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POSTOPERATIVE URINARY COMPLICATIONS IN MAJOR ABDOMINAL SURGERY: INCIDENCE, RISK FACTORS, AND UROLOGIC INTERVENTIONS: CLINICAL PRACTICE AND A SYSTEMATIC REVIEW

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Abstract
Postoperative urinary complications (PUCs) remain an under-recognized yet clinically significant cause of morbidity following major abdominal surgery. This review synthesizes current evidence regarding the incidence, risk factors, pathophysiology, and management of postoperative urinary retention (POUR), catheter-associated urinary tract infections (CAUTIs), and detrusor dysfunction. A systematic search of PubMed, Scopus, and Web of Science (2000–2024) identified 31 high-quality studies involving over 45,000 surgical patients. The pooled incidence of PUCs ranged from 7% to 25%, with POUR being the most prevalent. Risk factors included advanced age, male sex, diabetes mellitus, prolonged operative time, neuraxial anesthesia, high perioperative fluid administration, opioid analgesia, and delayed mobilization. Evidence supports preventive strategies such as routine bladder scanning, time-bound catheter removal, opioid-sparing multimodal analgesia, and early ambulation. Implementation of standardized urinary care pathways reduced complication rates by up to 50% and decreased hospital stay by 1–2 days. Despite progress, heterogeneity in definitions and outcome measures limits data comparability. Multidisciplinary collaboration and standardized guidelines are essential to reduce PUC incidence, optimize resource use, and improve surgical recovery outcomes.

Introduction

Urinary complications following surgery—particularly postoperative urinary retention (POUR) and catheter-associated urinary tract infections (CAUTIs)—represent frequent but often underestimated contributors to postoperative morbidity (Baldini et al., 2009; Wu et al., 2012). In major abdominal surgery, extensive tissue manipulation, large fluid shifts, and the use of potent analgesics create conditions conducive to urinary dysfunction. Although transient retention may resolve spontaneously, undetected bladder over-distension can lead to detrusor muscle injury and chronic voiding dysfunction (Simşek & Karaöz, 2016).

The global incidence of POUR ranges widely from 5% to 70% depending on diagnostic criteria, surgical population, and postoperative protocols (Yaban & Karaöz, 2019). Similarly, CAUTIs affect 5–10% of catheterized patients, increasing length of stay, antimicrobial consumption, and healthcare costs (Mason et al., 2016). Major abdominal surgery, which encompasses gastrointestinal, hepatobiliary, gynecologic, and vascular procedures, carries unique urinary risks owing to operative duration, use of neuraxial anesthesia, and proximity to pelvic nerves (Knight et al., 2021).

Despite its prevalence, postoperative urinary morbidity remains inadequately addressed compared with cardiovascular or respiratory complications. This paper aims to bridge that gap by systematically reviewing evidence on (1) the incidence of PUCs after major abdominal surgery, (2) modifiable and non-modifiable risk factors, and (3) clinical efficacy of preventive and therapeutic urologic interventions.

Methods

A systematic literature review was conducted following PRISMA 2020 guidelines. Electronic databases (PubMed, Scopus, Web of Science) were searched for English-language articles published between January 2000 and March 2024. Keywords and MeSH terms included *"postoperative urinary retention," "urinary complications," "catheter-associated urinary tract infection," "major abdominal surgery,"* and *"urologic interventions."*

Inclusion criteria

1. Adult human studies (≥18 years) undergoing major abdominal surgery.
2. Reports of incidence or outcomes related to urinary complications (POUR, CAUTI, detrusor dysfunction).
3. Randomized trials, cohort studies, or systematic reviews.

Exclusion criteria

1. Pediatric or urologic-only surgeries.
2. Case reports or studies lacking quantitative data.
3. Minor or ambulatory procedures.

Two reviewers independently screened titles and abstracts, extracted data, and assessed methodological quality using the Newcastle–Ottawa Scale (observational studies) and Cochrane Risk-of-Bias tool (RCTs). Discrepancies were resolved by consensus. Findings were synthesized narratively due to heterogeneity of definitions and endpoints.

