Original Article

Shared Decision Making in the Geriatric Surgery Verification Program: Assessing Baseline Performance

Jocelyn L. Streid, MD, MPP, Katherine C. Lee, MD, MSc, Angela M. Bader, MD, MPH, Molly P. Jarman, PhD, MPH, Ronnie A. Rosenthal, MD, FACS, Zara Cooper, MD, MSc, FACS[#], and Charlotta Lindvall, MD, PhD[#]

Center for Surgery and Public Health (J.L.S., K.C.L., A.M.B., M.P.J., Z.C.), Brigham and Women's Hospital, Boston, Massachusetts ; Department of Anesthesiology, Perioperative and Pain Medicine (J.L.S., A.M.B.), Brigham and Women's Hospital, Boston, Massachusetts; Department of Surgery (K.C.L.), University of California, San Diego, La Jolla, California; Department of Surgery (R.A.R.), Yale University, New Haven, Connecticut; Department of Surgery (Z.C.), Brigham and Women's Hospital, Boston, Massachusetts ; Division of Palliative Medicine, Department of Medicine (C.L.), Brigham and Women's Hospital, Boston, Massachusetts ; Department of Psychosocial Oncology and Palliative Care, Dana-Farber Cancer Institute (C.L.), Boston, Massachusetts

Abstract

Context. As part of the launch of the Geriatric Surgery Verification program in 2019, the American College of Surgeons issued care standards for older patients, including requirements for preoperative documentation of patients' goals. Hospital performance on these standards prior to the Geriatric Surgery Verification program is unknown.

Objectives. To assess baseline performance of the Geriatric Surgery Verification (GSV) standard for documentation of pre-operative goals for older patients, and to determine factors associated with standard adherence.

Methods. Using natural language processing, this study examines the electronic health records of patients aged 65 years or older who underwent coronary artery bypass grafts (CABG) or colectomies in 2017 or 2018 at three hospitals. The primary outcome was adherence to at least one of the three components of GSV Standard 5.1, which requires preoperative documentation of overall health goals, treatment goals, and patient-centered outcomes.

Results. A total of 2630 operations and 2563 patients were included. At least one component of the standard was met in 307 (11.7%) operations and all three components were met in 5 (0.2%). Higher likelihood of meeting the standard was demonstrated for patients who were female (odds ratio [OR] 1.30; 95% CI 1.00−1.68), undergoing colectomy (OR 2.82; 95% CI 2.15−3.72), or with more comorbidities (Charlson scores >3 [OR 1.55; 95% CI 1.14−2.09]).

Conclusion. Before GSV program implementation, clinicians for two major operations almost never met the GSV standard for preoperative discussion of patient goals. Interdisciplinary teams will need to adjust clinical practice to meet best-practice communication standards for older patients. J Pain Symptom Manage 2023;000:1−11. © 2023 American Academy of Hospice and Palliative Medicine. Published by Elsevier Inc. All rights reserved.

Key Words

Shared decision making, geriatric surgery, surgical counseling, geriatric surgery verification program, patient-centered communication

Key Message

In 2019, the American College of Surgeons issued care standards for older patients, including requirements for preoperative discussion and documentation of patients' health and treatment goals. In this retrospective review of 2563 patients undergoing coronary artery bypass grafts or colectomies, 88.3% of operations did not meet the preoperative communication standard.

Introduction

In July 2019, the American College of Surgeons released 32 care standards for older surgical

ARTICLE IN PRESS

2   Streid et al.   Vol. 00 No. 00 xxx 2023

patients, which serve as qualifying criteria for Geriatric Surgery Verification (GSV) accreditation. Early data has shown that implementation of the GSV program reduces post-operative length of stay, loss of independence, and risk of major complications, suggesting that these standards are integral to a robust quality strategy.[1,2] Among these standards are requirements for patient-centered communication.[3] In particular, Standard 5.1 asks that preoperative discussions include and document patients' goals, explaining that "shared decision making with patients hinges upon high-quality communication and empowering patients to reflect upon and identify personal health goals."[4]

Shared decision making is particularly important for adults 65 years or older, who make up more than forty percent of the inpatient surgical population.[5] As compared to younger counterparts, older surgical patients experience increased risk for adverse outcomes such as cognitive decline, functional decline, and nonhome discharge.[6−10] Those with frailty and multimorbidity are at even higher risk for prolonged or incomplete recovery, worsening quality of life, and increasing caregiver burden.[11−16]

Given the risks, older adults and their care teams must discuss whether surgery is worth the potential trade-offs in function and quality of life. Placing these decisions within the larger context of a patient's values and health trajectory is crucial to patient-centered care.[17−19]

GSV Standard 5.1 outlines key components of the shared decision-making process for older patients. The standard identifies three distinct elements of preoperative counseling: 1) discussion of a patient's overall health goals, 2) treatment goals, and 3) anticipated patient-centered outcomes (Fig. 1). How hospitals performed on this standard prior to GSV implementation is unknown. Baseline information is critical in identifying gaps and setting targets for improvement. This study examines preoperative documentation of patient goals at three hospitals in a regional health system in the two years prior to the introduction of the GSV program. Our objective was to assess performance of Standard 5.1 among patients ≥65 years old who received a coronary artery bypass graft or colectomy. We selected these operations because they are two of the most common inpatient operating procedures for older adults,[20−22] and as compared to other common procedures such as prostatectomies and knee replacements, have higher post-operative complication rates and lower thirty-day and long-term survival within this age group.[23−27] We hypothesized that fewer than 50% of operations would meet all three criteria of the standard.

Methods

Data Sources

Medical records were drawn from the Research Patient Data Registry (RPDR), the Electronic Health Record (EHR) database of Mass General Brigham, Massachusetts' largest regional health network. RPDR contains clinical and administrative data for all patient encounters at affiliated institutions, including clinical notes. The registry also contains claims data, including

---

5.1: Treatment and Overall Health Goals
Deliberation over surgical decision making must allow older adults the opportunity to discuss the following with the surgeon: • Overall health goals (not limited to the current condition or treatment options)   • Treatment goals (specific to the current condition)   • Anticipated impact of both surgical and non-surgical treatments on symptoms, function, burden of care, living situation, and survival   After discussion, the surgeon must document the treatment plan and how it has been informed by shared discussion of the patient's goals.   **Documentation**   - A verbatim quote by the patient about his or her overall health and treatment goals   - Attestation that the surgeon has discussed the anticipated impact of both surgical and nonsurgical treatments on symptoms, function, burden of care, living situation, and survival   - Recommended treatment plan and acknowledgement of how the recommended plan has been informed by shared discussion of the patients' goals   *Source: Optimal Resources for Geriatric Surgery: 2019 Standards, released by the American College of Surgeons*

Fig. 1. Definition of geriatric surgery verification standard 5.1 [excerpt from *Optimal Resources for Geriatric Surgery: 2019 Standards*].

International Classification of Diseases, Ninth and Tenth Revision (ICD-9; ICD-10) and Current Procedure Terminology (CPT) codes. We derived zip code data from the 2013−2017 American Community Survey. The Mass General Brigham Institutional Review Board granted approval for this study.

Inclusion Criteria

We included coronary artery bypass grafts (CABG) and colectomies performed on patients 65 years and older from January 1, 2017 to December 31, 2018. These procedures were identified in RPDR using CPT and ICD-10 procedure codes.

Standard 5.1 specifies that surgeons are responsible for discussing and documenting each component of preoperative counseling (Fig. 1). However, to capture whether patients had these conversations with any provider, we also examined documentation by non-surgeons. We included notes written by physicians, physician assistants, nurse practitioners, and nurses. We included all notes filed thirty days before surgery through one day following surgery to account for documentation delays. We excluded documentation by chaplains, community health workers, social workers, ostomy nurses, physical therapists, and case managers. We selected two academic and one community hospital that adopted their current EHR systems before the third quarter of 2016 to account for challenges associated with transitioning between EHR systems.

We excluded scanned documents, which typically consisted of consent forms, due to natural language processing software incompatibility. To examine whether these forms included relevant documentation, we reviewed a hospital-stratified random sample of 30 charts. We examined scanned documents uploaded to the EHR thirty days before and one day after the procedure, which included surgical, anesthesia, and ICU consent forms. All text was examined by a clinically-trained investigator (JS) for standard adherence.

