# Creation and implementation of a novel clinical workflow based on the AAST uniform anatomic severity grading system for emergency general surgery conditions

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## ABSTRACT

**Objective**   Emergency general surgery (EGS) conditions encompass a variety of diseases treated by acute care surgeons. The heterogeneity of these diseases limits infrastructure to facilitate EGS-specific quality improvement (QI) and research. A uniform anatomic severity grading system for EGS conditions was recently developed to fill this need. We integrated this system into our clinical workflow and examined its impact on research, surgical training, communication, and patient care.

**Methods**   The grading system was integrated into our clinical workflow in a phased fashion through formal education and a written handbook. A documentation template was also deployed in our electronic medical record to prospectively assign severity scores at the time of patient evaluation. Mixed methods including a quantitative survey and qualitative interviews of trainees and attending surgeons were used to evaluate the impact of the new workflow and to identify obstacles to its adoption.

**Results**   We identified 2291 patients presenting with EGS conditions during our study period. The most common diagnoses were small bowel obstruction (n=470, 20.5%), acute cholecystitis (n=384, 16.8%), and appendicitis (n=370, 16.1%). A total of 21 qualitative interviews were conducted. Twenty interviewees (95.2%) had a positive impression of the clinical workflow, citing enhanced patient care and research opportunities. Fifteen interviewees (75.0%) reported the severity grading system was a useful framework for clinical management, with five participants (25.0%) indicating the system was useful to facilitate clinical communication. Participants identified solutions to overcome barriers to adoption of the clinical workflow.

**Conclusions**   The uniform anatomic severity grading system can be readily integrated into a clinical workflow to facilitate prospective data collection for QI and research. The system is perceived as valuable by users. Educational initiatives that focus on increasing familiarity with the system and its benefits will likely improve adoption of the classification system and the clinical workflow that uses it.

**Level of evidence**   Level III.

## BACKGROUND

Emergency general surgery (EGS) conditions encompass a diverse group of pathologies that fall under the purview of the acute care surgeon.[1] These conditions account for approximately 7% of US hospital admissions and are projected to cost our healthcare system over $30 billion this year.[2 3] Efforts to mitigate the burden of EGS conditions have been hampered by lack of standard classification systems. Without consensus nomenclature to grade disease severity or methods to capture key outcomes, multi-institutional studies and quality improvement (QI) initiatives on patients with EGS conditions have proven challenging.[4–6]

The American Association for the Surgery of Trauma (AAST) recently developed a uniform anatomic severity grading system to classify the severity of 16 common EGS conditions[7] (referred to hereafter as 'AAST EGS grades'). Like the AAST traumatic organ injury scale[8–10] and onco-logic staging systems, AAST EGS grades classify the degree of affected organ pathology as well as the extent of spread of disease. Disease severity is classified from least (grade I) to most severe (grade V).[11] Several studies have demonstrated that AAST EGS grades facilitate multi-institutional outcomes research.[12–17] However, the potential of AAST EGS grades to propel real-time, point-of-care research has yet to be explored. We aimed to develop a clinical workflow that integrates prospective AAST EGS grade assignments within the electronic medical record (EMR) at the time of patient evaluation. We also developed a clinical guide to assist trainees in integrating AAST EGS grades into clinical use. We hypothesized that this workflow would (1) build an EGS-specific database to facilitate point-of-care research; (2) aid in clinical training and improve surgical trainee-attending communication through creating a shared mental model; and (3) serve as a pilot model for establishing a multi-institutional EGS registry. We used a mixed methods model to evaluate the efficacy of this workflow in achieving these aims, identify obstacles to the widespread adoption of this workflow, and propose solutions to overcome those obstacles.
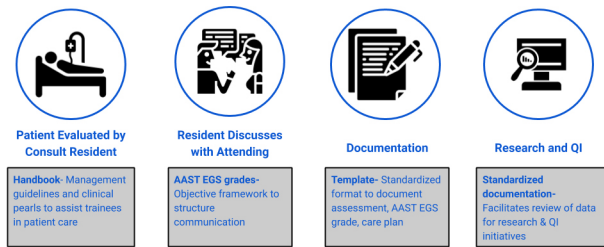
**Figure 1** Schematic of the current acute care surgery clinical workflow. Gray boxes introduce hypothesized improvements as a result of proposed interventions derived from integration of the AAST EGS grading system. AAST, American Association for the Surgery of Trauma; EGS, emergency general surgery; QI, quality improvement.