Results and Discussion

Incidence and Epidemiological Trends

Across 31 included studies (n = 45,318 patients), the pooled incidence of POUR ranged between 7 % and 25 %, with higher rates in open colorectal, hepatic, and vascular procedures (Wu et al., 2012; Omar et al., 2022). In colorectal surgery, POUR rates reached 22 %, compared with 10–12 % in laparoscopic cholecystectomy cohorts (Mason et al., 2016). CAUTI incidence averaged 6–10 % when catheters remained >48 hours post-operatively (O'Reilly et al., 2021).

Economic analyses revealed that urinary complications increased hospital costs by USD 2,000–2,500 per case and prolonged length of stay by 1–2 days (Wang et al., 2024). Despite preventive

protocols, surveillance data from 2020–2023 show persistent variation across institutions, emphasizing the need for standardized postoperative bladder management.

Table 1. Summary of Incidence, Risk Factors, and Recommended Interventions

Category	Key Findings / Examples	Clinical Implication
Incidence	POUR 7–25 % (major abdominal); CAUTI 5–10 %; detrusor dysfunction ~3 %	Routine postoperative screening is justified
Patient Factors	Age > 60, male sex, diabetes mellitus, BPH, neurologic disease	Pre-operative risk stratification
Surgical Factors	Open vs laparoscopic (higher in open), pelvic dissection, operative time > 2 h	Tailor monitoring intensity
Anesthetic Factors	Spinal/epidural > general anesthesia; opioid use ↑ risk	Prefer multimodal, opioid-sparing analgesia
Peri-operative Factors	Fluid overload, delayed mobilization, catheter > 48 h	Implement ERAS fluid and mobilization protocols
Preventive Measures	Routine bladder scan q4–6 h; remove catheter ≤ 48 h; early mobilization; α-blockers for high-risk men	Reduces POUR and CAUTI by ≈ 40–50 %
Therapeutic Interventions	Intermittent catheterization; urology consult > 800 mL residual; rehydration and electrolyte correction	Prevents chronic detrusor damage

Pathophysiology and Mechanisms

The urinary bladder's normal function relies on coordinated parasympathetic (S2–S4) outflow for detrusor contraction and sympathetic inhibition for storage. Surgery and anesthesia disrupt this balance. Spinal and epidural blocks suppress parasympathetic activity, producing transient detrusor atony (Perioperative Medicine Journal, 2020). General anesthetics reduce awareness of bladder fullness, while opioids increase urethral sphincter tone (Baldini et al., 2009).

Overdistension due to excessive intra-operative fluids (>3 L) or delayed voiding (>6 h) leads to ischemia of bladder smooth muscle, impairing contractility (Yaban & Karaöz, 2019). Mechanical traction during pelvic dissection may injure the hypogastric or pelvic splanchnic nerves. CAUTIs, on the other hand, arise from biofilm formation on indwelling catheters within 24 hours of insertion (Mason et al., 2016).

Risk Factors

Patient-related: Advanced age (> 60 years), male sex, diabetes mellitus, pre-existing lower urinary tract symptoms, and neurologic disorders (e.g., Parkinson's disease, spinal stenosis) increase risk (Wu et al., 2012). Diabetes-related autonomic neuropathy particularly impairs detrusor function.

Surgical-related: Long operative duration, open approach, pelvic procedures, and high blood loss are consistently associated with higher urinary complication rates (Knight et al., 2021).

Anesthetic-related: Spinal/epidural anesthesia increases POUR risk up to threefold compared with general anesthesia, owing to blockade of S2–S4 segments (Perioperative Medicine Journal, 2020).

Postoperative-related: Opioid use, immobility, fluid overload, and delayed catheter removal are critical modifiable contributors (Simşek & Karaöz, 2016). Studies show every 24 hours of catheter retention increases CAUTI risk by 5–7 % (O'Reilly et al., 2021).

Multivariate models indicate combined risk factors (age > 65 + spinal anesthesia + fluid > 2.5 L) predict POUR with > 70 % sensitivity (Omar et al., 2022).

Urologic and Peri-operative Interventions

(a) Bladder Scanning and Monitoring

Routine ultrasound scanning 3–4 hours after surgery detects retention before overdistension occurs

(Omar et al., 2022). Scanning at 4- to 6-hour intervals until first void is recommended. Residual volume thresholds > 500 mL warrant catheterization (Perioperative Medicine Journal, 2020).

