GYNECOLOGY

Safety of robotic-assisted gynecologic surgery and early hospital discharge in elderly patients

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BACKGROUND: A minimally invasive surgical approach has proven to decrease peri- and postoperative complications and shorten duration of hospital stay; however, there are limited data evaluating the safety of robotic-assisted surgery and early hospital discharge in the elderly population. Because age is a well-known, independent risk factor for perioperative morbidity and gynecologists treat many elderly patients, this is an important area of study.

OBJECTIVE: The objective of the study was to evaluate discharge timing and surgical outcomes in elderly compared with younger patients undergoing robotic-assisted gynecologic surgery.

STUDY DESIGN: This was a retrospective cohort study of all patients who underwent robotic-assisted gynecologic surgery at a high-volume, single institution from January 2013 through May 2016. Demographic information, discharge timing, and peri- and postoperative outcomes were compared for patients <65 years with those ≥65 years using univariate and multivariate analyses.

RESULTS: There were 2757 patients included, with 2521 <65 years and 236 ≥65 years. Median age of the younger group was 42 years, while the median age of the elderly group was 69 years. Elderly patients had a higher body mass index (kilograms per square meter) (28 vs 26, $P < .001$) and higher American Society of Anesthesia classification ($P < .001$). Elderly were more likely to have malignancy as the indication for surgery (68% vs 11%, $P < .001$) and to undergo hysterectomy (81% vs 38%, $P < .001$) or surgery with lymph node dissection (44.5% vs 7.1%, $P < .001$). Elderly patients had a higher incidence of intraoperative complications (9% vs 4.6%, $P = .002$) and longer median hospital stay (17 vs 7 hours, $P < .001$) compared with younger patients. Same-day discharge was more common in younger patients (76% vs 45%, $P < .001$), and elderly patients were more likely to have admissions lasting >23 hours (13% vs 3%, $P < .001$) on univariate and multivariate analysis. Analysis of postoperative outcomes included 2023 patients with available postoperative data (80% of total population) (1794 <65 years, 229 ≥ 65 years). There were no differences between elderly and younger patients in overall postoperative complications, reoperations, intensive care unit admissions, emergency room visits, or hospital readmission within 6 weeks of surgery.

CONCLUSION: Despite having more preoperative risk factors and more surgically complex procedures, elderly patients undergoing robotic-assisted gynecologic surgery had similar postoperative complication rates, and almost half of elderly patients were safely discharged the day of surgery. Our data suggest that robotic-assisted gynecologic surgery and early hospital discharge are safe in elderly patients.

Key words: early hospital discharge, elderly, robotic-assisted surgery

The use of minimally invasive robotic surgery has increased substantially since approval by the Federal Drug Administration in 2005. Despite concern about increased cost and operative time, robotic surgery offers several technical advantages as a result of advanced 3-dimensional technology, which may be especially important in complex cases.[1–3] Although valuable, these advantages must be correlated with clinical outcomes in patients. Studies have demonstrated that a robotic approach is superior to laparotomy and at least equivalent to traditional laparoscopy in terms of clinical outcomes for a variety of gynecologic indications.[4–13]

Despite numerous studies on the minimally invasive robotic approach, there is a paucity of data regarding the safety of robotic-assisted gynecologic surgery in the elderly. Age is a well-established, independent risk factor for morbidity and mortality in gynecologic surgeries, and with the increasing longevity of the population, gynecologists will continue to treat many elderly women.[14–16] Studies have demonstrated that traditional laparoscopy is safe, feasible, and superior to laparotomy in the elderly;[17–20] however, few have evaluated the robotic platform in this population.

Prior studies evaluating robotic surgery for endometrial cancer indicate no difference in estimated blood loss, transfusion rate, operative time, or surgical complications between elderly and younger patients.[20] Some suggest longer hospital stay, and higher rates of postoperative complications for elderly patients, but others report no differences.

We sought to evaluate the safety of robotic-assisted gynecologic surgery in the elderly for a wide variety of indications at a single, high-volume center. The primary outcome of our study was to evaluate peri- and postoperative outcomes between younger and elderly patients. The secondary outcome included differences in hospital and discharge timing between these 2 groups.

Materials and Methods

Approval was obtained from the New York University (NYU) School of Medicine Institutional Review Board (number 09-0102). Subjects included all patients who underwent robotic-assisted gynecologic surgery at NYU Langone Medical Center from June 2013 through May 2016.

