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The Effects of an Electronic Whiteboard on Transfer Process Efficiency and Staff Satisfaction in an Interdisciplinary Proton Therapy Practice

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THE EFFECTS OF AN ELECTRONIC WHITEBOARD ON TRANSFER PROCESS EFFICIENCY AND STAFF SATISFACTION IN AN INTERDISCIPLINARY PROTON THERAPY PRACTICE

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This DNP Project, submitted by Tammy Buchanan in partial fulfillment of the requirements for the Degree of Doctor of Nursing Practice from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

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Dr. Gayle Roux, Dean of the College of Nursing and Professional Disciplines

PERMISSION

Title	*The Effects of an Electronic Whiteboard on Transfer Process Efficiency and Staff Satisfaction in an Interdisciplinary Proton Therapy Practice
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Abstract

The complex needs of the anesthetized proton therapy patient population, combined with challenges in interdisciplinary communication and metric acquisition, caused inefficient workflow processes within a large, newly-founded Midwestern academic proton therapy practice. Using the implementation of an electronic whiteboard patient tracking tool known as the Eboard, the overall goal of the project was to improve workflow efficiency and staff satisfaction among members of the interdisciplinary care team. The subjects included 90 radiation oncology, nursing and anesthesia staff administering care to patients who required anesthesia sedation to complete their proton therapy treatments. To review workflow efficiency, transfer times from the preoperative area to the treatment area were evaluated in the anesthetized proton therapy patient population before and after the implementation of the Eboard. Additionally, a five-point Likert scale survey was used to evaluate staff satisfaction among the interdisciplinary care team pre- and post-implementation. The study found that the Eboard was successful in decreasing transfer process times and increasing staff satisfaction within the interdisciplinary care group.

Keywords: efficiency, electronic whiteboard, interdisciplinary, proton therapy, satisfaction, workflow

The Effects of an Electronic Whiteboard on Transfer Process Efficiency and Staff Satisfaction in an Interdisciplinary Proton Therapy Practice

The complex needs of the anesthetized proton therapy patient population, in combination with challenges in interdisciplinary communication and metric acquisition, caused inefficient workflow processes within an interdisciplinary proton therapy practice. The implementation of an electronic whiteboard (EW) patient tracking tool known as the Eboard, resulted in enhanced workflow and improved staff satisfaction among members of the interdisciplinary care team. This paper reviews the significance, design, and analysis of the Eboard implementation. It includes a literature review of electronic whiteboard technology and how it can enhance patient care, workflow efficiency, and interdisciplinary collaboration.

Background and Significance

Proton therapy has emerged as the most precise and advanced form of radiation therapy today. It is especially beneficial in cases of pediatric cancers leading to better control of radiation doses, shortened radiation times, sparing of healthy tissues, and reduced side-effects (Mayo Clinic Proton Beam Therapy Program, 2017). However, proton therapy treatments are lengthy, intense, and risk prone. Each of the 20- plus consecutive treatments requires up to 120 minutes of stationary positioning, and encompasses transitions to multiple care areas to complete. To facilitate this type of treatment in young children, or those patients who could not otherwise remain motionless, each treatment is combined with sedation anesthesia.

Each anesthetized proton therapy patient’s treatment begins in the preoperative care area where they are prepared for their daily treatment and anesthesia sedation care. Concurrently, during this time radiation treatment therapists ready immobilization devices, treatment table tops, and review treatment plans prior to the patient’s arrival in the treatment area. Once the proton beam and all equipment needed for treatment are ready, radiation treatment therapists call for the patient. This step is quickly followed by the induction of anesthesia from an anesthesia care team consisting of a nurse anesthetist and pediatric anesthesiologist. After induction the patient is relocated to a special proton therapy table top where a portable monitor displays critical information regarding the patient's status as they are transferred between treatment areas. Patients are transferred a minimum of two times, and a maximum of five times for each treatment. Patients are remotely monitored during the majority of their treatments, due the radiation exposure risk posed to staff caring for the patient. Once the patient has successfully completed their proton beam treatment, they return to the post-operative recovery area where they will be monitored as they awaken from the sedation anesthesia. When discharge criteria are met, the patients are free to leave and pursue their daily routines, which often include additional medical appointments and chemotherapy. The proton therapy patient's treatment journey is highlighted in *Appendix A.*

The Problem

The specialized needs of this unique patient population necessitate coordinated and efficient interdisciplinary care to prevent poor patient outcomes and utilize resources appropriately. The complex needs of the patient population – in combination with challenges in interdisciplinary communication and metric acquisition – resulted in inefficient workflow processes in the anesthetized proton therapy practice, which caused:

- treatment delays;
- prolonged anesthesia and recovery times;
- inappropriate utilization of proton staff and equipment;
- dissatisfaction among staff and patients;
- inadequate metric acquisition and financial reimbursement;
- and threats to patient safety.

Definition of the Transfer Process

For the purpose of this capstone project the patient transfer process was defined as the collaborative readiness of all interdisciplinary team members and equipment, followed by the induction of anesthesia and transfer of the anesthetized patient to a separate physical treatment area. The transfer of the patient to multiple, separate treatment areas introduced the opportunity for medical errors and oversights. Given that these patients are unable to advocate for themselves, accurate provider-to-provider handoffs are principle to the safety of the anesthetized patient population. Utilizing the existing coordination and communication tools available, the mean transfer process time was calculated to be approximately 55 minutes.

Complexity of the Patient Population

Adding sedation anesthesia to the treatment regimen of this complex patient population necessitated additional resource availability. The treatments themselves are lengthier, so additional pre- and post-anesthesia space is needed, and equipment and personnel trained in the care of anesthetized and pediatric patients must be present at all times (McMullen, Kerstiens, & Johnstone, 2014). Additionally, the physical, social, and emotional needs of the patient population required care providers - such as child life therapists and social workers - to be present.

During its first year of service the proton therapy center included in the study treated 549 patients. Initially only 8% of the total proton therapy patient population required anesthesia sedation, however, by the eighteen month milestone 15% of patients required anesthesia sedation to complete treatments. These additional patient needs, in combination with the increase in population, exacerbated the need to utilize available resources more effectively and efficiently.

Lack of Data Acquisition

Workflow process times within the proton therapy center became difficult to evaluate due to a lack of networking between interdisciplinary information systems. Patient and process data were not easily captured, which resulted in the absence of process reviews and patient flow evaluation. Metric acquisition was crucial to enhance optimization of patient care regimens, maximize financial reimbursement, and validate the need for additional space, equipment, and personnel.

Physical Communication Barriers

Due to several physical communication barriers unique to the proton therapy treatment area, collaboration and communication between disciplines was adversely affected. Each treatment area is separated by eight-foot thick walls. This physical barrier resulted in decreased reception of wireless communication options as shown by a failed voice over internet protocol (VOIP) device trial, and suboptimal hand-held device reception. To assist with communication, a call light system was used to relay information pertaining to the timing of care activities; however, this system was not fulfilling its requirement to communicate timely, accurate information. A review of this system’s utilization found it to be erratic, with the average call light being left on three-to-four times longer than in similar procedural areas. In addition, the lack of adequate communication lead to frustration and dissatisfaction among interdisciplinary staff. This finding was substantiated by a staff survey which found that 42% of the staff believed they lacked the appropriate tools to communicate efficiently between disciplines.

The Solution – the Eboard

The goal of this capstone project was to improve transfer process efficiency and staff satisfaction among interdisciplinary staff caring for the anesthetized proton therapy patients through the implementation and use of the Eboard. The Eboard is an electronic whiteboard patient tracking tool that utilizes the patient electronic health record (EHR) to provide reliable and relevant information to users (*Appendices B & C*). Staff use the Eboard to communicate and coordinate patient care activities. The primary benefit of the Eboard is the ability to communicate accurate patient information to all staff involved during critical times of transition. This is especially true in a complex patient population such as the anesthetized pediatric proton therapy patients.

