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High value care education in general surgery residency programs: A multi-institutional needs assessment

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ABSTRACT

Background: The ACGME mandates that residency programs provide training related to high value care (HVC). The purpose of this study was to explore HVC education in general surgery residency programs.
Methods: An electronic survey was distributed to general surgery residents in geographically diverse programs.
Results: The response rate was 29% (181/619). Residents reported various HVC components in their curricula. Less than half felt HVC is very important for their future practice (44%) and only 15% felt confident they could lead a QI initiative in practice. Only 20% of residents reported participating in a root cause analysis and less than one-third of residents (30%) were frequently exposed to cost considerations.
Conclusion: Few residents feel prepared to lead quality improvement initiatives, have participated in patient safety processes, or are aware of patients' costs of care. This underscores the need for improved scope and quality of HVC education and establishment of formal curricula.

Introduction

Nearly twenty years ago, the Institute of Medicine's landmark publication, "Crossing the Quality Chasm: A New Health System for the 21st Century," brought much-needed attention to critical gaps in the quality of healthcare in the United States.[1] Since that call to arms there has been an increasing focus on the concept of "value" and providing high-value care (HVC). HVC means "providing the best care possible, efficiently using resources, and achieving optimal results for each patient," or more simply, health outcomes achieved per dollar spent.[2] In practice, HVC is a complex balance of achieving safe, timely, effective, efficient, equitable and patient-centered care, all while containing costs. The cost of healthcare is multifaceted and refers to "the total costs of the full cycle of care for the patient's medical condition, not the cost of individual services."[3] Surgeons today are expected to not only understand and participate in HVC delivery, but also to lead initiatives intended to improve the value of surgical care. The American College of Surgeons (ACS) has further emphasized the importance of focusing on

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HVC delivery in surgical practice through the establishment of the ACS Transforming Health care Resources to Increase Value and Efficiency (THRIVE) program, in partnership with Harvard Business School's Institute for Strategy and Competitiveness. The program is intended to support hospitals and surgical practices in their efforts to improve patient outcomes while lowering costs associated with surgical care delivery.[3]

Leading organizations in graduate surgical education have also increasingly emphasized the importance of teaching HVC concepts during residency and fellowship training. The Accreditation Council for Graduate Medical Education (ACGME) is a not-for-profit organization that sets standards for graduate medical education and seeks to "improve health care and population health by … advancing the quality of resident physicians' education through accreditation." 4 The ACGME Common Program Requirements mandate residency programs provide training related to HVC, including quality improvement (QI), patient safety (PS), patient experience and cost-conscious care. The ACGME Milestones provide a framework of levels of knowledge, skills, attitudes and other attributes that residents are expected to achieve for each of the six core competencies as they advance through residency. The competencies of systems-based practice (SBP) and practice-based learning and improvement (PBLI) encompass concepts related to systems of healthcare delivery, personal practice improvement and QI.[5] A decade after the Core Competencies were introduced, a study by the American Hospital Association identified significant gaps in physicians' demonstration of these competencies in practice, particularly in SBP.[6] Subsequently, the Common Program Requirements were revised in 2018, adding explicit language around core HVC topics, including the requirement to provide trainees with their own individualized patient care data, and to "emphasize a culture of safety and quality improvement".[7,8] Medical specialties have begun implementing HVC curricula,[9,10] but the extent to which general surgery has done this appears limited.

The aim of this study was to explore the current state of HVC education in general surgery residency programs across the United States. In particular, we sought to explore details about existing HVC curricula and their prevalence, define residents' knowledge and attitudes towards HVC, understand the extent to which residents believe their programs are meeting the ACGME Common Program Requirements, and the extent to which residents are achieving the ACGME Core Competency Milestones related to HVC. A national survey-based investigation of general surgery residents was performed to explore these questions.

Materials and methods

Study sample

This research was conducted through a collaboration with the Association for Surgical Education Graduate Surgical Education Committee. Members of the committee queried the program directors of the general surgery residency programs at their respective institutions regarding willingness to distribute the survey to their residents. A snowball sampling technique was employed to identify additional programs willing to distribute the survey.[11] A total of 29 programs were contacted via their Association for Surgical Education - Graduate Surgical Education Committee members. Of those, 19 program directors agreed to participate and ultimately 14 programs did participate.

