STRAIT
Simulation Training For Rapid Assessment And Improved Teamwork

Principal Investigator: Matthew B. Weinger, MD

Team Members: Audrey Kuntz, Becky Arndt, Debbie Arnow, Arna Banerjee, James Barnett, Jim Bills, Ray Booker, Edward Byrd, Autumn Clark, Dan France, Judy Hall, Audrey Kuntz, Susie Leming-Lee, Abeer Madbouly, Nathan Mercaldo, Willam O'Byrne, Emily Patterson, Debianne Peterman, Jim Pichert, Lisa Rawn, Jonathan Schildcrout, Yaping Shi, Jason M. Slagle, Ted Speroff, Dila Vuksanaj, Ken Wallston, Chuan Zhou, Matt Zimmerman

Organization: Center for Perioperative Research in Quality (CPRQ), Departments of Anesthesiology and Biomedical Informatics, Vanderbilt University School of Medicine, Nashville, TN 37212; and the Geriatric Research, Education, and Care Center (GRECC) at the Middle Tennessee VA Healthcare System, Nashville, TN 37232

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Abstract

Purpose: We hypothesized that a simulation-based performance improvement intervention would improve the quality of clinical handovers.

Scope: A simulation-based training intervention to improve patient handovers between anesthesia providers (APs) and post-anesthesia care unit (PACU) nurses (RNs) at an adult (VUH) and a pediatric (VCH) PACU was developed, implemented, and evaluated.

Methods: We developed a didactic webinar, an electronic handover report tool, a 2-hour simulation-based training session, and a 1-hour "refresher" course used several months later. Training focused on interpersonal skills and overcoming obstacles to effective handovers. Trained RN observers scored 981 actual PACU handovers over 12 months using a validated tool. A different blinded observer scored pre- and post-training simulated handovers. A culture survey was administered to PACU clinicians before and after the intervention.

Results: Baseline (pre-training) data were stable. After training, handover quality improved significantly, with more than 70% of handovers rated as "effective" in both PACUs ($P<0.001$). The training status of the handover giver (AP) was the critical determinant of handover effectiveness. Following full implementation, new (untrained) clinicians also performed effective handovers, suggesting culturization or implicit training. PACU culture of communication improved on some but not all elements.

Key Words: Care transition, handover, teamwork, communication, patient safety, medical error, manikin simulation, standardized clinician, anesthesiology, safety culture

Word Count: 185

Purpose:

The primary purpose of this AHRQ-funded research project was to determine if a simulation-based training intervention would change clinicians' behavior in the real world. We focused on handovers, because transitions of care have been shown to be a time of great safety vulnerability.

Our intervention, called STRAIT (Simulation Training for Rapid Assessment and Improved Teamwork), was targeted at the post-procedure handover between anesthesia providers (APs) and nurses (RNs) in the post-anesthesia care unit (PACU). This particular clinical handover situation was chosen because it involves interprofessional communication about a critical patient and, importantly, because it is a well-defined and logistically feasible encounter amenable to study and improvement. We designed STRAIT to have wide applicability across Vanderbilt University Medical Center (VUMC). STRAIT utilized hybrid simulation techniques (e.g., high-fidelity manikins as the just emerging patient) along with simulated clinicians (e.g., to expose trainees to standardized conflict situations).

The specific aims of this project were to 1) develop a simulation-based training and quality improvement intervention directed at PACU handovers; and 2) determine if the implementation of this initiative improved the quality of PACU handovers.

The specific deliverables of this project were to:

1) Identify the teamwork, communication, and other attributes that distinguish an effective from an ineffective PACU handover.
2) Develop a webinar that addressed the rationale for and basic knowledge about standardized handovers.
3) Develop a high-fidelity simulation-based PACU handover curriculum focused on communication skills and overcoming obstacles to success.
4) Develop and deploy an electronic handover tool that would be well received by clinicians and would optimally support the educational objectives of the training intervention.
5) Develop a valid rating instrument that could be reliably used in real time while observing real-world PACU handovers.
6) Successfully deliver the handover training program to all eligible APs and PACU RNs at VUMC.
7) Determine the effects of the initial training intervention and of a follow-up refresher course on actual handover performance (between-subjects design, see Methods).
8) Determine the effects of simulation-based training on the ability of individual providers to perform effective simulated PACU handovers (within-subjects design, see Methods).*
9) Describe the organizational (PACU-centric) learning curves for handover improvement specifically looking for changes in PACU culture, as evidenced by the performance of untrained handover dyads.
10) Measure changes in the culture of communication (see Methods) in the PACU before, during, and after implementation of the STRAIT intervention.
11) Explore methods to assess handover-related changes in PACU patient outcomes.*
12) Create video recordings of simulated scenarios that can be used by others who wish to deploy our handover curricula but do not have access to simulated clinician actors. Pilot the use of these videos in a handover training course.

As described in detail below, we have successfully addressed our specific aims at the present time and have accomplished 10 of the 12 deliverables. Two items (indicated by asterisks) are both substantially accomplished but not yet complete at this time.

Scope:

This handover improvement project involved two VUMC PACUs within a single academic medical center. The adult PACU (VUH) was used as the initial intervention site, while the pediatric PACU (VCH) served as a parallel control site. Three months later, the VCH PACU received the training intervention. We measured the impact of STRAIT on communication effectiveness in both simulated and actual care handovers. The primary hypothesis of this project was that simulation-based communication training of AP and PACU RN personnel would significantly improve the quality of actual PACU handovers.

Study Rationale

Communication failures continue to be the most frequently cited "root cause" of adverse events reported to The Joint Commission (personal communication, Margaret VanAmringe, February 2, 2010). Over a recent 8-year period, Vanderbilt paid out nearly $3 million for 31 surgical malpractice claims in which a major factor was a problem with clinician-clinician communication. Clinician communication is essential for establishing a culture of safety (Singer, 2003).

Most healthcare is provided by interdisciplinary teams. Yet, performance incentives in healthcare are targeted at individuals, not teams, as are job and other selection and assessment processes. Traditional specialty-centric clinical education programs are deficient in team training. To coordinate effectively, team members must have mutual knowledge about each member's roles, functions, skills, competencies, and goals (Klein, 2005). Interventions that improve healthcare communication and coordination can have profound and widespread impact on care quality.

When communication must cross professional boundaries (e.g., nurse and physician), differences in culture, training, norms, attitudes, perspectives, goals, expectations, status, gender, and socioeconomics can predispose to misunderstandings. Effective communication is even more difficult when the individuals involved are stressed by time pressure, sleep deprivation, or fatigue–situations ubiquitous in healthcare (Weinger, 1990). Other communication barriers that challenge healthcare providers include hierarchical status, uncertainty about who is responsible for patients' care management, and lack of a structured or standardized method for communication (Thomas, 2003). Variations in communication style can also lead to misunderstanding or frustration among caregivers.

Unfortunately, few successful educational collaborations between nurses and physicians have been published (Zwarenstein, 2006). Interdisciplinary training has developed slowly for reasons that include tradition, professional silos, scheduling, and cost. Moreover, much of the literature on clinical communication and care transitions has emphasized clinician-patient and *intra*professional interactions.

Handovers

Handovers are "conversations rather than reports" (Brandwijk, 2003) and typically consist of four phases–preparation (by both parties), patient arrival in the new location, the actual handover (e.g., RN-MD interaction), and post-handover management by the receiving clinician. Successful handovers avoid unwarranted shifts in goals, decisions, priorities, or plans, including missing tasks or redoing ones performed by the previous person in the role (Patterson, 2004). Prior to the initiation of our project, we could find no studies of simulation-based interventions specifically intended to improve handover quality.

