

Human Factors and Ergonomics in Patient Safety Curriculum

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Abstract

The importance of teaching human factors and ergonomics (HFE) and patient safety is registered in two compelling facts: 1) the numbers of physicians who train in VA hospitals and 2) in the need for hospitals to function as highly reliable organizations. In the United States, more than half of the physicians-in-training do at least part of their medical school and residency training at veterans' health care facilities. Health care currently does not measure up to other high-reliability organizations. By providing a HFE-based patient safety curriculum, we hope to improve patient safety at the frontlines. We see the lasting benefit as residency programs that produce physicians who are competent, patient safety problem solvers throughout their careers who will assist health care organizations to become highly reliable. © 2011 Wiley Periodicals, Inc.

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1. INTRODUCTION

The VA National Center for Patient Safety (NCPS) is charged with promoting a safe medical environment and decreasing the risk of serious harm to patients that may occur as a result of receiving health care services. NCPS has promoted improvement of health care safety through application of human factors and ergonomics (HFE) problem-solving methods in clinical settings and through use of engineering methods such as root cause analysis (RCA) and failure mode effects analysis.

Graduate medical education (GME) comprises a unique and critically important component of the VA

health care system. Physicians-in-training (residents) are involved in providing much of the front-line clinical care at VA hospitals and clinics. In addition, the VA is responsible for providing a large proportion of all medical education in the United States. Thus the education of physicians-in-training in the principles of HFE and patient safety has the potential to affect medical care currently provided at VA hospitals and the knowledge of the future physician workforce nationally. Because of this, NCPS provides training to faculties of physician training programs without regard for VA affiliation.

From the planning stages through implementation, the NCPS core curriculum considers the requirements of the Accreditation Council for Graduate Medical Education (ACGME) for practice-based learning and systems-based practice. Historically NCPS presented workshops as part of the annual ACGME conference to encourage recognition of efforts to find engineering-based solutions to patient safety issues as their residency review committees (RRCs) visited programs (Gosbee, Williams, & Dunn, 2006). The resolute and

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strong recommendation from the American Board of Medical Specialties (ABMS) contributes to the demand for qualified patient safety problem solvers. Future medical board certification and recertification exams will evaluate patient safety problem-solving competencies (Kachalia, Johnson, Miller, & Brennan, 2006).

2. METHODS

In 2004 NCPS began providing HFE-based patient safety curriculum workshops for faculty development. The two-day workshops demonstrate content and methods for teaching physicians-in-training by using the evidence base from a field long in existence, but relatively new to health care: HFE (Bagian, in press). For most of the content, we propose *integrating* rather than adding to already time-constrained, content-packed residency programs. This is possible by adding a patient safety perspective to case conferences or teaching rounds, as well as providing ready-to-use content and methods that can be adapted to a number of small segments of time, e.g., Doc-U-Drama (Kirkegaard & Fish, 2004).

However, the exception to integration of content is in-depth patient safety problem solving through RCA or health care failure mode and effect analysis (HFMEA). Both require a considerable time obligation. At the outset we proposed measuring the success of the workshop by the appearance of physicians-in-training on RCA teams. By 2008 it was clear that other forces were at least as influential, but the statistical method for that measurement is presented here as a snapshot of the program both because it is interesting and because we drew encouragement from the results.

The importance of teaching HFE-based patient safety is registered in two compelling facts: 1) the numbers of physicians who train in VA hospitals and 2) the need for hospitals to function as highly reliable organizations. In the United States, more than half of the physicians-in-training do at least part of their medical school and residency at veterans' health care facilities (Brotherton, Rockey, & Etzel, 2004). Health care currently does not measure up to other high-reliability organizations (HROs), but it should continue to be evaluated by standards of HROs (Tamuz & Harrison, 2006).

