

ORIGINAL RESEARCH

From perineal wound failure modes to a standardized care bundle in single-port robot-assisted transperineal radical prostatectomy: a before–after quality-improvement study

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Abstract

Background: Single-port robot-assisted transperineal radical prostatectomy (SP-RARP) may facilitate early continence recovery and can be considered for selected patients with obesity or prior abdominal surgery. However, our initial institutional cohort showed a clinically important rate of surgical site infection (SSI). **Methods:** This single-center before–after quality-improvement study compared a historical cohort of 60 patients who underwent SP-RARP with an implementation cohort of 35 patients managed using a standardized perineal incision care bundle. Potential SSI-related failure modes were identified from the historical cohort, and the perineal wound-care bundle was developed accordingly. The primary outcome was 30-day SSI; secondary outcomes included wound-culture positivity, antimicrobial escalation, readmission, time to wound dryness, time to drainage removal, time to urinary catheter removal, length of hospital stay, duration of postoperative fasting, total medical costs, incisional pain, allergic reactions, and perineal skin blistering. **Results:** In the historical cohort, SSI was associated with omitted perineal cleansing, lack of enhanced bowel preparation, residual hair, more perineal sutures, and prolonged strip-drain retention (all $p < 0.05$). Bundle implementation reduced SSI ($p = 0.025$), positive wound cultures, and mean medical costs, but was accompanied by slightly higher incisional pain and minor local skin reactions. **Conclusions:** Based on our exploratory study, a standardized perineal incision care bundle was associated with lower SSI, faster recovery, and reduced resource use after SP-RARP, while increased pain and local skin reactions were observed.

Keywords

Prostate cancer; Single-port robotic surgery; Transperineal prostatectomy; Surgical-site infection; Quality improvement

1. Introduction

Transperineal prostatectomy avoids the peritoneal cavity and is particularly useful in selected patients with previous abdominal surgery or obesity [1, 2]. Robot-assisted transperineal prostatectomy remains a relatively new and technically evolving approach, with published evidence largely based on initial single-center series and learning-curve analyses [1]. Combined with a single-port robotic platform [2, 3] it offers limited tissue trauma, no abdominal incision, direct access to the prostate, clear apical exposure, and less interference from abdominal adhesions [1, 4–6]. Our center previously performed single-port robot-assisted transperineal radical prostatectomy (SP-RARP) in 60 patients. Early continence recovery appeared favorable, but perineal wound infection was relatively common [1, 7].

The perineum is moist, hair-bearing, folded, difficult to expose, and close to the anorectum, making it prone to con-

tamination by resident and fecal flora [8]. Therefore, infection, dehiscence, and delayed healing are common after perineal incisions [9]. These complications increase morbidity and resource use and may hinder wider adoption of this procedure.

Evidence for preventing perineal wound infection comes mainly from abdominoperineal resection (APR), after which infection rates remain high. Incisional negative-pressure wound therapy (iNPWT) may help, but the evidence is heterogeneous and cost remains a concern [9–12]. These findings cannot be directly extrapolated to prostatectomy because its wounds are smaller, less traumatic, and differently contaminated.

Surgical site infection (SSI) prevention guidelines emphasize skin preparation, appropriate antimicrobial prophylaxis, and postoperative surveillance [13, 14]. Prolonging prophylaxis or broadening coverage without indication does not reduce infection after robot-assisted radical prostatectomy [15,

16]. Transperineal prostatectomy therefore requires a preventive, reproducible, procedure-specific wound-care protocol.

We therefore conducted a failure mode analysis of our historical SP-RARP cohort, identified modifiable and time-dependent risk factors, and developed a standardized perineal incision care bundle. Its effectiveness was then evaluated in another implementation cohort. We hypothesized that the bundle would reduce SSI, accelerate recovery, and decrease resource use.

2. Materials and methods

2.1 Study design

This was a single-center before-and-after quality-improvement study of patients with prostate cancer who underwent SP-RARP. The historical cohort included 60 patients and the implementation cohort included 35 patients who underwent SP-RARP with the bundled incision-care protocol. Patients were included if they were admitted from May 2022, were aged 18–85 years, had histologically confirmed prostate cancer diagnosed by transrectal ultrasound-guided prostate biopsy, were eligible for robot-assisted laparoscopic radical prostatectomy, and had no significant abnormalities in routine blood tests, coagulation function, or liver and kidney function. Patients were excluded if they had distant metastases; other serious diseases that could substantially shorten life expectancy or increase the risks associated with treatment, including other malignancies; severe cardiac, hepatic, pulmonary, or other major organ dysfunction; or a history of human immunodeficiency virus infection, other acquired or congenital immunodeficiency disorders, or organ transplantation. The same robotic platform and case-selection criteria were used in both periods, and all procedures were performed by the same senior urologist. Fig. 1 summarizes the study design and standardized care bundle. In the present analysis, the historical cohort served both as the source for failure-mode identification and as the preimplementation comparator; the implementation cohort was used for the postimplementation outcome comparison and did not determine selection of the bundle components.

2.2 Analysis of potential failure modes for incisional infection after SP-RARP

Factors potentially associated with SSI were classified by temporal sequence and putative mechanism. Baseline susceptibility factors included Mini-Cog score [17], diabetes, hemoglobin, smoking history, age, body mass index (BMI), American Society of Anesthesiologists (ASA) class, and Charlson Comorbidity Index. Factors related to contamination control included preoperative perineal cleansing, enhanced bowel preparation, and residual perineal hair. Factors related to surgery and incisional burden included operative time, robotic console time, time required to establish surgical access, intraoperative blood loss, prostate volume, and number of stitches used for perineal closure. Postoperative management factors included the timing of drainage-strip removal, prophylactic infrared irradiation, and support from trained care staff.