To try to improve clinical handovers, Dr. Michael Leonard and colleagues at Kaiser Permanente developed the SBAR (Situation-Background-Assessment-Recommendation) technique. Endorsed by the Institute for Healthcare Improvement (IHI), SBAR provides a structure for team communications about patients' conditions and a standardized frame for handover-specific communications. SBAR is purported to promote communication that allows clinicians to set expectations for continued patient care while encouraging collaboration, teamwork, and a culture of safety. In 2005, VUMC adopted SBAR as its organizing theme for all handovers. In this project, SBAR's elements were taught, and the extent to which clinicians communicated its critical items was assessed.

This project focused on improving the handover between anesthesia providers and PACU nurses after invasive procedures. These handovers allow a care transition so that anesthesia providers can return to the OR to anesthetize the next scheduled patient. It is important to make sure the recently anesthetized patient

is stable (i.e., stable cardiac and respiratory systems, good pain control), because a failed handover can have catastrophic consequences. On the other hand, there is typically pressure to minimize "turnover time" between cases and thus anesthesia providers have incentives to make handovers as brief as possible.

Very few prior studies were found to be directly relevant to this project. Anwari (2002) surveyed providers during 276 PACU handovers in Saudi Arabia. Handover quality was assessed by four indicators: the quality of verbal information about the patient, the condition of the patient on admission, the anesthetist's professional behavior, and the nurse's satisfaction with the handover. PACU nurses rated the anesthetist's behavior acceptable or better in 87% but were unsatisfied in 52% of the handovers. Moreover, the overall quality of the handover was judged as good in fewer than half the patients. Schwilk et al. (1994) investigated 198 postoperative handovers involving 120 patients in a U.S. hospital and compared the results with those of a former study in a German hospital. In both hospitals, a short verbal information transfer always occurred but was of quite variable duration (e.g., 112±104 sec in the U.S.). Hillel & Vicente (2003) studied causes of PACU RN interruptions but did not look at the initial handover.

Methods

Overview

This study was conducted at Vanderbilt University in the primary PACU of two hospitals: the adult (VUH) and pediatric (VCH) hospitals. The study used a multiple baseline, staggered entry, prospective cohort design with repeated measures. The study cohort consisted of anesthesia providers (AP), including residents and CRNAs, and nurses (RNs) in two physically separate PACUs. As shown in **Figure 1**, in both PACUs, there was an initial baseline of field observations (actual patient handovers). These observations then continued throughout the study. Then, all available RNs and APs working in the adult PACU received simulation-based handover training. A handover support tool, printed automatically upon the initiation of the closing phase of each operative procedure, was introduced in the PACU during this initial training period. The VCH clinicians received training 4 months later. Throughout the study period, reinforcement of the importance of handover communication, feedback from field observations, and other items requiring additional emphasis were provided through posters and emails to providers. Six months after the initial VUH training, a 1-hour simulation-based refresher course was given to all participating VUH PACU RNs and APs. A final 3 months of post-intervention field observations were obtained. In addition, although not part of the original grant proposal, we created video recordings of the simulated clinician handover encounters used in the original training. In Fall 2008, we then conducted four training sessions of new APs and RNs, in which we used observation and discussion of these videos to ascertain if this would be as effective as individual participation in the scripted simulated handovers.

Participants

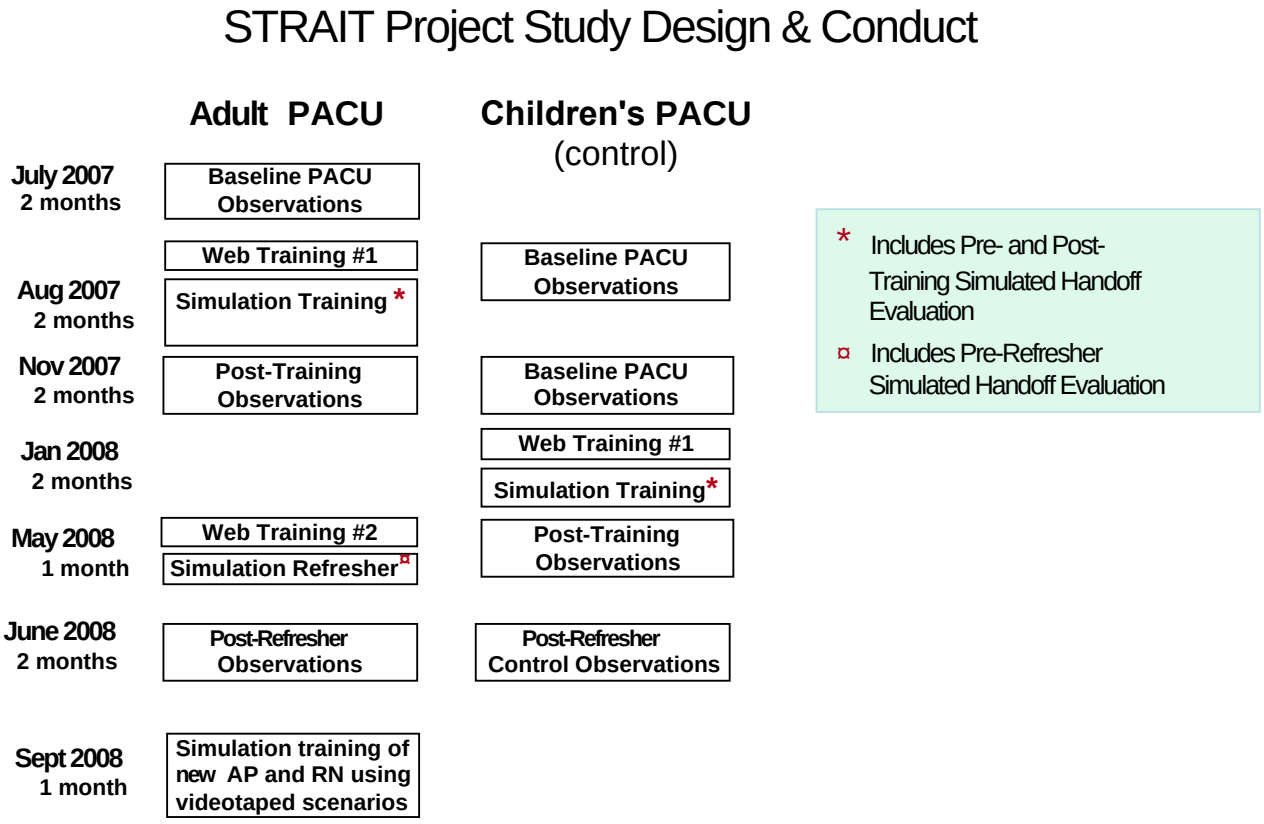
The primary study population was 45 anesthesia residents, 47 certified registered nurse anesthetists (CRNAs), and 88 PACU nurses. This was an institutional quality improvement project, and the training sessions were mandatory for all PACU RNs and APs (excluding faculty). Human Subjects Committee approval was obtained. All PACU clinicians were assigned a random *confidential* code number. The purpose of tracking de-identified providers was to link training status to observed handovers and to track a clinician's performance over time. Participants were fully informed about the project through in-services, emails, flyers, and posters.

Curriculum Development

A collaboration between the research team and the VUMC Perioperative Improvement Task Force throughout 2006 organized the information content essential to an effective PACU handover around the SBAR format. Due to the implementation of this project and the VUMC Handover Initiative, VUMC policy requires that all PACU handover follow this format.

Initially, two investigators experienced in observational methods observed more than 50 PACU handovers. These observations and a review of the literature laid the foundation of the initial draft curriculum. Notable pre-study findings included significant variability in handover content, detail, organization, and communication style and the use of paper-based handover forms. Handovers involving less stable patients were more frequently interrupted, less thorough, and paradoxically briefer than those involving stable patients.

