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Robotic-assisted radical prostatectomy is pushing the boundaries: a national survey of frailty using the national surgical quality improvement program

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Abstract

Background: Robotic-assisted radical prostatectomy (RARP) has been found to be comparable and, in some cases, favorable to open surgical approaches, while being used in a frailer population.

Objectives: We aimed to illustrate the trend in population frailty and compare morbidity and mortality postoperatively in patients who underwent RARP.

Design and Methods: The National Surgical Quality Improvement Program data set was used to select patients who underwent RARP between the years 2011–2019. Age, frailty indicators, surgical characteristics, and perioperative morbidity and mortality were compared between the years 2011–2019 using the chi-square test (χ^2) for categorical variables and the one-way analysis of variance (ANOVA) for continuous variables.

Results: Our patient population consisted of 66,683 patients who underwent RARP. There was an increase in mean age and frailty indicated by an increase in 5-item frailty score $\geqslant$2, metabolic syndrome index = 3, and American Society of Anesthesiologists' (ASA) class $\geqslant$3 between the years 2011–2019 ($p < 0.001$). Whereas the rate of mortality and morbidity, indicated by postoperative Clavien–Dindo grade $\geqslant$4 and major morbidity, remained the same over the same period ($p > 0.264$). Furthermore, operative time and length of stay decreased over the same period ($p < 0.001$).

Conclusion: RARP is being performed on more frail patients, with no added morbidity or mortality.

Keywords: frailty, morbidity, mortality, prostatectomy, robotic surgical procedures, trends

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Introduction

Prostate cancer (PCa) is the second most common cancer in men with 1.4 million cases diagnosed in the year 2020.[1] Clinically localized PCa treatment modalities include radical prostatectomy, cryosurgery, radiotherapy, focal therapy, and active surveillance.[2,3] Robotic-assisted radical prostatectomy (RARP) has been extensively compared with the open surgical approach and has shown comparable and in some cases favorable outcomes.[4,5] Furthermore, RARP has also demonstrated better overall outcomes in terms of blood loss, nerve sparing, and urinary incontinence which has increased its adoption in treating PCa.[6] There is also an increasing interest in population frailty assessment whereby several scores have been developed to assess frailty preoperatively in urologic procedures.[7,8] Improved medical standards worldwide have led to an increase in the geriatric populations; hence, making frailty a concern of increasing importance.[9–11] Therefore, the need to refine surgical procedures to cater to

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a frailer population has emerged. RARP is one of those surgical procedures that is being refined over the past decades and possibly being offered to more frail patients over the years. In this study, we used a nationally validated, risk-adjusted data set to illustrate the increase in population frailty that underwent RARP and compare morbidity and mortality postoperatively between the years 2011 and 2019.

Materials and methods

Study design

The American College of Surgeons–National Surgical Quality Improvement Program (ACS-NSQIP) data set was used to select patients who underwent RARP between the years 2011 and 2019. The current procedural terminology (CPT) code 55866 and principal operative procedure CPT code description were used to select RARP patients. A total of 66,683 patients underwent RARP during the study period and were included in the study. The ACS-NSQIP database is a nationally validated, risk-adjusted, outcomes-based program. It encompasses 963 centers and more than 65 collaboratives both inside and outside the United States. Data are collected by Surgical Clinical Reviewers (SCRs) that receive intensive training and follow-up support; in addition, data quality is ensured by an Intra-Rater Reliability Audit of participating sites.

Data availability

The (ACS-NSQIP) data are subject to a data use agreement. To access the data set, a request to the ACS-NSQIP participant use form should be placed at the following link (https://www.facs.org/quality-programs/acs-nsqip/participant-use).