To identify clinically meaningful potential failure points,

relevant variables were further converted into binary states with clear clinical interpretations: diabetes, hemoglobin <130 g/L, no preoperative perineal cleansing, no enhanced bowel preparation, residual perineal hair, operative time ≥ 210 min, ≥ 10 stitches in perineal closure, drainage-strip removal ≥ 36 h, no infrared irradiation, and no support from trained care staff. Mini-Cog score was analyzed as a continuous variable.

Variables that could occur after infection, including positive wound culture, escalation of antimicrobial therapy, time to wound dryness, medical costs, readmission, pain, allergic reactions, and skin blisters, were treated as outcomes and were not analyzed as potential causes of SSI.

The purpose of this screening was to identify consistent, interpretable, and modifiable patterns that could lead to incisional infection after transperineal prostatectomy, rather than to estimate the independent causal effect of each factor on SSI.

2.3 Development and implementation of the standardized care bundle

Potential failure points identified in the previous case analysis were converted into standardized interventions to form a perioperative care bundle, as follows:

- Preoperative assessment. Diabetes, obesity, smoking, nutritional status, hematologic abnormalities, and cognitive function were assessed, and necessary care support was arranged according to the patient's condition.
- Enhanced bowel preparation. A low-residue semi-liquid or liquid diet was given for 2 days before surgery, followed by preoperative laxatives and a cleansing enema.
- Enhanced perineal skin preparation. A physician confirmed complete removal of perineal and perianal hair while avoiding skin injury during hair removal.
- Cleansing of the perineal skin under tension. The perineal skin folds were fully opened with moderate traction and scrubbed twice with a brush and soapy water before routine skin antiseptics.
- Irrigation before wound closure. Before closure, the wound was irrigated locally with hydrogen peroxide and povidone-iodine according to the department's standardized protocol.
- Early drainage removal. The drainage strip was removed within approximately 12 h after surgery.
- Prophylactic infrared irradiation.
- Microbiological testing and antimicrobial management. Perineal wound exudate was cultured, and antimicrobial therapy was adjusted according to infection severity, pathogen identification, antimicrobial susceptibility results, and local resistance patterns.

These measures were implemented together as a standardized protocol. The bundle was based on an integrated analysis of multiple SSI-related risk signals in the historical cohort. Priority was given to factors with a clear temporal relationship, a plausible biological mechanism, and clinical modifiability, rather than solely to the statistical significance of any single factor.

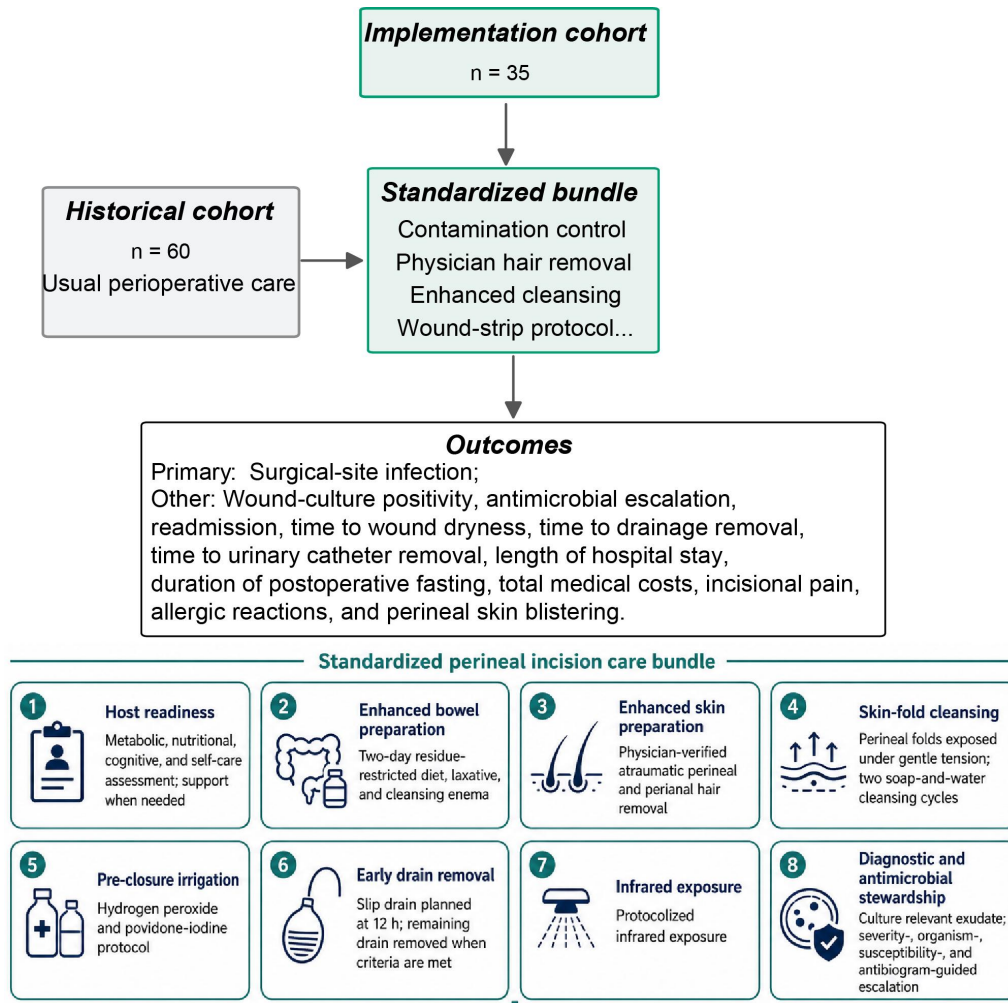


FIGURE 1. Study design and mechanism-informed bundle architecture.