In an HRO, individuals and systems must perform in a highly reliable manner consistently or risk serious harm. True HROs recognize that the contributions to safety from front-line workers are of the highest value. In GME and health care delivery, the tension for learn-

ing is also clear. Physicians-in-training are primarily in the hospital to learn (Gwande, 2002), yet they, along with nurses, are most frequently present at the front lines of care. Both are well positioned to identify and propose solutions for patient safety issues. By providing HFE-based patient safety curriculum to their program faculty and leaders, the NCPS contributes to physicians' capabilities as problem solvers.

3. DESCRIPTION OF THE VA NATIONAL CENTER FOR PATIENT SAFETY RESIDENCY CURRICULUM COURSE

Because faculty workshop participants come from a variety of residency programs and medical specialties, discussion time is reserved to allow for sharing the wealth of experience brought by attendees. Discussion is provoked through use of dramatic simulation (Kirkegaard & Fish, 2004), case studies, and modified patient safety case conferences.

The sessions include epidemiological data establishing the scope of the problem (Bates et al., 1995; Brennan et al., 1991; Kohn, Corrigan, & Donaldson, 2000; Schimmel, 2003; Steel et al., 1981), basic concepts of HFE (Sojourner, Aretz, & Vance, 1993); engineering and safety terminology; and patient safety problem-solving strategies. Attendees apply engineering methods such as usability testing (Anderson, Gosbee, Bessesen, & Williams, 2010; Gosbee & Anderson, 2003), heuristic evaluation, and redesign to medical devices and health care systems — taking a hands-on approach (Williams, 2005) to fixing patient safety issues. They learn to use tools that will prepare physicians-in-training to participate in RCA and other patient safety problem-solving activities.

One of the barriers to learning to teach patient safety is the vocabulary that rapidly becomes familiar to teachers. For those new to the topics of HFE and patient safety, the introductory sections are described as overwhelming and the pace as too fast. The answer to both questions (how best to convey what is essential without resorting to use of specialty jargon) seems to lie in using interactive teaching methods so that concepts are taught even if the terminology for the concept isn't assimilated into the participant's vocabulary (Stone 2008).

Other evolutionary changes to the GME faculty development workshop include increasing the time

devoted to RCA and a shift in focus from teaching a general understanding of how an RCA is conducted to teaching and practicing two RCA tools: cause-and-effect diagramming and compliance with rules of causation. These two key methods allow novice investigators to discover root causes on a par with experts (Woodcock, Drury, Smiley, & Ma, 2005). In addition, guest faculty from either VAMC- or university-affiliated programs present success stories of resident participation on actual RCA teams. This emphasizes the concept that physicians-in-training should be allowed to experience the RCA process with patient safety experts rather than being lectured about the process.

HFE has remained at the heart of the curriculum. The Patient Safety Case Conference evolved from a 15-min mention, from one case to two or three — varying with the complexity of the case and interest in the discussion. HFE draws discussion away from blaming and toward finding systemic problems. Legal and ethical issues of patient safety are included in the introduction and scattered in appropriate places throughout other sessions. The importance of establishing and maintaining trust emerged as a related concept. Asking physicians-in-training to talk about their mistakes is easier done if their mentors speak of their own mistakes. In the workshop this discussion occurs after participants have examined the contribution of design-related adverse events (Samore, Evans, Lassen et al., 2004; Small, 2004; Way et al., 2003).

The most recent workshops have included two often-mentioned, related concerns: strategies for safe hand-offs and managing fatigue. Initially we included strategies for convincing others of the importance of including patient safety in resident curriculum. ACGME requirements have reduced the need for making the case. In consideration of the need to assess learners, specific tools were developed for each section along with instructor's guides for teacher preparation. The longer workshops also include time for faculty-guided curriculum planning.

3.1. Selected Changes in Approach

Changes that are not evident if only the first agenda and an agenda from recent workshops are looked at are those things that were tested and rejected. A discussion of adult learning principles took us too far from the heart of our concern for teaching HFE-based patient safety. We resolved instead to demonstrate those principles as we conduct the workshops. The goal is

to use very few slides and to pause frequently for individual or small-group work. After the 2005 ACGME annual conference, we added a workbook (Ausubel, 1960) to encourage cognitive processing (Stone, 2008; Wade, 2006).

