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Evidence-Based Hospitals

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EVIDENCE-BASED HOSPITALS

DISSERTATION

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the College of Public Health at the University of Kentucky

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ABSTRACT OF DISSERTATION

EVIDENCE-BASED HOSPITALS

In 2011 the University of Kentucky opened the first two inpatient floors of its new hospital. With an estimated cost of over $872 million, the new facility represents a major investment in the future of healthcare in Kentucky. This facility is outfitted with many features that were not present in the old hospital, with the expectation that they would improve the quality and efficiency of patient care. After one year of occupancy, hospital administration questioned the effectiveness of some features. Through focus groups of key stakeholders, surveys of frontline staff, and direct observational data, this dissertation evaluates the effectiveness of two such features, namely the ceiling-based patient lifts and the placement of large team meeting spaces on every unit, while also describing methods that can improve the overall state of quality improvement research in healthcare.

KEYWORDS: Bayesian Models, Dimension Reduction,
Quality Improvement, Patient Safety,
Teamwork

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To JS and RJ

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CHAPTER ONE: INTRODUCTION

“Presque tous les hommes meurent de leurs remèdes, et non pas de leurs maladies.”

(Nearly all men die of their remedies, and not of their illnesses.)

- Molière, *Le Malade Imaginaire* (1673), Act III, sc. iii.

"*Alle Dinge sind Gift und nichts ist ohne Gift; allein die Dosis macht, dass ein Ding kein Gift ist.*"

(All things are poison and nothing is without poison, only the dose makes a thing not a poison.)

- Paracelsus, *Defensio No. III* (1538)

Why Hospital Design is Worth Investigating

The way that healthcare is delivered in the United States matters to patients, to providers, and to healthcare institutions. Delivery systems should promote positive patient outcomes, protect the long-term interests of providers, and allow institutions to remain solvent. Providing high-quality healthcare has always been important, but finding ways to do so while lowering cost has never been more culturally relevant than it is in an era of ballooning healthcare needs and a tight economy.

To improve the state of our healthcare system, we must not only improve the treatments available to patients but also the mechanism by which those treatments are administered. Healthcare involves complicated plans delivered through a fragmented network of providers, specialties, and locations. It is a system whose structure creates potential risks for everyone who participates in it (Institute of Medicine (U.S.). Committee on Quality of Health Care in America., 2001).

Even in ideal conditions, the high-acuity care provided in hospital settings is a dangerous endeavor. It is the art of inducing specific toxicities into fragile people. People receiving treatment in a hospital are, of course, suffering from one or more serious conditions. They must depend on others for their treatment, and they come to the hospital to receive care that cannot be provided anywhere else. They are, by any meaning of the word, vulnerable. Deviations from an ideal delivery system create additional risks for patients, risks that compound the danger of whatever initially brought them into the hospital. According to then-Secretary of the U.S. Department of Health and Human Services Kathleen Sebelius, at the turn of the millennium, "[…] more Americans were dying every year from the care they received in hospitals, than from all the diseases put together that sent them to the hospital" (Institute of Medicine (U.S.), 2011).

One goal of a high-quality hospital is to reduce the exposure of this vulnerable population to additional risks. Surgeons must not only set the bone, they must also wash their hands to avoid causing infections. Physicians must not only choose a drug, they must also consult with a pharmacist when they are unsure. Supporting these risk-management activities is as much a part of the institution's responsibilities as having equipment in the operating rooms and drugs in the dispensary.

Though they are the hospital's *raison d'être*, patients see only a fraction of what goes into providing their care. For the most part, they are left to trust that the institution is protecting them while they are vulnerable. But a hospital is not only risky due to the complexity of medical treatments occurring within, it is itself an inherently risky place to be. There are some unique dangers that exist in inpatient facilities. For instance, as many as 1 in 6 hospital patients can be expected to develop a pressure ulcer, a condition that is virtually unheard of outside of hospitals and long-term care facilities (Bansal, Scott, Stewart, & Cockerell, 2005). These wounds to the skin are not only painful in their own right, they also leave inpatients particularly vulnerable to a variety of devastating nosocomial infections (Wounds International, 2010). The pathogens that evolve in hospital settings are particularly hard to treat and are another danger faced almost exclusively by hospital patients. Finally, patients must trust that all of their providers can work together, so the hospital must not only promote effective collaboration but it must also keep teams together so that mutual trust can be established among providers. Preventable human costs like employee days lost to injury or days sending a replacement pool nurse to cover an unfamiliar unit undermine team cohesion and can indirectly promote the possibility of a medication or treatment error affecting a patient (O'Leary, Buck, et al., 2011).

These examples highlight three basic categories of hospital risks. Pressure ulcers are well-known to hospital staff and administration as an adverse event to be avoided and they can be monitored. Nosocomial infections are also a known risk but they cannot be perfectly monitored. Effective collaboration, however, is far harder to define or identify and is therefore harder to address at an institutional level.

With hospitals housing expertise in so many distinct but intertwined areas of healthcare, a lack of team cohesion is a particularly insidious risk. Though hard to measure, effective teamwork is worth pursuing because a lack thereof not only endangers patients, it also wastes institutional resources. To provide comprehensive patient care, a hospital must include many interlocking professions. It must not only house many specialties within medicine, but also nursing specialties, pharmacy, physical therapy, and social work to name a few. Ignoring the unique perspectives of different professions not only puts patients at risks, it also mitigates the value of hiring these specialists, which can affect both staff and institutional quality in the long-term (O'Leary, Sehgal, Terrell, & Williams, 2011).

A hospital is built as a space in which to offer care, and the structure of that space affects the quality of the care. A high-quality hospital must be designed in a way that promotes the fastest possible return to health for patients, that keeps providers safe and happy, and that maximizes the utility of institutional resources. The goals of this dissertation are to understand the factors influencing the effectiveness of two specific design elements. In particular, I will be investigating the staff's use of ceiling-based patient lifting equipment and also their use of centralized interprofessional Team Stations for communication and collaboration. In doing so, I aim to achieve a larger goal of outlining a process by which effective health services research can be conducted within a hospital setting.

This work is all situated in the newest section of the University of Kentucky's Chandler Hospital, which is designated as Pavilion A. The ceiling-based lifts and the Team Stations are present in every inpatient unit in Pavilion A. Both features were absent in the spaces these units occupied in the old hospital. Because of this clear divide, and because they were introduced without any coordinated effort to effectively change the culture of these units, Pavilion A provides an ideal setting for a natural experiment to see how design features can affect staff behavior.

Pavilion A

The ceiling-based lifts and the Team Stations are intended to improve the delivery of healthcare in Pavilion A. While Pavilion A is currently just one section of Chandler

Hospital, the plan is for all units to eventually move into this new building. As such, Pavilion A represents a major infrastructure investment for University of Kentucky Healthcare (UKHC). The whole building is 1.2 million square feet. When it is completed it will have 8 patient floors and 512 patient beds. It will also have space for a pharmacy, a radiologic testing suite, physical rehabilitation services, laboratory testing, food services, as well as both educational and conference spaces. The construction of Pavilion A is ultimately expected to cost $872 million.

Planning for Pavilion A began in 2006. The first section, the Emergency Department, opened in 2010. In May of 2011, the first two inpatient floors were opened. These two floors are nearly identical to one another, yet serve very different patient populations. The 6^{th} floor focuses on neurosciences and has a large subunit dedicated to the treatment of stroke patients. The 7^{th} floor houses a variety of surgical patients, most of whom are cared for by either the Trauma Surgery team, the General Surgery team, or the Orthopedic Surgery team. A generic floorplan for these floors is included as Appendix 1.

Each of these floors is made up of two towers. The two towers are connected by a central space that houses features such as elevator banks and waiting rooms. All patient care occurs on the towers. On both floors, the two towers are mirror images of each other. Each tower has a 12-bed Intensive Care Unit (ICU) and a 20-bed section that is a combination of Acute Care and Progressive Care. The two sections on each tower are along a single continuous “racetrack”-style hallway, but are separated by heavy doors that require badge access to open, leaving them to operate largely as distinct entities. A closer view of the layout of a representative tower is included as Appendix 2. With six inpatient floors still in the planning stages, UKHC administration wanted to investigate whether two of the most controversial design elements were being used as expected on the built floors before including them in the plans for future units.

Ceiling-Based Patient Lifts

Ceiling-based patient lifts are motors that attach to a track which is built into the ceiling. They exist in each of the 128 inpatient rooms currently in use in Pavilion A. A variety of harnesses can be attached to the motors for various needs such as moving a patient between a bed and a chair or holding a limb elevated for an extended period of time. The purchase and installation of each lift costs approximately $15000, not including the purchase and maintenance of the slings that are necessary to use the lifts.

By far the most common expected use of the lifting devices is repositioning patients within their beds. Patients who need help repositioning themselves are those who are considered to be at high risk for developing pressure ulcers. Regular repositioning is performed as a prophylactic measure against the development of pressure ulcers. For those patients who need assistance, repositioning is required at least once every two hours, and often more frequently than that. Nearly 100% of ICU and Progressive Care patients and approximately half of Acute Care patients are expected to require this service. By reducing the mechanical burden of moving a patient, the lifts should ease adherence to the prescribed repositioning schedule and, in doing so, reduce the rate of pressure ulcers for patients in these units.

Five months after the 6th and 7th floors of Pavilion A opened, UKHC formed a Safe Patient Handling Advisory Team. One goal of this team was to foster the use of the lifts as a means of reducing injuries to staff. The team operated as a subcommittee of the

University of Kentucky Human Resources department, not of UKHC. The need to reduce patient handling-related injuries came out of a University investigation, not a UKHC one. Therefore, UKHC administration seems to view the lifts primarily as a tool for patient handling, with a secondary purpose being reducing workplace injuries.

The University of Kentucky was concerned about patient handling-related injuries because of the high proportion of University-wide compensation claims that could be traced back to repositioning-related activities. From 2006-2010, the same period in which Pavilion A was being planned and constructed, patient handling injuries accounted for 31% of the University's occupational injury costs. Over that same period, they accounted for 44% of injury costs in Chandler Hospital. The proportion of cost relative to the percentage of claims they made up (12% and 16%, respectively) highlights how expensive these injuries are compared with other common causes.

In 2010, immediately prior to the opening of Pavilion A, there were 535 occupational injury claims, of which 120 (22%) were related to patient handling. These 120 claims cost the hospital at least $695128.34, or 58% of the total cost of all injury claims in the hospital that year. When the 120 claims were further broken down into those related to patient transfers, transport, repositioning and other/unknown, repositioning was #2 in terms of incidence (35%) and #1 in total cost (39%).

Injuries cost the institution more than money; they also cost team cohesion, which affects staff morale, retention, and, ultimately, institutional quality. Lost and restricted workdays mean calling in staff who are less familiar with the unit, both in terms of culture and equipment. From May of 2011 through July of 2012, the first 15 months in which Pavilion A had inpatient floors, those floors had 15 injuries related to patient handling. These 15 injuries led to over 237 lost workdays and another 191 restricted or reassigned workdays. Despite the new equipment, eight of these injuries were related to repositioning patients.

Team Stations

Team Stations are large workspaces that are shared by multiple professions. The analogous spaces in the old hospital were called Nurses' Stations. The rebranding of this space was a deliberate effort on the part of UKHC to create a space that was communal not just within the major profession of direct patient care, but all professions that are involved with it (e.g., medicine, pharmacy, social work, physical therapy, respiratory therapy, etc.). The Team Stations exist in Pavilion A in two configurations, one for the intensive care side of the tower and one for the other side. The ICUs have a panopticon-style design from which staff can see into most of the ICU patient rooms on that unit. The non-ICU sides have stations near the middle of the Acute/Progressive units and have walls that obscure its view from most of the hallway. The desire for interprofessional work to occur in the Team Stations is further demonstrated by the decision to create small offices within the non-ICU design to house individuals from pharmacy, social work, and other professions that were not housed on inpatient floors prior to the move to Pavilion A.

The Team Stations were designed to support individual work, but they were built specifically to facilitate collaborative work. While they have many individual computer stations within them, large monitors and work surfaces were installed with the vision of many people working together face-to-face. Both the ICU and the non-ICU designs are approximately 600 square feet. The amount of space and the number of computers installed in each Team Station suggest that groups of up to 20 people would need to be accommodated by these spaces.

Since the exterior walls of Pavilion A are built, the allocation of space within floors of Pavilion A is a zero-sum game. The Joint Commission requires patient rooms to have windows for a hospital to be accredited and the 32 rooms per tower take up all available space on the outer side of the racetrack hallways. This leaves only the so-called “Center Core” region, which is the interior of the racetrack, as a place where the design may be modified. The Center Core, which is approximately 8800 square feet per tower, must provide space for supplies, soiled laundry, offices, conference rooms, classrooms, breakrooms, kitchenettes, emergency stairwells, and structural supports in addition to any space that is given to Team Stations. In their current configuration, roughly 14% of each tower’s Center Core is taken up by Team Station space. Their utilization should justify the amount of space that they take up.

The design of Pavilion A could not accommodate every feature that would ideally be included on every inpatient floor. For example, some unimplemented features that various parties would have appreciated are rest areas for medical residents, larger conference rooms and classrooms, expanded kitchenettes for staff and for guests, and more interprofessional offices. If Team Stations cannot be utilized as intended, there is a litany of possible other features for which their space could be repurposed.

Quality in Healthcare

With growing demand and diminishing resources, hospital administrators around the country are increasingly focused on the value of their quality improvement efforts

(Prybil, Bardach, & Fardo, 2014). The goal of UKHC in implementing these new features in Pavilion A is to improve the quality of its services, but also to assess whether both the direct and opportunity costs of these improvements represents a good value proposition. To assess the value of these features, UKHC sought to understand whether the reality of Pavilion A matches the vision held for it at the outset. If the reality matches the vision, planners for future floors should be reluctant to deviate from the current design, as the theory behind the design will have been shown to be valid, at least thus far, under similar use cases. There is also incentive to keep the floors standardized because hospitals last for decades, during which time its units may grow or shrink in size. UKHC does not want a space that is overly specific to one patient population knowing that it may be occupied by a different unit in the future.

On the other hand, if the reality does not match the vision, UKHC administration should choose either to change the workflow to match the design or to change the design to match the workflow. When making this choice, it is important for the institution to understand the underlying processes that led to a disconnect between the reality and the vision. Understanding the processes can inform the choice of intervention to maximize the chance of success.

In this dissertation, I will outline research methods that can improve the state of Quality Improvement research in healthcare and apply these methods to two issues faced by UKHC.

CHAPTER TWO: LITERATURE REVIEW

Why Pressure Ulcers are a Problem for Hospitals

Pressure ulcers are localized injuries to the skin that sometimes include injury to the underlying tissue. Pressure ulcers usually occur over a bony prominence. The National Pressure Ulcer Advisory Panel [NPUAP] and the European Pressure Ulcer Advisory Panel [EPUAP] define them as injuries resulting from pressure, though often they result from a combination of pressure, shear, and other forces (NPUAP & EPUAP, 2009). An estimated 2.5 million patients in U.S. hospitals and long-term care settings develop pressure ulcers each year, causing significant excess morbidity in an already high-risk population. An estimated 60,000 patients die from complications related to hospital-acquired pressure ulcers each year (Lyder, 2011).

The primary risk factor for development of pressure ulcers is long-term distortion of the skin. For example, a person lying in bed has a normal force exerted by the bed in response to the force of weight. The normal force pushes against the body's natural shape, flattening the skin and distorting the underlying tissue. Particularly around bony prominences, this perpendicular force of pressure interacts with the elastic tissue in the body to produce compression stress, shear stress, and tensile stress, all of which mechanically weaken the integument system and impede blood flow to the area. For those with chronic exposure to such forces in a localized part of the body, the result is the creation of a region where the body is both more likely to develop a wound and less capable of launching an immune response.

Pressure ulcers are staged by visual inspection using a four-tier international classification system where Stage I is the least severe and Stage IV is the most severe. In broad strokes, Stage I is characterized by intact skin with non-blanching redness in a localized area. Stage II is characterized by partial loss of dermis. Stage III is characterized by full loss of dermis, potentially leading to exposed fat but not exposing bone, tendon, or muscle. Finally, Stage IV is characterized by full loss of dermis and exposed bone, tendon, or muscle. In addition to the international system, the U.S. also uses two additional categories. The first of these is termed "Unstageable" or "Unclassified" and is characterized by full loss of dermis but unobservable depth due to slough or eschar (i.e., non-viable tissue somewhat similar to very thick scabs). The second is termed "Suspected Deep Tissue Injury" and is characterized by discolored intact skin or blood-filled blisters (NPUAP & EPUAP, 2009).

