Preferred Terms and Icons for Labels on Electrosurgical Units: Survey of VA Nurses

Matthew A. Taylor, Airan Li, Jamie L. Estock, Monique Y. Boudreaux-Kelly, Ivan Thibault Pham, and Maureen C. Casey

Abstract
Electrosurgical units (ESUs) developed by different manufacturers use varying terminology and icons to label the same components, which can result in confusion among users and the potential for erroneous ESU configuration. The objective of the current study was to identify nurse-preferred terms and icons for labeling ESU components. A total of 163 operating room (OR) nurses from Veterans Health Administration facilities across the United States were surveyed regarding terms and icons found on 25 ESU models. The results showed that 81% of OR nurses preferred ESUs that included both a term and an icon for labeling each component. In addition, greater consensus existed among OR nurses regarding preferred terms, rather than preferred icons, for representing each component. These findings on OR nurses’ preferred terms and icons can be leveraged to improve ESU labeling practices and inform the development of a standardized, user-centered set of labels for ESU components.

Language standardization refers to the consistent use of terms and icons to communicate the same concepts. Language standardization can facilitate user comprehension, improve situational awareness, and increase effectiveness of communication across staff within an organization and from different organizations. Use of language standardization is common within many domains, including aviation, military command and control, emergency management, and occupational safety. Within healthcare, perioperative nurses use consistent terminology and coding in patients’ charts to communicate interventions and contributions to patient surgery and care. Despite the justification, despite precedence in other domains, and despite recommendations for using a standardized language to improve human performance, the medical device industry has been slow to standardize language used in labels of common device components, such as those found on electrosurgical units (ESUs).

ESUs are used to cut, coagulate, and desiccate tissue during surgery. Correct configuration of these devices has notable implications on surgical outcomes and patient safety. Operating room (OR) nurses typically are responsible for configuring ESUs. Many OR nurses rely on the visual guidance provided by ESU labels to ensure that they are configuring the correct components.

Unfortunately, manufacturers of ESUs are inconsistent in their use of terms and icons for labeling components that are common across models. For example, during a review of 25 different ESU models from 10 different manufacturers, it was found that manufacturers use six different terms and 11 different icons to label the monopolar pencil receptacle. It also was observed that the receptacle was labeled with 14 different combinations of terms and/or icons. Further, inconsistencies were seen in the terms and icons used to label the receptacle, both within and across manufacturers. Considering the variability in terms and icons used in common components across ESU models and the prevalence of multiple ESU models in the surgical environment, there is considerable risk for misinterpretation and erroneous configuration of devices.

User preference is a metric used to guide and influence many aspects of device design, including label content. OR nurses are the primary users of ESUs; however, the current literature is devoid of data on OR nurses’ preferred terms and icons for labeling ESU components. Therefore, in an initial attempt to help the medical device
industry move toward standardization of labels for ESU components, the objective of the current work was to identify a set of OR nurse-preferred terms and icons.

**Methods**

**Setting**
This project was conducted within the Veterans Health Administration (VHA), which is one of the largest healthcare systems in the world.\(^{19}\) From the many VHA healthcare facilities, the focus was narrowed to the 137 Department of Veterans Affairs (VA) medical centers (VAMCs) with surgery programs\(^ {20}\) because of their high concentration of OR nurses and ESUs. The 137 VAMCs are located within the United States and its territories. In fiscal year 2017, a total of 424,643 surgical cases were performed across these VHA ORs (S.L. Layne, written communication, March 2018).

**Sample**
Through a screening question at the start of the survey, participation was restricted to OR nurses who had used an ESU in the previous 30 days. Survey participation was voluntary, and no identifiable information was collected. The project was categorized as a VHA operations activity and not human subject research; therefore, institutional review board approval was not warranted.

**Survey Instrument**
This project assessed nurses’ preference for terms and icons used on ESU models, rather than developing and testing preference of novel terms and icons. A survey was developed based on a review of labels across the 25 most common ESU models within the VHA inventory (Figure 1).\(^ {21-31}\) The review of labels was focused on components, such as the modes and receptacles, used in the operation of ESUs. During the review, terms and icons used to label 13 ESU components common across a majority of ESU models were extracted. For example, monopolar pencil and bipolar forceps receptacles, which were found on all 25 ESU models, were among the targeted components. In the survey, the terms and icons used to label each component were presented as response options.

