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**CONCEPTS**

**Evidence-Based Emergency Medicine**

# Designing clinical guidelines that improve access and satisfaction in the emergency department

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## Abstract

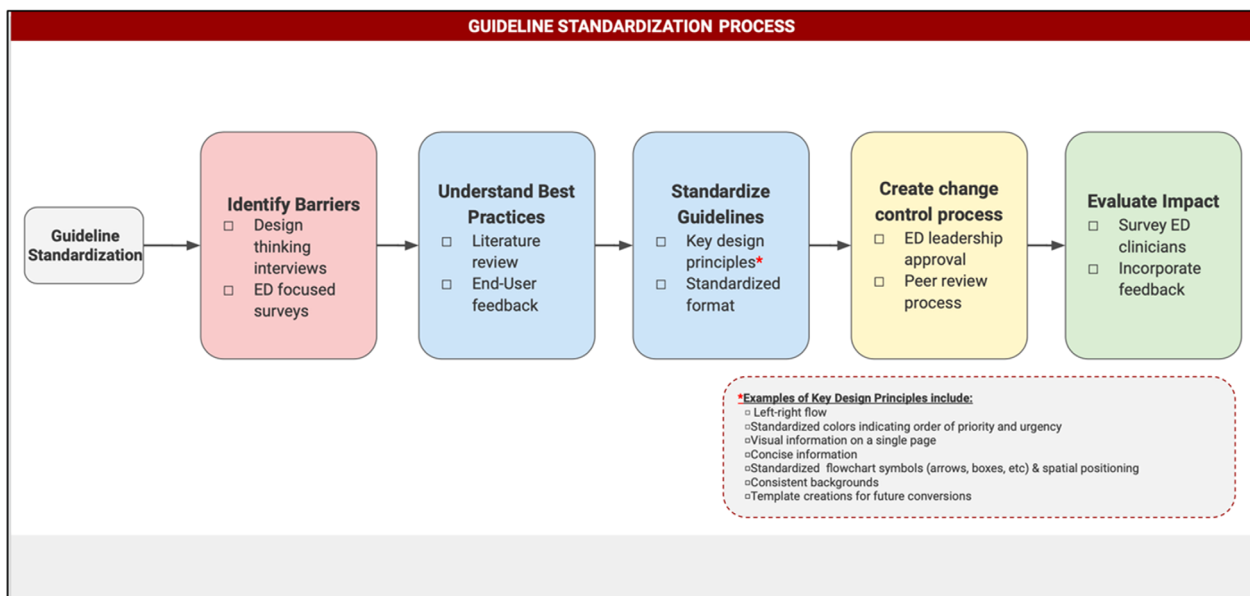
Clinical guidelines are evidence-based clinician decision-support tools that improve health outcomes, reduce patient harm, and decrease healthcare costs, but are often underused in emergency departments (EDs). This article describes a replicable, evidence-based design-thinking approach to developing best practices for guideline design that improves clinical satisfaction and usage. We used a 5-step process to enhance guideline usability in our ED. First, we conducted end-user interviews to identify barriers to guideline usage. Second, we reviewed the literature to identify key principles in guideline design. Third, we applied our findings to create a standardized guideline format, incorporating rapid cycle learning and iterative improvements. Fourth, we ensured the clinical validity of our updated guidelines by using a rigorous process for peer review. Lastly, we evaluated the impact of our guideline conversion process by tracking clinical guidelines access per day from October 2020 to January 2022. Our end-user interviews and review of the design literature revealed several barriers to guideline use, including lack of readability, design inconsistencies, and guideline complexity. Although our previous clinical guideline system averaged 0.13 users per day, >43 users per day accessed the clinical guidelines on our new digital platform in January 2022, representing an increase in access and use exceeding 33,000%. Our replicable process using open-access resources increased clinician access to and satisfaction with clinical guidelines in our ED. Design-thinking and use of low-cost technology can significantly improve clinical guideline visibility and has the potential to increase guideline use.

## KEYWORDS

clinical guidelines, open access publishing, physician satisfaction, research design, standardization

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**FIGURE 1** Outline of guideline standardization process, converted using our team's guideline standardization procedure. ED, emergency department.

## 1 | INTRODUCTION

Clinical guidelines, which are evidence-based clinical workflows designed to support clinicians and enhance clinical decision making, are an important strategy for improving the consistency and quality of healthcare. As healthcare use increases in the United States, developing and implementing clinical guidelines has become increasingly supported by federal investment and adopted across multiple practice settings.<sup>1,2</sup> Clinical guidelines are commonly used throughout the hospital and range broadly, including everything from guiding antithrombotic therapy and streamlining management of febrile infants to recommending targeted screening for lung cancer.<sup>3-5</sup> For patients, clinical guidelines can improve health outcomes, lower morbidity and mortality, reduce patient harm, and improve care quality.<sup>6-9</sup> For clinicians, clinical guidelines improve the quality of clinical decisions and consistency of care, decrease medical errors, and decrease overall cost of care for hospital systems.<sup>6,10</sup>

Despite the benefits of clinical guidelines, emergency departments (EDs) often have low and variable rates of use in clinical practice.<sup>11-15</sup> At our institution, Zuckerberg San Francisco General Hospital (ZSFG), an urban, safety net, academic-affiliated level I trauma center, <1 user per week accessed the clinical guidelines on our ED's legacy cloud-based information storage system between October 2019 and October 2020.<sup>11</sup> Recognizing the importance of clinical guidelines in providing high-quality, efficient, and equitable care, we assembled a multidisciplinary team of clinicians, administrators, students, and designers to rethink how clinical guidelines are designed and accessed in our ED.