Figure 1. Study Design and Conduct



Educational objectives were refined by the team and validated by other clinicians. Early on, it was decided that the training would address both the specifics of the PACU handover–what information needs to be transmitted and the structure within which it should be transmitted–as well as structured guidance on effective communication strategies. We wanted to emphasize in the training that *how* one communicates is as important as *what* one communicates.

Scenarios were created that provided specific reproducible opportunities to observe performance related to the objectives chosen. Thus, measurement objectives and instruments were developed in parallel so that the performance measures accurately and reliably assessed performance on the objectives. These behaviors were taught both explicitly and implicitly. Thus, the scenarios reinforced the desired communication behaviors, which were modeled by instructors and the simulated clinicians and practiced by the trainees. The curriculum was refined through iterative cycles of pilot testing and review employing a user-centered design approach.

Development of Handover Scenarios

As a key component of the introductory didactic webinar, 10 video vignettes were created to represent both effective and ineffective handovers. These vignettes were derived from observations, reports from clinicians, and occurrence-reporting systems. All scenarios were vetted with a panel of clinicians for accuracy and authenticity and were videotaped using standardized clinicians (SCs) or trained actors portraying either a PACU RN or an AP. The videos were used to assess the face validity of the observation tool and to train and certify the study observers, and they were interwoven into the e-learning modules for the clinicians.

Four additional scenarios were developed specifically for the training sessions. Each scenario was based upon study objectives and was designed to elicit a range of realistic responses from the SC. These scenarios required a more intensive level of scripting and SC training due to the wide range of possible interactions with trainees and to ensure the realistic PACU environment was replicated.

A mid-fidelity manikin simulator (SimMan™) or a standardized (actor) patient (SP) was used, as appropriate, as the emerging patient in each of the handover scenarios. The manikin's responses were programmed, and the SP was trained to respond to trainees' actions and behaviors in order to support the goals of the scenario. In addition, in all training scenarios (see below), the PACU clinician trainee either gave or received a handover to or from a simulated (actor) clinician (SC). SCs were trained to accurately and consistently portray the clinical role and also respond appropriately to unexpected turns of events.

Assessment Tool Development

We iteratively refined and tested a prototype handover evaluation tool in parallel with curriculum development. We used absolute rather than relative rating scales: ratings were based on the observers' best-trained judgment about how that aspect of a handover should be conducted. Given the real-time conditions and the complexity of field ratings, the evaluation instrument was designed to capture the most important items efficiently and reliably. The rating forms were pilot tested in simulated handovers and then field tested extensively. The final instrument contained eight categorical global ratings (introduction and social greeting, readiness for report, content completeness, content organization and clarity, level of engagement, comprehension confirmation, and coordination and conflict resolution). There was also a separately rated comprehensive overall "handover effectiveness" score. All of the ratings were done on a five-point scale, with each point anchored by specific detailed behavioral examples. An SBAR-based checklist was completed during each observation but was not explicitly included in the scoring.

Observer Training

Trained nurses who were blinded to participants' training status observed actual PACU handovers. Four observers were trained although one ultimately did most of the observations. Observer training began with directed reading about anesthesia and post-anesthesia care followed by 16 hours of direct observation of anesthesia and PACU care. Training sessions on scoring were followed by practice scoring of videotaped and then actual handovers. Each observer viewed and scored a series of PACU handovers under mentored guidance. To be "certified," observer trainees evaluated simulated handover "test" videos to compare their ratings to the ratings agreed upon by the expert panel, which included several VUMC attending anesthesiologists and experienced PACU registered nurses who reviewed the videos individually and then discussed them as a group in a follow-up meeting. Observer trainees' video ratings had to meet strict criteria (e.g., ratings had to match certain key items, including the global rating, and could not be more than ±1 rating point different than the panel's ratings for any of the items) in order for an observer be certified and allowed to collect actual data.

Informatics Tool Development

During preliminary observations and curriculum development, we recognized that each PACU used a different paper-based tool during handovers. These tools did not adequately support either the

institutionally mandated SBAR format or core aspects of our evolving curriculum. Therefore, the research team worked closely with operational personnel to create a new electronic handover support tool that was automatically printed in the PACU when the OR nurse indicated that the surgeon was closing the incision. The tool was iteratively refined based on feedback from APs and RNs in both hospitals. The new handover support tool was deployed in all PACU upon initiation of VUH simulation training. Thus, this informatics tool was introduced in the VCH PACU 2 months into their baseline (pre-training) period.

Webinar

Before their training session, each trainee was expected to complete a 45-minute web-based multimedia course on PACU handovers that covered basic material about why this training was important, roles and responsibilities of providers, identifying barriers to handovers, overcoming barriers to effective handovers, and what to expect during the simulation training. The webinar incorporated video clips of simulated examples of good and bad handover attributes. The webinar concluded with a multiple-choice test to assess the trainee's knowledge retention. Later in the study, we developed a second 15-minute pre-refresher webinar that reinforced previous content and introduced additional methods to communicate and to escalate level of concern when things were not going well. Webinars were delivered via the same mechanism as other institutional web-based training (VandySafe™, VUMC, Nashville, TN using the Learning Management System produced by Pure Safety™, Nashville, TN). At least 2 weeks prior to their scheduled simulation training, trainers received an email instructing them to log onto the home page to complete the webinar. Regular reminder emails were generated as needed.

Simulation-Based Training

The two scheduled AP trainees received an email at least 2 days prior to their scheduled training slot that instructed them to study brief, but detailed, clinical synopses of the four "patients" they would encounter during training. Each 2-hour training session took place in our state-of-the-art Vanderbilt Center for Experiential Learning and Assessment (CELA). The clinician trainees, two anesthesia providers (AP_1 and AP_2) and two PACU RNs (RN_1 and RN_2) were relieved from clinical duties during regular work hours by supernumerary replacement workers (paid for by the hospital). Each course was taught by two instructors: a faculty anesthesiologist and a nurse educator. Baseline *testing* (pre-training) handover scenarios were conducted in pairs of providers (AP and RN) and videotaped for offline analysis by blinded raters. When the first pair did their simulated handover, the other pair was sequestered in an anteroom. For the four *training* scenarios, SCs were trained to initiate certain behaviors to trigger verbal and nonverbal responses from the AP or RN trainees. During the four training scenarios, nonparticipating trainees observed their colleagues via a video feed. Immediately following each scenario, instructor-facilitated peer debriefings, which often lasted longer than the scenario itself, occurred.

The four training scenarios addressed the key educational objectives of training:

- Critical information content and use of a structured/standardized approach (e.g., SBAR);
- Identifying and emphasizing the most important information;
- Sensitivity to the other persons needs and requirements; listening; reading nonverbal cues;
- Attention management–particularly dealing with interruptions and distractions;
- Task prioritization–balancing patient care demands and communication requirements;
- Dealing with time pressure and with competing priorities; and
- Being assertive when one's (or the patient's) needs are not being met.

Because formal evaluation can reinforce learning, in the last 10 minutes of the session, paired learners (again, 1 AP and 1 RN) performed a post-training simulated PACU handover on which they were told they would be evaluated. For this scenario, the pairings were changed so that each trainee

worked with a different trainee of the opposite role (i.e., AP_1-RN_2 then AP_2-RN_1). This post-training (testing) handover was also videotaped to evaluate the immediate impact of the training experience. The instructors concluded the session by asking the trainees for comments, questions, and concerns. Trainees completed an anonymous written course evaluation that used 10-point Likert scale items to rate course content and quality, including their assessment of its anticipated impact on their clinical practice.