From the first, the central goal of curriculum development has been to build a solid foundation for understanding the *systems* approach to patient safety. To accomplish this both for faculty attending the workshops and for physicians-in-training, we have resolutely kept the principles and tools of HFE as foundational to teaching patient safety.

The goals and objectives for the curriculum have changed only slightly over the six years of workshop production.

3.2. Goals

1. Physicians-in-training are active agents of change toward a systems and quality approach, away from the *blame-and-train* model (Tamuz & Harrison, 2006).
2. Physicians-in-training incorporate understanding of human performance and HROs into patient care and patient safety activities (Tamuz & Harrison, 2006).
3. VA health care facilities help affiliated residency programs provide excellent education (Brotherton et al., 2004).

3.3. Objectives for Both Faculty and Physicians-in-Training

1. Understand the scope and gravity of adverse events.
2. Know theoretical and practical reasons why blame-and-train approaches fail.
3. Become familiar with the basics of safety engineering and human factors and ergonomics.
4. Understand the importance of discovering root causes and contributing factors in developing effective interventions.
5. Become familiar with human factor engineering techniques and principles related to root causes and why they are crucial to the design of effective interventions.
6. Understand the relative strength of patient safety interventions, i.e., why the first solutions to come to mind may not produce the desired outcome.

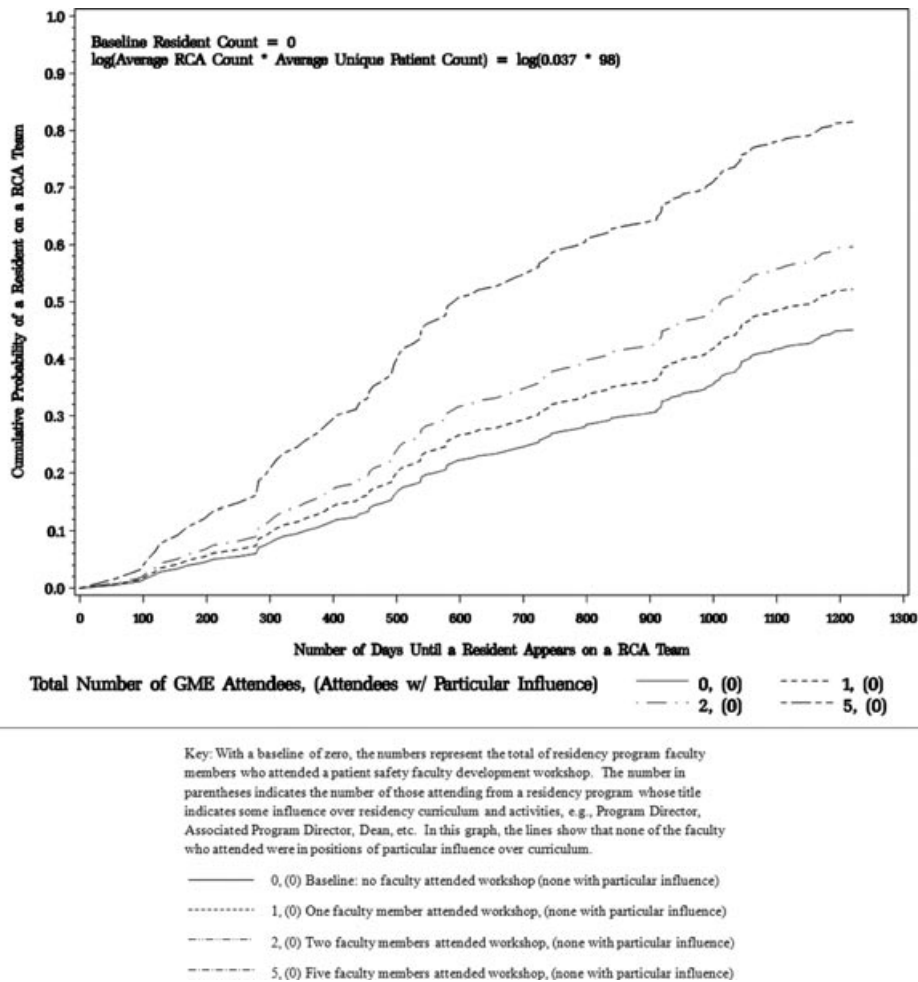


Figure 1 Illustrates that by day 575 there is a 0.5 probability that a facility having five workshop attendees will have realized a resident on a RCA team. A facility without the GME training intervention (no attendees) has a probability of only 0.22 of resident participation by the same day.