2.4 Outcomes and microbiological evaluation

The primary outcome was a clinically diagnosed SSI within 30 days after surgery, as documented by the treating surgical team in the medical record. SSI included superficial incisional infection, deep incisional infection, organ infection, and delayed wound healing, and was jointly assessed by senior specialist members of the stoma care team at our center. In our previous study, SSI included only deep incisional infection and organ/space infection, while delayed wound healing was analyzed separately [1]. Other outcomes included a positive culture of wound discharge, escalation of antimicrobial therapy, and readmission. Recovery outcomes included time to wound dryness, time to drainage-strip removal, time to urinary catheter removal, length of hospital stay, duration of postoperative fasting, and total medical costs. Medical costs were reported in Chinese yuan (CNY) and excluded the fixed fee for use of the robotic surgical platform. Safety outcomes included wound pain score, allergic reactions, and perineal skin blisters. A positive wound culture was analyzed as a separate secondary outcome and was not required for the clinical SSI diagnosis.

2.5 Statistical analysis

Categorical variables were presented as counts and percentages, and continuous variables as medians and interquartile ranges (IQRs). All statistical tests were two-sided, and p values < 0.001 were reported as $p < 0.001$. In the historical cohort, associations between binary variables and SSI were analyzed using Fisher's exact test, with unadjusted odds ratios (ORs) and 95% confidence intervals (CIs). A continuity correction of 0.5 was applied when any cell in a 2×2 table contained zero observations. Continuous variables were compared using the Mann–Whitney U test, and effect sizes were expressed as rank-biserial correlation coefficients. In the before-and-after analysis, absolute risk differences and 95% CIs were reported for binary outcomes, with 95% CIs calculated using the Newcombe score method. Risk ratios (RRs) and log-scale 95% CIs were also reported, and groups were compared using Fisher's exact test. For continuous outcomes, medians and IQRs were used for descriptive reporting. The primary estimand was the between-group difference in outcome distributions, assessed using the Mann–Whitney U test. Differences in sample medians with bootstrap 95% CIs were reported as descriptive effect estimates. For incisional pain and total medical costs, mean differences with bootstrap 95% CIs and Welch's t tests were reported as sensitivity analyses. Because only 15 SSI events occurred in the historical cohort and some exposures

showed sparse data or complete separation, no multivariable etiologic regression model was constructed to avoid overfitting and unstable parameter estimates. No adjustment for multiple comparisons was applied; therefore, secondary and subgroup p values should be interpreted as exploratory. Because RR confidence intervals and Fisher exact p values were obtained using different methods, their nominal significance thresholds may not always coincide.

3. Results

3.1 Historical failure modes and rationale for the bundle

Supplementary Table 1 and Fig. 2 summarize the factors associated with SSI in the historical cohort. These factors were grouped into four categories: host susceptibility, contamination control, operative and wound burden, and postoperative management. The care bundle was developed based on the overall temporal sequence, biological plausibility, and clinical modifiability of the identified factors, rather than on individual variables reaching $p < 0.05$.

3.1.1 Host susceptibility

Both of the 2 patients with Mini-Cog scores ≤ 2 developed SSI, compared with 13 of 58 patients (22.4%) with scores of 3–5 (continuity-corrected OR = 16.85, 95% Wald CI: 0.76–372.80, $p = 0.059$). When Mini-Cog score was analyzed as a continuous variable, it did not differ between the SSI and non-SSI groups ($p = 0.144$). Patients with abnormal cognitive screening may require closer perioperative management and monitoring. Those with cognitive impairment, including Alzheimer disease, may have poorer hygiene and fecal incontinence and may

need enhanced nursing and professional caregiver support. SSI was more frequent in patients with diabetes (7/16, 43.8% vs. 8/44, 18.2%; OR = 3.50, Wald CI: 1.00–12.22, $p = 0.088$). Patients with SSI had lower hemoglobin levels (median, 121 vs. 134 g/L; rank-biserial $r = -0.43$, $p = 0.014$). Patients with anemia may therefore require additional measures to prevent wound infection.

3.1.2 Contamination control

SSI occurred in 13 of 16 patients (81.2%) without preoperative perineal cleansing and 2 of 44 (4.5%) who received cleansing (OR = 91.00, 95% CI: 13.69–604.95, $p < 0.001$). Preoperative cleansing was strongly associated with lower SSI risk. SSI occurred in 12 of 16 patients (75.0%) without enhanced bowel preparation and 3 of 44 (6.8%) who received it (OR = 41.00, 95% CI: 8.04–209.12, $p < 0.001$). All 60 patients were instructed to remove perineal and perianal hair themselves or with family assistance, yet 18 (30.0%) had residual hair. SSI occurred in 8/18 patients (44.4%) with residual hair and 7/42 (16.7%) without it (OR = 4.00, 95% CI: 1.16–13.74, $p = 0.048$). The strong association with preoperative perineal cleansing was unexpected. Patients who completed cleansing may also have had better hygiene, adherence, and perioperative self-management. More complete bowel preparation may reduce enteric contamination of the perineal region during and after surgery.

3.1.3 Operative and wound burden

Median operative time was longer in patients with SSI than in those without SSI (225 vs. 190 min; $r = 0.35$, $p = 0.044$). Dichotomization at 210 min reduced the precision of the association (OR = 3.00, $p = 0.126$). This may suggest that longer instrument manipulation within the perineal incision provides

