In Situ Simulation for Systems Testing in Newly Constructed Perinatal Facilities

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Macro-systems simulation is a methodology to assess existing services and support major culture shift to a new healthcare environment. Given credible local precedent, simulation can be effective for orienting staff, identifying process gaps and enabling their refinement prior to the transition. Select strategies enable staged process translation in an intensive care unit without exposing patients to potential risk. Orchestrating immersive, realistic in-situ simulations minimizes surprises at transition and enhances patient satisfaction. Such endeavors substantially elevate the perception of the value of simulation within an institution.

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Many stressors affect organizational change in an intensive care environment,1 particularly when transitioning to a new facility. The sensitive management of such change is difficult because few individuals have in-depth expertise in patient care, health care facility design and construction, as well as organizational management. Facility designers can bridge the gap by exploring similar facilities with local clinician-based workgroups.2 Roundtable discussions can generate conceptual frameworks for translating an intricate overlay of hospital processes to the new environment. However, unexpected speed bumps inevitably arise throughout the implementation. Some of these surprises are discoverable beforehand with the use of simulation. Scenario-based simulation has become a standard methodology for orientating staff and modeling team performance.3 The same techniques can be used for hospital systems testing. Health care systems may be studied as complex interactions of people and processes.4 These may be analyzed at the microsystems level, such as team performance on a local task, through the macrosystems level, which may include interactions of departments within a hospital or even between facilities within a hospital system. Transitioning an intensive care unit to a new facility benefits from a macrosystems approach by refining processes, translating existing workflows to a new arena, and minimizing latent hazards. Full-scale immersive simulation, by creating the macrosystem in its expected future form, gives clinical experts the opportunity to prepare for the transition with previously inconceivable insight.

Background

Women and Infants’ Hospital, Rhode Island’s regional high-risk maternal and neonatal referral center, recently opened the nation’s largest single family room neonatal intensive care unit (NICU). The new NICU is 5-fold larger, separated onto 2 floors, and changed from a bay-type model to single family rooms, enabling parents to be at the bedside 24 hours per day. Transition to this new floor plan presented many challenges: multidisciplinary care teams struggled with the effectiveness of old processes in a new environment; previous nurse practitioner coverage became insufficient; an electronic medical record had to be implemented. Existing practices interfacing with a host of other departments, such as laboratory and radiology, had evolved over generations of caregivers. As individual practices relocated to the new environment, the previous redundancy that enhanced patient safety became an unknown. To address these challenges, TESTPILOT NICU—Transportable Enhanced Simulation Technologies for Pre-Implementation Limited Operations Testing in the NICU (unpublished data)4—was implemented to test the integration of specific practices into the new NICU environment prior to moving in patients and staff. Its successes

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were in the context of growing institutional acceptance of simulation.

**Establishing the Milieu: Pre-TESTPILOT**

Although the validity of simulation within health care has grown globally during the past few decades, adoption of microsystems testing within a given institution is unlikely without first establishing local precedent. Credibility within the institution, paralleling the development of simulation education skill sets, evolves over time. Consistent advocacy by hospital management is essential for a growing simulation program.

Our institutional stage was set over 5 years of incremental exposure to simulation, progressing from laboratory research to educational outreach to serial microsystems testing. Debriefing expertise was built in conjunction with colleagues at the Rhode Island Hospital Medical Simulation Center, while researching retention of neonatal resuscitation procedural skills and team behaviors. Mock drills in the NICU, once sporadic and halfhearted, became routine and time-pressed. Obstetrical emergencies also became routinely drilled by the use of simulation. Great strides towards acceptance of the methodology were made during MedTeams® training of operating room and labor and delivery staff to facilitate teamwork behavior. The historical focus on staff education became more blended with process improvement. Simulation became regarded with great passion by key advocates, and, at a minimum, reluctant acceptance throughout the institution. Repeated practice in the smaller venues had primed the institution so when questions arose about patient safety after moving to the new facility, the only obvious answer was TESTPILOT.

**Macrosystems Simulation: TESTPILOT NICU**

There are decades of experience in health care for adverse event analysis and medical device design via the use of microsystems simulation. Human factors have been evaluated for pediatric sedation teams and transport helicopter environments. Simulated disasters have been used to test hospital surge capacity, and code teams have been oriented. New emergency rooms have been tested, but the scope and complexity of TESTPILOT NICU was unprecedented in the literature. A functional intensive care unit was simulated before its opening. The aims were to assess translation of existing processes to the new NICU, to minimize patient risk exposure, to allow personnel from all shifts to explore the new NICU, and to integrate solutions, gathered from TESTPILOT-NICU, into the orientation workshop for all staff.

Extensive organization was required to bring the whole program together. Scenarios were scripted by a multidisciplinary team on the basis of specific learning objectives, setting the stage with commonly encountered clinical situations. Six simultaneous scenarios were designed to push the envelope without being absurd, challenging providers to truly test the system under stressful conditions.

Simulation sessions were scheduled to allow all staff to be involved and yet yield timely results. If the testing had occurred too early in the construction schedule, individual systems would not be fully functional. Scheduling the sessions too late to would make it impossible to correct problems identified before the patient move date.

Participants were recruited from all shifts and specialties, enticed by the opportunity to explore the new NICU. Ten rooms were stocked with supplies and standard equipment and staged with monitors, hybrid paper charts for orders, and an active electronic medical record to mimic routine documentation. Adaptations had to be made for the evolving functionality of these, as well as the wireless communication devices. These walkie-talkie devices were supposed to enable sending laboratory results directly to the provider, but were not initially programmed, for simulation purposes results were simply delivered on a piece of paper. Low through high-fidelity mannequins were placed as appropriate to the scenario, although the bulk of the simulation realism was defined by the environmental cues and confederate staff. After orientation to the facility, multidisciplinary teams settled into each room. The study facilitator “confederates” introduced assignments, and allowed teams to explore the vignette over two progressive simulations, each followed by debriefing.