3.4. Learning Outcomes for Both Faculty and Physicians-in-Training

1. Formulate knowledge of key patient safety principles, such as *human factors and ergonomics* and *high reliability* from long-term projects or applied research activities.
2. Demonstrate ability to teach multidisciplinary groups by using hands-on, interactive teaching methods (Stone, 2008).
3. Perform basic human factors and safety evaluation of health care systems including devices, medications, and architecture in an operational environment, recognizing when to consult with HFE experts (Anderson, Wagner, Bessesen, & Williams, submitted for publication; Bridger & Poluta, 1998).

4. Understand and apply a business case analysis for patient safety intervention (Stalhandske, 2004).
5. Serve as a *translator* among various professional disciplines (e.g., among engineering specialists, medical specialists, and other related disciplines).
6. Become an agent of change toward an HRO (Tamuz & Harrison, 2006).

4. RESULTS

Since 2004, more than 20 patient safety curriculum courses have been held in 15 different cities. There have been over 750 attendees representing residency training programs at 80 different residency programs. A total of 32 medical specialties are represented, with

internal medicine (35%) and surgical specialties (10%) constituting the largest groups. Attendees have had a wide variety of job titles, including academic (professor, program director, dean) and physician managers (chief of staff, medical director, chief resident) (Gosbee et al., 2006).

4.1. Measurement

The challenge is to reliably measure resident participation in RCAs across a large and diverse health care system in which facilities vary by size and type. For the snapshot, we considered only hospitals with known residency program affiliations, the average daily number of RCAs going on at any one time (opportunities for resident participation), the average daily number of unique patients seen at the hospitals, and the number of physicians-in-training on teams at each facility

before there are faculty attendees at the GME curriculum workshop. We considered the pre-workshop level as the baseline propensity of physicians-in-training to be on RCA teams for that facility.

We began with a lofty measure for the success of workshops — the participation of residents on RCA teams. When the numbers did not show significant change, we looked more closely at the swiftness of change. Although this provided only a snapshot in time, it revealed encouraging results. From basic demographic information on registration forms for the workshops, we identified affiliated VAMCs. (No other identifying data are retained for this analysis.) NCPS receives information about the (role-based) composition of RCAs teams at VA hospitals as well.

We looked at residency program locations for workshop participants and composition of RCA teams of