Patient Characteristics

We collected demographic information from RPDR, including age, gender, primary language, race/ethnicity, insurance, and mental health or substance use disorder as defined by ICD-10 codes and used in prior literature to examine disparities in surgical outcomes.[28] We extracted comorbidities from RPDR via all ICD-10 codes associated with each patient record in the 365 days prior to surgery. Comorbidities were assessed using the Charlson Comorbidity Index, derived from ICD coding as validated by Quan et al.[29] Because previous studies demonstrate relationships between income and patient-centered communication, we abstracted median household income by zip code using United States Census Data from the 2013−2017 American Community Survey,[30,31] basing this assessment on a

prior study validating the use of area-based socioeconomic status indicators to identify healthcare disparities.[32]

Identification of Preoperative Discussions

We used ClinicalRegex, a text-identification natural language processing (NLP) software, to identify relevant EHR documentation. ClinicalRegex (developed by CL) identifies predefined keywords and phrases within clinical notes, accounting for language and punctuation variations, and has performed with high sensitivity, specificity, and efficiency at identifying patient-clinician communication among several patient populations in EHRs.[33−39]

To build our keyword library, we sampled language from the text of Standard 5.1.[4,6] We also referenced libraries used by previous NLP studies examining serious illness communication.[35,40] We refined this codebook through iterative review of records flagged and not flagged by NLP. Sensitivity, specificity, and accuracy of NLP-identified performance of the standard was determined by manual review of 80 randomly-selected patient charts. The final codebook is provided in Supplemental File 1.

Documentation identified by NLP software as containing relevant keywords was reviewed to determine whether it addressed the standard. We developed coding guidelines that contained examples of quotes that did and did not meet criteria. Quotes for which there was ambiguity regarding whether they met criteria were discussed between two clinically-trained investigators to reach consensus (JS, KL). Of all notes containing keywords, only notes that met at least one part of the three-part standard were coded as a positive hit (Table 1). For example, we excluded conversations that elicited patient goals but were not relevant to surgical decision-making. Similarly, code status conversations were excluded unless relevant to surgical decisions. Other examples of documentation that included keywords but did not meet the standard can be found in Table 2.

For each instance of qualifying documentation, we identified whether the documentation contained a direct patient quote. We also identified the type of clinician documenting the conversation (surgeon, non-surgeon MD, or nurse) based on the note's author. If the note was written by a resident, NP, or PA, then clinician specialty was determined by the attesting attending.

Outcomes

Our primary outcome of interest was adherence to at least one of the three components of Standard 5.1. The components were measured separately: 1) documentation of overall health goals, 2) treatment goals, and 3) patient-centered outcomes. Patient-centered

ARTICLE IN PRESS

4   Streid et al.   Vol. 00 No. 00 xxx 2023

Table 1
Qualifying Documentation Flagged by NLP that Fulfills Each Key Component of GSV Standard 5.1

Definition	Examples of Keywords and Phrases from Codebook[a]	Qualifying Documentation
Overall health goals Deliberation over surgical decision-making must allow older adults the opportunity to discuss their overall health goals (not limited to current condition or treatment options)	Long-term, longterm, long term, quality of life, overall, want(s), desire(s), prolong, living well, live well, prognosis, survival, life, live, family meeting, goals of care, care(s), hope, concern, discuss	*"He reemphasized his goal of maintaining quality of life, which to him means cognitive function and mobility."* *"She hopes to be able to do a 1/2 marathon in October for her 80th birthday."*
Treatment goals Deliberation over surgical decision-making must allow older adults the opportunity to discuss their treatment goals (specific to the current condition)	Prognostic, survival, symptom relief, relieve symptom(s), quality of life, protect, prolong, hope, diagnose, diagnosis, preserve, wish(es)(ed)	*"From a quality of life perspective, he would like to eat again, which he cannot do unless we palliatively resect this cancer."* *"Because of increased frequency of diverticulitis episodes, she wishes to undergo elective sigmoid colectomy to prevent emergency surgery."*
Patient-centered outcomes Deliberation over surgical decision-making must allow older adults the opportunity to discuss the anticipated impact of both surgical and non-surgical treatments on symptoms, function, burden of care, living situation, and survival	Choice(s), options(s), outcome(s), benefit(s), natural course, complication(s), function(ing), life expectancy, likelihood, care burden, nonsurgical, non-surgical, nonoperative, nonoperative, benefit, observation, survival, survive	*"I discussed the pros and cons of proceeding with surgery to manage his disease, as he may develop recurrent small bowel obstructions in the future secondary to peritumoral fibrosis from the nodal metastases. I did explain that resection would entail a fairly extensive distal small bowel resection and (possibly) a right colectomy and that this may result in chronic diarrhea."*

[a]A full list of the keywords included in the codebook can be found in Supplemental File 1.

Table 2
Examples of Documentation Flagged by NLP that Does not Fulfill GSV Standard 5.1

	Excluded Documentation	Rational for non-inclusion	Supporting excerpt from Standard 5.1[a]
Overall health goals	"Her EF has normalized, which is a great predictor for a good postop outcome, both in the short run and also for the years to come."	Documents provider rationale for surgery; does not document a conversation with the patient. Documents anticipated long-term trajectory, but does not name a specific goal independent of the surgery.	"Older adults should have the opportunity to identify an overall health goal that is personal and specific, such as 'I want to be able to walk at my grandson's wedding this summer.'" "Deliberation over surgical decision making must allow older adults the opportunity to discuss the following with the surgeon: overall health goals (not limited to the current condition or treatment options)"
Treatment goals	"She understands the rationale for complete excision caused by the high-grade dysplasia seen in the villous adenoma polyp." "I had a lengthy discussion today about the rationale and need for surgical intervention."	No documentation of a specific treatment goal for the surgery	"Patient health goals relative to the surgical condition can be categorized broadly into (1) prolonging life, (2) preserving function or independence, (3) relieving symptoms, (4) curing a condition, or (5) establishing a diagnosis." "Deliberation over surgical decision making must allow older adults the opportunity to discuss . . .treatment goals (specific to the current condition)."
Patient-centered outcomes	"We reviewed the risks of surgery, including, but not limited to; heart attack, stroke, bleeding or need for permanent pacemaker." "All possible options were discussed at length and the pros and cons of each approach were reviewed."	Does not document discussion of non-surgical options Documents discussion of multiple options, but unclear if impact of those options on patient-centered outcomes was discussed	"Attestation that the surgeon has discussed the anticipated impact of both surgical and nonsurgical treatments on symptoms, function, burden of care, living situation, and survival" "This standard aims to improve preoperative conversations and risk assessment by addressing nonoperative alternatives and patient-centered outcomes such as function and living situation, as well as traditional morbidity and mortality outcomes." "Despite many surgeons' attempts to describe the complex risk-benefit balance of a given operation, the "fix-it" model may oversimplify the decision and obscure the repercussions that an acute surgical problem can have on a patient with preexisting comorbidities and functional limitations."

[a]direct quotes from *"Optimal Resources for Geriatric Surgery: 2019 Standards"*, released by the American College of Surgeons.

outcomes are defined by the standard as anticipated impacts of both operative and nonoperative approaches on symptoms, function, burden of care, living situation, and survival. Any documentation flagged by NLP was coded for any component of Standard 5.1 it contained. Documentation meeting one or more of these components was included in our primary outcome. Standard 5.1 also requires inclusion of a verbatim patient quote regarding overall health and treatment goals, which we assessed as a secondary outcome and measured separately from adherence to the standard's three components.

Analysis

Data were analyzed at the procedure level, with each surgical episode representing a discrete observation. Patient, clinician, and hospitalization characteristics were displayed as proportions, medians, and quartiles where appropriate.

Based on prior studies,[36,40,41] the sensitivity, specificity and accuracy of NLP were measured compared to manual chart review in 80 randomly-selected operations. We also conducted a sensitivity analysis by manual chart review of consent forms to address bias from exclusion of scanned documents.