Survey instrument development

The survey instrument was developed in line with recommendations from the Association of Medical Education in Europe and prior survey methodology literature regarding survey development for educational research.[12,13] A focused literature review was performed to identify published and validated questionnaires on HVC education. However, there is a dearth of validated survey instruments regarding HVC and QI for residency education. One available survey, the Residency High Value Care Scale, validated for use with internal medicine residents, was identified and utilized as a framework to guide survey development for this study.[14] Survey items applicable to our study population, general surgery residents, were preserved and used in their original form. In addition, the ACGME General Surgery Milestones and Common Program Requirements were utilized as conceptual frameworks to guide survey development, with a focus on items pertinent to HVC concepts.[15] Survey items that were developed and utilized to investigate QI education in other surgical specialties were also incorporated.[16] Content validity was ensured through discussion with and feedback from HVC experts, health systems engineers and HVC curricula directors in graduate medical education.[12] The survey instrument was pilot tested in a small group of general surgery residents at the host institution. This was done in line with recommendations from the Association of Medical Education in Europe for best practices in survey development.[12] Questions were then edited for content and clarity based on feedback from the pilot testing and re-circulated for approval.

The 40-item survey instrument was divided into sections including HVC curricula, HVC experiences, quality of care, shared decision-making, cost-conscious care, QI knowledge and demographics (Supplement). Standard demographic information, such as post-graduate year (PGY), age, gender, and race/ethnicity, was collected. Residents were asked to identify HVC curricular concepts and instructional methods employed at their programs. They were then queried on specific experiences and achievements that mapped to the ACGME Milestones. Importantly, participants were not merely presented with the milestones and asked to rank their level of achievement. Rather, the behavioral anchors were pulled from the Milestones (Levels 2, 3 and 4) and participants were asked whether or not they had achieved each item.[15] SBP and PBLI milestone achievements related to *Improvement of Care* were most aligned with HVC and QI concepts. Program achievement of ACGME Common Program Requirements, such as provision of resident-specific patient care outcomes, were explored. Survey items related to cost-conscious and patient-centered care from a previously validated instrument were also included.[14] Respondents were queried about their attitudes toward the importance of HVC and QI education. Previously developed knowledge questions were used to reflect foundational QI principles.[16] Free text response options were provided throughout the survey to capture unanticipated responses. This study was deemed exempt by the University of Utah Institutional Review Board.

Survey administration and data analysis

Study data were collected and managed using Research Electronic Data Capture (REDCap).[17] In September 2019, the survey was distributed via an electronic link to general surgery residents at 14 geographically diverse programs. One reminder e-mail was sent two weeks following the initial invitation. Respondents could elect to enter into a drawing for a $50 gift card. Descriptive statistics and measures of bivariate associations were calculated using R Version 3.6.1 (The R Foundation for Statistical Computing, Vienna, Austria). Fisher's exact and chi-squared tests were used for categorical data.

Results

A total of 14 program directors at geographically diverse

institutions agreed to distribute the survey link to their current residents in September 2019. Program characteristics are shown in Table 1. This resulted in 619 general surgery residents being eligible to participate in the survey. The response rate was 29% (181/619) with an even distribution of male and female respondents (n = 62, 47% and n = 69, 53%, respectively). Of 181 respondents, 50 (28%) did not answer all demographic questions. There was greater consistency in response rates for PGY1-PGY4 residents (19–24% of respondents) with a smaller percentage of respondents in the PGY5 year (12%) (Table 2).

Curricula

Residents reported having various components of HVC in their curricula, with notably higher percentages reporting content on QI (n = 137, 84%) and PS (n = 131, 80%), relative to content on patient experience (n = 101, 62%), and cost-conscious care (n = 88, 54%). Seventeen percent (n = 25) reported no HVC curricula. While there was no difference in exposure to QI or PS amongst junior (PGY 1–3) or senior (PGY 4+) residents, junior residents were more likely to identify curricula related to patient experience (p = 0.006), cost-conscious care (p = 0.014) and high value care (p = 0.004). Instructional methods were variable, with 49% of residents reporting use of online modules, 57% lectures and 44% small group discussion.