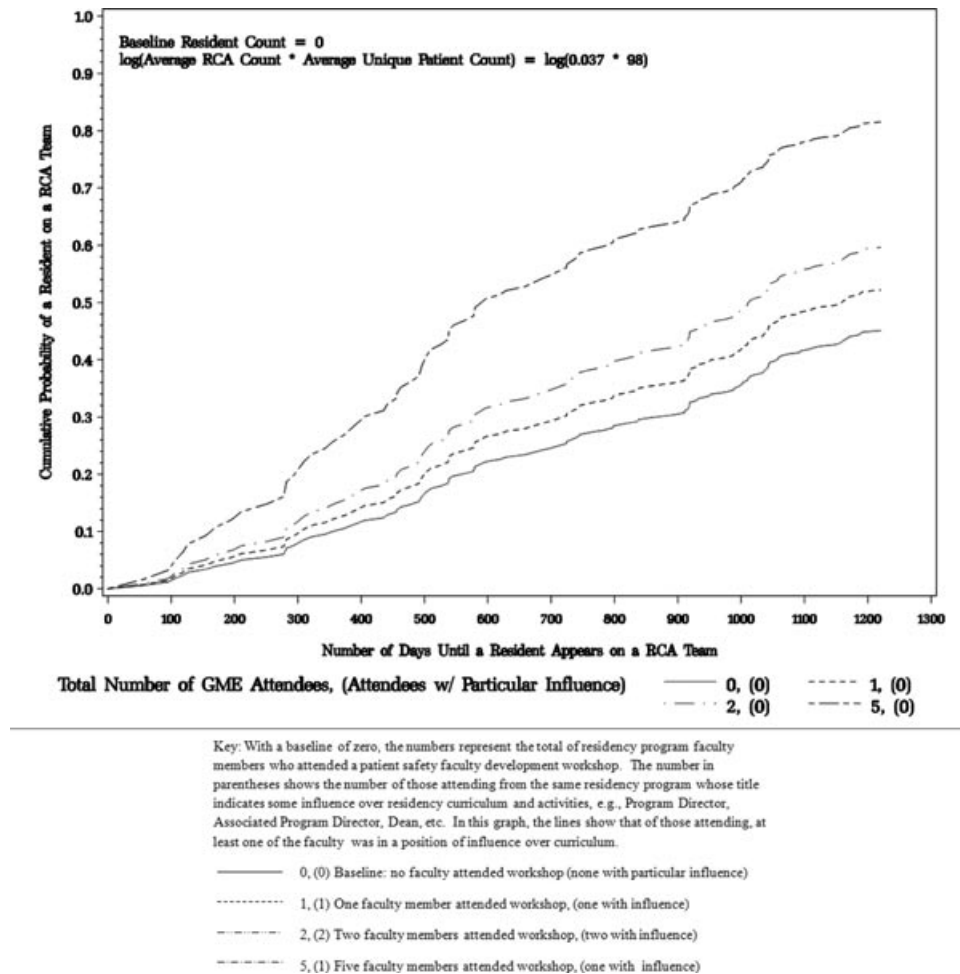


Figure 2 The count is adjusted to include those attending a workshop whose titles indicate particular influence. For facilities with two who are both influential and five including at least one who is influential, there is an estimated 50% chance of having resident RCA participation within a year. Having no GME training extends this chance well beyond 3 years.

those university affiliates. A Kaplan–Meyer survival analysis revealed that the mean number of days until a resident participated in an RCA was significantly less if their faculty had attended the curriculum workshop, as compared with programs that did not have a faculty member attend (see Figure 1). Programs sending more than one faculty member to a workshop had greater resident involvement in RCA teams. Additional comparisons were made regarding the residency role of the attendees (see Figure 2).

In the snapshot we considered only two differential types and based the classification on a box checked on the registration form plus the text description of their job title. Physicians were classified dichotomously as having a title that indicated influence or a title that indicated primarily teaching. Program directors, assistant or associate directors, deans, department chairs — those with decision-making authority were designated as *influential*. The likelihood of a patient safety activity being added to the residency training program is related to the number of faculty to attend and/or the particular position of influence held by those attending the NCPS curriculum workshop.

In this model the fixed covariates are the opportunity to participate, the daily number of unique patients at the hospital, and that baseline propensity for physicians-in-training on the team. Physicians-in-training appear on RCA teams sooner after a workshop than would be otherwise expected. If residency faculty

and program leaders do not see value in the activity, the time obligation makes resident participation difficult. At the time a resident begins involvement with an RCA team, we can look to see if the affiliated university has sent faculty or leaders to the workshop. This is only a snapshot in time. As the workshops continue, the picture changes as more physician teachers and leaders attend.

One-hundred-twenty-four facilities were part of the original snapshot, all with medical university affiliation. Seventy-seven did not have a single RCA resident event occur during the time period studied. Twenty-five facilities had at least one GME attendee and the maximum observed number for a facility was eleven.