Pressure ulcers are not unique to hospital patients, but reducing pressure ulcer risk factors in hospitals would dramatically reduce the presence of this condition in the population. It is estimated that 25% of all pressure ulcers, hospital-acquired or otherwise, begin forming in the operating room during surgery. An estimated 3-17% of all hospital patients will develop a pressure ulcer during their inpatient stay, though estimates for surgical populations range as high as 66% (Bansal et al., 2005).

Despite the clear incentive to better understand this phenomenon, it was only in 1959 that research into the amount of force and length of exposure necessary for ulcers to form began being published. This led to the first pressure ulcer risk assessment tool to be published by Norton, McLaren, & Exton-Smith in 1962. The Norton Scale has five subscales (physical condition, mental condition, activity, mobility, and incontinence) but is fundamentally only concerned with a patient's risk for chronic exposure to skin distortion. In the 1970s, research into the interactions between pressure and microclimate and between pressure and friction began. Perhaps the most widely adopted pressure ulcer risk assessment tool, the Braden Scale, was first published in 1988. The Braden Scale incorporates a new understanding of concomitant risk factors beyond chronic skin distortion into its six subscales (sensory perception, moisture, activity, mobility, nutrition, and friction/shear).

Despite these advances, to this day key pieces for understanding the development of pressure ulcers remain unknown. The known risk factors alone are inadequate to explain the majority of cases. There is also a lack of data to support the theorized mechanisms of action for the development of pressure ulcers (NPUAP & EPUAP, 2009).

In recent years, however, new incentives have emerged for U.S. hospitals to support research into pressure ulcers. Pressure ulcers are a growing concern here for two reasons. First, many factors that are associated with increased risk of pressure ulcers are expected to increase in the U.S. population in the near future. The known major risk factors include obesity, diabetes, and advanced age, all of which are current epidemics in the U.S. and show no signs of diminishing in the near future. Therefore it is expected that the proportion of hospital patients whose morbidity and length of stay are complicated by pressure ulcers will only increase unless prevention and treatment techniques improve (Sullivan & Schoelles, 2013).

The second major reason for increased interest in pressure ulcers has to do with the unique reimbursement system for healthcare in the United States. Since October 2008, the Centers for Medicare & Medicaid [CMS] no longer reimburses hospitals for the additional scope or complexity of care required when a patient develops a Stage III or higher pressure ulcer while under the hospital's care (Agency for Healthcare Research and Quality, 2011). Hospital-acquired pressure ulcers not only create a new condition that the hospital must treat for free, they also complicate the initial condition for which the patient was admitted. Despite the complication, CMS pays the hospital as if the patient had remained at whatever acuity level they were at before developing the pressure ulcer. Treatment costs for pressure ulcers are estimated at $1 billion per year (Bansal et al., 2005). In 2006, approximately 75% of those treatment bills were sent to Medicare and 15% were sent to Medicaid, meaning up to $900 million in treatment costs incurred by hospitals are subject to CMS regulations regarding reimbursement for pressure ulcers (Russo, Steiner, & Spector, 2006).

While not all of the treatment bills were specifically for hospital-acquired pressure ulcers, it is safe to say that the vast majority of them were. The exact proportion of pressure ulcers that are hospital-acquired is unknown. As mentioned previously, estimates for the rates of hospital-acquired pressure ulcers vary wildly, but the rate of pressure ulcers that develop outside of hospitals, long-term care facilities, and other healthcare settings is thought to be virtually zero (Bansal et al., 2005). One reason to believe that reports of hospital-acquired pressure ulcers may be overestimates is that skin integrity assessments are often not performed thoroughly at the time of admission. Consequently, any later observation of pressure ulcers is automatically labeled as hospital-acquired, even if the patient came to the facility with a pressure ulcer present.

Conversely, the aforementioned rise in obesity and diabetes coupled with an aging population means that more patients come to the hospital with promoters of pressure ulcer development but lacking one necessary component cause: immobilization. Once disease or surgery leaves the patient immobile for many hours, the recipe for ulceration is complete. Since immobilization is strongly associated with hospitalization, the growing rate of pressure ulcers is likely not simply a result of improved surveillance. The proportion of pressure ulcers acquired in healthcare settings – and particularly in hospitals – may truly be approaching 100%.

Healthcare facilities have tools in the fight against pressure ulcers. Prevention strategies can be broadly categorized into one or more of five overarching domains: risk assessment, skin care, nutrition, support surfaces, and education (AHRQ, 2011). These approaches serve to guide specific prevention treatments, regularly remove topical irritants, promote the body's healing capacity, limit chronic exposure to pressure forces, and improve the vigilance of caregivers, respectively. As with any program, adherence is imperfect due to competing time demands, inconsistent operational definitions, and imperfect communication. Even with perfect adherence to recommended guidelines, some pressure ulcers may still be unavoidable. The consensus belief is that most pressure ulcers can be avoided, but that some cases, such as those caused by things such as hemodynamic instability that is worsened by movement, an inability to maintain nutrition or hydration status, or the details of specific advance directives may make a goal of 100% prevention unachievable (J. M. Black et al., 2011).

The rising number of patients at high risk for pressure ulcers means that healthcare facilities face a future of providing more care – and more high-cost care – to their patients. Since hospitals have little if any influence on national trends regarding diet, physical activity, or aging, how can hospital administration improve their budget prospects? Innovations in technology (e.g., low air loss mattresses, friction-reducing sheets, and mechanical repositioning devices) promise to reduce the caregiver burden with respect to following best practice guidelines. Still, the amount of peer-reviewed research in this field is inadequate. Guidelines have coalesced around educated guesses made by practitioners and published in “gray literature” such as conference proceedings and white papers. Most of these devices’ effectiveness claims come in the form of promotional materials. How do they fare in a real-world setting? What factors affect their usefulness? Amidst concern about rising incidence rates, and with increased financial motivation, academic medical centers are poised to lead the effort of testing interventions for reducing hospital-acquired pressure ulcers.

Why Hospitals Must Foster Interprofessional Collaboration

Hospitals exist to deal with patients who are too ill to be treated by any one profession, making interprofessional teamwork essential in a hospital setting (Lingard et al., 2006). Teamwork, however, can take many different forms (Yeager, 2005). Two of the key components of teamwork that are often inappropriately mistaken as being synonymous are communication and collaboration. Communication is just the transactional conveyance of information (Zwarenstein et al., 2007). Collaboration is the process of working towards a common goal with shared decision-making authority (Zwarenstein & Reeves, 2006). Hospitals are often better at the former than the latter, but a culture of collaboration is critical to effective delivery of quality care (Yeager, 2005).

Unfortunately, fostering a collaborative environment in a hospital setting is challenging due to the fast-paced, high-stress nature of hospital work (Lingard, Espin, Evans, & Hawryluck, 2004). Teamwork in a hospital is predominantly quick, unplanned, and transactional (Lewin & Reeves, 2011). Even within a given profession, a lack of collaboration has been associated with an increased risk of errors (Alvarez & Coiera, 2006). The failure to synthesize the available perspectives of multiple professions makes a lack of collaboration even costlier (Sheehan, Robertson, & Ormond, 2007). While electronic medical records [EMRs] offer promise as a tool to achieve asymmetric communication, the utility of EMRs is not consistent across professions, leading to redundant work and poor electronic communication across professions (Green & Thomas, 2008).

Published efforts to foster face-to-face collaboration in hospitals have shown meaningful successes. Interventions that call for multiple professions to be in the same room at the same time have led to significantly reduced length of stay measures for patients (Pape, Thiessen, Jakobsen, & Hansen, 2013). They have also led to better clinical documentation of patients and, consequently, better discharge planning (Aston, Shi, Bullot, Galway, & Crisp, 2006). Forcing interprofessional teamwork has also been shown to lead to both more efficient and more consistent decision-making on behalf of the healthcare team (Mitchell, Parker, & Giles, 2013). Finally, these interventions have raised the level of care that team members can offer when working independently while also reducing absences, conflict, stress, and burnout in the workplace (Aston, Shi, Bullot, Galway, & Crisp, 2005; Deneckere et al., 2013; Jones & Jones, 2011).

On the other hand, forcing face-to-face interaction was also found to promote the transmission of inaccurate information (Fernandez, Tran, Johnson, & Jones, 2010). Further, while these interventions increased communication, it is less clear that they increased collaboration (Sinclair, Lingard, & Mohabeer, 2009). Despite forcing professions to work together, hierarchies remained that stifled open communication (Reader, Flin, Mearns, & Cuthbertson, 2007). Due both to the differing scope of practice awarded by various professional licenses and the preexisting culture of medicine, nursing, and others, truly shared decision-making across professions may be unattainable (Lingard et al., 2012).

Interventions to foster collaboration can fail to even be successfully implemented – let alone successful in meeting their goals – unless hospital administration continually pushes staff to embrace the change (Rice et al., 2010). In addition to entrenched attitudes regarding hierarchy and autonomy within professions, even professions that work together on a daily basis can have a poor understanding of each other's roles (Muller-Juge et al., 2013). While changing the frontline culture must overcome both inertia and entrenched beliefs, hospital administrators themselves often fail to model successful collaboration for their staff by not working together to achieve common organizational goals (R. C. Clark & Greenawald, 2013).

Interprofessional collaboration is not only influenced by the conceptual structures of the institution, but also by the physical structure. A lack of "off stage" space for informal teamwork not only reduces communication but also prevents the levels of comfort necessary for collaboration (Lewin & Reeves, 2011). The structure of work areas can therefore hinder or promote a culture of collaboration. Even something as simple as labelling a space a "Nurses' Station" as opposed to a "Team Station" may create meaningful differences in the levels of interprofessional collaboration in an institution (Gum, Prideaux, Sweet, & Greenhill, 2012).

Research into the level of collaboration in hospitals is difficult for two main reasons. First, there is no agreed-upon mechanism for measuring collaboration quantitatively (Parker, Jacobson, McGuire, Zorzi, & Oandasan, 2012). Even efforts to measure communication quantitatively are at high risk for bias, as individuals have been found to adjust both their behavior and their understanding of what is meant by effective communication as a consequence of participating in the study (Battles & King, 2010). Second, efforts to measure collaboration qualitatively have often taken an ethnographic approach (Gum et al., 2012; Jones & Jones, 2011; Lewin & Reeves, 2011; Sinclair et al., 2009). Ethnography can identify elements that support or hinder the development of a culture of collaboration, but with data collection periods that can be several years, the timescale is far too slow for quality improvement programs whose efforts are often measured in the span of weeks. With demonstrable need for hospitals to actively encourage collaboration to better achieve their mission in the face of entrenched workflows, a quickly implementable methodology that blends the benefits of quantitative and qualitative approaches would greatly benefit a hospital's efforts to measure the level of collaboration occurring locally.

The History of Process Improvement Methods in Healthcare

The most commonly used tools for both understanding and improving a process in healthcare are rooted in the work of Walter Shewhart. In the 1920s Shewhart developed the Plan-Do-Study-Act or PDSA cycle of assessing process control and quality improvement (Best & Neuhauser, 2006). This cycle, popularized by W. Edwards Deming in the 1950s, formalizes quality improvement as a continuously iterative process in which planned interventions must be rigorously assessed (McCarthy, Ward, & Young, 1994). The idea that changes should be implemented as experiments led to two more expansive schools of thought, namely the “Lean” and “Six Sigma” approaches of process improvement.

PDSA says that interventions should be studied but says nothing about how best to do so. Through the 1950s, management at Toyota formalized a series of steps that their quality control projects should take, which became known as the Toyota Production System or TPS (Teich & Faddoul, 2013). When moved away from the realm of automobile manufacturing, the generalized version of this approach became known as Lean manufacturing (D. M. Clark, Silvester, & Knowles, 2013). The primary goal of a Lean approach to improvement is to reduce waste in a process, where waste is anything that does not add value to the consumer. Steps taken from TPS that inform how to use a Lean approach in healthcare include measuring variation in a process or outcome and engaging frontline workers in understanding both the current state of the system as well as the outcome of any intervention (Kimsey, 2010).

Another popular approach to improvement – Six Sigma – was developed in the 1980s at Motorola (Pocha, 2010). Six Sigma is focused on reducing variation in a process, where variation is defined as an unwanted outcome or a defect from an ideal product (Chassin, 1998). As with TPS and Lean, a Six Sigma approach to improvement includes both objective quantitative assessment and gathering qualitative data from frontline staff (Lanham & Maxson-Cooper, 2003).

Both the relatively simple PDSA approach and the more sophisticated Lean and Six Sigma approaches place an emphasis on measuring and understanding root causes.

Nevertheless, the mechanisms for how to do high-quality research to address these goals remain largely undefined. PDSA gives no guide to study design, while Lean and Six Sigma only go so far as to say that both quantitative and qualitative data are important. Therefore, some sort of mixed-methods approach seems to be called for by popular process improvement techniques, but the implementation of these techniques is often far less rigorous in practice.

When the Institute of Medicine published its landmark report *To Err is Human: Building a Safer Health System*, the estimate of up to 98,000 preventable patient deaths per year grabbed the attention of the public and healthcare workers alike and prompted a surge of quality improvement projects in hospitals around America (Kohn, Corrigan, & Donaldson, 2000). Prior to this point, there had been editorials calling for structured process improvement in healthcare but the application of any of these approaches remained virtually unheard of (DelliFraine, Langabeer, & Nembhard, 2010). Today, many hospitals use PDSA, Lean, Six Sigma, similar programs, or a combination thereof in their quality improvement efforts (Vest & Gamm, 2009). Although the formal structure of these approaches promises a scientific approach to improvement, these methods are often implemented in healthcare with neither statistical rigor nor valid, reliable measures. Institutions often seem more focused on showcasing their attempts to improve rather than on the results of their data (Young & McClean, 2008).

Systematic reviews on both Lean and Six Sigma in healthcare repeatedly come to the same conclusion. There is increasing evidence that these tools are widespread in healthcare but only a small proportion of these efforts seem to make good use of their data. One review covering the first decade of this millennium found that of 177 articles published on applied Lean or Six Sigma interventions in healthcare, just 34 reported anything on the outcome of their intervention and only 11 included any statistical analysis (DelliFraine et al., 2010). Another review on 18 interventions to change workflows in Emergency Departments found only one study where the effect of change on employees was even measured (Holden, 2011). Perhaps most confusingly, in a review of 55 articles that explicitly claimed to use the Six Sigma approach to improvement, just 16 even reported their post-intervention sigma level (DelliFraine, Wang, McCaughey, Langabeer, & Erwin, 2013). The emerging consensus is that the promise of structured approaches to improvement is high, but that these tools are routinely misunderstood and misapplied in healthcare (D. M. Clark et al., 2013).

It has been well over 20 years since the publication of prominent editorials calling for systematic improvement techniques to be adopted in healthcare (Berwick, 1991). It has been 15 years since preliminary reports from *To Err is Human* emerged and the healthcare field began recognizing the need to improve quality through the understanding of underlying processes (Kim, Spahlinger, Kin, & Billi, 2006). Yet, despite the rapid familiarization with prominent approaches to engineering systems to produce high-quality products, the adoption of rigorous scientific methods into improvement projects in healthcare remains poor (Radnor, Holweg, & Waring, 2012). The desire to improve is evident (Moorman, 2005). With the combination of clinicians and researchers, academic medical centers are poised to lead the effort to raise the quality of implementing structured approaches to systematic improvement.

CHAPTER THREE: CEILING-BASED PATIENT LIFTS

Introduction

When the University of Kentucky opened two new patient floors of its inpatient hospital, ceiling-based patient lifts were installed in all of the new patient rooms. Staff moving in from older units did not have experience with ceiling-based lifts, and one year after the move administration was uncertain if the new equipment was being properly utilized. This equipment, intended to ease the physical burden of patient handling, would improve compliance with patient repositioning policies that aim to reduce the rate of pressure ulcer formation. Furthermore, prior to the new hospital opening, injuries related to handling patients were the most common cause of worker compensation claims for the entire University.

A hospital that is safer for both patients and staff was a goal of the new hospital design, but that design's effectiveness had not yet been ascertained. This project's primary goal was to evaluate the utilization rates for the ceiling-based lifts, which were the only patient handling tools provided in the new units. If utilization proved to be lower than expected, a secondary goal was to determine the barriers that staff faced when choosing whether or not to use the equipment. This research project was conducted in three phases to understand the factors promoting or hindering use of the ceiling-based lifts. All phases were reviewed and approved by a University of Kentucky Institutional Review Board.

Methods

Lifting Count Data

The first phase of the study was analyzing data from counters that automatically recorded the use of the lifting devices themselves. Each unit's remote control can display, among other things, the total number of uses and the average uses per week for that unit since it was last reset. This information was collected from 120 of the 128 installed ceiling lifts over a three week period; the 8 omissions were due to patients being in the room each time the observer went to collect data from the devices. All units had complete data going back at least 3 months, and 117 of them had complete data going back 12 months or longer.