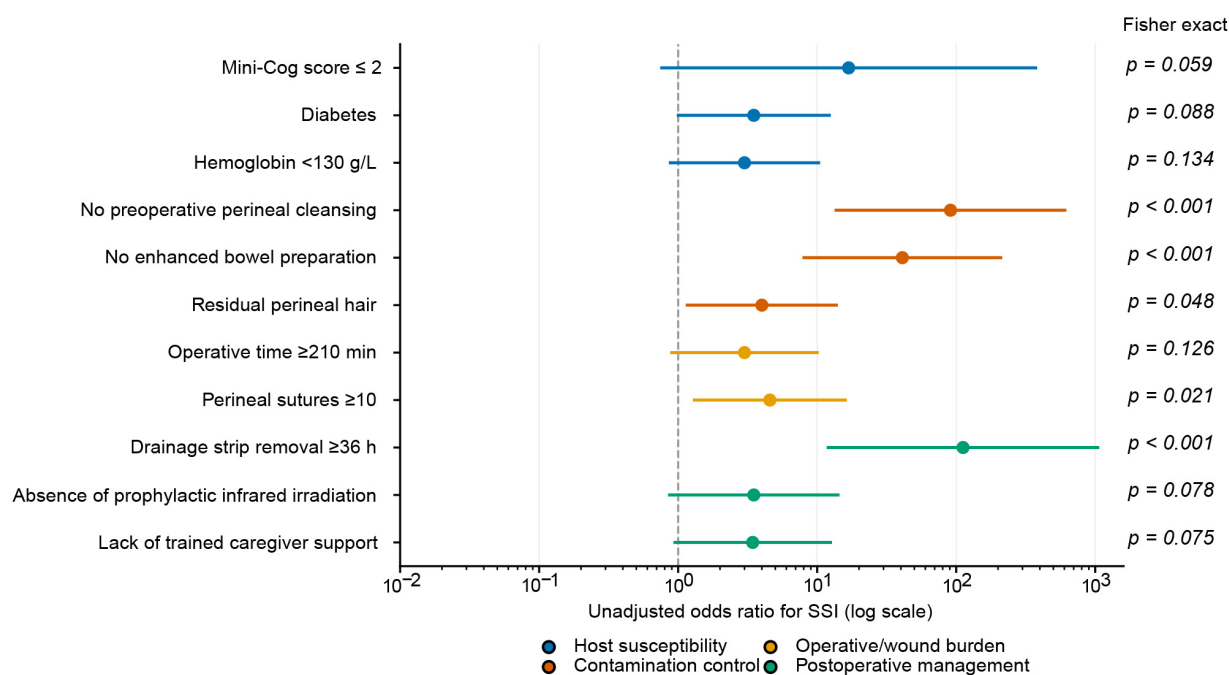


FIGURE 2. Mechanism-oriented historical SSI associations. Unadjusted ORs and 95% CIs are grouped by mechanistic domain. Displayed p values are from two-sided Fisher exact tests. Estimates are exploratory; sparse cells produce wide CIs. SSI: surgical site infection.

more opportunities for pathogen introduction. Among 17 patients with ≥ 10 stitches in the perineal wound, 8 (47.1%) developed SSI, compared with 7 of 43 patients (16.3%) with < 10 stitches (OR = 4.57, 95% CI: 1.31–15.96, $p = 0.021$). Analysis of stitch count as a continuous variable gave a consistent result ($r = 0.45$, $p = 0.008$). Longer operations may increase wound exposure and contamination, while more perineal sutures may reflect a larger wound, greater tissue traction or suture tension, more extensive tissue manipulation, and local dead-space formation.

3.1.4 Postoperative management

SSI occurred in 14 of 19 patients (73.7%) whose drainage strip was removed ≥ 36 h after surgery and in 1 of 41 (2.4%) with earlier removal (OR = 112.00, 95% CI: 12.02–1043.33, $p < 0.001$). The absence of prophylactic infrared irradiation (OR = 3.50, $p = 0.078$) and lack of trained caregiver support (OR = 3.44, $p = 0.075$) also showed weaker associations with SSI.

3.1.5 Characteristics of SSI cases in the implementation cohort

Only two patients developed SSI during the implementation period. One had cognitive impairment and developed fecal incontinence after surgery, and the other did not complete enhanced bowel preparation as required and consumed a large amount of high-fiber food before surgery.

3.2 Effectiveness outcomes

After the care bundle implementation, SSI decreased from 15/60 (25.0%) in the historical cohort to 2/35 (5.7%), with an absolute risk difference of -19.3 percentage points (95% CI: -32.2 to -3.4 , Fisher's exact $p = 0.025$) (Supplementary Table 2; Fig. 3A). Positive wound cultures decreased from 12/60 (20.0%) to 2/35 (5.7%) (Fig. 3B), with an absolute risk difference of -14.3 percentage points (95% CI: -26.8 to 1.0) and RR = 0.29 (95% CI: 0.07–1.20, $p = 0.074$) (Fig. 3C). Although clinically relevant, this reduction did not meet the conventional threshold for statistical significance, and the 95% CI crossed the null. Escalation of antibiotic therapy decreased from 14/60 (23.3%) to 2/35 (5.7%), with RR = 0.24 (95% CI: 0.06–1.01, $p = 0.044$). Although the 95% CI for the continuity-corrected RR crossed 1, readmission decreased from 7/60 (11.7%) to 0/35 ($p = 0.044$), with an absolute risk difference of -11.7 percentage points (95% CI: -22.2 to -0.2) and RR = 0.11.

The 15-case rolling event rates showed a visible decline in SSI and wound-culture positivity after bundle implementation, although these trajectories were descriptive and were not analyzed as an interrupted time series (Fig. 4).

3.3 Microbiology

A total of 12 patients in the historical cohort had positive wound cultures: *Escherichia coli* in 5 (41.7%), *Enterococcus faecalis* in 3 (25.0%), *Bacteroides fragilis* in 3 (25.0%), and *Staphylococcus aureus* in 1 (8.3%). The 2 patients with positive wound cultures in the care-bundle implementation cohort both yielded *E. faecalis* (Supplementary Table 3; Fig. 5). Because only 2 cultures were positive during implementa-

tion, pathogen distributions were described without inferential comparison between cohorts. The detection of enteric, perineal, and skin-associated organisms was consistent with the rationale for strengthened contamination control, but the small number of cultures does not support attribution of the observed reduction to a specific bundle component or pathogen group.

