A systematic review and meta-analysis of unplanned hospital visits and re-admissions following radical prostatectomy for prostate cancer

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Abstract

Introduction: Unplanned visits (UPV) — re-admissions and emergency room (ER) visits — are markers of healthcare system quality. Radical prostatectomy (RP) is a commonly performed cancer procedure, where variation in UPV represents a gap in care for prostate cancer patients. Here, we systematically synthesize the rates, reasons, predictors, and interventions for UPV after RP, to inform evidence-based quality improvement (QI) initiatives.
Methods: A systematic review was performed for studies from 2000–2020 using keywords: "re-admission," "emergency room/department," "unplanned visit," and "prostatectomy." Studies that focused on UPV following RP and that reported rates, reasons, predictors, or interventions, were included. Data was extracted via a standardized form. Meta-analysis was completed.

Results: Sixty studies, with 406 107 RP patients, were eligible; 16 028 UPV events (~5%) were analyzed from 317 050 RP patients. UPV rates after RP varied between studies (ER visit range 6–24%; re-admissions range 0–56%). The 30-day and 90-day ER visit rates were 12% and 14%, respectively; the 30-day and 90-day re-admission rates were 4% and 9%, respectively. A total of 55% of all re-admissions after RP are directly due to postoperative genitourinary (GU)-related complications such as strictures, obstructions, fistula, bladder-related, incontinence, urine leak, renal problems, and other unspecified urinary complications. The next most common re-admission reasons were anastomosis-related, infection-related, cardiovascular/pulmonary events, and wound-related issues. Thirty-four percent of all ER visits after RP are directly due to urine-related issues such as retention, urinoma, obstruction, leak, and catheter problems. The next most common ER visit reasons were abdominal/gastrointestinal issues, infection-related, venous thromboembolic events, and wound-related issues. Predictors for increased re-admission included: open RP, lymph node dissection, Charlson comorbidity index≥2, low surgeon/hospital case volume, and socioeconomic determinants of health. Of the 10 interventions evaluated, a 3.4% average reduction in UPV rate was observed, highlighting an approximate two-fold decrease. Meta-analysis demonstrated a significant benefit of interventions over controls with odds ratio 0.62 (95% confidence interval 0.46–0.84). Interventions that used multidisciplinary, nurse-centered, programs, with patient self-care/empowerment were more beneficial than algorithmic patient care pathways and preoperative patient education.
Conclusions: Twenty years of international, retrospective, experience suggests UPV after RP are often related to GU complications, infection- or wound-related factors. QI interventions to reduce UPV should target these factors. While many re-admissions after RP appear to be unavoidable, ER visits have more opportunity for volume reduction by QI. The interventions evaluated herein have potential to reduce UPV after RP.

Introduction

Prostate cancer (PC) is the second most common cancer, with >1.28M new cases per year.[1] PC has international variation in incidence and mortality rates dependent on income and resource status of countries.[2] The most common treatment for localized PC is radical prostatectomy (RP). Approximately nine thousand RPs are performed every year in Canada, and ninety thousand in the USA.[3,4] Although the five-year survival rate of PC is 98%, morbidity remains important for quality-of-care improvements.

Unplanned visits (UPV) after index hospitalization—including re-admissions and emergency room (ER) visits—are quality of care indicators.[5-10] Reducing re-admissions and ER visits is a policy priority.[9] In California, the California Cancer Registry reports that 14.7% of PC patients experience unplanned hospitalizations after index admission.[11] In Ontario, Cancer Care Ontario has reported that 28% of PC-RP patients have UPV (3.2% re-admission and 24.7% ER visits), hence contributing to increased healthcare costs and suboptimal patient outcomes.[9] Patients who undergo RP for PC have the highest rate of ER visits compared to breast, lung and colorectal cancer patients.[9] The intricate causality of re-admissions leads to disagreement about whether re-admissions can be averted, while many studies have shown a connection between successful QI initiatives and reductions in re-admission.[10] Although re-admission rates are a promising quality indicator, data suggests that they alone do not reflect quality of care, and hence policy makers should consider augmenting their use with other measures of hospital quality.[12-15]

Reducing UPVs is dependent on multiple factors, such as medical avoidability, cancer site, and procedure type. In all types of patients, a systematic review of 34 studies reported that the proportion of avoidable re-admission varies, with a median of 27.1%, and a wide range from 5% to 79%.[16] In a cohort of general medicine patients, Auerbach *et al*. found that 26.9% of re-admissions may be avoidable.[17] Comprehensive understanding of the rates, reasons, and predictors of UPV is important for developing effective quality improvement (QI) interventions.

UPV after surgery are morbid for the patients and increase costs for the system, therefore UPV are either avoidable or necessary in healthcare. In this study, we performed a systematic review and meta-analysis to evaluate UPVs following RP. We report the rates, reasons, predictors for UPV, and appraise the interventions used to reduce UPV.

Methods

Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) Statement was used.[18]

Literature search and information sources

MEDLINE (OVID), PubMed (NCBI) and EMBASE (OVID) were searched from January 2000 to December 2020 using a search strategy that combined the keywords “re-admission,” “unplanned visit,” “emergency room visit” and, “radical prostatectomy” (Supp. Table 1) (ANM). Iterative inclusion and exclusion of search terminology was used to encompass the relevant literature. A two-step deduplication process was used with EndNote (v8.0, Clarivate Analytics, Philadelphia, USA), and Systematic Review Assistant-Deduplication Module (SRA-DM) (v2.4.3, Bond University Centre for Research in Evidence-Based Practice, CREBP, Robina, Australia).[19] The last search was performed in Dec 2020.

Eligibility criteria and study selection

English language studies that focused on UPV and RP were included. Outcomes of interest were re-admission or ER visit within 30- or 90-days. Exclusion criteria included: studies that did not report any outcomes of interest, purely cost analyses/economics, other prostatectomy, and molecular/basic science mechanistic/pathogenesis research. The references of systematic and narrative reviews were examined to identify additional studies. Conference abstracts/papers, editorials/letters, commentaries, news articles, opinion pieces, small N<50 case series and case reports were excluded. If studies reported UPV rates, reasons for UPV, predictors of UPV, or interventions that reported any UPV outcomes, they were included (Figure 1). An initial screening of title and abstract was performed, and the full text of potentially eligible studies were reviewed (ANM and JBS) for eligibility (Figure 1).

All studies that passed title/abstract screening underwent full-text review to assess inclusion eligibility (Figure 1). Inclusion/exclusion discrepancies were solved by a third reviewer (ML). Studies that included at least one outcome/variable of interest were included (Figure 1).