Refresher Course Training

Beginning 6 months after the initial course, the VUH PACU clinicians returned for a 1-hour simulation-based "refresher course." This course was similar to the initial course. The paired trainees (AP & RN) first did a video-recorded testing scenario (to evaluate training retention). They then participated, as described above, in two new training scenarios that addressed attributes that were identified as still ineffective in actual PACU handovers. For example, the refresher curriculum emphasized more sophisticated communication techniques. Specifically, we introduced the importance of and a method to speak up if safety issues arise during the handover, based on the acronym CUSS ("I'm **C**oncerned" "I'm **U**ncomfortable" "I think **S**afety is at risk" "**S**top").

Observation of Actual PACU Handovers

Trained observers observed and scored in real-time actual handovers in the two study PACUs during daytime shifts. Six to 12 cases were observed each week in each PACU. Sampling was stratified according to time of day and day of week to attain a uniform and unbiased distribution of case types and providers. To be blinded to the greatest extent possible as to the training and experience of the participants, the observers were either not active clinicians or worked at a nonstudy site in the facility. Moreover, the observers did not participate in any of the simulation-based training. Observers did not interact with clinical personnel except to obtain self-evaluation surveys from the providers after their handovers were over. For each handover, the observer noted the time, date, and the two providers' names (which were converted to the random code numbers before being entered into the database).

Feedback to Providers

The intervention included performance feedback to PACU clinicians. Although feedback alone is usually ineffective for changing clinician behavior, it can be a useful complement to other strategies for improving performance. On a monthly basis, we collated and distributed electronically to all providers in the intervention unit(s) control charts showing the results of the handover observations. The X-bar control charts (i.e., Y-axis average score and X-axis date) showed results for overall handover effectiveness. The distributed material included textual summary of the results and encouragement to improve in specific areas of identified ineffectiveness.

Communication Culture Survey

We administered a communication culture survey to all anesthesia providers and PACU RN personnel in the institution prior to the start of the simulation-based training; then, at the end of the study, we will administer a communication culture survey to all anesthesia providers and PACU RN personnel in the institution. The communication culture survey is based on the teamwork climate scale embedded within the Safety Attitudes Questionnaire (SAQ). For our study application, we modified the SAQ's six-item teamwork climate scale to create customized communication culture surveys for both the anesthesia providers and the PACU RN. The communication culture survey measured perceived quality of collaboration between anesthesia provider and PACU RN. The surveys measured provider perceptions of communication, collaboration, conflict resolution, and assertiveness.

Database Development

A large amount of effort went into the design and development of the databases necessary to collect and analyze the data from the four core aspects of the study–participant training history, simulated

handover videos, observed handovers, and culture survey data. Database design, construction, maintenance, data entry, and data validation were far more complex and effortful than we had expected.

Data Analysis – Handover Performance Data

A global score with a range of 1 (not at all effective) to 5 (extremely effective) was used to rate each handover. A majority of the handovers were scored either 2 (somewhat effective, 55%) or 3 (moderately effective, 36%); thus, the global score was dichotomized into acceptable (≥ 3) and unacceptable (≤ 2) handovers. To examine the relationship between acceptable handovers and training status and study phase by location, two logistic regression models were created that controlled for the patient's age, gender, and ASA; the observer ID; and the amount of time the RN and AP had been on duty. Handovers missing any of the covariates were excluded from the regression analysis (n=4, 0.4%). These models differed by the definition of training status–the first used neither versus either trained, whereas the second used neither, AP only, RN only, or both trained. The study phase was grouped into three distinct categories: pre-training or baseline, after the training began, and after the refresher began. This was modeled using piecewise linear splines with knots located at the date of a phase transition. Due to instances in which an RN, an AP, or both performed multiple handovers, robust standard errors were used to characterize uncertainty.

An additional logistic model was created to relate the acceptability of a handover to the items of the evaluation tool. These evaluation items included introduction, readiness, SBAR items, content organization and clarity, confirming comprehension, level of engagement, and coordination/conflict resolution. Completeness of content was excluded, because over 90% of the responses for this item had a score of 2. Each SBAR item corresponded to the number of items checked within each category. This model then controlled for location, phase, and observer ID and utilized robust standard error estimates.

Differences between AP and RN responses to items of the self-evaluation form were calculated. The self-reported item that corresponded to the overall effectiveness of the handover did not coincide with the global score given by the observer; thus, the comparison between these items of was not performed. All analyses were generated in R, version 2.9.1.

Data Analysis–Communication Culture Survey (CCS)

The Communication Culture Survey is a 14-item instrument designed to assess the state of communication (ease, support, reception, etc.) among medical center staff members. It consists of two seven-item sections that inquire about staff interactions within the PACU and OR. Each item is scored on a scale from 1 ("strongly disagree") to 5 ("strongly agree"). The only identifying information collected included position (either AP, RN, or resident/CRNA) and primary work location (adult or VCH). Anesthesia providers completed both PACU and OR items, whereas RN respondents completed only the PACU-related items. To assess communication changes during the PACU handover study, this survey was administered at three time periods (pre-training, post-training, and post-refresher times) reflecting the start, middle, and end of the project, respectively.

For each survey period, a PACU and OR global score was created to summarize each survey section by averaging the PACU or OR items scores, respectively. Prior to the creation of these global scores, items that were originally phrased in a negative tone were adjusted by reassigning their scores on a scale of 1 ("strongly agree") and 5 ("strongly disagree"). This transformation allowed a straightforward calculation of each score and resulted in larger global scores being indicative of a greater positive response. Linear regression models were used to characterize the association between each global score and position, location, and time period. It was of interest to examine these effects within the categories of the others, so all two- and three-way interactions were included each model. Residual and quantile-quantile plots were created to assess the model assumptions. Due to the dependencies within the data (multiple responses by individual subjects), robust standard errors estimates were calculated. Expected global scores, and their associated 95% confidence intervals were used to summarize these models. The statistical significance of the differences between locations and positions within or across survey periods

was assessed using the Wald test at the two-sided α=0.05 level.

Results

Simulation-based Training

We provided initial simulation-based handover training to 237 PACU clinicians (36 anesthesiology residents, 74 CRNAs, six SRNAs, three sedation-team RNs, and 118 PACU nurses) and the refresher course training to 148 clinicians (40 anesthesiology residents, 35 CRNAs, and 73 PACU nurses). Despite reluctance to participate, particularly by more senior RNs and CRNA ("we've been doing this for years; why do we need to be 'trained'?"), as can been seen from the evaluations summarized in **Table 1**, the courses were VERY well received by the clinicians.

PACU Observations

Descriptive statistics for the observed actual PACU handovers are summarized in **Table 2**. Between July 2007 and November 2008, 981 handovers were observed: 389 at Vanderbilt's Children's Hospital (VCH), and 592 at the University Hospital (VUH). These handovers involved 226 physicians (AP) and 118 registered nurses (RN) and were observed by four independent reviewers or observers. The majority of the handovers involved unique AP/RN pairings (83%) and were primarily observed by a single trained observer. As expected, all handovers were conducted by untrained APs and RNs during the baseline phase. However, we note that a number of APs trained at VUH performed handovers during the baseline phase at VCH (19.5%). Handover durations, prior time on duty of the AP/RN, and observed patient characteristics were comparable within locations across the study phases. Acceptability of handovers increased across study phases for each location (7% to 70% in VUH and 22% to 73% in VCH).

