Early Outcomes Following Implementation of a Multispecialty Geriatric Surgery Pathway

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Objective: To examine geriatric-specific outcomes following implementation of a multispecialty geriatric surgical pathway (GSP).

Background: In 2018, we implemented a GSP in accordance with the proposed 32 standards of American College of Surgeons' Geriatric Surgery Verification Program.

Methods: This observational study combined data from the electronic health record system (EHR) and ACS-National Surgery Quality Improvement Program (NSQIP) to identify patients ≥ 65 years undergoing inpatient procedures from 2016 to 2020. GSP patients (2018–2020) were identified by preoperative high-risk screening. Frailty was measured with the modified frailty index. Surgical procedures were ranked according to the operative stress score (1–5). Loss of independence (LOI), length of stay, major complications (CD II–IV), and 30-day all-cause unplanned readmissions were measured in the pre/postpatient populations and by propensity score matching of patients by operative procedure and frailty.

Results: A total of 533 (300 pre-GSP, 233 GSP) patients similar by demographics (age and race) and clinical profile (frailty) were included. On multivariable analysis, GSP patients showed decreased risk for LOI [odds ratio (OR) 0.26 (0.23, 0.29) $P < 0.001$] and major complications [OR: 0.63 (0.50, 0.78) $P < 0.001$]. Propensity matching demonstrated similar findings. Examining frail patients alone, GSP showed decreased risk for LOI [OR: 0.30 (0.25, 0.37) $P < 0.001$], major complications [OR: 0.31 (0.24, 0.40) $P < 0.001$], and was independently associated with a reduction in length of stay [incidence rate ratios: 0.97 (0.96, 0.98), $P < 0.001$].

Conclusions: In our diverse patient population, implementation of a GSP led to improved geriatric-specific surgical outcomes. Future studies to examine pathway compliance would promote the identification of further interventions.

Keywords: frailty, geriatric surgical pathway, NSQIP

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The population of older adults is growing rapidly in the United States, and this is of great concern as individuals over the age of 65 account for ~40% of all inpatient surgeries.[1,2] To better care for the growing population of older surgical patients, the American College of Surgeons (ACS) partnered with the John A. Hartford Foundation to develop a Geriatric Surgery Verification Program (ACS-GSV).[3] This program recommends the implementation of 32 evidence-based standards that reflect the 4 M's (Mentation, Mobility, Medication, Matters) described by the Age-Friendly Hospital Program and have been shown to address the unique challenges of caring for our older surgical patients.[3,4]

Clinical pathways designed to improve outcomes are not new to surgical care. Enhanced recovery after surgery (ERAS) is a robust perioperative program designed to implement evidence-based strategies to reduce the variability in care provided by multiple teams across several disciplines.[5] Implementation of an ERAS program has been shown to reduce length of stay (LOS) and 30-day complications by several investigators.[5–8] Although ERAS has been successful at improving outcomes for many different surgical procedures, it does not provide the patient-centered care coordination that many of our older adults require.[9] Furthermore, although many of the perioperative standards recommended by the ACS-GSV align with ERAS, there are several evidence-based standards that are not addressed. These standards include the following:

(1) Screening patients for functional and cognitive impairment through a Comprehensive Geriatric Assessment (CGA). A CGA has been shown to decrease LOS, discharge to a higher level of care, perioperative mortality, and cost.[10]
(2) Conducting a preoperative multidisciplinary geriatric surgery conference to review high-risk patients which has been shown to be associated with significant changes to the treatment plan.[11]
(3) Including Geriatric Medicine in the postoperative care of the surgical patient which has been shown to shorten time to surgery and reduce LOS and mortality compared to usual care.[9]
(4) Providing safe transitions of care through detailed communication between the acute care facility and the skilled nursing facilities or home. Lack of follow up following discharge from an acute care facility is associated with increased likelihood of 30-day readmission and death.[12–14]

In 2015, we implemented our ERAS program in Colorectal Surgery, followed by General, Gastrointestinal, and Hernia Surgery in 2016. Implementation of ERAS resulted in a significant reduction in LOS and major complications.[7,15] In 2018, 3 years following successful implementation of our ERAS program, we implemented our geriatric surgery pathway (GSP) across multiple surgical specialties at The Johns Hopkins Bayview Medical Center. Pathway implementation was in compliance with the 32 recommend standards of the ACS-GSV.[3] The purpose of this study is to examine geriatric-specific outcomes following implementation of the GSP across surgical specialties. In addition to those outcomes routinely evaluated following ERAS implementation (LOS and postsurgical complications), we examined loss of independence (LOI) at discharge and 30-day all-cause unplanned readmissions.[10]

