Wuethrich P, Miccoli M, Carli F. Early removal of urinary catheter leads to greater post-void residuals in patients with thoracic epidural. <i>Acta Anaesthesiologica Scandinavica</i>. Sep 2012;56(8):1020-1025. 13. Antonescu I, Baldini G, Watson D, et al. Impact of a bladder scan protocol on discharge efficiency within a care pathway for

	<p>ambulatory inguinal herniorrhaphy. <i>Surgical endoscopy</i>. 2013;27(12):4711-4720.</p> <p>14. Tripepi-Bova KA, Sun Z, Mason D, Albert NM. Early Removal of Urinary Catheters in Patients With Thoracic Epidural Catheters. <i>Journal of Nursing Care Quality</i>. 2013;28(4):340-344.</p> <p>15. Lai KY, Chan WK, Ho WF, Leung CS, Li YK. Application of bladder scan in ambulatory management protocol for acute urinary retention with presumed diagnosis of benign prostatic hypertrophy. <i>Hong Kong Journal of Emergency Medicine</i>. 2014;21(5):300-307.</p>
--	--

Article Category	References
“C” articles include literature available in intervention studies that assessed AUA or IPSS symptom scores as predictors of post-operative urinary retention, in a variety of different common surgical procedures.	<ol style="list-style-type: none"> 1. Elkhodair S, Parmar HV, Vanwaeyenbergh J. The role of the IPSS (International Prostate Symptoms Score) in predicting acute retention of urine in patients undergoing major joint arthroplasty. <i>The Surgeon</i>. 4// 2005;3(2):63-65. 2. Cronin JJ, Shannon FJ, Bale E, Quinlan W. Prediction of post-operative urinary retention in hip and knee arthroplasty in a male population. <i>Eur J Orthop Surg Traumatol</i>. 2007/01/01 2007;17(1):47-50.

eTable 2. Panel Co-Chairs and Panelists for the RAND/UCLA Appropriateness Panel

Co-Chairs / Panel Leaders (not-voting)

Name	Title*	Affiliation*	RAND/UCLA Appropriateness Method Experience
Jennifer Meddings, MD, MSc	Assistant Professor	University of Michigan, Ann Arbor, MI	Experience conducting multiple RAND/UCLA appropriateness panels
Steven Bernstein, MD, MPH	Professor	University of Michigan, Ann Arbor, MI	Co-author of <i>The RAND/UCLA appropriateness method user's manual</i>
Ted Skolarus, MD,	Assistant Professor	University of Michigan, Ann Arbor, MI	Experience participating in and conducting multiple RAND/UCLA appropriateness panels

Panelists**

Name	Title*	Affiliation*	Specialty
Michael Balk, RN	Operating Room Circulating Nurse	Mercy Health Saint Mary's Hospital, Grand Rapids, MI	Nursing
Donald R. Bodner, MD	Professor of Urology	Louis Stokes Cleveland VA Medical Center, Cleveland, OH Case Western Reserve University School of Medicine, Cleveland, OH	Urology
Sansern Borirakchanyavat, MD	Chief of Urology	Southern California Permanente Medical Group, Panorama City, CA	Urology
Bruce L. Jacobs, MD, MPH	Assistant Professor	University of Pittsburgh School of Medicine, Pittsburgh, PA	Urology
John T. Leppert, MD, MS	Assistant Professor	Stanford University, Stanford, CA; VA Palo Alto Health Care System, Palo Alto, CA	Urology
Daniel J. Morgan, MD, MS	Associate Professor; Hospital Epidemiologist	University of Maryland, Baltimore, MD; VA Maryland Healthcare System, Baltimore, MD	Infectious Diseases
Michael C. Risk, MD, PhD	Assistant Professor	University of Minnesota, Minneapolis, MN; VA Minneapolis Health Care System, Minneapolis, MN	Urology
Andrea Starnes, RN	Infectious Diseases Nurse Case Manager	VA Ann Arbor Healthcare System, Ann Arbor, MI	Infectious Diseases; Nursing

Seth A. Strobe, MD, MPH	Assistant Professor	Washington University School of Medicine, St. Louis, MO	Urology
Jonathan N. Warner, MD	Assistant Professor	University of Michigan, Ann Arbor, MI	Urology
John T. Wei, MD, MS	Professor	University of Michigan, Ann Arbor, MI	Urology

