Technology Target Studies: Technology Solutions to Make Patient Care Safer and More Efficient

AMERICAN ACADEMY OF NURSING WORKFORCE COMMISSION MONOGRAPH

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I. Executive Summary

In 2000, the Workforce Commission of the American Academy of Nursing (AAN) was charged with developing unique strategies for dealing with existing and future nursing workforce shortages. At that time, a massive nursing shortage had developed — prompted by both a shortage of trained nurses and burgeoning demand for nursing services. Clearly, public health was threatened.

The Workforce Commission acknowledged that many groups were addressing the issue, and focused its own efforts on how patient care demands could be managed — particularly through technology — to reduce stresses, physical strains, and inefficiencies of work and workflow for nurses. Technology was seen as a way to create efficiencies that would enable nurses to meet patient needs more effectively and efficiently, resulting in safer patient care.

In mid-2002 the Workforce Commission began identifying technologies that could improve the practice environment. An invitational, multidisciplinary conference entitled "Using Innovative Technology to Enhance Patient Care Delivery" was held to assess the existing nursing delivery system relative to predicted workforce availability and to envision and describe a future nursing care delivery system. The 115 attendees identified five preferred scenarios, along with action plans to achieve those goals:

1. Provision of patient specific information which is accessible at the site of services.
2. Interactive point of care technologies for care givers and patients.
3. Technology that improves medication processes.
4. Best practice models immediately available across all care settings.
5. Efficient inpatient care environment that responds to issues of trust, responsibility and accountability.

The Commission focused on two primary objectives:

1. Gaining better patient and provider interaction which would result in better outcomes, more efficiency and improved patient and employee satisfaction, and
2. Using technology to provide the right information to the right people at the point of care, automating non-direct delivery processes, and re-structuring the care environment.

Conference participants indicated the two priority action steps needed to reach the desired states were:

1. Comprehensive, universally available, integrated patient records.
2. Technology assisted medication use processes.

Based on recommendations from conference participants and the Workforce Commission, the Academy focused subsequent Workforce Commission efforts on:

- Research into the state of technology that impacts nursing care, to identify the gaps between existing and desired capabilities, and
- Partnering with the technology industry to develop commercially available technologies to enable redesigned nursing practices.

Subsequently, the Workforce Commission developed and tested the Technology Drill Down (TD2) process to identify technologies that would reshape practice environments. This took place at three sites: University of Virginia Medical Center, Kaiser Permanente Orange County Medical Center and Cedars-Sinai Medical Center.

The two-day TD2 process focused on medical/surgical unit workflow from a systems-wide perspective. The process engaged an interdisciplinary group of 20–30 participants that could include nurses, unit clerks, pharmacists, materials managers, information technology specialists, social workers and respiratory therapists. Participants first identified tasks that might be better-facilitated by technology. Workflow was examined with an eye toward improvements that technology might bring.

Many similarities in workflow processes were identified at the three TD2 sites. There were also many detailed areas specific to each site, where additional study and workflow process modification could lead to changes in the work environment. At all three sites, the leading workflow process concern was in streamlining and enhancing multidisciplinary communications.

The second concern at all three sites was improving supply chain functions such as those associated with materials distribution and medication management. Each group identified enhancements to improve speed and enhance accuracy of medication fulfillment, simplified access with dispensing machines, electronic charting, inventory control, alerts, and improved safety across the medication cycle.

The three interdisciplinary teams generated 400 ideas for developing and testing technology over the following three to five years. The ideas were categorized into potential technology applications:

- Integrated electronic medical record across the continuum of care.
- Electronic medication systems to facilitate ordering, administration, evaluation and medication reconciliation across the continuum of care.
- Staff scheduling system (accessible both at work and at home) to facilitate control over schedules and minimize errors, also allowing staff to obtain report remotely and participate in patient care planning.
- Equipment and supplies connected to tracking and deployment systems.
- Voice over information systems.
- Wireless and voice-activated systems for patient care and documentation.
- Technology to support patient activities of daily living, nutrition, mobility and hygiene.
- Rooms designed to support care delivery, prevent patient and staff injury, patient and family education and communication.
- Non-invasive, wireless patient care monitoring systems.
- Enterprise wide patient scheduling systems.
- Multilingual wireless communication systems
- Provision within all systems of alerts, embedded evidence based protocols and evaluation properties linked to a data repository and accessible across the continuum of care.

In April 2005, the Workforce Commission and the American Organization of Nurse Executives (AONE) discussed those findings with representatives of leading technology companies. More than 60 technology companies had been invited. The Commission shared a general review of the three technology drill downs and answered questions.

Company representatives responded positively to the information, indicating they found the TD2 process interesting and compelling, but asked that more research and analysis be conducted.

Funding that additional work was a formidable challenge, but in November 2005, the Robert Wood Johnson Foundation provided financial support for Technology Drill Downs at 25 acute care hospitals. The goals were to 1) improve the process for identifying technological solutions to medical/surgical unit workflow inefficiencies, and 2) accumulate a wealth of data that, coupled with a findings-dissemination process, would capture the attention of industry and prompt development of workflow-enhancing technologies.

Outcomes from the Technology Targets project included development of functional requirements for new or revised technology products emerging from TD2 and a DVD describing the TD2 process. Major project activities included:

- Implementing a Technology Drill Down or TD2 process within at least 25 acute care settings.
- Creating an Advisory Committee/Coalition comprising AAN, AONE, RWJF, industry and other health care organization representatives to decide upon optimal strategies for ensuring that increasing numbers of hospitals embrace the TD2 and TCAB/PDA models and that project findings result in the development of useful technologies.
- Posting, publishing and disseminating a report that analyzes and evaluates the TD2 outcomes.

TD2s were conducted at the 25 sites nationwide between March 2006 and May 2007. The majority of hospitals were in urban areas, with 250 or more beds. At those facilities 40 percent of nurses, physicians and other staff used paper or manual charting. Only three percent of units had complete electronic health records (EHR) and less than 20 percent had partial EHRs. Few stored medications or supplies close to patients.

During the TD2, participants named workflow categories that needed to be changed to have an ideal work environment. A total of 327 statements were analyzed and eight workflow categories were identified:

- Admission, discharge, transfer
- Care coordination
- Care delivery
- Communication
- Documentation
- Equipment & supplies
- Medication
- Patient movement

As a second step in the TD2, participants pinpointed descriptive statements about process issues for each of the workflow categories needing change. There were 766 unique statements analyzed, revealing 41 key concepts describing the process issues.

Ten key concepts referred to most frequently in the process issue statements were safety, documentation, information access, inconsistent process, workload, intrateam communication, orders, systems integration and data entry. A matrix linking process issue key concepts to workflow categories revealed six key concepts that occurred in all eight workflow categories: communication, documentation, emotional response, safety, system integration and waste.

Nineteen of the 41 key concepts were listed in more than half of the eight workflow categories. Results indicated many common process issues and workflow categories exist across nursing units participating in the TD2s.

From the TD2 participants, analysts identified almost 600 unique descriptions of technological innovations that could significantly improve patient care. The most frequently cited categories were information systems, devices, and hardware. Bedside, order entry, and electronic medical records (and clinical information systems) were listed most often as the specific types of technology needed. Overwhelmingly, participants called for integrated, voice-activated and handheld systems. The suggested technology solutions most frequently impacted the functions of documentation, medication and communication.

The multi-phase Technology Targets projects produced requirements for current and future technology needed to improve practice environments. There are four main outcomes of suggested technology:

- Eliminate work
- Provide access to resources
- Accomplish regulatory work
- Efficient use of space

In summary, **nurses want** specific characteristics in technology solutions.

- **Systems to provide tracking, documentation, and communication.**
- **Integrated systems with interoperability.**
- **Needed functionality that eliminates "work-arounds".**
- **Features of voice activation, hand-held capability, "smartness", and bedside availability.**

The following statements are supported by findings from the Academy's seven years of work identifying technology targets:

- Improving the practice environment is essential to retaining nurses, providing safe patient care and increasing the direct time nurses spend with patients.
- Using the TD2 process, facilities can identify inefficient and burdensome workflow processes in their institutions that could be improved with technology.
- Nursing-Technology development partnerships are vital for redesigning our future practice environments.

One of the most important insights and recommendations from this work is the need to incorporate the perspectives of nurses when designing systems and making purchasing decisions. Without this input, technology systems may not achieve the goals of maximizing productivity, reducing demand, promoting safety and improving quality of care. Limiting input into technology systems to the C-Suite alone, and not including the users and frontline providers, could lead to expensive, inefficient and cumbersome workflow processes.

Nurses no longer want to be passive consumers of technology. This is a great opportunity for health care providers, direct care providers and technology vendors to partner around developing better functionality for electronic and information systems and devices used in care delivery.

II. Introduction to the Problem

In 2000, the American Academy of Nursing formed a Workforce Task Force, later designated as the Workforce Commission (Appendix A, Workforce Commission), to develop unique strategies for dealing with existing and future nursing workforce shortages. Workforce Commission members include nursing executives, deans, faculty and managers at esteemed organizations and institutions. The Workforce Commission used both face-to-face and virtual meetings to strategize on ways to impact the increasing demand being placed on nurses in acute care environments.

It was well documented that although nursing had experienced previous shortages, the events of this decade were considered different and were anticipated to be far-reaching, threatening the public's health. The differences were thought to be due to facts that the population in general is aging and requires more intensive and complex nursing care, nursing care providers are themselves aging and forced to leave their positions due to increased physical demands, and younger individuals are not as readily selecting nursing as a career. Another factor is that patients are hospitalized for shorter periods of time, requiring a much higher level and intensity of nursing care while they are hospitalized. Another way to state the problem is that the difference in this shortage can be attributed to underlying factors related to both shortages in supply and increases in demand. For the past decade many organizations, governmental agencies and health policy makers began to work on the supply side of the nursing shortage by increasing enrollments in nursing schools, launching media campaigns to inform individuals about the vast variety of nursing roles available in a nursing career, to entice younger individuals into nursing, and to lobby for and establish scholarship funds or loans for potential nursing students and nursing faculty.

The Workforce Commission acknowledged the efforts of others and decided to focus on how the demands of patient care could be influenced, particularly by technology, to reduce stresses, physical strains, and inefficiencies of work and workflow that nurses experience daily. Studies have repeatedly shown that a significant portion of registered nurses in hospitals spend up to as much as 40 percent of their time in non-direct care. Insufficient effort has been directed toward remedying this through the development and/or application of suitable technologies. Technology is viewed as tools, machines, instruments and appliances, all seen as physical devices of technical performance. The Commission was clear that although information systems are part of technology, other devices also needed to be considered for reducing demands on nurses' non-direct care time. Commission members believed that technology could be used to create efficiencies that would enable the work of nursing to meet the needs of patients more effectively and more efficiently.

III. Phase I, Invitational Conference

Using Innovative Technology to Enhance Patient Care Delivery

In July 2002 the Academy and its Workforce Commission began the first phase of efforts to address the demand side of what then loomed as a serious nursing shortage. An invitational, multidisciplinary conference was sponsored to determine how technology could ease the demand on nurses' time and make their work more effective. Working with consultants and futurists, conference participants explored possible technologies that could be used to redesign nursing practice and care delivery environments to meet patient care demands more efficiently and effectively. The conference was designed to specifically 1) assess the existing nursing delivery system relative to predicted workforce availability and 2) define a future nursing care delivery system. Attendees were asked to consider how technology might be deployed to create an ideal care delivery system or work environment within five to ten years.