The accuracy of the embedded counter was a concern. Therefore, thirty-one randomly selected rooms were tested three times each to ensure that the counter worked appropriately, and one of these rooms was tested a further 60 times. The amount of weight used in the tests was as little as ten pounds. In 153 test uses, the counter updated the number of lifts appropriately 100% of the time.

Given the hospital's repositioning policies as well as policies that prohibit the manual lifting of patients on the new units, a range of plausible lift usage rates was constructed using patient census data and patient mobility scores. However, adjustments were made for the fact that not all patients were good candidates for the lift units. For instance, their use on patients with spinal precautions was contraindicated. Therefore ranges of estimates for the percent of patients needing repositioning but who cannot use the lifts were solicited from experienced frontline staff and from nurse managers. Because the sample of lifts represented a virtual census of all lifting devices in the hospital, no statistical testing was necessary to determine if the observed rates were below the anticipated rates.

Survey Data

The second phase of the study was a survey of all nurses and nurse technicians who regularly work on the hospital floors equipped with the ceiling lifts. They were invited to take part in a REDCap survey about their perceptions of the ceiling-based lifts (Harris et al., 2009). Among the questions, respondents were asked to self-report the percent of time they used the lifts when transferring or moving their patients. Possible explanatory variables, including perception of the lifts on a variety of measures and certain demographic variables were then correlated with self-reported frequency of use of the equipment. The entire survey is included as Appendix 3.

With ordered categories as the outcome, an ordinal logistic regression model was sought to explain variation in the outcome. From the survey, 20 variables were considered as possible predictors of self-reported lift use, including the eight characteristics of the respondents themselves that are described in Table 3.1. Other examined variables were perceptions of:

1. Confidence in the equipment
2. Adequacy of training
3. Ease of use
4. Effectiveness at preventing injuries to staff
5. Efficient use of time
6. Availability of assistance
7. Safety of equipment to patient

The final five variables considered for inclusion were: 1) the years of experience in their job each respondent had, 2) a quantitative measure of how long each use of the lift took the respondent, 3) whether the respondent felt they had sufficient equipment to handle patients safely, and 4) the frequency with which the respondent had left work in either pain or 5) discomfort in the preceding month.

Meaningful predictors were identified using least-angle LASSO regression (Efron, Hastie, Johnstone, & Tibshirani, 2004). Asymptotically unbiased estimates of the remaining variables' effects were then obtained using an ordinal logistic model. All analyses were done in R 3.1.2 (R Core Team, 2014). The survey instrument used is included as Appendix 3.

Focus Group Data

The third phase of the study was a series of focus groups. The same population that was recruited for the survey was invited to discuss opinions about the lifts and to bring up any issues that might be limiting use of the equipment. Four focus groups were recruited. Since nurses work in teams based on patient acuity levels, three groups were devoted to three distinct nursing experiences. One was for acute care nurses, one for progressive care nurses, and one for intensive care nurses. These are the three domains by which nursing staff are described in the new hospital. The fourth group was made up of nursing technicians, who move from one acuity level to another and so there was no perceived need to divide them. A semi-structured interview was designed using key findings from the survey data. The list of pre-planned questions is included as Appendix 4. Responses were classified into meaningful themes using the Constant Comparative method (Glaser & Strauss, 1967; Lincoln & Guba, 1985). Themes that were identified during the analysis of these focus groups both validated and deepened the lessons learned from the survey responses.

Results

Lifting Count Data

Let A denote the proportion of the time in which a patient room has a patient assigned to it. Let B denote the proportion of patients with mobility issues, and who are therefore required to receive repositioning assistance. Let C denote the proportion of patients for whom use of the ceiling-based lifting equipment is for some reason contraindicated. The proportion of patients for whom use of lift is indicated is then given by the following formula:

$$B * (1 - C)$$

The approximate number of patients to whom this applies at a particular time is therefore:

$$128 \text{ rooms} * A * B * (1 - C)$$

The approximate proportion of the time that a given room is occupied by a patient for whom use of the ceiling-based lift is indicated is given by:

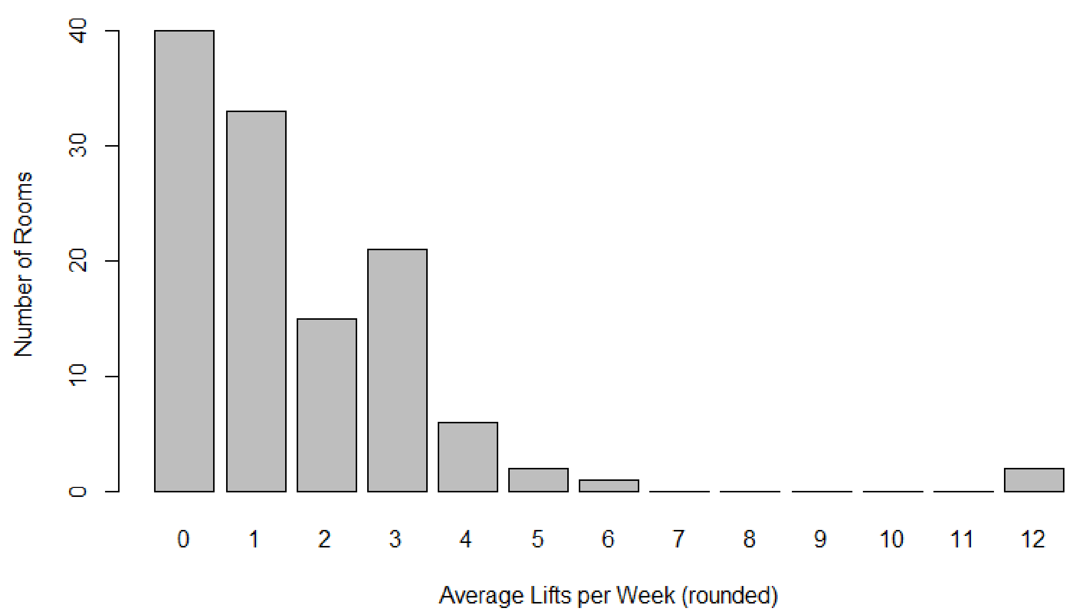
$$A * B * (1 - C)$$

The anticipated minimum weekly average lift count for a given room is the above formula multiplied by the minimum number of repositions called for per week. Since the minimum for all indicated patients is 12 times per day, the minimum per week is the above formula multiplied by 84.

Patient census data and interviews with administrative staff show that the occupancy rate in the first year of occupancy was at least 50% in Acute Care rooms and at least 90% in both Progressive Care and Intensive Care rooms. Coincidentally, the proportion of patients whose mobility scores indicated that they required assistance was also 50% in Acute Care rooms and 90% in both Progressive Care and Intensive Care rooms. Staff opinions on the prevalence of contraindications to equipment use varied, but all agreed that no more than 20% of patients in Acute Care rooms had such contraindications and no more than 50% of Progressive Care and Intensive Care patients had contraindications. The anticipated average uses of lifting devices in the Acute Care room was therefore at least 16.8 per week and was 34.02 for rooms in either the Progressive Care or the Intensive Care units.

The distribution of observed weekly averages rounded to the nearest whole number for 120 of the 128 rooms is shown in Figure 3.1.

Figure 3.1: Average Lifts per Week by Room (n = 120)



Fully 1/3rd of all rooms averaged less than one lift per week; 90% averaged less than four lifts per week. Only two rooms averaged more than six lifts per week and none were even close to the lower bound of the estimate of 17-34 lifts per week anticipated if policies were being observed. There is clearly a sizable gap between the expected use of this new equipment and its actual use in the first year of the two new patient floors.

Survey Data

All nurses and nursing care technicians in these units were to be trained on the use of the lifts prior to starting work in the new hospital. Of the 260 people who were expected to use the lifts as part of their everyday responsibilities, 99 (38%) replied with sufficient information to be included in analysis. Summary demographics are presented in Table 3.1.

Table 3.1: Survey Respondent Characteristics (n = 99)

Job title	
Nurse	74
Nursing Care Tech	24
No response	1
Employment type	
Full time weekday	84
Full time weekend	10
Part time (call)	3
No response	2
Unit type	
Acute care	21
Progressive care	49
Intensive care	28
No response	1
Patient repositionings per day	
0	0
1-5	15
6-15	65
16-25	13
> 25	4
No response	2

Gender	
Female	92
Male	7
No response	0
Age	
< 25	19
25-40	52
41-55	20
> 55	7
No response	1
Shift	
Days	55
Nights	39
Other	4
No response	1
Patient moves per day	
0	4
1-5	78
6-15	15
16-25	2
> 25	0
No response	0

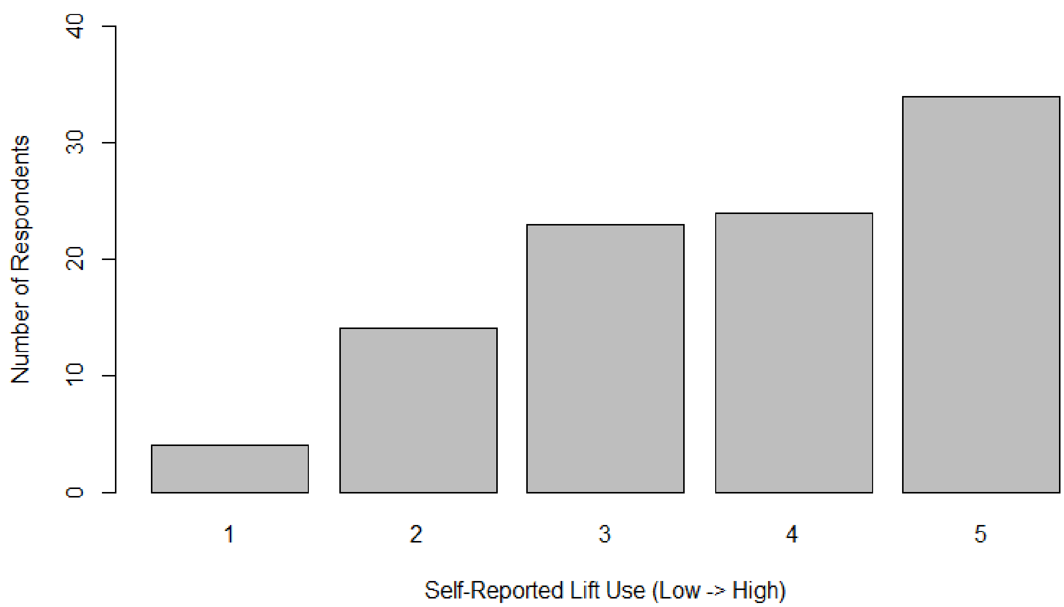
The only reason some responses were excluded from the analysis was if they did not answer the dependent variable question. The key question was phrased as: "I use the equipment available on my unit for transferring and moving patients," which was followed by a labeled visual analog scale. Except for omitting a response to this one question, partial responses were included in the analysis.

Despite using a continuous scale for the outcome measure, respondents showed a preference for round numbers. Values near 25%, 50%, 75%, and 100% were disproportionately common. Because participants did not seem to be answering this question as a continuous measure, responses were classified into five levels of percentages as follows:

Level 1 = [00, 20]
Level 2 = [21, 40]
Level 3 = [41, 60]
Level 4 = [61, 80]
Level 5 = [81, 100]

The distribution of responses by level is shown in Figure 3.2.

Figure 3.2: Respondent Lift Use Categories (n = 99)



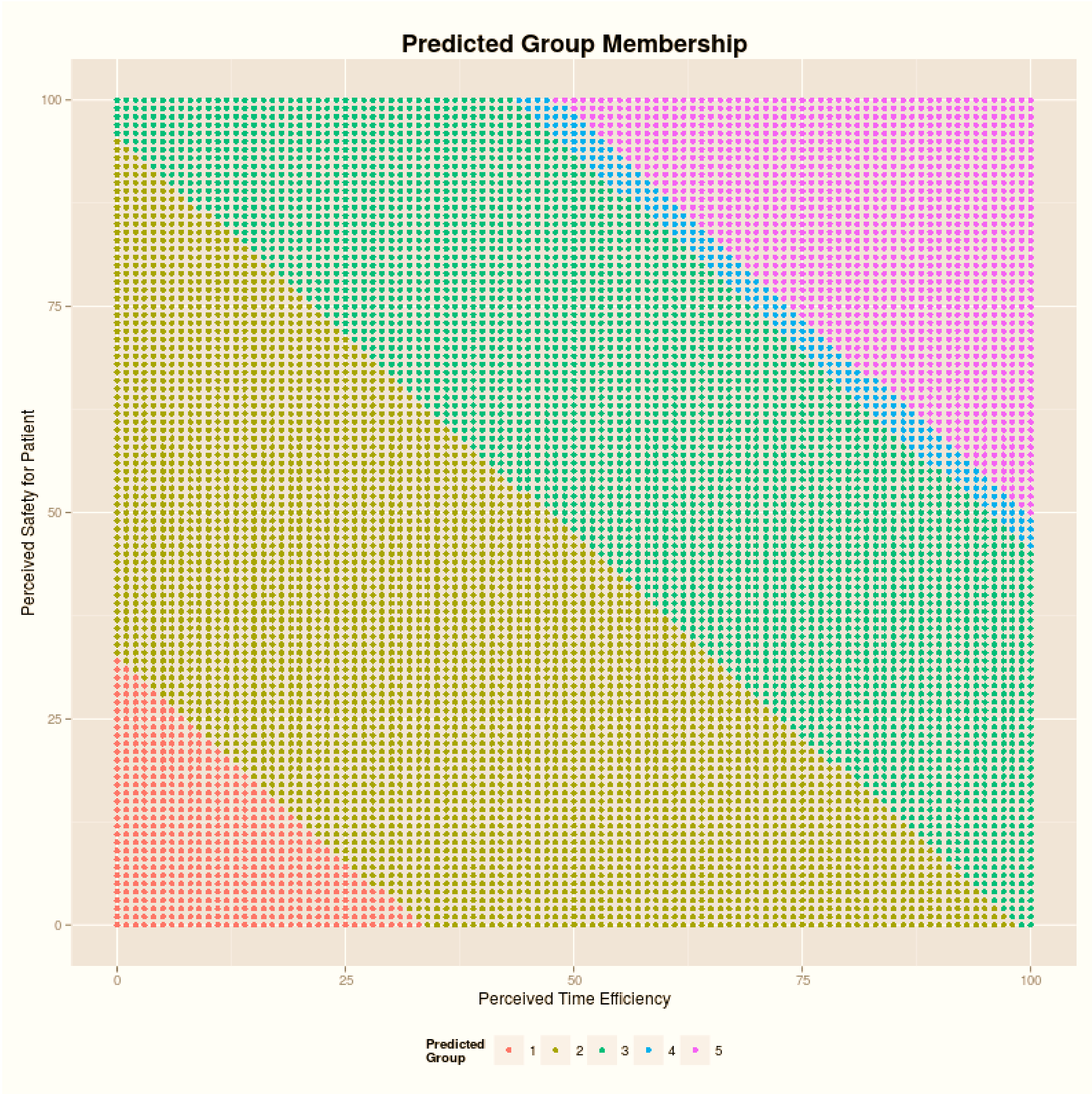
Variable selection was done using least-angle LASSO regression. Using the BIC, the only two variables that were effective predictors of self-reported lift use were the extent to which respondents felt use of the equipment was an efficient use of their time and the extent to which respondents felt that the equipment was safe for the patient. A second LASSO model investigated whether an interaction between these two variables would also be an effective predictor and determined that the interaction term should not be included in the final model. Since LASSO results bias effect estimates toward the null, the two variables were then run through standard ordinal logistic regression to report approximately unbiased estimates. Model results are summarized in Table 3.2.

Table 3.2: Ordinal logistic regression model parameters and estimates

	Model Parameters				$\widehat{OR}$ for 10-unit Increase		
Variable	*Estimate*	*SE*	*t statistic*	*p-value*	*Estimate*	*2.5%*	*97.5%*
Time efficiency	0.0277	0.00961	2.88	0.004	1.319	1.097	1.602
Safe for patient	0.0285	0.01387	2.06	0.040	1.330	1.016	1.753

The model says that the odds of being in a higher-use group are estimated to go up nearly 1/3rd for every ten-unit increase in either perceived time efficiency or perceived safety for the patient, both of which were measured on scales of 0-100. Since the model includes a different intercept term for each response level and odds ratios are multiplicative, with only two variables of interest it may be easier to convey the predicted group membership of individuals who fall anywhere along these spectra graphically than analytically. Figure 3.3 shows which level an individual is predicted to fall in for each possible combination of the above two variables.