*At time of panel participation

**Panelists selected by co-chairs based on clinical expertise and geographic diversity. Panelists were invited to participate via email. Panelists were allowed to suggest other members for the panel. These suggestions were then reviewed by co-chairs before deciding whether to officially invite the clinician.

eTable 3. Representative Questions from the Pilot-Tested, Semi-Structured Role-Specific Interview Guide

URINARY RETENTION ALGORITHM QUESTIONS
<p>What protocols are in place for managing post-op urinary retention?</p> <p>[If none ask]: What protocols or guidelines would you find most helpful?</p> <p>What (content) would that include? Key decision points?</p> <p>When to re-insert Foley? When to consult with urology?</p> <p>Would you like protocols on paper checklists?</p> <p>In EMR, on a website, on a phone app?</p>
<p>We are considering developing a protocol to help manage and diagnose post-op urinary retention. Are you involved in the management of post-op urinary retention?</p> <p>[If yes ask]: We would welcome your opinions on a draft protocol we are considering:</p> <p>What do you think of this draft protocol?</p> <p>What do you like about it? How could we improve it?</p> <p>Where should this algorithm be found? For example, within the EMR or posted in the PACU?</p> <p>What changes would be needed to make a protocol work effectively in your setting?</p>

eTable 4. Appropriateness Ratings for Monitoring of Urinary Retention after Catheter Removal

Clinical Scenario: Lack of urine output in post-operative patient or medical inpatient	Evaluation Using Bladder Scanner		Evaluation Using Intermittent Straight Cath (ISC) (instead of scanning)		Evaluation Using Indwelling Urinary Catheter (IUC) Placement (instead of scanning)	
	with symptoms	without symptoms	with symptoms	without symptoms	with symptoms	without symptoms
No urine output <1 hour	Appropriate	Inappropriate	Inappropriate			
No urine output 1 to <2 hours						
No urine output 2 to <3 hours		Uncertain				
No urine output 3 to <4 hours		Appropriate				
No urine output 4 to <5 hours						
No urine output 5 to <6 hours						
No urine output > 6 hours						

eTable 5. Presumptive Treatment of Urinary Retention after Catheter Removal When a Bladder Scanner is Unavailable

Clinical Scenario: Lack of urine output in post-operative patient or medical patient	Intermittent Catheterization		Indwelling Catheter Placement Overnight	
	with symptoms	without symptoms	with symptoms	without symptoms
No urine output <1 hour	Inappropriate	Inappropriate	Inappropriate	Inappropriate
No urine output 1 to <2 hours	Uncertain			
No urine output 2 to <3 hours			Appropriate	
No urine output 3 to <4 hours	Appropriate	Uncertain		
No urine output 4 to <5 hours		Appropriate		
No urine output 5 to <6 hours		Appropriate	Appropriate	
No urine output > 6 hours				

eTable 6. Appropriateness Ratings for Treatment of Urinary Retention Based on Bladder Scan Volume

Clinical Scenario: Post void scanned volumes	Intermittent Straight Catheterization (ISC)		Indwelling Urinary Catheter (IUC) Placement Overnight	
	with symptoms	without symptoms	with symptoms	without symptoms
<100 ml	Inappropriate	Inappropriate	Inappropriate	Inappropriate
100-199 ml	Uncertain			
200-299 ml				
300-399 ml	Appropriate		Uncertain	
400-499 ml		Uncertain	Uncertain	
500 ml and up		Appropriate	Appropriate	

eTable 7. Appropriateness Ratings for Transitioning from Intermittent to Indwelling Catheter for Urinary Retention