Data abstraction and organization

Data abstraction was performed by two independent abstractors (ANM and JBS) using a standardized collection form. Data extracted included: study characteristics, rates, reasons, predictors, and interventions for UPV following RP. Rates of re-admission and ER visit were calculated. Reasons for re-admission and ER visit were compiled in table format. Given that an extremely low proportion of patients have an UPV event (likely <10%) and most reported hazard s/odds/risk ratios are near 1, statistically significant ($p<0.05$) predictors of re-admission were reported as raw effect estimate ratios for later meta-analytic input. Reasons for UPV were grouped into sub-categories and presented in tabular format and summarized by incidence. Any re-admission from all studies was considered to be an UPV, implying direct admission to hospital. Any ER visit from all studies was considered an UPV.

Crude meta-analysis of re-admission predictors

Effect estimates were natural logarithm transformed and entered into Med Calc (v.19.1.1.). Generic inverse variance analysis was conducted for predictors with >1 reporting study (Supp. Fig. 1).[20] Forest and funnel plots and meta-analytic outputs were summarized in figures. Other non-groupable predictors are illustrated as a crude forest plot.

Meta-analysis of UPV interventions

Any interventional (case-control) study that reported any UPV outcome data (primary or otherwise, all endpoints) were included in the meta-analysis. Meta-analysis was conducted using the Mantel-Haenszel method in Rev man (v.5.4.1.), using both fixed and random effects models. Heterogeneity and publication bias were approximated; forest and funnel plots were generated. Rev man tools were used to complete the risk of bias analysis. $P<0.05$ was considered statistically significant in all analyses.

Results

Study characteristics (100% reporting)

After removal of duplicates, 998 records underwent title and abstract screening (Fig. 1). One hundred and sixteen full text studies were assessed, 60 met inclusion criteria (Fig. 1; Table 1).[21-80] Thirty-five studies were from the USA, 14 from Europe, 4 from Canada, 3 from Asia, and the rest from other continents (Table 1).[21-80] The included studies were published between 2004-20 (Table 1).[21-80] Thirty-four studies were from single centers, while the rest were either state/province-level, or used multi-center administrative databases (e.g. NSQIP, OHIP and SEER etc.) (Table 1).[21-80] In terms of surgical approach, 50% underwent MIRP (including 36.0% RARP), 29% underwent open procedures, and 21% were unspecified RPs.

Rates of UPV after RP (78% reporting)
The data of 406,107 patients who underwent RP is presented in table 1. All 60 studies reported an ER/ED visit and/or re-admission rate, at time frames ranging from 14-days to five-years or unknown endpoints (Table 1).[10-60] A total of 16,028 (~5%) UPV (30- or 90-day) events were captured through our analysis of 317,050 RP patients. The 30-day and 90-day ER visit rates were 11.7% (463/3,955; n=4 studies) and 14.0% (1,131/8,054; n=3 studies), respectively. The 30-day and 90-day re-admission rates were 3.6% (8,520/238,973; n=28 studies) and 8.9% (5,914/66,068; n=13 studies), respectively. Only studies that reported 30- or 90-day UPV rates were included in the aggregate rate analysis, and as a result 89,057 (~22%) RPs were excluded.

Reasons for UPV after RP (28% reporting)
Only ~28% of total RP patients reported specific reasons/causes of UPV (N=113,017 patients; N=24 studies; Table 2). All studies reported on re-admissions, and four studies reported on ER visits (Table 2). 55% of all re-admissions after RP are directly due to post-operative complications related to GU such as strictures, obstructions, fistula, bladder-related, renal problems, and other unspecified urinary complications (8,187/93,515, 8.8%). The next most common reasons for re-admission, in decreasing incidence, anastomosis-related (stricture, leak, sclerosis; 1,593/21,728, 7.3%), infection-related (abscess, UTI, epididymitis, cellulitis, orchitis, sepsis; 1,247/61,524, 2.0%), cardiovascular/pulmonary events (1,243/52,778, 2.4%), and wound-related issues (dehiscence, disruption, infection; 1,048/26,952, 3.9%) (Table 2). 34% of all ER visits after RP are directly due to urine-related issues such as retention, urinoma, obstruction, leak, and catheter problems (291/6,563, 4.4%). The next common reasons for ER visits are, in decreasing incidence, abdominal/GI issues (abdominal pain, ileus, hernia, constipation, jaundice, lymphoceles, unspecified GI issues; 157/6,563, 2.4%), infection-related (abscess, UTI, epididymitis, cellulitis, orchitis, sepsis; 155/6,563, 2.4%), venous thromboembolic events (VTE; 131/5,595, 2.3%), and wound-related (dehiscence, disruption, infection; 68/6,563, 1.0%) (Table 2). Many re-admissions appear to be medically unavoidable, while ER visits have more opportunity for volume reduction by QI. Here we highlight key groups of complaints, issues, and complications which have potential for QI targeting.

Predictors of UPV after RP (56% reporting)
Twelve of 60 studies reported predictors of re-admission after RP (N=229,399 [56%] patients; Supp. Fig 1; Supp. Table 2), and 98% of these patients are reported from national cancer/administrative databases. Statistically significant ($p<0.05$) predictors of re-admission after RP included: pre/post-op patient demographics and comorbidities, social/economic features, hospital or surgeon case volume, and surgical approach (Supp. Fig 1; Supp. Table 2).

Most studies have found that minimally invasive radical prostatectomy (MIRP), most commonly robot-assisted RP (RARP), predict lower odds of re-admission over open RP (ORP) (Supp. Table 2). However, in aggregate analysis of effect estimates, it was found that RARP has a non-significant positive effect on re-admission, with low study heterogeneity but high publication bias (Supp. Fig. 1a-b). Furthermore, ASA≥3 has a non-significant negative effect on re-admission, with low study heterogeneity but high publication bias (Supp. Fig, 1c-d). Finally, CCI≥2 (i.e., presence of comorbidities) has a significant negative effect on re-admission with low study heterogeneity but high publication bias (Supp. Fig, 1e-f).

Socioeconomic determinants of health (SDH), such as race and economic deprivation, have a significant negative effect on re-admission and ER visit,[66,67,80] with low study heterogeneity but high publication bias (Supp. Fig. 1g-h). Likewise, lymph node dissection (LND) has a significant negative effect on re-admission, with low study heterogeneity but high publication bias (Supp. Fig. 1i-j). Whereas adverse markers of tumor pathology (such as AJCC T3, Gleason score >8 etc.) have a significant negative effect on re-admission, but this result is attributed with high study heterogeneity and high publication bias.

A large variety of pre/post-operative patient characteristics have been associated with significantly increased odds of re-admission (Supp. Table 2; Supp. Fig. 1m). Preoperative factors associated with increased re-admission included: mental disorders, cardiopulmonary diseases, older age, and high BMI >35 (Supp. Table 2; Supp. Fig. 1m). On the other hand, high surgeon (>18/y) or hospital case volume (≥46/y, ≥150/y), through a minimally invasive approach, have been associated with significantly decreased odds of re-admission (Supp. Table 2; Supp. Fig. 1m). Other factors that predict higher re-admission include: age>70y, LoS>3d, high operative time >251mins, and the presence of post-operative complications (Supp. Table 2; Supp. Fig. 1m).