The response to TESTPILOT was overwhelmingly positive. Nurses, physicians, respiratory therapists, radiology and laboratory technicians, assistant nurse managers, neonatal nurse practitioners, secretaries, and other hospital staff participated. Most cited high impact on their practice, and their action substantiated their words as each session generated another wave of volunteer confederates. Participants generated constructive data during the debriefing process, identifying numerous latent safety threats. Where difference of opinion persisted, retesting in the simulation environment became the tie breaker. Practice change was documented for the majority of issues by move day, largely spontaneously once simulation made the threat obvious.

Staff closest to the process made the changes rather than by top-down corrective measures. Debriefing was richer and subsequent changes were readily adopted because of the deliberate focus on discovery. The findings were used to either retool processes or tailor staff training workshops, both of which led to better preparedness and patient safety.

In addition, patient satisfaction showed marked epoch improvement, as measured by Press Ganey survey. Overall facility rating among comparable training institutions shifted from 20th to 50th percentile to the 99th percentile after transition, suggesting that the move to more appealing surroundings was not accompanied by a decrease in the quality of care provision.

TESTPILOT’s success resulted from widespread and interdisciplinary support from risk and facilities management, information technology, and nursing education. Repeated practice smoothed scenario flow. Participant vesting in simula...
tion correlated with the most insightful patient safety discoveries and staff preparedness. Commitment was boosted by the passion of NICU leadership as frontline participants, as well as by engaging clinicians through realistic patient care scenarios, including stressed “parents.” Debriefing focuses on process improvement rather than clinical skills created a less-threatening environment for all participants. People shared openly, and this debriefing material became the core for staff orientation workshops. Using mannequins before the transition, our understanding of real and specific patient safety risks expanded greatly, without putting neonates at risk. By the time move day came, we were collectively so far into our comfort zone, most of the focus was on the physical transport rather than durable patient care.

A Simulation Program: Post-TESTPILOT

After its success on the main stage, simulation’s hospital-wide demand has outstripped our ability to support it. Thirty-five supported events in 2009 became 106 in 2010. Department champions are supported to perform scenario development, in situ implementation, and facilitated debriefing. Applications include facility renovations, protocol development, security drills, computerized order entry, and transportation system development.

When obstetrics was faced with the possibility of moving an adult Acute Monitoring Service farther from the operating arena, simulation was used to evaluate staff response times and ergonomics in the new room location. Simulated scenarios clarified optimal furniture and equipment floor plans, identified supply and ancillary service deficits, and defined ergonomic placement for shelving, sharps box, oxygen supply and monitors. Staff response and patient mobilization times were adequate, which enhanced buy-in for the renovation. Following upon another set of simulations, obstetric management of post-partum hemorrhage at WIH has been re-evaluated. Our Massive Blood Transfusion protocol triggers, staff roles, communication processes and blood bank workflows have been redefined. An improved response to this crisis has been documented on several events. Opportunities to reduce complications of shoulder dystocia have been found during drills with a strain gauge simulator. Simulation of the massively obese patient is being used for management of the fallen patient using a mechanical hoist.

Ongoing systems testing with simulation in the NICU includes fire evacuation and child abduction drills, identifying unexpected security gaps. New policies are implemented with the simulation methodology, such as thermoregulation and reducing oxygen exposure in the extremely low birthweight neonate. During implementation of computerized physician order entry system, simulation again promoted process improvement. Computerized physician order entry sets were recursively improved with testing on simulated patients by multiple providers, bringing clarity to new communication processes among providers, nutritionists, and pharmacists.

In addition to monthly in situ mock codes, we simulate neonatal transports between hospitals for both systems testing and staff training. This program was central to the development of a centralized nationwide Neonatal Transport System in Kosovo. After the initial program development and equipment preparation, patient transports were simulated between tertiary and regional hospitals in Kosovo. Processes were created for real-time medical control by qualified physicians, communications and dispatch capability from intake through call-back, and multidisciplinary direction to include nursing. The community staff practice stabilization, the tertiary transport team troubleshooting mechanical and physiological complications, and all practice their communication and teamwork behaviors. In addition, best of all, they learn the usefulness of simulation as a methodology for systems testing and for maintaining the proficiency of their transport staff.

Summary/Conclusions

With extensive coordination, large scale simulation improves understanding of the overlay of systems smooths integration of processes, and promotes patient safety. Macro-systems simulation can generate core momentum for a simulation program. Precedent with micro-systems simulation is a key ingredient—stakeholders’ familiarity can make or break the overall momentum. However, technology is important only to the extent it enhances realism. A technology that draws participants into their native roles helps them forget they are “playing”, at which point they start discovering. So go in situ. Simulate vital signs on familiar monitors, with visual and auditory cues. Incorporate informatics into simulation similar to the routine documentation, retrieval or order entry. Only integrate high-tech mannequins as needed to demonstrate specific pathophysiology at the bedside; most scenarios progress well with simple mannequins.

The TESTPILOT methodology may not be generalizable to other transitioning healthcare institutions. Abbreviated applications in other departments in other institutions have yielded proportionate results. The optimal scale for macro-systems simulation likely differs in high volume academic tertiary referral centers compared with smaller community hospitals. The effectiveness of TESTPILOT in other environments remains to be tested.

References