The conference's 115 attendees represented national associations, regional and local health care provider organizations, government agencies, clinicians in direct care delivery, equipment suppliers and medical system vendors. To provide input from frontline clinicians, nurse managers attending the conference were asked to bring a direct clinical care provider (e.g. staff nurse) with them. More than 30 associations were represented at the conference and included nursing, health, and non-health organizations (Appendix B, Associations). Conference funding was provided by major professional organizations, health delivery systems, medical information system vendors, equipment vendors, academic and research entities, governmental agencies and foundations (Appendix B, Sponsors).

The keynote speaker — Robin A. Felder, PhD, Professor and Director, Medical Automation Research Center, University of Virginia — provided a vision of a technology- assisted work environment that improves practice and patient care outcomes. Participants broke into groups for a preliminary discussion of ideas for making nursing practice more efficient through technology. Interactive sessions were facilitated by Nellie O'Gara, President/CEO of Health eSolutions, Inc.

Ed O'Neill, PhD, Director, Center for the Health Professions, summarized supply and demand side data on workforce shortages and implications for health practice and policy. A multidisciplinary panel looked at existing technologies and how they might be improved or augmented. Panel members included Thomas M. Priselac, President and CEO, Cedars Sinai Health System, Jeff Rose, MD, Chief Medical Officer, Cerner Corporation, Carol Bradley, MSN, RN, Regional Vice President & Editor, Nurseweek, Richard Kremsdorf, MD, President, Five Rights Consulting, Inc. and Sara White, RPH, Director Pharmacy Services, Stanford Hospital and Clinics. Papers presented to conference attendees were published as a supplemental section in the May/June 2003 issue of *Nursing Outlook* (Volume 51, Number 3, pages S1-S42).

Later, participants were divided into ten work groups to address specific topics relative to the use of technology in direct patient care. Each work group heard a presentation about their topic from an industry expert before starting to work. The topics and experts were as follows:

- Using technology to improve patient safety and quality — Don Parsons
- Using technology to improve operational efficiency and effectiveness in interdisciplinary practice — Richard Kremsdorf
- Using technology to improve medication use processes to decrease errors — Sarah White
- Using technology to promote community health and personal "e-health records" — Kathryn Bingman
- Using technology to create work environments and decreasing redundancy — Dennis Gallant
- Using technology to improve practice environments through simulation — Audrey Nelson
- Using point of care technology to improve workforce productivity through automation — Mikella Streicher
- Using technology to improve operational efficiency through elimination of waste and redundancy — Joyce Sensmeir
- Using technology to support workflow management — Rosemary Kennedy
- Using technology to improve point of care technologies — Gary Jollon

The goal of each work group was to envision a nursing practice and care delivery environment where the available workforce meets patient care demands safely and adequately. This included defining a "desired state" and identifying an action plan to achieve it. Group members were guided through a six-step exercise, known as an interactive planning model, by

a facilitator. The six-steps were:

Exercise #1: Clarify Dimensions of Nursing Practice and Care Delivery Environment

Exercise #2: Define the Desired State of the Assigned Dimension

Exercise #3: Define Key Success Measures

Exercise #4: Identify Challenges to Success

Exercise #5: Outline Recommendations for Overcoming Challenges

Exercise #6: Prioritize Action Steps

A comprehensive report (Appendix B, Work Group Reports) was prepared by each group using a predetermined format for submission to the Academy for incorporation into the plan for a future state. Findings and recommendations from each group were abstracted for presentation to all participants at the concluding session.

Also at the conference, Michael Shabot, MD, FACS, Medical Director, Enterprise Information Services, Cedars Sinai Medical Center outlined strategies for implementation and evaluation of innovative technology-assisted practice improvements. Participants were provided with a brief overview of each desired state and the action plans for each work group topic. Using an interactive keypad voting process, participants voted on their level of agreement with how each desired state would provide needed efficiencies and ultimately enhance patient care. Key findings for the ten work groups were published in the May/June 2003 issue of *Nursing Outlook* (Volume 51, Number 3, pages S39–S41) and are presented in this document.

Through this process, five preferred states and their action plans were identified:

1. **Provision of Patient Specific Information which is Accessible at the Site of Service**

   Characteristics of desired state:

   - Comprehensive, interactive longitudinal electronic medical record across the continuum of care, with core data elements for patients, clinicians and sites which is available immediately and universally.
   - System infrastructure supporting both individual and public health management systems.
   - Centralized data repository that permits the "care" environment to be anywhere people need care.
   - Data repository supported by decision support technology.
   - Technology-based patient and user identification system.
   - Data acquired via passive and active technology and merged with other current and historical data.
   - Data collected from multiple data sites and resources and formatted in a user-friendly format.

2. **Interactive Point of Care Technologies for Care Givers and Patients**

   Characteristics of desired state:

   - Easily transported device for data input and output of information with warnings, alerts and prompts.
   - Next generation nursing tool combining cell, pager and call bell; confirms orders, and reacts to alarms.
   - Smart equipment and devices plug into database and link back to nursing tool.
   - Electronic device data upload of real time information.
   - Automatic and intelligent systems that activate decision and therapeutic systems with predetermined and predefined notification systems, facilitating response to patient problems and relieving the nurse of many non-value communication tasks.

3. **Technology that Improves Medication Use Processes**

   Characteristics of desired state:

   - Availability of drug when it is needed.
   - Proximity of drug to patient.
   - Medication administration designed and delivered within the context of other real work.
   - Automated delivery.
   - Standardized packaging that covers doses needed for all age groups.
   - No clinical handwriting; provider doses direct electronic entry.
   - Event data systematically analyzed, shared and learned from.

4. **Best Practice Models Immediately Available Across All Care Settings**

   Characteristics of desired state:

   - Use of simulation technology to learn and test a variety of "what if?" situations and human dynamics in the care environment. Simulation is the educational vehicle of choice for clinical, environmental, interpersonal and team dynamics learning. Simulation technology is the first step for evaluating a proposed change, replacing trial-and-error and avoiding unintended consequences of change.

- Applying simulation for education and competency testing has improved outcomes for patients, nurses and interdisciplinary team relationships.
- Patient care practice models include models of patient care staffing.
- Computerized evidenced based guidelines.
- Clinical decision support.
- Public policy and regulatory agencies responsive to institutions' technology needs.

5. **Efficient Inpatient Care Environment that Responds to Issues of Trust, Responsibility and Accountability**

   Characteristics of desired state:

   - Nurses are supported as a knowledge worker with paperless, error-free robotics.
   - Nurses are fully participatory patient care managers, responsible for and driving the flow of information and activities that surround a patient.
   - Workflow systems are designed to orbit the patient-nurse dyad, enhancing the nurse-patient direct connection and interaction with the patients for whom care is provided. Nurse is focal point for workflow.
   - Patient communication and education are interactive at the point of care.
   - Patient monitoring technologies are patient-based and create patient satisfaction.
   - Patient feedback component is easy to use.
   - Treatment modalities are sophisticated and reduce physical demands.
   - Care delivery employs state-of-the-art technology that creates flexible and adaptable environment.
   - System is structured to significantly reduce or eliminate delays in care due to unavailability of resources.
   - Physical environment is self-sustaining, proactively maintained and supports a care delivery system that tracks and accurately identifies patient, providers and supplies.
   - Technology is employed so that patients/families are empowered to actively participate in elements of care.

When viewed comprehensively, the five desired states centered on two primary objectives:

- **Gaining better patient and provider interaction which would result in better outcomes, more efficiency and improved patient and employee satisfaction; and**
- **Using technology to provide the right information to the right people at the point of care, automate non-direct care delivery processes and re-structure the care environment.**

Priority action steps for reaching the desired states that received the highest consensus from conference participants were:

- Comprehensive, universally available, integrated patient record; and
- Technology-assisted medication use processes.

Even though the conference was held on a summer weekend, attendees were eager to participate and were enthusiastically engaged. Many health care professionals asked to be included in the conference. Audience size was limited to allow time for adequate discussion and completion of the group exercises. This illustrates the importance to health care leaders and providers of identifying technologies that could improve efficiencies in nursing practice.

At the concluding session, participants were surveyed on the extent to which conference goals were met. They responded as follows:

1. **Conference goal to envision a nursing practice and care delivery environment where available workforce meets patient care demands safely and adequately**

Outstanding	22%
Very Good	55%
Fairly Well	21%
Poor	2%

2. **Conference goal to identify action plans including recommendations for design and implementation of technology assisted practice environments, measures of success, and priority action steps to get to the future**

Outstanding	12%
Very Good	29%
Fairly Well	49%
Poor	9%

As indicated, conference proceedings were published in the May/June 2003 issue of *Nursing Outlook* (Volume 51, Number 3, Pages S1–S41). In addition, presentations to share conference results were made by:

- Linda Burnes Bolton, Chair Workforce Commission to Institute of Medicine

- Pamela Cipriano, Workforce Commission to Food and Drug Administration
- Linda Burnes Bolton and Margaret McClure, Workforce Commission to Health care Information and Management Systems Society

Based on the Workforce Commission's review of conference results, the following recommendations were presented to the American Academy of Nursing for consideration.

1. **American Academy of Nursing-Sponsored Summits**

   Sponsor national summits around each of the five desired states. Attendees should represent key disciplines involved in work identified in the desired state and include providers, researchers, technology experts and vendors. Experts from non-health care industries experienced in the technology being suggested in the desired states should be invited to provide insights and transfer knowledge.

   The goal is to present the desired states to a larger audience, further refine desired state concepts, include current information technology engineering initiatives inside and outside of the health care industry, determine the scope of available technology and determine the potential timing and feasibility for the implementation of the desired states.

2. **Inventory/Identify Care Models that Use Advanced Technological Initiatives Relating to Desired States**

   The Academy should issue a national "Call for Practice Models Which Employ Advanced Technology." This will identify provider organizations that have successfully implemented advanced technology to support routine non-direct care activities performed by nurses.

   The goal is to help the Commission quantify the extent to which providers undertake such initiatives, their understanding of the technology's impact on care delivery and the extent to which the model has facilitated the objective of addressing the demand side of the workforce equation. Implemented models will be reviewed and evaluated by an inventory form developed by the Academy through document review, on-site visits, observation and focus groups.

3. **Detail the Action Steps Necessary to Implement Desired States**

   After conducting the summits and inventorying advanced technological initiatives, a comprehensive set of realistic action steps needed to implement the desired state must be developed by the Academy. Indication of resources needed, stakeholders who must be involved, and the designated time frame must be included.

   The goal is development of a strategic work plan to guide the redesign of nursing practice by implementing systems and technology that will increase workflow efficiencies and increase the amount of time nurses devote to patient care.

4. **Solicit Providers to Pilot Projects Using Characteristics of Desired States**

   After the detailed action steps are developed, the Academy should issue a national "Call to Action" soliciting providers to pilot advanced technology that could redesign care delivery.

   The goal is to assess the impact of the technology initiatives on the efficient use of nurses' time, on providing assistance with non-direct care activities, on effectiveness in meeting the demands of patient care, and on the enhancement of care delivery. Pilot results will be used to hypothesize how each desired state affects the demand side of the workforce shortage.