Keep in mind that the variables are the number of days until a resident begins participation on an RCA team, the number of physicians-in-training participating on teams, the cumulative count of workshop attendees just prior to each recurrence, the cumulative count of workshop attendees with *influence*, and the interaction of a facility's average daily RCA count and its average daily unique patient count. An increase of one in the cumulative number of faculty attending a workshop will increase the likelihood of a resident's being on an RCA team by 1.236 times. For each increase of one in the cumulative number of those with particular influence in a residency program, likelihood of resident participation in RCA increases by more than 2.5 times.

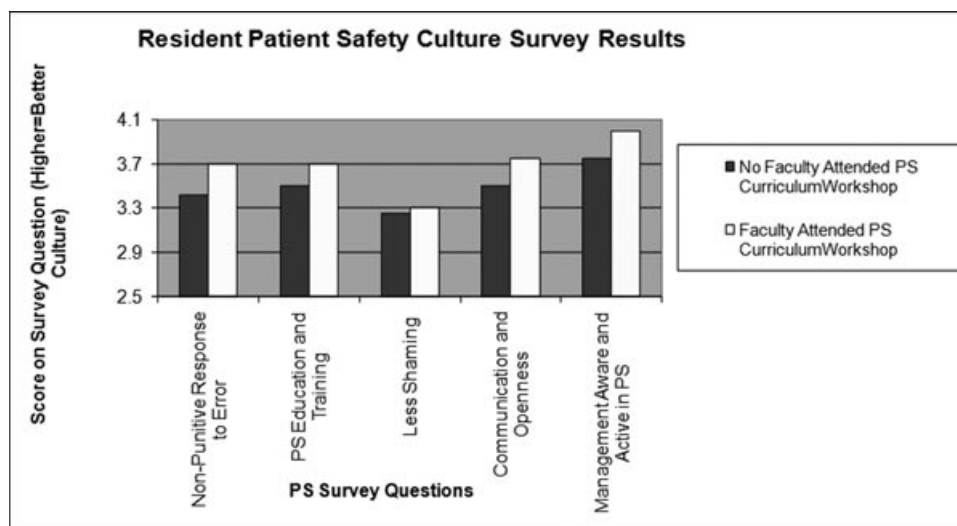


Figure 3 Favorable changes across five dimensions for physicians-in-training: nonpunitive response to error; education, training, resources; less use of shame; communication, openness; and senior management awareness and promotion of patient safety.

4.2. Measuring Change in Patient Safety Culture

Another measure that continues beyond the snapshot view is the patient safety culture survey. NCPS conducts this survey of all employees and trainees in VA hospitals approximately every three years. The results show favorable changes across five dimensions for physicians-in-training who have received HFE-based patient safety course content (Figure 3).

5. CONCLUSIONS

The VA NCPS has conducted regular HFE-based patient safety workshops for faculty development for 6 years. Ultimately the goal is to contribute to both the excellence of residency education and to improve patient safety through involvement of physicians-in-training in patient safety activities. We see the lasting benefit as residency programs that produce physicians who are competent patient safety problem solvers throughout their careers who will assist health care organizations to become highly reliable.

Although RCA participation is a proxy measure of success, it is a time-intensive patient safety activity. Therefore we draw more encouragement than numbers or the snapshot of data may seem to warrant. Residency programs report to us that they are finding a variety of other patient safety improvement projects to which their physicians-in-training contribute. These patient safety projects are often included in portfolios of physicians-in-training. Portfolios are made available during residency review committee visits as part of the ACGME accrediting process. Several residencies offer full month-long patient safety rotations.

These patient safety activities are difficult to claim as evidence of the success of our workshops because the need to include patient safety curriculum is widely recognized from residency program levels to regulatory and accrediting bodies. The credit for developing opportunities for physicians-in-training to be involved in patient safety activities belongs to those residency programs.

It might seem ideal to dream of the results of GME patient safety education as a reduction in medical errors. This seems reasonable only in those first few seconds of framing the answer to what you would wish for if Aladdin made the offer. Because the goal is to protect patients from unintended harm, measuring success is rather about changes made to the way physicians

think — and providing physicians-in-training with the opportunity to become physicians who are able to recognize and treat *system* ills.

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