

Helping RCA Teams Be More Successful and Effective By Illustrating Principles of Human Factors Engineering with a “Hands-On Museum”

By Linda Williams, RN, MSI, NCPS cybrarian

The Challenge

So, you have a good understanding of the principles behind designing systems for the way we humans are built and how we function cognitively and physically. You understand that human factors engineering (HFE) applies what is known about human capabilities and limitations when designing products or processes: that the more intuitive the design, the more user-friendly and safer the end product. You get it.

However, you find RCA teams repeatedly concluding that patient safety solutions should be based on warning signs, on training, or on asking clinicians to “be more careful.” These weak solutions won’t solve the problem.

You also hear talk that improving human performance can reduce the likelihood of adverse medical events. You know this isn’t the solution either; maintaining a consistently high level of human performance is an unrealistic goal, and can never be an optimal solution.

Often, professionals develop clever and creative “work-arounds” when devices, equipment or architecture are not quite suitable. In other words, they become accustomed to making “the hand fit the glove.” The ability to make a system work, regardless of poor design, makes people less willing to criticize and correct systems issues.

One of the best ways we’ve found to overcome these and other challenges, and to better understand HFE principles, is to provide a way for clinicians to pause and think about how a specific system functions. That’s why we created our “Hands-On Museum.” Through experiences with the displays, clinicians easily recognize that problems can arise not from a lack of skill or ability, but from a dysfunctional system or device.

Making HFE principles come alive

Start with something all humans understand. Everyone has bad days. Less than optimal human performance can result from sleep deprivation, physical exhaustion, extreme stress, or other unpredictable aspects of normal life. Understanding this and accepting it in a patient safety analysis is just the starting point.

The potential for harm is present at the point of healthcare delivery when you combine a normal human in a normal condition, such as sleep deprivation, and the results of engineering and programming by other normal humans. The purpose of HFE design is to better understand normal human performance and design things accordingly.

To make this concept clear to those who have not studied

this, consider starting a collection of devices and equipment that illustrates both good and bad human factors designs.

We at NCPS have found our Hands-On Museum to be a novel and valuable teaching aid. If a picture is worth a thousand words, an object conveying the same message — an object that can be handled and tested — is worth even more. Refining observational skills by making well-designed objects and those with problem designs available for handling allows one to better draw conclusions on how devices and equipment function.¹

If an ambu-bag that looks like it should function well fails to recover its shape sufficiently to deliver a succession of breaths that meets a minimum tidal volume standard, how much greater the risk in a complex device such as a perfusion machine?

A hands-on collection need not be extensive or require special storage space. You don’t need to invest a lot of muscle and money to start your own Hands-On Museum.² Let a few key people know that you are interested in collecting exhibits. Explain to them that this will help RCA teams better understand HFE principles and improve patient safety at their facility.

How do you display your museum exhibits?

Our Hands-On Museum is a permanent fixture at NCPS, but it can also be used as a traveling exhibit. We have a space dedicated to the testing and development of the collection. For special training sessions, it is possible to store and retrieve these portable exhibits as needed. In limited space, participants have passed the exhibits hand-to-hand; space permitting, tabletop displays allow visitors to interact with exhibits.

There are two components to each exhibit: the item and a descriptive placard. The placard narrative has three parts: the challenge that the item presents to correct use by a human, the HFE design principle(s) that are illustrated, and a possible solution based on HFE principles. Here is one example:

Suction Canisters that Explode

Human Factors Challenge:

The canister liner looks like a cup. The mental model for carrying a cup is to grip it around the side. Pressure from gripping the side can pop the cap and cause the contents to spew. (Unequal pressure between outside of liner and inside of liner creates risk of spewing.)

Solution:

Use suction canisters that do not have liner systems or redesign the canister with a handle to suggest carrying it like a bucket.



Engineering Principles:

- 1) Affordances (such as shape) suggest or imply methods of use/handling. Good design takes advantage of affordance and is careful not to contradict it.
- 2) Provide feedback for impending failure in time for successful recovery.
- 3) Perform usability testing with real users in real situations (or in high fidelity simulations).

Improving Chemotherapy Safety

The mission of the Patient Safety Center for Inquiry (PSCI), Minneapolis, Minn.

By Anna E. Schorer, MD, director, PSCI for Chemotherapy Safety, associate professor of medicine, University of Minnesota

“TO ERR IS HUMAN, but to really foul things up requires a computer.”