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AJOG at a Glance

Why was this study conducted?

To further the evidence on the safety of robotic-assisted gynecologic surgery in the elderly population.

Key findings

Elderly patients had higher rates of preoperative risk factors and more surgically complex procedures. The elderly remained in the hospital longer and were more likely to be admitted for more than 23 hours, but despite this, 45% of this population were safely discharged home the same day as surgery and 87% were discharged within 23 hours. Rates of postoperative complications did not vary between the elderly and younger groups.

What does this study add to what is known?

Data on the safety of traditional laparoscopy in the elderly have been established previously. This paper now adds to this by evaluating the robotic platform and confirming its safety in the elderly population. Additionally, it supports early hospital discharge in elderly patients undergoing robotic-assisted gynecologic surgery.

Subjects were identified and a database was created using the institutional operating room registry and filtering for all gynecologic robotic cases. These patients were divided into 2 groups based on age at the time of surgery: a younger group, defined as age <65 years, and an elderly group age ≥65 years.

Age 65 years was used to define elderly in our study for several reasons. It is the traditional definition used to target programs such as Medicare and Social Services and may have implications for these groups. Second, it is the definition used by several prior studies examining minimally invasive surgery in the elderly.[17,20] Finally, because our sample size decreases with increasing age (only 23%, 75 years old and older) we believed age 65 years would provide useful information on outcomes in the elderly patients while sufficiently powering for meaningful analysis.

We reviewed the electronic medical records for all enrolled patients. We collected demographic and other data including age, race, ethnicity, body mass index (BMI; kilograms per square meter), smoking status, and American Society of Anesthesia (ASA) classification.

Perioperative data included procedure performed, the indication for surgery (malignant vs benign), total surgical time, estimated blood loss (milliliters), intraoperative complications, and reoperation prior to discharge. Total surgical time was defined as the time from incision to closure of skin.

Intraoperative complications included any anesthesia complication (anesthesia-induced hypertension/hypotension, physical damage from endotracheal tube placement, and desaturations with extubation), structural damage to abdominopelvic organs (including bladder, ureter, small bowel, large bowel, mesentery, uterus, vagina, and blood vessels), conversion to laparotomy, and need for intraoperative transfusion.

Data on hospital discharge timing included length of hospital stay (measured in hours from the time the patient exited the operating room to the time of hospital discharge) and admission status. Admission status was divided into 3 categories: same-day discharge defined as patients discharged before midnight on the day of surgery, 23 hours of observation defined as patients who stayed past midnight on the day of surgery but were admitted for 23 hours or less, and full admission defined as patients admitted for more than 23 hours.

Postoperative outcomes were collected including common postoperative complications (fever, wound infection, urinary tract infection, abscess, other infection related to surgery, port-site hernia, small bowel obstruction, ileus, fistula, postoperative transfusion requirement, position-related nerve injury, pulmonary embolism, deep vein thrombosis, and arrhythmia), reoperation after discharge and within 6 weeks, intensive care unit (ICU) admission, emergency room visits, and hospital readmissions within 6 weeks.

Statistical analysis

The continuous variables used to compare outcomes for the different age groups were tested for normality via the Kolmogorov-Smirnov test; univariate tests were applied according to whether the variable of interest was distributed normally (ie, Student *t* test) or not normally (ie, Mann-Whitney *U* test). Associations between categorical variables were evaluated with χ^2 tests or a Fisher exact test as appropriate for the category size.

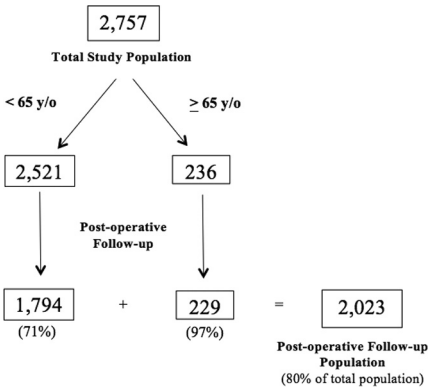
Multivariate assessment was conducted using logistic and linear regression analysis to account for potential confounders to our measured outcomes of interest. The acceptable α error level was set at $P = .05$ with 2-tailed tests. Data were analyzed with SPSS statistical software (version 20; SPSS, Inc, Chicago IL).