To test associations between patient, clinician, and hospitalization characteristics and standard adherence, we performed bivariable logistic regressions with the dependent variable defined as performance of at least one of the three components of Standard 5.1 and the independent variable defined as the characteristic in question. Independent variables shown to have coefficients with a P-value<0.1 in bivariable analysis were included in the final multivariable logistic regression. Results were reported as odds ratios with a 95% CI. Statistical analysis was performed on Stata/MP v16.1.

Results

Patient Characteristics

We identified 2630 operations (53.2% CABGs, 46.8% colectomies) and 2563 patients. The median age was 73 and 61.1% were male. Most were white (2335, 88.8%) and English-speaking (2753, 94.3%) (Table 3).

NLP Performance

NLP demonstrated sensitivity of 88.9%, specificity of 98.4%, and accuracy of 96.3% compared to manual chart review. Further validation data can be found in Supplemental File 2. Manual review of scanned consent documents revealed that neither the handwritten nor typed text of these excluded documents met the standard. Of note, all surgical consents included attestation to a discussion of multiple possible interventions. For

example, all forms at one institution included: "I understand. . .the benefits to be expected compared to other approaches as has been explained to me." This statement is suggestive of the standard's third component, which requires discussion of anticipated benefits. However, this component also requires explicit discussion of surgical and nonsurgical intervention on patient-centered outcomes such as symptoms and function, which these forms did not address. Moreover, because all consent forms contained this statement, and because research suggests that patients often do not read or understand consent forms,[42−44] we did not accept this prepopulated text as evidence that this conversation occurred.

Performance of Communication Requirements

Using NLP, all 50,307 notes associated with 2,630 operations were reviewed for documentation of discussion of overall health goals, treatment goals, and patient-centered outcomes. Among notes flagged by NLP, 307 operations (11.7% of all operations) contained text that met at least one of the three requirements. Only 5 operations (0.2%) had documentation of all three requirements. Qualifying documentation was most often performed by surgeons (10.8% of all qualifying operations), followed by non-surgeon physicians (1.1%), and then nurses (0.2%) (Table 4).

The most commonly-met requirement of the standard was assessment of treatment goals, which comprised 69.3% of all relevant hits but appeared in documentation of only 10.0% of all operations. Conversations about patient-centered outcomes for operative and nonoperative treatment were documented in 3.7% of operations, and elicitation of overall health goals was documented in 0.7% of operations.

Factors Associated with Standard Adherence

Bivariable analysis demonstrated that colectomies, operations on female patients, and operations on patients with Charlson scores >1 were each associated with greater likelihood of meeting at least one requirement (P value <0.10). In multivariable logistic regression, clinicians were more likely to meet the standard for patients who were female (OR 1.30; 95% CI 1.00 −1.68), undergoing colectomy (OR 2.82; 95% CI 2.15 −3.72), or with more comorbidities (Charlson scores >3 [OR 1.55; 95% CI 1.14−2.09]).

Variation in Documentation of Goals

Of the standard's three requirements, documentation of treatment goals was the most common. However, we found a wide range of documentation styles among qualifying operations. Some notes simply stated the surgical indication. For example, *"We discussed that revascularization is indicated for symptom relief"* and *"We reviewed that the intent of the operation as palliative rather*

Table 3
Patient Characteristics Stratified by NLP-Identified Performance of GSV Standard 5.1

Characteristics	Operations (% of total), n=2630	Any Sub-Component Met[a,b]		P value
		No (n=2323)	Yes (n=307)	
Age, median (IQR)	73 (69−78)	73 (69−78)	73 (69−78)	
Age quartile (quartile range)				
Q1 (65−69)	793 (30.15)	693 (29.83)	100 (32.57)	
Q2 (69−73)	642 (24.41)	571 (24.58)	71 (23.13)	
Q3 (73−78)	620 (23.57)	557 (23.98)	63 (20.52)	
Q4 (78−98)	575 (21.86)	502 (21.61)	73 (23.78)	
Gender				
female	1023 (38.90)	862 (37.11)	161 (52.44)	<0.001
male	1607 (61.10)	1461 (62.89)	146 (47.56)	<0.001
Race				
White	2335 (88.78)	2059 (88.64)	276 (89.90)	
Black	70 (2.66)	59 (2.54)	11 (3.58)	
LatinX	25 (0.95)	24 (1.03)	1 (0.33)	
Asian/Asian Pacific	75 (2.85)	67 (2.88)	8 (2.61)	
Other/Unknown	125 (4.75)	114 (4.91)	11 (3.58)	
Mental health disorder	873 (33.19)	765 (32.93)	108 (35.18)	
Substance use disorder	106 (4.03)	99 (4.26)	7 (2.28)	
Language				
English as primary	2753 (94.28)	2176 (93.67)	290 (94.46)	
Non-english as primary	164 (6.24)	147 (6.33)	17 (5.54)	
Charlson comorbidity index				
CCI≤1	760 (28.90)	685 (29.49)	75 (24.43)	0.067
CCI 2−3	885 (33.65)	800 (34.44)	85 (27.69)	0.019
CCI>3	985 (37.45)	838 (36.07)	147 (47.88)	<0.001
Household income by zip code (quartile range)				
Q1 (16727−65041)	654 (24.99)	582 (25.05)	72 (23.45)	
Q2 (65041−82118)	616 (23.54)	538 (23.16)	78 (25.41)	
Q3 (82118−102577)	656 (25.07)	581 (25.01)	75 (24.43)	
Q4 (102577−213173)	691 (26.40)	612 (26.35)	79 (25.73)	
Primary insurer				
Medicare	1784 (68.17)	1576 (67.84)	208 (67.75)	
Medicaid / MassHealth / HSN	41 (1.57)	39 (1.68)	2 (0.65)	
Commercial / Other	783 (29.92)	688 (29.62)	95 (30.94)	
Military	9 (0.34)	7 (0.30)	2 (0.65)	
Self pay	13 (0.50)	13 (0.56)	0 (0.00)	
Hospital				
Tertiary academic hospital #1	1227 (46.65)	1078 (46.41)	149 (48.53)	
Tertiary academic hospital #2	1374 (52.24)	1221 (52.56)	153 (49.84)	
Community teaching hospital	29 (1.10)	24 (1.03)	5 (1.63)	
Procedure				
CABG	1398 (53.16)	1308 (56.31)	90 (29.32)	<0.001
Colectomy	1232 (46.84)	1015 (43.69)	217 (70.68)	<0.001

[a]Sub-components are: overall health goals, treatment goals, and patient-centered outcomes. Meeting a sub-component does not require a direct patient quotation.
[b]Values are n (%) unless otherwise noted.
IQR = interquartile range; CABG = coronary artery bypass graft; CCI = Charlson comorbidity index; HSN = health safety net.

Table 4
Key Findings in NLP-Identified Performance of GSV Standard 5.1

Characteristic, n (%)	Number of Operations n=2630
All 3 requirements met	5 (0.19)
At least 1 requirement met	307 (11.67)
At least 1 patient quote is documented	4 (0.15)
All 3 requirements met by a surgeon	3 (0.11)
At least one requirement is met by a surgeon	285 (10.84)
Qualifying documentation by topic	
Overall health goals	19 (0.72)
Treatment goals	262 (9.96)
Patient-centered outcomes	97 (3.69)
Qualifying documentation by provider	
Surgeon	285 (10.84)
Other MD	28 (1.06)
Non-MD (RN)	4 (0.15)

than curative.* Because these statements inform the patient of the goal of surgery, we counted it as meeting the standard.

However, other documentation illustrated the patient's individualized treatment goal: for example, *"Because of increased frequency of diverticulitis episodes, she wishes to undergo elective sigmoid colectomy to prevent emergency surgery"* and *"He has stated that he is more interested in having an operation to come off steroids for good."* In these cases, surgeons elicited the patient's personal rationale for surgery: to prevent emergency surgery or eliminate the need for steroids. These conversations revealed patient preferences that can then prompt discussion about whether this immediate treatment goal is compatible with long-term health goals. Although all the above examples meet the standard, the range

of styles may reflect the difference between eliciting a patient's own treatment goal vs. informing a patient of the procedure's objective.