While over half of respondents reported training in QI, participation in QI experiences was variable. Sixty percent (n = 86) of respondents reported receiving training in QI principles and 53% (n = 76) reported receiving training in how to apply QI methodology, both of which are Common Program Requirements. Over half of respondents (n = 78, 54%) had performed the basic steps of a QI project but only 43% (n = 62) had worked in a team to do so. Similarly, 44% (n = 63) had led a QI activity.

ACGME milestones and Common Program Requirements

Residents reported higher rates of achieving behaviors that mapped to SBP Milestones than PBLI Milestones. The practice domain of *Improvement of Care* was utilized for the SBP and PBLI competency questions. Eighty-one percent (n = 116) of residents reported completing activities that mapped to the SBP *Improvement of Care* Level 2 Milestone, 67% (n = 96) that mapped to Level 3 and 43% (n = 62) to Level 4. There was no difference by post-graduate year. Fifty-four percent (n = 78) reported meeting PBLI *Improvement of Care* Level 2 Milestones, 27% (n = 39) Level 3 and 44% (n = 63) Level 4.

Table 2
Demographics of respondents.

Demographics	n[a]	(%)
Age		
25–29	52	(39%)
30–35	72	(55%)
>35	8	(6%)
Gender		
Female	69	(52%)
Male	63	(48%)
Post-graduate year		
1	41	(24%)
2	33	(19%)
3	36	(21%)
4	32	(19%)
5	20	(12%)
6+	12	(6%)
Race/Ethnicity		
White or Caucasian	101	(70%)
Black or African American	3	(2%)
Asian	20	(14%)
Hispanic or Latinx	11	(8%)
American Indian or Alaskan Native	1	(<1%)
Native Hawaiian or other Pacific Islander	2	(1%)
Other	6	(4%)

[a] Demographic questions were optional and not answered by all participants.

Quality improvement and patient safety

The majority (n = 104, 75%) of residents reported their institution participates in the National Surgical Quality Improvement Project (NSQIP) but only 28% (n = 29) reported receiving NSQIP data on their own patient outcomes. Fewer than half of residents (n = 65, 47%) use formal mechanisms of near-miss event reporting (n = 17, 12% always, n = 22, 16% often, n = 26 19% sometimes). Over one-quarter of residents (n = 37, 26%) reported never having witnessed an adverse or near miss event. Only 20% (n = 28) of residents reported having participated in a root cause analysis.

Patient experience

Most residents reported that they feel prepared to participate in shared decision-making (strongly agree n = 49, 34%, agree n = 77, 56%) with their patients. Thirty-one percent (n = 43) reported that they always do so, while 55% (n = 75) often do so and 12% (n = 17) sometimes participate in shared decision-making discussions with patients.

Table 1
Characteristics of participating general surgery residency programs.

Participating Institution	Location	Training Environment	University or Community-Based	Residents per Year
Carle Foundation Hospital	Urbana, IL	Urban	Community	2–4
Cleveland Clinic	Cleveland, OH	Urban	University	10
Florida Atlantic University	Boca Raton, FL	Urban	Community	7
Geisinger Medical Center	Danville, PA	Rural	Community	4
Louisiana State University	New Orleans, LA	Urban	University	10
Northwestern University	Chicago, IL	Urban	University	5
The Ohio State University	Columbus, OH	Urban	University	7
University of Alabama at Birmingham	Birmingham, AL	Urban	University	8
University of Minnesota	Minneapolis, MN	Urban	University	7
University of Nebraska	Omaha, NE	Urban	University	5
University of Southern California	Los Angeles, CA	Urban	University	7
University of Texas – Southwestern	Dallas, TX	Urban	University	13
University of Utah	Salt Lake City, UT	Urban	University	6
West Virginia University	Morgantown, WV	Urban	University	5

Cost-conscious care

The majority of residents have limited exposure to cost-conscious care considerations (n = 39, 29% often and n = 2, 2% always) but how robust this experience is varies. A minority report (24%) attendings often (n = 31, 23%) or always (n = 1, 1%) discuss cost of care for their patients. Just 19% are always (n = 3, 2%) or often (n = 23, 17%) aware of costs of care for their patients while 45% are rarely (n = 52, 38%) or never (n = 10, 8%) aware (Fig. 1). Junior residents report more often having the necessity of their work-up questioned by the attending (p = 0.016), but there were no other differences by training level.