## METHODS
### Clinical workflow integration overview
Our institution integrated AAST EGS grades into our general surgery consult service's clinical workflow in July 2017. Our general surgery service is staffed by acute care surgery (ACS) surgeons (n=9) as well as surgeons from other specialties (n=11). Trainees responsible for evaluating patients with EGS conditions and assigning EGS grades were provided a handbook detailing the EGS grading system. The handbook synthesized EGS grading criteria, clinical pearls, and clinical management guidelines for 13 of the 16 EGS conditions.[7] Three conditions not routinely managed by our general surgery consult service—esophageal perforation, pleural space infection, and pelvic inflammatory disease—were excluded from our clinical workflow. A new documentation template that requires EGS grade assignment at the time of consultation was deployed within our EMR. EGS grades were assigned based on the clinical criteria described by Tominaga et al.[7] Imaging, pathologic, and operative criteria were not considered. Figure 1 provides a schematic of our service's clinical workflow and shows areas where integration of AAST EGS grades, the handbook, and the documentation template were hypothesized to improve the efficiency and quality of our care pathway.

The workflow underwent phased implementation (online supplemental figure 1). Phase 1 focused on familiarization with the AAST EGS grading system and its application when evaluating patients. This was accomplished via distribution of the consult handbook, email communications, and in-person education. Phase 2 pilot tested the documentation template, which was formally integrated within the EMR during phase 3. The last phase examined implementation barriers via a written survey of trainees and qualitative interviews of trainees and attending surgeons.

### EMR documentation template
We built an EGS-specific history and physical (H&P) documentation template within our EMR (Epic, Epic Systems, Verona, WI). The template's patient assessment included a compound drop-down menu for trainees to select the EGS condition and severity grade while writing the consult note. To ensure accurate grade assignment, the drop-down menu included expert-derived clinical criteria corresponding to each severity score.[7] To allow future comparative studies, the drop-down menu also tasked assignment of common alternative disease severity scales (ie, Alvarado score for appendicitis, Tokyo criteria for acute cholecystitis). The template included a wildcard (blank) option to allow authors to document conditions other than the core 13 EGS clinical conditions.

### Extracting point-of-care data
The Stanford Translational Research Integrated Database Environment (STRIDE) compiles comprehensive patient records in a research compliant format that can be readily queried.[18] We extracted H&P documentation on patients with EGS conditions between July 30, 2018 and November 18, 2019 by querying STRIDE for the text string 'EGS clinical score' (unique identifier found within the EGS-specific templates).

### Preliminary survey
The Qualtrics survey tool (Qualtrics XM, https://www.qualtrics.com) was used to build and distribute a 10-question Likert-like survey to ascertain feasibility and usability of the EGS clinical workflow in August 2018, 1 year after implementation of EGS grades within our general surgery consults. Eligible survey respondents were trainees who had completed at least one rotation on the ACS service after July 2017. To avoid bias, coauthors were not eligible to complete the survey. A $100 gift card was awarded to a random survey respondent to incentivize participation. We performed descriptive analysis of survey results using Microsoft Excel (Microsoft, Redmond, WA).

### Qualitative interviews
Preliminary survey results informed semistructured interviews to further elucidate perceptions regarding AAST EGS grades and our clinical workflow. Eligible interviewees included trainees who had completed at least one rotation on the ACS general surgery service after July 2017, and attending surgeons who staffed at least one general surgery call shift every 2 months. Interviewees were awarded $50 gift cards for participation. Coauthors were not eligible to participate. After verbal consent, interviews were conducted and recorded over telephone. Audio recordings were transcribed by a professional transcription service (JSTS Transcription Service, San Mateo, CA) and analyzed using Dedoose v.7.0 (SocioCultural Research Consultants, Los Angeles, CA). We employed iterative and inductive coding, which is an exploratory approach used commonly in qualitative research to develop a codebook based on themes that emerge from the data. Two coders (KEB and LMK) adjudicated coding application via consensus. We conducted a check for validity by searching for disconfirming evidence by theme.[19]

## RESULTS
### Point-of-care data extraction
We identified 2291 encounters of patients presenting with EGS conditions during our study period. The most common diagnoses were small bowel obstruction (n=470), acute cholecystitis (n=384), and appendicitis (n=370) (table 1).