3.4 Recovery and resource use

After bundle implementation, median time to wound dryness decreased from 3.75 d (IQR: 3.38–4.12) to 3.00 d (IQR: 2.50–3.50), with a descriptive median difference of -0.75 d (Mann–Whitney U, $p < 0.001$, Fig. 6A). Median time to negative-pressure perineal drain removal decreased from 5.5 to 4.0 d after surgery (Fig. 6B), urinary catheter removal from 14.0 to 11.00 d (Fig. 6C), hospital stay from 7.50 to 6.00 d (Fig. 6D), and duration of postoperative fasting from 18 to 10 h (all Mann–Whitney U, $p < 0.001$, Supplementary Table 4). Median total medical costs decreased from approximately CNY 14,500 to CNY 13,000 (Fig. 6E). Sensitivity analysis using mean costs showed a similar reduction, from CNY 14,500 to CNY 12,800 (mean difference: CNY 1700; bootstrap 95% CI: CNY 1179–2221; Welch's t -test, $p < 0.001$). Because only total costs were available, the decrease could not be attributed separately to fewer SSIs, shorter hospital stays, less antibiotic use, or other changes in care. Overall, observed recovery intervals were shorter and medical costs were lower during the care-bundle period. We recognize that temporal and other broader changes may also have influenced these outcomes. They should therefore be viewed as associations, not causal effects.

3.5 Incisional pain and skin safety

Incisional pain increased from a median of 1 (IQR: 1–2) to 2 (IQR: 1–3) after bundle implementation (Mann–Whitney U test, $p = 0.034$). Skin-related adverse events also increased. Allergic reactions increased from 1/60 (1.7%) to 6/35 (17.1%), with RR = 10.29 (95% CI: 1.29–81.97, $p = 0.009$), and skin blisters increased from 2/60 (3.3%) to 7/35 (20.0%), with RR = 6.00 (95% CI: 1.32–27.30, $p = 0.011$) (Fig. 7; Supplementary Table 2). Recorded allergic reactions mainly comprised wheals or urticaria-like skin changes (Fig. 8A).

4. Discussion

Combining multiple evidence-based measures is reasonable, although studies are heterogeneous [18]. We developed a standardized care bundle based on failures related to perineal wound infection identified in historical cases of robot-assisted single-port prostatectomy. After implementation, SSI decreased from 25.0% to 5.7%, an absolute reduction of 19.3 percentage points. Time to wound dryness, duration of drain and urinary catheter placement, and hospital stay were shorter, while antibiotic escalation, readmission, and medical costs decreased. Wound pain, allergic skin reactions, and blistering increased. Representative perineal incision images at 48 hours postoperatively demonstrated an SSI in the historical period (Fig. 8B) and an allergy-like cutaneous rash during the standardized bundle implementation period (Fig. 8A).

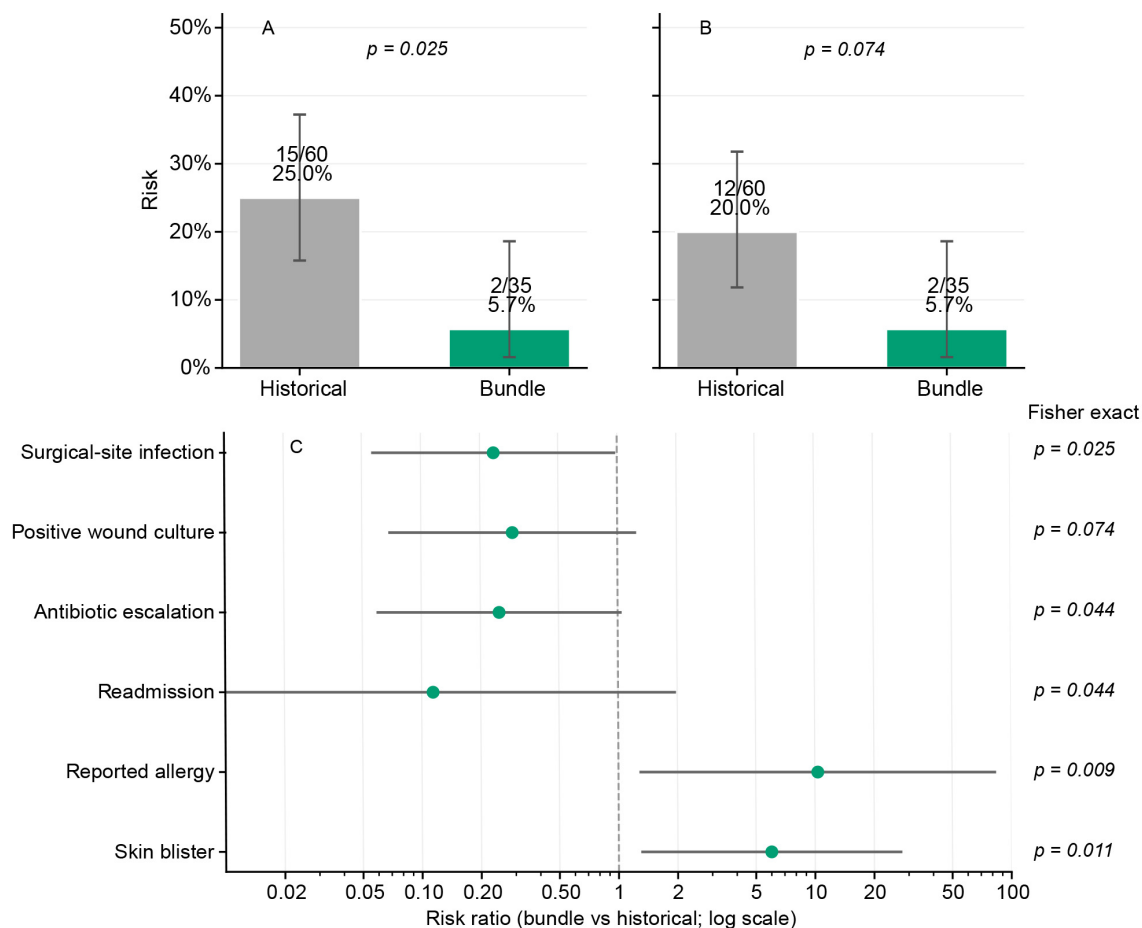


FIGURE 3. Effectiveness outcomes before and after bundle implementation. (A,B) Surgical-site infection and positive wound-culture rates. Bars show observed proportions and error bars show Wilson 95% CIs. Displayed p values are from two-sided Fisher exact tests. Culture positivity declined numerically but did not cross the conventional 0.05 threshold. (C) Binary outcomes after bundle implementation. Risk ratios compare the bundle period with the historical period on a logarithmic scale. Horizontal lines show 95% CIs; displayed p values are also from two-sided Fisher exact tests. Zero-event risk ratios use a 0.5 continuity correction.