Clearly, *Using Innovative Technology to Enhance Patient Care Delivery* produced exciting results. A solid list of desired states for using technology to make nursing's practice environment more efficient and effective were identified. Although it was acknowledged that some action steps would require further refinement, participants accomplished a remarkable amount of work.

In response to the four recommendations received from the Workforce Commission, the Academy identified five action items around which they would continue the work. Subsequent phases of the Workforce Commission's work focused primarily on the first two steps of the five listed below:

- Instigate research that inventories the state of technology that impacts nursing care to identify the gaps between existing and desired states,
- Partner with the technology industry to develop commercially available technologies to enable redesigned nursing practices,
- Partner with inventors and scientists working on developing technology for health care and related fields,
- Establish simulation and demonstration models for redesigning the nursing practice environment, and
- Set five to seven year priorities and action steps.

IV. Phase II, Pilot Study:

Creating a Technology Enhanced Practice Environment in Acute Care Hospitals

The initial multidisciplinary conference, presented as Phase I of the work, provided clear direction for the Workforce Commission's efforts. Over the next two years the Commission focused on two actions: 1) research to identify gaps between existing and desired states relative to the use of technology that would make nursing environments more efficient and care delivery more effective, and 2) partnering with the technology industry to develop commercially available technologies to enable redesigned nursing practices.

With funding primarily from the Robert Wood Johnson Foundation, and additional funding from Johnson and Johnson Corporation, the American Academy of Nursing's Workforce Commission conducted pilot observation studies at three facilities across the United States. Since technology experts there were already studying methods to automate specific areas of the health care environment at the University of Virginia , the University of Virginia Medical Center (UVaMC) in Charlottesville, VA was selected as the first pilot site. That redesign pilot was held in February 2004. The method used to analyze workflow was then tested at UVaMC (representing large, academic medical centers) and also at Cedars-Sinai Medical Center in Los Angeles and Kaiser Permanente Orange County Medical Center in Anaheim, CA — both representing the smaller, community hospital sector.

Participants from all three facilities were invited to help establish the method for this review, later designated *Technology Drill Down*, or TD2. Participants included staff nurses, other care providers and support staff, technology experts, design experts, process engineers and AAN Workforce Commission representatives. Other care providers and support staff were pharmacists, therapists, social workers and storeroom managers.

Each two-day TD2 session identified an ideal practice environment that would eliminate waste and redundancy, improve the system of care to prevent errors to patients, facilitate interdisciplinary team coordination, improve patient and staff satisfaction, and improve care at the bedside.

Each session began with introductions and a project overview by Workforce Commission members. Participants joined in a group exercise to envision the ideal acute care medical-surgical work environment. They identified and mapped the workflow appropriate for the future desired state and conducted a gap analysis of the current state against the future desired state. Ideas and comments from participants were captured real-time using an interactive white board

The workflow document was presented to the participants for a reality check prior to being adopted as an official representation of the discussion. A copy of the workflow map was printed and provided to the group.[1] Participants received information about technology currently available. At the University of Virginia site, presentations included a demonstration of the Vocera voice recognition system from Alan Oktay, technology available in the field for immediate adoption from Dr. Robin Felder, and human factors work from Drs. Stephanie Guerlain and Ellen Bass. Ron Moen of the Institute for Health care Improvement/The Robert Wood Johnson Foundation project "Transforming Care at the Bedside" discussed synergies with the AAN project.

From the work flow map, several clinical processes were identified as potential priority areas that would lend themselves to a technology solution. At UVaMC, for example, the list was as follows:

- Material management and supply stocking;
- Enhanced multi-disciplinary communication;
- Change of shift report, abbreviated information on all patients at the point of care;
- Medication administration and management;
- Interdepartmental automated resource allocation;
- Automated care plans, electronic flow sheets based on diagnosis;
- Vital sign monitoring equipment;
- Discharge process;
- Room set up;
- Bedside patient/family education;
- Review work assignment and supporting care delivery team members;
- Patient/staff locators;
- Staff/student training; and
- Automated triggers to define ability to take next admission.

Using a prioritization matrix, each group member selected their top three items and cast a single vote for each item chosen. When votes were tallied, four

[1] *Linette Geisel of Prism e-Solutions facilitated the interactive white board sessions and recording of the future state mapping. This process later evolved into a laptop bases use of Visio software projected on to a screen.*

processes emerged as priority items for further design work. For example, at UVaMC the four processes were:

- Materials management and supply stocking;
- Enhanced multi-disciplinary communication;
- Change of shift report, abbreviated information on all patients at the point of care; and
- Medication administration and management.

On the second day at each location, participants self-selected into small groups to work on one of the four processes identified the day before. Each group considered the following about their chosen workflow process:

- Identify problems with the current workflow process preventing the ideal state;
- Identify elements that are most conducive to change;
- Identify technology solutions that would enable workflow process change;
- Plot the technology solutions on a time/cost grid; and
- Make suggestions regarding how to implement the desired technology.

An additional design conference was held in Anaheim, CA, in August 2004 with Kaiser Permanente Orange County Medical Center to replicate the Workforce Commission's February conference in Virginia. The session examined ways that technology could enhance the efficiency of the work environment for clinicians on a hospital medical/surgical unit. The multidisciplinary participants included representatives of medical/surgical nursing, nursing administration, respiratory therapy, laboratory, materials management, dietary, physical therapy, environmental services, information technology, pharmacy and social work.

The two-day conference agenda mirrored the session held at UVaMC and was planned jointly with Cedars-Sinai Medical Center to keep the agendas synchronized. After consulting with UVaMC organizers it was decided to move the design phase (identifying workflow processes most conducive to technology) and the presentations on existing technology applications to earlier in Day One. This allowed more time for discussion of the current workflow process and identifying gaps when it was compared to the "ideal day." Day Two was reserved for small group work to expand the priority areas identified by the group, the same process used at the UVaMC session. (Appendix C, Agenda Comparison)

Process areas identified in Anaheim for further exploration were as follows: (Appendix C, Kaiser)

- Supply chain;
- Scheduling; and
- Streamlining communications.

The third design conference in the pilot series also was held in August 2004 at Cedars-Sinai Medical Center. The goal was to envision the ideal acute care work environment with attention to safety enhancements, ideal workflow and process changes, and preservation of RN time for essential direct patient contact. The two-day conference process followed that conducted in Anaheim. The prioritized workflow processes were (Appendix C, Cedars-Sinai):

- Communications;
- Supply chain management;
- Documentation; and
- Point of care.

Many similarities in workflow processes were identified at the three sites. There were also many detailed areas specific to each site, where additional study and workflow process modification could lead to changes in the work environment.

The key workflow process priority identified at all three sites was streamlining and enhancing multidisciplinary communications to improve workflow. Each group's responses reflected the availability of electronic information, as well as the capability and current state of information systems. Despite varying degrees of functionality, the following themes were consistent:

Team communication:

The greatest need expressed was for information to be accessible at the point-of-care. This included use of technology such as voice activated hand-held devices, other wireless communication devices, and interactive "white boards" in a patient's room. The desire to create and edit shared goals, a patient's discharge plan, and routine charting represented a significant portion of team interaction. With electronic adjuncts, teams could decrease the need for face-to-face interaction to essential exchanges. Alerts built into the information system were also considered essential for notifying one or more care givers about a patient's emergent needs.

Nurse-to-nurse communication:

Nurses most often cited the "change of shift report" as a major opportunity to transform the work environment. The report is a ritualistic exchange of information that

occurs when the oncoming shift of nurses and other staff receive information about the patients to be cared for. The process was cited as inefficient, time-consuming and repetitious, since much of the information shared is accessible from other electronic or written formats. Nurses called for elimination of redundancy in the reports, to help work flow more efficiently. They identified various wireless and portable devices as tools for streamlining the change of shift report. The ability to acquire information quickly and store it electronically was a priority.

Patient information communication:

Nurses sought to have patient information available effortlessly via technology. New technology that could passively acquire and record patient vital signs was seen as creating significant time savings. A tracking device such as RFID, GPS or a "smartcard" for patients could facilitate information exchange about patient location or other vital data.

Family communication:

Nurses want to communicate with family members at times convenient for all. Protocols should be established so that families know what to expect and who will be communicating. Videoconferencing capabilities would also be helpful.

Improvement of supply chain functions:

The second most significant area named at all three sites was improvement of supply chain functions such as those associated with materials distribution and medication dispensing and administration. Each group identified enhancements to improve speed and enhance accuracy of medication fulfillment, simplified access with dispensing machines, electronic charting, inventory control, alerts, and improved safety across the medication cycle.

The three interdisciplinary teams generated 400 ideas for developing and testing technology over the next three to five years. The ideas were categorized into these potential technology applications:

- Integrated electronic medical record across the continuum of care.
- Electronic medication system that facilitates ordering, administration, evaluation and medication reconciliation across the continuum of care.
- Staff scheduling system, accessible from home and work, that would facilitate control over schedules and minimize errors. Staff could obtain the report remotely and participate in patient care planning.
- Equipment and supplies connected to tracking and deployment systems.
- Voice over information systems.
- Wireless and voice activated systems for patient care and documentation.
- Technology to assist with patient activities of daily living, nutrition, mobility and hygiene.
- Rooms designed to support care delivery, prevent patient and staff injury, patient and family education and communication.
- Non-invasive, wireless patient care monitoring systems.
- Enterprise wide patient scheduling systems.
- Multilingual wireless communication systems.
- For all systems — alerts, embedded evidence based protocols, and evaluation properties linked to a data repository and accessible as the patient moves across the continuum of care.

The most valuable part of the work was creation of the TD2 process to examine and analyze nursing workflow in acute care. Equally important was the subsequent envisioning and design of the future desired state. The unique aspect of this work is the identification of technology applications that can automate processes and reduce unnecessary and/or time-consuming activities that now occupy a registered nurse's time in non-direct patient care.

After the initial conference at the University of Virginia, the Workforce Commission had recognized that replication and potential validation of findings would be necessary prior to more wide-spread implementation of the workflow analysis process. The additional TD2's at Kaiser and Cedars-Sinai provided the opportunity to use consistent facilitation, as well as introduction of concepts of automation, to elicit analysis of workflow.

Replication of the workflow analysis helped verify similarities and differences in acute care clinical organizations. Refining the technique by having consistent facilitation of the workflow mapping was beneficial for comparing results. While findings demonstrate a high degree of similarity, there is recognition of the diversity of clinical settings.

Demonstration of the reliability of the workflow analysis process is reassuring in offering the TD2 technique in different organizations. That process has the potential to shape the products developed by the technology industry so they address the real needs of clinicians at the bedside and redesign the nursing environment so it becomes more efficient and effective (Appendix C, Pilot Executive Summary).

V. Phase III, Technology Targets Study

A. Planning

As the three pilot studies were being conducted to develop and refine the TD2 process, Workforce Commission members concurrently worked to complete a planning process, known as Phase III, for the multi-phased initiative. The purpose was to help the Academy:

- Form a coalition of technology vendors to refine and/or develop appropriate technological applications;
- Identify specific indirect and direct care activities relevant to automation, or for which technological applications might prove enabling;
- Determine how to test the applicability of technologies in actual patient settings; and
- Determine how to identify the impact of workflow changes that enhance patient safety and improve staff satisfaction with their practice environments.

In September 2004 the American Organization of Nurse Executives joined forces with the Academy on the Technology Targets project. The collaboration strengthened resources and extended the Workforce Commission's ability to reach health care executives to promote the use of technology to redesign nurse work environments.