Predicted probabilities of an acceptable handover were calculated from each regression model, given a referent set of parameters (a 6- (VCH) or 50- (VUH) year-old male patient with an ASA status of 2 and an AP/RN pair that have been on duty for 7.5 and 6.5 hours, respectively). Probabilities, and their 95% confidence intervals (CIs), corresponding to dates that were one fourth and three fourths the way through each phase were tabulated and plotted (**Tables 4** and **5**, **Figure 1**). Space was added between each symbol and vertical bar in the figure, but the plotted values correspond to one fourth and three fourths, as highlighted during the baseline phase at VCH. Comparisons with the baseline "neither" trained group and by training status are summarized in **Tables 3**, **5,** and **7**. Three main findings are noted upon review of these summaries. First, a large training effect is observed between the baseline and after training began phase within VUH (OR=34.7, 95% CI=11.5, 104.9, Table 3) and within the baseline phase at VCH (12.7 [6.5, 24.7]). This indicates that training had an impact on the acceptability of handovers. Next, the impact of training decreased over time, which demonstrates a change in culture when coupled with the increase in acceptability of handover among those AP/RN pairs where neither was trained (OR= 51.4 and 29.9 in the VUH and VCH, respectively; Table 4). Finally, AP-only handovers did not differ from those when both were trained (p values>0.1), and RN-only handovers did not differ from those when neither were trained (p-values>~0.1), which implies that the immediate impact of training is due whether or not the AP is trained.

Of the review items on the post-anesthesia handover evaluation tool, content organization/clarity (OR=365, 95% CI=76, 1760) and confirming comprehension (24 [7, 85]) had the largest estimated associations with the acceptability of a handover. Each SBAR item was also significantly associated with this value but with far smaller associations. Finally, **Table 7** shows that APs provided statistically higher self-evaluation ratings than RNs at both locations, but the magnitude of these differences was greater at VUH than VCH. The mean difference in overall ratings was 0.2 at VUH and was 0.1 at VCH, but, because these items were scored on a 1-to-5 scale, this difference may not be clinically meaningful.

Communication Culture Survey Results

In total, 552 surveys were completed. Of these, 71 (12.8%) were excluded due to either the respondent's location (non-VCH, non-VUH, n=55), position as an SRNA (n=15), or having multiple surveys in a single monitoring period (n=1). Regardless of position, location, and survey period, PACU and OR scores were generally >3.5, which indicated that the respondents agreed with the survey items. The unadjusted global scores increased throughout the monitoring period. The magnitude of both the PACU and OR scores were highest among faculty members followed by residents/CRNAs and then RNs. PACU scores were higher in the VUH locations than in the VCH, whereas the opposite relationship was noted for the OR scores. When the data were aggregated across location and position, the expected PACU global scores during pre-training, post-training, and post-refresher times were 3.83 (3.70, 3.97), 4.09 (3.98, 4.19), and 4.10 (4.01, 4.20), respectively. Compared with pre-training measures, these ~0.25-unit increases were statistically significant. Increases in scores were observed in all position/location subgroups except faculty members at VCH and RNs at VUH, but these decreases were not significantly different from pre-training measurements. Other notable increases from pre-training time included RNs at VCH (0.56 [0.23, 0.88]) and residents/CRNAs at VUH (0.37 [0.12, 0.63]). As with the PACU score, the OR global scores among all respondents increased over the survey period, but this increase was not significantly greater than what was observed at baseline. Similar patterns were observed in each position/location subgroup.

Comparison of Pre- versus Post-Training Simulated Handover Performance

We collected nearly 300 video recordings of handovers conducted by AP-RN pairs before simulation training (both VUH and VCH PACUs), immediately after simulation training (both PACUs), and before the refresher course training (VUH PACU providers only). These videos have now been reviewed and scored by a single blinded rater. Intra-rater reliability and validity anchoring were confirmed regularly throughout the data collection phase. The ratings data have been validated and entered into our database. We will examine individual clinician's handover performance under the three conditions (pre-training, post-training, and pre-refresher conditions) while adjusting for the participant's role (AP vs. RN), age, experience, and time since the training ended (for the pre-refresher period). Generalized linear mixed-effects models with the logistic link function will be used for analyses. To capture the effect of handover training, we will compare the covariate adjusted rates of acceptable handovers between the pre-training, post-training, and pre-refresher time periods using (simulation-based) likelihood ratio tests.

PACU Outcome Data

We have pulled from Vanderbilt's electronic medical record de-identified patient data for all patients who entered the VUH and VCH PACUs for a 3-month period before the study began (May-July 2007) and the same three calendar months after study conclusion (May-July 2009). The dataset includes patient demographics (age, gender, ASA status); surgical procedure; PACU admission vital signs; length of PACU stay; and the occurrence of shivering, nausea, vomiting, hypothermia, and uncontrolled pain.

Preliminary analyses compared the rates of shivering, vomiting, or nausea (SVN; a composite index), and the time recovering in the PACU between the pre-study (2007) and the post-study (2009) periods. Multiple logistic regression was used for the binary SVN endpoint, and multiple linear regression was used for the (log-transformed) time in the PACU endpoint. In both analyses, adjustments were made for potential confounders: ASA class (1, 2, 3, or 4), ASA emergency (yes/no), gender, age, and surgery duration. For the SVN endpoint, the odds ratio comparing the post-study period to the pre-study period was 0.49 (95% CI: 0.31, 0.77) at VUH and was 0.33 (95% CI: 0.11, 1.06) at VCH, showing strong evidence to suggest reductions in rates of SVN at VUH and consistent but (due to very low rates of SVN) weaker evidence for such reductions at VCH. For time in the PACU, there was weak evidence suggesting that patients at VUH spent more time in the PACU during the post-study period than in the pre-study period, with an adjusted 3.4 percent increase in the median length of stay (95% CI: 0.0, 7.2). However, at VCH, the trend was in the opposite direction. Between the pre-study and post-study periods, there was a highly significant, 9.1% (95% CI: 6.9, 11.2) drop in median PACU stay. Although these preliminary

results generally show improvements in PACU-related outcomes, we will not be able to determine whether these improvements were due to the handover project or to other changes in the patient population, surgical care, PACU care, or other unknown secular trends.

Use of Simulated Handover Videos for Training New Providers

We conducted 10 training sessions (n=39 providers; 15 new anesthesia residents, three new CRNAs, and 19 previously untrained PACU RNs). These sessions were identical to the prior 2-hour simulation-based PACU handover training in every way *except* that the four training scenarios were accomplished by viewing two video-recorded handovers.

Summary of Findings

We accomplished virtually all the project's objectives and generated important findings and products. We developed a comprehensive PACU handover improvement curriculum, consisting of a 45-minute modular multimedia webinar, handouts, simulated scenarios, faculty instructional materials, and training guides for the standardized clinicians. Lessons learned will guide our and others' development of simulation-based curricula, not just for handovers but more generally for improving clinicians' communication skills. We developed a valid and reliable tool to rate PACU handover effectiveness either in real time (actual handovers) or recorded onto video. We developed, refined, and deployed an electronic handover tool that was very well received by perioperative physicians, reinforced our training curricula, and is being used as a model for other eHandover tools at our institution. We successfully delivered the simulation-based handover training program to over 300 anesthesiologists, nurse anesthetists, and PACU nurses. The course received exceedingly high ratings, including from experienced providers who were quite skeptical of its value before attending.

We performed nearly 1000 observations of actual PACU handovers and demonstrated unequivocally that our intervention improved handover effectiveness. There were four primary findings. First, we found large effects of training with odds ratios of handover effectiveness pre- vs. post-intervention of 34.7 (95% CI of 11.5, 104.9) in the adult PACU and of 12.7 (CI of 6.5, 24.7) in the children's PACU. Second, as predicted, the impact of training decreased over time which, when coupled with the increased handover effectiveness by untrained AP/RN pairs over time (not predicted), suggests a handover culture change in the PACUs. We do not know if this finding is due to implicit training of new clinicians or other phenomena. Third, handovers for which only the AP was trained did not differ significantly from those when both AP and RN were trained, whereas handovers in which only the RN was trained did not differ significantly from those when neither provider was trained. This suggests that the immediate impact of training is in effect, whether or not the handover giver (AP) is trained. We cannot tell from this study whether this effect will generalize to all handovers or if it is due to differences in status between the handover giver (MD or CRNA) and receiver (RN) in this specific type of handover. Finally, with our scoring tool, observers' ratings of handover *content organization & clarity* (OR=365, 95% CI: 76, 1760) and of *confirming comprehension* (24, [7,85]) had the largest estimated associations with global handover score.