Knowledge

Half of residents (n = 92, 51%) were correctly able to identify process, outcome and balancing measures. Far fewer reported that they had heard of the National Academy of Medicine (formerly the Institute of Medicine) core aims for quality in healthcare (n = 29, 22%) or the QI cycle of plan-do-study-act (n = 45, 34%). This did not vary amongst junior or senior residents (p = 0.13) or by gender (p = 0.36). There was no difference in correctly answering knowledge questions by type of instructional methods (p = 0.94) but those who reported no curriculum were less likely to answer knowledge questions correctly (p < 0.001).

Attitudes

Over half of residents (n = 72, 54%) felt understanding HVC principles is very important in their current role, but less than half felt it is very important for their future practice (n = 59, 44%) and only 15% (n = 20) feel they would be able to lead a QI initiative in practice (Fig. 2). There was no difference in attitudes amongst junior or senior residents (p = 0.23, p = 0.32, p = 0.88, respectively). A minority of residents (n = 11, 8%) felt very empowered to impact systems of care delivery as a result of their HVC training; 37% (n = 49) felt fairly empowered, 30% (n = 41) and 17% (n = 23) felt not at all empowered. Again, there was no difference by training level (p = 0.84).

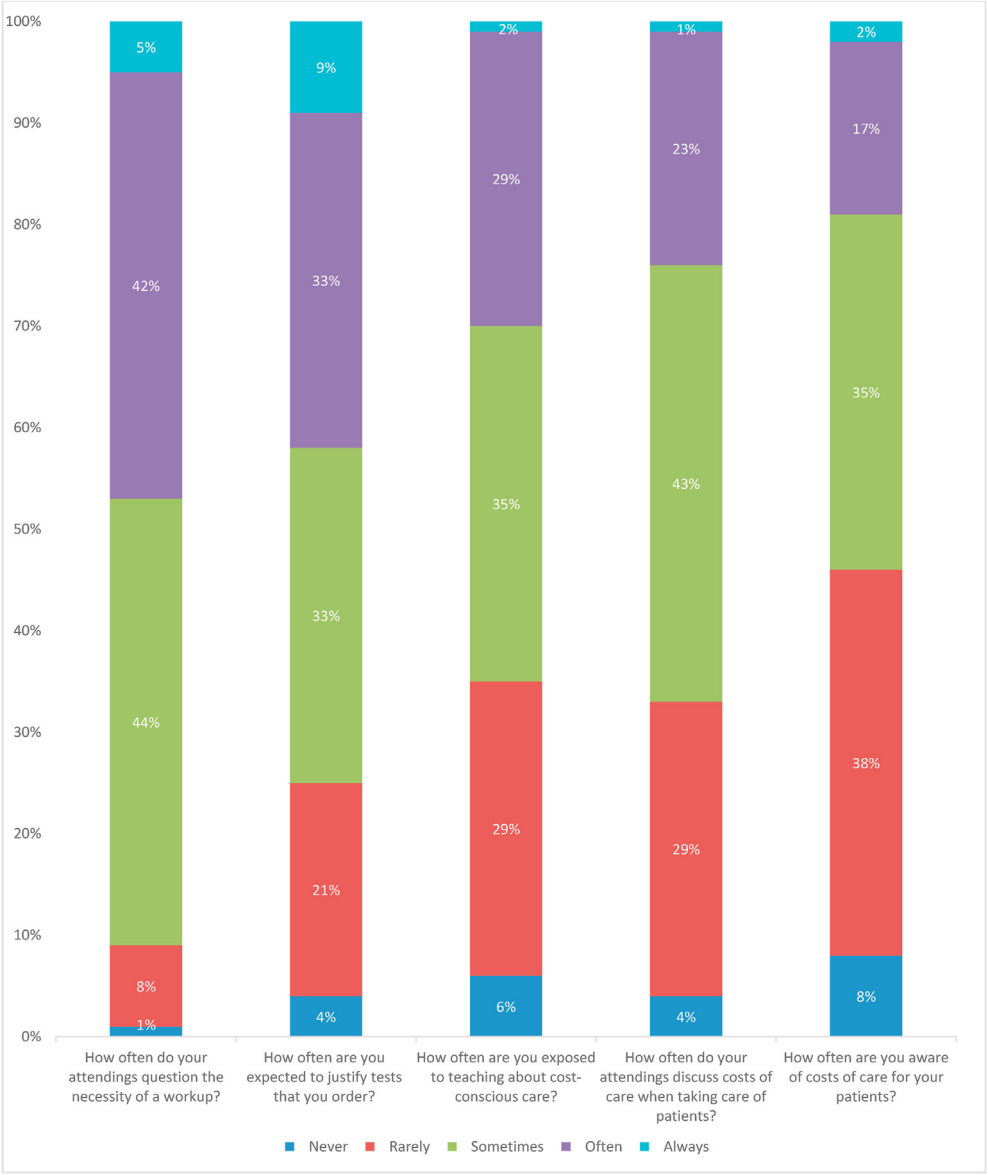