In this article, we describe a replicable, evidence-based, design-thinking approach for developing best practices for clinical guideline

design. We show that standardizing and streamlining guideline design can improve the clinician use of and satisfaction with clinical guidelines in the ED setting.

## 2 | UNDERSTANDING GUIDELINE UNDERUSE

Our approach to understanding and addressing guideline underuse in the ED included the following 5 key phases: (1) identify barriers to guideline usage with end-user interviews, (2) understand best practices with a thorough literature review, (3) create standardized guidelines using design-thinking methodology, (4) develop a change-control process with peer review, and (5) evaluate impact with clinician surveys and website user data metrics (Figure 1).

### 2.1 | Identifying barriers and understanding best practices

To understand best practices as well as common barriers for guideline design and implementation, we conducted 12 interviews with emergency clinicians to assess their existing opinions of clinical guidelines.<sup>11</sup> The interviews, conducted by 1 of the authors during a 2-week period, followed a semistructured protocol; themes were recorded in memos immediately after the interviews. These interviews revealed that the lack of standardized, easily accessible clinical guidelines made it difficult for guidelines to be quickly referenced by frontline clinicians. Clinicians struggled to quickly access up-to-date clinical information because information was not centralized, guidelines were scattered over multiple platforms, and updates were made over email with

**TABLE 1** Challenges to guideline usage in the emergency department.

Internal challenges	External challenges
Accessibility	Guideline implementation
Information scattered across multiple systems	Lack of awareness of guidelines by clinicians
Difficulty accessing password-protected cloud-based system	Lack of a change-control process
Confusion regarding most updated version of clinical guidelines	Guideline usage
Design	Poor guideline layout or complexity
Overwhelming amounts of text	High workload or time burdens when using guidelines
Lack of standardization	Lack of evidence base and physician collaboration

variable updating of protocols in the cloud-based system. Emergency clinicians were also overwhelmed by the hundreds of text-heavy, non-standardized pages of documents. This led to confusion, a lack of trust, and an overall underuse of clinical guidelines.

Combining our interview data with a review of current literature, we discovered several common critical barriers to guideline use (Table 1). Commonly identified challenges include the following: lack of awareness by clinicians, poor guideline layout or complexity, lack of collaboration during guideline development, difficult or restricted guideline access, high workload or time burdens when using guidelines, and lack of a change-control process.<sup>16-19</sup> Qualities of successful guidelines were also elucidated: easy to understand and interpret in real time,<sup>17</sup> review by a target group,<sup>16</sup> evidence based,<sup>18</sup> and easily accessible.<sup>16</sup>

### 3 | DESIGNING STANDARDIZED GUIDELINES

Among the barriers we discovered through our end-user interviews and literature review, we focused specifically on design barriers given the high potential for improvement with low-cost intervention.

We conducted a literature review on flowchart design to understand how to redesign guidelines for improved accessibility and applicability using the search terms “flowchart design” AND “design principles.” Our PubMed search returned 32 results, 5 of which were useful for understanding key design factors for ideal clinical guideline display, such as a consistent reading frame, standardized colors and flowchart symbols, concise visual information, and standardized guideline templates. After identifying guideline use barriers and validated best design practices for guideline creation, we created a streamlined process for converting the hospital’s previously underused text-based clinical guidelines into standardized, intuitive visual guidelines using the key principles highlighted next.

- **Concise visual information on a single page**<sup>20,21</sup>: Guidelines were limited to a single page to improve readability with input from a team of emergency physicians and leadership to ensure clinical fidelity. Guidelines that could not fit all the existing clinical information onto 1 page with a minimum size 8 font were either expanded to a 16:10 slide size or were expanded to  $\geq 2$  slides. Condensing verbose clin-

ical guidelines to only 1 to 2 pages of relevant clinical information was overseen by emergency physicians and leadership to ensure no clinically critical information was removed.

- **Standardized flowchart symbols (arrows, boxes, etc) and spatial positioning**<sup>22-24</sup>: Standardized symbols were used for consistency as used by IBM data processing techniques. Key steps in the clinical guidelines were kept in boxes outlined in black, with arrows progressing through subsequent steps. In each box, all information was condensed into bullet points. Any additional information beyond guideline steps, such as contraindications or medication dosages, were housed outside of the main flow and emphasized in a dotted orange box.
- **Consistent reading frame**<sup>22,23</sup>: Our team employed a standardized left-to-right flow to ensure uniformity so clinicians can have a common approach to each clinical guideline. This approach differed from previous clinical guidelines, which often included multiple flow directions (eg, top to bottom, left to right) in a single document.
- **Standardized colors indicating order of priority and urgency**<sup>24,25</sup>: We standardized guideline colors by order of priority and urgency as referenced in communication accessibility manuals. Gray was used to highlight the first prompt or question in the guideline. Subsequent steps used green (“yes” or no further action required), yellow (“unsure” or further diagnostics required), or red (“no” or intervention/procedure required). Phone numbers and links were highlighted for consistency and ease of retrieval.
- **Templates for flowchart creation**<sup>26</sup>: Our team created several templates using a standardized flowchart format, including single and multistep clinical workflows with and without branch points. A team of resident physicians and medical students converted existing clinical guidelines into this standardized format for every guideline. These templates are used to create every new clinical guideline for our ED and can be downloaded for free from Appendix 1.
- **Easily accessible, open-access platform**: Previously, clinical guidelines were scattered throughout a password-protected, cloud-based system, which many clinicians found difficulty to access and confusing to navigate. During the COVID-19 pandemic, our team developed an open-access, mobile-friendly centralized digital information hub—known as E\*Drive ([edrive.ucsf.edu](http://edrive.ucsf.edu))—which we then expanded to include all of our recently reformatted clinical guidelines.