We found that, using the communication domain subset of the Safety Attitudes Questionnaire (SAQ), there were significant but small (~0.25 units on a five-point scale) improvements in the Communication Culture of the PACUs over the course of the study and that these were greater in physicians and in the adult hospital. The OR culture scores did not increase as much. We also found a small but significant improvement in short-term PACU outcomes (incidence of shivering, vomiting, or nausea) post- versus pre-study as well as a decrease in median length of PACU stay. We cannot exclude secular trends.

One aspect of the project is not yet complete: the statistical analysis of the blinded observer's ratings of the simulated handovers. Finally, we created video recordings of simulated scenarios and used these to train a separate cohort of PACU providers. Both the trainees' course evaluations and preliminary data on their simulated and actual handovers suggest that this may be a promising lower-cost alternative to the use of simulated clinicians.

Performance and Sustainability of Cultural Changes

Change is not easy, but when a culture embraces a common shared mental model, transitions to a new way of performing tasks have the potential for a more successful integration into practice. By the end of our study, untrained AP and RN providers often performed handovers as well as trained providers did. This strongly suggests that cultural phenomena were occurring in the PACU. Although not part of our formal observations, anecdotal evidence suggested that trained staff would informally train other providers through intra- and interdisciplinary mentoring. For example, clinicians taught their colleagues how to utilize the handover tool and how to provide or receive reports. This sort of acculturation reflects an individual's commitment to the organizational culture by embedding values in thought process and demonstrating through actions. Mentoring across disciplines is a significant indication that a unit's culture has shifted from a "we/they" to a more collegial team approach, with the patient as the central priority. Vanderbilt has attempted numerous "changes" and "interventions" in its PACUs, some with more success than others. Anecdotally, the handover improvement intervention seems to have had more traction and "stuck" better than many other change efforts. We do not know whether this apparent success is due to the multimodal nature of the intervention, the powerful common learning experience, the strong organizational signal of importance, or all of these.

Relevant Publications & Products During Project Period

Presentations

1. Slagle, J. M, Kuntz, A., France, D., Speroff, T., Madbouly, A., and Weinger, M.B.: Simulation Training for Rapid Assessment and Improved Teamwork: Lessons learned from a project evaluating clinical handoffs. Presented by Dr. Slagle at the 51st Annual Meeting of the Human Factors and Ergonomics Society (HFES) in Baltimore, MD, October 2007.
2. Kuntz, A., Bills, J.L. Developing e-learning from the perspective of two generalists: Technical demonstration. Presented by Dr. Kuntz at the Conference of Southern Group on Educational Affairs (SGEA) in Nashville, TN, April 2008.
3. Kuntz, A. H., Bills, J. Where there's a will, there's a way: Developing e-learning from the perspective of two generalists. Presented by Dr. Kuntz at MedBiquitous Annual Conference in Baltimore, Maryland, May 14, 2008.
4. Slagle, J. M., Kuntz, A., Speroff, T., France, D., & Weinger, M. B.: Assessing the Effects of a Simulation-Based Training Initiative on PACU Handoffs. Presented by Dr. Slagle at the Academy for Healthcare Improvement's (AHI) International Scientific Symposium in Nashville, TN, December 9, 2008.
5. Weinger, M. B., Slagle, J. M., Kuntz, A., Mercaldo, N., Peterman, D., Speroff, T.: A simulation-based handoff training initiative significantly improves the quality of actual PACU handoffs. Presented by Dr. Slagle at the International Anesthesia Research Society (IARS) Annual Meeting in San Diego, CA, March, 2009.
6. Arndt, R., Weinger, M. B., Slagle, J., Kuntz, A., Speroff, T., France, D: Improving communication and patient safety in the PACU. Presented by Becky Arndt at the Association of Perianesthesia Nurses National Conference, Washington, DC, April 19-23, 2009.
7. Weinger, M.B., Slagle, J., Kuntz, A., France, D., Speroff, T., Schildcrout, J., and the PACU Handover Improvement Team: A handover training and improvement initiative significantly improved the effectiveness of actual clinical handovers. Presented as a podium paper by Dr. Weinger at the Academy Health Conference in Chicago, IL, June 29, 2009.

8. Banerjee, A., Slagle, J., Kuntz, K.; Weinger, M. B., and the PACU Handover Team: The PACU Handover Project-A curriculum design. Presented by Dr. Banerjee at the International Conference on Communication in Healthcare (ICCH) in Miami, Florida, October 4-7, 2009.
9. Banerjee, A., Slagle, J., Kuntz, A., Weinger, M. B.: A handoff training and improvement initiative: The curriculum design. Presented by Dr. Banerjee at the American Society of Anesthesiologists Annual Meeting, San Francisco, California, October 8-11, 2009.
10. Arndt, R., Weinger, M. B., Slagle, J., Kuntz, A., Speroff, T., France, D: Simulation and improving communication and patient safety in the PACU. Presented by Becky Arndt at the Tennessee Simulation Alliance Conference, Nashville, TN, October 8-10, 2009.

Publications

1. Slagle, J. M, Kuntz, A., France, D., Speroff, T., Madbouly, A., and Weinger, M.B.: Simulation Training for Rapid Assessment and Improved Teamwork: Lessons learned from a project evaluating clinical handoffs. Proceedings of the Human Factors and Ergonomics Society 51: 668-71, 2007.
2. Weinger, M.B.: Experience ≠ Expertise: Can simulation be used to tell the difference? (editorial) Anesthesiology 107(5): 691-4, 2007.
3. Weinger, M. B., Slagle, J. M., Kuntz, A., Mercaldo, N., Peterman, D., Speroff, T.: A simulation-based handoff training initiative significantly improves the quality of actual PACU handoffs (abstract). Anesthesia and Analgesia 108 (2S): S113, 2009
4. Banerjee, A., Slagle, J., Kuntz, A., Weinger, M. B.: A handoff training and improvement initiative: The curriculum design (abstract). Anesthesiology 111: A1606, 2009.
5. Weinger, M. B. The pharmacology of simulation: A conceptual framework to inform progress in simulation research. Simulation in Healthcare 2010 (in press).

Table 1. Trainees' Evaluations of Simulation-Based Training Courses

Questions	**Initial Simulation-Based Course**				**Refresher Course**		**New Clinician Training Course (videos only)**	
Question	**VUH AP**	**VUH RN**	**VCH AP**	**VCH RN**	**VUH AP**	**VUH RN**	**VUH AP**	**VUH RN**
Quality of course content	7.5 ± 1.4	8.0 ± 1.0	8.0 ± 0.9	8.2 ± 0.8	7.1 ± 1.3	7.8 ± 1.1	7.9 ± 0.9	7.8 ± 0.8
Quality of your Experience	7.4 ± 1.5	8.1 ± 1.0	8.1 ± 0.7	8.2 ± 0.8	7.1 ± 1.5	7.8 ± 1.1	8.1 ± 0.8	7.9 ± 1.2
Instructors' facilitation of your learning?	8.1 ± 1.3	8.3 ± 0.9	8.4 ± 0.6	8.5 ± 0.6	7.6 ± 1.4	8.1 ± 0.9	8.3 ± 0.8	8.3 ± 0.7
How valuable to your future career?	7.5 ± 1.7	8.2 ± 1.0	8.1 ± 0.9	8.4 ± 0.7	7.1 ± 1.9	8.0 ± 1.1	8.1 ± 1.0	8.1 ± 1.1

Ratings on a 10-point scale from 0=worst to 9=best.