Fig. 1. Exposure and experience with cost-conscious care.

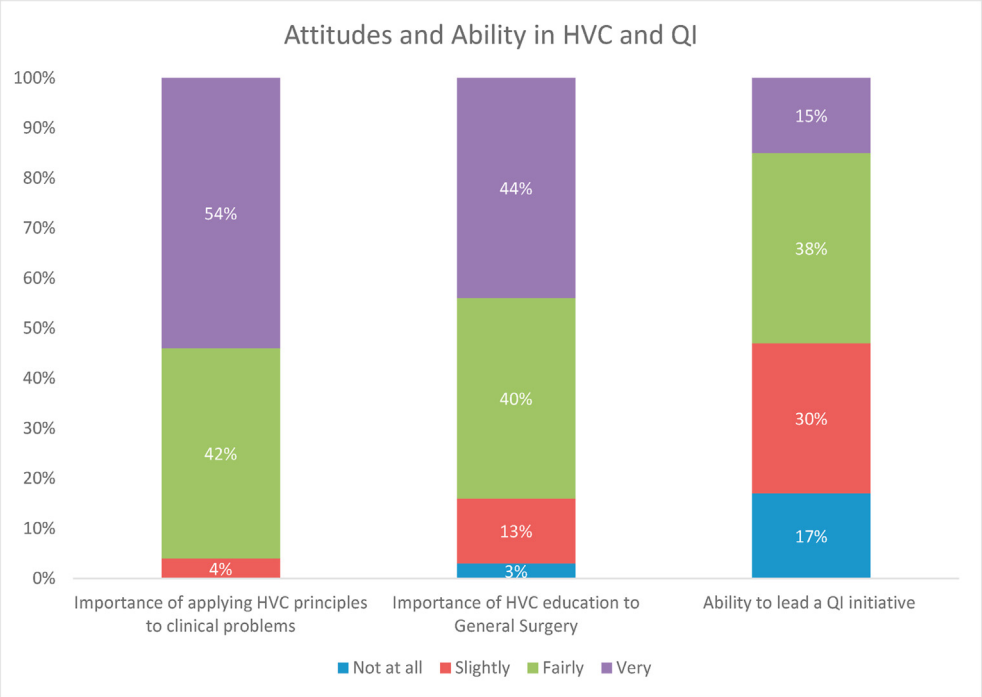

Fig. 2. Attitudes and ability in HVC and QI.

Discussion

Over the last two decades, there has been greater awareness of the importance of monitoring patient outcomes and seeking to improve the quality of surgical care, with an emphasis on patient safety and reducing adverse events. More recently, the additional constructs of patient experience and delivery of cost-conscious care have risen to the forefront as priorities in surgical care.[3] Therefore, it is absolutely critical that our surgical training programs develop and implement effective curricula in these core competency domains to prepare future surgeons for their role in delivering HVC. The results of this study demonstrate that while QI and PS curricula have largely been established in general surgery residency programs, gaps remain. Furthermore, resident education and training in the emerging components of HVC, patient experience and cost-conscious care, have not yet received the attention they deserve and curricula in these areas remain in their infancy. Less than one-quarter of residents are often aware of costs of care or have attendings discuss these considerations. The finding that junior residents report more exposure to these concepts than senior residents suggests some change has already begun.