METHODS

The GSP was implemented at The Johns Hopkins Bayview Medical Center across General Surgery, Orthopedics, Vascular surgery, Plastic and Reconstructive Surgery, and Urology targeting the 32 standards determined by the ACS to be optimal resources for geriatric surgery.[3] Participation was initiated in all patients ≥65 years who underwent high-risk screening with the Edmonton Frail Scale (EFS).[16,17] Patients with an EFS ≥6 are considered high-risk for frailty. The GSP pathway included performing a CGA on all high-risk individuals and discussing high-risk individuals on a preoperative multidisciplinary call. Our GSP interventions included in this pathway are shown in Figure 1. Briefly, our high-risk frail patients on the GSP are seen and/or followed by Geriatric Medicine who provided guidance focused on medication management and delirium prevention. All inpatients ≥65 years at Johns Hopkins Bayview Medical Center undergo routine delirium screening using the 4AT.[18] In addition, our surgical nurses on the ward have undergone Geriatric Resource Nurse (GRN) training through the Nurses Improving Care for our Health System Elderly (NICHE) program.[19] The materials in this program include education on medications that should be avoided in the elderly (Beers criteria),[20] delirium screening and prevention, and the importance of ambulation. Nutritional services are provided to inpatients who are at high risk for frailty and include calorie counts, early return of dentures, and aspiration risk prevention. In addition, we recommend supplemental health shakes to high-risk frail patients preoperatively. The Johns Hopkins Health system established an Activity Motivation Program (AMP) entitled the "Highest Level of Mobility" (HLM) program.[21] This program utilizes the Activity Measure for Post-Acute Care (AMPAC) scores to drive mobility goals with patients. This is a nurse run mobility program that incentives patients to be active while in the hospital.[22] Finally, postoperative pain management is led by our acute care pain team and established protocols and ordersets exist for management of postoperative pain in the elderly. These protocols begin in the operating room with use of regional anesthesia and continue in the postanesthesia care area and on the surgical ward.

Study Design

This pre-post implementation study evaluated the effects of our GSP on postoperative outcomes. The pre-GSP implementation cohort included a retrospective analysis of all patients ≥ 65 years undergoing an inpatient nonemergent surgical procedure from July 2016 to December 2017. This time period is 1 year after ERAS implementation and prior to GSP implementation. A prospective consecutive cohort of patients ≥65 years who underwent preoperative high-risk screening (EFS) and had inpatient nonemergent surgery from February 2018 to December 2020 served as our study population (GSP). Specialties included were General Surgery, Orthopedics, Vascular surgery, Plastic and Reconstructive Surgery, and Urology. Exclusion criteria included patients ≥65 years undergoing emergent surgery between February 2018 and December 2020 and patients who did not have an EFS completed as this is the cornerstone of the GSP. Procedures from specialties that did not occur during our GSP study period (Gynecology and Thoracic) were also excluded (Fig. 2). Ethical standards were met, and approval was obtained from The Johns Hopkins University Institutional Review Board. This study followed strobe guidelines for publication.

We analyzed our total study population to examine the overall postoperative outcomes comparing pre-GSP to our GSP