Table 2. Descriptive Summaries of Observed Handovers by PACU and Phase

	VUH			VCH	
	Baseline	**Post-Training**	**Post-Refresher**	**Baseline**	**Post-Training**
General					
Phase Dates	07/06/07 - 08/14/07	08/16/07 - 05/01/08	05/05/08 - 11/20/08	08/15/07 - 01/25/08	01/28/08 - 08/27/08
Handovers, n	70	338	184	200	189
Handover Duration, min	7.1 ± 8.3	6.9 ± 5.1	10.3 ± 53.0	5.9 ± 9.5	10.0 ± 52.8
AP/RN Characteristics					
Trained: Neither, %	100.0	23.1	9.8	80.5	10.6
Trained: RN Only, %	0.0	46.8	59.8	0.0	15.9
Trained: AP Only, %	0.0	7.1	8.2	19.5	16.4
Trained: Both, %	0.0	23.08	22.3	0.0	57.1
Hours on Duty, AP	8.8 ± 2.7	8.8 ± 2.6	7.8 ± 2.8	6.8 ± 3.0	8.0 ± 2.2
Hours on Duty, RN	6.9 ± 2.7	6.7 ± 3.3	5.7 ± 3.2	5.6 ± 3.2	6.6 ± 2.3
Patient Characteristics					
Age, years	46.9 ± 16.1	48.6 ± 18.3	50.0 ± 18.5	8.0 ± 6.0	7.0 ± 6.1
Male, %	55.7	60.2	57.6	62.3	61.9
ASA 1, %	8.7	7.4	7.6	24.0	31.8
ASA 2, %	44.9	41.1	38.6	55.5	48.2
ASA 3, %	46.4	47.0	48.9	18.0	19.1
ASA 4, %	0.0	4.4	4.9	2.5	1.1
General Anesthetics, %	92.7	91.7	90.8	99.5	99.5
Global Score					
Global Score	2.1 ± 0.3	2.4 ± 0.6	2.9 ± 0.7	2.2 ± 0.5	2.9 ± 0.6
Global Score≥3, %	7.1	34.9	70.1	22.0	72.5

Table 3. Probability of an Acceptable Handover (two-training status levels)

	Neither Clinician Trained		Either/Both Clinicians Trained	
	Probability	95% CI	Probability	95% CI
VUH				
Baseline: ¼	0.04	(0.01, 0.11)	---	---
Baseline: ¾	0.08	(0.04, 0.13)	---	---
Training/Post-Training: ¼	0.14	(0.08, 0.23)	0.30	(0.21, 0.40)
Training/Post-Training: ¾	0.25	(0.11, 0.48)	0.59	(0.49, 0.69)
Refresher/Post-Refresher: ¼	0.44	(0.23, 0.67)	0.70	(0.61, 0.78)
Refresher/Post-Refresher: ¾	0.68	(0.34, 0.90)	0.65	(0.52, 0.76)
VCH				
Baseline: ¼	0.11	(0.06, 0.19)	0.25	(0.14, 0.41)
Baseline: ¾	0.18	(0.11, 0.29)	0.61	(0.48, 0.73)
Training/Post-Training: ¼	0.41	(0.22, 0.62)	0.77	(0.68, 0.85)
Training/Post-Training: ¾	0.79	(0.38, 0.96)	0.77	(0.57, 0.90)

Table 4. Comparisons with Baseline/Neither Trained and Any vs. Neither

	Neither		Any		Any vs. Neither	
	OR (95% CI)	P Value	OR (95% CI)	P Value	OR (95% CI)	P Value
VUH						
Baseline: ¼	1.0	---	---	---	---	---
Baseline: ¾	2.0 (0.9, 4.4)	0.096	---	---	---	---
Training/Post-Training: ¼	4.0 (1.3, 12.6)	**0.019**	10.1 (3.3, 30.6)	**0.000**	2.5 (1.3, 4.8)	**0.005**
Training/Post-Training: ¾	8.0 (1.9, 34.3)	**0.005**	34.7 (11.5, 105)	**0.000**	4.3 (1.5, 12.3)	**0.006**
Refresher/Post-Refresher: ¼	18.9 (4.7, 75.5)	**0.000**	57.0 (19.1, 170)	**0.000**	3.0 (1.2, 7.9)	**0.024**
Refresher/Post-Refresher: ¾	51.4 (9.2, 286)	**0.000**	44.6 (14.6, 137)	**0.000**	0.9 (0.2, 3.8)	0.845
VCH						
Baseline: ¼	1.0	---	2.6 (1.9, 3.8)	**0.000**	2.6 (1.9, 3.8)	**0.000**
Baseline: ¾	1.8 (0.9, 3.7)	0.109	12.7 (6.5, 24.7)	**0.000**	7.1 (3.5, 14.4)	**0.000**
Training/Post-Training: ¼	5.5 (1.9, 16.0)	**0.002**	27.4 (12.3, 60.9)	**0.000**	4.9 (2.1, 11.3)	**0.000**
Training/Post-Training: ¾	29.9 (4.6, 196)	**0.000**	27.0 (9.1, 79.9)	**0.000**	0.9 (0.2, 4.9)	0.907

Table 5. Probability of Acceptable Handover (four different handover dyad training status levels)

	Neither		RN Only		AP Only		Both	
VUH	Probability	95% CI	Probability	95% CI	Probability	95% CI	Probability	95% CI
Baseline: ¼	0.05	(0.02, 0.11)	---	---	---	---	---	---
Baseline: ¾	0.08	(0.05, 0.14)	---	---	---	---	---	---
Training/Post-Training: ¼	0.15	(0.09, 0.24)	0.19	(0.12, 0.29)	0.74	(0.43, 0.91)	0.54	(0.36, 0.71)
Training/Post-Training: ¾	0.26	(0.11, 0.49)	0.49	(0.36, 0.62)	0.74	(0.52, 0.88)	0.72	(0.58, 0.83)
Refresher/Post-Refresher: ¼	0.45	(0.24, 0.68)	0.65	(0.53, 0.75)	0.68	(0.45, 0.85)	0.79	(0.66, 0.89)
Refresher/Post-Refresher: ¾	0.69	(0.35, 0.90)	0.63	(0.48, 0.76)	0.55	(0.22, 0.85)	0.80	(0.57, 0.92)
VCH								
Baseline: ¼	0.11	(0.06, 0.19)	---	---	0.24	(0.13, 0.40)	---	---
Baseline: ¾	0.18	(0.10, 0.29)	---	---	0.60	(0.42, 0.75)	---	---
Training/Post-Training: ¼	0.40	(0.21, 0.62)	0.39	(0.17, 0.67)	0.74	(0.59, 0.86)	0.83	(0.72, 0.91)
Training/Post-Training: ¾	0.77	(0.35, 0.95)	0.70	(0.39, 0.89)	0.71	(0.40, 0.90)	0.78	(0.56, 0.91)