Figure 3.3: Predicted Lift Use Group Membership



Focus Group Data

Three key themes identified during the analysis of the focus groups were: 1) that training had neither been thorough nor timely, 2) that there is often difficulty finding the auxiliary equipment necessary to use the lifts, and 3) that there is a variation in staff attitudes toward the devices themselves.

Training on the use of the lifts was not standardized for all employees in the new units. Employees were given expert training in a single simulated session held approximately 4 months before the new units opened. Staff hired after that session received no formal training on use of the lifts. Even those who had received the expert training complained that it was insufficient and poorly timed. As one nurse stated, “Now that I have used the lifts, I know what questions to ask.”

The lack of standardized training promoted a proliferation of often inconsistent beliefs about the lifts being spread as fact. Some staff believed that the lifts were not indicated when moving patients less than 180 pounds while others said less than 100 pounds. In fact, use of the lifts are indicated when staff would bear at least 30 pounds of the patient's weight, and there is no minimum safe weight. Some staff believed that the lifts could not handle more than 500 pounds. In fact, the lifts are rated to bear up to 1200 pounds. Widespread uncertainty about what the lifts can tolerate combined with a misguided belief that only handling morbidly obese patients presents an injury risk are thought to contribute to the low observed level of lift use.

Even when staff wanted to use the lifting devices, issues with finding the appropriate sling or other staff to assist in setup often meant the device was not a viable option. To use the lift, one of a variety of specialized task-specific slings has to be attached to the ceiling unit and placed under the patient. Some of the major types of slings are chair slings for moving into or out of a seated position, repositioning slings for boosts and rolls within a bed or for lateral moves to an adjacent bed, and limb slings to support the weight of an extremity for an extended period of time such as during wound cleaning. Slings were frequently not stocked to par in a given unit, or were haphazardly organized so that finding the right model would take longer than staff could afford.

Once the right sling was found, the staff had to find another staff member to help place the sling under the patient. Several nurses said it was common for them to feel so rushed by their other duties that by the time they found assistance, they would abandon plans to use the lift in favor of moving the patient manually. One of the advantages of a mechanical lift is that it can theoretically transform patient handling from a task that requires two to four people into a task that one person can do alone. Because the slings were not routinely left under the patient for fear of increasing the risk of pressure ulcers, this major potential benefit of the lifts was unrealized.

Despite the frustrations surrounding the process of using the lifts, positive views about the devices were far more common in the focus groups than were negative ones. As one nurse reported, “You're an idiot if you don't use them.”

Most focus group participants reported feeling either agreeing with this statement or expressed a more qualified support where they would use the lifts any time that finding staff to assist with setup was not an issue. A few staff did report negative feelings about the lifts, pointing to stories where something in the process went wrong. There have been cases where a patient was not balanced in the sling and slipped out, or where a faulty sling tore under a patient. Participants who reported safety concerns about the lifts inevitably pointed to these instances as reasons to never use them.

Discussion

This study shows that the mere presence of expensive, well-designed, recommended equipment is not sufficient to motivate its use by staff. One major impediment seems to be that misinformation about the lift may be commonly spread without proper communication and training. Also, a factor that greatly limited the use of these particular lifts seems to be that it is difficult and time-consuming to place a sling underneath a patient. Identifying these causes through the focus group exercise was important because they lead to some potential solutions, such as standardizing training and placing a sling under most patients as part of remaking the bed.

This study clearly showed that the lifts are not being used as often as they should be. If anything, this analysis underestimated what the expected number of lifts should be, as all estimates used in the calculation were the conservative extreme. For instance, the weighted mix of Acute Care, Progressive Care, and Intensive Care occupancy rates would predict an overall 72.5% occupancy rate. In reality the occupancy rate for the units from the time of opening to the time that data was collected was 84.36%. Similarly, the formula used a fixed number of 12 uses per day when a patient needs help repositioning. In reality, the order to reposition once every two hours is a minimum, and patients do sometimes need to be repositioned hourly – or even more frequently. Finally, the formula did not include any uses other than repositioning. Like the previous two examples, factoring in moving a patient to a bed or to a chair would only raise the expected weekly average to something higher than 16.8 for Acute Care rooms or 34.02 for Progressive Care and Intensive Care rooms. Therefore the gap between actual use rates and expected use rates is likely underestimated.

The analysis of survey data was interesting for two reasons. First, identifying which factors were strongly associated with higher self-reported lift use provides essential information for crafting a well-designed intervention in the future. Interestingly, the two factors that emerged strike a balance between the importance for the equipment to be good for the provider (time efficient) and good for the patient (safe for the patient). The fact that the estimated coefficients for these two variables are similar indicates that these two concerns are balanced in the eyes of patient-care staff.

The focus group data provided an understanding of the issues faced by patient-care staff when trying to use the equipment. It captured why people felt that use of the lifts was not time efficient and also why they sometimes thought that the equipment was not safe for the patient. In theory some of this same information might have been captured through the use of open-ended questions on a survey. In reality, the depth of information recorded through such a mechanism would be unlikely to reach the same level as what came up in hour-long discussions. Furthermore, only by having multiple staff members talking together did it become clear that people had vastly different understandings of the lifts. While a survey might have captured variation in responses, the presence of opposing viewpoints within a conversation confirmed that they truly had differing understandings about when to use the lifts, as they did not acquiesce into agreement when challenged.

In summary, it is clear from the results of the surveys and focus groups that training is needed to provide accurate information about the lifts and to show patient-care staff how and when to properly use the lifts. The hospital had in place written procedures, but these procedures were not being routinely followed. The surveys and focus groups also indicated that proper use of the lifts needed to be reinforced by supervisors. Staff deserve the benefit of the doubt and so it is assumed that they are moving and repositioning patients as needed. This study only shows that they are not using the provided lifting equipment to do so.

Strengths of this study include the discovery of clear solutions for current problems. To date, there have been no published systematic investigations of the use of patient lifting equipment. This study's findings have implications for both patient and staff safety. The mixed methods approach gave a holistic view of the situation demonstrating that good quality data can be easily collected at little expense. This study's conclusions are also very robust because – except for the rate of contraindications – all assumptions were supported by objective data and estimates erred on the side of being extremely conservative. Given the paucity of peer-reviewed research on the utilization of patient lifting equipment, this study sets the stage for follow-up work. In the context of an applied quality improvement project, this study also succeeded in offering specific actionable suggestions for improving utilization rates in this hospital. These suggestions include improving the availability of patient slings, easing the burden of sling placement by putting repositioning slings on the bed as part of bed make-up, and properly training staff when, why, and how to use the lifts. Once these tasks are consistently accomplished, a follow-up study should be conducted to evaluate the impact of the lifts in reducing injuries.

This study does have several limitations. Chief among these is the fact that it does not address whether the equipment is effective when properly used. While avenues have been identified to potentially increase the lift use rate, there is still no solid evidence that the equipment will reduce either staff injuries or patient pressure ulcers. Furthermore, this study does not address whether ceiling-based lifting devices alone would be sufficient equipment to have an impact on these problems. It is quite plausible that the lifts only work as part of a more comprehensive plan for safe patient handling. Finally, this study is based only on a sample from a single institution and both the survey and focus group portion were prone to some volunteer bias, meaning caution is advised before applying these conclusions to other institutions.

Conclusion

It is clear that use of the ceiling-based lifts lags far behind what hospital policies would dictate. It is also apparent that frontline staff do not have a uniform understanding of what the lifts can do and how to operate them. Even for those with positive views of the lifts, ancillary issues such as shortages of slings make the lifts an unreliable tool for their job. With some educational programs to target perceived patient safety and standardize training on lifts and their capabilities, along with a relatively minor investment in additional slings to improve both time efficiency and availability of the lifts, it appears that regular use of the lifts is still achievable. Based on these results, these changes are likely to be welcomed by staff, especially since staff were involved in suggesting these remedies.

CHAPTER FOUR: TEAMWORK AND DESIGN

Introduction

When the University of Kentucky opened the first eight units in its new inpatient hospital, each unit included approximately 600 square feet designated as a “Team Station.” This space was intended to facilitate interprofessional collaboration. Staff moving in from older units did not have experience with such a space and one year after the move, administration was uncertain if the Team Stations were being sufficiently utilized. Although the equivalent space in older units was the traditional “Nurses’ Station,” nurses in the new units were expected to work at decentralized workstations outside each patient room. The relabeling of a large central workspace reflected an intentional shift away from a centralized Nurses’ Station, and is part of a larger effort in healthcare to promote interprofessional teams through physical design (Gum et al., 2012). A hospital that facilitates interprofessional teams was a goal of the new design, but that design’s effectiveness had not been ascertained.

This project’s primary goal was to evaluate the rate of interprofessional collaboration occurring in the Team Stations. If the Team Stations were not used frequently for interprofessional collaboration, one secondary goal was to determine how these spaces were being used. Another secondary goal was to determine both where and how frequently interprofessional collaboration was occurring. A tertiary goal was to evaluate staff opinions on how the hospital’s design was influencing where teamwork occurs. This research project was conducted in three phases to understand the factors promoting or hindering use of the Team Stations. All phases were reviewed and approved by a University of Kentucky Institutional Review Board.

Methods

Time Utilization Data

The first phase of the study involved observational data to describe which professions used which spaces, where collaborations happened, and – in particular – where interprofessional collaborations happened. Over a three week period a trained observer walked a predetermined route through the eight new units a total of 75 times. The route was made up of 259 ordered points across (and between) all eight units. At each point, the observer recorded the approximate number of staff present, the professions represented, and whether the work being done was solo or collaborative. In order to break the Team Stations into easily-observable areas without asking the observer to be overly intrusive, each Team Station was subdivided into multiple observation points. A sample data collection screen of the device used by the observer is included as Appendix 5. The observations were taken at a semi-random selection of times to ensure thorough coverage of the daytime hospital shift, who work from 7am to 7pm. Each lap took nearly one hour to complete, and each hour-long timeslot was covered at least five times during the course of the study.

Data analysis was done using Bayesian Poisson regression. Sampling of the posterior distributions was done in JAGS 3.4.0 as accessed through R 3.1.2; all other analysis was done in R 3.1.2 directly (Plummer, 2003; R Core Team, 2014) . A diffuse Cauchy distribution with a central value of 0 and a scale value of 2.5 was selected as a minimally informative prior for all regression coefficients (A. Gelman, Jakulin, Pittau, & Su, 2008). Posterior quantities of interest were included in the sampling program so they could be directly assessed from the posterior, rather than estimated post-hoc with parameter estimates. The sampler ran five chains and each chain collected 17,000 samples, though the first 2000 in each chain were discarded to allow for burn-in. Convergence and possible auto-correlation were assessed using JAGS' Rhat and n.eff estimates. Out-of-sample predictive power and model complexity were assessed using p_{opt}, a variant of DIC (Plummer, 2008). The regression model was as follows:

$$\text{Interprofessional collaborations} \sim \text{Poisson}(\lambda * \text{space size})$$

$$\begin{aligned}\log(\lambda) = \ & \beta_1(\text{Breakroom}) + \beta_2(\text{Classroom}) + \beta_3(\text{Conference room}) \\ & + \beta_4(\text{Core supply area}) + \beta_5(\text{Hallway}) + \beta_6(\text{Patient room}) \\ & + \beta_7(\text{Staff desk}) + \beta_8(\text{Team Station}) + \beta_9(\text{ICU Core supply area}) \\ & + \beta_{10}(\text{ICU Hallway}) + \beta_{11}(\text{ICU Patient room}) \\ & + \beta_{12}(\text{ICU Team Station})\end{aligned}$$

Focus Group Data

The second phase of this study involved focus groups. Eight groups were planned. One group was to be nurses from ICU units and one was to be nurses from non-ICU units. Only two nurses showed up at the first focus group for non-ICU nurses, so ultimately a ninth focus group was held to get a larger field of opinions from that population. Of the remaining six groups, one was for MDs, one was for nursing technicians, one was for the patient care managers on the 6th floor, and one was for the patient care managers on the 7th floor; the final two focus groups were for professions that have a frequent presence on these units but do not have large staff sizes to draw from (e.g., pharmacists, physical therapists, social workers, and patient care facilitators). A semi-structured interview was designed using key findings from the survey data. The list of pre-planned questions is included as Appendix 6. Responses were classified by expert personnel into meaningful themes using the Constant Comparative method (Glaser & Strauss, 1967; Lincoln & Guba, 1985). Themes that were identified during the analysis of these focus groups were then further explored in the broader population using a survey.

Survey Data

The third phase of this study was an online survey administered through REDCap (Harris et al., 2009). All staff who were invited to participate in the focus groups were also invited to complete the survey. Among the questions, respondents were asked Likert-style questions to assess their concordance with issues that emerged from the focus group data. The entire survey is included as Appendix 7.

Results

Time Utilization Data

The resulting dataset had 19,425 observations and contained information on time, unit, space type (e.g., patient room, Team Station, or supply area), professions present, and whether the work being done was solo or collaborative. In the process of restructuring the data and creating new variables, some obvious examples of user error on the part of the observer came to light. The first type of error was where employees were observed, but no activity was recorded as being done. This occurred in 20 observations.

The second type of error was where a work type was recorded but the number of people was marked “Not Obtainable.” This occurred in 5 observations. The third type of error was where collaborative work was recorded, but less than two employees were recorded as being present. This occurred in 45 observations. With an overall estimated observer error rate of 70/19,425 or 0.36%, the time utilization data was considered to be very reliable. Because the proportion was so small and did not occur with any obvious pattern with regards to time or location, these 70 problematic observations were dropped from the analysis.

A further 520 observations that were taken in areas between units such as the equipment cleaning area and small offices were also dropped from analysis. These data points had been collected because at the study design phase the research team thought that these areas not part of the patient care floor might be utilized for collaboration, but that was never observed. By removing them, some factor variables were able to be converted into more easily-interpretable dichotomous covariates and no interprofessional collaboration data was lost. Finally, observations of the Resident Workrooms were also dropped. These offices are behind security doors that are typically only accessible with an MD’s security badge. Although our observer was given access to this space by UK Healthcare administration, the residents began to block the door to prevent his access midway through the study. To that point, no interprofessional collaboration had been observed in these spaces and – given the security card policy – none would be expected. The final dataset included 18,536 observations, with key factors described in Table 4.1. Note that the rows may not sum exactly to 100% as a small proportion of observations (<2%) contained a mixture of worktypes in a single observation.

Table 4.1:Work Done by Space Type

Type	Observations	Solo Work	Intraprofessional Collaborations	Interprofessional Collaborations	Empty
Breakroom	298	15.4%	6.0%	4.4%	74.2%
Classroom	300	2.0%	8.3%	3.0%	86.7%
Conference room	300	2.0%	2.0%	1.3%	94.7%
Core supply area	2996	7.5%	0.9%	0.5%	90.8%
Hallway	2673	11.3%	5.2%	1.8%	81.7%
Patient room	9574	27.0%	18.9%	3.4%	54.5%*
Staff desk	299	65.6%	12.4%	6.0%	15.7%
Team Station	2096	29.2%	14.0%	4.3%	53.2%
Total	*18536*	*21.5%*	*12.7%*	*2.8%*	*65.0%*

***Observations of patient rooms that were "Not Obtainable" are included here as having been empty of staff.**

Even if Team Stations were not the primary space for collaboration to occur, it was theorized that by virtue of their size, they might be the primary space for large collaborations to occur. Table 4.2 summarizes the fraction of observations in which each level of occupancy was observed. In the case of patient rooms, if the door was closed and no staff was at the immediately adjacent workstation, this was recorded as "Not Obtainable." In practice it was observed that staff typically leave the door open when they are working in a patient room. This was later confirmed in the focus groups. Therefore, although a large proportion of observations of patient rooms were marked "Not Obtainable," it is believed that these observations can be interpreted as having no staff in that space.

