

Developing a Biomedical Engineering Website for Clinical Users

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It is 2 am in the cardiac step-down unit. A nurse needs to set up a secondary infusion on a new infusion pump, a procedure that she has never done before. She had attended the in-service training session before the pumps arrived the previous month, but there was a great deal of information to absorb. Clinical nurse specialists, who provide assistance with technology-related questions, are not available during the night shift. The nurse decided to ask a fellow staff nurse for assistance. Unfortunately, her co-worker has never programmed a secondary infusion with the new pumps either. She then called the supervisor covering her floor. After responding to a code on another floor, the supervisor finally arrived and walked the nurse through the necessary steps.

Staff training and technical support are critical to patient safety. The situation above, fortunately, resulted in nothing more than a slight delay in treatment, but in an emergency situation, any delay could have much more serious consequences. At Massachusetts General Hospital (MGH) in Boston, a staff website specifically dedicated to equipment resources for clinicians has helped to bridge the gap between classroom training and the experience that comes with actual clinical use.

Rationale

Medical equipment in hospitals continues to increase in both quantity and complexity, requiring clinicians to keep up to date on the latest technologies. In-service training is typically provided for new equipment, but learning all the nuances of a new device only comes with experience. Today people rely on the Internet for information, so a website specifically designed to provide quick access to equipment resources for devices used at MGH was the logical solution. If the nurse in the scenario was presented with the same problem today, she could go to the nearest computer and open the Biomedical Engineering website. She would navigate to “Infusion pumps” on the menu, select the pump model, click on “Quick Reference Guide” and locate a step-by-step procedure she needed in seconds.

Check Points

To create an effective equipment resource:

- ✓ Solicit input from the various user groups.
- ✓ Include a nurse in the development to ensure that needs are met.
- ✓ Balance the need for intuitive user interface and ease of maintenance.
- ✓ Include information on all major devices and models, including troubleshooting tips and frequently asked questions.

Development of the Website

The website was created by a design team, which consisted of a clinical engineer who had received technical training in website design and development and a nurse who serves as the technology specialist in biomedical engineering. The technology specialist is a critical care nurse and acts as the liaison between nursing and biomedical engineering for issues related to technology at the patient bedside. Both had many years of experience at the hospital and an in-depth understanding of the technologies and their users. The clinical engineer/developer first created the main Biomedical Engineering website for internal use by technical staff (<http://biomed.partners.org/main>). She was then able to leverage the experience gained and design elements used, such as the menu structure and navigation, to develop the clinical site. This proved to be quite beneficial as the technical hurdles were resolved during the internal site development process and customers were spared the learning curve.

Access to the technical expertise of the Systems Engineering Group—a subset of Biomedical Engineering—was also a significant benefit. Biomedical Engineering purchased its own server for both of its web applications, but the hospital’s information systems (IS) department administers and maintains it. IS also provided assistance with the search engine that is used on

both sites. While the main Biomedical Engineering website includes certain documents that are accessible to the general public, the “clinical” site is available only to Partners Healthcare employees.

The first step in the design process was to solicit input from the various user groups. The team attended nursing leadership, nursing practice, and operations staff meetings to present the concept and request feedback. Having a nurse attend meetings as part of the development team was invaluable in making sure the site met the needs of its main user group. Key factors in design included balancing the need for an intuitive and consistent user interface with the need for ease of maintenance. It is important to plan for future expansion of the site as more content is added.

After much collaboration, the team delivered a website that met the challenge of helping nurses stay current on the many devices they rely upon for patient care. The site includes a menu of all the major patient-care devices that Biomedical Engineering supports. Users access information for each device model, including an overview of where and how the device is used, a quick reference guide, troubleshooting tips, frequently asked questions, accessory ordering information, and special notices.

In addition to device-specific documentation, the site provides equipment-related policies and procedures, how-to documents, and a “Who to Call for What” list that indicates the appropriate department for obtaining and servicing equipment and supplies. Photos are used throughout the site to differentiate among various models and to illustrate key points. The home page is updated periodically with technology news, safety tips, and an “Ask Biomed” question-and-answer section. It also includes an easy way for clinical staff to ask Biomedical Engineering non-urgent questions, as well as a “Suggestion Box” for requests to add more information to the site.