—*Farmer's Almanac*, 1978

Patient Safety Centers of Inquiry (PSCIs) are programs supported by NCPS. Each PSCI focuses on a particular safety problem and is charged with developing, implementing and disseminating innovations to improve patient safety.

The PSCI for Chemotherapy Safety was established at the Minneapolis VAMC (MVAMC) in 2003, with formal project partners at the Cincinnati and Iowa City VAMCs and collaboration with oncology professionals at the Boston, San Diego, Cleveland, and Syracuse VAMCs.

Our PSCI's mission is to improve the health of veterans with cancer by reducing preventable adverse events associated with chemotherapy. In particular, our efforts have examined problems in chemotherapy that are not addressed – or are even exacerbated – by computerized order entry.

For example, CPRS makes it easy to renew medications, but oncologists report incidents of patients receiving unintended refills of oral chemotherapy from unauthorized prescribers. As a remedy, we reviewed all oral chemotherapy agents stocked by our pharmacy and surveyed VA oncologists to learn which agents should never be refilled or renewed without oncology staff approval. We presented a recommendation to the pharmacy and therapeutics committee of the MVAMC that specific drugs cannot be renewed or refilled unless authorized by a staff oncologist. This recommendation was successfully implemented as a facility policy in 2004 and subsequently adopted VISN-wide in 2005.

One of our safety goals is to support standardization of treatments. When fully achieved, this will result in all chemotherapy being written from templates that reflect institutional policy and evidence-based treatment and have been reviewed by a multi-disciplinary team.

Since October 2003, the PSCI has collected and analyzed all chemotherapy

orders written at its study sites. We document remarkable consistency between sites in the types of chemotherapy regimens used; but, broad variation in the use of supportive medications, such as growth factors and anti-nausea medicines, between and within institutions.

We identified a core anthology of regimens that are commonly used. Of the 1,215 orders written during the first year of the PSCI, there were 125 distinct chemotherapy regimens written. The most frequently used regimens were prescribed dozens of times, while some treatments might be used only once a year. For each regimen, we have retrieved the original published clinical trial and reviewed the treatment details to establish a “gold standard” for dose rules.

To enhance facility-wide standardization of supportive medicines, we distributed policy papers and guidelines from national bodies for the use of antiemetics and other supportive medications. We then surveyed practitioners at each PSCI-participating facility for their preferred antiemetic sets. These standards are the basis for our efforts to create facility-specific templates for chemotherapy.

Because CPRS does not compute or restrict dosing of drugs, a chemotherapy order may exceed the safe and appropriate dose for a drug. To provide resources that would reduce the chance of a chemotherapy overdose, we reviewed published trials and pharmacy resources, and then developed a table listing the usual and maximum doses of each of the chemotherapy drugs, including individual dose, daily, and cyclic dose maxima. This table can be accessed by VA employees via our PSCI Web site: vaww.visn23.med.va.gov/psci.

VA employees often say, “If you've seen one VA . . . you've seen one VA.” They mean, of course, that every facility has unique physical and human resources with problems that are likewise unique. Despite this, through visits and conversations, the PSCI is identifying themes that recur throughout the system. One way to identify the high frequency safety concerns is to review the compiled data from NCPS.

Early in 2005, NCPS performed a search of their SPOT database using the key word “chemo” and retrieved 457 incident reports from a four-year period. We categorized and tabulated these incident reports: falls or other injuries to chemo patients (92); adverse events related to pumps, venous access devices or other aspects of drug infusions (66); medication errors (257); and an assortment of other issues (42).

The reports of chemotherapy medication errors reflect the difficulty of using CPRS for complex dosing and schedules. We found incidents that involved drugs being given at the wrong time (87), or patients being given the wrong dose (71) or the wrong drug (43).

In the reports where it was possible to determine the step when an error was committed, 37 percent occurred at the administration step and 31 percent at the ordering step. Administration errors frequently were attributable to confusion about the intended treatment schedule (unclear communication of orders) or uncertainty about whether an earlier step in a sequence had been completed (unclear documentation of therapy). Thirty-seven percent of the ordering errors were due to incorrect drug doses.

Chemotherapy prescribing problems have plagued the VA since the introduction of CPRS. Unlike traditional paper orders, computerized orders are directed either as a pharmacy or nursing order and the components of an order set are not linked together electronically, although they must be linked in execution. The fragmentation of the components of a set of instructions for care has created a daunting challenge for oncologists who want to order chemotherapy in CPRS. A chief concern remains that key information about the plan of care will not be communicated to the clinical staff when using CPRS.