Patient demographics and outcomes

In this study, we aimed to compare the trends of age, overall frailty, operative time (OT), length of stay (LOS), and perioperative morbidity and mortality for patients undergoing RARP between the years 2011 and 2019. To assess frailty, we used three indicators of frailty or population health: 5-item frailty index (5-iFI), metabolic syndrome index (MSI), and American Society of Anesthesiologists' (ASA) classification. To assess perioperative mortality and morbidity, we used the Clavien–Dindo grade, major morbidity, and 30-day mortality.[12,13] The compressed 5-iFI was derived from an 11-item frailty index score.[14] The index allocated 1 point for each of the following comorbidities: chronic obstructive pulmonary disease (COPD) or pneumonia, congestive heart failure, dependent functional status, hypertension, and diabetes.[14] Frailty scores were then divided into three groups: score of 0, 1, and $\geqslant 2$. The MSI allocated one point for each of the following comorbidities: hypertension requiring medication, diabetes, and obesity [body mass index (BMI) $>30\,kg/m^2$].[15]

Statistical analysis

Age, frailty indicators, OT, LOS, and perioperative morbidity and mortality were compared between the years 2011 and 2019. Chi-square test (χ^2) was used to compare categorical variables and the one-way analysis of variance (ANOVA) was used to compare continuous variables within different years. A 5-item frailty score $\geqslant 2$, MSI score $= 3$, and ASA class $\geqslant 3$ indicated high frailty and poor population health and were compared between different years. Rates of mortality, major morbidity, and the Clavien–Dindo grade $\geqslant 4$ were also compared between different years. Then, we constructed graphs depicting the changes in trends over the years. Two-sided p value significance was set at 0.05. IBM SPSS Statistics version 28 (190) (IBM Corp., Armonk, NY, USA) was used for the statistical analysis.

Results

A total of 66,683 patients underwent RARP between the years 2011 and 2019. Mean age increased from 61.68 ± 7.2 to 63.5 ± 7.1 between the years 2011 and 2019 ($p < 0.001$) (Table 1).

With respect to the 5-iFI, the frequency of hypertension, diabetes, COPD or pneumonia, dependent functional status, and congestive heart failure were 52.2%, 13.1%, 1.8%, 0.2%, and 0.1%, respectively (Table 2). In this study, 44.6% had a 5-iFI $= 0$, 43.6% had a 5-iFI $= 1$, and 11.8% had a 5-iFI $\geqslant 2$. For the Clavien–Dindo grade, 65.1% had a grade of I and II, 13.4% had a grade of III, 20% had a grade of IV, and 1.5% had a grade of V. For the MSI, 5.9% of patients had a grade of 3 (Table 2).

When compared between the years 2011 and 2019, patients with 5-iFI $\geqslant 2$ showed an increase from 9.4% in 2011 to 12.5% in the year 2019 ($p < 0.001$). Similarly, patients with MSI $= 3$ also showed an increase from 4.1% in 2011 to 6.1% in 2019

Table 1. Patient age, frailty, operative time, length of stay, and perioperative morbidity and mortality between the years 2011 and 2019.

***N*=66,683**	**Year of operation**									***p* value**
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	
	***N*=4374**	***N*=4611**	***N*=5151**	***N*=5779**	***N*=7205**	***N*=8558**	***N*=9587**	***N*=10,145**	***N*=11,273**	
Frailty and comorbidity, *N* (%) or mean ± SD										
Age	61.68 ± 7.2	62.2 ± 7.2	62.4 ± 7.2	62.1 ± 7.1	62.5 ± 7.1	62.8 ± 7	63 ± 7.1	63.3 ± 7	63.5 ± 7	<0.001*
5-item frailty index ⩾2	413 (9.4)	497 (10.8)	564 (10.9)	674 (11.7)	849 (11.8)	1055 (12.3)	1079 (11.3)	1277 (12.6)	1406 (12.5)	<0.001*
Metabolic syndrome index=3	181 (4.1)	249 (5.4)	291 (5.6)	343 (5.9)	438 (6.1)	536 (6.3)	562 (5.9)	656 (6.5)	685 (6.1)	<0.001*
ASA class ⩾3	1435 (32.8)	1497 (32.5)	1884 (36.6)	2153 (37.3)	2727 (37.8)	3425 (40)	3941 (41.1)	4302 (42.4)	4780 (42.4)	<0.001*
Mortality and morbidity, *N* (%)										
Mortality	7 (0.16)	7 (0.15)	7 (0.14)	8 (0.14)	9 (0.13)	10 (0.12)	11 (0.11)	14 (0.14)	15 (0.13)	0.99
Clavien–Dindo ⩾4	65 (1.5)	81 (1.8)	77 (1.5)	94 (1.6)	122 (1.7)	140 (1.6)	163 (1.7)	186 (1.8)	193 (1.7)	0.859
Major morbidity	225 (5.1)	262 (5.7)	250 (4.9)	281 (4.9)	381 (5.3)	447 (5.2)	538 (5.6)	573 (5.6)	606 (5.4)	0.264
Surgical characteristics, mean ± SD										
Operative time (min)	212.3 ± 73	210 ± 75	209.5 ± 74.5	208.5 ± 73.4	205.8 ± 75	205.2 ± 71.7	206.6 ± 71.8	208.2 ± 72.6	206.3 ± 71	<0.001*
Length of stay (days)	1.81 ± 5	1.82 ± 3.4	1.69 ± 2.5	1.71 ± 2.1	1.73 ± 2.1	1.68 ± 2.2	1.66 ± 2.16	1.5 ± 1.63	1.47 ± 1.56	<0.001*