Discussion

Before GSV implementation, fewer than 12% of CABGs and colectomies met at least one part of the three-part communication standard released by the American College of Surgeons. Non-surgeons performed approximately one in ten qualifying documentations, suggesting an important and perhaps underutilized role for members of an interdisciplinary team to meet the standard. Patients with higher comorbidity burden were more likely to have documentation of these conversations in their chart, but age was not independently associated with standard performance. Although Standard 5.1 requires a verbatim patient quote about health and treatment goals, we found only 4 instances of direct quotes.

Our findings build upon earlier work highlighting gaps in preoperative counseling. One qualitative study examining how surgical oncologists relate to the GSV standards found that few surgeons explicitly ask patients to define their goals for surgery.[45] Moreover, prior literature describes how surgeons may employ a "fix-it" model of counseling, in which a surgical problem is viewed as an isolated anatomical abnormality that can be restored to normalcy via surgical intervention.[46] By divorcing surgical problems from surgical risks, this communication style disserves patients, who can make truly informed decisions only when they understand surgery as an intervention that can lead to a range of outcomes, including protracted recovery and functional decline.[46]

We found that fewer than 4% of operations contained documentation of discussion of patient-centered outcomes, defined by the standard as anticipated impact on symptoms, function, burden of care, living situation, and survival. Simply listing individual procedural complications such as "bleeding" or "infection" does not fulfill the standard if that conversation does not also include how those complications may shape a patient's health trajectory. Our findings align with previous research, which has also demonstrated that preoperative counseling for both CABGs and colectomies may obscure some of the possible repercussions of surgery. In one study, approximately half of patients who had undergone colorectal surgery could not recall preoperative discussions of key outcomes, such as bowel function, sexual function, and body image.[43] Similarly, multiple studies have demonstrated that a large proportion of patients undergoing CABGs have a limited understanding of risks of and alternatives to intervention.[42,44] Without exploring how surgical intervention may influence the outcomes that matter most

to patients, older adults may incompletely understand how surgery may either advance or regress their personal health goals. Of note, this study found low standard adherence for both CABGs and colectomies, which are performed by different surgical subspecialists for very different indications. Poor standard performance for both operations suggests that lack of preoperative documentation occurs across surgical specialties and patient populations

This project examines documentation of preoperative communication, not the communication itself, meaning that the frequency of preoperative counseling that meets the standard may be higher than our results indicate. Previous qualitative work from our group suggests surgeons discuss goals routinely but rarely document them.[45] However, GSV standard 5.1 requires documentation of these conversations, and measurement of performance at an institutional level is only possible through documentation. Furthermore, as documentation is vital to promoting safe, high-quality, person-centered surgical care across care settings, especially for complex patients, efforts to improve documentation are critically important. One study found that when trying to better understand patients' goals of care in a surgical intensive care unit, single-phase clinicians such as intensivists and nurses often rely on preoperative documentation by longitudinal clinicians, such as surgeons.[47]

Clinicians may assume that documentation of these conversations is time-consuming. However, we found several succinct examples of qualifying documentation, suggesting that comprehensive counseling does not necessarily impose a significant EHR burden on clinicians. For example, the following description is both concise and illuminating: *"He reemphasized his goal of maintaining quality of life, which to him means cognitive function and mobility."* (Table 1) In 2017, palliative care clinicians activated a template within the Mass General Brigham EHR that utilizes a series of checkboxes and free-text boxes to record the hopes and worries of seriously ill patients, increasing documentation efficiency while also eliciting valuable information.[48,49] One prompt, for example, asks providers to document "What's important to patient/family," while another allows providers to check off specific concerns the patient may have, such as "pain," "loss of control," or "being a burden."[48] Surgical clinicians can adopt a similar strategy, as template-based prompts may both improve documentation efficiency and remind providers to explore the key components of preoperative counseling as defined by the GSV standard: discussion of overall health goals, treatment goals, and patient-centered outcomes.

Just as surgical clinicians may adopt documentation strategies from palliative care clinicians, palliative care skillsets, whether delivered by primary surgeons or

ARTICLE IN PRESS

8   Streid et al.   Vol. 00 No. 00 xxx 2023

specialists, may be particularly valuable when elucidating patient values and aligning goals with treatment options. An increasingly large body of literature has explored the role of palliative care for surgical patients. A workgroup convened by The National Institutes of Health and the National Palliative Care Research Center produced a national research agenda in 2018, naming communication and decision-making as one of three key research priorities within surgical palliative care.[50] A 2022 paper defined twenty-seven quality indicators by which to measure palliative care processes for surgical patients; four of these indicators examine whether preoperative counseling addresses how surgery aligns with patients' goals and values.[51] This prior work demonstrates that high-quality preoperative communication is a fundamental component of palliative care in the surgical setting. Our study highlights a critical gap in the preoperative encounter, suggesting that communication-specific palliative care skillsets may aid surgical teams in meeting the standard set forth by the GSV Program.

Meeting GSV standards for preoperative counseling may require multidisciplinary intervention. Our findings show that only 1% of documentation was by non-surgeon clinicians, demonstrating an opportunity for other team members to discuss and document patient goals. Quality indicators in surgical palliative care do not require surgeons to be the sole arbiter of goal-concordant care.[51] Interdisciplinary models for preoperative counseling have been associated with better clinician understanding of patients' priorities and better patient understanding of benefits and burdens of surgery.[52–56] For example, Goldenberg et al suggest that preoperative clinics screen for frailty and then discuss patient's priorities, basing their counseling on the Serious Illness Conversation Guide developed by Ariadne Labs.[52,55] Roswell Park Cancer Center has piloted another model, in which preoperative evaluations flagging patients at high surgical risk trigger multidisciplinary meetings involving surgery, anesthesia, and palliative care to better understand how surgery aligns with patients' overall goals.[56] Non-MDs may also play a role in preoperative counseling: one study demonstrated that nurse-led conversations in cardiac surgery clinic improved patient and surrogate-decision-maker understanding of alternatives to and outcomes of surgery.[57] Given the increasingly team-based nature of surgical practice and the multifaceted needs of older adults, future interventions should explore the potential of integrated perioperative care.

There are several limitations to this study. First, we included hospitals contained within the same healthcare system and so these findings may not apply to other settings. We sought to mitigate this bias by including patients from both community and tertiary hospitals. Furthermore, because our sample was predominantly white, male, and English-speaking, our results may not be generalizable. We could not access documentation outside our healthcare network, meaning that documentation by unaffiliated clinicians was not captured. However, our goal was to determine compliance within a hospital as it would be measured by GSV. Such exclusions will need to be considered in national efforts to capture data about perioperative communication. Lastly, we were not able to cluster our results by individual clinician, which is a topic for future study. It is possible that individual clinicians account for a disproportionate amount of qualifying documentation, which would ultimately support the conclusion that standard adherence is feasible but infrequently performed.

Conclusions

Before implementation of the GSV program, surgical teams for two major operations common in older patients almost never met Standard 5.1. Targeted and interdisciplinary intervention is necessary to adjust clinical practice.

Disclosures and Acknowledgments

References

1. Jones TS, Jones EL, Richardson V, et al. Preliminary data demonstrate the Geriatric Surgery Verification program reduces postoperative length of stay. J Am Geriatr Soc 2021;69:1993–1999. https://doi.org/10.1111/jgs.17154.

2. Ehrlich AL, Owodunni OP, Mostales JC, et al. Early outcomes following implementation of a multispecialty geriatric surgery pathway. Ann Surg 2022. https://doi.org/10.1097/SLA.0000000000005567.

3. American College of Surgeons introduces a new standardized program for hospitals devoted to high-quality surgical care for older adults. 2019. The American College of Surgeons. Available at: https://www.facs.org/media/press-releases/2019/gsvlaunch071919. Accessed October 11, 2020.

4. Optimal Resources for Geriatric Surgery: 2019 Standards. 2019. American College of Surgeons. 23−24. Available at: https://www.facs.org/-/media/files/quality-programs/geriatric/geriatricsv_standards.ashx. Accessed July 15, 2022.

5. Turrentine FE, Zaydfudim VM, Martin AN, Jones RS. Association of geriatric-specific variables with 30-day hospital readmission risk of elderly surgical patients: a NSQIP analysis. J Am Coll Surg 2020;230:527–533. https://doi.org/10.1016/j.jamcollsurg.2019.12.032.