In this crude meta-analysis of effect estimates, publication bias was high, and hence these predictors should also be interpreted individually (Supp. Table 2), and within healthcare system contexts, when formulating QI initiatives to reduce UPV. For example, using these predictors as risk stratification indicators can help focus clinical attention on those patients that are at the most risk of UPV, hence potentially improving healthcare quality.

Interventions that reduce UPV after RP: meta-analysis and narrative summary (1% reporting)
4,154 (~1%) RP patients were included in the interventions analysis. A 3.4% average reduction in UPV rate is achievable as an effect of the ten evaluated interventions, highlighting a ~2-fold

average decrease in UPV rate (intervention UPV rate =4.85%; control UPV rate =9.45%) (Fig. 2c-d). Tested interventions significantly lowered UPV rate as compared to paired control groups per study (Mean of differences=3.39% [95% CI: 0.01-6.69%], p=0.0455, pairing effectiveness, p<0.0001) (Fig. 2c-d).

Meta-analysis of these ten studies showed an overall effect estimate of 0.62 [95% CI: 0.46-0.84] (FE: p=0.002; RE: p=0.008), favoring interventions over controls (Fig. 3a). There was no detection of heterogeneity (Q=7.3017, p=0.6057; I^2=0.00% [0-53.86%]) or publication bias (Egger's p=0.6315; Begg's p=0.4208) (Fig. 2a-b). The overall low quality of the included studies resulted in a high risk of bias (Fig. 2a). Re-admission or ER visit are reported as only secondary outcomes in these studies, and therefore more studies that focus primary outcomes on UPV are needed to draw more precise conclusions.

Ten of 60 studies tested interventions,[21-23,29,32,37,42,45,51,76] such as standardized care pathways, ERAS and fast-track surgery (FTS), and medical/surgical alterations of clinical course (Table 3). Care pathway-like standardized nursing plans and patient education programs did demonstrate only a slight reduction in re-admission and ER visit (Table 3).[21] Likewise, home health care services increased ER visit at 16-days (p<0.01), but appeared to be effective for lowering re-admission (p=0.06) (Table 3).[37] In a short-stay ambulatory extended recovery program aimed at reducing length of stay, drain management lessons, web-based interactive classes, and printed materials did not change re-admission and ER visit after RP (Table 3).[51]

However, other support systems with ready-access to healthcare personnel are shown to be more effective.[23,29,76] In Australia, Birch *et al*. have demonstrated that a 10-step nurse-led "Robocare" pathway for RARP is effective at reducing re-admission (no statistics reported; Table 3).[23] A specialist nurse that is closely involved with patient care at every step, with a long-term follow-up phone clinic, and pre/post-operative education were shown to be effective components of "Robocare" (Table 4), in terms of patient satisfaction surveys.[23] Similarly, a pilot study from Canada by Flannigan *et al*. demonstrated significantly lowered UPV (131/321 vs. 20/115, p=0.02), using a nurse-centered standardized follow-up program which focused on catheter-, staple- and drain-related management issues (Table 4).[29] Another key element in this study was that RP patients had telephone access to the nurse for inquiries, who was able to quickly solve minor issues without a need for UPV (Table 4).[29]

A standardized care pathway, from Turini *et al*., illustrated that a 75% re-admission reduction (with no significant changes in ER visit) is possible using their component methodologies, with excellent patient satisfaction levels (Table 3).[76] Some of the components of their pathway included: explicit preoperative instruction, preoperative pelvic floor rehabilitation, intraoperative opium suppository, postoperative MIRP coordinator visit to answer questions without delay, complete Foley catheter instructions, stool softener, and follow-up phone call.[76] A fast-track surgery (FTS) program in LRP found no effect on re-admission.[32] Finally, Lin and colleagues report that an ERAS program after LRP has significant benefits for short-term outcomes, while having no effect on re-admission rates.[45]

Discussion

In this comprehensive systematic review and meta-analysis, we found that the UPV visit rate was 3.6% for re-admission and 11.7% for ER visit at 30 days after RP. 55% of all re-admissions after RP are directly due to post-operative complications related to GU such as strictures, obstructions, fistula, bladder-related, renal problems, and other unspecified urinary complications. 34% of all ER visits after RP are directly due to urine-related issues such as retention, urinoma, obstruction, leak, and catheter problems. Other common reasons for UPV are infection-related (abscess, UTI, epididymitis, cellulitis, orchitis, sepsis) and wound-related issues (dehiscence, disruption, infection). Intervention studies performed to reduce UPV included: care pathways, ERAS/FTS, discharge planning nursing interventions, medical/surgical interventions, and patient education, among others. All things considered, a multidisciplinary, nurse-centered, intervention seems most likely to be effective at reducing UPV after RP to improve outcomes.

Patients return to hospital due to urinary catheter, wound- or drain-related reasons (Table 2). This study reports the most common reasons and hence helps shed light onto the questions around UPV preventability. Of note there are several risk factors for re-admission including lower socioeconomic status, black race, low surgeon, and hospital case volume (Supp. Table 2; Supp. Fig. 1). Consistently, studies found that robotic RP is associated with lower odds of re-admission (Supp. Table 2). Although, regional and national healthcare system infrastructure does not support RARP in many parts of the world. It has been suggested that using these factors for prospective stratification of high-risk patients can aid in tailoring length of stay and targeting QI interventions.[81-83] No single intervention alone is able to significantly reduce UPV rate (except Flannigan *et al*. and Turini *et al*.),[29,76] however their collective effect has potential for greater significance (Table 3; Fig. 2). Our meta-analysis suggests that intervention groups are better than control groups, in terms of UPV rate, by average ~2-fold. Importantly, nurse-centered, patient education programs that promote self-care while allowing healthcare staff access are proven to be more effective at reducing re-admission and ER visit after RP, rather than information-heavy, algorithmic care pathways aimed at early discharge (Table 3). Furthermore, Ploussard *et al*. illustrate that ERAS and prehabilitation pathways, in synergy, can result in improved short-term surgical outcomes and reduced costs after RARP, without an increase in re-admission rate.[62] The consideration of longer time-scales of medical attention (i.e., extended follow-up and pre-operative prehabilitation) should not be excluded in designing QI initiatives, and hence the primacy of one dedicated staff responsible for addressing minor complications before patients require re-admission is central.