<table>
<thead>
<tr>
<th>Combination</th>
<th>Term</th>
<th>Icon</th>
<th>Manufacturers/Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&quot;Hand control&quot;</td>
<td><img src="https://example.com/icon1.png" alt="Hand control icon" /></td>
<td>Bard/System 3000, Cameron-Miller/26-500</td>
</tr>
<tr>
<td>2</td>
<td>&quot;Monopolar&quot;</td>
<td><img src="https://example.com/icon2.png" alt="Monopolar icon" /></td>
<td>Bovie/Aaron 3250, Bovie/ICON GP, Bovie/IDS-300</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td><img src="https://example.com/icon3.png" alt="Bovie Icon" /></td>
<td>Bovie/ICON GI</td>
</tr>
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<td>4</td>
<td>&quot;Monopolar&quot;</td>
<td><img src="https://example.com/icon4.png" alt="Monopolar icon" /></td>
<td>Bovie/IDS-310</td>
</tr>
<tr>
<td>5</td>
<td>&quot;Monopolar&quot;</td>
<td><img src="https://example.com/icon5.png" alt="Monopolar icon" /></td>
<td>Conmed/Beamer CE600</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td><img src="https://example.com/icon6.png" alt="Conmed Icon" /></td>
<td>Conmed/System 2450, Conmed/System 5000</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td><img src="https://example.com/icon7.png" alt="Conmed Icon" /></td>
<td>Conmed/System 7550</td>
</tr>
<tr>
<td>8</td>
<td>&quot;Monopolar&quot;</td>
<td><img src="https://example.com/icon8.png" alt="Monopolar icon" /></td>
<td>Covidien/Force EZ, Covidien/Force EX, Covidien/FT10, ERBE/VIO 2005, ERBE/VIO 3000, ERBE/VIO 3000S, ERBE/VIO 7550, ERBE/VIO 100, Olympus/ESG-400</td>
</tr>
<tr>
<td>9</td>
<td>&quot;Monopolar&quot;</td>
<td><img src="https://example.com/icon9.png" alt="Monopolar icon" /></td>
<td>Covidien/Force Triad</td>
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<td>10</td>
<td>&quot;Fingerswitch/ handpiece&quot;</td>
<td><img src="https://example.com/icon10.png" alt="Fingerswitch icon" /></td>
<td>Ellman/Surgitron Dual RF120</td>
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<tr>
<td>11</td>
<td>&quot;Cut/ coagulate&quot;</td>
<td><img src="https://example.com/icon11.png" alt="Cut/Coagulate icon" /></td>
<td>ERBE/ICC 350</td>
</tr>
<tr>
<td>12</td>
<td>&quot;Monopolar/ hand control&quot;</td>
<td><img src="https://example.com/icon12.png" alt="Monopolar icon" /></td>
<td>Megadyne/Mega Power</td>
</tr>
<tr>
<td>13</td>
<td>&quot;Handpiece&quot;</td>
<td><img src="https://example.com/icon13.png" alt="Handpiece icon" /></td>
<td>Olympus/UES-40</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td><img src="https://example.com/icon14.png" alt="Handpiece icon" /></td>
<td>Soering/MBC 601</td>
</tr>
</tbody>
</table>

**Figure 1.** Labels for the monopolar pencil receptacle on 25 electrosurgical unit (ESU) models from 10 different manufacturers were reviewed. It was discovered that manufacturers use a total of six different terms and 11 different icons. The receptacle is labeled with 14 different combinations of terms and/or icons. Further, inconsistencies were observed in the terms and icons used to label the receptacle, both within and across manufacturers.

**Preferred Labeling Method**
The survey captured nurses’ preferred method for labeling ESU components by asking them to choose whether they preferred labels that used terms only, icons only, or both terms and icons.

**Preferred Terms and Icons for Individual Components**
Depending on each nurse’s preferred labeling method, he/she was subsequently presented with a series of questions about preference for specific terms, specific icons, or both terms and icons for labeling individual ESU components. For example, if the nurse’s preferred labeling method was “terms only,” the subsequent questions only inquired about his/her preferred term for the individual components. The survey

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\(^{19}\) Layne, S.L. (written communication, March 2018).