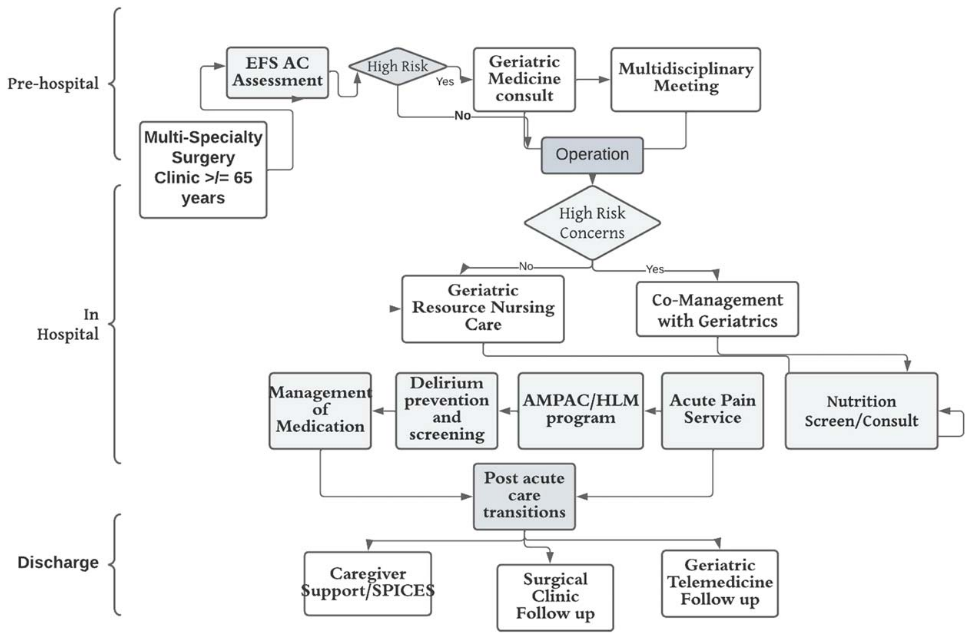

FIGURE 1. Geriatric-pathway roadmap for elective surgery. SPICES is an acronym for a multidimensional assessment protocol developed to identify risk factors associated with care for older adults (skin integrity, eating difficulties, incontinence, disorientation, evidence of falls, and sleep disturbance).

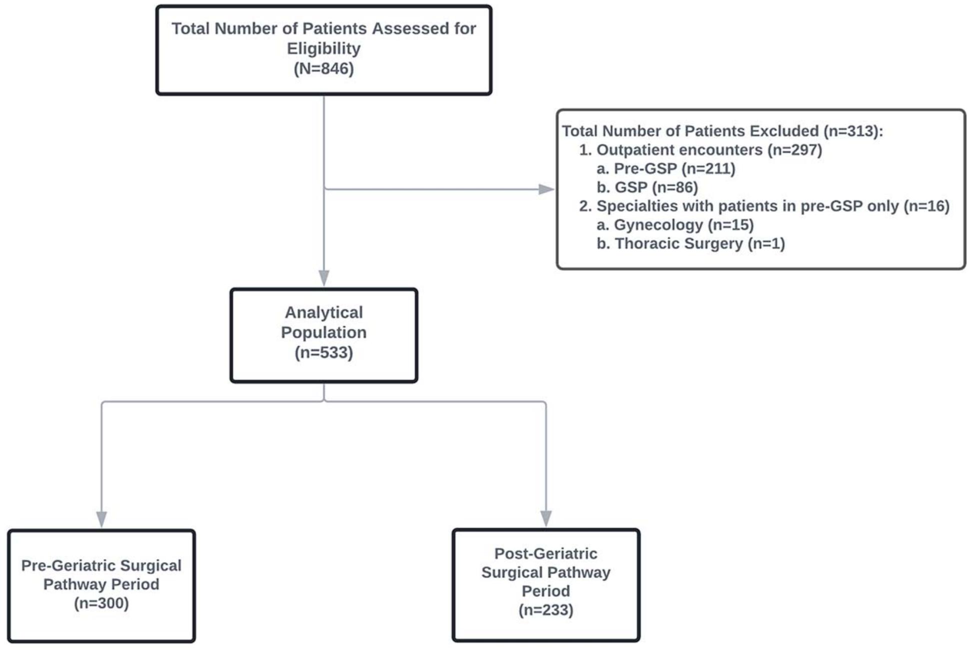

FIGURE 2. Consort flow diagram for geriatric surgery pathway recruitment.

cohort. We also performed a subgroup analysis to examine the effect of GSP implementation on our most vulnerable frail patients. Finally, we were only able to control for procedure variability using service line designation and a validated scoring system for procedures, the operative stress score (OSS).[23,24] Therefore, we chose to perform propensity matching for patients in the pre-GSP and GSP contingent on demographics and clinical profile.