Despite the widespread efficacy of ERAS/FTS programs after RP for PC, the programs usually have positive effects on short-term post-op outcomes, such as shorter flatulating/defecation time, shorter time to drain removal, while having no effect on re-admission rate or blood loss.[84,85] A meta-analysis from Lv *et al*. showed that ERAS/FTS had a non-significant effect on the re-admission rate outcome, hence favoring conventional care.[84] Further tailoring and extension of ERAS/FTS programs, using the synthesis herein, can potentially help for longer-term outcomes, such as UPV. Given that the presence of multiple complications and a short length of stay are associated with postoperative re-admissions,[82] and that home health care increases ER visit rate,[37] there is legible value in interventions that focus on specific groups of re-admission reasons, such as catheter problems, DVT and bleeding such as those by Afzal *et al*. and Kubota *et al*.[22,42] Given that LND during RP can increase the rates of DVT/PE events,[77] particular attention is warranted in this subset of RP patients. Older and more comorbid patients have higher risk of major complications after RP; our study finds that GU complications make up the majority of re-admissions, and thus preoperative assessment strategies are crucial.[86] In this manner, the exact timing of post-RP complications becomes valuable knowledge.[87] Merhe *et al*. report the timing of surgical complications after RP, and note that they occur in this approximate order: bleeding/transfusion on the same day, pneumonia and renal complications at 4 days, cardiac arrest at 5 days, DVT at 11 days, and sepsis at 12 days.[87] Minor complications, such as UTIs (15d) and wound infections (16d) occur later.[87] Given that 55% of all re-admissions and 36% of all ER visits are due to GU-related complications/issues, and that 46% of complications occur after index discharge,[87] and that post-discharge complications are predictive of re-admission (OR 16.40, $P < 0.001$),[87] QI initiatives should focus on post-discharge (rather than pre-discharge) interventions. Finally, during a global pandemic (COVID-19), healthcare systems are highly strained, and access to care can be lowered; hence, overnight stays or same-day discharge for RARP (and other MIRP) are considered to be safe.[40,50,54]

Other systematic reviews have addressed the effectiveness of interventions at reducing UPV in other disease sites and procedures.[88-90] A descriptive systematic review of 43 studies, reporting 30-day UPV reduction, by Hansen *et al*., ultimately found that no single intervention applied in isolation was correlated with a significant drop in 30-day UPV risk (similar to our findings).[89] However, Hansen *et al*. constructed an accurate taxonomy for the types of interventions for UPV: pre-discharge, post-discharge and bridging interventions.[89] Applying a similar taxonomy, Leppin *et al*. performed a meta-analysis of 42 trials that tested initiatives preventing re-admission and found an overall reduced relative risk of 0.82 [95% CI: 0.73-0.91, $p<0.001$, $I^2=31\%$].[90] Interestingly, pre-2002 studies were 1.6x more effective at reducing re-admission than those published later ($p=0.01$).[90] Interventions with multiple complex components [1.4x, $p=0.001$], with more healthcare personnel involved in management [1.3x, $p=0.05$], and facilitating patient self-care [1.3x, $p=0.04$] were significantly more effective than others.[90] More recently, a comprehensive meta-analysis of 47 studies by Braet *et al*. found an overall relative risk reduction for re-admission [RR: 0.77 (95% CI: 0.70-0.84), $p<0.00001$, $I^2=34\%$], ER visit [RR: 0.75 (95% CI: 0.55-1.01), $p=0.06$] and even mortality [RR: 0.70 (95%

CI: 0.48-1.01), p=0.06].[88] Interventions beginning during the index hospitalization and continuing post-discharge were much more effective (p=0.01), yet contrary to Leppin *et al*., interventions with multiple components were no more effective than simpler single component interventions (p=0.54).[88,90]

A study by Gani *et al*. aimed to quantify 30-day re-admission variability that could be ascribed to patient-, surgeon- and specialty-level factors in order to elucidate patterns of possible preventability.[91] A marginal proportion of the variability in re-admission was due to surgeon- (2.8%) and specialty-level (14.5%) factors, whereas the vast majority was due to patient-related factors (82.8%).[91] Despite the importance of natural disease pathology, prognosis and procedure, social factors are important. As a result, developing strategies to reduce UPV may need to address the social factors that contribute to UPV (Supp. Table 2; Supp. Fig 1). Other factors such as post-operative complications, pre-operative comorbidities, ASA class and length of stay are also important (Supp. Table 2; Supp. Fig 1).[81-83] Whereas socioeconomic, volume and surgical approach factors can help stratify patients before index surgery, pre-op and post-op characteristics can aid in tailoring clinical courses towards ideal in-hospital stays.

Similar to our findings, interventions focusing on patient self-care were more effective than any others (p=0.02).[88] Our data suggests comparable findings to these previous systematic reviews. Studies focusing on patient empowerment, self-care facilitation, starting interventions early, tailoring the post-operative course per patient complexity, nurse-centered, and access to immediate troubleshooting via telephone were effective at reducing re-admission (Table 3). Minor complications (e.g., abdominal/GI issues, infection-related, VTE events) seem to be more likely ER visits, whereas major complications (e.g., GU-related complications, anastomosis-related, cardiovascular/pulmonary events) are more likely to result in re-admission (Table 2); therefore, a QI initiative applies mainly to more minor issues. It must also be noted that some re-admissions and ER visits are unavoidable and inevitable, but through the data herein, clinicians may gain a comprehensive picture to consider QI.

Our study has its limitations, stemming mainly from the fact that no RCTs were included, because no RCTs were available. Not all our included studies reported data for all our variables/outcomes of interest, which limited the quantitative depth of our examination. Furthermore, our study aims to serve as a guideline for clinicians planning post-surgical courses to improve quality of patient care, and therefore it is important not to overstate our findings past their collected context: RP for PC. Next, our meta-analysis also has some missing data, that is explained in Figure 2. Additionally, there were some methodological differences between the included studies that limited our full comprehension of the literature, although our narrative summaries help compensate. Furthermore, there is uncontrollable overlap and potential double-counting of RP patients given that many of the included studies utilized national databases. Finally, our meta-analysis should be interpreted with a grain of salt considering the variability of

UPV endpoints and high risk of bias. Further RCTs are required to help establish whether or not the interventional recommendations noted herein are valid in the overall RP patient population.

Some potential clinically-relevant strategies may include diversion from the ER and earlier re-admission of major issues; whereas minor wound infections should likely not come to the ER. Drain-, wound-, catheter-management has potential to also help reduce UPV after RP. Targeting minor post-discharge complications, while focusing on 30-day re-admission outcomes, with a comprehensive QI initiative, has potential to tackle UPVs. Evidence from our systematic review illustrates the importance of focusing clinical questions to specific disease sites and interventions, especially when assessing QI initiatives to bring about large-scale surgical quality changes in the healthcare system. Our study shows that there are some unavoidable UPVs, and different strategies can be used for different types of issues. Reducing re-admission and ER visit rates after RP can improve quality of care. Our study reports the UPV visit rates following RP and identifies the most common reasons for UPV after RP. Furthermore, we report potential stratification parameters and the efficacy of published interventions in this patient population. An understanding of the patients at risk for UPV and reasons for UPV can help inform the development of novel intervention strategies to tackle this healthcare burden.