\(^{20}\) There are 137 VAMCs in the United States.

instructed nurses to choose from an array of terms and/or icons to represent the individual ESU components.

Nurse-preferred terms for labeling five of 13 ESU components was assessed because those components had varying terminology across the ESU models. Nurse preference of terms for the remaining eight (of 13) components was not assessed because terminology was consistent per component and indicated a de facto standardization among ESU models.

Nurse-preferred icons for labeling all 13 ESU components was assessed because icons varied greatly across ESU models. In the survey, nurses were presented with standardized typography for terms and graphic reproduction of icons, as opposed to photographs of terms and icons as they appear on each ESU. This reproduction of terms and icons allowed confounding variables to be minimized through the use of uniform parameters, such as the color, size, and resolution. Each question included a response option of “I prefer a different term/icon,” which gave nurses the opportunity to indicate instances when none of the surveyed terms or icons were preferred.

Recent Experience with ESU Models
The survey captured nurses’ experience with the 25 most prevalent ESU models within VHA inventory. These were the same 25 models that were reviewed during survey development and therefore dictated the terms and icons used as response options throughout the survey. The question asked nurses to review a list of names and images for 25 ESU models and identify those ESU models that they had used during the previous six-month period.

Procedures
The survey, which was administered online via Question Pro (www.questionpro.com), was open to nurses during a 26-day period in November 2016. Recruitment emails with a direct link to the survey were sent to a national list of VAMC OR employees.

Data Interpretation and Analyses
To assess preference, individual nurse responses on each survey question were aggregated. The response option selected by the largest proportion of nurses was categorized as their “primary” choice, and the response option selected by the second largest proportion of nurses was categorized as their “secondary” choice. Next, a two-tailed chi-squared goodness-of-fit test (one variable) followed by a one-tailed, one-sample proportion test (i.e., binomial test) were used to determine whether a statistically significant difference existed between the nurses’ primary and secondary choices.

Based on the aforementioned series of tests, only those primary choices that were statistically different from the secondary choices as items that were preferred by nurses were considered. Whether the secondary choices were statistically different from the remaining items was not assessed because the objective of the study was identifying nurse-preferred items.

To evaluate the relation between nurses’ preferred terms and icons and their recent experience with those terms and icons, a database was created to identify the specific terms and icons used on each of the 25 ESU models. Using the database, the nurses’ responses to the question about recent experience with ESU models was cross referenced to determine their recent experience with the terms and icons in the survey. With that information, a two-by-two contingency table of nurse-preferred term or icon (preferred/not preferred) versus recent experience with that term or icon (recently encountered/not encountered) was created. For each table of data, a Fisher’s exact test was used to evaluate whether a statistically significant relationship existed between nurses’ term or icon preference and recent experience.

Microsoft Excel 2010 (Microsoft, Redmond, WA) and Minitab version 18.1 (Minitab, State College, PA) were used to collate and analyze survey data. An alpha level of 0.05 was applied for all statistical tests reported.

Results
Characteristics of Nurses
A total of 165 eligible nurses completed the survey, resulting in an estimated participation rate of less than 14%. Among the 165 participants, one nurse was located in Puerto Rico.
Rico and the others were located in VHA healthcare facilities across 32 different U.S. states. Nurses who completed the survey were distributed geographically across each of the five VHA regions.

Of the 165 nurses, 96% reported using an ESU “almost daily,” therefore suggesting that the vast majority of participating nurses were frequent ESU users. From the sample of nurses, 22% used only one ESU model, 35% used two ESU models, 26% used three ESU models, and 17% used four or more ESU models during the previous six-month period. These data revealed that 78% of nurses had used two or more ESU models during the previous six months.

Nurses’ Preferred Labeling Method
A chi-squared goodness-of-fit test revealed that the proportion of nurses who preferred labels that included both terms and icons (81%), terms only (17%), and icons only (2%) differed significantly ($\chi^2[2, n = 165] = 175.89, P < 0.001$). Follow-up analyses with one-sample proportion tests revealed that the nurses’ primary choice of labels with both terms and icons was significantly greater than their secondary choice of labels with terms only ($z = 21.96, P < 0.001$).