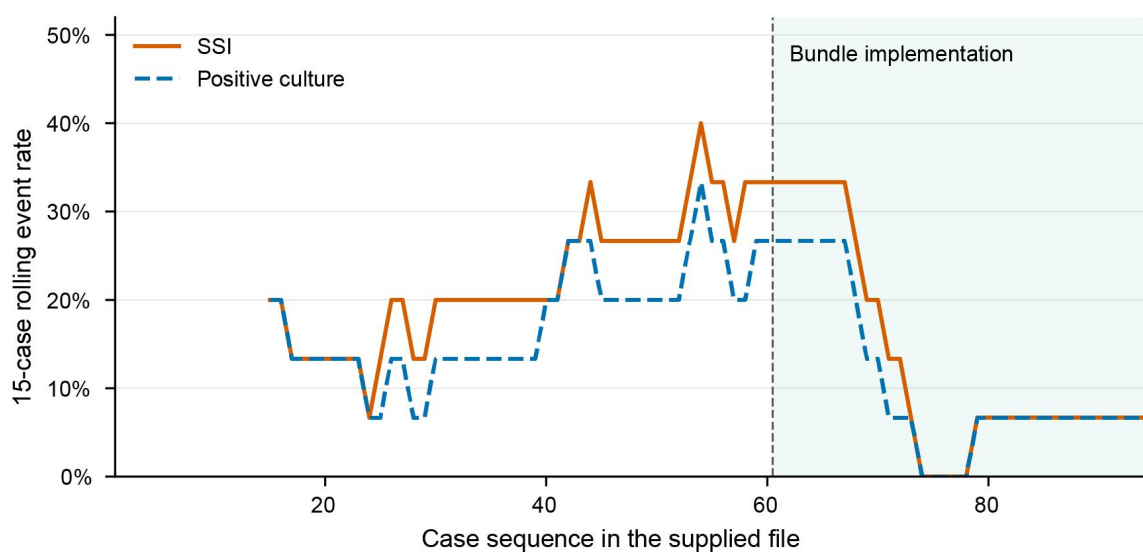


FIGURE 4. Rolling event rates by case sequence. Fifteen-case rolling rates are shown for SSI and positive wound culture; the vertical line marks bundle implementation. The plot is descriptive and is not an interrupted time-series analysis. SSI: surgical site infection.

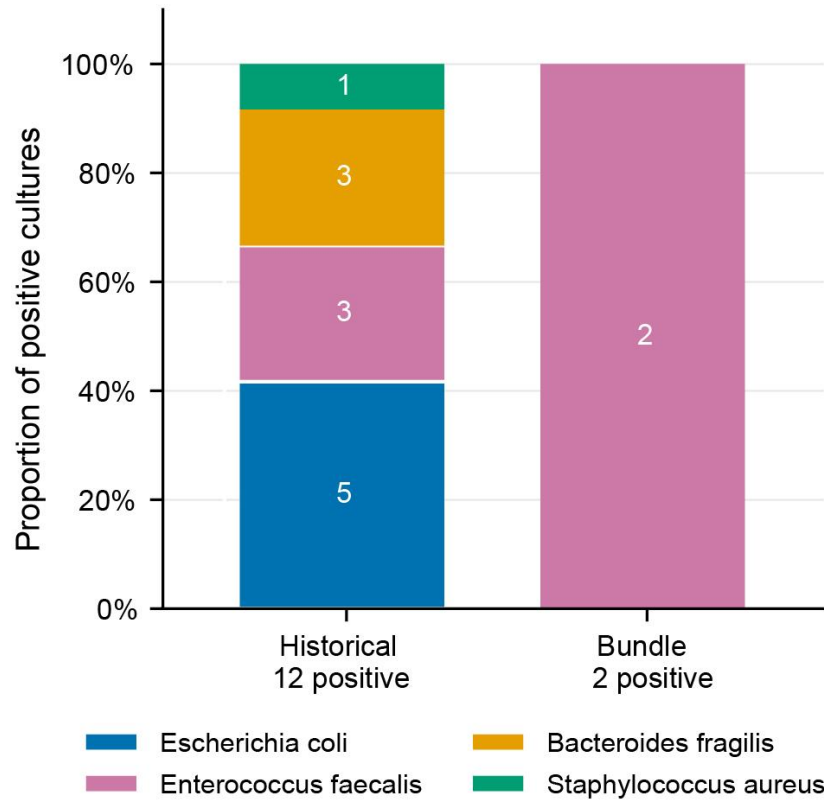


FIGURE 5. Microbiology among positive cultures. Historical isolates comprised *E. coli* (n = 5), *E. faecalis* (n = 3), *B. fragilis* (n = 3), and *S. aureus* (n = 1); both bundle-period isolates were *E. faecalis*.