Results

Two thousand seven hundred fifty-seven patients underwent robotic-assisted gynecologic surgery at our institution over the study period and were included in the analysis. There were 2521 in the younger group, aged <65 years (Figure), and 236 in the elderly group, aged ≥65 years. Patient characteristics are presented in Table 1.

The median age of the younger group was 42 years (range 15−64), while the median age of the elderly group was 69 years (range 65−87, $P < .001$). Within the elderly group, 75% of the patients identified as white as compared with 41% in the younger group ($P < .001$), while the younger group had more black (26% vs 8%) and Asian (12% vs 8%) patients as compared with the elderly group ($P < .001$). The younger group also had significantly more patients who identified as Hispanic as compared with the elderly group (16% vs 7%, $P < .001$).

FIGURE 1
Patient flow diagram



Flow diagram describing the number and percentage of patients in each age group included in the total study population and the post-operative follow-up population.

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TABLE 1
Patient Characteristics

Patient characteristics	<65 y (n = 2521)	≥65 y (n = 236)	*P* value
Age, y (median, range)	42 (15–64)	69 (65–87)	< .001
Race			< .001
White	1042 (41%)	177 (75%)	
Black	654 (26%)	18 (8%)	
Native Hawaiian/Pacific Islander	11 (1%)	1 (1%)	
Asian	316 (12%)	20 (8%)	
American Indian/Alaska Native	3 (0%)	0	
Other/unknown	495 (20%)	20 (8%)	
Ethnicity			< .001
Non-Hispanic	2125 (84%)	219 (93%)	
Hispanic	396 (16%)	17 (7%)	
Smoking status			< .001
Never smoker	1854 (74%)	140 (59%)	
Former smoker	458 (18%)	90 (38%)	
Current everyday smoker	125 (5%)	4 (2%)	
Current some days smoker	60 (2%)	0	
Current few days smoker	8 (0%)	0	
Unknown	16 (1%)	2 (1%)	
BMI, kg/m^2 (median, range)	26 (16–64)	28 (16–60)	< .001
ASA score			< .001
1	729 (29%)	1 (1%)	
2	1612 (64%)	151 (64%)	
3	180 (7%)	82 (34%)	
4	0 (0%)	2 (1%)	
Surgery for malignant indication	281 (11%)	160 (68%)	< .001

ASA, American Society of Anesthesiologists; *BMI*, body mass index.

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Smoking status also varied significantly between the 2 groups. The younger group was significantly more likely to have never smoked (74% vs 59%) or to be a current smoker (7% vs 2%) as compared with the elderly group, while patients in the elderly group were more like to be a former smoker (38% vs 18%, $P < .001$). ASA class also varied significantly, with 29% of the younger group receiving an ASA class score of 1 as compared with only 1% of the elderly group ($P < .001$) and 7% of the younger group receiving an ASA class score of 3 as compared with 34% of the elderly group ($P < .001$). Patients in the elderly group also had a significantly higher BMI (28 vs 26 kg/m^2, $P < .001$) and were more likely to have malignancy as the indication for surgery (68% vs 11%, $P < .001$) as compared with the younger group.

Table 2 describes the type of surgical procedure performed by age group. Younger patients were more likely to undergo hysterectomy alone (21% vs 3%, $P < .001$) or benign procedures such as ovarian cystectomy (13.6% vs 0%, $P < .001$), myomectomy (39% vs 1%, $P < .001$), and removal of endometriosis (16.8% vs 0%, $P < .001$) as compared with the elderly. Elderly patients were more likely to undergo hysterectomy with additional procedures including bilateral salpingo-oophorectomy (BSO) or unilateral salpingo-oophorectomy (USO) (36% vs 11%, $P < .001$) and lymph node dissection (42% vs 6.1%, $P > .001$) as compared with younger patients. Surgery that included lymph node dissection was more common in the elderly group (44.5% vs 7.1%, $P < .001$) than the younger group.

Surgical data are presented in Table 3. On univariate analysis, surgery in elderly patients was significantly longer than in younger patients (215 vs 171 minutes, $P < .001$). Elderly patients also had a higher incidence of intraoperative complications (9.3% vs 4.7%, $P = .002$). Of these intraoperative complications, elderly patients had higher rates of conversion to laparotomy (3.4% vs 1.1%, $P = .005$) and anesthesia complications (1.3% vs 0.3%, $P < .001$). Neither intraoperative transfusion nor structural damage was significantly different between the 2 age groups. Estimated blood loss did not vary significantly between the 2 groups. Ten patients in the younger group and no patients in the elderly group required reoperation prior to discharge, which was not statistically significant ($P = .33$).