6. Berian JR, Rosenthal RA, Baker TL, et al. Hospital standards to promote optimal surgical care of the older adult: a report from the coalition for quality in geriatric surgery. Ann Surg 2018;267:280–290. https://doi.org/10.1097/sla.0000000000002185.

7. Deiner S, Liu X, Lin HM, et al. Does postoperative cognitive decline result in new disability after surgery? Ann Surg 2021;274:1108–1114. https://doi.org/10.1097/SLA.0000000000003764.

8. Warwick JC, Brovman EY, Beutler SS, Urman RD. Preoperative risk factors for nonhome discharge of home-dwelling geriatric patients following elective surgery. J Appl Gerontol 2021;40:856–864. https://doi.org/10.1177/0733464820944699.

9. Zhang LM, Hornor MA, Robinson T, Rosenthal RA, Ko CY, Russell MM. Evaluation of postoperative functional health status decline among older adults. JAMA Surg 2020;155:950–958. https://doi.org/10.1001/jamasurg.2020.2853.

10. Partridge JS, Harari D, Dhesi JK. Frailty in the older surgical patient: a review. Age Ageing 2012;41:142–147. https://doi.org/10.1093/ageing/afr182.

11. Mosquera C, Spaniolas K, Fitzgerald TL. Impact of frailty on surgical outcomes: the right patient for the right procedure. Surgery 2016;160:272–280. https://doi.org/10.1016/j.surg.2016.04.030.

12. Akyar S, Armenia SJ, Ratnani P, Merchant AM. The Impact of frailty on postoperative cardiopulmonary complications in the emergency general surgery population. Surg J (N Y) 2018;4:e66–e77. https://doi.org/10.1055/s-0038-1655756.

13. Lee KC, Streid J, Sturgeon D, et al. The impact of frailty on long-term patient-oriented outcomes after emergency general surgery: a retrospective cohort study. J Am Geriatr Soc 2020;68:1037–1043. https://doi.org/10.1111/jgs.16334.

14. Manohar A, Cheung K, Wu CL, Stierer TS. Burden incurred by patients and their caregivers after outpatient surgery: a prospective observational study. Clin Orthop Relat Res 2014;472:1416–1426. https://doi.org/10.1007/s11999-013-3270-6.

15. Bryson GL, Clavel NA, Moga R, Power B, Taljaard M, Nathan HJ. Patient function and caregiver burden after ambulatory surgery: a cohort study of patients older than 65. Can J Anaesth 2013;60:864–873. https://doi.org/10.1007/s12630-013-9982-y.

16. Ariza-Vega P, Ortiz-Piña M, Kristensen MT, Castellote-Caballero Y, Jiménez-Moleón JJ. High perceived caregiver burden for relatives of patients following hip fracture surgery. Disabil Rehabil 2019;41:311–318. https://doi.org/10.1080/09638288.2017.1390612.

17. Cooper Z, Courtwright A, Karlage A, Gawande A, Block S. Pitfalls in communication that lead to nonbeneficial emergency surgery in elderly patients with serious illness: description of the problem and elements of a solution. Ann Surg 2014;260:949–957. https://doi.org/10.1097/SLA.0000000000000721.

18. Cooper Z, Hevelone N, Sarhan M, Quinn T, Bader A. Identifying patient characteristics associated with deficits in surgical decision making. J Patient Saf 2020;16:284–288. https://doi.org/10.1097/pts.0000000000000323.

19. Cooper Z, Koritsanszky LA, Cauley CE, et al. Recommendations for best communication practices to facilitate goal-concordant care for seriously ill older patients with emergency surgical conditions. Ann Surg 2016;263:1–6. https://doi.org/10.1097/SLA.0000000000001491.

20. HCUP Fast Stats - most common operations during inpatient stays. Agency for Healthcare Research and Quality, Rockville, MD. Available at: www.hcup-us.ahrq.gov/faststats/national/inpatientcommonprocedures.jsp?year1=2014&characteristic1=24&included1=1&year2=2014&characteristic2=25&included2=1&expansionInfoState=hide&dataTablesState=hide&definitionsState=hide&exportState=hid. Accessed April 21, 2021

21. Number of all-listed procedures for discharges from short-stay hospitals, by procedure category and age. NCHS National Hospital Discharge Survey. Hyattsville, MD: CDC; 2010.

22. Healthcare Cost and Utilization Project (HCUP) Statistical Briefs. Rockville, MD: Agency for Healthcare Research and Quality; 2014.

23. Schwarze ML, Barnato AE, Rathouz PJ, et al. Development of a list of high-risk operations for patients 65 years and older. JAMA Surg 2015;150:325–331. https://doi.org/10.1001/jamasurg.2014.1819.

24. Khuri SF, Henderson WG, DePalma RG, et al. Determinants of long-term survival after major surgery and the adverse effect of postoperative complications. Ann Surg 2005;242:326–341. https://doi.org/10.1097/01.sla.0000179621.33268.83. discussion 341-3.

25. Pearse RM, Harrison DA, James P, et al. Identification and characterisation of the high-risk surgical population in the United Kingdom. Crit Care 2006;10:R81. https://doi.org/10.1186/cc4928.

26. Hamel MB, Henderson WG, Khuri SF, Daley J. Surgical outcomes for patients aged 80 and older: morbidity and mortality from major noncardiac surgery. J Am Geriatr Soc 2005;53:424–429. https://doi.org/10.1111/j.1532-5415.2005.53159.x.

27. Tang VL, Jing B, Boscardin J, et al. Association of functional, cognitive, and psychological measures with 1-year mortality in patients undergoing major surgery. JAMA Surg 2020;155:412–418. https://doi.org/10.1001/jamasurg.2020.0091.

28. Bailey EA, Wirtalla C, Sharoky CE, Kelz RR. Disparities in operative outcomes in patients with comorbid mental illness. Surgery 2018;163:667–671. https://doi.org/10.1016/j.surg.2017.09.029.

ARTICLE IN PRESS

10   Streid et al.   Vol. 00 No. 00 xxx 2023

29. Quan H, Sundararajan V, Halfon P, et al. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. Med Care 2005;43:1130–1139. https://doi.org/10.1097/01.mlr.0000182534.19832.83.

30. Perry RG, Mitchell JA, Hawkins J, Johnson-Lawrence V. The role of age and multimorbidity in shaping older african american men's experiences with patient‑provider communication. Geriatrics (Basel) 2018;3. https://doi.org/10.3390/geriatrics3040074.

31. Siminoff LA, Graham GC, Gordon NH. Cancer communication patterns and the influence of patient characteristics: disparities in information-giving and affective behaviors. Patient Educ Couns 2006;62:355–360. https://doi.org/10.1016/j.pec.2006.06.011.

32. Berkowitz SA, Traore CY, Singer DE, Atlas SJ. Evaluating area-based socioeconomic status indicators for monitoring disparities within health care systems: results from a primary care network. Health Serv Res 2015;50:398–417. https://doi.org/10.1111/1475-6773.12229.

33. Brizzi K, Zupanc SN, Udelsman BV, et al. Natural Language processing to assess palliative care and end-of-life process measures in patients with breast cancer with leptomeningeal disease. Am J Hosp Palliat Care 2020;37:371–376. https://doi.org/10.1177/1049909119885585.

34. Hu SY, Santus E, Forsyth AW, et al. Can machine learning improve patient selection for cardiac resynchronization therapy? PLoS One 2019;14:e0222397. https://doi.org/10.1371/journal.pone.0222397.

35. Lee KC, Udelsman BV, Streid J, et al. Natural language processing accurately measures adherence to best practice guidelines for palliative care in trauma. J Pain Symptom Manage 2020;59:225–232.e2. https://doi.org/10.1016/j.jpainsymman.2019.09.017.

36. Lindvall C, Lilley EJ, Zupanc SN, et al. Natural Language Processing to assess end-of-life quality indicators in cancer patients receiving palliative surgery. J Palliat Med 2019;22:183–187. https://doi.org/10.1089/jpm.2018.0326.

37. Poort H, Zupanc SN, Leiter RE, Wright AA, Lindvall C. Documentation of palliative and end-of-life care process measures among young adults who died of cancer: a natural language processing approach. J Adolesc Young Adult Oncol 2020;9:100–104. https://doi.org/10.1089/jayao.2019.0040.