With additional funding from the Robert Wood Johnson Foundation, the Academy hosted planning sessions that culminated in Phase IV, the major component of the Technology Targets project. After one planning session the Workforce Commission met with technology vendors to further the formation of a coalition. The planning sessions included stand-along Workforce Commission meetings, plus an April 2005 meeting of technology vendor representatives with attendees (and Board Members) at the American Organization of Nurse Executives (AONE) annual conference.

During this process, outcomes from the Phase I Conference, *Using Innovative Technology to Enhance Patient Care Delivery* and the Phase II Pilot Study, *Creating a Technology Enhanced Practice Environment in Acute Care Hospitals* were reviewed by the Workforce Commission, which also:

- Finalized a template for workflow analysis, called Technology Drill Down or TD2, for workflow process improvement. It was decided the TD2 model would be applied in additional acute care practice environments.
- Identified potential technology company partners and finalized the role of industry, health care leaders, staff nurses and the public in achieving the Workforce Commission's primary goals.
- Developed a tactical plan for the Workforce Commissions work over the next two to five years.

The Workforce Commission defined the mission/objective of the partnership with technology companies as being to, "Create the practice environment of the future to meet the work demand for nurses and other health care providers by leveraging technology." Workforce Commission responsibilities for the partnership were outlined as follows:

- Create industry partnerships;
- Establish a national program office funded by industry partnerships;
- Manage the National Program Office;
- Identify practice needs that can be impacted by technology using the TD2 process;
- Identify stakeholders;
- Inform, advise, and shape opportunities for industry partners to develop products;
- Facilitate/engage health care facilities to transform their work environments;
- Influence, stimulate, and support development priorities for funding agencies;
- Disseminate and evaluate to the "universe;" and
- Identify technology in health care field that is underused, misused, or produces a "work around;" technology from other fields that could be adapted; opportunities for new product development.

It was felt that to expand workflow analyses in acute care settings using TD2, a national program office (NPO) needed to be established for coordination and oversight. The National Program Office Director would be responsible for the following:

- Write grants or support fund development;
- Execute and evaluate grants;
- Coordinate TD2 process at facilities;
- Collect data, coordinate meetings, interact with executive staff and create reports;
- Be the voice to the public;
- Supervise the dissemination of work;
- Interface with stakeholders;
- Manage the multiple cycles;
- Recruit and manage the facilities; and

- Work with industry partners to organize and manage the TD2 cycles and meetings, provide an interface/liaison with industry partners and the project, recruit new industry partners , and communicate with industry partners.

The Workforce Commission also felt a National Advisory Council needed to be established to inform the Commission about what is happening within the larger health care environment. The Council would also help develop the TD2 methodology, recruit people involved in technology to the project and help with the adoption of appropriate technology and abandonment of inappropriate technology. It was felt the Council should be limited to 16 members to maximize effectiveness.

The Council was to:

1. Advise the Workforce Commission on a format that achieves the most effective synthesis and presentation of data from the Time & Motion study, the Transforming Care at the Bedside project and the Technology Drill Down study.
2. Help strengthen relationships with technology companies and secure their interest in utilizing Technology Targets outcomes for building new or improved technologies for use in the acute care nursing environment.
3. Help build and implement an outcomes dissemination plan.
4. Help increase the impact of these findings by extending the reach of our results to more nurses and other health care constituencies.

A meeting was held in October 2006 to review current progress on TD2 and the other studies of Transforming Care at the Bedside (TCAB) and Time and Motion. TCAB, supported by RWJF in collaboration with the Institute for Health care Improvement, focused on improving the quality and safety of patient care and increasing retention of experienced nurses. Thirteen hospitals participated in the initial study. The Time and Motion study determined how medical surgical nurses spent their time on 36 nursing units and how the architectural structure of those units influenced nurses' use of time and distance traveled to accomplish their work. Identifying drivers of inefficiency would target changes needed for improved quality of care and safety.

During the meeting, Patricia Price and Jennifer Moorehouse of IDEO facilitated discussion of common themes and implications of the work, identification of other groups considering similar work, and the opportunities to link and leverage the work of these projects. The Advisory Council was jointly shared with the RWJF funded Time and Motion Study led by Dr. Marilyn Chow and Ann Hendrich, and thus also provided guidance for the upcoming "Nurse Work Environment Innovation Summit" held at the Garfield Center in Oakland, CA, in early 2007. The final roster of Advisory Council members is listed in Appendix D, Advisory Council.

To recruit technology vendors into the partnership, the Commission identified potential benefits for industry partners. It was believed that partners, facilities, the health care industry and consumers would all benefit from the partnerships, creating a win — win — win — win situation with redesigned nursing environments. Specific benefits were:

- Privilege/opportunity to partner with credible/objective organizations;
- Access to America's health care organizations through a partnership with AAN/AONE.
- Access to synthesized data and critical information on the latest urgent product needs through practitioners and patient-care providers through the national program office;
- Access to outcomes/synthesis of chief nursing officer/staff nurses and other disciplinary team members to identify critical needs including "low-hanging fruit" through the national program office;
- Access to analyzed and synthesized data about existing under-used, misused, and worked-around technology products;
- Opportunity to attend and participate in national stakeholder meetings;
- Opportunity to recommend and/or choose facilities for Technology Drill Down sessions;
- Venue to provide their ideas, thoughts, and concerns about products during technology drill down sessions and/or stakeholder meetings;
- Receive recognition as innovator of technology that is addressing health care workforce needs; and
- Access to National Program Office.

In return, each industry member of the coalition was asked to pay a $50,000 membership fee. The fees would make it financially feasible to establish the National Program Office (NPO) that would research, advise and shape opportunities for industry partners to develop products. Through the NPO, further TD2's would be conducted to identify technological enhancements for the nursing profession in a larger sample of acute care medical-surgical units.

Workforce Commission members personally contacted technology vendors to invite them to become industry partners even before the December meeting. Vendors received a written overview of the project aimed at ensuring all potential partners received more detailed and consistent information (Appendix D, Overview). It included a two-year timeline (2005–2006) to guide the establishment of the coalition, an organizational chart detailing relationships among all of the participating groups, and a TD2 logistical process flowchart illustrating how the work would be done.

All exhibitors scheduled for the AONE meeting in April 2005 and other targeted vendors received packets of information, inviting them to become industry partners.

In April 2005, the Academy's Workforce Commission and AONE sponsored a meeting with representatives from seven interested technology companies. More than 60 technology companies had been invited (Appendix D, Letter). The meeting represented efforts toward forming a Workforce Commission-technology company partnership or coalition. Commission members shared a general review of the three technology drill downs and answered questions (Appendix D, Q & A). A follow-up letter was sent to vendors who were invited to attend, summarizing the meeting and again inviting them to join the coalition (Appendix D, Follow-up).

Company representatives responded positively to the information, indicating they found the TD2 process interesting and compelling. However, despite their interest in the data and outcomes, all but three companies were reluctant to provide financial commitment to a joint project that did not allow for exclusive access to the findings of the TD2's. It had been determined that nine partners were needed to financially support and implement the National Program Office business concept and plan.

At this point the Workforce Commission began developing alternative plans and strategies for expanding the workflow analysis of nurses' practice environments. The project took a more comprehensive and synergistic approach that would result in improved hospital technologies. Called "Technology Targets: A Synthesized Approach for Identifying and Fostering Technological Solutions to Workflow Inefficiencies on Medical/Surgical Units," and funded by the Robert Wood Johnson Foundation the revised initiative would also aim to analyze outcomes of three RWJF-funded processes, Transforming Care at the Bedside/PDA study, a time and motion study, and 25 technology drill downs.

B. Conduct of the Study, "A Synthesized Approach for Identifying and Fostering Technological Solutions to Workflow Inefficiencies on Medical/Surgical Units"

The Workforce Commission decided that continued work to improve practice environments using technology could not be financed through a Commission-technology company partnership. Some technology companies were not interested in paying a coalition membership unless they received exclusive access to TD2 results. Some also felt that data from more than three acute care practice pilot sites was needed to justify the investment. Still, it is significant that technology vendors generally supported the TD2 process as a strategy to identify technology needs that would positively impact practice environments.

Impetus for continuing and expanding the project was additionally based on the fact that data from the pilot studies showed a "continental divide" between technology products deployed in American hospitals and health care systems and the products' utility. Typically technology needs have been assessed through focus groups and interviews with top-level administrators and executives at individual hospitals or health care systems. These methodologies neglect to incorporate the perspectives and experiences of nurses and other frontline staff, resulting in technology products that make medical/surgical unit work processes less efficient and more cumbersome.

Nurses have been resourceful and agile enough to work around problematic technologies, but the problems interfere with workflow and a far-from-optimal work environment, causing some to leave hospital nursing. It was also observed that technology developments have been almost entirely in the therapeutic realm of health care rather than enabling care delivery methods. The TD2 process, incorporating the experience and viewpoints of bedside nurses, increases the likelihood that new care delivery technologies can be developed that work to the advantage of nurses, other frontline staff and patients.

Subsequently, The Robert Wood Johnson Foundation (RWJF), which supported the first three phases of the work, invited the AAN Workforce Commission to submit a concept paper describing how the project could be expanded. RWJF then invited the Commission to submit a grant proposal that would allow for full implementation of the project.

In October 2005, $357,880 was requested from RWJF for an 18-month project to support TD2 efforts at 25 acute care hospitals. Funds would support a full-time project coordinator and expert consultation for TD2's. RWJF funded the Technology Targets project in November 2005. The initial grant period ran until June 2007, with a subsequent no-cost extension until that November to complete the data collection and begin data analysis.

The Technology Targets project goals were to 1) implement an improved process for identifying technological solutions to medical/surgical unit workflow inefficiencies, and 2) accumulate a wealth of data that coupled with a findings-dissemination process would capture the attention of industry and prompt them to develop technologies that improve workflow processes. Proposed major project activities included:

- Analyzing data and findings from Transforming Care at the Bedside (TCAB) and the Time and Motion study;
- Implementing a Technology Drill Down or TD2 process within at least 25 acute care settings;
- Creating an Advisory Committee/Coalition comprising AAN, AONE, RWJF, industry and other health care organization representatives to decide upon optimal strategies for ensuring that increasing numbers of hospitals embrace the TD2 and TCAB/PDA models and that project findings result in the development of useful technologies;
- Posting, publishing and disseminating a report that analyzes and evaluates the TD2 outcomes; and
- Working with HealthTech to define its partnership role in disseminating the TCAB/PDA and TD2 processes as well as findings.

Outcomes anticipated from the Technology Targets project included:

- Dissemination of a paper and/or CD/ROM that provides a concise description and explanation of the Technology Drill Down (TD2) process and how hospitals and other health care settings can employ and/or adapt it for assessing technology needs;
- Functional requirements for new or revised technology products emerging from the TCAB/PDAs, the Time and Motion Studies and the Technology Drill Down (TD2) processes;
- A report analyzing and evaluating the functional requirements emerging from the TD2 processes and synthesizing them with relevant TCAB/PDA and Time and Motion study findings;
- An AAN-based online data repository; and
- A stakeholder-driven planning, dissemination and engagement process to ensure project replication as well as the development of technological processes and products to improve medical/surgical unit workflow.