Data Collection

Patient data included demographics (age, sex, race), clinical, procedural, and outcomes data. All patient demographical, clinical, and procedural data were extracted from the electronic health record system (EHR). The total score of the EFS was obtained from the EHR, achieving 100% data acquisition. Specifically, JHBMC partnered with the ACS-National Surgery Quality Improvement Program (NSQIP) in 2014 for successful implementation of care pathways and our methodology has been well-described.[15] Data entered into ACS NSQIP on JHBMC participants is extensive. Because we have previously utilized this robust registry to examine our outcomes following ERAS implementation, we chose to merge patients abstracted from our EHR with the NSQIP registry. A merge of both data sources produced aggregated data that served as the analytical dataset.

Modified Frailty Index

Frailty was identified using the modified frailty index (mFI) which is embedded into the ACS NSQIP registry and has been previously described.[25] The mFI includes 5 conditions (each scoring 1 point) which are common comorbidities associated with the frailty syndrome including: (1) history of chronic obstructed pulmonary disease; (2) congestive heart failure within 30 days before surgery; (3) functional health status before surgery (independent, partially dependent, or totally dependent); (4) hypertension requiring medication; and (5) diabetes mellitus requiring oral agents or insulin. To calculate the mFI, a tally of each condition present is recorded for a possible score of 0–5 points. Previous research indicates that a score of 2 or more is sufficient to suggest a risk for adverse events following surgery.[26,27] Thus participants from both cohorts were stratified as frail if assigned a mFI ≥ 2. As the mFI is a multimorbidity index, we did not risk adjust for any additional comorbidities.

Operative Stress Score

The OSS has been validated and previously described.[23,24] Briefly, the OSS is assigned using the primary Current Procedural Terminology codes using an ordinal scale of 1–5 and corresponds to the anticipated level of physiologic stress caused to a patient by that specific procedure. Higher OSS scores indicate more physiologic stress levels. Using this scoring system allows for risk-adjusted analysis for the variety of surgical procedures included in this study.

Postoperative Outcomes

Postoperative outcome measures included: (1) LOI defined as a either a change in functional status (activities of daily living) or discharge to a higher level of care (home vs. home health, skilled nursing facility, or rehabilitation facility); (2) LOS defined as a count in days from the day of the procedure to discharge; (3) complications graded using Clavien-Dindo (CD) classification system[28] with CD grade of II–IV considered major as they are deemed life-threatening and required intervention; and (4) 30-day readmission defined as all-cause unplanned readmission within 30 days from discharge. Overall, 30-day mortality was recorded.

Statistical Analysis

We compared the patients' demographics, clinical, and procedural data by pre-GSP and GSP implementation periods. To do this, we used the nonparametric Wilcoxon rank-sum tests to compare the medians; dichotomous and categorical variables were compared using χ^2 test and the Fisher exact tests. Results

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are summarized as frequencies and proportions. The Akaike Information Criterion was used for our model selection. For postoperative outcomes, we performed multivariable logistic regressions for LOI, CD, and readmissions. A quasilikelihood multivariable Poisson model was used to evaluate LOS. Results are presented as odds ratios [OR (LOI, CD, and readmissions]), and incidence rate ratios [IRR (LOS)] with their corresponding 95% confidence interval.

Propensity score analysis was performed by using treatment effects estimation models to calculate matched scores that estimate the average treatment effects of GSP on our postoperative outcomes. The propensity scores are contingent on (1) intervention dependent—pre-GSP/GSP and (2) intervention independent age, sex, race, frailty status, OSS, and surgery specialty (general, orthopedic, plastic and reconstructive, urology, and vascular). In addition, we limited bias and ensured the quality of the matched pairs by utilizing robust estimations for standard errors and maximum iterations. Our final propensity-matched groups were balanced without violating the basic assumptions of the models.[29]

The threshold for alpha was 5%, that is, a P value of <0.05 was statistically significant. We performed all analyses using STATA 14.0 (StataCorp, College Station, TX).

RESULTS

Overall, there were 533 patients ≥65 years who underwent inpatient surgery at JHBMC and met inclusion criteria (Fig. 2). The pre-GSP cohort included 300 patients and the GSP cohort, 233 patients. Demographics and univariate outcomes for these individuals are delineated in Table 1. Overall, patients in both cohorts were similar by the demographic characteristics of age and race and the clinical profile of frailty. Fewer male patients were in the GSP versus pre-GSP cohort (52% vs. 63%, $P=0.01$). Procedural classification demonstrated more orthopedic cases in the GSP cohort, however, no difference in OSS was noted between the 2 cohorts. Unadjusted analysis of the 2 cohorts revealed a significant lower rate of LOI for the GSP cohort as compared to the pre-GSP cohort (12% vs. 27%, $P<0.001$). The median LOS was higher by 1 day for the GSP cohort when compared to the pre-GSP cohort (3 vs. 2 days, $P=0.001$).