### Preliminary survey
Fifteen of 21 eligible respondents (70%) completed the survey. Survey results are shown in online supplemental figure 2. A majority of respondents reported that AAST EGS grades were useful for formulating care plans (57%) and that integration of the grading system into the consult H&P note was helpful (53%). Only 27% (n=4) of respondents thought that the clinical workflow benefitted communication between trainees and attending surgeons.

### Qualitative interviews
We conducted a total of 21 interviews (6 attending surgeons, 15 trainees). Interview duration ranged from 9 to 28 minutes (mean

**Table 1** Point-of-care data extraction of patients presenting with emergency general surgery (EGS) conditions between July 30, 2018 and November 18, 2019 using the H&P documentation template

| EGS condition | Patient encounters (n) |
|---|---|
| Acute appendicitis | 370 |
| Peptic ulcer disease | 27 |
| Bowel ischemia | 13 |
| Small bowel obstruction | 403 |
| Colitis | 234 |
| Acute diverticulitis | 274 |
| Breast infections | 329 |
| Acute cholecystitis | 384 |
| Acute pancreatitis | 172 |
| Soft tissue infections | 2 |
| Hernias | 28 |
| Perirectal abscesses | 55 |

H&P, history and physical.

duration=17 minutes). Overall, 20 interviewees expressed positive impressions of the clinical workflow.

### Familiarity with AAST EGS grades-integrated clinical workflow

Of 16 interviewees reporting familiarity with the novel workflow, 10 reported learning about the initiative through informal interactions (ie, service sign-outs, seeing the documentation in patient charts, and informal discussions) whereas nine recalled learning about the workflow through formal lectures. All interviewed trainees found the consult handbook useful in supporting their clinical work and thought that EMR inclusion of EGS grades facilitated fluency with the disease severity classification system.

### Perceptions of the AAST EGS grades-integrated clinical workflow

Interviewees overall thought the new workflow enhanced patient care and facilitated clinical research. Table 2 provides illustrative excerpts from interviews. There were mixed opinions regarding integration of management guidelines into our clinical workflow as well as the utility of EGS grades for structuring communication.

### Utility of management guidelines in the AAST EGS grades-integrated clinical workflow

As previously mentioned, the handbook contained management guidelines for each of the 13 EGS conditions. Guidelines were further stratified for each condition according to the severity grade of each disease process. These guidelines were based on current practices in our department; however, the compilation of the handbook represents the first time that these pathways were codified and distributed to trainees in written form. Fifteen interviewees (13 trainees, two attending surgeons) thought management guidelines corresponding to assigned EGS grades were useful, but nine (six trainees and three attending surgeons) expressed reservation. Table 3 contains representative statements from interviews further explaining these sentiments. Junior trainees valued management guidelines as a means to reinforce clinical acumen and avoid errors of omission. Reservations centered around the potential for inaccurate patient disease severity assignment leading to delegation of patients to inappropriate care pathways. Additionally, there was some resistance to formally codifying management guidelines due to perceived concerns over the loss of clinician autonomy.