Nurses’ Preferred Label for Individual Components
Questions about term preference for the five ESU components were answered by 162 nurses (those who responded as preferring a labeling method of “terms only” [n = 28] or “both terms and icons” [n = 134]). The icon preference questions for the 13 ESU components were answered by 137 participants (those who responded as preferring a labeling method of “icons only” [n = 3] or “both icons and terms” [n = 134]).

One-sample proportion tests identified a nurse-preferred term for labeling all five ESU components surveyed (Table 1) but only identified a nurse-preferred icon for labeling nine of 13 ESU components surveyed (Figure 2). These findings indicated that nurses did not have a significant preference toward any single icon for representing the following ESU components: monopolar accessory instrument receptacle, monopolar coagulation function, monopolar cut function, or monopolar spray mode. The full set of aggregated results from the survey is provided in the online data supplement (available at http://aami-bit.org/loi/bmit).

Nurses’ Recent Experience with ESU Models
Fisher’s exact test did not reveal a statistically significant relationship between nurses’ preferred terms or icons and their recent experience with those terms or icons ($P > 0.05$). This outcome suggested that nurses’ recent experience with the terms and icons, based on the ESU models that they reported to have used during the previous six-month period, had no impact on their choice of preferred terms and icons.

Discussion
The current survey revealed that the majority of OR nurses’ preferred ESU component labels that included both terms and icons—a finding that is consistent with research from other domains. For example, software usability studies have found that participants reported greater usefulness of labels with both terms and icons, as opposed to only terms or icons.\textsuperscript{36,37} The inclusion of both

<table>
<thead>
<tr>
<th>ESU Components</th>
<th>Total Terms Surveyed</th>
<th>Primary Chosen Term</th>
<th>Secondary Chosen Term</th>
<th>One-Sample Proportion Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monopolar pencil receptacle</td>
<td>6</td>
<td>“Monopolar/ hand control” (35%*)</td>
<td>“Monopolar” (19%)</td>
<td>$z = 5.21, P &lt; 0.001$</td>
</tr>
<tr>
<td>Monopolar accessory instrument receptacle</td>
<td>6</td>
<td>“Monopolar/ foot control” (46%*)</td>
<td>“Monopolar” (23%)</td>
<td>$z = 6.94, P &lt; 0.001$</td>
</tr>
<tr>
<td>Monopolar foot controller receptacle</td>
<td>4</td>
<td>“Monopolar footswitch” (64%*)</td>
<td>“Foot pedal” (31%)</td>
<td>$z = 8.97, P &lt; 0.001$</td>
</tr>
<tr>
<td>Bipolar forceps receptacle</td>
<td>5</td>
<td>“Bipolar” (67%*)</td>
<td>“Bipolar/ foot control” (16%)</td>
<td>$z = 17.77, P &lt; 0.001$</td>
</tr>
<tr>
<td>Bipolar foot controller receptacle</td>
<td>4</td>
<td>“Bipolar footswitch” (83%*)</td>
<td>“Foot pedal” (7%)</td>
<td>$z = 36.9, P &lt; 0.001$</td>
</tr>
</tbody>
</table>

Table 1. Findings from statistical analyses of nurses’ term preference per electrosurgical unit (ESU) component. Each percentage is based on the number of nurses who chose the given term to represent a component. An asterisk indicates that a significantly greater proportion of participants preferred the primary chosen term over the secondary chosen term. Statistical notations from the one-sample proportion test are listed in the last column and should be compared with an alpha level of 0.05.
terms and icons on a label offers advantages under various conditions.36–39 Including terminology appears to be most useful during learning stages of an interface. Icons, once learned, are associated with greater cognitive efficiency.37 This finding indicates that manufacturers should use both terms and icons in ESU labels, which will account for nurses’ preference and ensure interface usability from novices to experts. Based on statistically significant results from our analyses, we identified a nurse-preferred term for labeling five ESU components and a nurse-preferred icon for labeling nine ESU components. However, of note, the nurse-preferred terms for two of the five ESU components (monopolar pencil receptacle and monopolar accessory instrument receptacle) and the nurse-preferred icon for six of the nine ESU components (monopolar pencil receptacle, monopolar blend mode, bipolar forceselectaper, bipolar foot controller receptacle, bipolar function, and bipolar macro mode) were chosen by fewer than 50% of nurses. This finding suggests that rather than being optimal for labeling ESU components, the nurse-preferred terms and icons might simply be the best among those surveyed. Future research should consider measuring nurses’ perception of term and icon quality. In absence of this information, whether the preferred terms and icons are of sufficient quality is unclear.