On multivariate regression analysis controlling for race, ethnicity, smoking

TABLE 2
Procedure type

Procedure	<65 y (n = 2521)	≥65 y (n = 236)	*P* value
Hysterectomy alone	529 (21%)	7 (3%)	< .001
Hysterectomy plus BSO/USO	288 (11%)	86 (36%)	< .001
Hysterectomy plus LND with or without BSO/USO	153 (6.1%)	99 (42%)	< .001
LND with or without BSO	14 (1%)	6 (2.5%)	.005
BSO/USO	162 (6.4%)	32 (13.5%)	< .001
Removal of abdominal/pelvic mass	17 (1%)	5 (2%)	.03
Ovarian cystectomy	343 (13.6%)	0	< .001
Myomectomy	987 (39%)	2 (1%)	< .001
Removal of endometriosis	425 (16.8%)	0	< .001
Vaginal trachelectomy	10 (0.5%)	0	1.00

BSO, bilateral salpingo-oophorectomy; *LND*, lymph node dissection; *USO*, unilateral salpingo-oophorectomy.
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status, BMI, ASA score, and malignant indication for surgery, difference in length of surgery was no longer significant between the 2 age groups ($P = .31$). Incidence of intraoperative complications remained significantly higher in the elderly patients ($P = .03$). Specifically, anesthesia complications remained significant on multivariate analysis ($P = .03$), whereas the rate of conversion to laparotomy did not remain significant ($P = .31$).

Results for length of hospital stay and hospital discharge are presented in Table 4. The postanesthesia care unit stay did not vary significantly between the 2 groups. Overall median hospital stay was longer in the elderly patients as compared with the younger patients (17 vs 7 hours, $P < .001$).

Admission status also varied significantly between the 2 groups. Seventy-six percent of younger patients were discharged on the day of surgery vs 45% of the elderly patients ($P < .001$). In total, 97% of younger patients were discharged within 23 hours of surgery, as compared with 87% of elderly patients ($P < .001$). Three percent of younger patients and 13% of elderly patients were admitted for >23 hours ($P < .001$). Differences in hospital admission status remained significant on multivariate regression analysis adjusting for race, ethnicity, smoking status, BMI, ASA score, and malignant indication for surgery (Table 4).

Two thousand twenty-three patients were included in the analysis of postoperative outcomes (1794 <65 years, 229 ≥65 years) after 734 patients were excluded because of unavailable postoperative follow-up information (the patient did not present for postoperative evaluation or received postoperative medical care at an outside institution not associated with this institution's electronic medical record system) (Figure 1).

Table 5 describes postoperative outcomes in patients with available follow-up data. Overall rates of common postoperative complications did not vary significantly between the young and elderly groups on univariate or multivariate regression analysis (13.7% vs 14.9%, $P = .47$). Pulmonary embolism was the only complication that was significantly more common in elderly patients (1.3% vs 0.2%, $P = .02$).

On multivariate regression analysis controlling for race, ethnicity, smoking status, BMI, ASA score, and malignant indication for surgery, there was no

TABLE 3
Univariate and multivariate regression analysis of surgical data

Surgical data	<65 y (n = 2521)	≥65 y (n = 236)	Univariate *P* value	Multivariate *P* value[a,b]
Surgical time, min (median, range)[c]	171 (60–559)	215 (73–438)	< .001	.31
Estimated blood loss, mL (median, range)	100 (5–3000)	100 (5–1000)	.822	
Intraoperative complication overall	118 (4.7%)	22 (9.3%)	.002	.03
Intraoperative transfusion	50 (2%)	5 (2.1%)	.89	
Anesthesia complication[d]	8 (0.3%)	3 (1.3%)	< .001	.03
Structural damage[e]	50 (2%)	9 (3.8%)	.06	
Conversion to laparotomy[c]	28 (1.1%)	8 (3.4%)	.005	.31
Reoperation prior to discharge	10 (0.4%)	0 (0%)	.33	