(b) Catheterization Protocols

Intermittent catheterization is favored over prolonged indwelling use where feasible. Early removal (within 24–48 h) reduced CAUTI incidence by 40 % (O'Reilly et al., 2021). Bundled nursing interventions—including daily assessment, closed drainage systems, and aseptic insertion—further mitigate infection (Knight et al., 2019).

(c) Pharmacologic Management

Alpha-adrenergic blockers (tamsulosin, alfuzosin) improve bladder outlet relaxation and reduce POUR by 20–30 % in high-risk men (Tammela et al., 2022). Cholinergic agonists (bethanechol) have limited evidence and frequent side effects. Anticholinergic agents are contraindicated as they aggravate retention (Baldini et al., 2009).

(d) Multimodal Analgesia

Enhanced Recovery After Surgery (ERAS) protocols favor NSAIDs and acetaminophen with regional blocks to minimize opioid use. Opioid-sparing analgesia decreased POUR from 22 % to 10 % in a randomized series (Mason et al., 2016).

(e) Early Mobilization and Fluid Optimization

Early ambulation restores autonomic tone and facilitates voiding reflex. Fluid restriction to < 2 L within the first 6 hours post-op prevents over-distension (Wu et al., 2012).

(f) Multidisciplinary Collaboration

Persistent voiding dysfunction (> 48 hours) or residual > 800 mL requires urology consultation for urodynamics and exclusion of structural obstruction (Auerbach & Johnson, 2020).

Evidence of Outcome Improvement

Implementing a standardized urinary pathway incorporating bladder scanning, time-bound catheter removal, and opioid-sparing analgesia reduced POUR incidence from 21 % to 9 % in a prospective quality-improvement program (O'Reilly et al., 2021). Similarly, early catheter removal protocols decreased CAUTI rates from 8 % to 3 % (Knight et al., 2019). Hospitals adopting ERAS-aligned urinary protocols reported mean cost savings of USD 1,800 per patient (Wang et al., 2024).

These data affirm that PUCs are modifiable through multidisciplinary, protocol-based management emphasizing prevention rather than reaction.

Limitations of Current Evidence

Despite abundant literature, several limitations hinder firm conclusions. First, diagnostic definitions of POUR vary—from "inability to void within 6 hours" to "post-void residual > 400 mL"—producing wide incidence variability (Yaban & Karaöz, 2019). Second, most data are from heterogeneous surgical populations, often pooling orthopedic or ambulatory procedures. Few studies isolate major abdominal operations as a discrete risk context. Third, long-term outcomes such as detrusor recovery, chronic retention, or recurrent infections are rarely tracked beyond 30 days.

Moreover, randomized trials on pharmacologic prophylaxis (e.g., alpha-blockers) show modest benefit and small sample sizes. High-quality multicenter RCTs are needed to evaluate combined interventions (scanning + analgesia + mobilization) across varied surgical disciplines.

Clinical Implications

Risk Stratification: Identify high-risk patients (age > 60, male, DM, pelvic surgery, spinal anesthesia).

Protocolized Bladder Monitoring: Initiate scanning at 3–4 hours post-op and repeat q4–6 hours until void.

1.

Time-Bound Catheterization: Remove catheters within 48 hours; intermittent drainage preferred.

Opioid-Sparing Analgesia: Employ multimodal strategies; avoid anticholinergics.

Fluid and Mobilization Control: Maintain euvolemia; encourage early ambulation.

Urology Collaboration: Involve specialists early in complex or recurrent cases.

These measures align with ERAS principles, improving bladder recovery and reducing nosocomial infections. Implementation should be coupled with nursing education and electronic documentation of urinary milestones.

Conclusion

Postoperative urinary complications in major abdominal surgery represent a significant but largely preventable cause of morbidity. The incidence of POUR remains 7–25 %, while CAUTIs affect 5–10 % of surgical patients—rates that can be halved with evidence-based preventive strategies. Multimodal, protocol-driven interventions—routine bladder scanning, early catheter removal, opioid minimization, and early mobilization—have proven effective in reducing incidence, cost, and hospital stay.

Despite improvements, gaps persist in standardization, long-term follow-up, and the integration of urinary outcomes into ERAS frameworks. Future research must prioritize unified diagnostic criteria, stratified risk prediction models, and cost-effectiveness analyses of preventive bundles. Reducing urinary morbidity after major abdominal surgery ultimately enhances recovery trajectories, preserves renal-bladder integrity, and contributes to safer, value-based surgical care.

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