AMA, American Society of Anesthesiologists; SD, standard deviation.
5-item frailty index consists of chronic obstructive pulmonary disease or pneumonia, congestive heart failure, dependent functional status, hypertension, and diabetes. Metabolic syndrome index consists of hypertension requiring medication, diabetes, and obesity (BMI >30 kg/m^2). Major morbidity consists of deep incisional SSI, wound dehiscence, pneumonia, urinary tract infection, deep vein thrombosis, progressive renal insufficiency, bleeding requiring transfusion, sepsis, septic shock, pulmonary embolism, myocardial infarction, cardiac arrest necessitating CPR, unplanned intubation, ventilator dependent >48 h, acute renal failure necessitating dialysis, stroke, and coma.
[a]Statistical significance at $p < 0.05$.

Table 2. Components of 5-item frailty index, Clavien–Dindo classification adapted to the ACS-NSQIP, major morbidity, and metabolic syndrome index in our cohort.

5-item frailty index			***N* (%)**
Components	Chronic obstructive pulmonary disease or pneumonia, congestive heart failure, dependent functional status, hypertension, and diabetes		
0			29,773 (44.6%)
1			29,096 (43.6%)
⩾2			7814 (11.8%)
Clavien–Dindo classification adapted to ACS-NSQIP			***N* (%)**
Grades I and II	Occurrences of SSI, deep incisional SSI, organ space SSI, wound dehiscence, pneumonia, urinary tract infection, deep vein thrombosis, progressive renal insufficiency, bleeding requiring transfusion		3567 (65.1%)
Grade III	Unplanned reoperation		731 (13.4%)
Grade IV	Sepsis, septic shock, pulmonary embolism, myocardial infarction, cardiac arrest necessitating CPR, unplanned intubation, ventilator dependent >48 h, acute renal failure necessitating dialysis, stroke, coma		1091 (20%)
Grade V	Mortality		88 (1.5%)
Major morbidity			***N* (%)**
Deep incisional SSI, wound dehiscence, pneumonia, urinary tract infection, deep vein thrombosis, progressive renal insufficiency, bleeding requiring transfusion, sepsis, septic shock, pulmonary embolism, myocardial infarction, cardiac arrest necessitating CPR, unplanned intubation, ventilator dependent >48 h, acute renal failure necessitating dialysis, stroke, and coma			3563 (5.3%)
Metabolic syndrome index			***N* (%)**
Hypertension-requiring medication Diabetes Obesity (BMI >30 kg/m^2)	0	0 Factor	22,023 (33%)
	1	1 Factors	25,012 (37.5%)
	2	2 Factors	15,707 (23.6%)
	3	3 Factors	3941 (5.9%)

ACS-NSQIP, American College of Surgeons–National Surgical Quality Improvement Program; BMI, body mass index.

($p < 0.001$). Furthermore, patient with an ASA ⩾3 also showed an increase from 32.8% in 2011 to 42.4% in 2019 ($p < 0.001$). OT and LOS decreased from 212.3 ± 73 min and 1.81 ± 5 days in 2011 to 206.3 ± 71 min and 1.47 ± 1.56 days in 2019, respectively ($p < 0.001$) (Table 1 and Figure 1).