On adjusted multivariable analysis examining outcomes of interest, treatment on the GSP pathway (GSP cohort) was associated with a significant decreased risk for postoperative LOI [OR: 0.26 (0.23, 0.29) $P<0.001$] and major complications [OR: 0.63 (0.50, 0.78) $P<0.001$]. An independent association between LOI and the demographic and clinical characteristics of older age, being female, and frailty was seen (Table 2). Increased risk for major complications were seen for female patients and non-White patients. In this study population, treatment on the GSP pathway was not associated with improvement in LOS or readmission rate. Being frail and undergoing a procedure with a higher OSS was associated with an increased LOS and non-White patients were more likely to have a 30-day all-cause readmission (Table 2). After

TABLE 1. Patient characteristics and postoperative outcomes in the total study group (n = 533) comparing the pre-GSP cohort (n = 300) and GSP cohort (n = 233)

Patient Characteristics	Total (n = 533), n (%)	Pre-GSP (2016–2017) (n = 300), n (%)	GSP (2018–2020) (n = 233), n (%)	P*
Age, median (IQR), years	73.0 (69.0, 77.0)	73.0 (68.0, 77.0)	73.0 (69.0, 78.0)	0.13
Sex				
Male	309 (58.0)	189 (63.0)	120 (51.5)	0.01
Female	224 (42.0)	111 (37.0)	113 (48.5)	
Race				
White	446 (83.7)	255 (85.0)	191 (82.0)	0.51
Black	61 (11.4)	33 (11.0)	28 (12.0)	
Other	26 (4.9)	12 (4.0)	14 (6.0)	
Modified Frailty Index				
< 2	379 (71.0)	220 (73.3)	159 (68.2)	0.21
≥ 2	154 (29.0)	80 (26.7)	74 (31.8)	
Surgical specialty				
General	256 (48)	134 (44.7)	122 (52.3)	< 0.001
Orthopedics	19 (3.6)	0	19 (8.2)	
Plastic and reconstructive	2 (0.4)	1 (0.3)	1 (0.4)	
Urology	76 (14.3)	68 (23)	8 (3.4)	
Vascular	180 (33.7)	97 (32)	83 (35.6)	
Operative Stress Score				
2	106 (19.9)	70 (23.3)	36 (15.5)	0.06
3	321 (60.2)	178 (59.3)	143 (61.4)	
4	91 (17.1)	43 (14.3)	48 (20.6)	
5	15 (2.8)	9 (3.0)	6 (2.6)	
Postoperative outcomes				
Loss of independence	107 (20.1)	80 (26.7)	27 (11.6)	< 0.001
Length of hospital stay, median (IQR), days	3.0 (2.0, 5.0)	2.0 (1.0, 5.0)	3.0 (2.0, 6.0)	0.001
Major complications (CD ≥ 2)	90 (16.9)	56 (18.7)	34 (14.6)	0.24
30-day all-cause unplanned readmissions	37 (6.9)	15 (5.0)	22 (9.4)	0.06
Mortality—30 d	3 (0.6)	2 (0.7)	1 (0.4)	1.00

Race: other includes Asian, Native Hawaiian/Pacific Islander, American Indian/Alaska Native, or unknown; frailty is defined as Modified Frailty Index ≥ 2.
*P value χ^2 and exact (n < 10) tests for proportions and nonparametric Wilcoxon rank-sum tests for medians.
IQR indicates interquartile range.