### 3.1 | Creating a rigorous, change-control process

Among the barriers identified to clinical guideline usage, a common theme elucidated was general mistrust in the clinical guidelines—lack of a strong evidence base backing the clinical guidelines, lack of an interdisciplinary collaboration to cross-reference guidelines, and lack of a change-control process that was responsive to clinician needs.

Recognizing the importance of clinician trust in clinical guidelines, our team collaborated with emergency leadership to develop a rigorous change-control process whereby emergency leadership reviewed and cross-referenced each newly converted guideline before publication. Specialty-specific clinical guidelines were also reviewed by the leadership of the corresponding department. Once a guideline was approved, the name of the clinical leader(s) involved as well as the approval date were added to the guideline for credibility. The guideline was then uploaded to our open-access, digital clinical information hub.

By working closely with department leadership, we ensured all clinical guidelines, especially rapidly changing COVID-19–related guidelines, remained up to date.<sup>15</sup> By building a clinician-led team with a direct connection to department and hospital leadership, we were able to develop and adjust clinical guidelines in as few as 2 to 6 hours.

### 3.2 | Evaluating the Impact of Our Guideline Conversion Process

To assess clinician use of our newly converted clinical guidelines, we monitored web traffic data using Google Analytics, surveyed end users with a validated survey tool, and conducted interviews with end users. In addition, our team conducted 2 Institutional Review Board (IRB)–approved surveys to assess emergency clinicians' perceptions of the digital information hub and new guideline format in December 2020 and December 2021 (Appendix 2). We compared emergency clinicians' perceptions over time using  $\chi^2$  analysis. We also conducted semistructured interviews with 20 end users from October to December 2020 to gain additional insight into the impact of standardized guidelines in the ED.

## 4 | OUTCOMES AND RESULTS

Since the start of our project in October 2020, our team has converted 66 clinical guidelines into easy-to-follow flowcharts from >300 pages of text-heavy documents. Nearly 90% of the clinical guidelines were converted to single-page guidelines, a large improvement from the previously verbose, multipage guidelines. Examples of successfully converted guidelines include: upper gastrointestinal bleed, tissue plasminogen activator (tPA) reaction, postexposure prophylaxis, skin and soft tissue infection, pigtail catheters, and pediatric status epilepticus. The reformatted clinical guidelines are housed on our new, open-access digital information hub under specific categories including pediatrics, trauma, medical, and logistics. An example guideline conver-

sion is listed in Appendix 3 for reference. The design of our updated guidelines followed the key guideline design principles whenever possible. Occasionally, however, because of the high complexity and nuance of some of the clinical guidelines, we made slight deviations from our guideline design principles to smooth guideline flow and readability. For example, for guidelines such as the cervical spine clearance guideline, which required doubling back to certain steps based on clinical findings, we used a backward arrow to improve ease of readability.

Table 2 summarizes how our redesigned clinical guidelines address the barriers identified in our literature review and emergency clinician interviews. Our current analytics data demonstrate a dramatic increase in clinician access to clinical guidelines. Although our legacy cloud folder system averaged 0.13 users per day, >43 users per day accessed clinical guidelines on our new information hub in January 2022, which represents an increase in access exceeding 33,000%. Since launching our new standardized clinical guidelines, from October 2020 to January 2022, the number of visitors per month to our new digital information hub increased by an average of 15.9% per month, from 187 users in October 2020 to 1335 users in January 2022 (Figure 2).

The first survey of clinician end users conducted in December 2020 obtained a response rate of 47% (52 clinicians among 110 total emergency clinicians). At the time of survey administration, 18 clinical guidelines had been converted, standardized, and published on our digital information hub. The survey results demonstrated that before the standardization of guidelines, only 12.5% of respondents felt confident accessing clinical guidelines. In comparison, after guideline standardization, 96% of clinicians felt that they were able to access clinical information more easily.