**Table 2** Respondents' quotes illustrating the potential of the EGS uniform anatomic severity grading system-based workflow to provide novel opportunities for standardization in care, clinical research, and overall improved patient care

| Theme | Quotation |
|---|---|
| Standardization | 'The standardization of consult notes is really appealing. Having information that you should always include for common consults, and be able to compare across consults. I think that would be very useful.' |
| | 'I think that any time appropriate Standardization occurs, then that decreases the potential for human error.' |
| | 'If this synoptic note and scoring system is validated, it would be really important to have and to use for institutional transfer. You get these calls from community hospitals and you don't have an idea of how acute the patient is. You try to ask enough questions, but then the patients show up here [in a different condition than expected]. I think this being implemented beyond Stanford in general surgery could be really helpful.' |
| Facilitate clinical research | 'I think it will simplify categorization of patients for research rather than having to sift through dozens of charts later on.' |
| | 'I would say probably trying to get better data on some of the questions regarding decision making in general surgery. In non-operative management, there are a lot of challenging situations that we make decisions on based on our best judgment and/or discussion with other physicians, but there is little good data to go off. The numbers are small or non-existent. So I think that would be the most useful part.' |
| | 'Yes, in terms of the guiding data, it is important to know. Because a lot of the patients are probably managed non-operatively and are being missed as important.' |
| | 'I think you would get lots of good data about the consults we're seeing, how acute they are, how much we're operating, and what we're doing. I think it is a good way to collect data and organize it in an area that would be otherwise hard to follow.' |
| | 'Where I see value in it is in research. I think it's similar to organ injury grading for trauma, where at the time of initial evaluation and management, I would say it isn't particularly useful. I think it is more useful in the backend when it comes to research and classification for studies.' |
| Improve care | 'I think this is happening in different areas of medicine. Cancer is one example where staging is applied formally. I think it allows you to provide better quality care and to interpret other institutions' information.' |
| | 'This helps us understand our outcomes. I think that's motivating for everyone, because everyone wants to help take better of patients and be able to have metrics to know that we're doing that.' |
| | 'I think for the first time it will help to really not only classify the types of patients that come to an emergency general surgery service, but it also helps in terms of understanding trends in their care and how we can provide more efficient service to the patients.' |

EGS, emergency general surgery.

**Table 3** Respondents' opinions regarding the use of management guidelines

| Benefits of management guidelines | Reservations around management guidelines |
|---|---|
| 'It was really helpful to be able to match the clinical picture I was seeing up to something that was in the consult handbook and then feel comfortable that I making the right management decision for the patient.' | 'There's a reason why many physicians don't adhere to [protocols], because they don't believe that they apply to the patient population that they're taking care of.' |
| 'The consult handbook was especially nice because it was concise, focused on the things we see most often, and I could feel comfortable knowing that I had appropriately assessed the patient and placed them into one of the buckets and that my management decision was going to be in the realm of it was reasonable to treat the patient. It was nice to have that reassurance.' | 'I think it is possible [to protocolize treatment], but I think it's never that clean. We just need to find out what emergency cases fit into which category… I think in some ways it's comparable to injury grading and how we use that, but we may find out it's not. We don't really have any data.' |
| 'The consult handbook was great, especially starting out, to really guide what to do in these situations and give you the resource quickly make a diagnosis and know "these are the things I need to think about." It's not just take them to the OR. It's also remember to start antibiotics, start fluids, and these ancillary details might get lost in all the focus of "this patient has got to go to the OR".' | 'I think for straightforward things it's probably a good idea. Like for proven appendicitis or cholecystitis. But, I think for other kinds of emergency general surgery consults, like perforated viscus, you have no idea if its upper GI or lower GI. Perhaps the pathway for those scenarios is probably not the best thing and might lead people to the wrong route.' |
| 'I think with any grading or classification system, it provides a rubric and a starting point with suggested management based on disease severity, but you're not obligated to do that regardless of what your team ends up doing, it provides a baseline, agreed upon management and I think that is only going to be helpful.' | 'There are definitely times when the patient falls in between 2 different classes, but you're supposed to use your clinical judgment to be able to determine what their treatment is. That's the fault of any classification system. Sometimes there is gray. It's not always black and white.' |
| 'Having a classification system with a clear outline on what management steps we take, what tests to order, what studies to be done. I think that lets us make sure we don't miss any important workups or plans.' | 'I mean the residents may use that, but I don't think the faculty member is going to pull up a handbook. They're just not, it doesn't fit the workflow.' |
| 'I think that with the diagnostic information being brought in through the EGS classification system, it's going to really stratify branch points and management based on classification systems of these typical emergency general surgery problems.' | 'Sometimes I feel like there is almost a discrepancy between what my assessment and plan is as compared to the few words that are in the classification itself. I think sometimes there's a little bit of a disconnect there. Sometimes I would think to myself "is it ok to say other or select this criteria even if its not 100% applicable to the patient in one way but it is in another?"' |
| 'It makes it much more black and white in terms of how to communicate about the patient. I also provides a little bit of a checklist in the middles of the night when you're tired to make sure you don't forget anything.' | 'I think you're going to run into the same problem where you have now a second layer of "how do I interpret these guidelines?" I'm not sure how much it will be helpful, because the decision making process in always complicated no matter what. Patients are not that straightforward and they may not fit into certain guidelines. If the guidelines are written very carefully with definite hard points where there is certain criteria where for like 95% certainty this next step should happen, then I think it would be useful.' |