The TD2 process focuses on medical/surgical unit workflow from a systems-wide perspective. The process engages nurses, assistive personnel, unit clerks and departmental members from pharmacy, materials management, social work, and respiratory therapy. Interdisciplinary involvement of frontline workers is essential because work processes of the groups interface and are interrelated.

The TD2 process also allows for key decision makers — such as chief nursing officers and chief information officers, environmental experts such as clinical engineers, human factors' engineers, and architects — to be involved in identifying appropriate technology needs. Most importantly, TD2 gives a voice to front line bedside nurses, providing a vehicle for identifying what technology they need and how it should function in order to provide the best possible patient-centered care.

During Phase IV of the project, TD2s were conducted at 25 acute care hospital sites focusing on medical/surgical units. The results are reported in this monograph. Through dissemination of information about TD2, the Academy invited all other hospitals to conduct their own drill downs to identify needed change and facilitate redesign of their practice environments. To this end, the Workforce Commission developed a digital video disk (DVD) entitled Technology Drill Down to provide guidance for hospitals to conduct individual TD2 processes. The DVD is distributed through the Academy Web site *(www.aannet.org)* for shipping costs only. The DVD includes an overview of the TD2 process, a detailed facilitator's guide, handouts for TD2 participants, and templates for recording and reporting results. In addition to the DVD a software program Visio, easily purchased online or from an office supply store for about $150, is recommended to record the results of a TD2.

Once the process was refined through the three pilot TD2s, all 25 TD2s reported in the monograph were conducted as outlined in the *Technology Drill Down* DVD to assure consistency in data collection. As indicated in the TD2 Facilitator's Guide (Appendix E,

Facilitator's Guide), the first three steps of the TD2 process are:

1. Hospital administrators and leaders identify a medical/surgical unit that could benefit from a TD2.
2. An internal TD2 facilitator is identified who uses all the training materials on this DVD to prepare for and facilitate a TD2. A facilitator with experience in process improvement and Visio software can enhance the work.
3. Approximately 20–30 selected unit and interdepartmental representatives come together for a day and a half. They map out gaps between current workflow and an idealized workflow and, most importantly, potential technological applications that could close the gaps. Ideal participants should include all individuals who are critical in the efficient function of this unit. Participants can include but are not limited to:
   - Nursing Staff (four to six staff nurses from the unit);
   - Nursing Administration;
   - Pharmacy;
   - Clinical Engineering/Human Factors — Engineers/Systems Engineers;
   - Social Work;
   - Respiratory Therapy;
   - Physical/Occupational Therapy;
   - Radiology;
   - Information Technology/Services;
   - Patient Transportation;
   - Nutrition;
   - Case Management;
   - Architectural Engineering/Design — Integration/Industrial Engineering;
   - Patient Advocate;
   - Pastoral Care;
   - Emergency Department;
   - Unit Clerk;
   - Patient Education; and
   - Medical Staff.

The TD2 is conducted over a two-day period following an agenda provided (Appendix E, Agenda). Audiovisual, software, and computer equipment requirements are listed in the Facilitator's Guide. Diagrams for suggested room arrangements are also in the Guide.

Day 1 begins with a welcome and an introduction to the project. Individuals participating in the TD2 are asked to introduce themselves by name and department. Through a video and slides available on the Technology Drill Down DVD, Dr. Linda Burnes Bolton describes the Technology Targets Project and identifies proposed outcomes (Appendix E, Burnes Bolton Slides).

Under a facilitator, participants begin their work by identifying the major work categories that have issues they feel need change in their environment, e.g., medication administration, documentation, etc. Once categories are identified, participants discuss the current workflow for each work category. Participants are then guided to a discussion of future state by having them identify an ideal workflow for each work category. All of these data are captured on the electronic work flow charts using Visio (Appendix E, Work Flow Chart). Specific instructions for creating the workflow charts are included in the Facilitator's Guide.

During the lunch break TD2 participants watch a video lecture by Dr. Robin Felder, Professor and Director, Medical Automation Research Center, University of Virginia. He discusses existing and developing advanced technologies that can improve health care quality and efficiency. Participants then return to a discussion of current and ideal state for each work category. If necessary, the facilitator guides discussion to a focus on ideal state and does not allow participants to stay focused only on current state. By late afternoon an electronic document of current and ideal states for each identified work category has been recorded and can be archived, copied and distributed the next day for further group discussion.

Before Day 1 activities end, each participant votes on the list of work categories, choosing the top four that should be exposed to further drill down the next day (Appendix E, Voting Forms) Votes are tallied and presented to the group by the facilitator. Participants then self-select one of the four prioritized work categories to discuss gaps in the current and future work flow states and recommend technology solutions. That drill down, accomplished in small work groups, will identify technology solutions for four top priority work categories.

Each work group focuses on a different top four work category. Before Day 1 ends an overview of any current technology planned for implementation at the site is presented. Finally, the facilitator summarizes the work of Day 1, notes and captures the accomplished work and enthusiasm expressed, and outlines the process for Day 2.

On Day 2, participants convene with their chosen small group for 90 minutes, discussing their selected topic from the list of four prioritized work categories. They further examine the gap between current and ideal situations and specify aspects of the work flow processes that need to change. Small group discussion also identifies technology solutions that would enable the ideal state to exist.

Finally, the small groups discuss specifics of the ideal environment — what benefit would be gained, who would benefit and how. Results of small group discussion are recorded on a laptop computer by a volunteer recorder using the workgroup template (Appendix E, Workgroup Template). Each group reports on its findings and solutions to the entire group of participants.

Each work group then develops a time cost grid of its technology recommendations (Appendix E, Time Cost Grid). Each group considers its recommendations in terms of time and money required to implement the solution. This allows identification of technology projects (e.g., RFID tagging) that could be implemented quickly at relatively low cost versus technology projects (e.g., information systems) that would require larger capital outlay and take up to five years to complete.

Day 2 ends at Noon, after completing a wrap-up emphasizing results and accomplishments and a discussion of next steps. Participants are asked to complete a three-question evaluation form (Appendix E, Evaluation Form) before leaving. Data from each of the 25 TD2 sites were compiled and analyzed. Data items were entered into the data repository Prism eSolutions equationASP for management and analysis by the Technology Targets Project Coordinator, Marjean Griggs.

Participating organizations for the 25 TD2s held during 2006 and 2007 were:

- Allen Memorial Hospital — Waterloo, Iowa
  October 17–18, 2006
- Appalachian Regional Health care — Whitesburg, Kentucky, August 17–18, 2006
- Aurora Health care-West Allis Hospital — West Allis, Wisconsin, August 9–10, 2006
- Carolinas Medical Center — Charlotte, North Carolina, June 5–6, 2006
- Cedars Sinai Medical Center — Los Angeles, California (different units than pilot study)
  March 6–7, 2006
- Children's Mercy — Kansas City, Missouri
  October 31–November 1, 2006
- Duke University Health System — Durham, North Carolina, December 4–5, 2006
- Georgetown University Medical Center — Washington, DC, June 19–20, 2006
- Henry Ford Hospital — Wyandotte, Michigan
  February 28–March 1, 2007
- Inova Fairfax Hospital — Fairfax, Virginia
  February 20–21, 2007
- James A. Haley Veterans Administration Hospital — Tampa, Florida, March 8–9, 2007
- Kaiser Permanente West — Los Angeles, California
  May 21–22, 2007
- North Shore Long Island Jewish Hospital — Great Neck, New York, July 6–7, 2006
- Loyola University Medical Center — Maywood, Illinois, May 30–31, 2006
- Mercy Hospital — Pittsburgh, Pennsylvania
  May 17–18, 2006
- Porter Hospital — Denver, Colorado
  May 8–9, 2007
- Prairie Lakes Hospital — Watertown, South Dakota
  May 4–5, 2006
- St. Margaret Hospital — Pittsburgh, Pennsylvania
  September 19–20, 2006
- St. Mary's Hospital — Tucson, Arizona
  April 24–25, 2007
- Seton Hospital Northwest — Austin, Texas
  November 20–21, 2006
- University of California San Francisco Medical Center — San Francisco, California
  September 28–29, 2006
- University of Washington Medical Center — Seattle, Washington, April 17–18, 2007
- Utah Valley Regional Medical Center — Provo, Utah
  February 15–16, 2007
- Vanderbilt University Medical Center — Nashville, Tennessee, December 14–15, 2006
- Wesley Long Hospital — Greensboro, North Carolina
  September 14–15, 2006

A map of participating organizations is available in Appendix F, TD2 Site Map.

Demographic information was collected on all 25 sites in two surveys, processed as the first phase of data analysis, and is presented in this document. The first survey was completed during screening of sites to determine willingness to participate in the study. A follow-up survey determined impact of the TD2 on the organization. Each TD2 hospital was described by their number of beds. Seventy-two percent of hospitals had 250 beds or more, 20 percent of hospitals had 101 to 250 beds and two hospitals had fewer than 100 beds.

Table 1, Size of 25 TD2 Sites by Number of Beds

Number of beds	Number	Percentage
< 100	2	8
101–250	5	20
251–500	9	36
> 500	9	36

When asked to classify their geographic location, a majority of hospitals are considered urban. Less than a quarter of sites are suburban and only two are located in rural areas.

Table 2, Geographic Location of 25 TD2 Sites

Location	Number	Percentage
Urban	18	72
Suburban	5	20
Rural	2	8

All hospitals were not-for-profit with the majority of hospitals either academic health centers or community hospitals. A few hospitals were private and one hospital was a federal facility. More than 70 percent of the 25 sites were teaching hospitals. Forty-four percent of sites were recognized as Magnet Hospitals.

Eight of the 25 TD2 sites also participated in the Transforming Care at the Bedside (TCAB) project and 10 of the 25 TD2 sites had been involved in the Time and Motion study.

Table 3, TD2 Site Participation in TCAB and Time & Motion

TCAB	Number	Percentage
Yes	8	32
No	17	68

Time & Motion	Number	Percentage
Yes	10	40
No	15	60

Within the 25 sites, TD2s were sometimes held on more than one unit. About two-thirds of the sites used only one unit, but six facilities used three units and three hospitals used four or more units. At least 46 units implemented the TD2 process during data collection. If more than one unit participated in the TD2 process at a site, respondents were asked to select one unit to answer a series of questions in the follow-up survey.

Table 4, Number of Units Implementing TD2 at Each Site

Units Participating	Number of Sites	Percentage of Sites
One	16	64
Two	0	0
Three	6	24
Four or more	3	12
Total	46 or more	

Because the TD2 participants were identifying current workflow and comparing it to an ideal workflow, it was important to learn additional descriptive information about their units. When considering physical size of the unit, 10 of 25 reporting units had 31-40 rooms and four units had 41 or more rooms. No unit was smaller than 11 rooms.

Table 5, Physical Size of 25 Units by Number of Rooms

Number of Rooms	Number of Units	Percentage of Units
1–10	0	0
11–20	3	12
21–30	8	32
31–40	10	40
> 40	4	16

When asked about single patient rooms, one facility had no single rooms, but the majority had between 11 and 30 or more single rooms. When asked about shared rooms, nearly half of TD2 units had no shared rooms. In general these descriptors present an image of fairly large patient units with long corridors in which care providers had to walk and work to complete needed workflows.