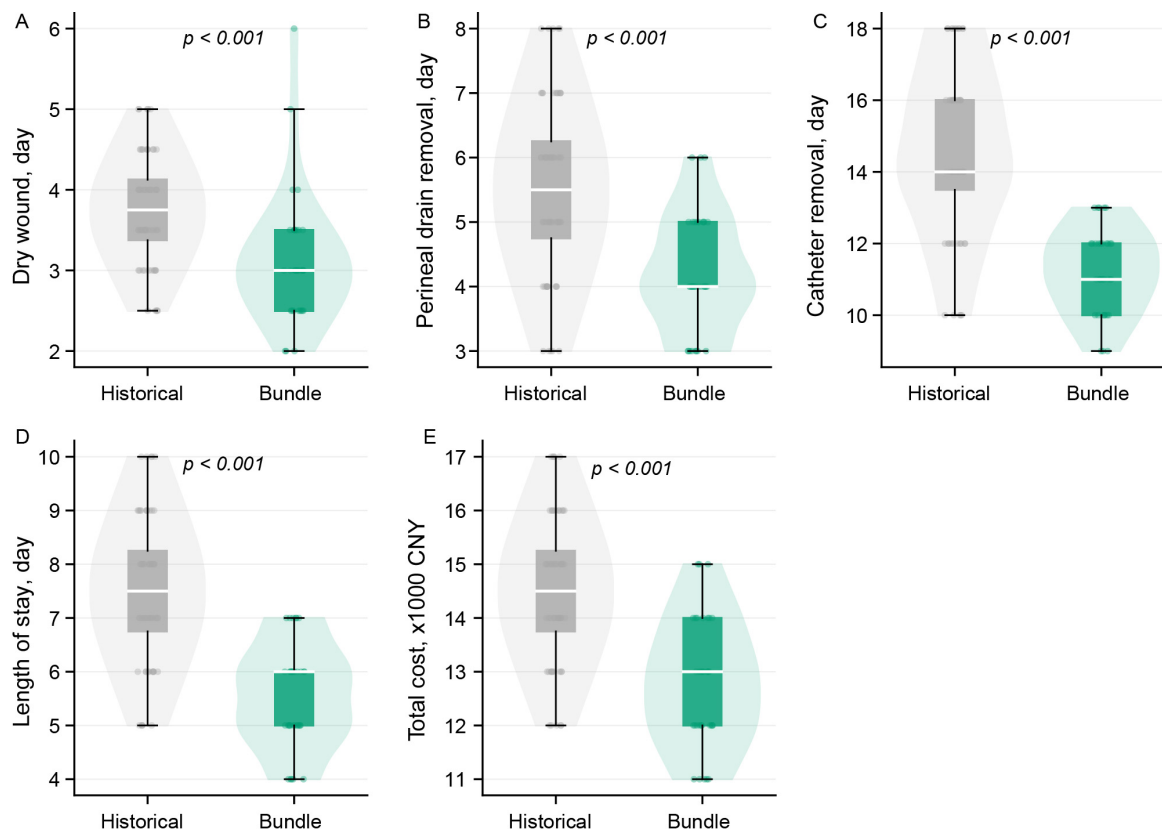


FIGURE 6. Comparison of clinical outcome and costs before and after bundle implementation. Box plots show wound drying (A), negative-pressure perineal drain removal (B), catheter removal (C), hospitalization (D), and medical cost (E). Displayed p values are from two-sided Mann–Whitney tests.

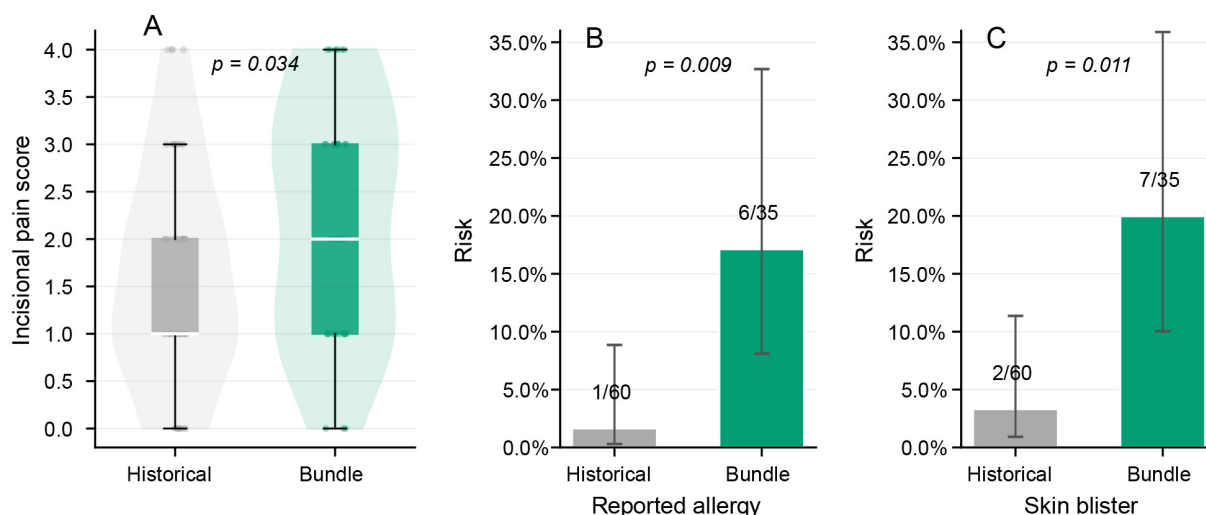


FIGURE 7. Incisional pain and skin safety events. (A) shows recorded incisional pain scores with a two-sided Mann–Whitney p value. (B,C) show recorded local allergic reactions and blistering with Wilson 95% CIs and two-sided Fisher exact p values.