Historically, the VA computer system, VistA, was initially used by pharmacy to print labels. CPRS, a graphical user interface with attributes of a browser, was subsequently developed to facilitate recording and retrieval of clinical informa-

A New, Simplified Approach to Medication Close Call Reporting

By Noreen Jennings, JD, RN, patient safety specialist, and Dale Ryan, RN, MSA, informatics nurse specialist, West Palm Beach VAMC

AT WEST PALM BEACH VAMC, staff members in pharmacy, nursing and patient safety were interested in increasing their ability to capture medication error close calls.

We had specific goals: to increase reporting, to improve its timeliness and accuracy, and to increase staff involvement, whether it meant reporting a close call or an actual event.

With the assistance of Information Resource Management, we developed a user-friendly, computer-based format that minimizes free text and offers simplified categories. When a category is chosen, such as a “prescribing error” or a “dispensing error,” another selection is displayed that allows a second choice from a subcategory, such as “wrong dose” or “wrong drug.” Both steps can be taken by simply pointing and clicking.

Close calls: Every computer desktop at our VAMC contains a “medication incident error” icon that can be accessed by any staff member. To report, a staff member enters the name and Social Security number of the patient, the name and dose of the drug, and a brief summation of the incident. *It can take, literally, as little as one minute to complete and submit the form.* Quality Management receives the

information and ensures its confidentiality; even the staff member who had entered the information can no longer access it.

Actual events: The medication incident icon can also be used to submit a report on an adverse event that in some way affected a patient. As is the case with close call reporting, the system is built to ensure that we preserve the database as “confidential and protected” under 38 USC 5705. When an actual adverse event occurs, the patient safety manager assigns it a Safety Assessment Code score. Depending upon the situation, either an RCA is conducted or the data is added to the medication aggregate.

Results and Benefits: During the first quarter after the implementation of this process, *our medication close call reporting increased from 10 to 173.* This is a remarkable increase in reporting. The medication aggregate team has used the information to review trends and issues, and to develop action plans to prevent future incidents. Since the report the team uses is formatted in an Excel database, it can easily be sorted according to categories, making trends readily apparent.

For instance, the team identified a trend attributed to the staff’s level of

knowledge and experience with order entry. A competency checklist has been developed to serve as a uniform reference for new providers being trained in order entry. All new providers will also be asked to complete an electronic self-learning module on CPRS.

Another issue concerned tracking IV-controlled substances by using a paper-based method versus segregating these medications in an automated dispensing machine (ADM). The team recommended standardizing our approach by having all controlled substances delivered directly to an ADM. They could then be removed individually for administration to patients.

Summary: Our system has dramatically increased close call reporting. This increase has significantly improved our medication aggregate team’s ability to develop action plans to improve patient safety. Our effort, though, is a “work in progress.” We continue to make changes and additions based on suggestions from our staff.

VA employees who wish to view screenshots of this system may click to vawww.ncps.med.va.gov/frontlines/index.html



Improving Chemotherapy Safety *(continued from page 2)*

tion by nurses and doctors.

VistA and CPRS are partial and imperfect images of one another. For example, all the pharmacists’ work is still performed in VistA; but other orders, such as nursing text orders, are not viewable in VistA. As a result, the pharmacist, an integral member of the multidisciplinary care team for a cancer patient, may be unaware of crucial information about a patient’s treatment. The VistA “Print Information” field for IV orders is limited to 60 characters. Therefore, if a clinician adds longer text instructions to the CPRS “Comments” section when placing an IV drug order, no part of this text is placed on the drug label or in BCMA; essentially, the text is left behind in CPRS.

The VistA pharmacy package is being re-engineered with a projected

release near the close of the decade, but it is not certain that all problems will be resolved.

We surveyed doctors, pharmacists, and clinical applications coordinators throughout the country to determine how chemotherapy is prescribed at each facility. Of the 41 facilities that responded, only five use direct physician order entry for cyclic chemotherapy; all of the others designate a pharmacist to place the orders. Twenty-three of these facilities use handwritten orders; ten are written in CPRS using a text order, pharmacy consult, or progress note. Three facilities are testing commercial software for prescribing.

A major goal of this PSCI is to determine whether the safety needs of veterans can be met with CPRS or whether commercial chemotherapy software is needed.

Testing of candidate software is ongoing at Minneapolis and Cincinnati. This is being compared to order sets produced at the Iowa City VAMC. Simulated clinical scenarios will compare the commercial software and CPRS chemotherapy order sets for their effectiveness, efficiency, flexibility, clarity and precision.