Implementation

The link to the site was added to the hospital’s online clinical reference library, which is easily accessible from

The screenshot shows the Partners BioMedical Engineering website. At the top, it says "PARTNERS BioMedical ENGINEERING" and "MASSACHUSETTS GENERAL HOSPITAL 817-724-1333". Below that is a search bar and a navigation menu with links like "Home Page", "Contact Us", "Site Map", "Model Shop Website", and "Printable version". The main content area is divided into three columns. The left column has a list of equipment categories with expandable arrows, including "NEW! Bladder Scanners", "Blood Warmers", "Defibrillators", "EKG Machines", "Electrosurgical Units", "Fetal Monitoring", "Infusion Pumps", "Monitors", "Pacemakers", "Pulse Oximeters", "PVR Machines", "MGH Equipment Policies", and "Other Resources". The middle column has a "Technology News" section with a headline "Sigma Spectrum large volume infusion pumps (LVP) to be upgraded with new software." and a "Safety Tips" section with a headline "Using the Override Function of the Sigma Spectrum large volume infusion pump". The right column has an "Ask Biomed" section with a question: "Question: Is there anything that can be done about the EKG artifact that we get from CVWH machines? We notice that even when we use the special CVWH outlets, we still get artifact on the monitor." and an answer: "Answer: Artifact displayed on the physiological monitor is a problem not only with CVWH machines, but for any device that uses PVC tubing and a peristaltic pump such as a heart-lung machine, ECMO machine, etc. The monitor detects a small electrical signal from the patient that is produced by the effect of the pump on the PVC tubing." At the bottom of the "Ask Biomed" section is a "Have a question for Biomed?" link.

The Biomedical Engineering website provides equipment information, hospital policies, and staff news.

the Start menu on computers throughout the hospital. This was extremely helpful for instructing users on how to access the site, as it avoided the need to provide the URL. When the site was officially launched, in-service training on its features and navigation was provided for any floor that requested it. The site’s launch was featured in both the nursing newsletter and the hospital-wide news bulletin. To encourage users to visit, mouse pads that included the path to the site were distributed to the floors.

The website has been very well received by users. MGH continues to receive positive feedback and requests to add more equipment. Operations staff report that they access the site frequently for information that assists them with their jobs, such as accessory ordering information. Nurse educators use the site as one of their teaching tools during orientation of new staff. Every page of the site has an easily accessible “printer-friendly” version that can be posted in equipment rooms and nursing lounges to highlight a unique issue with a piece of equipment. Nurses use the site to re-familiarize themselves with aspects of a piece of technology if they have been away from the bedside for a period of time, or to troubleshoot equipment issues. They also use the site to pose thoughtful questions, such as “why is there noise on my electrocardiogram (ECG) waveform when the patient is on a continuous veno-venous hemofiltration (CVVH) machine?”

Costs and Future Developments

The cost can be determined by the labor hours of the co-developers in design, development, and collecting and reviewing content. The latter was a much larger issue than had been anticipated. The lack of content readily available in electronic format from equipment manufacturers resulted in many hours spent creating material rather than simply adapting it for our use. Overall, site development took approximately 1,200 hours over 18 months and approximately 500 hours per year (approximately .25 FTE) to maintain. Maintenance means not only continually updating existing content so that site remains current as the technology changes, but also adding documentation for new devices. Other costs to be considered were for technical training, including courses in scripting languages, integrated development environments, server-side programming languages, and vector graphics and animation. Finally, there is a cost associated with on-going marketing activities to encourage the continued use of the site. For example, on Valentine's Day, bags of candy were distributed to the floors with

a message: "Happy Valentine's Day from Biomedical Engineering. We'd *love* to have you visit our site" (along with the path to the site).

While the site was initially intended to be an information resource, we have recently added both computer-based training (CBT) and instructional videos. We hope to continue with this, both by adding manufacturers' CBTs when available, and also by creating our own in-service videos for high-volume equipment, such as infusion pumps and physiological monitors. ■

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