### AAST EGS grades-integrated clinical workflow as a framework for communication

The majority of interviewees (14 trainees, two attending surgeons) did not think the new workflow improved communication. While standardized disease severity nomenclature was helpful, many thought EGS grades were not ubiquitously recognized or adopted within our department, limiting their utility as a framework for efficient and accurate communication.

### Overcoming barriers of new clinical workflow adoption

Interviewees identified three themes to enhance future clinical workflow adoption (figure 2). These included targeted educational initiatives to improve familiarity with the system and its major objectives, ideas to reinforce the use of the AAST EGS grades as a framework for formal communication, and the key role of senior stakeholders in driving adoption of the workflow.

### Tailored educational initiatives

Interviewees thought in-person education was more effective compared with emails for disseminating new clinical workflows. Trainees reported orientation to the clinical workflow immediately prior to starting the consult rotation would be helpful. Interviewees stressed the importance of highlighting expected outcomes of adopting a new workflow. Many reported they would be reluctant to adopt new workflows designed to meet non-clinical or non-educational ends (ie, improved billing). Figure 3 provides some best practices to promote familiarity with an AAST EGS grades-based workflow.

### Framework for formal communication

Many trainees were unsure which colleagues or superiors were familiar with AAST EGS grades, and for that reason, were hesitant to use them as a communication aid. The few interviewees who had attempted to use the grading scale to communicate the severity of a patient's condition noted that it had resulted in confusion as the surgeon was not familiar with the grading system. Interviewees also thought that multidisciplinary

**Figure 2** Barriers to implementation of the AAST EGS grades-integrated workflow identified through qualitative interviews. Obstacles are divided by theme with brief summaries of each perceived obstacle. Quotations illustrate participants' sentiments toward these issues. Blue boxes outline potential solutions to overcome the aforementioned barriers. AAST, American Association for the Surgery of Trauma; EGS, emergency general surgery.

**Figure 3** Best practices to maximize educational endeavors to promote familiarity with an AAST EGS grades-based workflow. Illustrative quotations from interviewees are provided for each. AAST, American Association for the Surgery of Trauma; EGS, emergency general surgery.

adoption of this workflow (eg, the emergency department and internal medicine services) could increase efficiency and improve patient care.

### Engaging senior stakeholders

Trainees highlighted the importance of attending surgeons and program leadership prioritizing EGS clinical workflow adoption. In addition to asking trainees to structure communication using EGS grades and using EGS H&P templates, interviewees suggested chief residents and attending surgeons should periodically audit patient documentation to ensure EGS workflow adoption.

### DISCUSSION

Integration of AAST EGS grades into clinical workflows (figure 1) has the potential to standardize communication between providers, protocolize clinical care, and facilitate point-of-care research using a prospectively assigned disease severity for EGS conditions. Our study highlights a phased strategy to adopt a new clinical workflow in an academic healthcare center in the USA and barriers to adoption identified via systematic QI initiatives. Through integration of a standardized documentation template into our EMR, we demonstrated that uniform anatomic severity scores can be prospectively assigned to patients in real time at the time of initial consultation. This standardized approach facilitated consistent data collection and is readily scalable and automated, allowing for integration into data registries. Similar approaches have led to successful research and QI initiatives in other surgical subspecialties including trauma (Trauma Quality Improvement Program[20]) and colorectal surgery.[21] In addition to data collection, our experiences demonstrated that AAST EGS scores provide a foundation to design EGS-specific educational initiatives, and may provide infrastructure for improving communication among the care team.