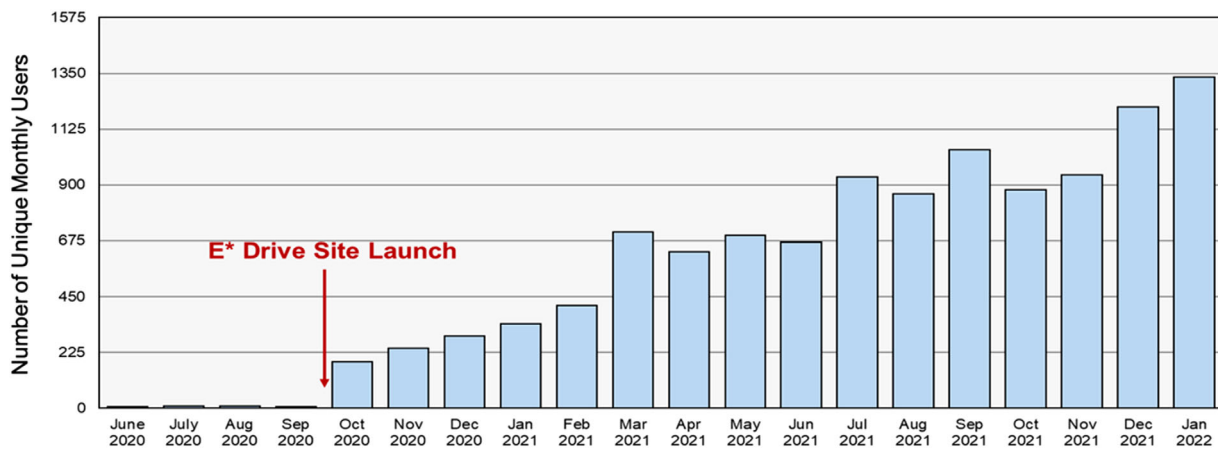
The second survey, conducted in December 2021, obtained a response rate of 55% (61 clinicians among 110 total emergency clinicians). At the time of survey administration, all 66 clinical guidelines had been converted, standardized, and published on our digital information hub. From 2020 to 2021, the proportion of emergency clinicians who “strongly agreed” that our information hub and its standardized clinical guidelines help them do their job more efficiently increased from 28% to 58% ( $P = 0.004$ ) and help them more easily access clinical information increased from 41% to 62% ( $P = 0.095$ ). Of the clinicians,  $\approx 98\%$  reported that they found the new, single-page clinical guideline flowcharts easier to understand and apply on shift than the prior multipage text documents, and 95% of clinicians “agreed” or “strongly agreed” that the new guideline templates helped them improve patient care (Figure 3).

Interviews with end users added additional insight to our understanding of the impact of standardized guidelines in the ED. One clinician stated that the new approach,

"Has saved thousands of work hours that would otherwise be spent searching for clinical guidelines and forms, by putting them all into one easy to navigate place. For clinicians who are new to our ED, it is a great resource for quickly getting up to speed on the workflows of our department."

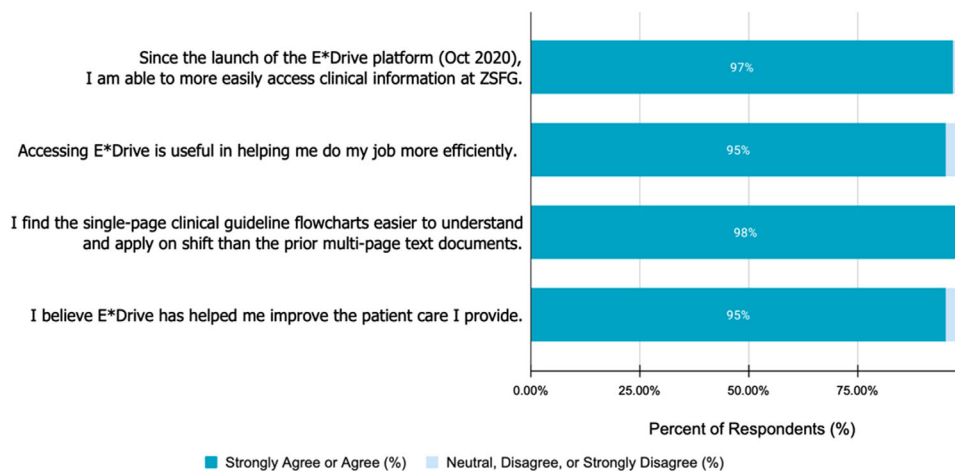
**TABLE 2** Commonly encountered clinical guideline barriers and strategies for improvement.

Clinical guideline barrier	Improvement strategy
Complex and difficult to read/use <sup>17</sup>	Standardize guidelines using design-thinking principles to a single-page, easy-to-read flow sheet without extraneous links
Not from a trusted source	Engage a group of clinicians and department leadership to develop and review guidelines
Lack of robust evidence base <sup>18</sup>	Redevelop guidelines to include credible sources and cross-collaboration with multiple specialties
Low clinician awareness <sup>16</sup>	Employ multipronged publicity strategy, such as emails, posters, and multimedia
Difficult to access	Develop an open-access, centralized digital information hub to house clinical guidelines, accessible from any computer, table, or mobile device (eg, <u>E*Drive</u> , accessible at <a href="http://edrive.ucsf.edu">edrive.ucsf.edu</a> ) <sup>11</sup>
Lack of interdisciplinary collaboration	Redevelop guidelines with an interdisciplinary team and integrate other department leaders into the change-control process
Financial constraints	Use out-of-the-box web technology—such as Google Slides and the Drupal web-building platform—to create user-focused clinical tools at a very low cost
Unresponsive to clinicians' needs	Use rapid-cycle end-user feedback to make real-time improvements to the clinical guideline standardization process throughout the development and maintenance phases
Lack of a change-control process	Create a clinician-led update team that follows a standardized change-control process to ensure consistency and reliability



**FIGURE 2** Guideline usage before and after guideline standardization on our digital information hub, E\*Drive.

**Respondents' perceptions of the usability, utility, and impact of E\*Drive [N=60]**



**FIGURE 3** Emergency department clinicians' perceptions of the standardized clinical guidelines published on our information hub (E\*Drive) and based on December 2021 survey data. ZSFG, Zuckerberg San Francisco General Hospital.