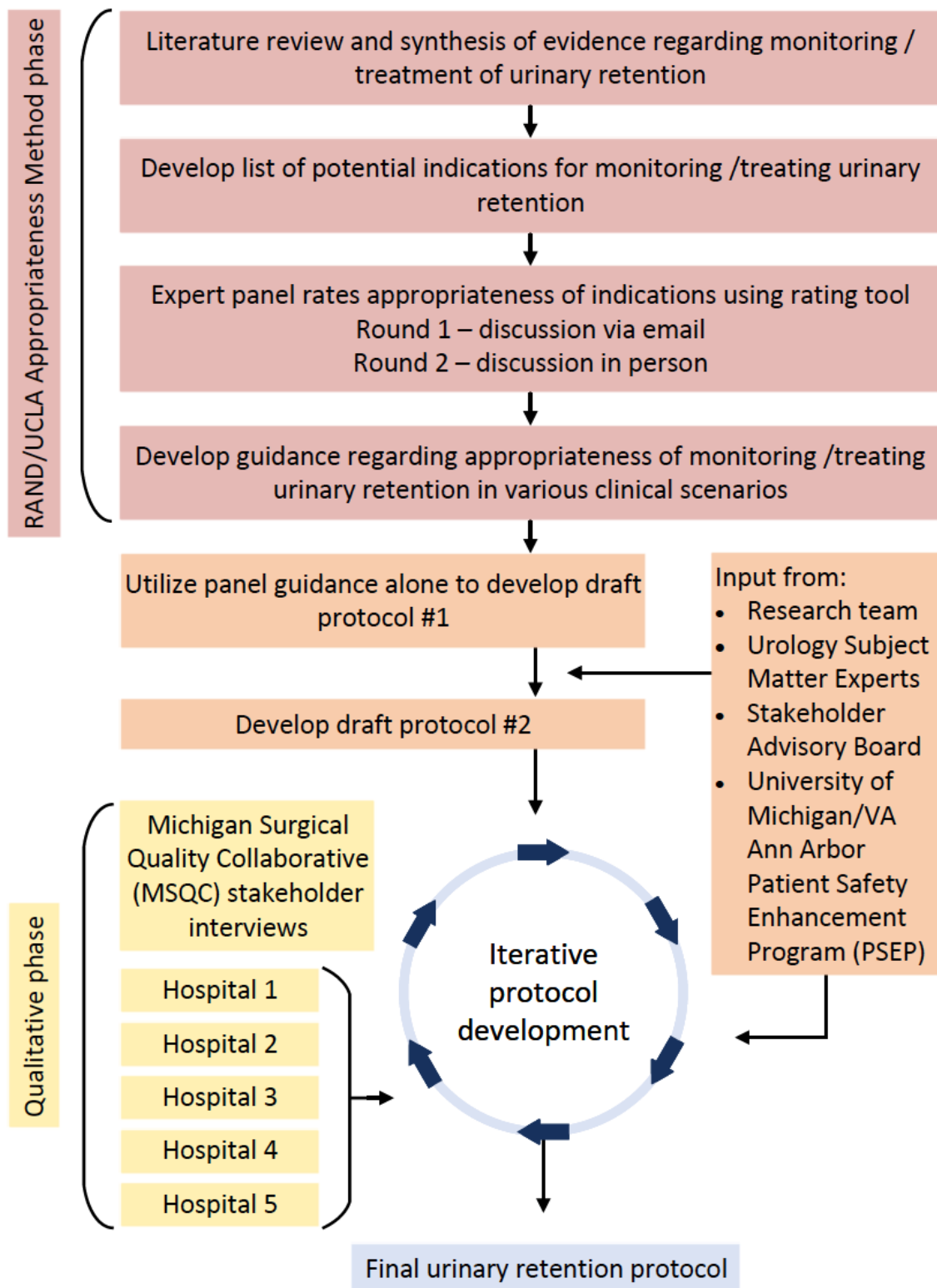
Clinical Scenarios	Transition from ISC to IUC
Patient requests indwelling catheter before any intermittent straight catheterization (ISC) attempted	Appropriate
Patient requests indwelling catheter after 1 ISC	
Patient requests indwelling catheter after 2 or more ISCs	
ISC needed once daily for 2 or more days	Inappropriate
ISC needed 2 times in 24 hours	
ISC needed 3 times in 24 hours	
ISC needed 4 times in 24 hours	
ISC needed bid for 2 or more days	
ISC needed >bid for 2 or more days	
ISC needed more often than q 4 hours	
ISC output >500ml q 4 hours	Appropriate
Initial ISC output <500ml	Inappropriate
Initial ISC output >500ml	Uncertain

eTable 8. Pre-Operative Strategies to Predict or Prevent Post-Operative Urinary Retention