Table 4.2:Occupancy by Space Type

Space Type	0	1	2-3	4-6	7+	Not Obtainable
Breakroom	74.16%	12.08%	10.74%	1.68%	1.01%	0.34%
Classroom	86.67%	0.33%	4.33%	2.33%	6.33%	0.00%
Conference room	94.67%	2.00%	1.67%	1.33%	0.33%	0.00%
Core supply area	90.82%	7.18%	1.70%	0.03%	0.00%	0.27%
Hallway	81.74%	10.18%	7.03%	0.90%	0.04%	0.11%
Patient room	19.28%	19.29%	21.88%	4.05%	0.31%	35.18%
Staff desk	15.72%	60.54%	22.41%	1.00%	0.00%	0.33%
Team Station	53.24%	21.56%	20.52%	4.48%	0.19%	0.00%
Total	*46.83%*	*16.24%*	*15.54%*	*2.84%*	*0.31%*	*18.24%*

Interprofessional collaboration was evenly spread throughout the day and there was no pattern by day of the week, so time was not considered in this analysis. The main variables of interest to consider were the space type and the unit's acuity level (i.e., ICU or non-ICU). In modeling the rate of interprofessional collaboration, the size of the observation area (in 100s of square feet) was included as an offset term in the regression model. Exponentiated parameter estimates are summarized and interpreted in Table 4.3. All Rhat estimates were 1.001, which gives evidence that in all cases the chains converged (Andrew Gelman, 2014). All n.eff estimates were at least 49,000, which gives evidence that even extreme posterior quantiles were reliably estimated (Raftery & Lewis, 1992). Mean deviance was 848.8, which, with a penalty of 80.6 gave a p_{opt} of 929.4.

Table 4.3: Estimates of Interprofessional Collaboration Rates per 100 sq. feet of Space

Space type	2.50%	mean	50%	97.50%
Breakroom	0.97	1.78	1.74	2.86
Classroom	0.34	0.72	0.70	1.26
Conference room	0.17	0.58	0.54	1.23
Core supply area	0.10	0.22	0.21	0.38
Hallway	1.16	1.66	1.64	2.25
Patient room	1.19	1.41	1.40	1.64
Staff desk	4.76	8.12	7.97	12.33
Team Station	0.79	1.14	1.13	1.57
ICU Core supply area	0.18	0.43	0.41	0.79
ICU Hallway	0.38	0.73	0.71	1.22
ICU Patient room	1.86	2.17	2.17	2.51
ICU Team Station	1.17	1.55	1.54	1.98

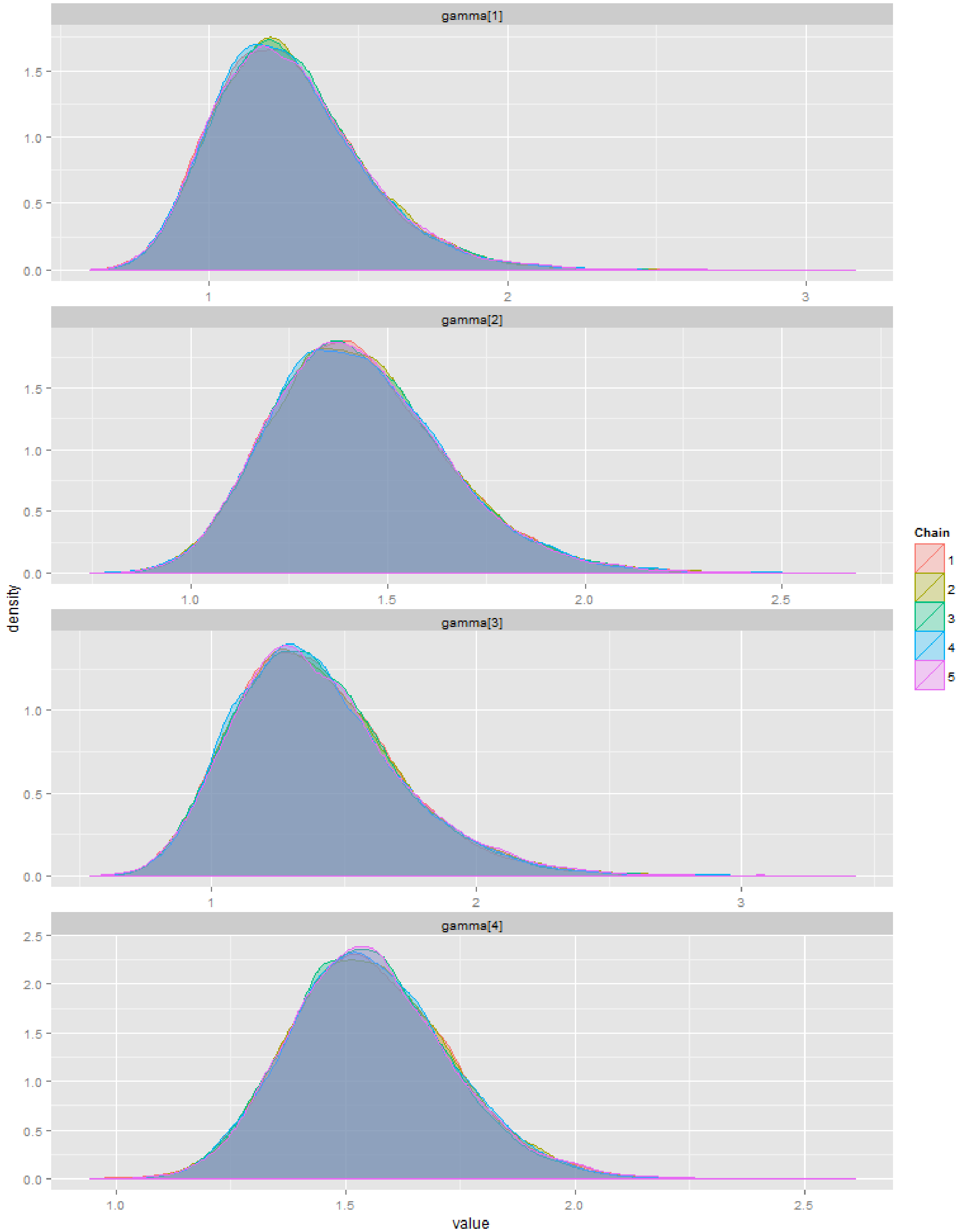
Table 4.3 can be read as saying, for example, that there is approximately a 95% chance for observing between 1.25 and 1.71 interprofessional collaborations per 100 square feet of non-ICU patient room space in a three week period. Because the posterior mean and the posterior median are both approximately 1.47, the posterior distribution passes a crude test for symmetry.

Of particular interest is whether the specialized Team Station space is more fertile for interprofessional collaboration than a more mundane space that is otherwise necessary for the hospital. To that end, four rate ratios of interest were sampled directly from the posterior. They are:

gamma[1] = non-ICU Patient room vs. non-ICU Team Station
gamma[2] = ICU Patient room vs. ICU Team Station
gamma[3] = ICU Team Station vs. non-ICU Team Station
gamma[4] = ICU Patient room vs. non-ICU Patient room

Their distributions are shown in Figure 4.1.

Figure 4.1: Distributions of Rate Ratios



The first distribution shows that with over 87% certainty the rate of interprofessional collaboration is higher in patient rooms than in Team Stations for the non-ICU units. Its central 95% credible interval is (0.86, 1.84). The second distribution shows that with over 98% certainty the rate of interprofessional collaboration is higher in patient rooms than in Team Stations for the ICU units (1.05, 1.92). The third distribution shows that with over 92% certainty the rate of interprofessional collaboration is higher for Team Stations on the ICU units than for Team Stations on the non-ICU units (0.89, 2.11). The last distribution shows that with over 99% certainty the rate of interprofessional collaboration is higher in patient rooms on the ICU units than for patient rooms on the non-ICU units (1.24, 1.93).

Focus Group Data

Five key themes identified during the analysis of these focus groups were: 1) nursing staff feel isolated in the new design, 2) nursing staff are sometimes difficult to locate, 3) perceived team cohesiveness has changed, 4) workspaces were poorly planned for some specific needs, and 5) the overall layout of the floor is problematic for many professions.

Isolation was identified as a byproduct of the decentralized workstations, which are spaced along the hallways adjacent to patient rooms. Several groups emphasized that the decentralized workstations are counterproductive to team-building. As one technician stated:

> I just wish that there was a central place to be together because we were told specifically when we moved over that there was no longer going to be a nurses' station, that we were no longer going to be together, that you had to be

> apart, you had to be outside your rooms, which is very isolating.

The decentralization of nurses was particularly problematic because nurses feel that mutual support is essential in performing many job duties. Management is aware of how decentralization has made it hard for nurses to seek assistance as needed. One of the four patient care managers for these units described her unsuccessful efforts to address this concern.

> I've really tried to promote having the small little huddles at a couple of times during their 12 hour shift just to find out what's going on on the unit and to touch base with each other. And they don't do it. Not like I would like for them to. They say they just don't have time. But I mean, something could be going on, something bad could be happening on one side of the unit and no one would know.

In addition to a reduced ability to get help in the event of emergencies, routine tasks that are expected of nurses are also made harder due to lack of available staff support. For instance, turning a patient over in bed is a task that cannot safely be done by a single nurse without assistance. Difficulty in finding assistance has led to unsafe situations. As one nurse confided:

> Sometimes, and I shouldn't do this because it's not legal for them to be doing this, but I ask respiratory to help me turn [a patient]. Or I ask, you know, people that they are not covered legally to help me turn.

The difficulty expressed about finding nurses was just the most obvious symptom of a larger problem. As one technician explained, "It's hard for doctors to find nurses, it's hard to find techs, it's hard to find help." Two other technicians described the cost this distance has exacted on team cohesion. "It used to be we could sit and get to know each other and get comfortable with each other. Now it's very impersonal." "We used to be more of a unit, it used to be more teamwork."

Conversely, for those professions who now have offices on the patient floors but were not located near other staff in the old units, the new design has dramatically improved their perception of being part of a larger team. As one patient care facilitator said, “I am just much more aware of what’s going on with the patients and the interdisciplinary staff.”

The presence of interprofessional offices within the non-ICU Team Stations was the lone bright spot for that workspace. As one patient care manager described the reality of interprofessional teamwork on her unit, “The whole interdisciplinary team approach and everybody getting together to discuss patients still does not happen.” With specific regard to the Team Stations, one nurse said:

> It’s a complete and total waste. We never meet there as a team when we are rounding. We always meet at the bedside, which is where we should be. It’s a complete waste of space. You could get rid of it and open it up and it would alleviate some of the issue that we have.

In addition to being underutilized, the issue being alluded to is how the layout – particularly on the non-ICU side but also for certain rooms in the ICUs – severely hampers the ability of staff to see and hear all of their patients simultaneously. In describing the overall platform of care in the new hospital, the responses from technicians and nurses varied little. Some representative responses were:

- “Layout isn’t great.”
- “The layout is awful. Nothing works right.”
- “I don't like it. I really don't.”
- “I hate it.”

Survey Data

The survey had 78 respondents. Basic information about the respondents is summarized in Table 4.4. Survey questions explored the five basic concepts that were identified as important through the focus groups. These were staff isolation, availability of staff support, patient-centered teams, workspaces, and unit layout. Responses to the survey are summarized in Table 4.5.

Table 4.4: Survey Respondent Characteristics (n = 78)

Profession	N	%
Physician	7	9.0%
Nurse	36	46.2%
Nurse Tech	10	12.8%
PT/OT/Resp	22	28.2%
No response	4	5.1%

Time in Pav. A	n	%
<1 month	2	2.6%
1-6 months	4	5.1%
7-12 months	8	10.3%
13-18 months	13	16.7%
>18 months	47	60.3%
No response	4	5.1%

Table 4.5: Survey Response Summary (n = 78)

Statement	Agree		Disagree		Neutral	
	n	%	n	%	n	%
I feel isolated from my coworkers.	31	39.7%	33	42.3%	14	17.9%
I am typically aware of when coworkers need help.	38	48.1%	24	30.4%	17	21.5%
I am aware of events going on in other rooms in my unit.	27	34.2%	34	43.0%	18	22.8%
It is easy to collaborate with others on my unit/floor.	40	50.6%	23	29.1%	16	20.3%
I have difficulty finding people when I need help.	39	49.4%	23	29.1%	17	21.5%
I feel like I am a valued member of my patient care team.	42	60.9%	9	13.0%	18	26.1%
I am satisfied with the amount of interaction I have with staff during my work day.	40	50.6%	20	25.3%	19	24.1%
It is easy to communicate with other members of the patient care team.	41	51.9%	20	25.3%	18	22.8%
Privacy is a concern in the locations where we meet as teams.	26	32.9%	39	49.4%	14	17.7%
I have sufficient access to quiet space for doing solo work.	41	52.6%	20	25.6%	17	21.8%
I am satisfied with the space we use for small group (2-3 people) discussions.	55	70.5%	7	9.0%	16	20.5%
I am satisfied with the space we use for large group (4+ people) discussions.	56	70.9%	7	8.9%	16	20.3%
The layout of the floor supports positive patient outcomes.	36	45.6%	15	19.0%	28	35.4%
The layout of the floor helps me do my job efficiently.	32	40.5%	26	32.9%	21	26.6%
The layout of the floor supports team-centered patient care.	26	32.9%	34	43.0%	19	24.1%
I am satisfied with the layout of the unit.	36	45.6%	26	32.9%	17	21.5%
I am satisfied with my ability to visualize what is going on within my unit.	17	21.8%	42	53.8%	19	24.4%

Since nurses are the primary caregivers on the floor and make up the majority of staff in these units, responses were analyzed for any apparent difference in the rates of agreement or disagreement among the 36 nurses as compared to the other 42 respondents. This was done by taking the raw count of agree and disagree responses and comparing nurses with non-nurses using Fisher’s exact test. Table 4.6 shows the results and the associated 2-tailed p-values. For easier comparisons, the counts have been replaced with proportions. Cells would sum to 100% if those who responded feeling “Neutral” were included, but these have been omitted.

Table 4.6: Responses for Nurses vs. non-Nurses

Statement	RN (%) Agree/Disagree	non-RN (%) Agree/Disagree	p-value
I feel isolated from my coworkers.	50.0/36.1	31.0/47.6	0.2106
I am typically aware of when coworkers need help.	30.6/36.1	62.8/25.6	0.0630
I am aware of events going on in other rooms in my unit.	36.1/41.7	32.6/44.2	0.8002
It is easy to collaborate with others on my unit/floor.	41.7/30.6	58.1/27.9	0.4400
I have difficulty finding people when I need help.	66.7/25.0	34.9/32.6	0.1164
I feel like I am a valued member of my patient care team.	63.9/11.1	57.6/15.2	0.7180
I am satisfied with the amount of interaction I have with staff during my work day.	47.2/25.0	53.5/25.6	1.0000
It is easy to communicate with other members of the patient care team.	50.0/25.0	53.5/25.6	1.0000
Privacy is a concern in the locations where we meet as teams.	33.3/44.4	32.6/53.5	0.7994
I have sufficient access to quiet space for doing solo work.	77.8/11.1	31.0/38.1	0.0008
I am satisfied with the space we use for small group (2-3 people) discussions.	83.3/2.8	59.5/14.3	0.1035
I am satisfied with the space we use for large group (4+ people) discussions.	86.1/5.6	58.1/11.6	0.2429
The layout of the floor supports positive patient outcomes.	38.9/27.8	51.2/11.6	0.1225
The layout of the floor helps me do my job efficiently.	38.9/36.1	41.9/30.2	0.7919
The layout of the floor supports team-centered patient care.	16.7/55.6	46.5/32.6	0.0084
I am satisfied with the layout of the unit.	27.8/41.7	60.5/25.6	0.0214
I am satisfied with my ability to visualize what is going on within my unit.	11.4/77.1	30.2/34.9	0.0085

This table shows that, for several of the items, there is reason to consider analyzing nurses’ responses separately from other responses. It also shows that nearly all of the facets targeted by the questions were problematic for a substantial portion of one or both groups.

Discussion

This study found that the layout of the new units has serious problems in terms of how it affects teamwork. The observational study showed that interprofessional collaboration occurs only rarely, regardless of location. It also showed that the large Team Stations are virtually never used to capacity. They are also very seldom used for their intended purpose of supporting interprofessional teamwork. In particular, the size of the Team Stations, which was supposed to support large group meetings, appears to be unjustified as large teams were hardly ever observed anywhere and did not occur at Team Stations more often than at patient rooms. Bayesian modeling confirmed a similar relationship to be true regardless of team size as the rate ratios showed that patient rooms were used for collaboration convincingly more frequently than Team Stations. This was true both on the ICU side and on the non-ICU side, though collaboration on the ICU side was higher in both locations. If Team Stations are typically empty or sparsely populated, and if they are not the preferred location for interprofessional collaboration when it happens, it is difficult to justify allocating a large amount of central space to their existence.

The focus groups were critical in understanding why the Team Stations are failing. It showed that no single intervention would address all of the root causes for this failure. The decentralized workstations and the inability to see patients from the non-ICU Team Station were identified as serious problems with the new design, and key issues to ask of a broader audience were identified through the focus groups. A survey crafted without the insights of the focus groups could have easily missed these fundamental problems with the new design, and how low use of the Team Stations was only one issue that is connected with other problems with the overall platform of care.