A second clinician added,

“I don’t need to search for information on walls or walk to where things are posted anymore. It’s fast, up to date, and information is well presented and easy to use in real-time.”

## 5 | INSIGHTS AND DISCUSSION

Clinical guidelines have a variety of benefits, including improving consistency of care, decreasing rates of morbidity and mortality, improving patient outcomes, improving the quality of clinical decisions, and increasing clinician efficiency. However, we found that guidelines were often underused in our ED as a result of internal and external challenges, the majority of which were rectified by using strategic design-thinking strategies.

Our approach to redesigning clinical guidelines in our ED, grounded in design-thinking methodology and guided by both real-time clinician input and design literature, has led to improved guideline use and clinician satisfaction. By standardizing clinical guidelines and improving accessibility through an open-access platform, we increased clinician use of clinical guidelines, which has the potential to significantly impact patient care.

Importantly, our process and approach were grounded in prior literature identifying specific barriers to guideline implementation (Table 1), which allowed us to pursue a rigorous redesign strategy aimed at improving guideline appearance, accessibility, and clinical validity. We standardized guidelines using key design pillars used across industries to optimize guideline readability (Table 2), which allowed us to develop a consistent template that is easy to read and apply in a busy clinical setting. We addressed barriers to access by building on our team’s previous success with an in-house centralized clinical information hub.<sup>11</sup> By housing our redesigned clinical guidelines on this open-access, mobile-friendly platform, we significantly increased traffic to clinical guidelines during the implementation phase. We ensured a rigorous, yet efficient, change control by creating a streamlined team of frontline clinicians, emergency leadership, and medical students to rapidly iterate on redesigned and updated guidelines, which allowed us to retain clinical integrity while displaying information clearly and efficiently.

We believe our process and final product are broadly applicable to other institutions because of our use of replicable design-thinking methods. Although our digital information hub and guideline redesign was targeted to our end users—frontline emergency clinicians—many of the barriers we identified are broadly relevant across health system departments, and our process can be tailored to address institution-specific factors. To maximize sustainability and replicability while minimizing financial costs, we used free online collaborative technology such as Google Slides to create user-focused clinical innovations at a low cost. We also created downloadable and editable templates for departments to use for the creation of other clinical guidelines.

Although our work was successful in standardizing and implementing dozens of updated clinical guidelines, our product and process have several key limitations. First, our survey results may be subject to non-response bias as clinicians who have not used or do not like the new standardized guidelines may have been less likely to respond to the survey. However, given the very high rates of user satisfaction reported in our results and our quantitative web-traffic data showing significant increases in use, we can conclude that the impact of our redesign was positive. Second, our end-user interviews focused on clinical guideline design and access rather than use and implementation in practice. Our results conclusively showed that overall traffic to clinical guidelines improved, and further research is currently being conducted to assess the impact of standardized clinical guideline designs on patient outcomes. In addition, the design of all clinical guidelines used a variety of colors, which did not account for clinicians who are color blind. Future iterations of these guidelines can include a palette that is color-blind friendly when appropriate to make sure the guidelines are inclusive for all clinicians. Finally, this study was carried out at a single institution, which may limit its broader applicability. However, given our use of open-access technology and standardized design principles, we believe our work has strong potential for implementation at institutions.

## 6 | IMPLICATIONS FOR PRACTICE

Clinical guidelines have the potential to improve care quality and health outcomes while decreasing costs. Through identifying and addressing barriers to clinical guideline use in the ED, such as design, accessibility, and cross-collaboration, our team has used novel methods to improve the use of and satisfaction with clinical guidelines. In our own hospital, other departments are beginning to use our guideline-standardization process to implement similar digital tools; on a broader scale, our process has been the recipient of national innovation awards, including the 2021 Urgent Matters Innovator of the Year National Finalist as well as the 2021 American Medical Association Impact Challenge Winner.

By relying on open-access tools such as Google Slides and publishing our guideline templates for free download, our product can be readily applied to and adapted by other health systems. Other institutions can create similarly impactful guidelines by using similar low-cost technologies and employing key design-thinking principles. Future work will focus on the investigation of guidelines on clinical care and the implementation of new, more interactive guideline formats.

### CONFLICT OF INTEREST STATEMENT

Christopher R. Peabody is a consultant for FujiFilm-SonoSite, Inc and Brainscope, Inc.