Our PSCI intermediate and long-range goals include: the coordination between VA cancer experts to propose, publish, and update consensus guidelines for treatment sets; a review of recurring and unique barriers to dissemination of innovations in technology; and further development of the technologies that accurately and effectively order chemotherapy treatments for VA patients.



Helping RCA Teams Be More Successful and Effective *(continued from front page)*

Where do you begin collecting?

As you consider the following sources, other ideas may come to mind. Ideally, you should obtain the actual object or its pertinent parts so that it can be handled and tested.

- Take a look through RCAs that mention equipment, devices or architecture.
- Revisit NCPS alerts and advisories — especially those that include photos of problem devices, such as the Risperidone oral medication syringe (pipette) [www.patientsafety.gov/alerts/Pipette.doc].
- Take this article to your biomedical engineer and ask for ideas and exhibit items.
- View the Institute for Safe Medication Practices' Web site (www.ismp.org) — look for photos of potential exhibits.
- Tour your facility and look for sticky notes attached to devices that provide warnings about safe or correct use.
- For photos and descriptive museum placards from the NCPS collection see www.patientsafety.gov/PSC/HOM/

How do you make the design issue clear?

You will need to take potential exhibits in hand, evaluate their usability, and consider how others will be challenged by them. See the examples pictured on this page.

When you have identified challenges to correct use of a device, you may want to cite the HFE principle that is countered.

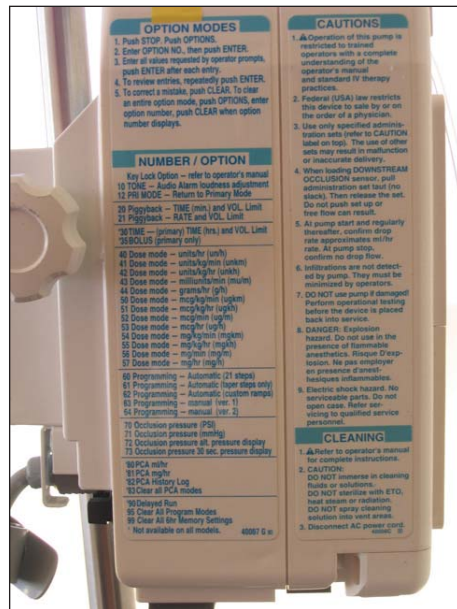
How do you connect the HFE principle to exhibits in your collection?

Start with a checklist of good design. As you handle the potential exhibit — considering issues that you've learned from an RCA, an alert or advisory, or another source — look for a connection with one or more of the design principles. Finding that connection will provide ideas for solving issues with the device.



Photos courtesy of Steve Bird, VAMC Walla Walla

An example of a device with a sticky note providing a warning about safe and correct use.



Consider the usability problem of threading an IV line through this pump, then programming it at a rate of 44 and volume of 100. Is it possible to read these instructions for use while handling the parts needed?



Think about assembling and using this ambu-bag in a time-sensitive situation. Is it obvious where to connect the mask, or will you waste time trying to figure it out?

Sample HFE checklist items:³

- __ Does this device look like another device or tool you have used before (e.g., ATM machines, calculators); and is that fact helpful?
- __ Is it obvious how you operate the device?
- __ Is it obvious what each button or switch will do?
- __ Do some buttons/switches look too similar to others?
- __ Is the message display big enough?
- __ Is the language simple and natural?
- __ Is the information useful? Do you need more information?
- __ Are the error messages understandable?
- __ Are you able to easily see all the important warnings and labels?

How do you get just-in-time information about HFE principles?

While the lesson of good design can be learned without spelling out the HFE principles involved, having the principles stated will assist in documenting the need for changes in devices, equipment or architecture.

If you need more information, consider consulting with HFE experts at NCPS. Our NCPS contact information can be found in the box below this article.

- ¹ Gosbee J, Anderson T. Human factors engineering design demonstrations can enlighten your RCA team. *Qual Saf Health Care* 2003;12:0-2.
- ² Gosbee J, Williams L, Dunn E (2004). VA Patient Safety Curriculum for Residents: An Update. Retrieved May 22, 2005 from www.acgme.org/acWebsite/bulletin/bulletin08_04.pdf
- ³ Gosbee J, Lin L (2005). *Human Factors Engineering to Improve Patient Safety*. (pp 28-30) Joint Commission Resources.



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