Literature Review

The literature review was conducted through the University of North Dakota's Harley French Library, and the Mayo Clinic's Plummer Library, using PubMed, Medline, and Google Scholar databases and health-care journals that met evidence-based standards. Initial search terms included "Efficiency", "Interdisciplinary", "Workflow", and "Electronic Whiteboard". Multiple refined searches using various Medical Subject Heading terms were added, as well as the application of appropriate language and time limitations. Eighteen articles that pertained to the use of EW technology, like the Eboard, in interdisciplinary care were chosen for full review. In addition, several articles pertaining to the care of the anesthetized proton therapy population and the role of health information technology (HIT) in providing safe and efficient patient care were analyzed.

Health Information Technology

While technology is often implemented as a means of increasing revenue in healthcare it has not been frequently applied as a tool for providing high quality, safe, efficient, patient-centered care. Therefore, an initial goal of the literature review included institutional quality and safety reviews, as well as federal policies and standards regarding the integration of HIT. In 2000, the Institute of Medicine (IOM) report, “To Err is Human”, found that “commonly, errors are caused by faulty systems, processes, and conditions that lead people to make mistakes or fail to prevent them”. System issues that were implicated in medical errors included “multiple care providers in multiple locations with access to incomplete information, delays in receiving information, and a lack of clinical decision support tools” (IOM, 2000). The seminal finding by the IOM led to federal mandates and continued publications citing HIT as playing a key role in high quality, safe, efficient, patient-centered care (IOM, 2001). Additional federal institutions and policies called for improving health care coordination and quality while reducing costs through the implementation of HIT (Nelson & Stagger, 2014). These initiatives include:

- ensuring that appropriate information to guide medical care is available at the time and place of care;
- reducing medical errors and advancing the delivery of care;
- reducing healthcare costs resulting from inefficiency, medical errors, and inappropriate care;
- and improving the coordination of care and information among health care providers (Nelson & Stagger, 2014).

These findings highlight similar issues identified in the Midwestern proton therapy center and call attention to the advantages that technology can bring to a complex practice site. The data retrieved by the Eboard system can enhance workflow and efficiency processes within the practice. Additionally, the real-time location capabilities afforded by the Eboard can increase interdisciplinary communication and coordination among staff. The benefits have the potential to enhance patient care and safety, as well as decrease frustration among staff.

Electronic Whiteboard Technology

Articles found regarding the effects of EW technology on collaboration, efficiency, and interdisciplinary care are characterized by five major areas of research: systemic review of literature, effects to workflow and processes, effects to providers, effects on communication and collaboration, and implementation of the technology.

Systematic Review of Literature

Systematic reviews of literature by Lopes, Balancieri, Manica, Teixeira and Dias (2014), and Randell et al. (2015) highlighted the processes, techniques, methods, practices, tools, implementation, outcomes and difficulties for the use of EW technology. While positive impacts on care processes were identified, both authors found an absence of evidence concerning impact on patient outcomes. Both authors agreed to the need for additional research outside of emergency departments and peri-operative areas. Furthermore, these authors identified a research gap regarding the most appropriate way to measure the outcomes afforded by EW technology. Ethnography, time intervals, and user satisfaction have all been used as measured outcomes, however, no validated tool is available to capture the complex processes that real-time patient tracking brings to a dynamic practice area.

Benefits to Workflow and Processes

While the systemic reviews highlighted broad aspects of such technology, several articles were found that supported the benefits to workflow and processes afforded by EW technology.

These systems are instrumental in improving workflow through the knowledge of location and activity. However, they do not dictate care or movement, but rather foster decisions made based on the judgements of individual care providers and the knowledge of their environment. In 2011, Drazen and Rhoades released an issue brief for the California Health Care Foundation that reviewed the use of tracking tools to improve patent flows in hospitals. They found that the benefits of implementing such solutions are well-documented and include:

- increased patient throughput;
- decreased length of stay;
- improved gathering of research and treatment data;
- improved utilization of resources (people and equipment);
- improved capture of revenue indicators and claims through record accuracy;
- and higher patient satisfaction rates (Drazen & Rhoades, 2011).

Benefits to Care Providers

The benefits of EW technology not only apply to workflow processes, but also extend to those providing care. EW tracking systems provide the technology for making collaboration across multiple disciplines and locations more efficient (Bardram & Hansen, 2010). This is achieved through the provision of situational awareness - including spatial, social, and temporal awareness of individual patients, providers, areas, and activities. Furthermore, it allows caregivers to visualize their workload, store status and scheduling information, communicate tasks and updates, and reference issues during collaborative discussions (Bardram & Hansen, 2010). Qualitative research by Bardram & Hansen in 2010 found that 70% of all working clinicians agreed that the EW provided easier access to critical information, while 87% agreed that they had a better overview of the work to be done. Similarly, in 2009, Wong, Caesar, Bandali, Agnew, and Abrams measured pre- and post- workflow analysis, user feedback, and free text comments added to the EW. Approximately 71% of survey participants believed that the EW improved and standardized communication with the care team (Wong et al., 2009). In 2011, Drazen & Rhoades found that the benefits of EW technology extended to the staff utilizing it, and included:

- improved patient and practitioner understanding of the care process and visit progression;
- improved staff morale and personal accountability;
- improved performance with accreditation agencies and quality measures;
- improved record keeping and therefore decreased liability;
- and increased patient safety, patient and family satisfaction and education.

EW technology can assist in the building of solid interdisciplinary teams through enhanced coordination, communication, and increased patient flow and safety. Combined with unit specific process improvements, EW technology has the power to optimize operations planning and maximize resource efficiency.

Data Acquisition Abilities

Efficiency and optimization hinge on the facilities desire and ability to acquire the measurement of key metrics such as room utilization, patient wait times, resource utilization, and scheduling information. Improved recording of treatment costs and charges, as well as resource allocation can be succinctly captured through the time stamped data accrued using EW technology. Meaningful use data, research data, and provider outcomes can also be tracked to provide continuous improvement by the interdisciplinary team. Overall, tracking systems reduce costs by improving operational efficiency when combined with lean practice, workflow reviews and flow simulation (Boulos & Berry, 2012).

Implementation

Implementation of technology can often be challenging in a complex interdisciplinary environment. The EW technology's user friendly platform and clear displays make implementation straightforward and low-risk. Design and implementation of EW technology was reviewed by Aronsky, Jones, Lanaghan, and Slovis in 2008. They found that when properly implemented the patient centric data offered by such technology helps to improve the efficiency of patient flow, create transparency and accountability, optimize information management, and maximize effective communication (Aronsky et al., 2008). Similarly, in 2009 Wong et al. investigated design and implementation of an EW. They found that EW technology was an effective tool to support collaborative work by providing mutual awareness, articulation, and ongoing management of activities performed by interdisciplinary teams. They believed that EW technology "has the ability to transform the healthcare process to a more timely and integrated experience; effectively increasing patient flow, safety, and satisfaction" (Wong et al., 2009).

Project Purpose

The overall goal of the project was to improve workflow efficiency and staff satisfaction among members of the anesthetized proton therapy interdisciplinary care team through the implementation of an electronic whiteboard patient tracking tool known as the Eboard. Two specific goals were identified to attain the project purpose.

The first goal was to improve process-efficiency by reducing transfer process times. The related objective was as follows: by April 23, 2017, improved transfer process-efficiency would be demonstrated through a statistically significant reduction in the mean transfer process time.