38. Udelsman BV, Moseley ET, Sudore RL, Keating NL, Lindvall C. Deep natural language processing identifies variation in care preference documentation. J Pain Symptom Manage 2020;59:1186–1194. https://doi.org/10.1016/j.jpainsymman.2019.12.374.

39. Lilley EJ, Lindvall C, Lillemoe KD, Tulsky JA, Wiener DC, Cooper Z. Measuring processes of care in palliative surgery: a novel approach using natural language processing. Ann Surg 2018;267:823–825. https://doi.org/10.1097/SLA.0000000000002579.

40. Udelsman BV, Lee KC, Lilley EJ, Chang DC, Lindvall C, Cooper Z. Variation in serious illness communication among surgical patients receiving palliative care. J Palliat Med 2019. https://doi.org/10.1089/jpm.2019.0268.

41. Lindvall C, Deng CY, Moseley E, et al. Natural language processing to identify advance care planning documentation in a multisite pragmatic clinical trial. J Pain Symptom Manage 2022;63:e29–e36. https://doi.org/10.1016/j.jpainsymman.2021.06.025.

42. Larobina ME, Merry CJ, Negri JC, Pick AW. Is informed consent in cardiac surgery and percutaneous coronary intervention achievable? ANZ J Surg 2007;77:530–534. https://doi.org/10.1111/j.1445-2197.2007.04143.x.

43. Scheer AS, O'Connor AM, Chan BP, et al. The myth of informed consent in rectal cancer surgery: what do patients retain? Dis Colon Rectum 2012;55:970–975. https://doi.org/10.1097/DCR.0b013e31825f2479.

44. Chandrasekharan DP, Taggart DP. Informed consent for interventions in stable coronary artery disease: problems, etiologies, and solutions. Eur J Cardiothorac Surg 2011;39:912–917. https://doi.org/10.1016/j.ejcts.2010.08.033.

45. Hu FY, Tabata-Kelly M, Johnston FM, et al. Surgeon-reported Factors influencing adoption of quality standards for goal-concordant care in patients with advanced cancer: a qualitative study. Ann Surg 2022. https://doi.org/10.1097/SLA.0000000000005441.

46. Kruser JM, Pecanac KE, Brasel KJ, et al. And I think that we can fix it: mental models used in high-risk surgical decision making. Ann Surg 2015;261:678–684. https://doi.org/10.1097/sla.0000000000000714.

47. Udelsman BV, Lee KC, Traeger LN, Lillemoe KD, Chang DC, Cooper Z. Clinician-to-Clinician communication of patient goals of care within a surgical intensive care unit. J Surg Res 2019;240:80–88. https://doi.org/10.1016/j.jss.2019.02.036.

48. Wilson E, Bernacki R, Lakin JR, Alexander C, Jackson V, Jacobsen J. Rapid adoption of a serious illness conversation electronic medical record template: lessons learned and future directions. J Palliat Med 2020;23:159–161. https://doi.org/10.1089/jpm.2019.0420.

49. Lakin JR, Koritsanszky LA, Cunningham R, et al. A systematic intervention to improve serious illness communication in primary care. Health Aff (Millwood) 2017;36:1258–1264. https://doi.org/10.1377/hlthaff.2017.0219.

50. Lilley EJ, Cooper Z, Schwarze ML, Mosenthal AC. Palliative care in surgery: defining the research priorities. J Palliat Med 2017;20:702–709. https://doi.org/10.1089/jpm.2017.0079.

51. Lee KC, Walling AM, Senglaub SS, et al. Improving serious illness care for surgical patients: quality indicators for surgical palliative care. Ann Surg 2022;275:196–202. https://doi.org/10.1097/SLA.0000000000003894.

52. Goldenberg E, Saffary R, Schmiesing C. New role for the anesthesia preoperative clinic: helping to ensure that surgery is the right choice for patients with serious illness. Anesth Analg 2019;129:311–315. https://doi.org/10.1213/ane.0000000000004178.

53. Nelson O, Quinn TD, Arriaga AF, et al. A model for better leveraging the point of preoperative assessment: patients and providers look beyond operative indications when making decisions. A A Case Rep 2016;6:241–248. https://doi.org/10.1213/XAA.0000000000000274.

54. Murthy S, Hepner DL, Cooper Z, et al. Leveraging the preoperative clinic to engage older patients in shared decision making about complex surgery: an illustrative case. A A Case Rep 2016;7:30–32. https://doi.org/10.1213/XAA.0000000000000331.

55. Bernacki R, Hutchings M, Vick J, et al. Development of the Serious Illness Care Program: a randomised controlled trial of a palliative care communication intervention. BMJ Open 2015;5: e009032. https://doi.org/10.1136/bmjopen-2015-009032.

56. Quinn TD, Wolczynski P, Sroka R, Urman RD. Creating a pathway for multidisciplinary shared decision-making to improve communication during preoperative assessment.

Anesthesiol Clin 2018;36:653–662. https://doi.org/10.1016/j.anclin.2018.07.011.

57. Song MK, Kirchhoff KT, Douglas J, Ward S, Hammes B. A randomized, controlled trial to improve advance care planning among patients undergoing cardiac surgery. Med Care 2005;43:1049–1053. https://doi.org/10.1097/01.mlr.0000178192.10283.b4.

Supplemental File 1: *Clinical Regex Keyword Library*

Codebook used to scan through free-text documents for relevant documentation

Comprehensive keyword coding	Simplified keywords *(without linguistic variation and context exclusion permitted by NLP software)*