As further justification for concern about icon quality, the survey revealed that for some of the components, a noteworthy percentage of nurses chose “I prefer a different icon,” which indicated dissatisfaction with the icons surveyed. For example, in the question about the bipolar forceslectaper, 20% of the nurses selected “I prefer a different icon,” which was the secondary chosen option among 10 icon options. Although the underlying variable leading to participants’ low satisfaction with some of the icons surveyed was unclear, previous research suggested that it could be the extent to which the icon is abstract, as opposed to concrete or representational of the ESU component.39,40 In support of this view, a review of the online data supplement shows that nurses reported a greater preference for icons that visually resemble the associated ESU components, as compared to icons that appear more ambiguous. This combination of findings reinforces the need for manufacturers to adopt a comprehensive approach to designing and testing label content to ensure a high level of user preference, perceived quality, and comprehension.4

Some findings indicate ways in which manufacturers can improve the extent to which icons visually resemble the associated ESU components. For example, the primary chosen icon was the same for both the monopolar foot controller receptacle and bipolar foot controller receptacle; however, a

<table>
<thead>
<tr>
<th>ESU Components</th>
<th>Total Icons Surveyed</th>
<th>Primary Chosen Icon</th>
<th>Secondary Chosen Icon</th>
<th>One-Sample Proportion Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monopolar pencil receptacle</td>
<td>11</td>
<td>28%*</td>
<td>18%</td>
<td>z = 2.88, P = 0.002</td>
</tr>
<tr>
<td>Monopolar accessory instrument receptacle</td>
<td>10</td>
<td>21%</td>
<td>18%</td>
<td>z = 0.88, P = 0.19</td>
</tr>
<tr>
<td>Monopolar foot controller</td>
<td>6</td>
<td>78%*</td>
<td>6%</td>
<td>z = 36.07, P &lt; 0.001</td>
</tr>
<tr>
<td>Monopolar coagulation function</td>
<td>5</td>
<td>34%</td>
<td>“I prefer a different icon”</td>
<td>z = 0.93, P = 0.177</td>
</tr>
<tr>
<td>Monopolar cut function</td>
<td>2</td>
<td>39%</td>
<td>34%</td>
<td>z = 1.27, P = 0.103</td>
</tr>
<tr>
<td>Monopolar pure mode</td>
<td>1</td>
<td>72%*</td>
<td>28%</td>
<td>z = 11.17, P &lt; 0.001</td>
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<tr>
<td>Monopolar spray mode</td>
<td>4</td>
<td>31%</td>
<td>26%</td>
<td>z = 1.57, P = 0.059</td>
</tr>
<tr>
<td>Monopolar blend mode</td>
<td>3</td>
<td>40%*</td>
<td>28%</td>
<td>z = 3.03, P = 0.001</td>
</tr>
<tr>
<td>Bipolar forceselectaper</td>
<td>10</td>
<td>26%*</td>
<td>“I prefer a different icon”</td>
<td>z = 1.72, P = 0.043</td>
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<tr>
<td>Bipolar foot controller receptacle</td>
<td>7</td>
<td>44%*</td>
<td>20%</td>
<td>z = 6.78, P &lt; 0.001</td>
</tr>
<tr>
<td>Bipolar function</td>
<td>4</td>
<td>40%*</td>
<td>21%</td>
<td>z = 5.44, P &lt; 0.001</td>
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<tr>
<td>Bipolar standard mode</td>
<td>1</td>
<td>79%*</td>
<td>“I prefer a different icon”</td>
<td>z = 16.52, P &lt; 0.001</td>
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<tr>
<td>Bipolar macro mode</td>
<td>2</td>
<td>48%*</td>
<td>“I prefer a different icon”</td>
<td>z = 3.22, P = 0.001</td>
</tr>
</tbody>
</table>

Figure 2. Findings from statistical analyses of nurses’ icon preference per electrosurgical unit (ESU) component. Each percentage is based on the number of nurses who chose the given icon to represent a component. An asterisk indicates that a significantly greater proportion of participants preferred the primary chosen icon over the secondary chosen icon. Statistical notations from the one-sample proportion test are in the last column and should be compared with an alpha level of 0.05.
notable difference existed in nurses’ percentage of preference (78% vs. 44%, respectively). Interestingly, the secondary chosen icon for the monopolar receptacle and bipolar receptacle were similar and preferred by 6% and 20% of the nurses, respectively.