Clinical Scenarios:	Assessment/ Treatment	Indwelling Catheter Placement	First Trial of Void
Conducting the following pre-operative assessments ROUTINELY for adult male patients			
AUA/IPSS to inform management of post-operative UR	Uncertain		
AUA/IPSS to inform the need for IUC in the operating room and timing of removal post-operatively			
Post void residual by bladder scanner in a patient with a history of prior UR			
Post void residual by bladder scanner in a patient who reports having difficulty voiding	Inappropriate		
Placing IUC ROUTINELY in the operating room in an adult male with any prior history of UR (assuming IUC otherwise not needed)		Inappropriate	
Conducting the FIRST trial of void on this day in an adult male post-operative patient with any prior history of UR			
Post-operative day #0			Appropriate
Post-operative day #1			
Post-operative day #2			Inappropriate
Post-operative day #3			
Post-operative day #4 or later			
Initiating alpha blocker medication (e.g., doxazosin, terazosin, or tamsulosin), if not contra-indicated, to PREVENT acute UR in a post-operative adult male or female patient with a history of prior post-operative UR and not currently being treated for UR	Uncertain		

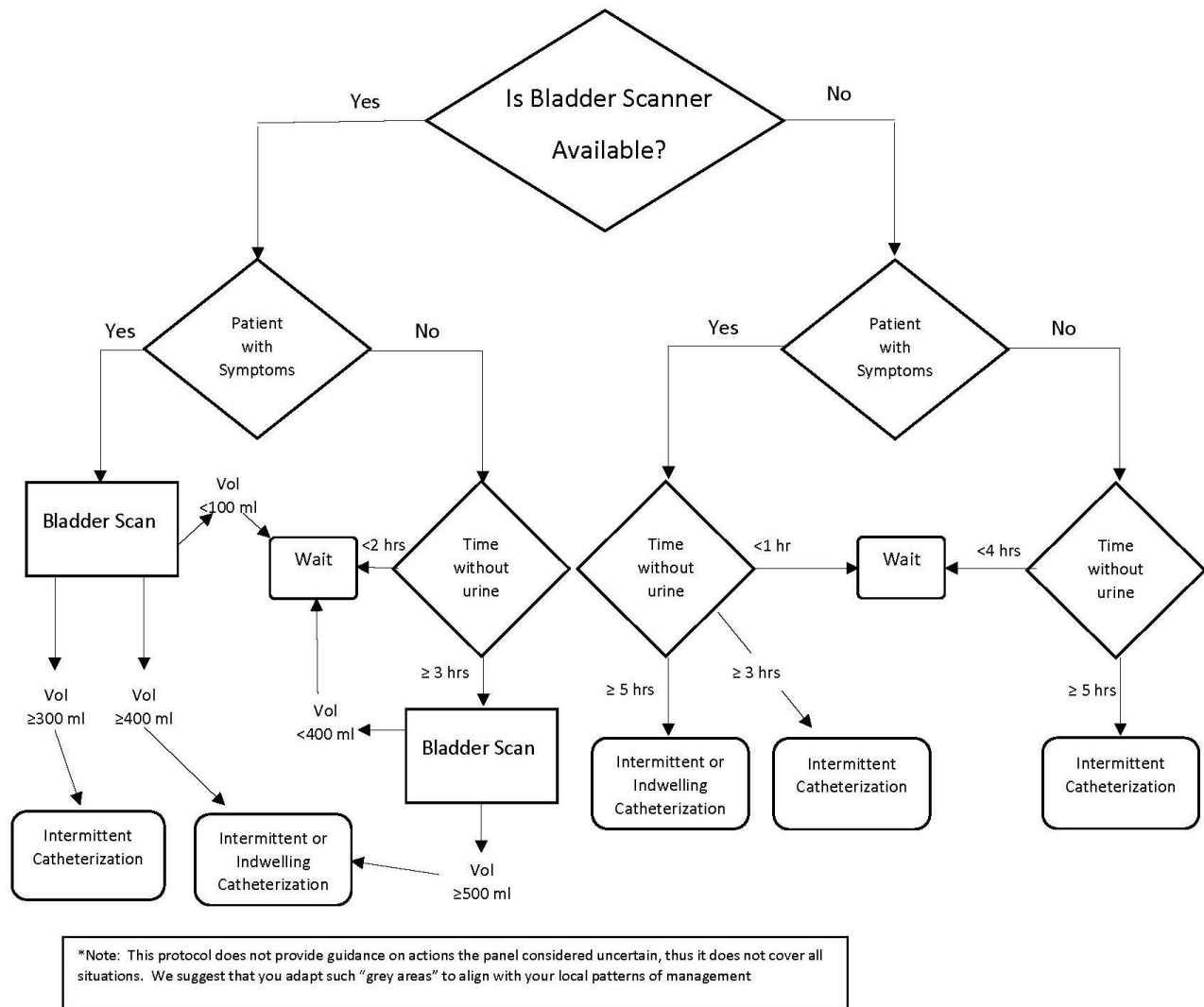
AUA: American Urological Association Symptom Score; IPSS: International Prostate Symptom Score; UR Urinary Retention; IUC: Indwelling Urinary Catheter.