Table 6, Number of Single Patient Rooms on 25 TD2 Units

Single Rooms	Number of Units	Percentage of Units
None	1	4
1–10	6	24
11–20	5	20
21–30	6	24
> 30	7	28

Table 7, Number of Shared Patient Rooms on 25 TD2 Units

Shared Rooms	Number of Units	Percentage of Units
None	12	48
1–5	4	16
6–10	1	4
11–15	3	12
16–20	3	12
> 20	2	8

Each of the next six topics describing participating units had a variable number of responses. Since the Technology Targets projects focus on medical surgical types of units, sites were asked what type of unit staff nurses who participated in the TD2s represented. Nearly 80 percent of responding units reported they were medical surgical units. Twenty one units out of 40 responding to this question were identified as adult medical/surgical units and another 10 units were telemetry units, a specific type of medical/surgical unit. Four units were orthopedic units, two were pediatric, one was an oncology unit and two were intensive care units.

Medication administration was identified in the pilot studies as a priority work category needing change, therefore TD2 sites were asked about the types of medication delivery and dispensing systems in use on their units. Units could indicate multiple systems. There were 80 responses to this question. Twenty one of the units used a central dispensing unit such as Pyxis or Omnicell. Twelve units used medication carts that served multiple patients. Equal numbers of units used either a courier delivery service or a pneumatic tube delivery system. Nine units had locked medication rooms. Robots were used in the pharmacies of eight units. Surprisingly, five units still relied on nurse retrieval from the pharmacy for other than missed medications. And only three units had medications stored in each patient's room, a contrast to ideals expressed in the TD2s.

Table 8, Types of Medication Delivery & Dispensing Systems on Participating Units

System (n=80)	Number of Units	Percentage of Units
None	0	0
Central dispensing unit	21	26
Robot in pharmacy	8	10
Courier delivery service	11	14
Nurse retrieval	5	6
Medication stored in patient's room	3	4
Medication carts serving multiple patients	12	15
Tube system	11	14
Locked medication room	9	11

Materials management was also an identified priority work category needing change. More than one response about materials management could be selected by TD2 units. Thirty-six units responded to where supplies were stored on the unit. Only four units had a patient server or locked cabinet in a patient's room for supplies. Most of the units had either several supply areas or one central supply area or closet. Mobile supply carts were used on five of the units. These findings contradict ideal states identified in the TD2s.

Table 9, Storage of Supplies on TD2 Units

Storage (n=36)	Number of Units	Percentage of Units
Patient server/ cabinet in room	4	11
One central supply area/closet	13	36
Several supply areas	14	39
Mobile supply carts	5	14

Information about the work category of documentation was obtained from TD2 participants. Units could select more than one response. There were 40 unit responses for nurses. On more than 40 percent of responding units, nurses still use a paper system for patient charting. Twelve units reported that nurses use a stationary electronic system located at the nurses' station or in an alcove. On 10 units a mobile computer-on-wheels was used for charting. Only one unit reported that nurses use a hand held device for charting. Responses indicate that nurses use a combination of paper and electronic systems.

Table 10, Methods Used by Nurses for Patient Charting on TD2 Units

Method (n=40)	Number	Percentage
Paper (manual)	17	43
Electronic– stationary location	12	30
Electronic– computer on wheels	10	25
Electronic– hand held device	1	2

Information from units about methods physicians use for patient charting differs from nursing methods used for charting. There were 54 responses about physician methods used for charting. The numbers of units reporting that physicians use paper charting was similar to nursing. The number where physicians used stationary electronic methods for patient charting or mobile computers-on-wheels was considerably lower than for nurses. Seven percent of units report physicians use hand-held devices, a marked increase from nursing. Interestingly, 20 percent of units reported that physicians use dictation, a method not used by nurses for patient charting.

Table 11, Methods Used by Physicians for Patient Charting on TD2 Units

Method (n=54)	Number	Percentage
Paper (manual)	21	39
Electronic– stationary location	10	19
Electronic– computer on wheels	8	15
Electronic– hand held device	4	7
Dictation	11	20

There were 44 unit responses about methods "other staff" used for patient charting, and results there were similar to those for nurses and physicians in terms of paper charting. Other staff and nurses had identical percentages for using electronic charting with stationary locations. When considering mobile electronic charting, other staff used this method the same as physicians and use it much less than nurses. Physicians and other staff showed the same results for hand-held devices and both use the method more than nurses. Only two percent of other staff employ dictation as a charting method.

Table 12, Methods Used by Other Staff for Patient Charting on TD2 Units

Method (n=44)	Number	Percentage
Paper (manual)	19	43
Electronic– stationary location	13	30
Electronic– computer on wheels	7	16
Electronic– hand held device	3	7
Dictation	2	5

It was quite surprising to learn that with the ubiquitous nature of computers, 40 percent of nurses, physicians and other staff used paper or manual charting for patient charting. Equally surprising was that less than 10 percent of any provider group used hand-held devices for patient charting. From the responses it was clear that care providers used a combination of methods to chart important patient data. This leads to duplicate charting, potential for error, wasted time and a need for access to multiple entry systems, findings evident in the TD2 processes.

In terms of computerized provider order entry (CPOE) systems, 16 of 25 (64 percent) TD2 participating sites had these systems and nine did not. If they had CPOE, units were asked who enters the orders. There were 39 responses from the 16 units with CPOE; most frequently, unit secretaries (38 percent) entered the orders. About 21 percent of physicians entered the orders and another 13 percent of physician's assistants or nurse practitioners entered orders. Eighteen percent of nurses entered orders. These responses indicate workflow changes may be needed to encourage physicians to directly enter their orders, an activity that reduces transcription errors and consequently medication errors.

Finally, sites were asked to indicate what automated systems were in use on their units at the time of the TD2. There were 91 responses to this question. Results are summarized in the following table.

Table 13, Electronic Systems in Use on TD2 Units

System (n=91)	Number of Units	Percentage of Units
Individual pagers and/or cell phones	18	20
Electronic Health Record — partial	17	19
Drug and IV dispensing cabinets	16	18
Supply dispensing cabinets	10	11
Devices automatically download patient data to HER	6	7
Integrated patient scheduling system for tests and appointments	6	7
PDA or other hand held device	4	4
Hands free communication device	4	4
RFID or barcode tracking of supplies	4	4
Electronic Health Record — complete	3	3
Barcode medication administration system	2	2
RFID or barcode tracking of equipment	1	1
RFID or barcode tracking of patients	0	0

As the data indicate, only 3 percent of the units hade a complete electronic health record (EHR) system and only 19 percent had a partial EHR. Fewer than 4 percent of TD2 units had equipment, supply and patient tracking devices. Less than one-fourth of units had simple devices such as cell phones at their disposal. Data confirms there is much work to be done to redesign nursing environments into more efficient and safe environments that incorporate time- and energy-saving technology.

At the end of each TD2 process, participant units were asked to indicate if the exercise was beneficial to them. Eighty percent of the units reported the TD2 process extremely or very beneficial. None reported the process lacked benefit.

It was surmised that participants enjoyed engaging in the highly interactive process and cared deeply about ways to improve their work environment using technology. For example, respondents stated the TD2 helped them "become more aware of the growing need to have systems that are fully integrated and communicate bi-directionally and populate information into one central record." TD2s provided a "morale boost related to staff participation in project." Another unanticipated benefit was face-to-face exchange among staff in different departments who had not met each other, but whose work is inextricably linked.

C. Data Analysis and Results "Technology Targets: Identifying Potential Technological Solutions to Improve the Nurse Work Environment on Medical/ Surgical Units"

As soon as sites completed their TD2s, data were entered into Prism e-Solutions Equation ASP which served as a data warehouse. Towards the end of data collection, TD2s were scheduled close together delaying data entry, but all data were posted in the data warehouse by August 2007. To maintain data integrity, exact phrases recorded on the worksheets were entered into the data repository. Data elements were site demographics, categories of workflow issues, process issues and technology solutions. Data were entered so they were linked to the sites that generated them.

TD2s produced a large volume of rich, complex data. It was imperative to capture and maintain the ideas and nuances of the data during analysis. There were 327 categories of workflow issues identified in the data set. Participants acknowledged 766 different or non-duplicate (unique) process issues out of a total of 946 statements of issues requiring improvement to enable nurses to stay at the bedside and meet the demand for patient care. Through the TD2s at 25 sites, there were 1,739 suggestions for technology solutions, 599 of them unique.

The Workforce Commission appointed a Data Subcommittee to oversee data analysis. Members were Drs. Linda Burnes Bolton, Pam Cipriano, Carole Gassert, Pat Moritz, and Ida Androwich, and Marjean Griggs, the Project Coordinator. The subcommittee worked with Prism e-Solutions to manipulate data within the repository. It was hoped that the database system would compile and count frequencies of the data points within each of the elements. The system was also asked to link the data from Day 1 to Day 2. Further, the system was asked to assign a value to the data points established in steps 1 & 2 in order to identify technology solutions that could be connected to the data points.

As the analysis evolved it became evident that Equation ASP was not robust enough to move, analyze, and link the data points as needed. An alternative strategy was to conduct a manual, qualitative content analysis of each set of data elements. To work with the data, each element's data points were downloaded into spreadsheets and then coded by subcommittee members. The database structure would not permit codes to be uploaded

without essentially reconstructing the database by re-entering the original data, a procedure that would have further delayed the determination of findings.

In late 2006 the subcommittee issued an RFP for a qualitative data analysis to be completed by May 2007 using existing data from the TD2s. Several qualitative researchers were encouraged to respond to the RFP but only one proposal was submitted. The proposed solution was not appropriate for project needs and was not approved. This left the analysis work to subcommittee members.

Although much of the work was done through "virtual" on-line meetings, the labor-intensive qualitative analysis required face-to-face meetings and maintaining the administrative support of the Project Coordinator. To support the data analysis and interpretation, a proposal was submitted to the Robert Wood Johnson Foundation for $99,668.00.

Key project components were:

1. Employ a project manager to facilitate continued data mining and produce an analysis for review by the investigative team consisting of Drs. Linda Burnes Bolton, Pamela Cipriano, Patricia Moritz, Carole Gassert, and Ida Androwich.
2. Disseminate the analysis linking specific workflow process issues with technology solutions, together with recommendations to AONE TCAB sites as well as hospitals throughout the United States. This information will was to be shared with the technology industry to influence development of products used by nurses that can increase safety and improve the patient care work environment.
3. Make available the analysis and findings through papers and presentations.
4. Work with key policy leaders in sharing the analysis to help them develop action steps for increasing patient safety and nurse work environment efficiency.

The grant support would enable the following:

- Identification of specific technology attributes (requirements definition) of new or revised technology that will address specific workflow and practice issues identified during the TD2 process.
- Identification of specific types of technology products to be developed, modified, and/or deployed in order to increase safety and improve the efficiency of the nursing practice environment.

Specific intended results of the grant were as follows:

- Completed data analysis describing workflow processes and patterns that can be improved with technology solutions.
- Present evidence to make the case for development and adoption of technologies that eliminate waste in nursing workflow patterns, creating more direct patient care time by registered nurses..
- Specify technical attributes (requirements definition) for development of new or enhanced technologies to eliminate waste and improve efficient workflow on medical surgical units
- Convene a forum where experts and industry leaders embrace the findings of the study
- Present policy recommendations for technology standardization, interoperability, and more rapid adoption in hospitals.