[a] Controlled for race, ethnicity, smoking status, body mass index, American Society of Anesthesia score, and malignant indication for surgery; [b] Multivariate regression was not computed for variables that were not significant on univariate regression analysis; [c] Significant on univariate regression analysis but not on multivariate regression analysis; [d] Anesthesia complications were anesthesia-induced hypertension/hypotension, physical damage from endotracheal tube placement, and desaturations with extubation; [e] Structural damage was injury to internal abdominopelvic organs including bladder, ureter, small bowel, large bowel, mesentery, uterus, vagina, and blood vessels.
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TABLE 4
Hospital timing

Time parameter	<65 y (n = 2521)	≥65 y (n = 236)	*P* value
PACU stay, h (median, range)	4.8 (0–357)	4.2 (1–28)	.28
Hospital stay, h (median, range)	7 (2–357)	17 (2.5–117.5)	< .001
Admission status			< .001
Same-day discharge	1914 (76%)	107 (45%)	
23 hours of observation	525 (21%)	98 (42%)	
Regular admission	82 (3%)	31 (13%)	

PACU, postanesthesia care unit.
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difference between young and elderly patients ($P = .08$). There were no significant differences between elderly and younger patients in reoperations, ICU admissions, emergency room visits, or hospital readmissions at 6 weeks. One patient, aged 68 years, died from complications of reoperation on postoperative day 3 from likely undiagnosed enterotomy at the time of original surgery for debulking and lymph node dissection.

Comment

The robotic platform is increasingly being utilized as a minimally invasive approach in gynecologic surgery because of distinct advantages. One area with noticeably limited data is the use of robotic-assisted gynecologic surgery in the elderly population. Several retrospective studies exist suggesting promising results; however, they are notably small and focus on patients undergoing surgery for endometrial cancer.[20–23] Krause et al[24] investigated outcomes in elderly patients undergoing robotic-assisted gynecologic surgeries for a wide range of indications.

This study included 705 patients, 50 patients aged ≥75 years and 655 patients aged <75 years. They found that elderly patients had a longer hospital length of stay and a greater likelihood of postoperative arrhythmia; however, there were no differences in operative time, intraoperative complications, or reoperations between these groups.[24]

In this study, we also demonstrate the safety of the robotic approach in our elderly population. Not surprisingly, we showed that our group of elderly patients was more likely to have medical comorbidities and malignant indication for surgery. In accordance with this, the elderly had higher rates of hysterectomy overall (81% vs 38%) as well as higher rates of hysterectomy with adnexal surgery and lymph node dissection.

These are likely more surgically complex procedures than those for the benign indications in the younger group. We also found an increased rate of intraoperative complications in the elderly, most notably anesthesia complications that remained significant on multivariate analysis. Although significant, the overall rate of anesthesia complications was low, with only 3 patients (1.3%) ≥65 years who experienced it, and as such, this rate seems to be acceptable in elderly patients undergoing robotic surgery. Transfusion and structural damage did not vary between the groups, and conversion to laparotomy was significant on univariate analysis but not on multivariate analysis.

We also found that elderly patients had a longer hospital stay, with only 45% of elderly leaving the same day as compared with 76% of the younger cohort. Despite this, a majority of the elderly patients who remained in the hospital overnight were admitted for 23 hours of observation, 42% of elderly patients compared with 21% of younger patients, with only 13% of elderly patients admitted for >23 hours, as compared with 3% of younger patients. This is not surprising because it is well established that age is associated with lower rates of same-day discharge after minimally invasive gynecologic surgery.[25–28]

As we have shown, elderly patients were more likely to undergo surgery for a malignant indication, and not only are these more medically complex patients and cases, but they are also significantly longer and require more anesthesia time and time in the postanesthesia care unit, which likely contributes to longer hospital stays.

In addition to medical factors, it is likely that a number of social determinants contributed to this result. In a study evaluating same-day discharge for robotic-assisted gynecologic procedures, Rivard et al[27] demonstrated that 20% of patients who required admission did so for social reasons (examples include lack of transportation home, awaiting arrangement of other health care services, lack of a support person), and these social blockades are more common in the elderly.

Additionally, it is possible that physicians are more cautious with elderly patients and have a lower threshold for admitting these patients. For those patients who are discharged the same day or within 23 hours, measures are taken to ensure frequent postoperative communication. These patients are called the day after surgery by a postanesthesia care unit nurse and on postoperative day 2 by an office nurse to assess postoperative progress and for any concerning complications.

Additionally, every patient, regardless of discharge timing, is called by their physician within 7–10 days for pathology review and check-in and has follow-up in the office within 2 weeks. Careful outpatient follow-up is needed to ensure safe early discharge.