The survey data suggested some possible respondent bias among those who had volunteered to participate in the focus groups. In general, the negative feelings that emerged as findings from the focus groups were shown to be minority opinions – albeit sizable ones – in the survey sample. For example, while feeling isolated was a strong theme in focus groups, 42.3% of respondents disagreed with the statement, "I feel isolated from my coworkers," while 39.7% agreed and 17.9% were neutral. It is not surprising that information coming from focus groups tended to be more critical than the findings of the survey. While questions asked in focus groups were phrased in ways that aimed to avoid biasing the responses, the mere invitation to participate in a focus group might be seen as an invitation for constructive criticism.

Table 4.6 shows that for many of the 17 survey items, there is reasonably strong evidence to support treating nurses as different from non-nurses in analyzing the survey. This makes theoretical sense as well, since nurses are essentially the only staff who spend the overwhelming majority of their time on a single unit. Physicians, therapists, and most other professions visit their patients throughout the facility and only spend a minority of their time on a given unit. Therefore the difference in responses can be seen as the approximate perspective of those whose professional life is strictly on the unit (i.e., nurses) as compared with the approximate perspective of those who merely visit the unit on a regular basis. This understanding explains why some items like access to quiet space for solo work are so different between the groups. Nurses can setup a workstation for themselves and have it for the whole day. Non-nurses have to search for an available computer. Typically the available computers are not located in ideal locations. The needs of these two groups with respect to issues such as accessing unit resources or needing to visualize the entirety of a unit at once are very different.

From the perspective of hospital administration, it may be problematic even if only small groups of respondents are displeased with some aspect of their workplace. For example, if a large majority of respondents felt positively about the Team Stations but a sizable minority of nurses disagreed, this should be enough to warrant some sort of response from the administration. It is possible that the appropriate response may be a deeper investigation. An unhappy minority might be inevitable and should not necessarily demand changes to the workplace, but it should at least prompt administration to look into the matter.

To see the extent to which the 17 survey items represent possible problems for administration to address, we can take the proportion of both nurses and non-nurses who selected the "non-desirable" response (e.g., 50% of nurses selected the non-desirable response that they feel isolated from their coworkers compared with 31% of non-nurses) and base a decision rule on the higher of these two. By this criteria, all 17 items elicited a non-desirable response from at least 10%, 14 items received one from >20%, 11 from >30%, 6 from >40%, and 3 from >50%. In my opinion, the call to action should occur somewhere between 5% and 20%, meaning that all or nearly all of these survey items are real problems on these units.

In summary, it is clear from the time utilization data that interprofessional teams are rarely meeting in person in the new hospital units. In particular, the Team Stations are not particularly conducive to interprofessional teamwork. In fact, these large spaces were found to typically be mostly empty. The focus groups and surveys identify some reasons why this may be the case and suggest possible changes that could help realize the hospital's initial vision.

In a hospital, interprofessional teams cannot succeed without including nurses. For Team Stations to be successful, nurses need sufficient support so that they can leave their station for a while to consult with a team and know that their patients are still being covered by other nurses. With the distance between patients being a fixed entity on these units, the only way to achieve this is to staff the units with more nurses. Even then, there must be more thought put into the assignment of nurses to particular rooms. Currently nurses are assigned to patients without regard to where on the unit those patients are physically located. To improve nurses' ability to visualize all of their patients simultaneously, nurses need to be assigned only to rooms that are adjacent to each other.

If these changes were made, it would be easier for nurses to be part of interprofessional rounds, but collaboration would still be occurring where the rounding team meets, which is usually by the patient rooms and not at the Team Stations. Due to its panopticon design, it would be easy to suggest that rounds be held from the Team Station on the ICU side, but the location of Team Stations on the non-ICU side is fundamentally flawed. Interprofessional rounds would address the underlying vision of the Team Stations, but there does not appear to be a way to significantly improve the utility of the non-ICU Team Stations. These spaces should be repurposed for some other means.

If the vision of interprofessional teams can be realized without such a large footprint on the non-ICU side, this should be considered a success, not a failure. There are many other potential features that could not be fit in the new design but would benefit the hospital. For instance, there is no breakroom for medical residents anywhere on these floors, which is a major oversight for an academic medical center. Alternately, adding offices for professions that were not previously on the floor such as pharmacy and social work has been very well-received, yet not every profession is represented on every tower. Adding a few more offices in this space could also be beneficial. There are many other purposes that could put the space to good use.

Contributions of this study include the introduction of time utilization methods to healthcare research. This is the first time that such a tool has been used to evaluate a healthcare facility. Furthermore, the short survey successfully inquired about key issues in the new design. The survey should be an easy-to-use instrument for future units to compare the impact of design using a pre/post-test study. Finally, the mixed methods approach gave a holistic view of the situation and demonstrated that good quality data can be quickly collected at little expense.

Limitations of this study include likely bias in all three phases. The observer probably had some influence on staff behaviors while collecting the observational data. Focus groups and surveys likely had some biases in their samples. Finally, this study is based only on a single institution, meaning caution is advised before applying these conclusions to other institutions.

Conclusion

It is clear that the hospital's vision for face-to-face interprofessional teams is not being realized. It is also apparent that this failure results at least in part from structural causes, and is probably also caused by institutional politics and professional cultures, as well. No single intervention will cause the large interprofessional teams to materialize. With some guidance, however, Team Stations might still become the primary spot for small interprofessional teams to meet. Whether or not hospital administration deems those efforts worthwhile for potentially modest improvements, a single vision would be welcomed by staff. The current dichotomy of wanting centralized Team Stations but a decentralized nursing staff is contributing to low morale and a lack of confidence in the new hospital.

CHAPTER FIVE: APPLIED REALIST TECHNIQUE

Introduction

The science of Quality Improvement (QI) in healthcare is dominated by two methods – Lean and Six Sigma – that were developed to improve production processes in manufacturing plants (D. M. Clark et al., 2013; Pocha, 2010). Are these methods sufficient for healthcare projects that seek to explain and motivate changes in human behavior? In this paper I will highlight some shortcomings of Lean and Six Sigma approaches as applied to healthcare and introduce a method I am calling the Applied Realist Technique (ART). This approach merges the goals of QI projects with a much more heavily theory-driven technique from social sciences called Realist Evaluation. In an effort to make ART accessible to frontline staff who regularly undertake QI projects in a hospital setting, I will also add some explicit structure to the methods of investigation, without limiting the tools at the investigators' disposal.

What is the current state-of-the-art?

In theory, both Lean and Six Sigma call for a mixture of quantitative and qualitative investigation. In practice the qualitative investigation in particular is often performed with minimal rigor (Flemming, 2007). Where they have been applied, health services researchers have found tremendous value in mixed methods approaches, because they both measure the outcome and illuminate potential causal mechanisms (Curry, Nembhard, & Bradley, 2009). Despite being suggested by QI paradigms, mixed methods have not consistently been implemented in practice. When they have been implemented, the individual components have generally been broken up into standalone reports, and not been reported upon as a cohesive whole (O'Cathain, Murphy, & Nicholl, 2008).

Because Lean and Six Sigma were both developed in the context of industrial production, they both seek to improve processes over which a tremendous amount of control is realistically attainable. If a part is defective (the concern of Lean) or if one in a million parts is defective (the concern of Six Sigma), it is obvious that the product was an aberration from a clear ideal. In such a case it is also clear that the process, broadly speaking, is at fault when the outcome is undesirable.

In contrast, when applied to health care workers, policies and equipment can promote or hinder behavior but cannot strictly control it. Furthermore, where an ideal production environment steadily turns ideal building blocks into an ideal product, a hospital brings in people with a variety of issues and seeks to achieve the best outcome possible for a given person under given circumstances. Even when the right procedures are followed in a hospital, there is no guarantee that the outcome will be ideal. In statistical terms, production environment problems are governed primarily by errors, whereas problems in a healthcare environment are primarily governed by variability.

Healthcare is not only affected by variable starting products and end goals, it is also subject to human decision-making. Tools that are designed to analyze failure in machines are understandably focused on quantifying defects and reducing their frequency. This is ultimately the same goal that a QI project has, but with the reasoning of healthcare workers as a step in the process. When a QI project needs to understand the decision-making process of healthcare workers, it must put a greater emphasis on the qualitative component that is a minor component in Lean or Six Sigma.

To achieve a more comprehensive understanding of the behavior of healthcare workers, a few QI researchers have recently begun to move away from the production-oriented systems of Lean and Six Sigma and make better use of a social science technique, namely Realist Evaluation. Realist Evaluation is a theoretical approach that emphasizes outcomes as a product of the interaction between mechanisms and context. To answer the questions asked in a Realist Evaluation, multiple methods are required, and a qualitative component is essential to understanding mechanisms. Realist Evaluation asks why a process works, for whom, and under what conditions (Pawson & Tilley, 1997). Unfortunately, applications of this approach remain rare, especially in the United States (Rycroft-Malone, Fontenla, Bick, & Seers, 2010). Worse still, applied QI researchers often misunderstand this approach and, even when trying to employ it, can remain overly focused on simply measuring outcomes (Byng, 2011). Perhaps the biggest impediment to the application of Realist Evaluation to QI problems is that it is described in very theory-heavy terms. These theories are outside the range of expertise of the healthcare practitioners who often lead QI efforts. Furthermore, there is no readily available guide on how to apply the concepts of Realist Evaluation in a step-by-step manner. As a result, Realist Evaluation remains an approach that is very rarely applied correctly to QI problems.

When do Lean and Six Sigma methods fail?

While the practice of Lean and Six Sigma is often far from their respective ideals, when applied to small-scale problems, the deficit may be relatively harmless. In this context, a small-scale problem is one that can be addressed with an easy-to-implement, easy-to-reverse change in process. The scale does not address the severity of impact for someone who is harmed as a result.

For example, if a patient received their medication at the wrong time, and the solution to the procedural mistake was to require nurses to sign and timestamp each medication separately as opposed to signing in once for all medications, the problem would be small in scale. The solution can be implemented almost immediately, and if at a later date it is determined that the cost in terms of nurse aggravation or additional time spent away from the bedside does not justify the increase in safety, it would be easy to return to the old status quo. In these settings, while Lean or Six Sigma may not arrive at an optimal solution to the problem immediately, doing so through trial-and-error may be relatively harmless to the institution, except for the potential delay in arriving at an acceptable solution and the wasted resources of iterative investigations on the same problem.

Large-scale problems, those that take place at the highest level of abstraction, are outside the scope of current QI methods and also of ART. These would address issues of behavior and organization throughout the entire institution. For example, if a hospital systematically overvalued physicians and undervalued nurses, an effort to change the entire social structure of the institution would require greater investigation than called for by ART.

ART is needed when doing QI work on middle-scale problems. These are targeted, measurable issues, where the cost of addressing them is high enough that finding the right solution the first time and in a brief time period is essential. Determining whether a hospital should invest a substantial amount of money in new equipment or changing the layout of a floor would be a middle-scale problem.

An intense mixed methods framework is not recommended as a replacement for existing methods in all circumstances. The scale of the problem must dictate and justify the use of ART (Cf. Curry et al., 2013). ART is an appropriate choice when the additional effort of rigorous mixed methods research is justified by the importance of attaining a deep understanding of underlying mechanisms and the role of context. In such a case, researchers need a way to blend the goals of a Lean or Six Sigma approach – “Is it working? – with those of a Realist Evaluation – “For whom, when, and why?” (J. Black, 2009).

What are the questions we want to answer?

For a given process and population, ART addresses the following questions:

- Is the process working?
- For whom is it not working?
- Why is it not working for them?
- How widespread are these issues in the population?
- What changes are advisable?

The first step in ART, as in Lean or Six Sigma, is to define and measure some indicator(s) of the issue at hand. If the issue is whether a piece of equipment is being used, the investigator must have a reliable and sufficiently objective measure of its use. Investigators should be wary of using secondary data at this step, as data collected for other purposes may not be a reliable measure of the indicator(s). For instance, existing data on work hours or the number of patients seen is notoriously unreliable in a hospital setting. Similarly, investigators should be wary of considering self-report data as sufficiently objective.

When investigating the effects of a recent change, ART assumes that the change was reflective of some underlying ideal. For instance, an investigation into the use of new patient lifting equipment assumes that the institution would prefer frontline workers to use the new equipment as opposed to continuing to lift patients as they did before having the equipment available. Because of this assumption, subsequent questions are framed in the negative to identify barriers to achieving the vision (e.g., “For whom is it not working,” instead of, “For whom is it working?”). In the course of an ART investigation, it is still important to solicit information from those for whom the process is working, but the recommendations that come at the end will focus on addressing the barriers indicated by those for whom it is not working.

After observational data has been collected, the next step of the investigation will be to assemble a broad list of possible causal factors for any process issues. This will either be elicited from the affected population through focus groups, or, if the problem has been studied in sufficient detail previously, investigators might know most of the possible causes at the outset. Once this list is made, it is important to measure how widespread these problems are in the population. This serves two purposes. First, by connecting the data from focus groups with that of surveys, the investigation is somewhat insulated from the sampling biases that might afflict either individual data source. Second, understanding the scope of the problem informs the scope of possible responses in the form of subsequent recommendations. At the end of a QI project, the goal is not only to understand what problems exist, but to also have recommendations for subsequent action.

How can we answer the right questions?

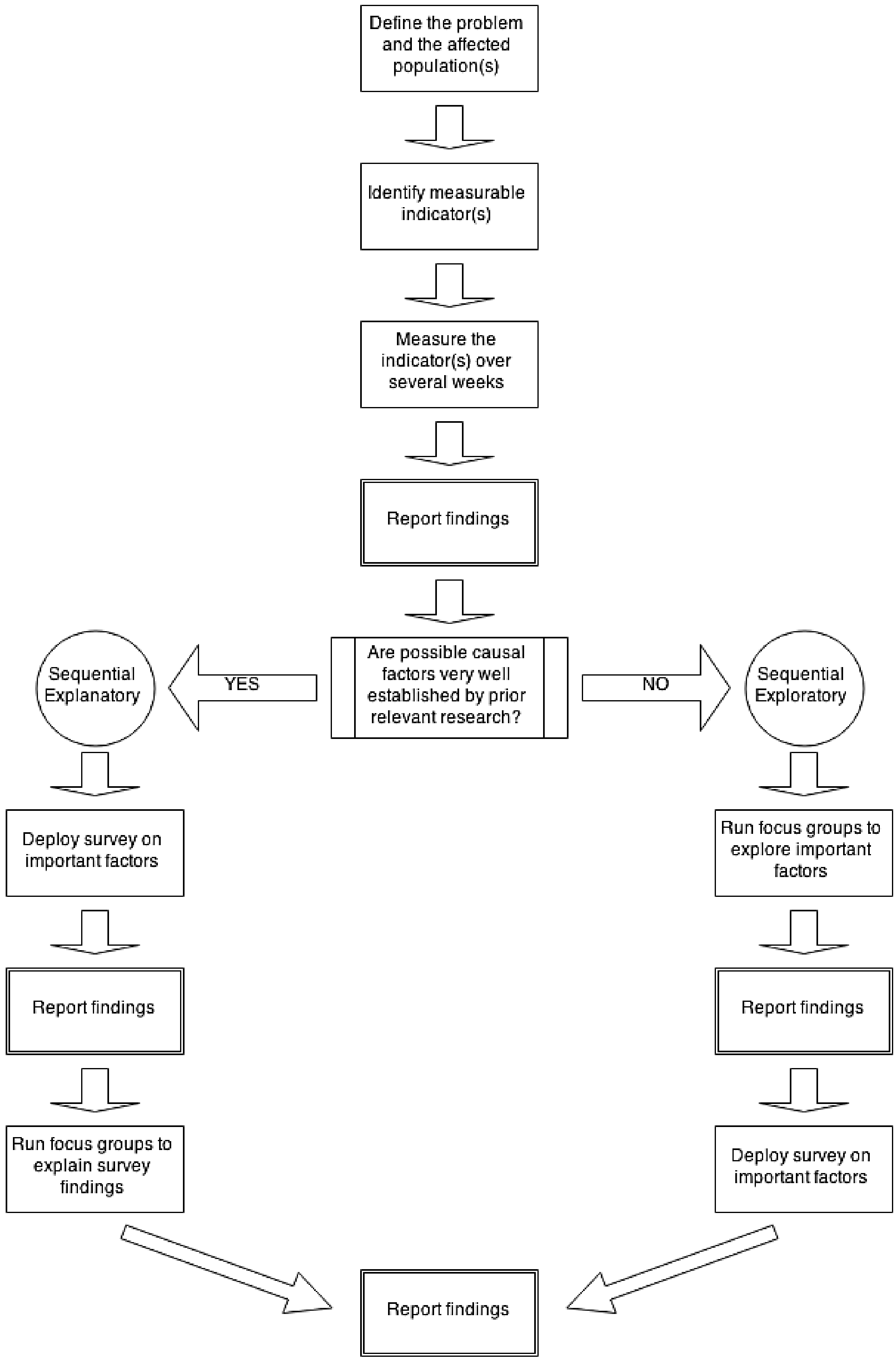
ART can be implemented in one of two structures. When a broad list of possible causal factors is known at the investigation's outset, a sequential explanatory structure is indicated. In this design, the survey precedes focus groups. In such a scenario, the survey assesses how widespread a variety of issues are in the population, and subsequent focus groups are held to explain why the issues are problematic and to suggest some possible solutions.