With respect to morbidity and mortality, patient perioperative mortality, major morbidity, and Clavien–Dindo perioperative morbidity remained similar through the years 2011 and 2019 with no statistically significant difference between them (Table 1 and Figure 2).

Discussion

In this study, we found that RARP was being utilized for a frailer population without an increase

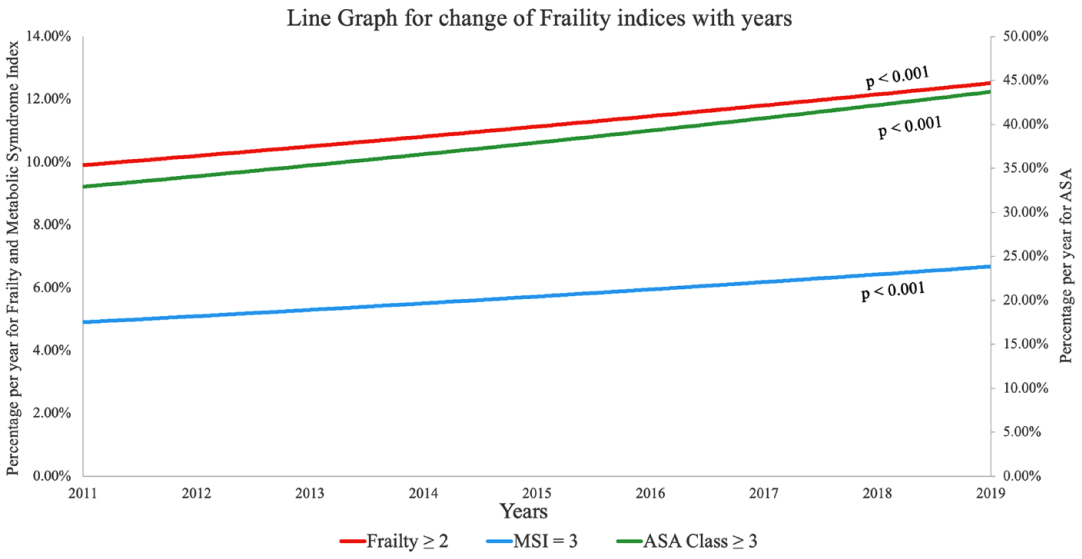

Figure 1. Line graph depicting the change of 5-item frailty index, metabolic syndrome index, and ASA class for patients undergoing RARP between the years 2011 and 2019.

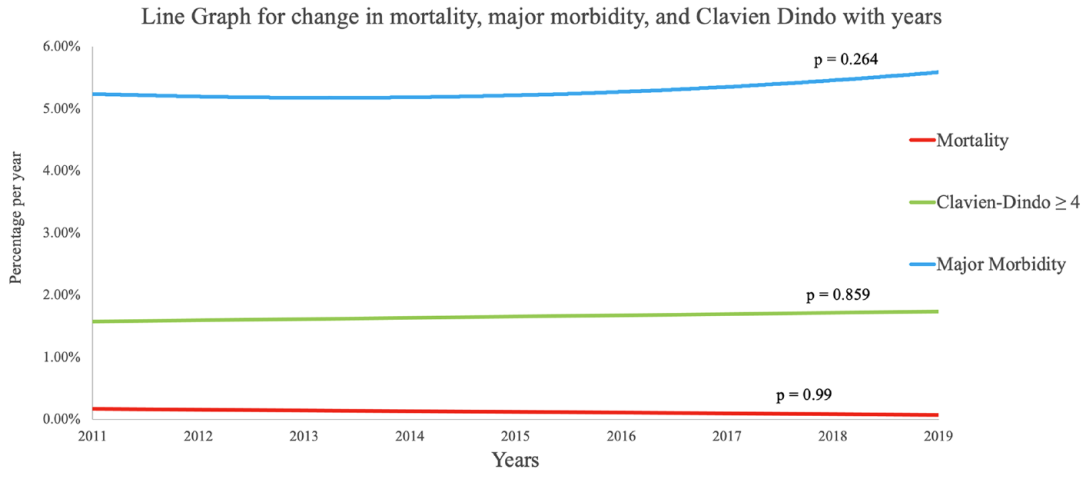

Figure 2. Line graph depicting the change of mortality, Clavien–Dindo classification, and major morbidity for patients undergoing RARP between the years 2011 and 2019.