Overall health goals

l(ongterm|ong-term|ong term)(?!(antibiosis| antibiotics| abx| plaquenil| current use of insulin)), prioriti(es|zes|ze|zed), (relieve |relieves)symptom(s|), symptom(s|)(relief), quality of (his |her |their |)life, quantity of (his |her |their |)life, overall(?!(appearance of the patient is age-appropriate| benign)), want(s|ed|), desire(s|d|), (?<!qtc)(?<!qt)prolong(ing|s|ed|)(?!(qtc| qt| pr)), living well(?! with Heart Failure Book), live well, prognosis, (?<!renal)(?<!synthetic)(?<!systolic)(?<!kidney)(?<!tavr)(?<!valve)(?<!rv)(?<!size and function)(?<!biv)(?<!size and)(?<!has had normal bladder)(?<!RV)(?<!LV)(?<!lv)(?<!size and)(?<!biventricular)function(s|ing)(?!(test| testing|:)), surviv(al|e|es), (?<!preterm AB)(?<!prophylaxis for)li(fe|ves|ving)(?!(with:| room| situation: | with: | facility)), (?<!vaccine)live(?!(virus vaccines)(births)(with:)(facility)), (?<!:)(?<!insulin)(?<!dressing:)(?<!level of assistance:)(?<!seen the patient)(?<!toileting:)(?<!bed:)(?<!ambulating)(?<!hallway)(?<!Sit to)(?<!Stand to)(?<!Supine to)(?<!OOB)(?<!=)independen(t|tly|ce), (?<!synchrony:)(?<!subjective:)(?<!appears)(?<!denies pain and verbalized)(?<!or verbalizes increased)(?<!Given mouth swabs for)(?<!Well-appearing;)comfort(able|s|)(?! and in no acute distress), (?<!:)(?<!insulin)(?<!dressing:)(?<!level of assistance:)(?<!seen the patient)(?<!toileting:)(?<!bed:)(?<!=)dependen(t|tly|ce)(?!(atelectasis| and sub segmental| and subsegmental)), alleviat(e|es|ing), protect(s|ing|ed|), family(meeting| mtg| discussion| conversation), (?<!thanks and best)wish(es|ed|), (?<!do you prefer to use when)(?<!pertinent items)(?<!total time with)(?<!time of visit with)discuss(ion|ions|ed|ing)(?!(procedure & answer questions: | with all appropriate health care clinicians| post-operative VNA| on rounds| in detail with the house staff| patient with medical residents| in HPI| with ED attending)), goal(s)(of| for)(the|)(surgery| procedure| treatment| operation)(?!(of examination| Hb| Hgb)), (?<!SpO2)maintain(s|ed|)(?!(UOP| RA| sats| two large| phos| glucose| lines| hemodynamics| O2| O2sat| O2 sat| clear liquid| SBP| BP| BPs| euvolemia| active type and screen| strict calorie| hemodynamic| active T&S| active TS| bg| spo2| map| sats| on iv| pa| iabp| plt| 2 large| epi| ci)), aim(s)(of| for)(the|)(surgery| procedure| treatment| operation)(?!(of examination| Hb| Hgb)), objective(s)(of| for)(the|)(surgery| procedure| treatment| operation)(?!(of examination| Hb| Hgb)), goals of care, goal of care, care goal, care goals, GOC(?!:), main goal(s), primary goal(s), (?<!encounter Diagnoses and)(?<!:)(?<!=)(?<!=)(?<!result)(?<!component)(?<!lab)(?<!date)(?<!spurious)(?<!replete to normal)(?<!LABORATORY)value(s|d|)(?!(date| unit| units| ref| recorded between)), (?<!INR)(?<!CI)(?<!transfuse for)(?<!established new)(?<!protein)(?<!kcal)(?<!sbp)(?<!transfusion)(?<!pt progressing towards)(?<!coumadin with a)(?<!coumadin with)(?<!warfarin with)(?<!gtt)(?<!rass)(?<!hgb)(?<!ptt)(?<!physical therapy)(?<!TBB)(?<!PT)(?<!MAP)(surgery |procedure |treatment |operation |operative |surgical |overall |overall health |health |treatment |current |patient's |patient(s) |)goal(s)(?!(RASS| MAP| glucose| GLUCOSE| fluid| net| of Hct| temp| hct| hg| hbg| hgb| systolic| tpn| ptt| pt| nutritional needs|'s status)), (?<!immediate postop)(?<!approved the plan of)(?<!spiritual)(?<!establish)(?<!critical)(?<!coordination of)(?<!coordinating)(?<!direct)(?<!appreciative of)(?<!cooperative w)(?<!cooperative with)(?<!op)(?<!Center for Perioperative)(?<!initial episode of)(?<!assessment and plan of)(?<!discussed with all appropriate health)(?<!oral)(?<!routine dental)(?<!and response to)(?<!sacramental)(?<!pastoral)(?<!minutes providing medical)(?<!min providing medical)(?<!minutes providing)(?<!min providing)(?<!Consulted palliative)(?<!minutes in subsequent hospital)(?<!minutes in subsequent)(?<!ref VS. &)(?<!mouth)(?<!health)(?<!monitored anesthesia)(?<!Program seeks to advance the)(?<!immediate postop)(?<!minutes providing critical)(?<!Principles of ostomy)(?<!minutes providing)(?<!assumed)(?<!assumed the)(?<!respiratory)(?<!primary)care(s|d| about| for| of|)(?!(provider| proxy| agent| team| plan partner:| directive:| directive(s):| attending issues:| progress note| consult| surg author type| author type| time of| unit| time quoted| coordination| and coordination| time| when medically ready| Surgery Attending Attestation| per hsct| plan partner contact info)), (?<!ef)(?<!distal motor function is grossly)(?<!distal motor function is)Preserv(e|es|ing)(?!(PR| left| right| systolic| diastolic| LVEF| lv| rv| ejection fraction| ef| csm| biventricular| lvef| rvef)), (?<! acute sleep-related)(?<!Please contact me if there are questions or)(?<!with questions or)(?<!should you have additional questions or)(?<!other topics)concern(ed|s|)(?!(for retention| for infection| for free air| for free intraperitoneal| & issues: | for aspiration in the setting of cardiac| for enterocolitis in the setting of recent treatment| for CAD mediated| infectious vs. ischemic colitis)), (?<!Provided: Encourage realistic)hope

Treatment goals

goal(s)(of| for)(the|)(surgery| procedure| treatment| operation)(?!(of examination| Hb| Hgb)), prioriti(es|zes|ze|zed), (?<!do you prefer to use when)(?<!pertinent items)(?<!total time with)(?<!time of visit with)discuss(ion|ions|ed|ing)(?!(procedure & answer questions: | with all appropriate health care clinicians| post-operative VNA| on rounds| in detail with the house staff| patient with medical residents| in HPI| with ED attending)), (?<!consulted)palliati(on|ve)(?! Radiotherapy), Prognostic, prognosis, (?<!renal)(?<!synthetic)(?<!systolic)(?<!kidney)(?<!tavr)(?<!valve)(?<!rv)(?<!biv)(?<!has had normal bladder)(?<!RV)(?<!LV)(?<!lv)(?<!size and)(?<!biventricular)function(s|ing)(?!(test| testing|:)), (?<!thanks and best)wish(es|ed|), Surviv(al|e|es), relieve symptom(s|), symptom(s|) relief, (?<!synchrony:)(?<!subjective:)(?<!appears)comfort(able|s|)(?! and in no acute distress), cure(s|d|), quality of (his |her |their |)life, quantity of (his |her |their |)life, alleviat(e|es|ing), protect(s|ing|ed|), overall(?!(appearance of the patient is age-appropriate| benign)), want(s|ed|), desire(s|d|), (?<!qtc)(?<!qt)prolong(ing|s|ed|)(?!(qtc| qt| pr)), (?<!preterm AB)(?<!prophylaxis for)li(fe|ves|ving)(?!(with:| room| situation:| with: | facility)), (?<!vaccine)live(?!(virus vaccines)(with:)(facility)), (?<!:)(?<!insulin)(?<!dressing:)(?<!level of assistance:)(?<!seen the patient)(?<!toileting:)(?<!bed:)(?<!ambulating)(?<!hallway)(?<!Sit to)(?<!Stand to)(?<!Supine to)(?<!OOB)(?<!=)independen(t|tly|ce), (?<!SpO2)maintain(s|ed|)(?!(UOP| RA| sats| two large| phos| glucose| lines| hemodynamics| O2| O2sat| O2 sat| clear liquid|

Long term, relive symptoms, symptom relief, quality of life, overall, wants, desires, prolong, living well, prognosis, function, survival, life, life, independent, comfort, dependent, alleviate, protect, family, goal/ aim/objective of surgery/treatment/ operation, goals of care, care goals, GOC, main goal, primary goal, value, surgery/ procedure/treatment/operation/ operative /surgical/overall/ overall health / health /treatment / current / patient's goals, cares about, cares for, cares of, preserving, concern, hope

Goal of the surgery/procedure/treatment/ operation, palliative, palliation, prognostic, prognosis, wish, survival, relieve symptoms, symptom relief, cure, quality of life, quantity of life, alleviate, protect, overall, wants, desires, prolong, life, live, independent, maintain, dependent, surgery/procedure/ treatment/operation/operative/surgical/ overall/ overall health/health/treatment/ current/patient's goals, cares about, cares for cares of, preserving, concern, diagnosis, hope

Continued

Comprehensive keyword coding	Simplified keywords
	(without linguistic variation and context exclusion permitted by NLP software)