Evidence to support this outcome was to be gathered by a random, one-month retrospective chart review pre-implementation, and a three-month prospective review of data collected after implementation of the Eboard occurs. The project evaluated time-data that were related to the transfer process of the anesthetized proton therapy patient's care (*Appendix D*).

The second goal was to improve the satisfaction of the patient transfer process among interdisciplinary staff caring for the anesthetized proton therapy patients. The related objective was as follows: by April 23, 2017, improved satisfaction related to the transfer process among interdisciplinary staff caring for the anesthetized proton therapy patient would be demonstrated. This outcome would be evidenced by statistically significant decrease in scores on a voluntary, five-point Likert scale pre- and post-implementation interdisciplinary staff satisfaction survey.

Theoretical Framework

Implementations of technology-based tools within an interdisciplinary patient care area are complex processes. Following a theoretical framework can provide guidelines for engaging individual and organizational support. In addition, the guidelines serve to enhance and expedite the adoption of technology into everyday practice. Theoretical foundations for this technology-based implementation were borrowed from John Kotter's eight-step change model (Kotter, 1996). The model assumes predictability and manageability of the change process, and therefore was utilized to support successful implementation of the Eboard (*Appendix E*).

The first phase of Kotter's change theory required "creating climate for change" (Kotter, 1996). This was achieved through interdisciplinary departmental meetings that included key leadership members of the radiation oncology, anesthesia and nursing teams. Through discussions regarding current struggles including scheduling oversights, equipment needs, and increasing census, a sense of urgency was created. An internal guidance coalition was created with the addition of input from operations management, engineering and information technology (IT) colleagues. It was surmised that the practice could benefit from the patient center data attainment, increased interdisciplinary communication abilities, and real-time decision making capabilities supported through the use of the Eboard.

The second phase of Kotter's change theory necessitated "engaging and enabling the organization" (Kotter, 1996). Champions from each discipline were engaged to learn more about what the Eboard could do for the proton therapy practice. The concerns and ideas of this group were then reiterated to IT counterparts so that the data attained and information communicated by the Eboard would be practice-specific. Collaboration, accountability, and the use of data acquisition to advance the practice were highlighted as benefits of the forthcoming implementation. The opportunity for interdisciplinary education during a "lunch and learn" session served not only as a mass communication event, but also the achievement of a short-term progress goal in engaging a wider organizational support for the Eboard initiative.

The final phase of Kotter's change theory called for "implementing and sustaining the change". After education of the interdisciplinary team, implementation of the project moved swiftly; consequently, the Eboard was well-received by staff in all disciplines. To solidify the change, monthly reminder and update emails were sent to group. This action kept the project in the focus of the group and helped to celebrate short-term wins.

Design and Methods

Setting

The proton therapy practice in this DNP project has been in operation since 2015. It is located within a large, midwestern, academic institution. The institution is "a nonprofit organization committed to clinical practice, education, and research" (Mayo Clinic, 2017). In alignment with its mission, there is an overall goal to advance the science of proton therapy from research, patient care, education, and leadership within the institution and from its benefactors. The benefits of proton beam therapy are in direct alignment with the institutional mission and values, and unite them with the necessity for innovation and collaboration among disciplines. A SWOT analysis for the institution in which the proton therapy practice is located was developed specific to the implementation of the project (*Appendix F*).

Approval and Security

Institutional review board (IRB) approval from the University of North Dakota was obtained by the principal investigator. The institution that houses the proton therapy center deemed this project to be a quality-improvement effort and did not require additional IRB approval.

All data collected from this project were viewed on a secured password required network, recorded on an encrypted spreadsheet, and stored on an encrypted password protected flash drive. All consents were stored in a locked cabinet in a locked office. Only the DNP student and institutional statistician could access this information. Data will be stored for a minimum of three years after data analysis is complete; or for a duration that is sufficient to meet federal, state, and local regulations, sponsor requirements, and organizational policies and procedures.

Participants and Sampling

Interdisciplinary staff participating in the transfer process include care providers from: radiation oncology therapists, anesthesiologists, certified registered nurse anesthetists, and registered nurses. These care providers were an integral part in the transfer and care of the anesthetized patients from the preoperative area to the treatment area. Approximately 90 interdisciplinary staff met inclusion criteria. Sampling included a one group, non-random, total participation of interdisciplinary staff caring for the anesthetized proton therapy patient population. The DNP student was responsible for recruiting all subjects who fulfilled the requirements, and utilized departmental resources and meetings as a means for recruitment and education of the qualifying participants.

Subject participation in this project was voluntary and all data collected will continue to be kept completely confidential. Participants were made aware that they were free not to answer any questions, or withdraw from the project at any time. Participant-specific data were not collected by use of the Eboard system. Using a redcap survey, the individual identity of staff satisfaction survey participants was hidden from the primary investigator.

It was deemed that there could be a possible risk of increased emotional and psychological stress to the participants as they learned to use the Eboard and respond to the staff satisfaction survey. These risks were not considered as being more than “minimal risk”. Every effort was made to provide a comfortable, non-threatening, learning and working environment for the participants. Additional assistance for adverse outcomes due to this project were available from the institutional employee assistance program.

Design and Measures

The overall goal of the project was to improve workflow efficiency and staff satisfaction among members of an interdisciplinary care team through the implementation of an electronic whiteboard patient tracking tool known as the Eboard. To evaluate the goals set forth by this project an observational, one-group pre- and post-test study, and employed non-random sampling technique with total subject group participation was utilized.

To measure the effects that the Eboard had on transfer process efficiency, mean transfer process times were compared pre- and post-implementation. This comparison included retrospective data from a random one-month pre-implementation time period *(Appendix G)* and prospective data from the three months following implementation of the Eboard technology (*Appendix H*). Quantitative time data were collected from the patient's electronic health record, the anesthesia call light system, the interdisciplinary procedural schedules, and the Eboard program. Once the "time-in-minutes" data were gathered, it was reported as mean transfer process times.

Interdisciplinary staff satisfaction was evaluated using a nine-question pre-implementation and a ten-question post-implementation, voluntary, staff satisfaction survey (*Appendices I & J*). The voluntary, five-point Likert scale survey investigated participant satisfaction in relation to the transfer process of the anesthetized proton therapy patients. Pre- and post-implementation survey results were reviewed by the institutional statistician and the primary investigator and assigned a score based on participant answers *(Appendix K).*

Tools

A five-point Likert scale survey was used to examine interdisciplinary staff satisfaction in relation to the transfer process of the anesthetized proton therapy patients. The survey consisted of a nine-question pre-implementation and a ten-question post-implementation, voluntary, staff satisfaction survey. Satisfaction of the interdisciplinary staff was recorded regarding three key factors: coordination, communication, and efficiency. With respect to interdisciplinary coordination, pre-implementation question number six corresponded to post-implementation question number one. With respect to interdisciplinary communication, pre-implementation question number seven corresponded to post-implementation question number two. With respect to interdisciplinary efficiency, pre-implementation question number eight corresponded to post-implementation question number three. Each survey was assigned a score based on the participants answers, with one being strongly agree, and five being strongly disagree. Statements were worded in a positive manner; therefore, a lower score would indicate improved interdisciplinary staff satisfaction. In addition, a section for recording demographics (i.e.: age, discipline, and education level), and a comment section for opinions and thoughts was included. The survey was sent out via an email link to a redcap survey, the use of which was to protect the anonymity of all participants. The data were obtained one week prior to implementation of the Eboard and again, three months after implementation of the Eboard.