Quality improvement and patient safety

Of all the components of HVC, QI has received perhaps the most attention over the past twenty years. Thus, it is not surprising that the majority of residents in this study reported that their programs provide QI and PS curricula. Importantly, those who reported any curricular modality were significantly more likely to answer basic QI and PS knowledge questions correctly, compared to those who reported no such curricula. This suggests that existing QI and PS curricula are effective in teaching foundational concepts. Unfortunately, this basic fund of knowledge does not appear to translate into practical skills in QI, with just 15% of residents reporting that they would feel very comfortable leading a QI effort in their future practice. While foundational knowledge of QI core concepts and terminology are important, the ability to translate the knowledge into action to improve surgical care delivery should be the goal of any graduate medical education endeavor. Residents should be provided with meaningful experiences in executing QI projects to develop their skills and confidence leading in this space.[18] In one QI curriculum that incorporated participation in QI projects, 70% of the residents who participated reported that they were well equipped to lead similar initiatives in the future, highlighting the importance of experiential learning.[19,20] Similarly, while residents report receiving PS education and training, few residents have participated in practical experiences, such as root cause analyses. This suggests there is a readily available opportunity for many programs to utilize.

Less than one-third of residents who responded to this survey reported receiving outcome data on their own patients, which is an ACGME Common Program Requirement that was added in 2018, with programs being subject to citation beginning in July 2019.[21] While this is a relatively recent addition to the Common Program Requirements, it is important for program accreditation and resident education that mechanisms for sharing individual resident data on their own patient outcomes be established and disseminated. Institutions that participate in NSQIP are able to utilize this platform to generate resident-level reports, which can be reviewed with residents periodically to familiarize them with the types of reports they will see in practice and establish life-long habits of personal performance review and improvement.[19,22]

Patient experience

While objectively defining patient experience is difficult, we sought to understand general surgery residents' exposure to this concept through survey questions related to shared decision-making. The vast majority of residents reported that they often or always engage in shared decision-making conversations with their patients (86%) and agree or strongly agree that they are prepared to participate in shared decision-making conversations with patients

in their future practice (92%), despite fewer residents reporting formal instruction in this area (62%). This finding is consistent with prior studies that have suggested that informal curricula, or role modeling by attending physicians, may be a more effective approach to teaching patient-centered care rather than formal curricula and instruction.[14,23,24] Unfortunately, only 38% of residents agreed or strongly agreed that they feel prepared to use overtreatment guidelines in discussions with patients about their plans of care. *Choosing Wisely*, an initiative of the American Board of Internal Medicine Foundation, provides society guidelines for tests, treatments and procedures that should be avoided, including guidelines from the ACS.[25] Surgical residents should be introduced to this tool, and development of a similar surgical tool may help facilitate discussions with patients about necessary and unnecessary testing and interventions.

Cost

The fundamental concept of "value" is the balance of quality and cost considerations in delivering optimal patient care. Without attention to cost conscious care delivery, HVC cannot be achieved. Unfortunately, the cost component of value has received the least attention to date, with just half of respondents reporting curricula in this domain. In addition to the lack of formal cost curricula, role modeling by attending surgeons is inadequate with about 1 in 3 respondents reporting exposure to teaching about cost-conscious care, and about 1 in 5 reporting their attending physicians discuss costs of care and that they are aware of the costs of care for their patients. These findings are similar to what has previously been reported in internal medicine.[14] Approximately 1 in 5 internal medicine residency graduates report they were always or frequently exposed to teaching about cost-conscious care, their attending physicians always or frequently discussed costs of care and were always or frequently aware of the costs of care for their patients, suggesting that the challenge with teaching cost conscious care is ubiquitous across medical specialties.[14]

While exposure, discussion and awareness of cost of care specifically are lower than one would hope, there are conversely higher rates of critical thinking regarding the necessity and justification of diagnostic testing amongst both specialties. Cost is just one part of the HVC equation. HVC entails the best possible use of resources to attain the best patient outcomes. This study, and prior work in internal medicine graduates, shows that a significant minority of trainees are thinking about or being questioned regarding their utilization of testing and resources.[12] While this is heartening, further work is necessary to ensure that the majority of residents have this experience, and that cost and value considerations are added into the equation. As the surgical community's experience in HVC education grows, we can also partner with our medical colleagues to meet the needs of our trainees.