in overall morbidity or mortality. Our findings demonstrate that patients, who were previously considered as inoperable, are now offered surgery without any increase in morbidity and mortality. Expert guidelines advocate treatment of localized PCa with curative intent for patients with life expectancy >10 years.[16,17] Moreover, radical prostatectomy for older patients heralded a higher complication rate, including higher medical complications as well as higher incontinence and erectile dysfunction rates.[18,19] For these reasons, many surgeons shied away from operating on elderly and frail patients with curative intent and sought alternative management pathways.

More recently, and with the adoption of robotic assistance over the past decades, studies have demonstrated that old age does not preclude offering radical prostatectomy for patients who were deemed to be nonsurgical candidates due to age alone. For instance, Yamada *et al.*[20] showed, in their series of RARP, that age was not an independent predictor of surgical as well as oncological outcomes. Furthermore, Labanaris *et al.*[21] in

their retrospective cohort study of RARP showed that patients older than 75 years of age did not yield increased complications in terms of potency, continence, or oncologic outcomes.

Undoubtedly, surgeon experience in RARP has increased over the years and this has been reflected by a decreased OT in our cohort. Increased comorbidities such as diabetes, COPD, congestive heart failure (CHF), dependent functional health status, and hypertension, which are components of the 5-iFI, have shown to be predictors of prolonged LOS in RARP.[22] Our cohort, however, demonstrated shorter LOS, and this could be explained by improved patient management, surgeon experience, and complication rates during RARP. Indeed, increased surgeon experience has shown improvements in surgery time, length of stay, and complications rates in RARP.[23]

Several studies have been able to demonstrate that RARP is feasible in more elderly and frail patients. Ubrig *et al.*[24] have demonstrated that RARP was feasible in patients ⩾75 with good functional and histopathologic results. Similarly, Roberts *et al.*[25] have showed that prostatectomy has been also increasingly adopted in Australia in elderly men; however, they only used age, without frailty indices, as a surrogate of overall health, which adds to the uniqueness of this study.

There are many contributing factors for the increased adoption of RARP among more elderly and frail patients. First, the US Preventive Services Task Force (USPSTF) has recommended for reduced serum prostate-specific antigen (PSA) screening since 2012; hence, possibly delaying the age at presentation of PCa to older patients.[26] Moreover, robotic assistance has allowed surgeons to be more comfortable in controlling for procedure-specific complications such as incontinence and erectile dysfunction that are especially pronounced in the elderly population.[27,28]

More importantly, assessing a patient's best treatment option based on age alone might be misleading and, in some cases, false. Hence, there is a need for an individualized approach when determining the best treatment option for patients. Therefore, the use of individualized life expectancy predictors, through frailty or comorbidity indices, seems to be a more reasonable alternative rather than risk-stratifying patients using age alone.[29] It has been previously shown that frailty indices are able to indicate increased patient vulnerability due to a decline in physiologic reserve and function as a result of aging.[30] Hence, serving as significant predictors of complications after surgery and prostatectomy, in particular.[13,31] These scores and indices can help surgeons better risk-stratify their patients and maximize the potential benefit of surgery.

In this study, we have included three independent frailty indices – the ASA class, the 5-iFI, and the MSI – as indicators of frailty and population health. These indices have helped us show that there is an overall trend over the past decade for the adoption of RARP in frailer and older population, without compromising on perioperative morbidity and mortality. Therefore, proving the refinement of the technique over the years and the current generalizability of this procedure to patients previously deemed nonsurgical.

Limitations

Several limitations exist in this study and results must be interpreted within the context of the study design. Although we utilized a large multicenter database, which is primarily focused on North America and is retrospective; thus, generalization to other populations might be limited. Furthermore, the cohort data lack variables that are tumor or procedure-specific, such as tumor stage and Gleason grade, which are important in choosing therapy for PCa. Other comorbidity indices such as the Charlson Comorbidity Index could not be incorporated into the analysis due to variables lacking in the NSQIP data set. Finally, the NSQIP data set is a collaboration of different centers; hence, expertise and surgical techniques could vary between different centers.