Table 6. Comparisons with Baseline or Neither Trained

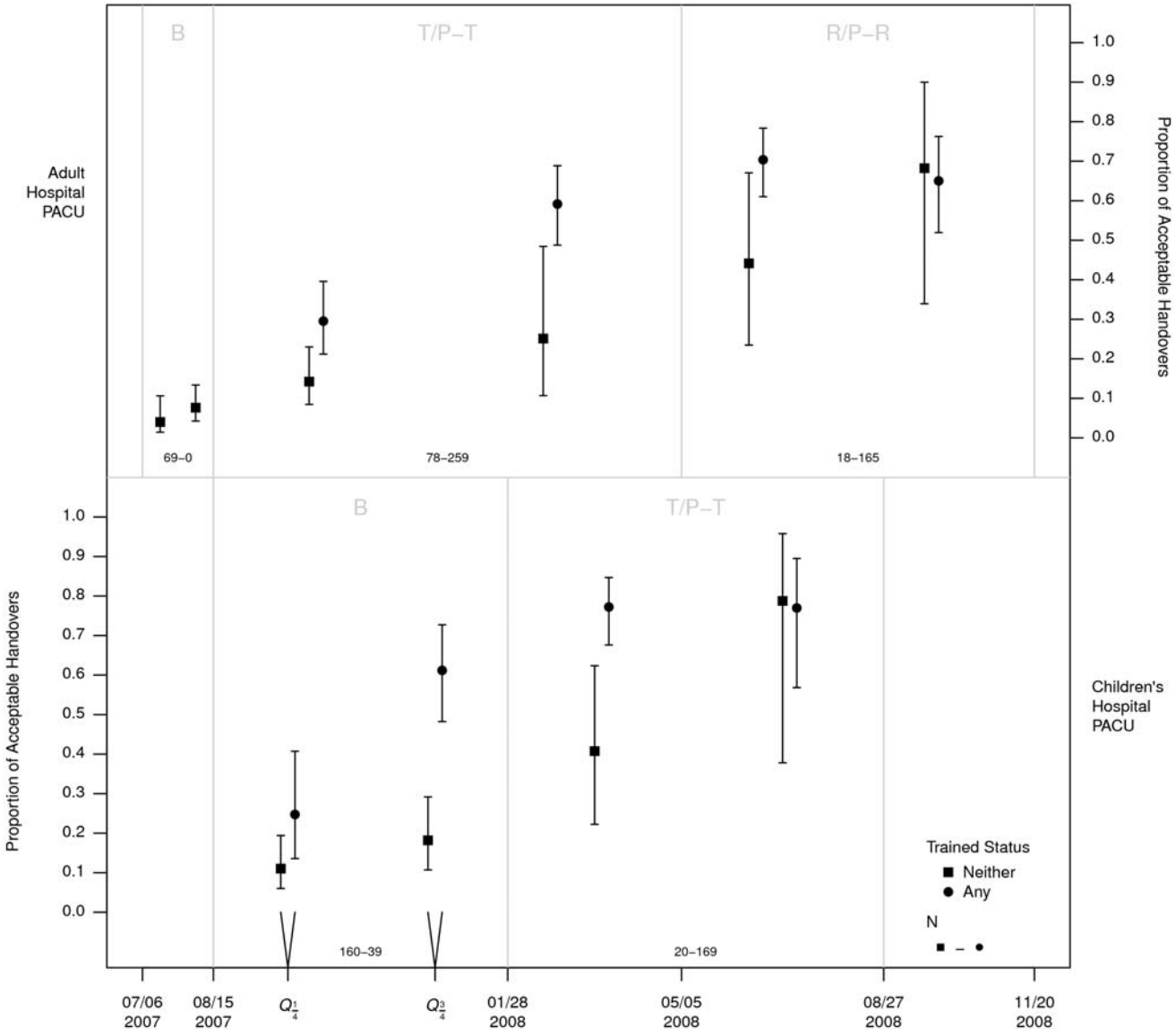
	Neither		RN Only		AP Only		Both	
VUH	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value
Baseline: ¼	1.0	---	---	---	---	---	---	---
Baseline: ¾	1.9 (0.8, 4.1)	0.124	---	---	---	---	---	---
Training/Post-Training: ¼	3.6 (1.2, 11.1)	**0.025**	4.9 (1.6, 15.0)	**0.006**	59.1 (11.9, 293)	**0.000**	24.8 (7.3, 84.0)	**0.000**
Training/Post-Training: ¾	7.3 (1.8, 30.4)	**0.006**	19.9 (6.5, 61.0)	**0.000**	59.3 (15.2, 232)	**0.000**	54.7 (17.2, 174)	**0.000**
Refresher/Post-Refresher: ¼	17.3 (4.5, 67.1)	**0.000**	38.8 (13.0, 116)	**0.000**	45.1 (11.3, 180)	**0.000**	81.3 (25.0, 264)	**0.000**
Refresher/Post-Refresher: ¾	47.2 (8.7, 257)	**0.000**	36.4 (12.0, 111)	**0.000**	26.2 (4.5, 152)	**0.000**	81.5 (19.1, 348)	**0.000**
VCH								
Baseline: ¼	1.0	---	---	---	2.6 (1.7, 3.9)	**0.000**	---	**---**
Baseline: ¾	1.8 (0.9, 3.8)	0.112	2.1 (0.5, 8.4)	0.312	12.3 (5.2, 29.3)	**0.000**	20.4 (8.9, 46.9)	**0.000**
Training/Post-Training: ¼	5.4 (1.8, 16.2)	**0.002**	5.4 (1.5, 19.4)	**0.010**	24.2 (8.9, 65.7)	**0.000**	42.0 (17.2, 102)	**0.000**
Training/Post-Training: ¾	27.1 (4.1, 178)	**0.001**	19.1 (4.7, 77.6)	**0.000**	20.1 (4.9, 82.9)	**0.000**	29.5 (9.1, 95.2)	**0.000**

Table 7. Handover Participant Self-Evaluations Summaries * by PACU †

	VUH	VCH §	ALL
AP Evaluations			
Overall, this handover was very effective	4.65 (4.64, 4.65)	**4.58 (4.58, 4.59)**	4.62 (4.62, 4.62)
I have worked with the other clinician many times previously	3.22 (3.21, 3.23)	**3.72 (3.71, 3.72)**	3.42 (3.41, 3.42)
I was under a great deal of time pressure during the handover	1.80 (1.79, 1.80)	**1.89 (1.88, 1.89)**	1.83 (1.83, 1.83)
The other clinician was very responsive to my needs	4.68 (4.67, 4.68)	**4.58 (4.58, 4.58)**	4.64 (4.64, 4.64)
RN Evaluations			
Overall, this handover was very effective	4.45 (4.44, 4.45)	**4.51 (4.51, 4.51)**	4.47 (4.47, 4.47)
I have worked with the other clinician many times previously	3.04 (3.03, 3.04)	**3.61 (3.61, 3.62)**	3.27 (3.26, 3.27)
I was under a great deal of time pressure during the handover	1.56 (1.55, 1.56)	**1.78 (1.77, 1.78)**	1.64 (1.64, 1.65)
The other clinician was very responsive to my needs	4.42 (4.42, 4.43)	**4.49 (4.49, 4.50)**	4.45 (4.45, 4.45)
AP-RN Evaluations ‡			
Overall, this handover was very effective	0.20 (0.20, 0.20)	0.09 (0.08, 0.09)	0.15 (0.15, 0.16)
I have worked with the other clinician many times previously	0.18 (0.17, 0.19)	0.09 (0.08, 0.09)	0.14 (0.14, 0.15)
I was under a great deal of time pressure during the handover	0.24 (0.23, 0.24)	0.11 (0.10, 0.12)	0.19 (0.19, 0.19)
The other clinician was very responsive to my needs	0.25 (0.25, 0.26)	0.10 (0.09, 0.10)	0.19 (0.19, 0.19)

***** Participant clinicians' self-rating after handover completion using a scale of 1 (strongly disagree) to 5 (strongly agree)
† Mean (95% CI)
§ Items in bold font indicate statistically significant difference, VUH vs. VCH.
‡ Items in italicized font indicate statistically significant difference, AP vs. RN.

Figure 1. Time-trend Plot by PACU, Phase and Training Status (two levels)



Literature Citations

Available upon Request