eFigure 1. Overview of multi-method approach applied to generate final algorithm

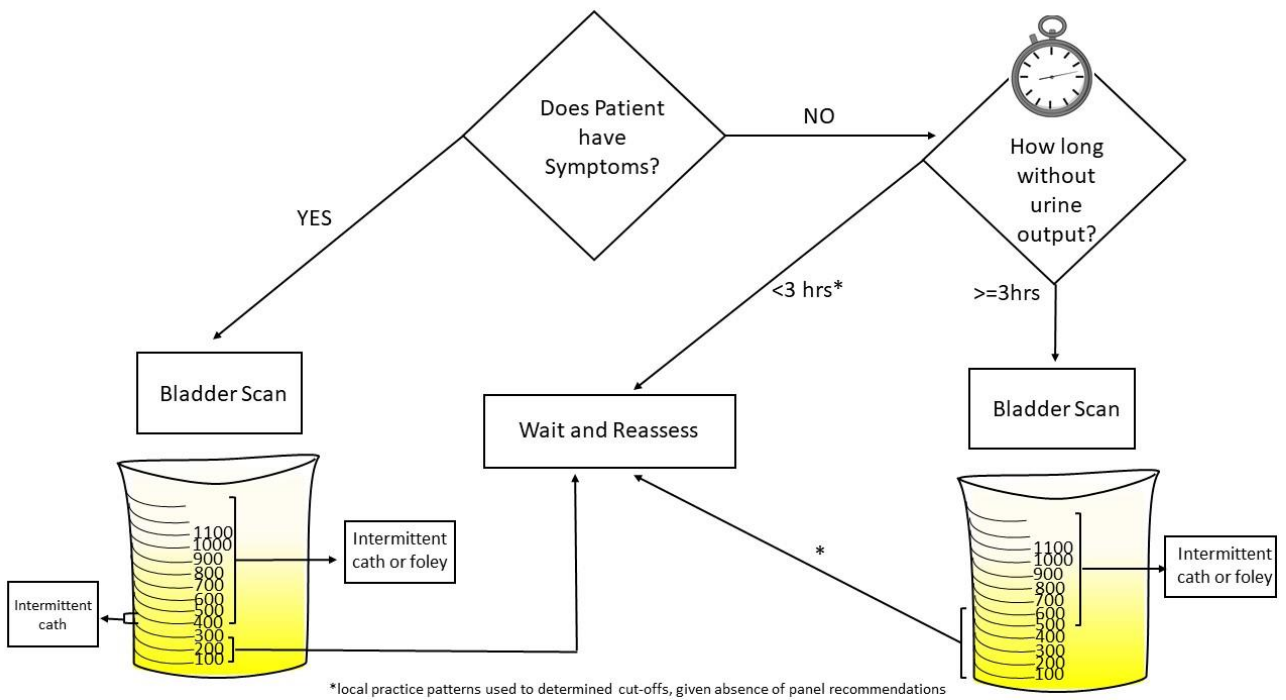


eFigure 2. Early Drafts of the Urinary Retention Evaluation and Catheterization Algorithm (URECA)

Draft Algorithm #1 Retention Evaluation and Management



Draft Algorithm #2 Retention Evaluation and Management



eFigure 3: Final Urinary Retention Evaluation and Catheterization Algorithm (URECA) (Full color version with icons)