Procedure for Implementation

The implementation of the Eboard was conducted over a five-month period. A detailed project timeline can be found in *Appendix L*. The principal investigator obtained consent to participate from all subjects who met inclusion criteria. A pre- implementation, staff satisfaction survey was sent out to all participants. Participants were given one week to return these surveys. Sixty-three of the 90 surveys sent out were returned which resulted in a 70 % participation rate. One week following the distribution of the initial staff satisfaction surveys, the official start date for the implementation of the Eboard was announced. This announcement occurred at participating staff members' weekly meetings. Educational sessions regarding the use of the Eboard were scheduled simultaneously.

Given that both anesthesia and nursing groups had prior experience with utilizing the Eboard, a formal educational session was not needed for these groups of participants. Instead, one week prior to the official implementation date, a reminder email was sent out to this population regarding the Eboard start date. One week prior to implementation, a "lunch-and-learn" educational session was provided for the radiation treatment therapist (RTT) subjects. Education was critical for this subject population, since RTTs had not previously utilized the

Eboard technology. This session used a PowerPoint presentation format to inform the subjects on the appropriate use of the Eboard system. Forty-five of the 50 (90%) radiation staff attended the educational session. In addition, a follow-up email with specific directions for use of the Eboard system was also sent to this population the same day.

One week following the announcement and educational sessions, official implementation of the Eboard occurred. Data acquisition began on the same day. Data acquisition continued for three months after implementation. The DNP student was on-site to assist and to answer any questions that arose upon implementation. One day prior to its initial implementation placard reminders were placed on each Eboard designated desktop to reinforce the use and adoption of the Eboard technology. Continued positive milestones and reinforcement of the Eboard's use were recognized on a regular basis by the primary investigator.

Following the final day of data acquisition, a post-implementation staff satisfaction survey was sent to all participants. Participants were given one week to return these surveys. Thirty-two of the 90 post-implementation surveys were returned resulting in a 35% participation rate.

Dissemination of the results to the group is tentatively slated for August, 2017. This should provide sufficient time for the DNP student to meet with proton therapy leadership and discuss findings, as well as future implications prior to revealing the results of the project to the subjects. Dissemination will occur at weekly departmental meetings, and a poster presentation is planned for the October 2017 Nurse Anesthesia Conference at the Mayo Clinic.

Data Analysis and Interpretation

Two specific goals were identified to attain the project's purpose of improving workflow efficiency and staff satisfaction through the implementation of the Eboard. The first goal was to improve the efficiency of the mean transfer process time among those patients receiving anesthesia to complete their proton therapy patients. The second goal was to improve the satisfaction of the transfer process among interdisciplinary staff caring for the anesthetized proton therapy patients.

Statistical Analysis

An observational, one-group pre- and post-test study, and employed non-random sampling technique with total subject group participation was used to measure the first DNP project goal. Convenience sampling of the transfer process time data for the one-month pre-implementation, and the three-month post-implementation were reviewed. Prior to the implementation of the Eboard, data acquisition was challenging, due to the lack of networking between current interdisciplinary information systems. Therefore, a one-month, random retrospective chart review of pre-implementation data was considered and ultimately determined to be sufficient for comparative analysis purposes. A corresponding analysis was conducted for the three months, post-implementation period. All values measured were nominal time variables. A Shapiro-Wilk test indicated that the scale sample data were normally distributed, so the mean transfer process times were statistically compared by use of an independent--samples ***t***-test. Descriptive statistics were used to determine the values of the mean, standard deviation, and coefficient-of-variation (*Appendices M, N, & O*). Because the research hypothesis was directional (i.e., that the Eboard would improve efficiency by reducing transfer times), one-tailed tests were performed at an alpha-value of .05.

To measure the second goal, in relation to the staff satisfaction survey, data were gathered from a voluntary pre- and post-implementation five-point Likert scale interdisciplinary staff satisfaction survey regarding transfer process. Tabulated scores from three corresponding questions regarding coordination, communication and efficiency of the transfer process were compared pre- and post-implementation. The staff satisfaction Likert scale data were able to be treated as scale data for analysis, having been determined to be normally distributed via a Shapiro-Wilk test. Responses to the three comparison questions were summarized using descriptive statistics, and then compared between time periods using the independent-samples ***t***-test, given that the sample data met the normality requirement (*Appendices P & Q*). Given that the directional hypotheses (i.e., the Eboard will improve staff satisfaction by increasing interdisciplinary coordination, communication, and efficient care), the significance of one-tailed tests performed at an alpha-level of .05 would be considered statistically significant.

Interpretation

Pre-implementation retrospective random one-month data of the mean transfer process included 26 one-month patient care sessions. These care episodes occurred on five individual patients with multiple care sessions for each patient. Utilizing data from the call-light system resulted in a 15% error in data acquisition. This was demonstrated in missing data for four of the 26 cases. It was found that the mean transfer process time before implementation of the Eboard was 58 minutes and 58 seconds.

Prospective mean transfer process data acquired from the three months after implementation of the Eboard included 176 patient care sessions. These care episodes occurred on 14 individual patients with multiple care sessions for each patient. Utilizing data from the Eboard system resulted in a 5% error in data acquisition. This was evidenced by missing data for ten of the 176 care sessions. It was found that the mean transfer process time after implementation of the Eboard was 25 minutes and 01 seconds. A 33-minute decrease in mean transfer process time was achieved after implementation of the Eboard, which equates to a 43% increase in transfer process efficiency.

Descriptive statistics found the differences between the two groups of mean transfer process times (pre- and post-implementation) to be significantly significant for the mean transfer process time. Therefore, the null hypothesis was rejected and the alternative hypothesis, that the Eboard did improve transfer process time was accepted.

Staff satisfaction data retrieved from pre-implementation survey regarding coordination, communication, and efficiency found that 68% of interdisciplinary staff agreed or strongly agreed that they had the necessary tools to coordinate among care teams. In addition, 58% of interdisciplinary staff agreed or strongly agreed that they had the necessary tools to communicate among care teams; and 54% of interdisciplinary staff agreed or strongly agreed that they had the necessary tools for efficient patient care.

Staff satisfaction data retrieved from the post-implementation survey found that 93% of interdisciplinary staff agreed or strongly agreed that they had the necessary tools to coordinate among care teams. Furthermore, 93% of interdisciplinary staff agreed or strongly agreed that they had the necessary tools to communicate among care teams; and 90% of interdisciplinary staff agreed or strongly agreed that they had the necessary tools for efficient patient care.

Overall staff satisfaction improved by an average of 31% after implementation of the Eboard. This included a 25% increase in satisfaction regarding coordination; a 35% increase in satisfaction regarding communication; and a 34% increase in satisfaction regarding efficiency.

Descriptive statistics found the differences between the two groups to be statistically significant in regards to coordination, communication, and efficiency. Therefore, the null hypothesis was rejected and the alternative hypothesis, that the Eboard did enhance staff satisfaction was accepted.

In addition to the comparative results reviewed from the survey, suggestions for improvement from the interdisciplinary staff included:

- incorporating a designated communicator from the radiation oncology team,
- redesigning the existing call-light system,
- increasing available resources (equipment and staff),
- changing current scheduling practices,
- and adding mass communications between departments, such as a monthly newsletter.

Discussion

Limitations

Generalizability. The anesthetized proton therapy patient population is by nature a dynamic and complex environment. Therefore, the cause of change in workflow efficiency and staff satisfaction inevitably raised questions of generalizability and direct relation. It would be naïve to conclude that the Eboard alone was the single factor responsible for the increase in workflow efficiency and staff satisfaction in this project. Experience of the interdisciplinary team, provider preference, and patient population acuity all impact the practice.