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Figures and Tables

Fig. 1. PRISMA flow diagram and radical prostatectomy (RP) patient breakdown.
*Inclusion/exclusion criteria are highlighted in methods section.

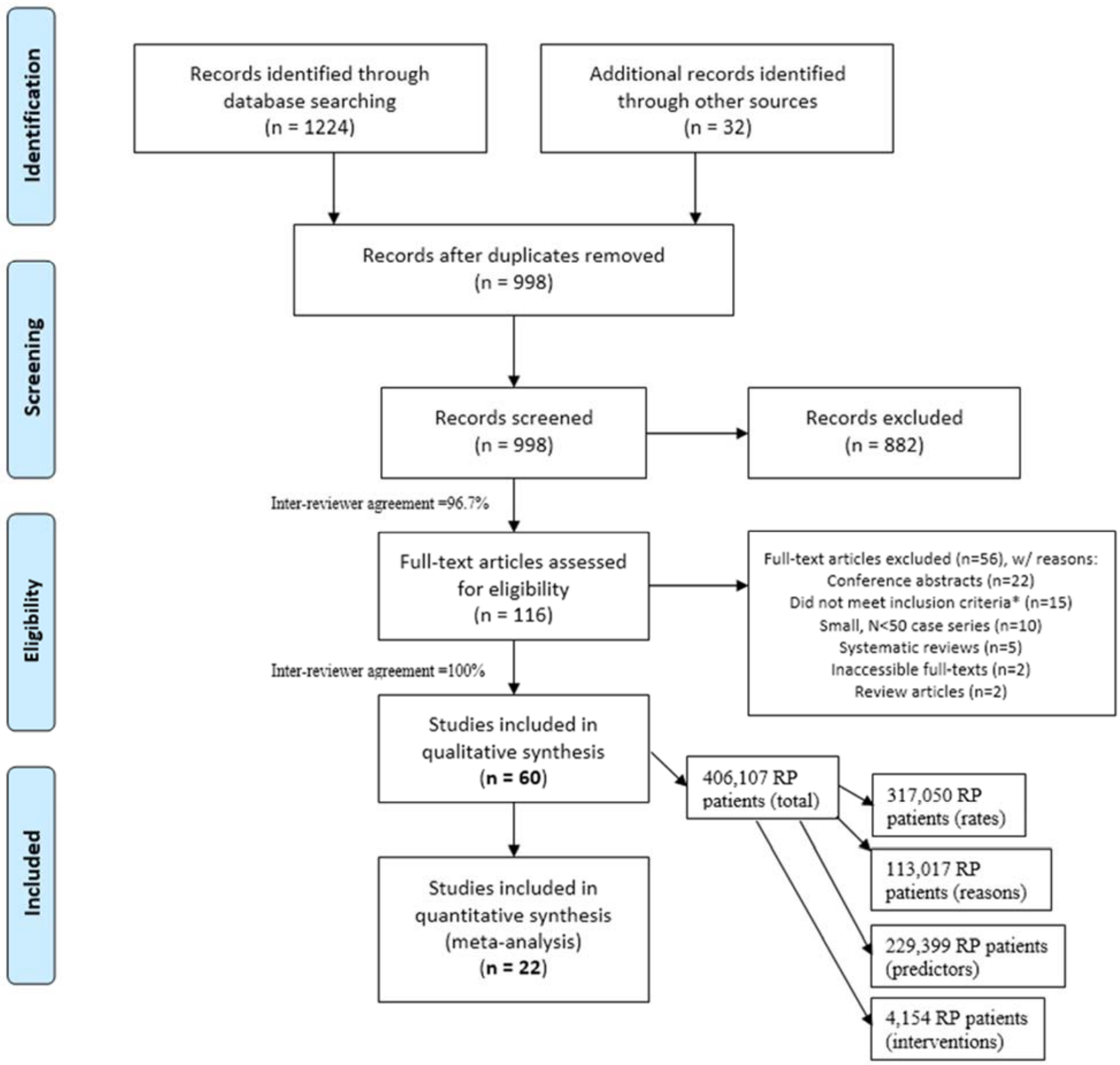

Fig. 2. Meta-analysis of interventions to reduce (all-cause/endpoint) unplanned visits after radical prostatectomy (RP) (n=10 studies). The overall effect favored the interventions at reducing unplanned visits in this meta-analysis as shown by the ***(a)*** forest and ***(b)*** funnel plots. The overall effect estimate of the ten tested interventions was 0.62 (95% confidence interval [CI] 0.46–0.84) (FE: p=0.002; RE: p=0.008) for the unplanned visit (re-admission *or* emergency room [ER] visit) event outcome. There was no detection of heterogeneity (Q=7.3017, p=0.6057; I^2=0.00% [0–53.86%]) or publication bias (Egger's p=0.6315; Begg's p=0.4208). The overall low quality of the included studies resulted in a high risk of bias; risk of bias is outlined in the right of the forest plot. All plots were generated using RevMan (v.5.4.1) and testing of publication bias was conducted using MedCalc (v.19.1.1). *The Birch et al 2016 study did not have a control group, so we used back calculation — while matching their intervention group sample size of n=124 — through the overall 90-day RDM rate for all RP patients, to calculate a hypothetical one. **The Kubota et al 2020 study compared four different groups of patients, and mainly focused on bleeding outcomes and perhaps as a result did not consider re-admission as a primary outcome. ***Re-admission or ER visit were reported as secondary outcomes of interest in most studies. ***(c)*** Unplanned visits (UPV) rates were calculated for all case-control studies as dichotomous event outcomes. Line plots were generated, and rates summarized in the table below the line graph. ***(d)*** Paired t-test shows that the intervention group had a significantly lower UPV rate than their paired controls. Mean of differences=3.39% (95% CI 0.01–6.69%), p=0.0455, pairing effectiveness, p<0.0001.