Conversely, when a broad list of possible causal factors is unknown, a sequential exploratory structure is indicated. In this design, focus groups precede the survey. In such a scenario, the focus groups suggest possible barriers to achieving the vision and possible solutions. Since focus group volunteers are likely to be a biased sample of the population, the subsequent survey assesses the severity of these barriers in relevant subpopulations.

Whichever mode is appropriate for a given application, it is important to remain open to other causal factors. This is especially crucial in a sequential explanatory approach. While it may be tempting to assume that researchers know what questions to ask of the population, it is still strongly recommended that, when conducting the focus group portion, investigators solicit suggestions for any other factors that may have influenced the measured outcome.

In either case, both the surveys and the focus groups are guided by observational data. The observational data should be collected first, and at least preliminary analysis should take place before constructing questions for either of the more subjective phases of the investigation. In this sense, whether sequential explanatory or sequential exploratory, both versions of ART are “nested” mixed methods designs (Cf. Fetters, Curry, & Creswell, 2013).

Figure 5.1: Flowchart for ART



Steps to ART

Here is a step-by-step guide for how to evaluate an issue using ART.

1. Define the problem and the affected population.
    - Key stakeholders include administration interested in the investigation and any staff who would be affected by a proposed change in workflow
2. Identify measurable indicator(s) of interest.
    - This is the same criterion on which a traditional "gap analysis" would be performed (e.g., time to complete a task or frequency at which it occurs)
3. Measure the behavior of interest over as long a time period as is reasonable.
    - Cover several consecutive weeks for rates to stabilize
    - Secondhand data was collected for other purposes and may be unreliable
4. Report at least descriptive statistics and outliers to the research team.

IF IMPORTANT FACTORS ARE ESTABLISHED BY PRIOR RESEARCH, PROCEED TO MODE A. OTHERWISE SKIP TO MODE B.

MODE A: Sequential Explanatory

5. Craft a survey asking about known behavioral explanatory factors.
    - Include questions about respondent demographics
    - Include questions regarding notable outliers from observational data only if doing so will not bias the responses to other questions
6. Launch widespread survey of known explanatory factors to all affected parties.
    - Affected parties includes those for whom the process is working well
7. Report at least descriptive statistics and outliers to the research team.
8. Draft open-ended focus group questions to solicit opinions on how to best address impediments to desired behavior.
9. Conduct focus groups for each affected professional group.
    - Be very hesitant to talk with multiple professions in a single focus group
10. Report the findings and recommendations back to stakeholders.

MODE B: Sequential Exploratory

5. Draft open-ended focus group questions to solicit explanations for any gap between expected behavior and observed behavior.
    a. Include questions regarding notable outliers from observational data only if doing so will not hinder the flow of discussion
6. Conduct focus groups for each affected professional group.
    a. Affected groups includes those for whom the process is working well
    b. Be very hesitant to talk with multiple professions in a single focus group
7. Report emergent themes to the research team.
8. Craft a survey asking about possible explanatory factors.
    a. Include questions about respondent demographics
9. Launch widespread survey of possible explanatory factors to all affected parties.
10. Report the findings and recommendations back to stakeholders.

What does ART offer?

ART offers administration and frontline staff a blueprint for implementing Realist Evaluation without requiring weeks of specialized training or understanding ontologic definitions. Through the use of multiple data streams, each of which targets a different facet of the investigation, ART researchers can “triangulate” their conclusions about a given problem (Williamson, 2005). This reduces the sensitivity of their conclusions to the methodological assumptions of any one approach and also increases the validity of their findings (Klassen, Creswell, Plano Clark, Smith, & Meissner, 2012).

The goal of any QI project is to assess whether changes are advisable and, if so, to identify those worth trying. Any hospital QI project that works its way through a Plan-Do-Study-Act cycle must at some point convince multiple stakeholders to change their workflow. Changing where bandages are stored affects the nursing staff who use them and the facilities management people who stock them. Centralizing or decentralizing the supply of bandages would also affect the purchasing staff who order them. Nobody in a hospital truly works independently.

An ART investigation collects a variety of forms of evidence, each of which may be differentially persuasive to various stakeholders. Since QI projects by definition seek to investigate changes in workflow and since recommended solutions must be justified to multiple disciplines, it is to the investigator’s advantage to have a variety of data streams on which to draw. Observational data may be more persuasive to management, or survey data to physicians, or focus group data to nurses, and so on (Kaplan, 2001). The combination of sources provides a comprehensive and convincing justification of the investigation’s conclusions.

ART has an explicit step-by-step guide, much like a Lean investigation. However it offers a much deeper understanding of root causes. In seeking that understanding, it engages key stakeholders in multiple ways. Through this engagement and with a variety of evidence types at hand, a QI project investigated with ART is well-situated to recommend and motivate institutional changes.

What if the phases lead to conflicting conclusions?

Conflicting statements are to be expected. Any investigation, ART or otherwise, must begin by assuming the honesty of respondents. At the very least, investigators must assume that all participants are reporting the truth as they see it. When discrepancies arise across data streams, researchers must investigate the differing statements, rather than brushing one away with the label of "dishonesty" or "misunderstanding". If, for instance, observational data suggests that a new piece of equipment is used at a surprisingly low rate but participants say they use it as indicated, the correct conclusion is either that it is needed less than envisioned or that staff do not understand when its use is indicated; it is not appropriate to explain this difference by simply discounting staff reports. Assuming that respondents are honest forces investigators to raise new questions when conflicts arise. Ignoring such conflicts or minimizing their importance is analogous to forcing facts to fit theory, but understanding them promotes a deeper exploration of key causal factors. This is not to say that investigators should be oblivious to obvious dishonesty, which may occur on rare occasions, but that they must make every effort to assume honesty before discarding information, lest they fall into the trap of making faulty conclusions for the sake of simplicity in their analysis.

Example

One example of ART in action was an investigation I led into the use of special team meeting rooms in a new hospital. Administration had put the rooms into new units when they were first built. The goal had been to foster face-to-face interprofessional communication. The administration wanted to know if the rooms were being used, if so by whom, and if not, why not. The research team collected observational data over three weeks and found that the meeting rooms were not used very frequently, but that usage varied by unit acuity level.

One interesting observation made during this phase was that patient room doors were often closed. We were unsure if the collaborations we had hoped to observe could be taking place behind those closed doors, so we included that question in the next phase of our process. The factors that could influence where each discipline spent their time were not known to the research team. Because the questions we wanted to ask next occurred at a high level of abstraction (e.g. broadly soliciting opinions about the space as opposed to asking specific questions such as how comfortable are the chairs), we selected the sequential exploratory model.

Through focus groups it became clear that the space worked very well for disciplines that did not have dedicated workspaces in the old units such as case managers and pharmacists, but the meeting rooms worked poorly for nurses. The focus groups identified as potential issues the fact that patient rooms could not be seen from the meeting spaces, that nurses may not perceive themselves to be valued team members by the physicians, and that they were not always aware when team meetings were taking place. Through the survey we confirmed that all of these points were problems, but that it was their inability to see patients from the meeting rooms that was most important. The first recommendations thus sought to address that weakness of the design for nurses while retaining the value that the meeting rooms offered to other professions.

Conclusion

Lean and Six Sigma have brought a tremendous structure and quantitative focus to QI projects. However, they were not designed with variable human systems in mind, and so they downplay the importance of qualitative investigation. Realist Evaluation explicitly calls for rigorous mixed methods studies in order to understand why programs succeed or fail, but is written for social sciences researchers in a way that is often inaccessible to the healthcare workers who lead QI initiatives in hospitals. By introducing the motivation and guide to performing ART, I hope to have brought together the structure and measurement that QI researchers are used to with the benefit of qualitative research that is stronger at answering the fundamental question, “Why?”

CHAPTER SIX: CONCLUSION

These projects afforded me the opportunity to practice my ART on two topics that were critical to the achievement of UKHC administration's vision for the new hospital. In both cases there had been a scarcity of data relevant to the administration's concerns. These projects significantly advanced the evidence base on both issues. Through a mixture of methods, both applied projects examined the extent of suspected problems, identified suspected causes, and suggested actionable solutions.

Use of the Ceiling-Based Lifts

In evaluating the use of ceiling-based patient lifts, the research team created a conservative estimate of how often the lifts should be used just based on the need to reposition patients to reduce the risk of pressure ulcers. Based on the actual usage rate, it was clear that the lifts were not being used nearly as often as they should have been. The question then became why frontline staff were not using equipment that was expected to make their jobs both safer and easier.

Through surveys we found that the most important factors were how time efficient use of the lifts was for providers and how safe use of the lifts was for patients. Interestingly, safety for the staff was not a meaningful predictor of their lift use. Through focus groups we identified why the lifts were not currently time efficient for providers and why staff thought the lifts might not be safe for patients We also verified that many if not most providers were willing to put themselves in harm's way in service of their patients.

Once the research team had well-informed theories about why staff were not using the lifts, recommendations were made to address the underlying issues. These primarily focused on making use of the lifts more time efficient for staff, but also included informing staff why the adverse events that called the safety of the lifts into question were no longer concerns. Finally, they called for standardizing the training given to new staff members so that knowledge on how to use the lifts and when their use is called for would be consistent among the employees. While outside the scope of my third chapter, the subsequent trial for improving time efficiency was an important part of my learning process in the doctoral program.

Slings Intervention Trial

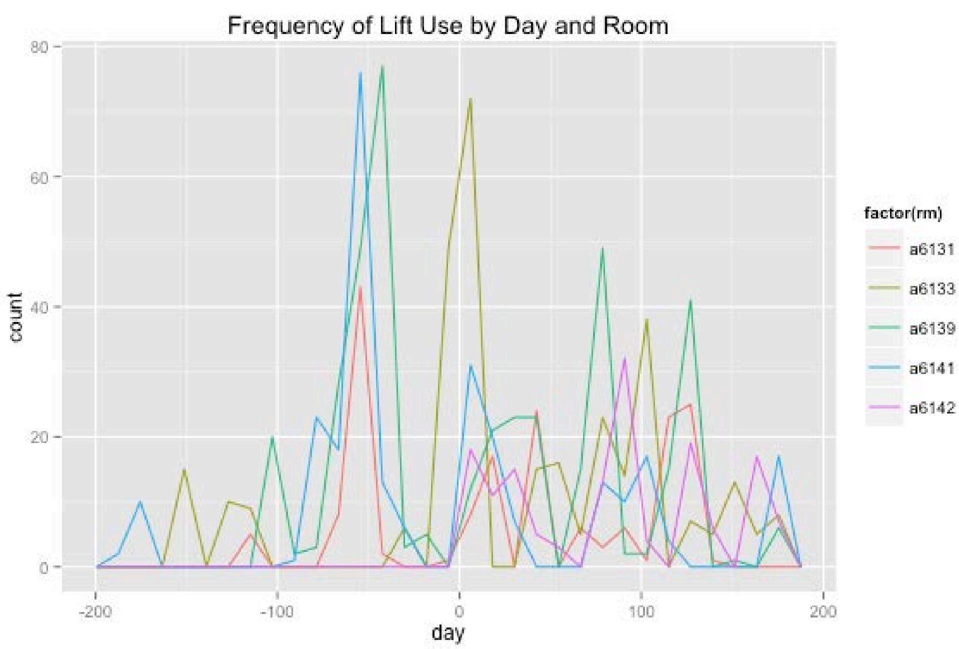
During the focus group discussions it became clear that the process for lifting a patient with the ceiling-based equipment was more complicated than the process for lifting a patient manually. To use the equipment, the staff needed to place a sling underneath a patient who could not assist them with the maneuver. As a result, use of the lift required the assistance of another staff member to manually roll the patient in bed so that the sling could be placed beneath them. In other words, repositioning a patient with the lift first required repositioning the patient manually. It is therefore obvious why staff were not using the lifts as often as called for by policy.

What if staff were able to use the equipment entirely without the assistance of another staff member? As part of a University of Kentucky Lean project, we tried an intervention where slings were placed on the bed as part of bed makeup, along with sheets and everything else that is put in place before a patient lies down. First we tried this approach for one patient for one day. That trial received positive qualitative feedback from the single nurse who was involved. Then we tried it for all of a single nurse’s patients for a single day. Again, the feedback was entirely positive. Eventually we scaled up to trying this approach for five rooms in one of the Intensive Care Units for a period of six months to see if lowering the burden of using the lifts would cause an increased rate of use.

The initial analysis was very encouraging. Were the lifts used more frequently in the post-intervention period than they had been in the six months immediately prior? Yes, the p-value of the single-tailed exact rate ratio test was $2.4 * 10^{-11}$. It was plausible, however, that lift use could have been clustered in a few days in which use was very high. Were the lifts used on more days in the post-intervention period than they had been in the six months immediately prior? Yes, the p-value of that single-tailed exact rate ratio test was $8.0 * 10^{-9}$. The analysis of this trial could have easily ended at that point, with evidence that lift use rose during the trial period and a conclusion that placing the slings on the bed as part of bed makeup was probably responsible. I believe this conclusion would have been wrong.

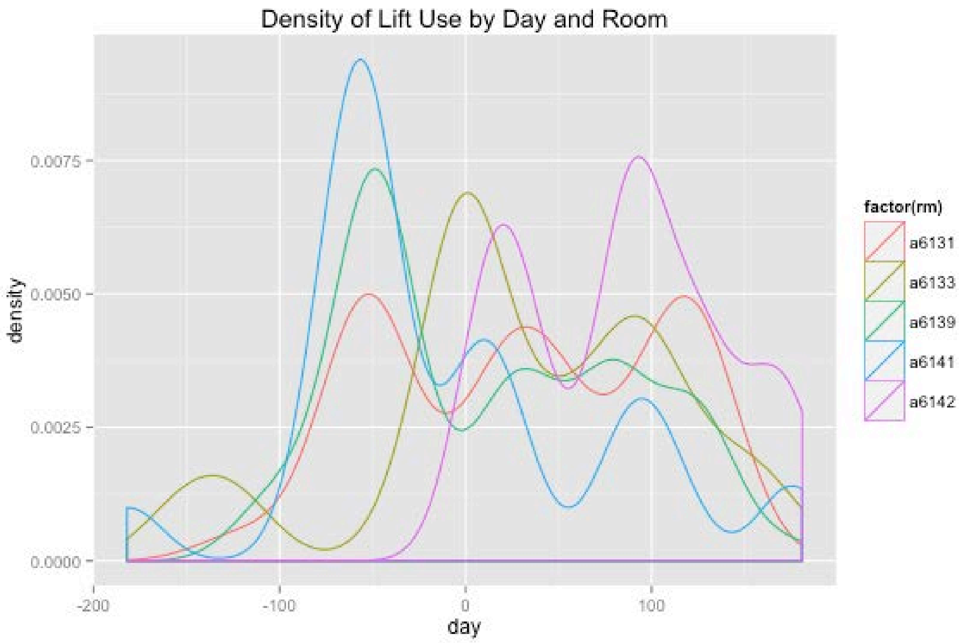
Below is a plot of lift use by day for each of the rooms in the trial. The x-axis is measured from the day on which the trial began, which is denoted as day 0.

Figure 6.1: Lift Use by Day Pre/Post Intervention



This data is noisy, but spikes in three of the five rooms are apparent around two months before the trial began. Here is a smoothed kernel density plot of the same data.

Figure 6.2: Lift Use by Day Pre/Post Intervention with Smoothing



It appears that all five rooms had a higher average use rate during the intervention, but the patterns do not support a causal relationship. In rooms A6131, A6139, and A6141, use peaked at around day -60, remained somewhat elevated during the trial, but was clearly declining during the trial period. In room A6133, use spiked at the start of the intervention but then similarly trended downwards during the trial. Finally, in room A6142, use rose a few days after the trial began, but was unsteady and may have also been declining near the end of the trial. A change point analysis similarly put low probability (<20%) on the underlying change happening when the trial started (Erdman & Emerson, 2008).