The future of high value care education

Though residents report that the fundamental concepts of QI and PS are being taught in general surgery residency programs across the country, this has not translated into recognition of the importance of career-long engagement in QI and PS processes. Furthermore, the more complex and increasingly prevalent concept of value, including issues with patient experience and cost-conscious care, have yet to be consistently and formally incorporated into curricula. It is imperative that QI and PS curricula are revisited and revamped to ensure residents gain the requisite skills and attitudes to incorporate these activities into their future career activities. Surgical educators must move away from merely checking this curricular box to ensuring competency goals are achieved. Furthermore, efforts must be made to augment the existing QI and PS curricula to include the additional and important topics encompassed by the concept of value: patient experience and cost-conscious care. Informal curricula, or how faculty role model behaviors related to these domains in the clinical environment, are similarly important. In order to achieve optimal educational experiences and outcomes for our residents, we must also address the culture of HVC delivery within our institutions and training programs.[18]

Limitations

There are several important limitations inherent to this study. As with all survey-based research, there is the risk of nonresponse error. The response rate (29%) is within the expected range for surveys distributed by e-mail and within a population that is subject to frequent requests to participate in surveys.[26] Those institutions with stronger HVC and QI cultures may have been more likely to participate and residents with a better understanding or experience of HVC may have been more likely to respond. To mitigate the potential for bias, we included geographically diverse institutions and both university-based and community-based programs. Given the limited number of programs, no subgroup analysis was undertaken to compare university-based to community experience. Further work may highlight differences amongst these distinct educational populations. Similarly, as results were anonymized, there is no analysis of individual institutions, which may have allowed identification of outliers as well as the typical experience.

As residents from all levels were surveyed, it is also possible that more junior residents had not yet been exposed to certain aspects of their curricula. To better understand this possibility, we did analyze responses by post-graduate year and saw few differences. Furthermore, by querying the residents, rather than program coordinators or program directors, we may have been able to better glean the sum of formal and hidden curricula, as opposed to simply the curricula as they stand on paper. This, however, does lead to the risk of self-assessment bias, in that residents may be over (or under) reporting their achieved behaviors. Furthermore, results may be affected by residents not realizing the components of HVC education and not registering efforts and teaching to limit waste (cost conscious care) or improve wait times (patient experience) as part of this curriculum.

Additionally, in the field of HVC and in surgical education, there are few validated questionnaires. We used the one available survey instrument and the remainder of the survey questions were developed in line with published recommendations through the use of content experts and pilot testing.[9,12,14] The Residency High Value Care Scale, developed by Ryskina and colleagues, was validated in a population of internal medicine residents.[9,14] As such, it may not be fully generalizable to a surgical population. Despite our efforts in survey development, it is possible that questions did not elicit the full experience of surgical residents. Similarly, this questionnaire-based study sought to elucidate a broad understanding of surgery residents' HVC experience. Nonetheless, this national survey of general surgery residents does provide an understanding of their experiences with HVC education and their attitudes.

Conclusions

This is the first national study of general surgery residents' experiences with and attitudes toward HVC during residency training. Despite increasing emphasis on HVC in surgical practice, there is variability in HVC education in surgical training. Few residents feel

prepared to lead QI initiatives, have participated in PS processes, or are aware of patients' costs of care, underscoring the need for improved quality of HVC education. Surgical educators and HVC leaders must collaborate to develop HVC curricula for use in graduate surgical education.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amjsurg.2020.09.032.

Conflicts of interest and financial disclosures

None.