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Neha Pondicherry BA  <https://orcid.org/0000-0003-2300-7902>

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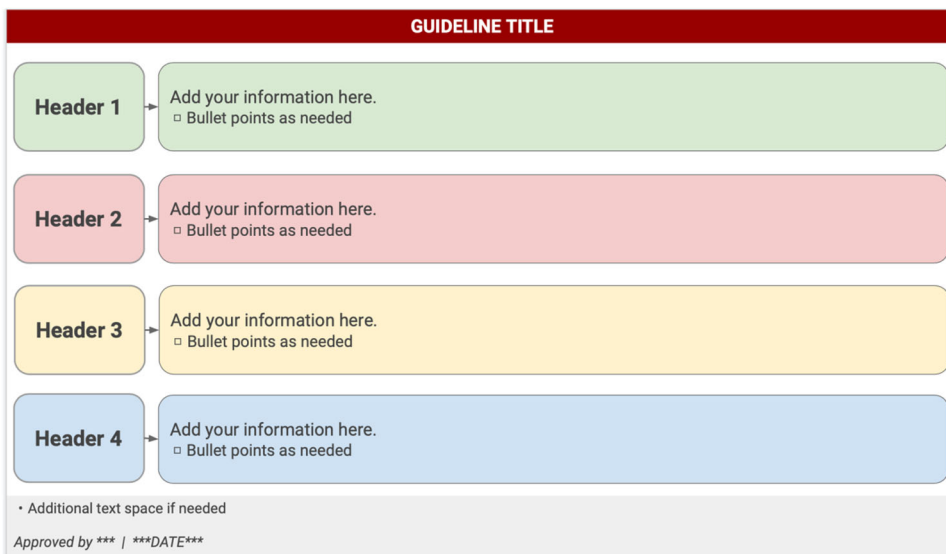
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**APPENDIX 1**

All of the E-drive guideline downloadable templates are available on Google Drive at the following shareable link: <https://drive.google.com/drive/folders/12XjLKocredSZQoaAJOP9GOIKd707ABFd?usp=sharing>.

The following are examples of some the templates available:

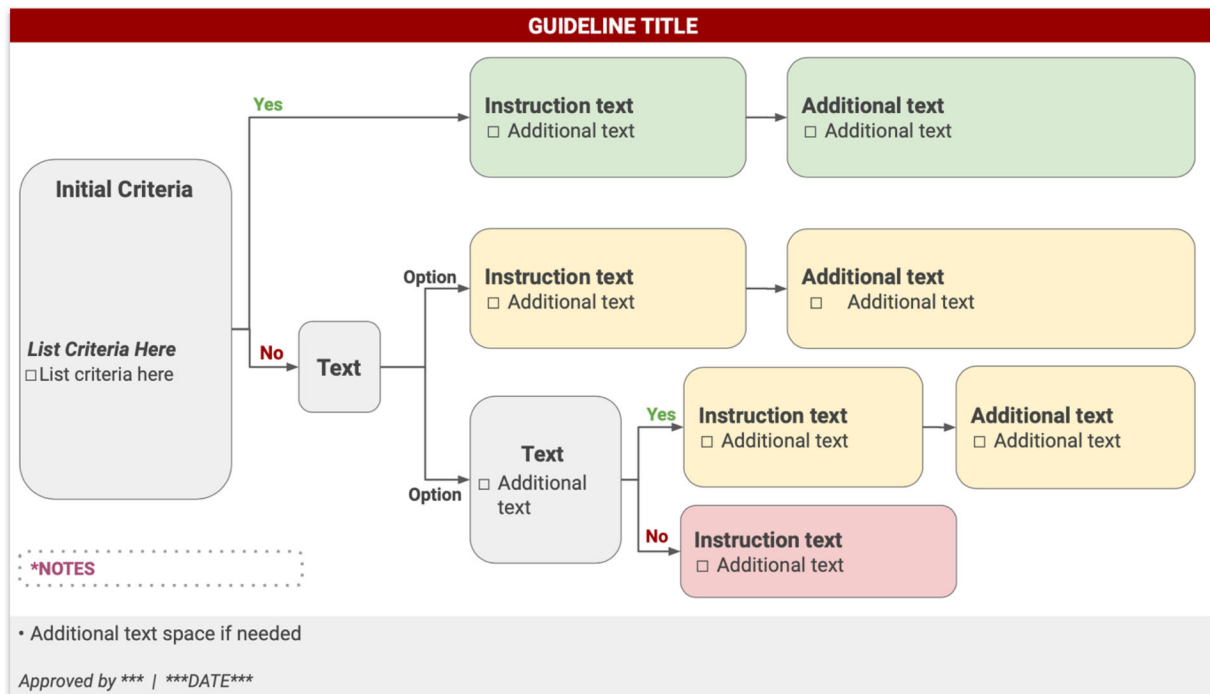




GUIDELINE TITLE			
TEXT	TEXT	TEXT	TEXT
OPTION	<input type="checkbox"/> Information	<input type="checkbox"/> Information	<input type="checkbox"/> Information
OPTION	<input type="checkbox"/> Information	<input type="checkbox"/> Information	<input type="checkbox"/> Information
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• Additional text space if needed

Approved by \*\*\* | \*\*\*DATE\*\*\*



**APPENDIX 2**

**December 2020 Survey**

If you would like to take this survey, click the “Agree” button to start the survey.