TABLE 2. Risk-adjusted analysis of postoperative outcomes for the total study population (n = 533)

	Loss of Independence		Length of Hospital Stay		Major Complications (CD ≥ 2)		30-Day All-Cause Unplanned Readmissions	
Variable	OR (95% CI)	P	IRR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
Pre-GSP	Ref		Ref		Ref		Ref	
GSP	0.26 (0.23, 0.29)	< 0.001	1.05 (0.99, 1.11)	0.11	0.63 (0.50, 0.78)	< 0.001	1.97 (0.99, 3.95)	0.06
Age	1.06 (1.04, 1.09)	< 0.001	1.01 (0.98, 1.03)	0.62	1.04 (0.97, 1.11)	0.32	0.97 (0.91, 1.04)	0.43
Male	Ref		Ref		Ref		Ref	
Female	1.76 (1.05, 2.94)	0.03	1.04 (0.94, 1.16)	0.45	1.39 (1.05, 1.83)	0.02	1.32 (0.66, 2.63)	0.43
White	Ref		Ref		Ref		Ref	
Black/others	1.24 (0.95, 1.62)	0.11	1.11 (0.86, 1.44)	0.42	1.39 (1.09, 1.77)	0.01	1.69 (1.00, 2.86)	0.05
Non-Frail	Ref		Ref		Ref		Ref	
Frail (MFI ≥ 2)	2.09 (1.93, 2.25)	< 0.001	1.30 (1.12, 1.51)	< 0.001	1.11 (0.47, 2.62)	0.81	1.19 (0.58, 2.45)	0.64
Operative Stress Score								
2	Ref		Ref		Ref		Ref	
3	0.90 (0.51, 1.61)	0.73	1.20 (0.87, 1.66)	0.27	0.88 (0.86, 0.89)	< 0.001	0.60 (0.26, 1.41)	0.24
4 and 5	2.89 (2.57, 3.26)	< 0.001	2.57 (2.41, 2.74)	< 0.001	2.49 (1.23, 5.03)	0.01	0.75 (0.27, 2.05)	0.58

Clavien-Dindo classification II–IV defined as major complications; race—other includes: Asian, Native Hawaiian/Pacific Islander, American Indian/Alaska Native, or unknown; frailty is defined as Modified Frailty Index ≥ 2.
Pre-GSP: 2016–2017; GSP: 2018–2020.
CI indicates confidence interval.

performing propensity matching of our study population, we were able to confirm that patients in the GSP cohort experienced a decreased risk for LOI by 46% [Beta −0.17, (−0.24, −0.11), $P < 0.001$] and major complication by 19% [Beta −0.07 (−0.14, 0.001), $P = 0.05$] (Table 3). There was no significant difference in LOS or 30-day all-cause, unplanned readmission.

As the goal of the GSP is to improve outcomes for our more vulnerable population, a subgroup analysis was performed examining outcomes in our frail patients. There were 154 patients (80 pre-GSP and 74 GSP) considered frail and the 2 cohorts were similar in age, sex, race, and OSS (data not shown). Table 4 demonstrates risk-adjusted postoperative outcomes for a subgroup of frail patients after GSP implementation. Our data demonstrates that GSP led to a significant decreased risk for LOI [OR: 0.30 (0.25, 0.37) $P < 0.001$) and major complications [OR: 0.31 (0.24, 0.40) $P < 0.001$] and reduction in LOS [IRR: 0.97 (0.96, 0.98), $P < 0.001$]. There was no significant change in risk for 30-day all-cause readmission for frail patients on the GSP.

DISCUSSION

This study shows that implementation of a GSP across surgical disciplines can result in nearly a 74% decreased risk for LOI and a 37% decreased likelihood of major complications. These findings were validated using propensity matching of our study population. The benefit of the GSP was extended to our more vulnerable patients who also experienced a significant reduction in risk of LOI and major complications as well as a reduction in LOS. Our findings examining multispecialty outcomes following implementation of a single GSP pathway are novel and generalizable as many other studies examine outcomes following single specialty or disease specific pathway implementation only. Furthermore, our data indicate that implementation of a GSP following ERAS implementation can results in improvement of an important geriatric-specific outcome, LOI.

Our results are similar to recent randomized and nonrandomized studies that have reported improved outcomes following GSP implementation. McDonald et al[30] demonstrated that among the 183 patients managed on their GSP, GSP patients were more likely to be discharged to home when compared to traditional care (62% vs. 51%, $P = 0.04$) and experience a lower mean number of complications (0.9 vs. 1.4, $P < 0.001$). Partridge et al,[31] in a randomized clinical trial of 85 vascular patients on a GSP, noted a significant decrease in postoperative medical and surgical complications. Both studies also demonstrated a decrease rate of delirium.[25,26] Preliminary outcomes following implementation of the ACS-GSV program at The Rocky Mountain Veterans Administration Hospital demonstrated a reduction in LOS by 3 days in older adults undergoing inpatient surgery in just 1 year following implementation.[32]