References

1. Committee on Quality Health Care in America - Institute of Medicine. In: *Crossing the Quality Chasm: A New Health System for the 21st Century. Institute of Medicine*. Washington D.C.: National Academy Press; 2001.
2. Razmaria AA. JAMA PATIENT PAGE. High-value care. *J Am Med Assoc*. 2015;314(22):2462.
3. [press release]. *American College of Surgeons and Harvard Business School's Institute for Strategy and Competitiveness Partner to Develop Value Measurement Tool for Hospitals*. American College of Surgeons; 18 July 2019.
4. Accreditation Council for Graduate Medical Education. Engaging each other: transformation through collaboration (2017 - 2018). Annual Report. In: *ACGME*. Chicago, IL: ACGME; 2018.
5. Accreditation Council for Graduate Medical Education. ACGME outcome project: competency descriptions 2002 [Available from: http://www.acgme.org/acwebsite/RRC_280/280_corecomp.asp.
6. Combes JR, Arespacochaga E. Physician competencies for a 21st century health care system. *J Grad Med Educ*. 2012;4(3):401–405.
7. Accreditation Council for Graduate Medical Education. *ACGME Common Program Requirements (Residency)*. Chicago, IL; 2018. Available from: https://www.acgme.org/Portals/0/PFAssets/ProgramRequirements/CPRResidency2019.pdf.
8. Accreditation Council for Graduate Medical Education. *Summary of Changes to ACGME Common Program Requirements Section VI*. Chicago, IL: ACGME; 2018. Available from: https://www.acgme.org/What-We-Do/Accreditation/Common-Program-Requirements/Summary-of-Proposed-Changes-to-ACGME-Common-Program-Requirements-Section-VI.
9. Ryskina KL, Korenstein D, Weissman A, Masters P, Alguire P, Smith CD. Development of a high-value care subscore on the internal medicine in-training examination. *Ann Intern Med*. 2014;161(10):733–739.
10. Chau T, Loertscher L. A multimodal high-value curriculum affects drivers of utilization and performance on the high-value care component of the internal medicine in-training exam. *J Community Hosp Intern Med Perspect*. 2018;8(1):23–25.
11. Goodman LA. Snowball sampling. *Ann Math Stat*. 1961;32(1):148–170.
12. Artino Jr AR, La Rochelle JS, Dezee KJ, Gehlbach H. Developing questionnaires for educational research: AMEE Guide No. 87. *Med Teach*. 2014;36(6):463–474.
13. Dilman DA, Smyth JD, Christian LM. *Internet, Phone, Mail, and Mixed-Mode Surveys: The Tailored Design Method*. Hoboken, NJ: John Wiley & Sons, Inc.; 2014.
14. Ryskina KL, Holmboe ES, Shea JA, Kim E, Long JA. Physician experiences with high value care in internal medicine residency: mixed-methods study of 2003-2013 residency graduates. *Teach Learn Med*. 2018;30(1):57–66.
15. ACGME (Accreditation Council for Graduate Medical Education). Surgery milestones 2019 june 30, 2019. Available from: https://www.acgme.org/Portals/0/PDFs/Milestones/SurgeryMilestones2.0.pdf?ver=2019-05-29-124604-347.
16. Purnell SM, Wolf L, Millar MM, Smith BK. A national survey of integrated vascular surgery residents' experiences with and attitudes about quality improvement during residency. *J Surg Educ*. 2020;77(1):158–165.
17. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)–a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inf*. 2009;42(2):377–381.
18. Malhotra NR, Vavra AK, Glasgow RE, Smith BK. *Six Steps to Engage Residents in Quality Improvement Education American College of Surgeons*; 2020. Available from: https://www.facs.org/education/division-of-education/publications/rise/articles/six-steps.
19. Kelz RR, Sellers MM, Reinke CE, Medbery RL, Morris J, Ko C. Quality in-training initiative–a solution to the need for education in quality improvement: results from a survey of program directors. *J Am Coll Surg*. 2013;217(6):1126–11232 e1, 5.
20. Sellers MM, Hanson K, Schuller M, et al. Development and participant assessment of a practical quality improvement educational initiative for surgical residents. *J Am Coll Surg*. 2013;216(6):1207–1213, 13 e1.
21. Accreditation Council for Graduate Medical Education. *Common Program Requirements Section VI Table of Implementation Dates Chicago, IL*; 2017. Available from: https://www.acgme.org/Portals/0/PFAssets/ProgramRequirements/2017CPRSectionVIImplementationTable.pdf.
22. Medbery RL, Sellers MM, Ko CY, Kelz RR. The unmet need for a national surgical quality improvement curriculum: a systematic review. *J Surg Educ*. 2014;71(4):613–631.
23. Stammen L, Slootweg I, Stalmeijer R, et al. The struggle is real: how residents learn to provide high-value, cost-conscious care. *Teach Learn Med*. 2019;31(4):402–411.
24. Stammen LA, Stalmeijer RE, Paternotte E, et al. Training physicians to provide high-value, cost-conscious care: a systematic review. *J Am Med Assoc*. 2015;314(22):2384–2400.
25. Antunez AG, Telem DA, Dossett LA. Assessment of surgical specialty societies' choosing wisely recommendations. *JAMA Surg*. 2019;154(10):971–973.
26. Bartel Sheehan K. E-mail survey response rates: a review. *J Computer-Mediated Commun*. 2006;6(2).