Respondents at both the resident and faculty level were most enthusiastic about the potential EGS grading systems to improve opportunities for research. To date, a national database of EGS patients does not exist, in part because EGS patients have such a broad range of clinical pathologies and indications for operative or non-operative management. In particular, surgical registries do not routinely capture patients with EGS conditions who are managed non-operatively (eg, uncomplicated diverticulitis, appendicitis, and pancreatitis).[5] An important aspect of our clinical workflow is that EGS severity grading was assigned by clinicians at the time of patient evaluation. This arguably imposes minimal additional physician burden, while providing accurate

EGS grading classification of patient disease. We hypothesize that more widespread adoption of this approach across institutions has the potential to improve accuracy of future local and national EGS registries, as well as provide an opportunity for granular clinical research of EGS patients who are managed both operatively and non-operatively. Additionally, imaging operative, and pathologic criteria have also been described[7] and could be integrated into this workflow to improve the robustness of classification.

Our early experience with the uniform anatomic severity grading system-based workflow did illustrate some significant barriers to adoption. We unexpectedly found that AAST EGS grades had not been uniformly deemed as a useful means to structure communication around EGS patients. However, respondents did note that they thought the system could facilitate improved communication with more formal education and widespread adoption. Structured communication frameworks such as the SBAR[22 23] and iPASS[24] tools have been shown to improve communication between members of the care team, decrease medical errors, and improve patient outcomes. We think that routine integration of EGS severity grading into clinical workflow can help create a shared mental model when discussing EGS conditions among care teams.

Through discussions with trainees and attending surgeons, we noted that familiarity with the system and its potential benefits are key to garnering adoption of the novel clinical workflow. This speaks to the importance of including attending surgeons in education initiatives early. This was a limitation in our original roll-out strategy, as only two of the attending surgeons interviewed had any a priori knowledge of the EGS severity grading system. It is also important for leadership to provide feedback to junior residents, including holding them accountable for using the proper documentation. In addition, didactic sessions should stress the benefits of the novel clinical workflow including opportunities for research, especially in areas of investigation for which adequate data and research infrastructure do not exist.

Finally, EGS grading guidelines (distributed as a handbook) were intended to provide an efficient reference for residents at the point of care and our data suggest that the tool is useful for junior residents (especially early in PGY-2 when they were relatively inexperienced). However, these guidelines are intended to be a mechanism for organizing diagnosis and management decisions. It should be underscored that these guidelines are not intended to replace sound clinical judgement and adequate supervision. Not all patients are classifiable by the EGS criteria, putting them at risk of being placed on an inappropriate care pathway. Proper patient selection is essential to the successful implementation of care pathways and treatment protocols, and it should be recognized early on that not all patients will be good candidates for these protocols. Providers should be encouraged to consider patient selection carefully and use clinical judgement when applying any treatment protocols.

This study did not specifically include intervention and control groups which may limit our ability to draw conclusions. Additionally, resident participation was limited to a subset of mid-level residents and attending surgeons, creating the possibility for some selection bias and may limit generalizability. Furthermore, this work sought to understand the opinions of a select group of general surgery residents from a single residency program. Because each residency program has its own culture, logistics and unique obstacles, the findings of this study may not be applicable to other academic surgery programs.

## CONCLUSION

AAST EGS grades can be readily integrated into clinical documentation to facilitate prospective data collection for QI and outcomes-based research. The system is perceived as valuable by users. Improved educational initiatives that focus on increasing familiarity with the system and its benefits will likely improve adoption of the classification system and the clinical workflow that uses it. The classification system provides a useful framework for clinical education and treatment guidelines, but should in no way replace sound clinical judgement. Lessons garnered from our early experiences implementing an EGS uniform anatomic severity grading system-based workflow can be integrated into a toolkit to facilitate multicenter EGS QI and research initiatives.

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