In contrast, we were only able to demonstrate a significant reduction in LOS among our frail patients and not in our total older surgical population. We also choose not to examine delirium as our delirium screening tool was implemented into

TABLE 3. Intervention effects analysis examined by propensity score matched pairs for the total study population (n = 533)

	Loss of Independence		Length of Hospital Stay		Major Complications (CD ≥ 2)		30-Day All-Cause Unplanned Readmission	
Variable*†	Beta (95% CI)	P	Beta (95% CI)	P	Beta (95% CI)	P	Beta (95% CI)	P
Pre-GSP	Ref		Ref		Ref		Ref	
GSP	−0.17 (−0.24, −0.11)	< 0.001	0.24 (−0.57, 1.05)	0.56	−0.07 (−0.14, 0.001)	0.05	0.04 (−0.01, 0.10)	0.10

Pre-GSP: 2016–2017; GSP: 2018–2020.
Clavien-Dindo classification II–IV defined as major complications.
*Propensity scores contingent on (1) intervention dependent—Pre-GSP/GSP; (2) intervention independent age, sex, race, frailty status, operative stress score, and surgery specialty (general, orthopedic, plastic and reconstructive, urology and vascular).
†Betas are average treatment effects from estimated potential-outcome means.
CI indicates confidence interval.

TABLE 4. Subgroup risk-adjusted analysis of postoperative outcomes examining the total frail population (n = 154)

	Loss of Independence		Length of Hospital Stay		Major Complications (CD ≥ 2)		30-Day All-Cause Unplanned Readmission	
Variable*	OR (95% CI)	P	IRR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
Pre-GSP	Ref		Ref		Ref		Ref	
GSP	0.30 (0.25, 0.37)	< 0.001	0.97 (0.96, 0.98)	< 0.001	0.31 (0.24, 0.40)	< 0.001	1.18 (0.98, 1.42)	0.08

Pre-GSP: 2016–2017; GSP: 2018–2020.
Clavien-Dindo classification II–IV defined as major complications.
*Adjusted for age, sex, race, frailty status, and operative stress score.
CI indicates confidence interval.

clinical care in 2019. Documentation of delirium without an active screen is believed to grossly underestimate the presence of this condition.[33] This study was conducted during the COVID pandemic. Therefore, patients included on in this study and the staff who participated in their care were impacted, however, no patients with known COVID were included as all patients were tested for COVID prior to surgical intervention. Currently, the effect of the pandemic can only be described with observational commentary and future studies are necessary to understand the broader impact more fully. We did observe the following: (1) Our nursing staff continued to support the GSP, however, mobilization of patients was more restricted due to COVID protocols. (2) Our multidisciplinary discussions were halted for 2 months during the pandemic secondary to the redeployment of many of the participants. However, during this same time period, very few elective cases occurred. (3) Finally, many of our older patients refused to go to a skilled nursing facility out of fear for contracting COVID. (4) Discharges outside of home required additional COVID testing which frequently delayed discharge. Therefore, the patients who participated in 2020 may have stayed longer and had less frequent discharges to places other than home. We did annualize our data to examine this potential effect, however, the data did not show any significant differences in annual LOI or LOS (Supplemental Tables 1 and 2, Supplemental Digital Content 1, http://links.lww.com/SLA/E11).

There is a growing body of evidence indicating that older patients often describe their desire to maintain quality of life and independence as a priority over life-prolonging procedures.[34] This is particularly important as a third of Medicare patients undergo a surgical procedure or are admitted to the intensive care unit in their last year of life.[2,35] After the successful implementation of our Gastrointestinal, Hernia, and Orthopedic ERAS programs at our institution, which have achieved 80% variable compliance since 2017 (data not shown), engaging participation in another pathway was challenging. However, we discovered how complimentary the goals of ERAS are to the goals of the GSP. Previous analysis of our ERAS patients demonstrated that not just implementing a pathway but achieving high compliance with the ERAS pathway variables improved postoperative outcomes for not only all ERAS patients, but specifically are frail ERAS patients.[26] The GSP provides an opportunity to enhance perioperative support our frail surgical patients and therefore, improve outcomes. In future studies, we hope to incorporate compliance measures to study this hypothesis. Nonetheless, implementation of the GSP was greatly aided by our collaborations with Geriatric Medicine and their willingness to perform CGAs and our nursing staff who underwent geriatric resource training through the NICHE program.[19] Achieving compliance with some of the ERAS variables can be challenging for older adults, specifically receiving preoperative education, early postoperative ambulation, pain management, and transitions of care upon discharge.[36] We believe the merging of these 2 complementary pathways (ERAS and GSP) led to our early improvement in postoperative outcomes.