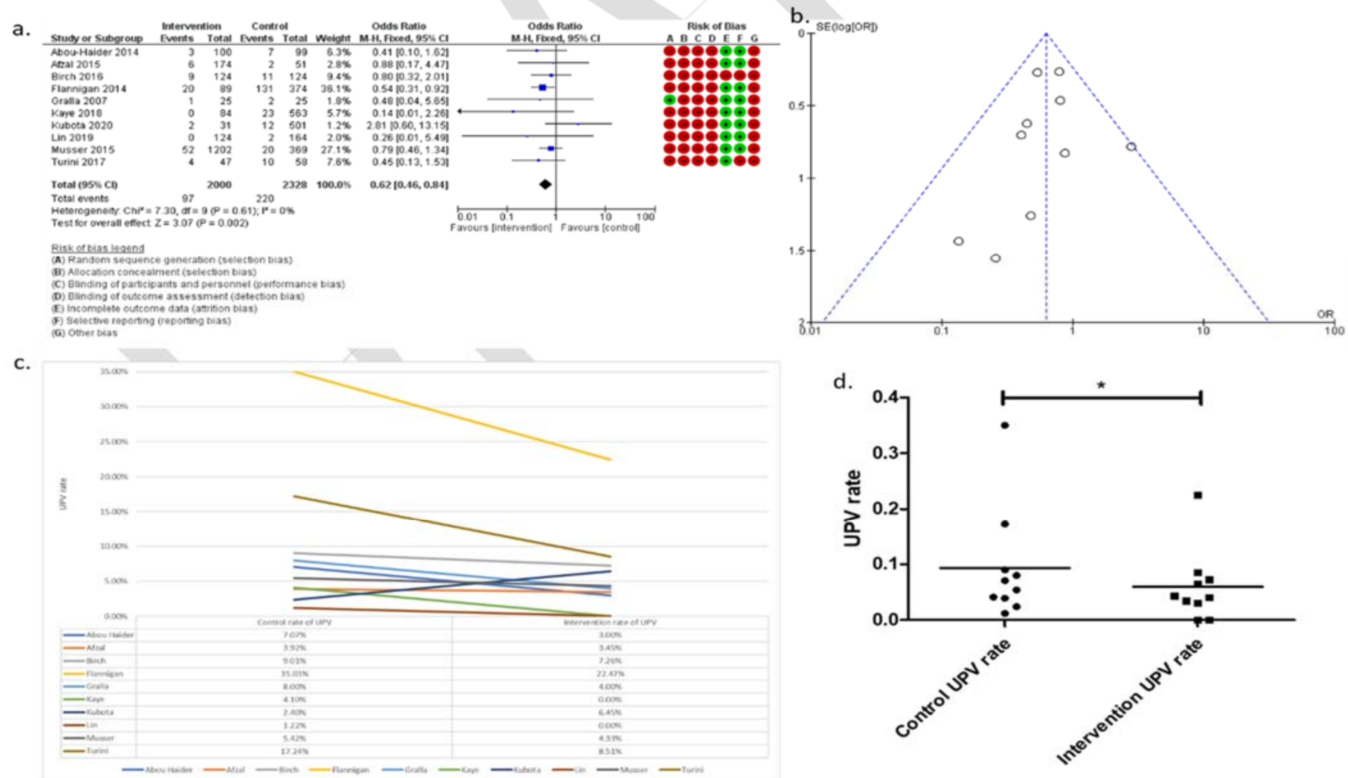

Table 1. Data sources, sample sizes, and unplanned visit rates in radical prostatectomy patients (n=60 studies)

Author & year	Data source and/or scope (country)	Total RP sample size (n)	Sample sizes by surgical approaches (n)	Re-admission rate (events/total, rate [%], endpoint)	Emergency room Visit rate (events/total, rate [%], endpoint)
Abou-Haidar 2014	Single-center (Canada)	199	RRP (73) LRP (35) RARP (91)	10/199 (5.03%) 90-day	24/199 (12.06%) 90-day
Afzal 2015	Single-center (U.S.)	225	RARP (225)	8/225 (3.56%) 30-day	29/225 (12.89%) 30-day
Birch 2016	Single-center (Australia)	124	RARP (124)	9/124 (7.23%)* Unknown endpoint	–
Brito 2018	ACS-NSQIP Database (U.S.)	29,012	RARP (29,012)	860/X (3.8%) 30-day	–
Chang 2005	Single-center (U.S.A)	994	RRP (994)	X/994 (3.0%) 30-day	–
Christensen 2016	Single-center (U.S.)	200	RARP (200)	7/200 (3.50%)* Unknown endpoint	–
Chung 2012	National Health Insurance	2741	RRP (1173) RARP (274)	257/2741 (9.34%) 90-day	–

	Research Database (Taiwan)		LRP (694)		
Coelho 2018	Single-center (Brazil)	1011	RRP (1011)	28/1011 (2.7%) 28-day	74/1011 (7.3%) Unknown endpoint
Flannigan 2014	Single-center (Canada)	436	RRP (274) LRP (47) ORP (115)	15/321 (4.67%) 90-day	77/321 (23.99%) 90-day
Friðriksson 2014	Prostate Cancer Database Sweden (Sweden)	24 122	RRP (16 375) RARP (6393) LRP (1354)	2,317/24 122 (9.61%) 90-day	–
Gandaglia 2014	SEER Database (U.S.)	5915	ORP (2357) RARP (3429)	230/5915 (3.89%) 30-day 334/5915 (5.65%) 90-day	–
Gralla 2007	Single-center (Germany)	50	LRP (50)	3/50 (6.00%) Unknown endpoint	–
Hall 2014	Single-center (Australia)	200	ORP (100) RARP (100)	21/200 (10.50%)* Unknown endpoint	–
Huang 2014	SEER Database (U.S.)	7534	RRP (4720) RPP (324)	554/7534 (7.35%) 90-day	1,030/7534 (13.67%) 90-day

			MIRP (2490)		
Judge 2007	Hospital Episode Statistics database (U.K.)	18 027	RP (18 027)	2,964/14,590 (20.32%)* 1-year	–
Kaufman 2006	Single-center (USA)	379	RRP (183) RARP (196)	10/262 (3.82%) 30-day	–
Kaye 2018	Statewide, MUSIC (U.S.)	647	RARP (647)	X/647 (4%)* 16-day	X/647 (22.4%)* 16-day
Kelly 2013	Irish Cancer Registry (Ireland)	2411	RP (2411)	854/1,535 (55.64%) 28-day	–
Kim 2015	IMS LifeLink Health Plan Claims Database (U.S.)	17 610	MIRP (8981) ORP (8629)	X/17,610 (10.5%) 90-day	–
Kotomari 2020	Single-center (U.S.)	613	RARP (613)	21/613 (3.43%) 30-day	–
Ku 2008	ACS-NSQIP Database (U.S.)	5736	RRP (5736)	133/5,736 (2.32%)* 14-day	–
Kubota 2020	Single-center (Japan)	606	RARP (606)	16/6060 (2.64%) Unknown endpoint	–