Validity. A validated tool was not utilized to measure transfer process efficiency or staff satisfaction. This correlated with the gap found in the literature regarding the appropriate form of measurement for technology tools such as the Eboard. Previous researchers have employed observational techniques, interviews, audits, and questionnaires when exploring satisfaction among EW users. However, due to time constraints these techniques were not able to be utilized. Additional questions regarding the validity of the results found included the fact that the proton therapy area of study has only been in operation for 18 months prior to the implementation of the Eboard, making it an environment with rapid change and growth.

Bias. The DNP student was included in the results of this DNP project. The experience and passion of the DNP student could have inadvertently added urgency to the need for, and utilization of the Eboard. User bias may also have been introduced into the DNP project through the knowledge that the transfer process was being examined, and through the previous user experiences with the Eboard. While the Eboard technology is not new to the nursing and anesthesia staff, the radiology staff had no prior knowledge of the system.

Confounding Variables. The combined use of the existing and new technologies may have caused unforeseen challenges with the implementation of the Eboard. Some resistance to use the Eboard may have been experienced due to the alleged duplication of communication systems. Additionally, a known change in electronic health record is slated for the institution within the coming year. This knowledge may have discouraged the urgency to adapt a current process knowing more change will be implemented in the future. Furthermore, the pre-implementation review of radiation ready was limited by the questionably accurate information available using the call light system. As stated before, this system was prone to inaccuracies since it was event, not patient driven, and lacked real-time information display capabilities.

Technology. While the Eboard technology connected, united and empowered the interdisciplinary team, it also suffered from end-user and equipment failures. The project began with a moratorium on purchases due to fiscal constraints. This delayed the initial plan to have a designated display available in each discipline's central location. Furthermore, at the time of implementation the large central display located in the PACU was also inoperable. This display was repaired within four weeks of the initial implementation. The lack of central displays may have hindered the spatial awareness, communication abilities and workflow patterns of the providers when a desktop was not readily available to view the Eboard. In addition, the proton beam itself was inoperable for two days of the initial implementation process. Each of these technology-based issues may have influenced the initial buy in, use, and adoption of the Eboard program by reinforcing the limitations of a technology-based project.

Strengths

Improvement in results. The DNP project was successful in improving workflow process efficiency by 43%. This was demonstrated through an average 33 minute decrease in the transfer process time of the anesthetized proton therapy patient. Additionally, staff satisfaction of the participants providing care for this group of patients improved by 31%. As noted in the statistical review, these improvements occurred despite an almost triple increase in workload, and occurred over a short three month time period.

Research gap closure. The quantitative data collected from this DNP project will be useful in closing the research gap that exists regarding the effects on EW technology in a complex outpatient environment. As evidenced by the literature review, the majority of the research regarding EW technology has been obtained through studies in the emergency and peri-operative environments. The patient population cared for by the participants in this DNP project has many striking similarities to both of these care areas. The dynamic nature of all of these practices necessitates keen interdisciplinary collaboration and communication to provide an efficient and positive outcome.

Process evaluation. The ability to successfully accumulate data for such a complex interdisciplinary process serves as a preliminary example of how the Eboard can be utilized to review and evaluate additional workflow processes. Furthermore, the validity of the transfer process time was vetted through the institutional statistician and the quantitative data accumulated clearly represent the anesthetized proton therapy patient's journey through the treatment process.

Interdisciplinary teamwork. The nature and acuity of the proton beam treatment center necessitates collaboration, communication and efficient use of resources among interdisciplinary staff to maintain stability. Approval and prioritization of the project by interdisciplinary leadership helped to support interdisciplinary teamwork and collaboration. In addition, the Eboard was able to increasing staff awareness (spatially, socially, and temporally), as well as incorporating real-time patient location abilities. This allowed the interdisciplinary team to be more aware of the workflow of the entire unit and be more respectful of unforeseen circumstances experienced by individual disciplines.

Data acquisition. One of the key improvements experienced with the implementation of the Eboard was the increase in data acquisition. Prior to the Eboard implementation the lack of networking systems between disciplines confounded challenges in interdisciplinary communication and collaboration. In addition to workflow process evaluation, the data acquired by the Eboard can be used to highlight the need for additional equipment and resources, enhance research efforts, and improve reimbursement data.

Patient Safety. Patient transportation and transfer are critical points for the introduction of medical oversights and errors. The Eboard was able to enhance the transfer process and patient safety by incorporating real-time patient data and location abilities. In addition, the increase in staff awareness (spatially, socially, and temporally) gave the staff a better overview of the entire transition period.

Future Implications

MRI implementation. The advantages that Eboard technology afford are easily adaptable to specific unit needs and can provide limitless quantified information to enhance patient care. Future implications of this study include the distribution of the technology to other disciplines that care for the anesthetized proton therapy patient population. The implementation of the Eboard to the magnetic resonance imaging (MRI) team will allow the acquisition of data and coordination for patients requiring MRI scans. These scans are often performed in the anesthetized proton therapy patient population to assess the proton treatment plan and diagnosis disease regression. This will directly impact the patient flow and efficiency of the overall unit.

Patient communication. Additional future implications include plans for the Eboard to be utilized to communicate and update patient status to family members. A monitor is currently installed in the proton therapy patient waiting area which will allow visitor to track the patient's progress through their treatment journey. This may be especially helpful in the pediatric proton patient population as it allows emotional parents and families an understanding of the treatment process, and some amount of control in an otherwise chaotic situation.

Review of systems and processes. This project's continued acquisition of data will allow the practice to continue to review additional care processes and impact patient care outcomes. Call light utilization and adjustment will be reviewed comparing data gained from the Eboard system. The data gained from the implementation of the Eboard will be utilized to fortify the existence of this technology as a new EHR is implemented within the institution. It has also paved the way for additional interdisciplinary projects to occur. Future projects include additional communication and coordination opportunities, standardization of safety procedures, evaluation of individual discipline processes, and future team building activities.

Conclusions

The ability to coordinate and streamline care provided by interdisciplinary team members was the basis for the implementation of the Eboard program. Both transfer process efficiency and staff satisfaction were positively impacted by the implementation of the Eboard. Additional benefits were seen in the reliability of data acquisition, compliance of current federal and institutional recommendations and enhanced overall interdisciplinary teamwork. Information and communication technology tools, such as the Eboard, can transform the healthcare process to a more timely and integrated experience. The Eboard's user friendly platform and clear displays made implementation straightforward and low-risk. Combined with unit specific process improvements, the Eboard technology could further optimize resource, increase interdisciplinary coordination, and improve process efficiency in the dynamic and complex anesthetized proton therapy patient population.