Conclusion

RARP is being offered and performed on more frail patients, indicated by a higher age, 5-item frailty score ⩾2, MSI score = 3, and ASA class ⩾3, without an increase in major morbidity, Clavien–Dindo grade, or mortality. Surgical treatment for PCa is expanding to a population previously deemed nonsurgical.

Declarations

Ethics approval and consent to participate

The deidentified database (ACS-NSQIP) does not constitute human subject research; therefore,

no consent to participate or institutional review board (IRB) approval was required or attained.

Consent for publication
Not applicable.

Author contributions
Nassib F. Abou Heidar: Conceptualization; Investigation; Methodology; Validation; Visualization; Writing – original draft; Writing – review & editing.

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Jad Abdul Khalek: Validation; Visualization; Writing – original draft; Writing – review & editing.

Hani Tamim: Data curation; Formal analysis; Software; Writing – original draft.

Albert El-Hajj: Conceptualization; Investigation; Methodology; Project administration; Supervision; Validation; Visualization; Writing – original draft; Writing – review & editing.

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Availability of data and materials
The (ACS-NSQIP) data are subject to a data use agreement. To access the data set, a request to the ACS-NSQIP participant use form should be placed at the following link (https://www.facs.org/quality-programs/acs-nsqip/participant-use). The American University of Beirut Medical Center is enrolled in ACS-NSQIP as a participating center. As such, the data were made available by the ACS-NSQIP center and the AUBMC Department of Surgery after signing the data use agreement.

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References
1. Sung H, Ferlay J, Siegel RL, *et al.* Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin* 2021; 71: 209–249.
2. Sanda MG, Cadeddu JA, Kirkby E, *et al.* Clinically localized prostate cancer: AUA/ASTRO/SUO guideline – part I: risk stratification, shared decision making, and care options. *J Urol* 2018; 199: 683–690.
3. Walker CH, Marchetti KA, Singhal U, *et al.* Active surveillance for prostate cancer: selection criteria, guidelines, and outcomes. *World J Urol* 2022; 40: 35–42.
4. Bhat KRS, Raghunath SK, Srivatsa N, *et al.* Outcomes of minimally invasive radical prostatectomy: a contemporary review. *Indian J Surg Oncol* 2020; 11: 580–588.
5. Pierorazio PM, Mullins JK, Eifler JB, *et al.* Contemporaneous comparison of open vs minimally-invasive radical prostatectomy for high-risk prostate cancer. *BJU Int* 2013; 112: 751–757.
6. Du Y, Long Q, Guan B, *et al.* Robot-assisted radical prostatectomy is more beneficial for prostate cancer patients: a system review and meta-analysis. *Med Sci Monit* 2018; 24: 272–287.
7. McIsaac DI, MacDonald DB and Aucoin SD. Frailty for perioperative clinicians: a narrative review. *Anesth Analg* 2020; 130: 1450–1460.
8. Kostakopoulos NA and Karakousis ND. Frailty assessment and postoperative complications in urologic oncology operations. *J Frailty Sarcopenia Falls* 2020; 5: 57–61.
9. Mendiratta P and Latif R. *Clinical Frailty Scale: StatPearls*. Treasure Island, FL: StatPearls Publishing LLC, 2022.
10. Albisinni S, Aoun F, Roumeguère T, *et al.* New treatment strategies for benign prostatic hyperplasia in the frail elderly population: a systematic review. *Minerva Urol Nefrol* 2017; 69: 119–132.
11. Gontero P, Mari A, Marra G, *et al.* Is partial nephrectomy safe and effective in the setting

of frail comorbid patients affected by renal cell carcinoma? Insights from the RECORD 2 multicentre prospective study. *Urol Oncol* 2021; 39: 78e17e26–78.