The deliverables were to develop a media kit, convene a forum to present results, production of a monograph, deliver presentations, and hold Webinars. The grant was funded on July 1, 2008 and was to end on January 31, 2009. A no-cost extension was granted until April 30, 2009 and a no-cost extension was awarded to be completed on October 31, 2009.

Workflow Categories

The first phase of data analysis was to process the 327 statements of workflow issue categories identified by participants during Day 1 of the TD2s. Data subcommittee members met face-to-face to accomplish this task.

A review of statements revealed several major categories of workflows. Each workflow category was written on a flip-chart page and posted around the meeting room. Consensus was reached regarding the initial list of categories. Each of the 327 statements was then reviewed to determine its theme and to which workflow category it should be assigned. That theme was listed on the flip-chart page as a subcategory under the appropriate category. If there was disagreement about placement of a statement, its theme or the category, a discussion occurred and changes were made until consensus of the subcommittee members was reached. The final eight workflow categories and examples of their subcategories were:

- Admission, Discharge, Transfer (ADT) — admissions, transfers, and discharges, patient placement.
- Care Coordination — access to prior records, care

plans/care planning, discharge planning, and patient rounds.

- Care Delivery — assignments, change in patient acuity, family & visitors, patient assessment, unplanned interventions.
- Communication — communication and care conference, incoming report, interaction with care team, support to other staff.
- Documentation — charting/charting and orders, compliance/non-compliance, information technology, orders.
- Equipment & Supplies — equipment, hunting and gathering, supplies, technology.
- Medication — medications, medication administration, narcotic count, pain management.
- Patient Movement — bed movement, bed management, patient flow, patient transport, room turnover.

The list of categories and the 115 subcategories is presented in Appendix G, Workflow Categories.

Process Issues

Analyzing workflow process issues proved to be more complicated but produced exciting results. Workflow process issue statements were generated on Day 1 of the TD2, but may have been refined by the work groups on Day 2.

Initially there were 946 statements. When duplicates were collapsed, there were 766 unique statements. ("Unique" is defined as different or non-duplicative.) As in the first phase of analysis, a review of statements revealed common themes among the statements. These common themes were labeled "key concepts." Subcommittee members collaborated to define each of the key concepts. Those definitions and examples of statements that fit the definitions are presented in Appendix G, Workflow Key Concepts Definitions. A total of 41 key concepts were identified. (Appendix G, Key Concepts).

To check the accuracy of identified key concepts, subcommittee members individually coded all statements to see if they could be placed under one of the key concepts. Virtual meetings of the subcommittee were then held to validate the codes for process issue statements. A very small number of statements were discarded because the wording was too vague or incomplete to assign meaning or a key concept to it. No statement was discarded without agreement of subcommittee members. Inter-rater reliability for coding was very high and after discussion agreement on coding reached 100 percent.

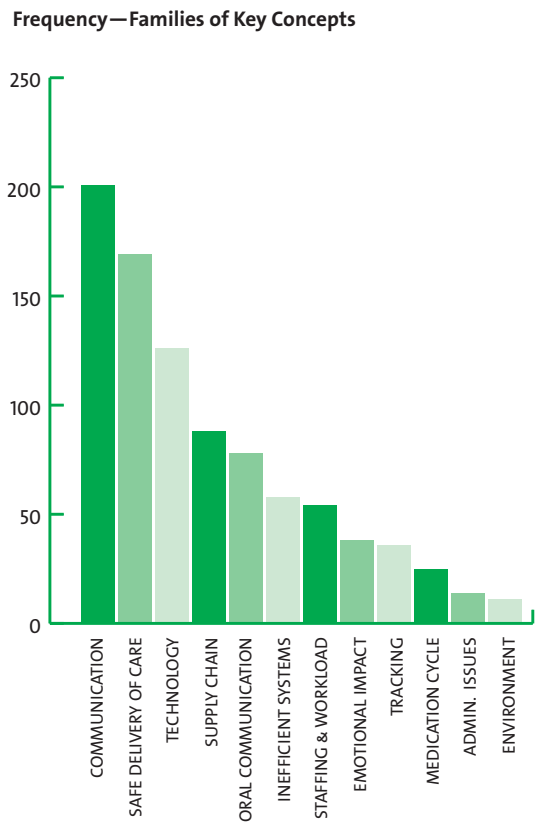
Of the 41 key concepts identified, 10 key concepts were referred to most frequently in the process issue statements. The top 10 key concepts in descending order of frequency were safety, documentation, information access, information, inconsistent process, workload, intrateam communication, orders, systems integration, and data entry.

To link the process issues to workflow categories identified in the first phase of data analysis, the key concepts were listed on a spreadsheet under each of the eight workflow categories, producing a matrix format. The matrix revealed that six of the 41 key concepts occurred in all eight workflow categories identified in the first phase of data analysis, emphasizing the importance of these process issues to TD2 participants. The six key concepts occurring in all eight workflow categories were:

- Communication,
- Documentation,
- Emotional response,
- Safety,
- System integration, and
- Waste.

Three of the 41 key concepts — information, staffing and workload — occurred in all but one workflow category. The key concepts of availability equipment, delay, education, inconsistent process, information access, interdepartmental communication, and results reporting were addressed in six of the eight workflow categories. In fact, 19 of the 41 key concepts were listed in more than half of the eight workflow categories. These results indicated many common process issues and workflow categories exist across nursing units participating in the TD2s.

When viewed as a whole, the 41 key concepts lent themselves to being aggregated into 12 "families of key concepts." Key concepts within each family are listed in Appendix G, Families of Key Concepts. Upon examining the frequency of aggregated key concepts, the results further demonstrate the similarities across nursing units conducting TD2s, as shown in the following graph.



Technology Solutions

The largest group of statements from TD2 participants concerned technology solutions. There were 1,739 original statements with suggestions for designing technology needed for idealized patient care environments that were reduced to 599 unique statements. Analysis of this data element followed a similar process to that used for process issues. Initial categorization of technology solutions required much greater detail than in previous analyses. It was necessary to code six levels of descriptors to identify the requirements for desired technology solution. Those levels were:

- Category of technology solution in the statement — i.e. information system, device, hardware, telecommunication, tool, software, or non-tech/non-infotech.
- Type of technology in the statement — 20 specific types of technology solutions were identified including bedside computer system, computerized provider order entry system, radio frequency identification device (See Appendix G, Technology Solutions Descriptors).
- Requirements 1 in statement — first specific feature that must be present in the technology solution, e.g., integrated.
- Requirements 2 in statement — second specific feature that must be present in the technology solution, e.g. voice activated.
- Function 1 in statement — functional area or workflow that would be addressed by the technology solution, e.g., documentation, communication.
- Function 2 in statement — functional area or workflow that would be addressed by the technology solution, e.g., documentation, communication.

Initially nine percent of original statements (148) were eliminated because there was not enough information to describe requirements for a technology solution. An additional 15 percent of the 599 unique statements were eliminated because they were not a technology solution. For example, statements of "rounds for equipment" and "hourly delivery" were eliminated. This left 523 statements to be further analyzed

To check the accuracy of identified descriptors, three subcommittee members individually coded all 523 statements to see if chosen descriptors could be used to accurately identify requirements for technology solutions. Virtual meetings of the three subcommittee members and the Project Coordinator were then held to validate the codes for technology solution statements. There were only six disagreements that needed to be discussed for the three coders to reach 100 percent agreement.

Once the coding was complete frequencies for each of the descriptors were determined. Because participants' language was retained throughout the analysis and phrasing varied from statement to statement, it was not possible for the computer to automatically determine frequencies from the spreadsheets. It was therefore decided to determine the frequencies using a hand count. During the counting a ruler was used to force the counters' eyes to the proper row of the spreadsheet and a calculator was used to maintain a running tally. Reliability of the count was assured by recounting three randomly selected categories. The recount produced identical numbers.

The first requirements descriptor looked at the category of technology solution needed. Since demographic data indicated nursing units were using a combination of manual and computerized systems, it is not surprising that information systems was the most frequently listed category of technology solution needed for an idealized environment. Nurses also want more devices to help them care for patients.

Table 14, Frequencies of Categories of Technology Solutions

Category	Frequency
Information system	785
Device	569
Hardware	167
Telecommunication	16
Tool	8
Software	4
Non-technology/ non-information technology	42

The next level of technology solutions descriptors was for specific types of technology. TD2 participants clearly want technology solutions at the bedside or point of care and want products to incorporate technology that helps them care for patients, particularly around orders, documentation, and tracking.

Table 15, Frequencies of Specific Types of Technology

Type Technology	Frequency	Type Technology	Frequency
Bedside	130	Smart pump	15
CPOE (order entry)	94	Wireless on wheels	14
EMR and CIS	92	Smart card	13
Tracking	76	Kiosk	6
Barcoding	69	Pyxis	5
Robot	38	Laptop/tablet	5
RFID	33	Decision support	3
PDA	32	Camera	3
Tube system	30	Data warehouse	2
MAR	25	GPS	2
Smart bed	19		

The third level of technology solution descriptors included specific features the technology solution needed to include. Participants overwhelmingly want technology that is integrated. There were many statements about current systems requiring multiple sign-on and duplicate entry of data. Secondly, TD2 participants want technology that is voice activated. Documentation could more easily be accomplished while procedures and interventions are in progress if care givers could say what they want to chart.

Table 16, Frequencies of Technology Solution Requirements

Requirement	Frequency	Requirement	Frequency
Integrated	211	Translation	34
Voice activated	133	Wireless	30
Handheld	84	Portable/mobile	25
Smart	41	Notification	19
Auto/auto populates	39	Hands free	19
Biometric	37	Interactive	16
Touch screen	37	Centralized	16

Finally, technology solution descriptors indicate what workflow functionality would be impacted most by the technology solution. A count of frequencies indicates that most commonly technology solutions would impact documentation. Since up to 40 percent of nurses' time can be spent on documentation, implementing technology to reduce the documentation burden would help nurses return to the bedside. The second most common functionality is medication administration, followed closely by communication. It was interesting to see that although report was seen as a problem for many nurses, they did not suggest technology solutions for this function. Perhaps technology vendors could develop products to help nurses give more efficient shift report. It would also be interesting to do a cost analysis on the use of technology according to the listed priorities to determine the enhancement of productivity and savings.

Table 17, Frequencies of Categories of Functions Impacted by Technology Solutions

Functional Category	Frequency
Documentation	232
Medication	167
Communication	157
Orders	109
Equipment	86
Supplies	65
Multifunction	64
Information	52
Education	51
Locator	47
Patient ID	33
Availability	30
Scheduling	28
Sign on/access	27
Report	27
Care delivery	26

D. Interpretation of Findings

TD2 participants produced more than 1,700 statements that upon analysis defined requirements for current and future technology. The suggested technology requirements would lead to four main outcomes:

Eliminate unnecessary or redundant work — develop systems that reduce the demands of documenting patient care by eliminating duplicate charting in multiple systems, automatically populate information systems with patient information already stored, automatically submit charges for supplies when they are removed from storage, use RFID to provide a current inventory of supplies and equipment, eliminate need for duplicate communication through scheduling systems, online communication and other strategies.

Provide access to resources — through tagging systems, notify direct care givers of physician availability, include two-way communication systems that allow immediate consultation with pharmacists, and include smart technology and decision support to facilitate interpretation of interventions and responses.

Accomplish regulatory work — build in data capture for required regulatory documentation, facilitate patient tracking and identification through integrated systems.