Finally, we did not see any improvement in all-cause readmissions during our GSP period. Others have also been unable to demonstrate a decrease in readmissions as a result of the GSP. A recent systematic review examining the benefits of comprehensive geriatric care by Saripella et al[37] showed that out of the 7 studies included in the analysis which looked at readmissions, there was no significant difference in readmission rates. When we examined our patients who were readmitted from each cohort, we noted that 5 of 22 (23%) patients readmitted from the GSP cohort were readmitted secondary to medical reasons while only 2 out 15 (13%) patients were readmitted for medical reasons in the pre-GSP cohort. In addition, the median LOS for patients readmitted from the GSP cohort was shorter than the pre-GSP cohort [4 d (1–30) vs. 11 d (3–42), $P = 0.001$, data not shown]. It is plausible that patients on the GSP receiving comanagement with Geriatric Medicine are being followed more closely and therefore are readmitted more readily resulting in higher readmission rates than desired but less overall hospital days. Regardless, further investigations are necessary to determine interventions to reduce readmissions in our patient population.

There are several limitations to this study. We chose to perform an observational pre-post study because all our floor nurses underwent online training in geriatric-specific care through the NICHE program as a part of our pathway implementation process. We thus could not perform a blinded simultaneous trial comparing patients within our pathway to those under usual care as we could not remove bias from the added training. In addition, this study did not include any measurements of compliance to the 32 ACS-GSV recommended standards. During the study period, a clinical dashboard extracting data from our EHR was designed to monitor GSP compliance and this dashboard was not available for data extraction until 2020. Finally, the patients' clinical characteristics in our GSP were diverse. We attempted to control for patient and procedure specific variables by the method we chose to complete our analysis; multivariable and propensity matching. For our multivariable analysis, in addition to age, sex, and race, we controlled for frailty using the mFI. The mFI is a validated index which includes conditions such as diabetes, hypertension, chronic obstructive pulmonary disease, coronary artery disease, as well as functional limitations. Therefore, we did not include additional disease conditions in our analysis. For procedural characteristics, we included the specialty service and the OSS in our propensity-matched analysis. The design of the GSP allowed us to control for the confounding effect of clinician or provider preferences by screening all patients prior to their initial clinic visit and recommending a comprehensive

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assessment by Geriatric Medicine should the patient be screened as high-risk. In addition, our preoperative multidisciplinary conference includes representation from team members from each service. The goal of this interventions is to increase communication of concerns to all providers involved in the care of the patient.

There are several areas for further research. Additional studies should include data on compliance with ACS-GSV standards. Pronovost et al[38] previously described a model of "translating evidence into practice" which describes how quality initiatives are best implemented and sustained when compliance data to process measures are recorded and shared with frontline providers. Sharing compliance metrics is instrumental in examining the value of a quality program. This data may also allow for clarification on causation regarding lack of improvement in LOS and the increased readmissions observed following GSP implementation. In addition, the early identification of frail patients at high risk for a surgical intervention may lead to delaying or canceling of the intervention following a CGA. Our study did not include patients who did not undergo an intervention. Previous unpublished work from our institution has suggested that our rate of all-cause case cancellation is 24% following the CGA. In other published work, specifically in geriatric oncology, the impact of the CGA on treatment planning is reportedly 21%–49%.[39] Further research is also needed in perioperative interventions to continue to evaluate ways to improve outcomes in geriatric surgery of all subspecialties.

CONCLUSIONS

Overall, we have demonstrated that the addition of a GSP to our perioperative surgical care plan improved postoperative outcomes in our older adults undergoing surgery. Furthermore, our novel findings are generalizable as our study included many different surgical subspecialties. As our US population continues to expand more readily among the proportion of those over 65 years of age and we continue to see a rise in older patients requiring surgery, the timing is paramount for expansion of the ACS-GSV program nationally.

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