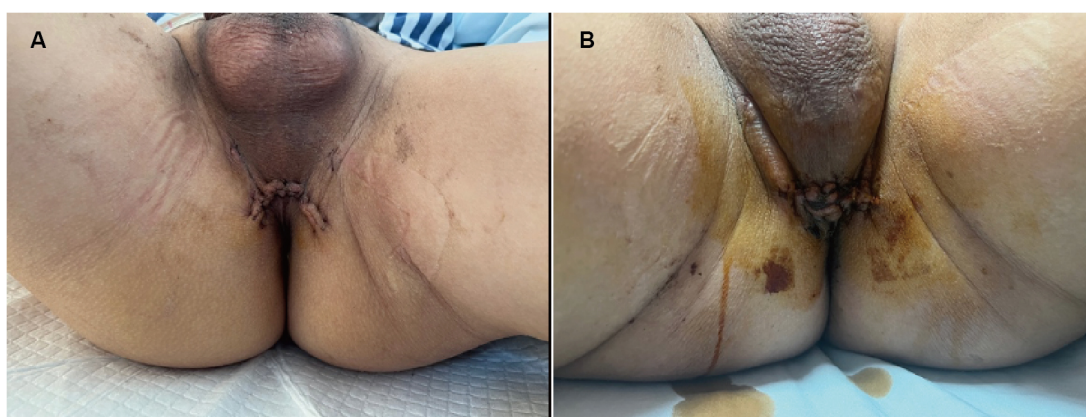


FIGURE 8. Representative perineal incision images. (A) Perineal incision 48 h after SP-RARP during the standardized bundle period, showing a mild allergy-like perincisional rash. (B) Perineal incision 48 h after SP-RARP during the historical period, showing surgical site infection.

Historical cohort analysis associated SSI with no preoperative perineal cleansing, no enhanced bowel preparation, residual perineal or perianal hair, more stitches for wound closure, and later removal of the drainage strip. Although these factors span different perioperative stages, each may increase local contamination, tissue injury, dead space, moisture, or persistent irritation from foreign material and thereby impair wound healing [19]. Incisional wound irrigation has been associated with SSI risk [20]. Thus, wound irrigation with hydrogen peroxide and povidone-iodine before closure may have contributed to the reduction in SSI. Measures were therefore selected by temporal sequence, clinical modifiability, and plausible mechanisms rather than p values alone, forming an integrated perioperative pathway. However, some factors had high ORs but wide 95% CIs, reflecting the small sample and sparse data; independent effects therefore cannot be inferred. The association between drainage strip removal and SSI may also reflect reverse causation, because drainage may have been prolonged in patients with early exudate or signs of infection. These findings identify modifiable management gaps but do

not establish causal relationships between individual measures and SSI.

Historical cultures mainly yielded *Escherichia coli*, *Enterococcus faecalis*, *Bacteroides fragilis*, and *Staphylococcus aureus*. The first three suggested intestinal or perineal contamination [21], whereas *Staphylococcus aureus* suggested a possible skin source. Both culture-positive cases during care-bundle implementation yielded *E. faecalis*. The small number of positive cases precluded assessment of changes in the pathogen spectrum. Overall, the findings were consistent with multiple sources of perineal contamination and supported stronger preoperative cleansing, bowel preparation, and local contamination control.

Besides lower SSI, shorter time to wound dryness, earlier drain and urinary catheter removal, and shorter hospital stays were observed during the care-bundle period. Mean medical costs decreased by CNY 1700. Because SSI increases resource use through antibiotics, dressing changes, longer stays, and readmission, preventing infection may reduce costs [22]. However, only total costs were available; itemized costs were

not recorded, and some expenses outside medical insurance were excluded. The decrease cannot therefore be fully attributed to the care bundle.

Wound pain scores and the incidence of allergic skin reactions and blistering increased after care-bundle implementation. Possible causes include friction during cleansing, repeated use of cleansers or disinfectants, dressing tension, local moisture, and repeated dressing changes [23]. Skin barrier protection and patient comfort therefore require attention. Cleansing, disinfectant selection, dressing fixation, and replacement frequency should be optimized to reduce irritation and pain while maintaining infection control.

This study has several limitations. It was a small, single-center before-and-after study without randomization, so temporal effects and concurrent changes in care could not be excluded. Only 15 SSIs occurred in the historical cohort, and some variables showed sparse data or complete separation. Multivariable regression was therefore not performed, and the findings indicate associations rather than independent risk factors. SSI follow-up, indications for wound culture, and microbiological data were incomplete in some patients, and adherence to individual bundle measures was not quantified. Generalizability to other institutions and surgical teams requires further validation. The operational SSI outcome relied on clinical documentation by the treating team rather than blinded independent adjudication. In addition, the before-and-after design is susceptible to secular trends and other contemporaneous changes in perioperative care. Because the historical cohort both informed bundle development and served as the comparator, the observed effect may be optimistic and requires independent external validation. Because SP-RARP is an emerging technique with a learning curve and limited multicenter evidence, wound-related failure modes may vary with team experience, patient selection, robotic platform, and local care processes. The bundle should therefore be adapted to local practice and prospectively validated rather than assumed to be universally transferable.

5. Conclusions

In this single-center before-and-after study, implementation of a standardized perineal wound-care bundle was associated with lower SSI after SP-RARP, shorter observed recovery intervals, and lower healthcare resource use, but with more pain and local skin reactions. Prospective multicenter studies across surgical teams and robotic platforms should further assess its effectiveness, safety, cost-effectiveness, local adaptability, and transferability.

AVAILABILITY OF DATA AND MATERIALS

The data that support the findings of this study are available from the corresponding author upon reasonable request.

AUTHOR CONTRIBUTIONS

HW—designed the study, conducted the research, and analyzed the data. MMA, JL and SZ—drafted the manuscript.

CY—provided the historical cohort data and contributed to manuscript editing. YZ—provided funding support, project administration, and resources for the study. XM—supervised the study and drafted the manuscript. All authors contributed to the revision of the manuscript, read the final version, and approved it for publication.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board of Sir Run Run Shaw Hospital, Zhejiang University School of Medicine (approval No. 2022-521-01). Written informed consent to participate in the study was obtained from all participants.

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Not applicable.

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CONFLICT OF INTEREST

The authors declare no other conflict of interest.

SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found, in the online version, at <https://oss.jomh.org/files/article/2105199125924331520/attachment/Supplementary%20material.xlsx>.

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