Lasser 2010	Single-center (U.S.)	239	RARP (239)	1/239 (0.42%) 30-day	–
Lenfant 2020	Single-center (U.S.)	210	RARP (210)	15/210 (7.14%) 30-day	–
Lin 2019	Single-center (China)	288	LRP (288)	2/288 (0.69%) 90-day	–
Link 2008	Single-center (U.S.)	1847	RARP (1847)	46/1,847 (2.49%)* Unknown endpoint	–
Lundstrom 2016	Prostate Cancer Database Sweden (Sweden)	17 043	RRP (9787) RARP (7256)	97/17,043 (0.57%) 30-day	–
Morgan 2016	Single-center (U.S.)	159	RARP (159)	0/159 (0.00%)* Unknown endpoint	10/159 (6.29%)* Unknown endpoint
Moschini 2017	Single-center (Italy)	1402	RARP (1402)	38/1,402 (2.71%) 30-day	–
Moschovas 2020	Single-center (U.S.)	147	RARP (147)	2/147 (1.36%) Unknown endpoint	–
Musser 2015	Single-center (U.S.)	1571	RARP (1191) LRP (380)	72/1,571 (4.58%) 30-day	178/1571 (11.33%) 30-day

Myers 2016	Statewide, MUSIC (U.S.)	2,245	ORP (92) MIRP (2153)	92/2,245 (4.10%) 30-day	–
Nam 2014	OHIP (Canada)	15 870	ORP (15 870)	2,749/15 870 (17.32%)* 5-year	–
Nason 2020	Single-center (Canada)	581	ORP (581)	22/581 (3.79%) 30-day 43/581 (7.40%) 90-day	46/581 (7.92%) Unknown endpoint
Nelson 2007	Single-center (U.S.)	1003	RRP (374) RARP (629)	63/1003 (6.28%)* Unknown endpoint	100/1003 (9.97%)* Unknown endpoint
Niklas 2016	Single-center (Germany)	1431	RRP (499) RARP (932)	224/1431 (15.65%) 30-day	–
Paterson 2016	Single-center (Scotland)	200	LRP (200)	18/200 (9.00%) 90-day	–
Pearce 2016	National Cancer Database (U.S.)	96 935	ORP (23 804) RARP (73 131)	2,875/96 935 (2.97%) 30-day	–
Pereira 2018	ACS-NSQIP (U.S.)	35 968	RP (35 968)	1,439/35 968 (4.00%) 30-day	–
Pilecki 2014	ACS-NSQIP (U.S.)	5471	RRP (1097) RARP (4374)	212/5471 (3.87%) 30-day	–

Pinochet 2010	Single-center (U.S.)	729	MIRP (729)	54/729 (7.41%) 30-day	106/729 (14.54%) 30-day
Ploussard 2020a	Single-center (France)	507	RARP (507)	X/507 (7.9%) 90-day	–
Ploussard 2020b	Multicenter (France)	358	RARP (358)	10/358 (2.79%) 30-day	–
Rabbani 2010	Single-center (U.S.)	4592	RRP (3458) MIRP (1134)	*240/4592 (5.23%) Unknown endpoint	*652/4592 (14.20%) Unknown endpoint
Ruhotina 2014	ACS-NSQIP (U.S.)	5459	MIRP (5459)	55/1467 (3.75%) 30-day	–
Schmid 2016a	ACS-NSQIP (U.S.)	5428	ORP (1204) MIRP (4224)	221/5428 (4.07%) 30-day	–
Schmid 2016b	SEER-Medicare Database (U.S.)	26 482	RP (26 482)	–	–
Schommer 2016	Single-center (U.S.)	372	RARP (372)	14/372 (3.76%) 30-day	–
Seveso 2017	Single-center (Italy)	800	RARP (800)	9/800 (0.11%) 30-day	–
Sood 2017	ACS-NSQIP (USA)	10 802	ORP (5401) MIRP (5401)	360/8028 (4.45%) 30-day	–

Sujenthiran 2017	Hospital Episode Statistics (U.K.)	17 299	LRP (5479) ORP (6873) RARP (4949)	*2695/17 299 (15.58%) 2-year	–
Thiel 2012	Single-center (U.S.)	100	RARP (100)	*5/100 (5.00%) Unknown endpoint	–
Thiel 2013	Single-center (U.S.)	100	RARP (100)	*0/100 (0%) 14-day	–
Tollefson 2011	Single-center (U.S.)	5908	RRP (4824) RARP (1084)	*11/5908 (0.19%) Unknown endpoint	–
Touijer 2008	Single-center (U.S.)	1430	RRP (818) LRP (612)	30/1162 (2.58%) 30-day	150/1,430 (10.49%) 30-day
Turini 2017	Single-center (U.S.)	105	RARP (105)	–	*14/105 (13.33%) Unknown endpoint
Tyritzis 2015	Multicenter, LAPRO (Sweden)	3544	ORP (863) RARP (2681)	255/3544 (7.20%) 90-day	–
Wallerstedt 2015	Multicenter (Sweden)	2625	RRP (778) RARP (1847)	220/2506 (8.78%) 90-day	–
Xia 2018	ACS-NSQIP (U.S.)	18 065	MIRP (18 065)	639/18 065 (3.56%) 30-day	–

The collective data of 406 107 RP patients is summarized here; 50.3% underwent MIRP (including 36.0% RARP), 28.9% underwent open procedures, and 20.8% were unspecified RP. *Irregular rate values due to unusual (not 30-day or 90-day) or unknown UPV endpoints. X indicates values which were not available from the reference study. LRP: laparoscopic radical prostatectomy; MIRP: minimally invasive radical prostatectomy; ORP: open radical prostatectomy; RARP: robot assisted radical prostatectomy; RPP: radical perineal prostatectomy; RRP: radical retropubic prostatectomy; UPV: unplanned visit.

Table 2. Reasons for unplanned visits in radical prostatectomy patients (n=24 studies)[21,23,29,30,35-37,43,44,47,49-55,57,64,66,71,73,77,78]								
UPV category	**Re-admission events**	**Total RPs**	**% of total re-admissions**	**% of total RPs**	**ER visit events**	**Total RPs**	**% of total ER visits**	**% of total RPs**
GU-related complications and issues[29,30,35,36,44,49,51,53,57,64,66,71,77,78]	8187	93 515	55.29%	8.75%	310	6563	36.34%	4.72%
Bladder-related complications (stricture, stones, rupture, stenosis)	765	31 631	5.17%	2.42%	–	–	–	–
Renal problems (insufficiency, failure)	46	17 441	0.31%	0.26%	–	–	–	–
Urinary/urine-related issues (incontinence, leak, retention, urinoma, obstruction, unspecified urinary complications)	2239	45 024	15.12%	11.41%	291	6563	34.11%	4.43%
Other unspecified GU complications	5137	64 219	34.69%	8.00%	19	4592	2.23%	0.41%
Anastomosis-related (stricture, leak, sclerosis)[29,49,57,71,78]	1593	21 728	10.76%	7.33%	–	–	–	–
Infection-related (abscess, UTI, epididymitis, cellulitis, orchitis, sepsis)[21,29,30,36,37,44,49,51,53,55,64,66,73,77,78]	1247	61 524	8.42%	2.03%	155	6563	18.17%	2.36%
Cardiovascular/pulmonary events[30,35,36,49,51,66,77,78]	1243	52 778	8.39%	2.36%	5	647	0.59%	0.77%
Wound-related (dehiscence, disruption, infection)[29,35,64,66,78]	1048	26 952	7.08%	3.89%	68	6563	7.97%	1.04%