At a glance, the differences in percentages between monopolar and bipolar icons may seem inexplicable; however, a closer inspection of the secondary chosen icons for both receptacles appears to provide insight. The secondary chosen icons for both receptacles were very similar, showing an image that resembles a foot controller, but the secondary icon for the bipolar foot controller (20%) also included an image that represented bipolar forceps. This combination of findings suggested that merging complementary concepts, such as an image of a foot controller and an image of the related handheld instrument, could further improve user preference and usability of icons.

Overall, future development of icons should consider adopting design aspects from multiple icons, as careful comparison and contrast of the icons could provide insight for ways to improve future iterations of ESU labels.

Finally, we found that nurses’ preference for terms and icons was not statistically dependent on familiarity, which strengthens the value of the findings. This result indicates that nurses’ preference was influenced by the quality of the specific terms and icons surveyed, as opposed to their previous experience with those terms and icons.

Limitations and Future Research
The current survey focused on preference of terms and icons found on 25 ESU models within the VHA inventory. As a result, one limitation of the current work is that viable terms and icons found on other ESU models may have been excluded. Future research should consider evaluating additional terms and icons, going beyond the 25 ESU models that were included in the current survey.

A review of ESU models would reveal that more than 20 modes are available across the various ESU models. Unfortunately, manufacturers often do not define the effects of each mode with comparable language and context, thereby making it difficult to discern similar and different operational outcomes among various modes. As a result, we only surveyed nurse term and icon preference for five modes that were described consistently across manufacturers. Future research should evaluate nurse preference of terms and icons from a greater breadth of ESU features, such as additional modes.

The study sampled 165 OR nurses who were geographically located across 32 of 50 U.S. states and Puerto Rico. Although these characteristics are respectable, readers should note that our findings may not be representative of the broader population of OR nurses. Including a larger sample size and broader population of nurses in future research could help to ensure that the findings are aligned with a majority of ESU users.

Collecting nurse preference of terms and icons is an important step toward standardization of ESU labels; however, user preference does not always translate into better performance with a device.41–43 Future research should expand on the current findings by evaluating nurse comprehension of terms and icons. Numerous sources suggest that a standardized language, such as the terms and icons used on ESU labels, should be tested with target users (e.g., nurses) and redesigned until a high level of preference and comprehension is achieved.35,39,40 Without this rigorous approach to development and usability testing, users likely will struggle to interpret information accurately and efficiently.40,44

Conclusion
The current review of 25 ESU models found considerable variability in the terms and icons used to label various components. This lack of consistency in terms and icons creates potential for healthcare staff to misinterpret and erroneously configure the ESU. To provide a foundation for addressing this concern, we generated a set of data on nurse preference for terms and icons representing 13 ESU components.

The goal of this project was to facilitate the development of a standardized set of terms and icons for labeling ESU components. Although precedence and empirical justification exist for adopting consistent and
standard labeling practices for medical devices.\textsuperscript{43,44,45} much work is needed to achieve such a goal with ESUs. Nevertheless, our findings regarding nurse preference have provided a strong foundation for working toward a standardized set of terms and icons for ESU labels.

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To Dr. Robin Hemphill, Dr. Peter Mills, Katrina Jacobs, and Tandi Bagian from the VA National Center for Patient Safety for funding this research and for their guidance, support, and recommendations throughout the project; to Dr. David Eibling for input during the pilot version of this project; to Wendi Ridgway-Price, Austin Mount-Campbell, and Laurene Hardy for reviewing earlier versions of the manuscript; and to the nurses at VA Pittsburgh Healthcare System who helped shape this survey into the version described in this article.

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References