- o Agree (1)
- o Disagree (2)

**Q6 Role**

- o Attending Physician (1)
- o Resident Physician (2)
- o Other (3)

**Q8 Residency Program**

- o UCSF Emergency Medicine (1)
- o UCSF Internal Medicine (2)

o UCSF Family Medicine (3)

o Other (4) \_\_\_\_\_

**Q9 Residency Graduation Year**

o 2021 (1)

o 2022 (2)

o 2023 (3)

o 2024 (4)

**Q11 Since the launch of the E\*Drive platform, I am able to more easily access clinical information at ZSFG.**

o Strongly Agree (1)

o Agree (2)

o Disagree (3)

o Strongly Disagree (4)

**Q14 I use the E\*Drive platform approximately:**

o Daily (1)

o Multiple times per week (2)

o Once per week (3)

o Once per month (4)

o Never (5)

**Q17 Select the component(s) of the E\*Drive platform that you find most useful:**

Clinical Protocols (1)

COVID-19 Workflows and Policies (2)

Social Medicine Resources (3)

**Q18 On a scale from 0–10, how likely are you to recommend the E\*Drive platform to a colleague?**

o 0 (0)

o 1 (1)

o 2 (2)

o 3 (3)

o 4 (4)

o 5 (5)

o 6 (6)

o 7 (7)

o 8 (8)

o 9 (9)

o 10 (10)

**Q21 Before the E\*Drive platform, I felt confident accessing clinical information on the wiki system at ZSFG.**

o Strongly Agree (1)

o Agree (2)

o Disagree (3)

o Strongly Disagree (4)

**Q22 Accessing E\*Drive is useful in helping me do my job more efficiently.**

o Strongly Agree (1)

o Agree (2)

o Disagree (3)

o Strongly Disagree (4)

**Q23 I find the E\*Drive platform understandable and easy to navigate.**

o Strongly Agree (1)

o Agree (2)

o Disagree (3)

o Strongly Disagree (4)

**December 2021 Survey**

If you would like to take this survey, click the "Agree" button to start the survey.

- Agree
- Disagree

**Q1** Since the launch of the E\*Drive platform (Oct 2020), I am able to more easily access clinical information at ZSFG.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

**Q2** Accessing E\*Drive is useful in helping me do my job more efficiently.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

**Q3** I find the E\*Drive platform easy to access and navigate.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

**Q4** E\*Drive helps me stay up-to-date with important announcements and changing guidelines (eg, COVID-related announcements, new equipment guidelines, etc).

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

**Q5** I am confident that E\*Drive contains up-to-date, accurate information.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

**Q6** The E\*Drive platform improves my ability to use clinical guidelines on shift.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

**Q7** I find the single-page clinical guideline flowcharts easier to understand and apply on shift than the prior multipage text documents (example: <https://edrive.ucsf.edu/ed-thoracotomy>)

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

**Q8** I believe E\*Drive has helped me improve the patient care I provide (eg, through streamlined logistics, after the latest clinical guidelines, etc).

- Strongly Agree
- Agree
- Neutral

- Disagree
- Strongly Disagree

**Q9** On a scale from 0–10, how likely are you to recommend the E\*Drive platform to a colleague?

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

**Q10** What would you like to see improved or added to the E\*Drive platform?

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**Q11** Role

- Attending Physician
- Resident Physician
- Fellow
- Nurse Practitioner
- Other \_\_\_\_\_