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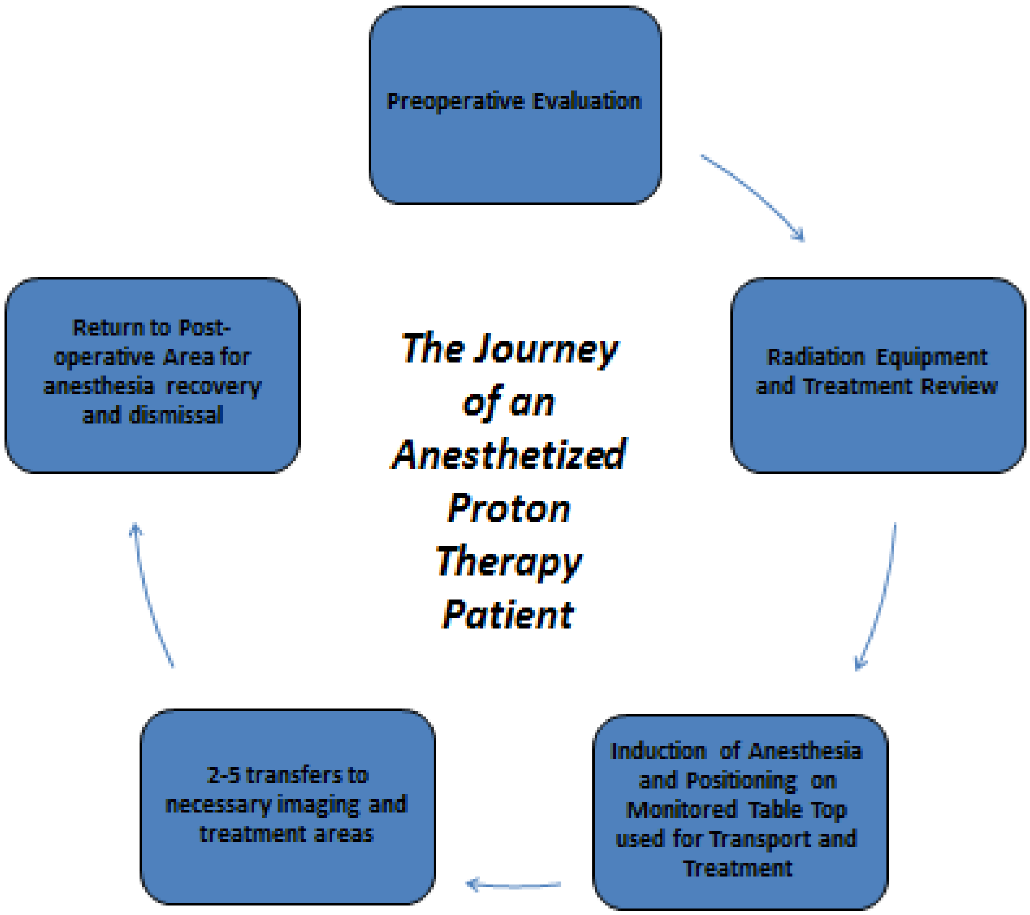
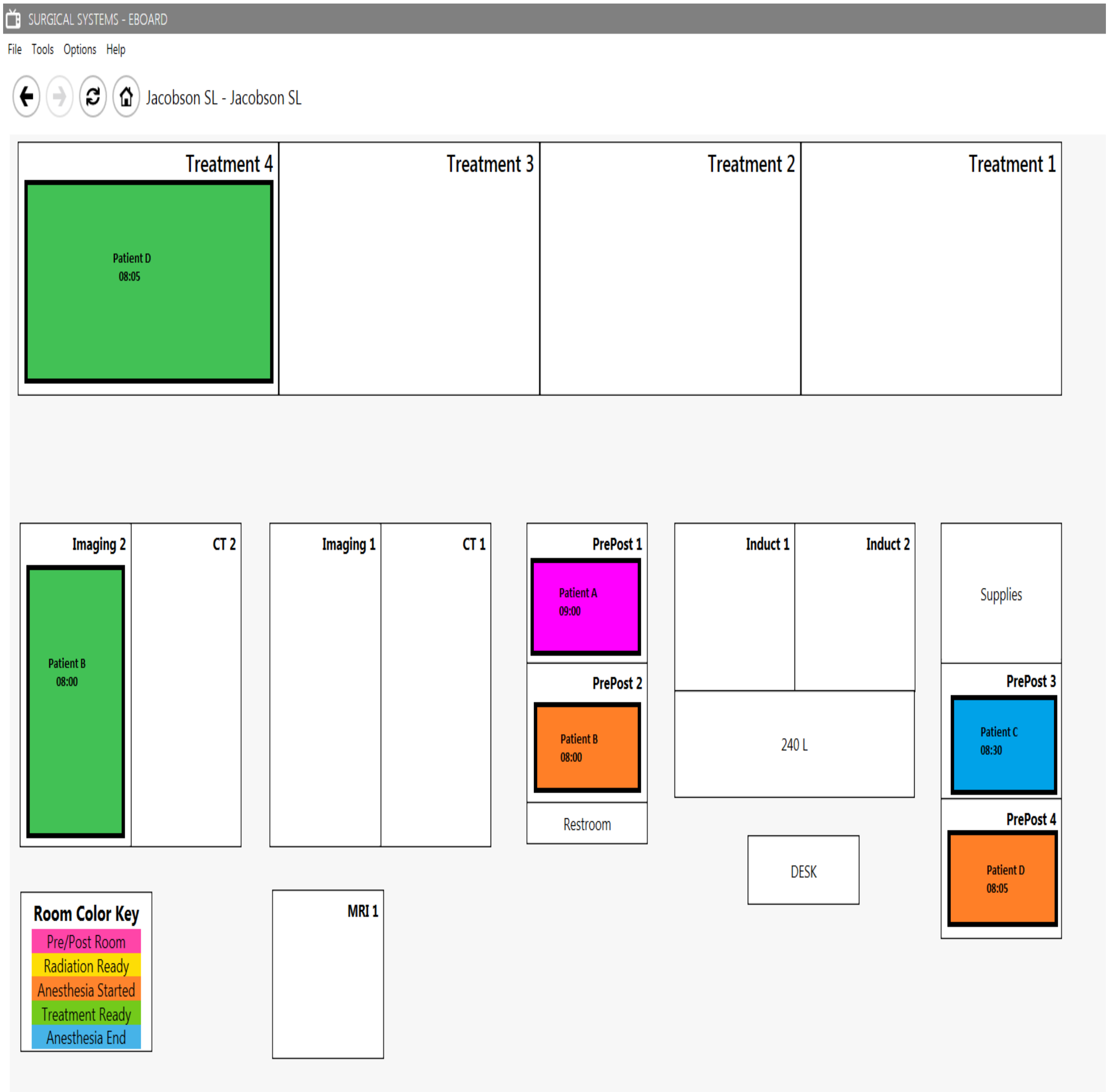
Appendix A

The Journey of a Proton Therapy Patient



Appendix B

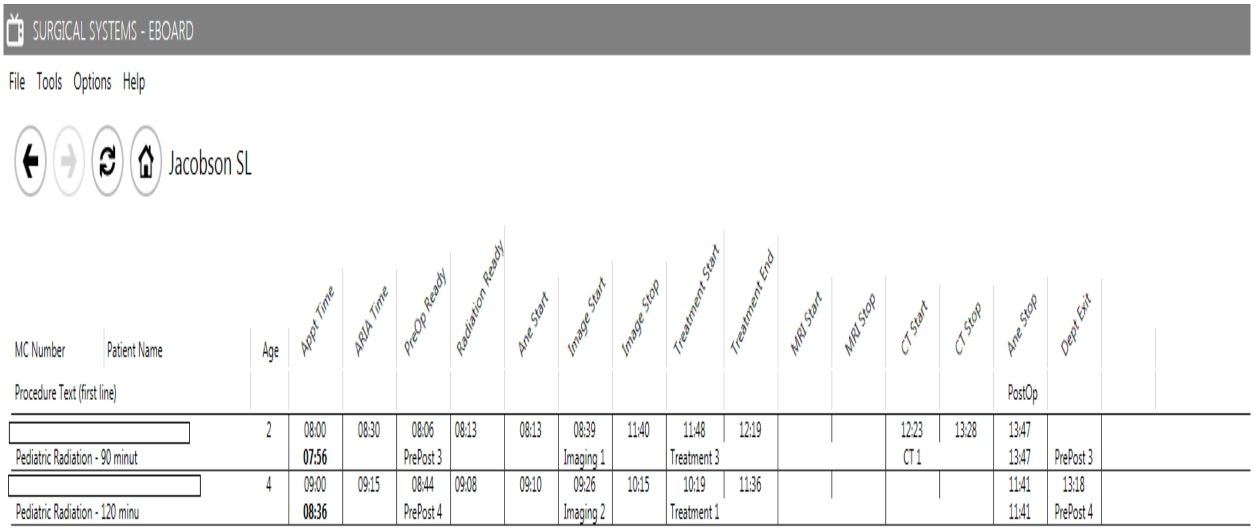
Map View of Eboard



Note: Information displayed on the Eboard map view included patient initials, consulting physician, and time of last critical transfer process event.