While elderly patients remained in the hospital longer, they did not experience increased rates of adverse postoperative outcomes compared with their younger counterparts. Overall rates of common postoperative complications did not vary significantly between the 2 age groups. Pulmonary embolism was the only complication that was significantly more common in the elderly on univariate analysis; however, this did not maintain

TABLE 5
Univariate and multivariate regression analysis of post-operative outcomes in patients with follow-up

Postoperative outcome	<65 y (n =1794)	≥65 y (n = 229)	Univariate *P* value	Multivariate *P* value[a,b]
Overall postoperative complications	245 (13.7%)	34 (14.9%)	.62	
Fever	88 (4.9%)	8 (3.5%)	.35	
Wound infection	42 (2.3%)	4 (1.8%)	.57	
Abscess	17 (1%)	1 (0.4%)	.45	
UTI	70 (3.9%)	13 (5.7%)	.21	
Other infection	19 (1.1%)	4 (1.8%)	.36	
Port-site hernia	11 (0.6%)	4 (1.8%)	.07	
SBO	8 (0.5%)	2 (0.9%)	.39	
Ileus	4 (0.2%)	2 (0.9%)	.11	
Postoperative transfusion	19 (1.1%)	5 (2.2%)	.15	
Position-related nerve injury	10 (0.6%)	1 (0.4%)	.82	
Arrhythmia	26 (1.5%)	6 (2.6%)	.19	
DVT	3 (0.2%)	1 (0.4%)	.41	
Pulmonary embolism[c]	4 (0.2%)	3 (1.3%)	.02	.08
Reoperation at any time	13 (0.7%)	4 (1.8%)	.11	
ICU admission	9 (0.5%)	1 (0.4%)	.9	
Emergency room evaluation within 6 wks	131 (7.3%)	24 (10.5%)	.09	
Hospital readmission within 6 wks[b]	57 (3.2%)	13 (5.7%)	.05	.69

DVT, deep vein thrombosis; *ICU*, intensive care unit; *SBO*, small bowel obstruction; *UTI*, urinary tract infection.

[a] Controlled for race, ethnicity, smoking status, body mass index, American Society of Anesthesiologists score, and malignant indication for surgery; [b] Multivariate regression was not computed for variables that were not significant on univariate regression analysis; [c] Significant on univariate regression analysis but not on multivariate regression analysis.

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significance on multivariate analysis ($P = .08$). Additionally, the rates of several postoperative outcomes did not vary between age groups, including reoperation, ICU admission, emergency room evaluation, and hospital readmission within 6 weeks of surgery on multivariate analysis.

This was a single-center, nonrandomized, retrospective chart review with several limitations. As a retrospective analysis, inherent selection bias exists, in which only healthier elderly patients who could tolerate surgery were selected as surgical candidates. Despite this, at NYU, robotic gynecologic surgery has become the standard practice, and all patients who were deemed appropriate surgical candidates, regardless of age, were offered the robotic approach.

Additionally, outpatient follow-up data were incomplete for 734 patients (20% of the original study population). Most of these patients were from the younger group, and only 7 patients (3%) of the elderly group were lost to follow-up. As a result, we have complete data for 229 patients in the ≥65 year age group, which is much larger than any study to date (Figure 1).

It is possible that patients who were included may have presented to outside physicians and hospitals for postoperative complications and may have experienced hospital readmissions not captured by our data collection. As a result there may be underreporting of adverse postoperative outcomes.

Finally, it is important to recognize limitations in generalizability. This study was completed at a single institution with a dedicated multidisciplinary robotic team, with experienced, high-volume robotic surgeons and may not be applicable to patients seeking care at smaller, less experienced centers or institutions. In addition, as a retrospective study, we do not have insight in to why or why not early discharge was chosen for individual patients. It is important to emphasize that, at our institution, there are no predetermined differences in our criteria for discharge based on age, and each patient is assessed individually by a provider to determine both medical and social appropriateness for discharge.

In summary, despite increased pre- and perioperative risk factors and longer hospital stay in our elderly patients, 45% were discharged the same day and 87% percent were discharged within 23 hours of surgery without a significant difference in postoperative complications, reoperations, ICU admissions, emergency room visits, or readmissions when compared with younger patients. Although the risks of surgery are increased in the elderly population, robotic-assisted gynecologic surgery and early hospital discharge were safe in our cohort of elderly patients. ■

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