**Q12** Residency Graduation Year

- 2022
- 2023
- 2024
- 2025

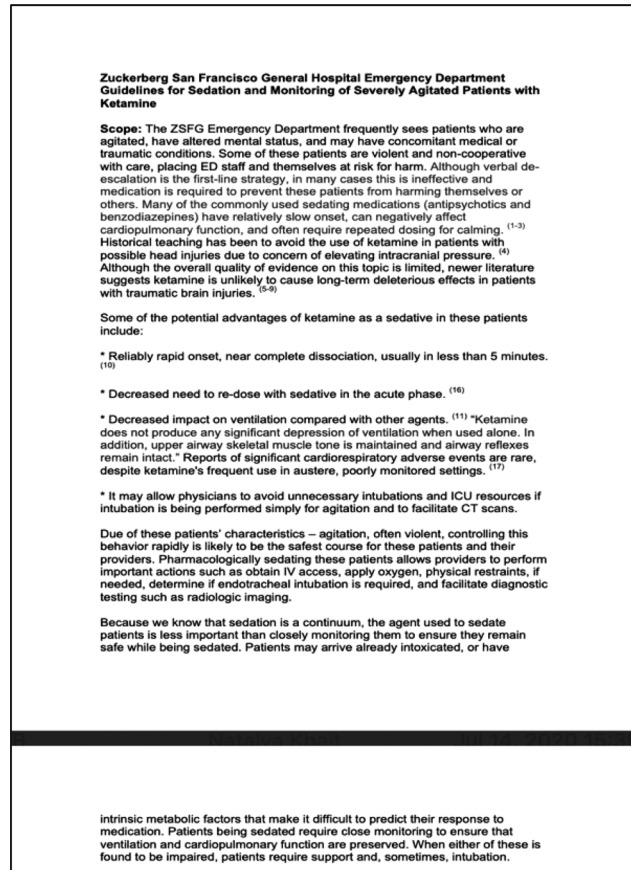
## APPENDIX 3

### Example Guideline Conversion

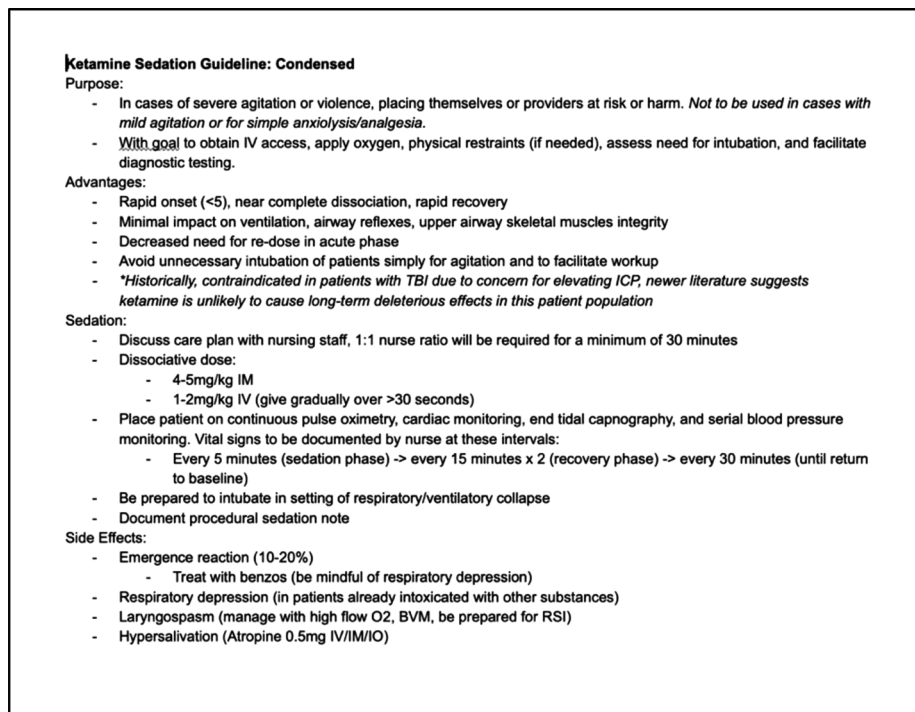
Our Ketamine Sedation Guidelines began as a 5-page document that was verbose and difficult to understand (Appendix Figure 1). In the original guideline, the most critical clinical information was buried in large amounts of extraneous text. Our first step in converting this guideline involved condensing the 5-page document into a 1-page document that highlighted the salient features of ketamine sedation (Appendix Figure 2). This step was conducted by senior resident physicians who possess the necessary clinical acumen to determine what parts of the guideline were clinically relevant and necessary to include.

Once the condensed version of the clinical guideline was created, a medical student converted the 1-page document into our standardized template using Google Slides (Appendix Figure 3). The important thematic elements from the guideline were drawn out: when to use ketamine sedation, sedation plan, advantages, and side effects. Once the main thematic boxes were identified, the additional information was added into corresponding boxes. The sedation plan was linked to advantages and side effects, and color coding of red, gray, and green boxes were used. The subtext in the boxes was divided using bullet points, and important information was bolded. The complete guideline conversion process took  $\approx 2$  days.

After the guideline development was complete, it was sent to the full team of physicians and leadership, including those in emergency medicine, neurosurgery, trauma surgery, and anesthesia, for final approval before being uploaded onto our open-access digital information hub. The entire process, from initial guideline condensation to final upload, took  $\approx 1$  week.



**FIGURE A1** Original 5-page guideline



**FIGURE A2** Condensed guideline

**Ketamine Sedation Guidelines**

**When to use Ketamine sedation**

- Severe agitation or violence, placing self or providers at risk of harm
- For procedural sedation
- To obtain IV access, apply oxygen, physical restraints (if needed), assess need for intubation, and facilitate diagnostic testing in an agitated/incapacitated patient
- **NOT** to be used in cases with mild agitation or for simple anxiolysis/analgesia

**Sedation**

- Discuss plan with nursing staff, 1:1 nurse ratio needed
- **Dissociative dose:**
  - 4-5mg/kg IM or 1-2mg/kg IV (give gradually over >30 seconds)
- Place patient on continuous pulse ox, cardiac monitoring, end tidal capnography, and serial BP monitoring
- Be prepared to intubate in setting of respiratory/ventilatory collapse
- Vital signs to be documented by nurse at these intervals:
  - Every 5 minutes (sedation phase)
  - Every 15 minutes x 2 (recovery phase)
  - Every 30 minutes (until return to baseline)
- Document procedural sedation note

**Advantages**

- Rapid onset (<5), near complete dissociation, rapid recovery
- Minimal impact on ventilation, airway reflexes, upper airway skeletal muscles integrity
- Avoid unnecessary intubation of patients simply for agitation, and to facilitate workup

*\*Historically, contraindicated in patients with TBI due to concern for elevating ICP; newer literature suggests ketamine is unlikely to cause long-term deleterious effects in this patient population*

**Side Effects**

- Emergence reaction (treat with benzos, be mindful of respiratory depression)
- Respiratory depression (in patients already intoxicated with other substances)
- Laryngospasm (manage with high flow O2, BVM, be prepared for rapid sequence intubation)
- Hypersalivation (consider Atropine 0.5mg IV/IM/IO)

Approved by the Departments of Emergency Medicine, Trauma Surgery, Neurosurgery & Anesthesia | May 2020

**FIGURE A3** E-Drive standardized guideline