Bleeding-related (hematoma, hematuria, hemorrhage, unspecified GI/GU bleeding)[21,29,30,43,49,51,53,55,66,73,78]	468	52 761	3.16%	0.89%	25	968	2.93%	2.58%
Other[21,23,30,37,49,51,55,66,77,78]	435	40 382	2.94%	1.08%	2	647	0.23%	0.31%
Abdominal/GI (abdominal pains, ileus, hernia, constipation, jaundice, lymphoceles, unspecified GI issues)[21,29,37,44,47,49-54,64,66,73,78]	368	53 284	2.49%	0.69%	157	6563	18.41%	2.39%
Venous thromboembolic events[30,35-37,44,51,55,64,66,78]	218	30 647	1.47%	0.71%	131	5595	15.36%	2.34%
Totals	**14 807**	**113 017**	**100%**	**13.0%**	**853**	**6563**	**100.00%**	**13.0%**

ER: emergency room; GI: gastrointestinal; GU: genitourinary; RP: radical prostatectomy; UPV: unplanned visits; UTI: urinary tract infection.

Table 3. Efficacy of interventions at reducing unplanned visits after radical prostatectomy

Description of intervention	Components of intervention	Efficacy measures	Conclusions	n	Ref.
Multidisciplinary, consensus-based enhanced recovery after RP in Canada	– Patient education – Standard medical orders – Customized nursing plan for the preoperative visit and each day of hospital stay (target=2 days)	– 12 ER visit both before and after pathway, no change – No differences in re-admission rates between groups either	– Median LoS significantly reduced – Complication and re-admission rates did not increase – No direct effect on UPV	200	Abou-Haider 2014
Surgical modification of technique for catheter placement in RARP	– Suprapubic catheter placement (SPC) using trocar with diagrams	– Significant reduction in catheter-related problems after RP (p=0.03) – 6/174 (3.45%) readmitted in urethral catheter (UC) group, and 2/51 (3.92%) in SPC group (p=0.45)	– SPC is safe and results in fewer catheter-related complications – No direct effect on UPV	225	Afzal 2015
Nurse-led RARP Care Pathway, "Robocare" with 10-steps in Australia	– The 10-step pathway is shown in Fig. 1 – A recurrent theme involves a specialist nurse that is constantly involved	– 29 issues of deviance from standard care were detected by phone clinic	– Study does not have a control group but does report a re-admission rate of 7.3%, which is lower than the literature average of ~9%	124	Birch 2016

	with patient care at every step	– Nine patients required re-admission and attention from urologist	– No direct effect of UPV – Effective at reducing re-admission rates		
RN standardized follow-up and dedicated post-op care after RP	– RN was "on-call" to assess and solve most patient issues to prevent re-admission	– 131/321 (usual care) vs. 20/115 (pilot RN) were readmitted after RP (p=0.02)	– Significantly less re-admission in the pilot program – Has direct effect on UPV – Effective at reducing re-admission and ER visit rates	321	Flannigan 2014
Home healthcare after RP in U.S. RN provided home-based care after surgery	– Home healthcare. Nothing described fully	– Patients with home care had higher ER visit (15.5% vs 6.9%, p<0.01) – Similar rates of catheter duration for >16 days (3.6% vs 3.0%, p=0.79) and need for catheter replacement (1.2% vs 2.5%, p=0.46) – Trend toward decreased re-admission (0% vs 4.1%, p=0.06)	– ~4% reduction in re-admissions but accompanied with a doubling of ER visits in study – Near-significant trend towards lowered re-admission – Effective at reducing re-admission rates, and ineffective at reducing ER visit rates	647	Kaye 2018

A short stay ambulatory extended recovery (AXR) program in U.S. after MIRP	– Multidisciplinary team – Foley catheter care/drain management and medication – Web based interactive classes, printed materials, teaching in person and videos – Postoperatively a clinical care pathway was used as well as nursing-initiated discharge criteria	– Rates of re-admission and urgent care visits were slightly lower during the ambulatory extended recovery phase with no significant difference between the groups – Reduced length of stay without changing re-admission or ER visit	– No direct effect on UPV – Slightly lower re-admission and ER visit rates – Ineffective at reducing re-admission and ER visit rates	1571	Musser 2015
Standardized care pathway for RARP	– Preoperative educational classes detailing the procedure, expectations about recovery and instructions about pelvic floor rehabilitation	– 75% reduction in re-admission after the program. No significant changes in ER visit	– Has a significant effect on re-admission – Effective at reducing re-admission rates, ineffective at reducing ER visit rates	108	Turini 2017
ERAS with specific clinical course outlined in LRP	– The ERAS program is described at length in Table 1 of the article – Education; prophylactic anticoagulation with heparin; intravenous anesthesia; preheat fluids and 1L Ringer's lactate	– 2 re-admissions in the control group and none in the ERAS group	– Less re-admissions in ERAS group – No direct effect on UPV –	288	Lin 2019

	transfusion; encourage early bedside activity				
Fast-track surgery course after LRP	– Pre-surgery enema x2; education, scrotal jockstrap, early movement exercises – Details of program outlined in Table 2	– 2 re-admissions in fast-track group, and 1 in the control group	– No direct effect on UPV	50	Gralla 2007
Continued anticoagulant therapies during the perioperative period after RARP	– Warfarin, DOAC, clopidogrel, prasugrel – Patients with a history of intervention for CV disease or stroke were referred to a specialist for perioperative continuation of these drugs	– 12/501 readmitted in control group and 2/31 readmitted in anticoagulant group – Mainly focused on bleeding outcomes, cardiovascular risk stratification, and aims to reduce DVT burden	– No direct effect on UPV – Anticoagulant group had higher re-admission rate, although the N was small –	620	Kubota 2020

ERAS, fast-track surgery, medical/surgical interventions, and other care pathways assessing re-admissions and/or emergency room visits in radical prostatectomy patients (n=10 studies). Only primary reports with author-generated data are included in this table. The total RP sample size of these 10 studies was 4154 patients, representing only ~1.0% of the total RP patients in this review. CV: cardiovascular; DOAC: direct oral anticoagulant; ER: emergency room; ERAS: enhanced recovery after surgery; LoS: length of stay; MIRP: minimally invasive radical prostatectomy; RARP: robot-assisted radical prostatectomy; RN: registered nurse; RP: radical prostatectomy; UPV: unplanned visit.