Appendix C

Line View of Eboard



Note: Information displayed on the Eboard line view included hospital number, patient name, patient age, scheduled appointment time, time the patient checked into the unit, scheduled treatment beam time, PACU ready time, Radiation ready time, Anesthesia induction time, Imaging start/stop time, treatment start/stop time, MRI start/stop time, CT start/stop time, Anesthesia stop time, and Department exit time.

Appendix D

Description of Time Data Measurements Regarding the Transfer Process

Variable	Description	Data Source	Data Range	Level of Measure	Timeframe for Collection
PACU ready	Time PACU staff are ready for anesthetic induction of patient	EHR pre-implementation; Eboard post-implementation	07:00 – 17:00	Time; Nominal	Retrospective random 1 month pre-implementation; 3 month post-implementation
Radiation ready	time radiation therapy staff and equipment are ready for patient to arrive in treatment area	Call light System pre-implementation; Eboard post-implementation	07:00 – 17:00	Time; Nominal	Retrospective random 1 month pre-implementation; 3 month post-implementation
Induction of anesthesia	Time patient is placed under anesthesia care	EHR pre-implementation; Eboard post-implementation	07:00 – 17:00	Time; Nominal	Retrospective random 1 month pre-implementation; 3 month post-implementation
Patient arrival in treatment area	Time of arrival in initial treatment area	EHR pre-implementation; Eboard post-implementation	07:00 – 17:00	Time; Nominal	Retrospective random 1 month pre-implementation; 3 month post-implementation

Note: The patient transfer process was defined as the collaborative readiness of all interdisciplinary team members and equipment, followed by the induction of anesthesia and transfer of the anesthetized patient to a separate physical treatment area. Time data was recorded as hh:mm:ss value.

Appendix E

Theoretical Model

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Appendix F

SWOT Analysis for Proton Therapy Practice

Strengths:

- Eboard technology is utilized within the greater intuition
- Eboard technology networks with existing EHR
- Eboard technology is easily adaptable to multiple disciplines
- Real-time information acquired allows for situational, spatial, and temporal awareness
- Acquisition and storage of cumulative data
- Two layouts available for increased understanding of processes (map and line view)
- Eboard technology could be utilized for patient and family communications in the future
- Increasing communication and coordination across multiple disciplines

Weakness:

- Technology can be limited by the end-user
- Technology can be prone to system errors
- The technology needed will necessitate learning from the radiation oncology staff
- Additional monitors will be a financial cost to the practice area

Opportunities:

- The ability to support more informed decisions regarding the patient population and practice area
- Increased interdisciplinary communication and coordination fostering teamwork
- Increased patient safety and satisfaction through improved communication and process understanding
- Increased unit work flow and throughput by improving process efficiency
- Improved metric acquisition including improved capturing of financial, research, and process information

Threats:

- Lack of support from Radiation Oncology leadership stemming from the lack of prior utilization of the Eboard technology
- Transition to new EHR system within the next year
- The belief that the existing call light system duplicates the Eboard information acquired
- Tying the findings of the research project directly to the utilization of the Eboard Technology

Appendix G

Pre-implementation Random Retrospective One-month Mean Transfer Process Times by Discipline

	Preoperative ready to treatment start	Radiation ready to treatment start	Anesthesia ready to treatment start	Mean transfer process time
Mean	0:59:25	1:12:05	40:46	0:58:58
Median	0:56:30	1:09:00	0:39:30	0:55:40
Standard Deviation	0:18:14	0:24:04	0:15:47	0:14:32
Coefficient-of-Variation	30.7%	33.3%	38.7%	24.6%

Note: The total number of cases that required anesthesia sedation to complete proton therapy treatments was 26. Five individual patients requiring multiple treatments made up the group. Due to a lack of data from the call light system, four radiation start times were missing, which resulted in a 15% error in data acquisition.

Appendix H

Post-implementation Prospective Three Month Mean Transfer Process Times by Discipline

1st month	Preoperative ready to treatment start	Radiation ready to treatment start	Anesthesia ready to treatment start	Mean transfer process time
Mean	0:47:00	0:25:48	0:13:36	0:27:35
Median	0:44:30	0:21:00	0:10:30	0:24:40
Standard Deviation	0:33:59	0:18:52	0:09:33	0:14:17
Coefficient-of-Variation	72.3%	73.1%	70.2%	51.8%
2nd month	**Preoperative ready to treatment start**	**Radiation ready to treatment start**	**Anesthesia ready to treatment start**	**Mean transfer process time**
Mean	0:44:01	0:29:46	0:12:14	0:29:00
Median	0:37:00	0:24:00	0:10:00	0:25:20
Standard Deviation	0:27:52	0:20:13	0:07:58	0:14:25
Coefficient-of Variation	63.3%	67.9%	65.2%	49.7%
3rd month	**Preoperative ready to treatment start**	**Radiation ready to treatment start**	**Anesthesia ready to treatment start**	**Mean transfer process time**
Mean	0:24:55	0:23:32	0:07:46	0:18:43
Median	0:20:00	0:19:00	0:06:00	0:16:30
Standard Deviation	0:16:22	0:14:01	0:04:42	0:08:50
Coefficient-of-Variation	65.7%	59.6%	60.5%	47.2%

Note: The total number of cases that required anesthesia sedation to complete proton therapy treatments during the three-month prospective data review period was 176. Fourteen individual patients requiring multiple treatments made up the group. Due to the lack of provider participation, the five, missing radiation start times were noted, which resulted in a 5% error in data acquisition.

Appendix I

Pre-implementation Staff Satisfaction Survey

1. What is your position in the proton therapy center?
    a. RN b. RT c. Anesthesiologist d. CRNA
2. How long have you been in your profession?
    a. <5 years b. 5-10 years c. 10-15 years d. >15 years
3. What is your age?
    a. 20-30 b. 31-40 c. 41-50 d. >50
4. What is your sex?
    a. Female b. male
5. What is your highest level of education you have completed?
    a. Associates degree b. Bachelor’s degree c. Master’s Degree d. M.D./PhD.

How much do you agree with the following statements?

6. I have the necessary tools to **coordinate care** among Radiation, Nursing and Anesthesia care teams?
    a. Strongly agree b. agree c. neutral d. disagree e. strongly disagree
7. I have the necessary tools to **communicate** among Radiation, Nursing and Anesthesia care teams?
    a. Strongly agree b. agree c. neutral d. disagree e. strongly disagree
8. I have the necessary tools **for efficient patient care** among Radiation, Nursing and Anesthesia care teams?
    a. Strongly agree b. agree c. neutral d. disagree e. strongly disagree
9. How would you suggest we improve patient care for the anesthetized Proton Therapy patients?

Appendix J

Post-implementation Staff Satisfaction Survey

How much do you agree with the following statements?