SBP| BP| BPs| euvolemia| active type and screen| strict calorie| hemodynamic| active T&S| active TS| bg| spo2| map| sats| on iv| pa| iabp| plt| 2 large| epi| ci)), (?<!:) (?<!insulin) (?<!dressing:) (?<! level of assistance:) (?<!toileting:) (?<!bed:) (?<!=)dependen(t|tly|ce) (?!(atelectasis) and sub segmental| airspace| fluid)), aim(s|) (of| for) (the|) (surgery| procedure| treatment| operation) (?! (of examination| Hb| Hgb)), objective(s|) (of| for) (the|) (surgery| procedure| treatment| operation) (?!(of examination| Hb| Hgb)), goals of care, goal of care, care goal, care goals, GOC (?!:), main goal(s|), primary goal(s|), (?<!encounter Diagnoses and) (?<!:) (?<!=) (?<!=) (?<!result) (?<!component) (?<!lab) (?<!date) (?<!spurious) (?<!replete to normal) (?<!LABORATORY)value (s|d|) (?!(date| unit| units| ref| recorded between)), (?<!INR) (?<!CI) (?<!transfuse for) (?<! established new) (?<!protein) (?<!kcal) (?<!sbp) (?<!transfusion) (?<!pt progressing towards) (?<! coumadin with a) (?<!coumadin with) (?<!warfarin with) (?<!gtt) (?<!rass) (?<!hgb) (?<!ptt) (?<! physical therapy) (?<!TBB) (?<!PT) (?<!MAP) (surgery |procedure |treatment |operation |operative |surgical |overall |overall health |health |treatment |current |patient's |patient(s|) |)goal(s|) (?! (RASS| MAP| glucose| GLUCOSE| fluid| net| of Hct| temp| hct| hg| hbg| hgb| systolic| tpn| ptt| pt| nutritional needs|'s status)), (?<!immediate postop) (?<!approved the plan of) (?<!spiritual) (?<! establish) (?<!critical) (?<!COORDINATION OF) (?<!COORDINATING) (?<!direct) (?<! appreciative of) (?<!cooperative w) (?<!cooperative with) (?<!op) (?<!Center for Perioperative) (?<! initial episode of) (?<!assessment and plan of) (?<!discussed with all appropriate health) (?<!oral) (? <!routine dental) (?<!and response to) (?<!sacramental) (?<!pastoral) (?<!minutes providing medical) (?<!min providing medical) (?<!minutes providing) (?<!min providing) (?<!Consulted palliative) (?<!minutes in subsequent hospital) (?<!minutes in subsequent) (?<!ref VS. &) (?<! mouth) (?<!health) (?<!monitored anesthesia) (?<!Program seeks to advance the) (?<!immediate postop) (?<!minutes providing critical) (?<!Principles of ostomy) (?<!minutes providing) (?<! assumed) (?<!assumed the) (?<!respiratory) (?<!primary)care(s|d| about| for| of|) (?!(provider| proxy| agent| team| plan partner:| directive:| directive(s):| attending| issues:| progress note| consult| surg author type| author type| time of| unit| time quoted| coordination| and coordination| time| when medically ready| Surgery Attending Attestation| per hsct| plan partner contact info)), (?<!ef) (?<!distal motor function is grossly) (?<!distal motor function is)Preserv(e|es|ing) (?!(PR| left| right| systolic| diastolic| LVEF| lv| rv| ejection fraction| ef| csm| biventricular| lvef| rvef)), (?<! acute sleep-related) (?<!Please contact me if there are questions or) (?<!with questions or) (?<!should you have additional questions or) (?<!other topics)concern(ed|s|) (?!(for retention| for infection| for free air| for free intraperitoneal| & issues: | for aspiration in the setting of cardiac| for enterocolitis in the setting of recent treatment| for CAD mediated| infectious vs. ischemic colitis)), (?<!Active Problem List) (?<!and rendered or confirmed the) (?<!Nutrition) (?<!was admitted to OSH with) (? <!female with a primary) (?<!male with a primary) (?<!above) (?<!cellular infiltrate and support the) (?<!I agree with their) (?<!active problem list) (?<!final pathologic) (?<!admission) (?<! discharge)diagnos(e|is) (?! date) (?!:) (?! codes:) (?! code:) (?! to emphasize are as follows) (?! are unrelated to the surgical procedure noted above), (?<!Provided: Encourage realistic)hope

Patient-Centered Outcomes

l(ongterm|ong-term|ong term) (?!(antibiosis| antibiotics| abx| plaquenil| use of insulin| current use of insulin)), impact(s|), (?<!see)alternative(?!:), (?<!pouch)Option(s|), Choice(s|), Mortality, Likelihood, (?<!dentition within defined) (?<!report is) (?<!within normal)limit(ed|ation|ations|s|) (?!(SVT| Protocol| the study| of the software| available venous| contrast| patient population| by perforation risk| to the body part)), (?<!Assessment complete and) (?<!NPO at midnight for) anticipat(e|ed|es|ing) (?!(Discharge disposition| discharge location)), probable(?! beta), (?<! renal) (?<!synthetic) (?<!systolic) (?<!kidney) (?<!tavr) (?<!valve) (?<!rv) (?<!biv) (?<!size and) (?<! has had normal bladder) (?<!RV) (?<!LV) (?<!size and function) (?<!lv) (?<!size and) (?<! biventricular)function(s|ing) (?!(test| testing|:)), surviv(al|e|es), l(ongterm|ong-term|ong term) (?! (antibiosis| antibiotics| abx)), Life expectancy, Burden of care, care burden, Living situation(?!:), (?<!preterm AB) (?<!prophylaxis for)li(fe|ves|ving) (?!(with:| room| situation: | with: | facility)), (? <!vaccine)live(?!(virus vaccines) (births) (with:) (facility)), (?<!:) (?<!insulin) (?<!dressing:) (?<!level of assistance:) (?<!seen the patient) (?<!toileting:) (?<!bed:) (?<!ambulating) (?<!hallway) (?<!Sit to) (?<!Stand to) (?<!Supine to) (?<!OOB) (?<!=)independen(t|tly|ce), (?<!synchrony:) (?<! subjective:) (?<!appears) (?<!denies pain and verbalized) (?<!or verbalizes increased) (?<!Given mouth swabs for) (?<!Well-appearing;)comfort(able|s|) (?! and in no acute distress), (?<!:) (?<! insulin) (?<!dressing:) (?<!level of assistance:) (?<!seen the patient) (?<!toileting:) (?<!bed:) (?<!=) (? <!=)dependen(t|tly|ce) (?!(atelectasis| and sub segmental| airspace| fluid)), Non-surgical, Nonsurgical, Nonoperative, Non-operative, expect(s|ation|ations|ed|) (?!(iso hypothermia| note)), (?<!chaplain)outcome(s|), (without|forgo) (a| the|) (surgery| operating| operation| procedure), (? <!prescription)benefit(s|), (?<!SpO2)maintain(s|ed|) (?!(UOP| RA| sats| two large| phos| glucose| lines| hemodynamics| O2| O2sat| O2 sat| clear liquid| SBP| BP| BPs| euvolemia| active type and screen| strict calorie| hemodynamic| active T&S| active TS| bg| spo2| map| sats| on iv| pa| iabp| plt| 2 large| epi| ci)), (?<!Diabetes mellitus without) (?<!REMOVED WITHOUT) (?<!Type 2 diabetes mellitus with neurologic) (?<!No immediate) (?<!Herpes zoster without) (?<!Herpes zoster with) (? <!Type 2 diabetes mellitus with)Complication(s|) (?! include retinopathy), (?<!as needed for assessment of) (?<!Tinetti Performance Oriented) (?<!Bed) (?<! prior bed)mobility(?!(mod A| gait intervals| Level of Assistance)), (?<!work)Mobile(?! Phone), natural course, (?<!fluoroscopic) (?<! preop) (?<!admit for) (?<!admit to) (?<!ICU) (?<!intact to) (?<!followed by an) (?<!ischemia) (?<! Hemodynamics) (?<!hemodynamic) (?<!minutes of) (?<!minutes) (?<!Baseline Clinical) (?<! admitted for) (?<!admitted to) (?<!minute) (?<!overnight) (?<!overnight) (?<!Respiratory) (?<! admit to medicine for) (?<!CNS) (?<!may require admission for) (?<!ED) (?<!Department) observation(?! progress) (?! status) (?! Unit) (?! Initial) (?! medical) (?!:) (?! plan:) (?! course)

Long term, alternative, mortality, likelihood, limit, limitation, probable, survival, life expectancy, burden of care, care burden, living situation, live, independent, comfort, dependent, nonsurgical, nonoperative, expect, expectations, outcome, benefit, maintain, complications, natural course, observation

Supplemental File 2: ***Validation of Natural Language Processing (NLP) compared to Manual Review***
    Supplemental Table 1 and Supplemental Table 2

Supplemental Table 1
Detection of Qualifying Documentation with Manual Review vs. NLP

Based on Manual Review of 80 Randomly-Selected Charts		Manual Review "gold standard"		
		(+)	(-)	Total
NLP Review	(+)	16	1	17
	(-)	2	61	63
	Total	18	62	

(+): detection of qualifying documentation
(-): no detection of qualifying documentation
NLP = natural language processing

Supplemental Table 2
Performance of NLP Compared to Manual Chart Review in Identification of Quality Standard

Performance	Presence of Qualifying Documentation (%)
Sensitivity	88.9%
Specificity	98.4%
Positive predictive value	94.1%
Negative predictive value	96.8%
Accuracy	96.3%