12. Dindo D, Demartines N and Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg* 2004; 240: 205–213.
13. Shahait M, Labban M, Dobbs RW, *et al*. A 5-item frailty index for predicting morbidity and mortality after radical prostatectomy: an analysis of the American College of Surgeons National Surgical Quality Improvement Program database. *J Endourol* 2021; 35: 483–489.
14. Chimukangara M, Helm MC, Frelich MJ, *et al*. A 5-item frailty index based on NSQIP data correlates with outcomes following paraesophageal hernia repair. *Surg Endosc* 2017; 31: 2509–2519.
15. Sorber R, Lehman A, Alshaikh HN, *et al*. Metabolic syndrome is associated with increased cardiac morbidity after infrainguinal bypass surgery irrespective of the use of cardiovascular risk-modifying agents. *J Vasc Surg* 2019; 69: 190–198.
16. Albertsen PC, Hanley JA and Fine J. 20-year outcomes following conservative management of clinically localized prostate cancer. *JAMA* 2005; 293: 2095–2101.
17. Mottet N, van den Bergh RCN, Briers E, *et al*. EAU-EANM-ESTRO-ESUR-SIOG guidelines on prostate cancer-2020 update – part 1: screening, diagnosis, and local treatment with curative intent. *Eur Urol* 2021; 79: 243–262.
18. Mandel P, Chandrasekar T, Chun FK, *et al*. Radical prostatectomy in patients aged 75 years or older: review of the literature. *Asian J Androl* 2017; 21: 32–36.
19. Merhe A, Hout M, Abou Heidar N, *et al*. Is age an independent risk factor for perioperative mortality and morbidity after radical prostatectomy? Analysis of the American college of surgeons national surgical quality improvement program database. *Arab J Urol* 2020; 18: 72–77.
20. Yamada Y, Teshima T, Fujimura T, *et al*. Comparison of perioperative outcomes in elderly (age ⩾75 years) vs. younger men undergoing robot-assisted radical prostatectomy. *PLoS ONE* 2020; 15: e0234113.
21. Labanaris AP, Witt JH and Zugor V. Robotic-assisted radical prostatectomy in men ⩾75 years of age: surgical, oncological and functional outcomes. *Anticancer Res* 2012; 32: 2085–2089.
22. Hajj AE, Labban M, Ploussard G, *et al*. Patient characteristics predicting prolonged length of hospital stay following robotic-assisted radical prostatectomy. *Ther Adv Urol* 2022; 14: 80737.
23. Davis JW, Kreaden US, Gabbert J, *et al*. Learning curve assessment of robot-assisted radical prostatectomy compared with open-surgery controls from the premier perspective database. *J Endourol* 2014; 28: 560–566.
24. Ubrig B, Boy A, Heiland M, *et al*. Outcome of robotic radical prostatectomy in men over 74. *J Endourol* 2018; 32: 106–110.
25. Roberts MJ, Papa N, Perera M, *et al*. Declining use of radical prostatectomy and pelvic lymphadenectomy despite more robotics: national population data over 15 years. *Asia Pac J Clin Oncol* 2020; 16: e118–e124.
26. McGinley KF, McMahon GC and Brown GA. Impact of the US Preventive Services Task Force grade D recommendation: assessment of evaluations for elevated prostate-specific antigen and prostate biopsies in a large urology group practice following statement revision. *Rev Urol* 2015; 17: 171–177.
27. Lantz A, Bock D, Akre O, *et al*. Functional and oncological outcomes after open versus robot-assisted laparoscopic radical prostatectomy for localised prostate cancer: 8-year follow-up. *Eur Urol* 2021; 80: 650–660.
28. Nyberg M, Hugosson J, Wiklund P, *et al*. Functional and oncologic outcomes between open and robotic radical prostatectomy at 24-month follow-up in the Swedish LAPPRO trial. *Eur Urol Oncol* 2018; 1: 353–360.
29. Walz J, Gallina A, Saad F, *et al*. A nomogram predicting 10-year life expectancy in candidates for radical prostatectomy or radiotherapy for prostate cancer. *J Clin Oncol* 2007; 25: 3576–3581.
30. Xue QL. The frailty syndrome: definition and natural history. *Clin Geriatr Med* 2011; 27: 1–15.
31. Levy I, Finkelstein M, Bilal KH, *et al*. Modified frailty index associated with Clavien-Dindo IV complications in robot-assisted radical prostatectomies: a retrospective study. *Urol Oncol* 2017; 35: 425–431.

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