1. I have the necessary tools to **coordinate care** among Radiation, Nursing and Anesthesia care teams?
    a. Strongly agree b. agree c. neutral d. disagree e. strongly disagree
2. I have the necessary tools to **communicate** among Radiation, Nursing and Anesthesia care teams?
    a. Strongly agree b. agree c. neutral d. disagree e. strongly disagree
3. I have the necessary tools for **efficient patient care** among Radiation, Nursing and Anesthesia care teams?
    a. Strongly agree b. agree c. neutral d. disagree e. strongly disagree
4. The Eboard improved the **coordination** of care among Radiation, Nursing and Anesthesia care teams?
    a. Strongly agree b. agree c. neutral d. disagree e. strongly disagree
5. The Eboard improved the **communication** among Radiation, Nursing and Anesthesia care teams?
    a. Strongly agree b. agree c. neutral d. disagree e. strongly disagree
6. The Eboard improved **efficiency of patient care** among Radiation, Nursing and Anesthesia care teams?
    a. Strongly agree b. agree c. neutral d. disagree e. strongly disagree
7. Overall, **patient flow and care** had been improved since the introduction of the Eboard?
    a. Strongly agree b. agree c. neutral d. disagree e. strongly disagree
8. The Eboard improves coordination and communication among disciplines more than the anesthesia call light system?
    a. Strongly agree b. agree c. neutral d. disagree e. strongly disagree
9. The Eboard is easier to use than the anesthesia call light system?
    a. Strongly agree b. agree c. neutral d. disagree e. strongly disagree
10. How would you suggest we improve patient care for the anesthetized Proton Therapy patients?

Appendix K

Staff Satisfaction Survey Data Pre- and Post-Implementation

	Frequency	Percent	Cumulative Percent
Question 6 Pre-implementation	SA = 8	SA = 12.7%	SA = 12.7%
Regarding Coordination	A = 35	A = 55.6%	A = 68.3%
N=63	N = 12	N = 19.0%	N = 87.3%
	D = 7	D = 11.1%	D = 98.4%
	SD = 1	SD = 1.6%	SD = 100%
Question 1 Post-implementation	SA = 11	SA = 34.4%	SA = 35.5%
Regarding Coordination	A = 18	A = 56.3%	A = 93.5%
N=32	N = 2	N = 6.3%	N = 100%
	D = 0	D = 0%	D = 100%
	SD = 0	SD = 0%	SD = 100%
Question 7 Pre-implementation	SA = 9	SA = 14.3%	SA = 14.5%
Regarding Communication	A = 27	A = 42.9%	A = 58.1%
N=63	N = 14	N = 22.2%	N = 80.6%
	D = 11	D = 17.5%	D = 98.4%
	SD = 1	SD = 1.6%	SD = 100%
	Missing = 1	Missing = 1.6%	
Question 2 Post-implementation	SA = 13	SA = 40.6%	SA = 41.9%
Regarding Communication	A = 16	A = 50.0%	A = 93.5%
N=32	N = 2	N = 6.3%	N = 100%
	D = 0	D = 0%	D = 100%
	SD = 0	SD = 0%	SD = 100%
	Missing = 1	Missing = 3.1%	

Appendix K (cont.)

Staff Satisfaction Survey Data Pre- and Post-Implementation

	Frequency	Percent	Cumulative Percent
Question 8 Pre-implementation	SA = 6	SA = 9.5%	SA = 9.7%
Regarding Efficiency	A = 29	A = 46%	A = 56.5%
N=63	N = 14	N = 22.2%	N = 79.0%
	D = 12	D = 19.0%	D = 98.4%
	SD = 1	SD = 1.6%	SD = 100%
Question 3 Post-implementation	SA = 12	SA = 37.5%	SA = 38.7%
Regarding Efficiency	A = 16	A = 50.0%	A = 90.3%
N=32	N = 3	N = 9.4%	N = 100%
	D = 0	D = 0%	D = 100%
	SD = 0	SD = 0%	SD = 100%
	Missing = 1	Missing = 3.1	

Appendix L

Project Timeline

Event								
IRB Approval	xx							
Recruitment of subjects	x	x						
Pre-implementation survey		xx						
Education of staff		xx						
Implementation of Eboard		xx	xxxx	xxxx	xxx			
Post-Implementation survey					x			
Data Entry & Analysis						x xxx	xxxxx	
Dissemination of results								x
Month	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.

Appendix M

Pre- versus 1st Month Post-Implementation Mean Transfer Process Statistical Significance Data

t-test

Time	N	Mean	Std. Deviation	Std. Error Mean	Coefficient-of-Variation
Pre	23	0:58:58	0:14:32	0:03:01	24.6%
Post 1st Month	42	0:27:35	0:14:17	0:02:12	51.8%

Independent- Samples t-test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
Pre- vs 1st Month Post-Implementation	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Mean Transfer time (equal variance assumed)	.146	.703	8.412	63	.000	0:31:22	0:03:43	0:23:55	0:38:49
Mean Transfer Time (equal variances not assumed)			8.370	44.470	.000	0:31:22	0:03:44	0:23:49	0:38:55

Appendix N

Pre- versus 2nd Month Post-Implementation Mean Transfer Process Statistical Significance Data

t-test

Time	N	Mean	Std. Deviation	Std. Error Mean	Coefficient-of-Variation
Pre	23	0:58:58	0:14:32	0:03:01	24.6%
Post 2nd Month	61	0:29:00	0:14:25	0:01:50	49.7%

Independent- Samples t-test

Levene's Test for Equality of Variances			t-test for Equality of Means						
Pre- vs 2nd Month Post-Implementation	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Mean Transfer time (equal variance assumed)	.138	.711	8.469	82	.000	0:29:57	0:03:32	0:22:55	0:36:59
Mean Transfer Time (equal variances not assumed)			8.440	39.382	.000	0:29:57	0:03:32	0:22:46	0:37:07

Appendix O

Pre- versus 3rd Month Post-Implementation Mean Transfer Process Statistical Significance Data

t-test

Time	N	Mean	Std. Deviation	Std. Error Mean	Coefficient-of-Variation
Pre	23	0:58:58	0:14:32	0:03:01	24.7%
Post 3rd Month	72	0:18:43	0:08:50	0:01:02	49.8%

Independent- Samples t-test

Levene's Test for Equality of Variances			t-test for Equality of Means						
Pre- vs 3rd Month Post-Implementation	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Mean Transfer time (equal variance assumed)	8.103	.005	16.052	93	.000	0:40:14	0:02:30	0:35:16	0:45:13
Mean Transfer Time (equal variances not assumed)			12.559	27.383	.000	0:40:14	0:03:12	0:33:40	0:46:49

Appendix P

Staff Satisfaction Survey t-test

Question	Survey	N	Mean	Std. Deviation	Coefficient-of-Variation
Coordination	Pre	63	2.33	.898	38.5%
(Pre-#6 vs. Post-#1)	Post	31	1.71	.588	34.4%
Communication	Pre	62	2.48	1.004	40.5%
(Pre-#7 vs. Post-#2)	Post	31	1.65	.608	36.9%
Efficiency	Pre	62	2.56	.969	37.9%
(Pre-#8 vs. Post-#3)	Post	31	1.71	.643	37.8%

Appendix Q

Staff Satisfaction Survey Results of Corresponding Questions Pre- and Post-Implementation

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Coordination (equal variance assumed)	3.865	.052	3.509	92	.001	.624	.178	.271	.977
Coordination (equal variances not assumed)			4.028	84.479	.000	.624	.155	.316	.932
Communication (equal variance assumed)	9.855	.002	4.269	91	.000	.839	196	.448	1.229
Communication (equal variances not assumed)			4.995	87.529	.000	.839	.168	.505	1.172
Efficiency (equal variance assumed)	8.531	.004	4.443	91	.000	.855	.192	.473	1.237
Efficiency (equal variances not assumed)			5.068	83.739	.000	.855	.169	.519	1.190

Note: With respect to interdisciplinary coordination, pre-implementation question number six corresponded to post-implementation question number one. With respect to interdisciplinary communication, pre-implementation question number seven corresponded to post-implementation question number two. With respect to interdisciplinary efficiency, pre-implementation question number eight corresponded to post-implementation question number three.