Efficient use of space — use integrated, voice activated, hand-held systems to facilitate collaboration among support staff and providers to have vacated beds cleaned, make bed assignments, and transport patients — and develop efficient equipment delivery and pick-up services to eliminate need to store seldom-used equipment needed only occasionally.

It was distressing to learn that in general nurses were disappointed with existing technology, indicating that they often have to develop "work arounds" that take time away from their patients. TD2 participants clearly stated that hospital executives and technology vendors need to "listen to the voice of the staff." The staff has definitely become sophisticated in their ability to say what technology works for them in delivering care and what increases their workload.

The Workforce Commission believes TD2 results reflect the following observations about the practice environment:

- Registered nurses practice with a very complex workflow;
- Practice environments can be described as chaotic;
- Use of combined electronic and paper systems present significant challenges;
- Non-compatible technologies may compromise safety;
- Systems and devices must be user-friendly;
- Care givers need a system that allows rapid retrieval of data; and
- There is a need for efficiency at the point of care.

In summary, **nurses want** specific characteristics in technology solutions:

- **Systems to provide tracking, documentation, and communication;**
- **Integrated systems with interoperability ;**
- **Needed functionality that eliminates "work-arounds"; and**
- **Features of voice activation, hand-held capability, "smartness", and bedside availability.**

Nurses no longer want to be passive consumers of technology. This is a great opportunity for health care providers, direct care providers and technology vendors to partner around developing better functionality for electronic and information systems and devices used in care delivery.

E. Dissemination of Findings

Beginning in 2002 and continuing throughout the technology targets projects, the Workforce Commission disseminated findings to appropriate audiences, including software manufacturers and the larger nursing community. Examples are provided below, with the complete list in Appendix I, Dissemination of Findings.

For example, presentations were been made to government agencies and public-private partnerships such as the Institute of Medicine, Food and Drug Administration, and the American Health Information Community. To reach the technology specialists and technology vendors, Commission members presented results to the American Medical Informatics Association and Health Information Management Systems Society membership. Through the American Nurses Credential Center (ANCC) National Magnet Conferences, the American Organization of Nurse Executives meetings and the International Council of Nurses, for example, Workforce Commission members shared the important findings with nurses.

The results of the project and the implications for the technology industry were disseminated in a series of presentations to American Organization of Nurse Executives Transforming Care at the Bedside Hospitals in November 2008, the AONE TCAB Community in June 2009, HIMSS in April 2009 and National Quality Forum (NQF) in March 2009.

As a result, 67 institutions have used the TD2 framework to identify their needs for technology and to communicate to potential technology providers the priorities for deployment of that technology. Several technology manufacturers have agreed to use the TD2 process in their engagement of nurses within facilities in the system design, build and implementation of their technology products. Epic Systems Corporation is one example. The NQF presentation discussed the use of TD2 to identify wasteful practices and opportunities to improve practice efficiency through the implementation of the solutions identified from the TD2 work.

Slides from the presentations (Appendix I, Presentations) have been shared with conference attendees as handouts or as postings on organizations' web sites. Slides presented at the ANCC Magnet Conference in October 2008 are available in Appendix I, Magnet Conference Slides

In 2003, the background papers and conference results for *Using Innovative Technology to Enhance Patient Care* were published as a supplement in the May/June issue of *Nursing Outlook*. Besides the supplement and this monograph, there have been four additional publications that have discussed the Technology Targets projects. The three journal articles are available in Appendix I, Publications.

- "President's Message: Innovative Solutions to the Nursing Workforce Shortage" Margaret McClure, *Nursing Outlook* September–October 2002.
- "American Academy of Nursing/American Organization of Nurse Executives Workforce Commission Technology-Enhanced Nursing Practice Project" Carole Gassert and Linda Burnes Bolton, *Nursing Outlook* — May 2005.
- "Using Technology to Mitigate the Nursing Shortage" Linda Burnes Bolton and Pat Moritz, *Policy and Politics in Nursing and Health Care*, 5th Edition — 2007.
- "Smart Technology, Enduring Solutions: Technology Solutions Make Nursing Care Safer and More Efficient" Linda Burnes Bolton, Carole Gassert and Pamela Cipriano, *Journal of Health care Information Management* — Fall 2008.

Related publications include:

- "Technology and Nursing: A Love/Hate Relationship" Judy Murphy, *Journal of Health Information Management*—volume 23/number 2, Spring 2009.
- "A Proclamation for Change: Transforming the Hospital Patient Care Environment" Ann Hendrich, Marilyn Chow, and Wendy Goshert, *JONA*—volume 39, number 6, June 2009.

In addition, the Workforce Commission has promoted public policy interactions. When initial results were available, The Academy of Nursing and American Organization of Nurse Executives held a press event in November 2007 that generated discussion about the projects and expectation for the final results.

To broaden dissemination, the Workforce Commission has developed a media kit that explains the purpose of the technology targets projects and gives overall results (Appendix I, Media Kit). There were two media releases about the technology targets projects (Appendix I, Media Releases):

- New Program Gears Up to Optimize Nursing Care — January 24, 2006.
- The American Academy of Nursing Calls for the Thoughtful Development and Deployment of Health IT — March 4, 2009.

Given the federal interest in funding and implementing information systems in relation to the economic stimulus plan and health care reform and it is important to disseminate the findings of this work beyond nurses, informatics specialists, and the technology vendors. It is exciting to see nationally supported efforts to make technology available in patient care settings. But as the Technology Targets studies show, we need to implement appropriate technology that meets the needs of care givers. To accomplish this goal, the Workforce Commission has developed a business case (Appendix I, Business Case) for health care executives and the American Academy of Nursing has issued a policy statement (Appendix, Policy Statement) regarding the development of appropriate technology for nursing practice environments.

VI. Synergy with Time & Motion and Transforming Care at the Bedside Studies

The three studies, Time & Motion, Transforming Care at the Bedside (TCAB) and Technology Drill Down (TD2) have several areas of commonality. Data collection occurred at some of the same sites. Eight of the 25 TD2 sites (32 percent) also participated in the TCAB study and 10 of the TD2 sites (40 percent) were part of the T&M study. Although all of the projects focused on acute care medical surgical nursing units and were concerned about increasing patient safety and improving the nursing practice environment, the individual project goals differed. All three studies intended project outcomes to be used to improve the practice environment.

Goals of the TD2 studies were to implement an improved **process** for identifying technological solutions to medical surgical unit workflow inefficiencies and to accumulate a wealth of data that when disseminated would capture the attention of the technology industry and prompt it to develop technologies that improve workflow processes. TCAB focused on improving the quality and safety of patient care and increasing retention of experienced nurses. The Time and Motion study determined how medical surgical nurses spent their time on 36 nursing units and how the architectural structure of those units influenced nurses' use of time and distance traveled to accomplish their work.

In the Time and Motion study, documentation accounted for 35 percent of nursing practice time. In TD2 documentation was identified as one of the six most common process issue key concepts, occurring in each of the workflow categories. Documentation in TD2 was also a workflow category. The T&M study identified three main targets for improving the efficiency of nursing care as documentation, medication administration and care coordination, all found to be key concepts when analyzing workflow categories in TD2. The three target areas were also found to be high leverage changes for TCAB. Documentation was identified with the key design theme of value-added care processes, medication administration was part of the safe and reliable care design theme, and care coordination was recognized as part of the patient centered care design theme.

Other high-leverage changes for value-added care processes in TCAB such as physical space design, optimizing inventory, eliminating waste and continuous flow of information were identified as process issue key concepts in TD2. Participants in TD2 suggested technology solutions such RFID devices, bedside computers, equipment and supplies in patient rooms, and integrated information systems to improve practice environments relative to workflow process issues.

In the final phase of the Technology Drill Down work, 67 AONE TCAB sites used the TD2 process to drive workflow process changes and identify areas where technology could enhance safety and care delivery. The specific blending of TCAB and TD2 methods shows promise for expediting implementation of revised workflows and serving as a catalyst for adopting technology with improved functionality at the point of care.

The three projects found that although there was considerable overlap in participating health care organizations and on nursing units, there was individuality among the participating units. Common findings suggest, however, a list of areas that need to be changed to improve efficiencies and safety in the practice environments.

VII. Conclusion and Impact of Technology Targets Projects

A follow-up survey was sent to each of the TD2 participating sites to determine what effect the TD2 process had on their organizations. Responses were quite positive. Within six months of the TD2, more than half of the 25 sites indicated the outcomes of the TD2 had been incorporated into their organization's goals. Nineteen (76 percent) of participating sites reported that specific improvements related to the TD2 outcomes had been included in the coming year's budget. A sample of comments about how the TD2 process impacted the unit participating in the TD2 are:

- Became more aware of the growing need to have systems that are fully integrated and can communicate bi-directionally and populate information into one central record.
- Awaiting the implementation of full EMR and Pyxis medication dispensing system.
- Not now but will as part of the process improvement initiative.
- Allowed the staff to think outside the box and envision what the environment could be. When we talk about improving the environment we talk about "our ideal" and then how we can make it happen.
- Looking to incorporate more technology into unit.
- It was useful in gaining nursing input into technology directions for the future.
- It helped identify process to improve timeliness and patient care, i.e., supply carts, medication administration times and methods.

TD2 sites indicated they had implemented or were planning to implement the following systems:

Type of System	Number	Percentage
Barcoding/RFID for supplies	3	6
Barcoding/RFID for medication administration	13	25
Electronic health record enhancements	17	32
Communication devices	12	23
Simplifications to medication delivery, administration	8	15

The technology targets projects focused on strategies for using technology to reduce the demand on nursing. Building systems with identified features will reduce the physical demand or burden of work for nurses and increase their retention, particularly with the aging workforce. The nursing demand will also be reduced by eliminating waste in nursing workflow that result from inefficient work patterns, interruptions, missing supplies, equipment and medications, and inaccessible information or documentation.

Study findings suggest how technology can be developed to return nurses to the bedside to increase their direct care time. Adding identified features to technology will also reduce opportunities for error in areas like medication administration, communication, patient identification, and timely acquisition of equipment and supplies.

Findings from the technology targets studies can be used for the development of health policy. For example, findings support health information system standards for interoperability, facilitate adoption of technology as an adjunct to other quality and safety measures, set industry standards for communication, and enable portability of health information.

TD2 participants clearly indicated they want to be part of purchasing decisions about technology solutions. Findings can galvanize purchasers of technology to demand products are patient and nurse friendly, affordable, and include suggested features that are tested before purchase. Findings likewise can increase the buying power of technology purchasers so products support interoperability, achieve communication integration and achieve workflow process and safety improvements.

In summary the following statements are supported by findings from the seven years of work on the technology targets projects:

- Improving the practice environment is essential to retaining nurses, providing safe patient care and increasing the direct time nurses spend with patients.
- Using the TD2 process, facilities can identify inefficient and burdensome workflow processes in their institutions that could be improved with technology.
- Nursing-Technology development partnerships are vital for redesigning our future practice environments.

One of the most important insights and recommendations from this work is the need to incorporate the perspectives of nurses when designing and deciding on which systems to purchase. Without this input, technology systems may not achieve the goals of maximizing productivity, reducing demand, promoting safety and improving quality of care. Limiting input into technology systems to the C-Suite alone, and not including the users and frontline providers, could lead to expensive, inefficient and cumbersome workflow processes.

VIII. Acknowledgements

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Appendices on CD-ROM