This was a major failure for me. The rate had risen in the trial period, but I was not comfortable putting forth a report saying that the trial was responsible for such a rise, nor that it would lead to sustained success. Perhaps I looked at the data too closely for my own good, but I learned a valuable lesson regarding the uncontrollable nature of field work and the danger of basing causal statements upon it. Incidentally, I asked several frontline staff and the unit's managers about the spikes clustered around day -60. Nobody had any ideas about what could explain the suddenly increased use.

Teamwork and Communication

In evaluating face-to-face communication, the research team brought in a tool that had never before been used in a healthcare setting. It had been used in architectural research, but had never been analyzed at a level deeper than descriptive statistics. Introducing the Time Utilization Study to healthcare and introducing statistical analysis to the Time Utilization Study were major achievements through which we were able to say that concerns about underutilization of Team Stations were well-founded.

When compared to other possible methods of evaluating Team Station use, the Time Utilization Study had two unique advantages. First, by not having a stationary observer sitting solely at the Team Station, the research team reduced the impact of any observational bias. Second, by collecting information across the entirety of the units, the resulting dataset was able to address a series of related issues. For example, we could quantify RN/RN interaction, RN/MD interaction, and so on. We could also describe where each interaction tended to occur. We had measurements of the frequency of groups of various sizes. Rather than have to go back and collect new data for each emerging question, a single method was able to collect data that addressed the initial question and a series of predictable follow-up questions.

The focus groups identified a host of problems with the Team Station designs and the overall floor layout. The subsequent survey assessed the distribution of these problems in relevant subpopulations, and appeared to have good face validity. The survey should be considered a useful product of this work, as it can be administered to future units in a pre-/post-test format when subsequent units are preparing to move into their new spaces.

Applied Realist Technique and Future Directions

The most ambitious part of this dissertation advances both theory and practice for Quality Improvement research. By recommending certain structures for the "Study" component of the Plan-Do-Study-Act cycle, I hope to improve the quality of Quality Improvement. As with any method, ART should continue to evolve as it is applied to more problems and in different environments.

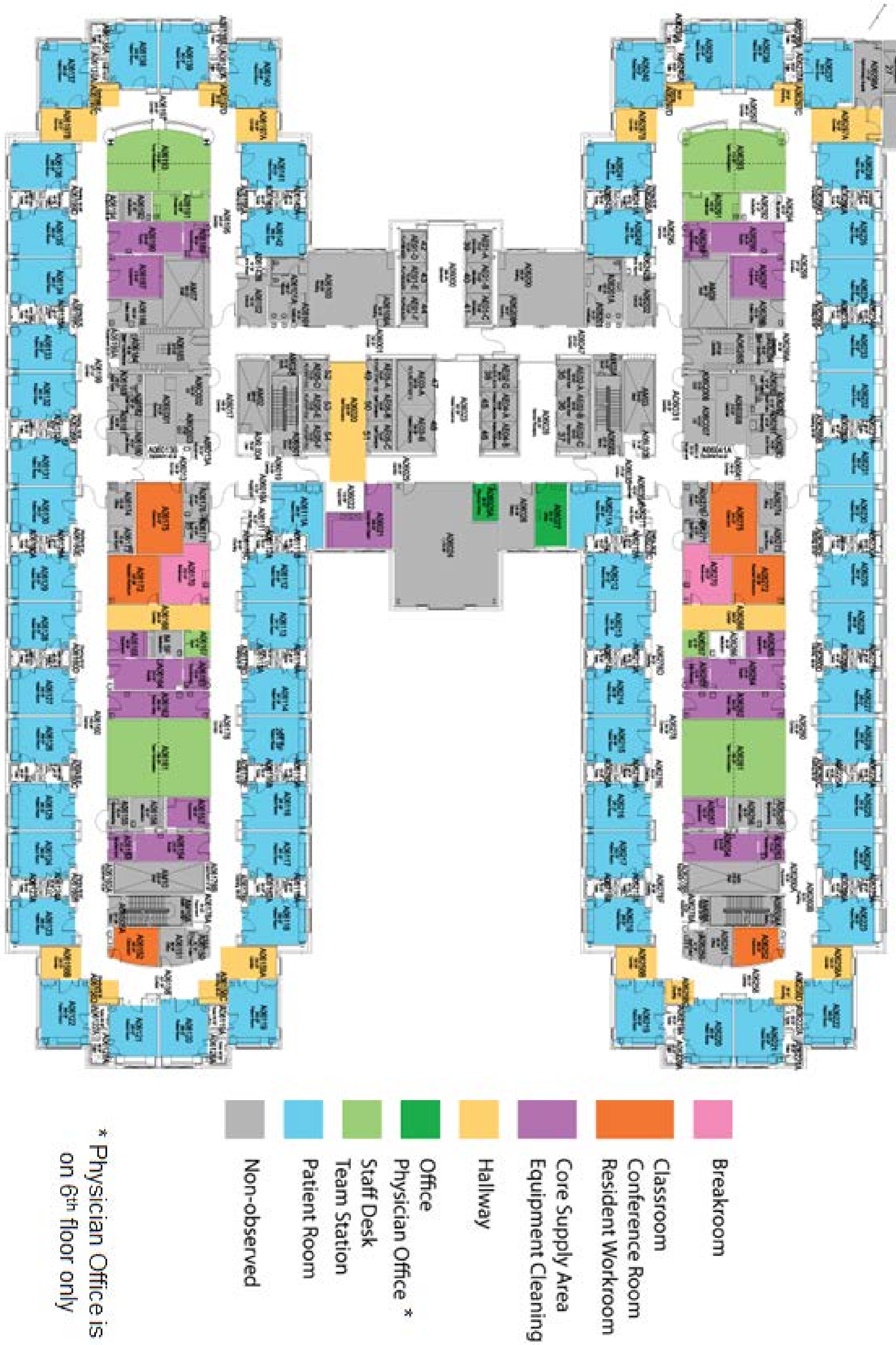
Personally, I would like to work on a more formal method of synthesizing conclusions across data streams. Since my own analyses tend to be at least partially Bayesian, one way to do this would be to improve the elicitation of informative prior distributions. That would allow some – but certainly not all – of the information that is conveyed in focus groups to carry over to the quantitative analysis of observational and/or survey data. Another potential avenue for exploration would be the development of decision rules, expounding further on what to do in the event of conflicting information across data streams.

For the two applied projects, there remains work to be done on planning the design of future floors in Pavilion A. I believe that turning use of the lifts into a solo job is a necessary but insufficient component for a successful intervention in use rates. Even if use rates rise, it remains to be seen if use of the lifts can deliver on the promise of reducing pressure ulcers in patients and workplace injuries in staff. As for the Team Stations, I believe a major change to the layout of the floor would be necessary to make them successful, especially on the non-ICU side. There is no possibility of the existing floors undergoing such a major renovation anytime soon, but hopefully future floors can be designed with our findings in mind. It would also be necessary for administration to recognize that nurses are being told two diametrically opposing ideals: 1) that they should spend as much time as possible near the patient's bedside at the decentralized stations, and 2) that they should spend much of their time in dialogue with other professions in the centralized Team Stations. The administration must realize that they have accidentally put forth two incompatible visions, unite behind one, and communicate that ideal to all staff. More generally, the administration must begin investigating the state of affairs in units that have not yet moved to Pavilion A, so that changes caused by moving are more easily recognized.

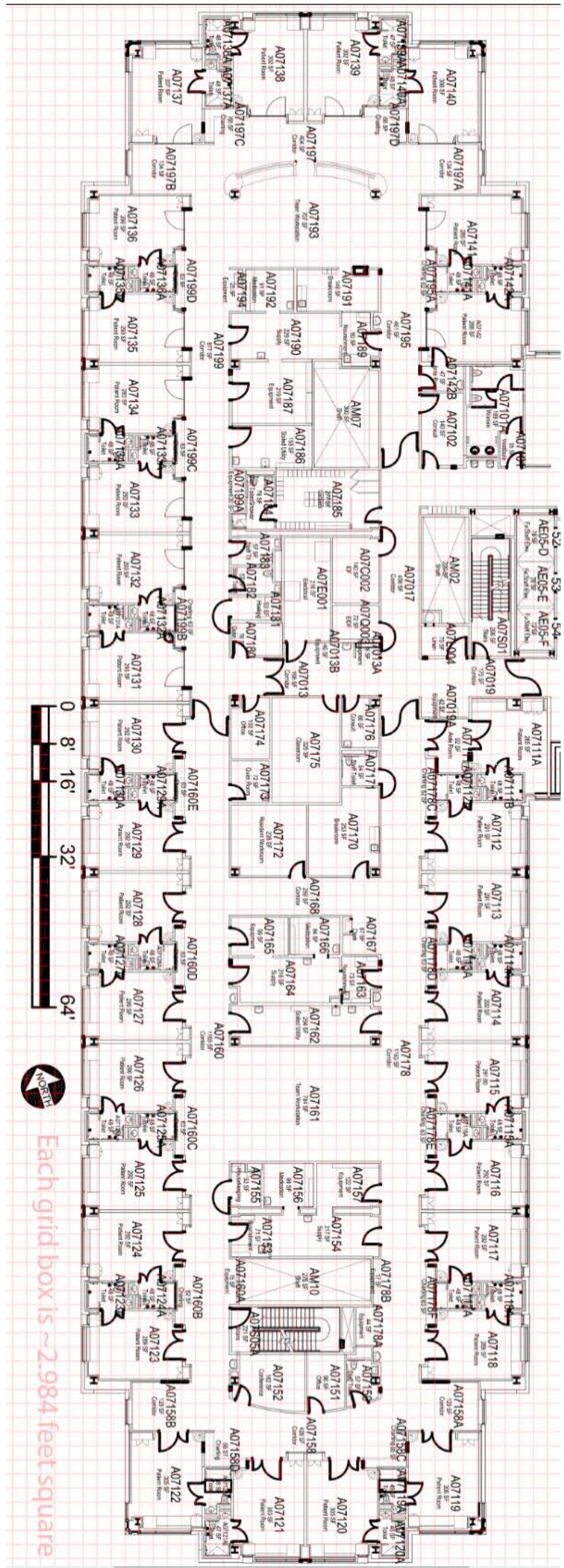
This brings me to my closing point. Doing QI work requires a combination of bringing fresh eyes to a problem and bringing in a detailed understanding of the system that can only come from being embedded within it. It requires the trust of the staff but an impartial perspective. It requires creativity in study design and a facility with both quantitative and qualitative methods. Perhaps most abstractly, it requires the capacity to build an ad-hoc team of experts who complement individual members' limitations in any of the above. This requires successful QI researchers to have not only knowledge, but also wisdom.

APPENDICES

Appendix 1: A Representative Floorplan in Pavilion A



Appendix 2: A Detailed View of a Representative Tower in Pavilion A



Appendix 3: Survey Instrument for Studying Patient Lifts

Confidential

Caregiver Opinions on Ceiling-Based Lifts

This study will survey healthcare professionals on their patient handling practices and how they perceive UK and the Pavilion A facilities support safe patient handling practices. You are being asked to participate in this research study because you are familiar with the patient-handling practices and equipment on the 6th and 7th floors of Pavilion A. Your responses will remain anonymous, which means the PI will not know that any information you provided came from you, nor even whether you participated in the study. Should you choose to participate, the survey should take you 3 to 5 minutes to complete. There are no foreseeable risks or discomforts with your participation. There are no penalties or loss of benefits for not participating. You may discontinue participation at any time.

The PI for this project is David Bardach. You may contact him at drbardach@uky.edu.

If you have complaints, suggestions, or questions about your rights as a research volunteer, contact the staff in the University of Kentucky Office of Research Integrity at 859-257-9428 or toll-free at 1-866-400-9428.

Survey responses are kept secure behind passwords on a secure server under UK control. All data is encrypted while in transmission with the server. Please be aware, however, that despite every precaution, there always remains some possibility of a data security breach which could lead to a loss of confidentiality. Whenever results are presented to UKHC staff, UKHC administration, or in any external reports, results will always be aggregated so that no participants can be identified. If results based on rare combinations of demographics could make you identifiable (i.e., 60-year-old newly hired male night shift nurses working in the Tower 100 ICU of Floor 6), those demographic-specific results will never be presented to anyone either internal or external to UK.

Would you like to volunteer to participate in this study?

☐ Yes
☐ No

The University of Kentucky wants to keep you safe. To do that, ceiling-based patient lifting devices have been installed in all patient rooms in Pavilion A. These devices are designed to minimize the risk of injury to hospital staff when lifting patients. To evaluate the effectiveness of these devices, we wish to ask you some questions about your use of them.

How would you rate your CONFIDENCE in using this product?

Very Poor — Average — Very Good

(Place a mark on the scale above)

How would you rate the adequacy of your TRAINING in using this product?

Very Poor — Average — Good

(Place a mark on the scale above)

What is your impression of this product's overall EASE OF USE?

Very Poor — Average — Very Good

(Place a mark on the scale above)

How effective do you think this product is at PREVENTING INJURIES to yourself?

Very Poor — Average — Very Good

(Place a mark on the scale above)

How EFFICIENT do you feel this product is in use of your TIME?

Very Poor — Average — Very Good

(Place a mark on the scale above)

How would you rate the AVAILABILITY OF ASSISTANCE for use of this product?

Very Poor — Average — Very Good

(Place a mark on the scale above)

How SAFE do you feel this product is for the PATIENT?

Very Poor — Average — Very Good

(Place a mark on the scale above)

Please list any patient-handling tasks for which you still do not have the proper equipment.

____

No identifying information is collected as part of this study. However, we are interested to see if certain demographic details may be associated with opinions on the ceiling-based lifts. We would greatly appreciate you answering these last few items, but they are all optional.

Gender	☐ Female ☐ Male
Age	☐ < 25 years old ☐ 25-40 years old ☐ 41-55 years old ☐ >55 years old
Primary shift	☐ Day shift 7a-7p ☐ Night shift 7p-7a ☐ Other
Please enter your primary shift.	
Employment Type	☐ Full time (>30 hours per week) ☐ WEPP (20-30 hours per week) ☐ Call (< 20 hours per week) ☐ Other
Years in your current position at UK	☐ 0-1 years ☐ 1-3 years ☐ 3-5 years ☐ 5-10 years ☐ >10 years
Total years working in patient care areas in any workplace	______________________
How many times a day total do you reposition a patient within their bed or chair?	☐ Never ☐ 1-5 ☐ 6-15 ☐ 16-25 ☐ 26 or more
How many times a day total do you move a patient into or out of a bed or a chair?	☐ Never ☐ 1-5 ☐ 6-15 ☐ 16-25 ☐ 26 or more
I use the equipment available on my unit for transferring and moving patients	Never — 50% of the time — Always (Place a mark on the scale above)
On average how long does it take you to gather equipment and personnel to perform a safe patient transfer / movement?	☐ One minute or less ☐ 1-3 minutes ☐ 3-5 minutes ☐ Greater than 5 minutes
Do you feel that you have enough equipment in your work area to assist you in moving patients, ensuring the patient's safety and your safety?	☐ Yes ☐ No
In the last month, have you experienced pain because of your patient handling activities?	☐ Yes ☐ No
In the last month, how often did you leave work feeling an increased level of discomfort because of your patient handling activities?	☐ I have not had pain this month ☐ Once this month ☐ Once a week ☐ More than once a week

Which of the following activites do you find to typically be the single most difficult?

- ☐ Repositioning patient in bed
- ☐ Lateral transfer bed to stretcher / stretcher to bed
- ☐ Transfer bed to bedside chair / bedside chair to bed
- ☐ Rolling patient for hygiene or utilization of bedpan
- ☐ Holding extremities (arm or leg) for procedure
- ☐ Standing / walking patient
- ☐ Transferring patient to / from wheelchair
- ☐ Other

What is the most difficult patient handling activity that you perform regularly?

____

On my unit, I have (check all that apply)

- ☐ ceiling-based lifts
- ☐ organized and accessible lift slings
- ☐ mobile floor-based lifts
- ☐ transfer slides and/or transfer aids
- ☐ none of the above

My level of training on safe patient handling equipment and procedures

- ☐ Expert, I know what to do, how to do it and I can train others.
- ☐ Confident, I have had training and use the equipment appropriately.
- ☐ Trained, I have had the training and am beginning to incorporate the equipment in my practice.
- ☐ Untrained, I have not been trained, or I do not feel that I have enough training to incorporate into my practice.

How satisfied are you that UK is making efforts to ensure your work environment is improved to increase patient & staff safety where it pertains to moving / transferring patients?

Dissatisfied Neutral Satisfied

(Place a mark on the scale above)

Job Title

- ☐ Nurse
- ☐ Nursing Care Tech
- ☐ Other

Please enter your job title.

____

Unit Type

- ☐ Acute Care
- ☐ ICU
- ☐ Progressive Care / Tele

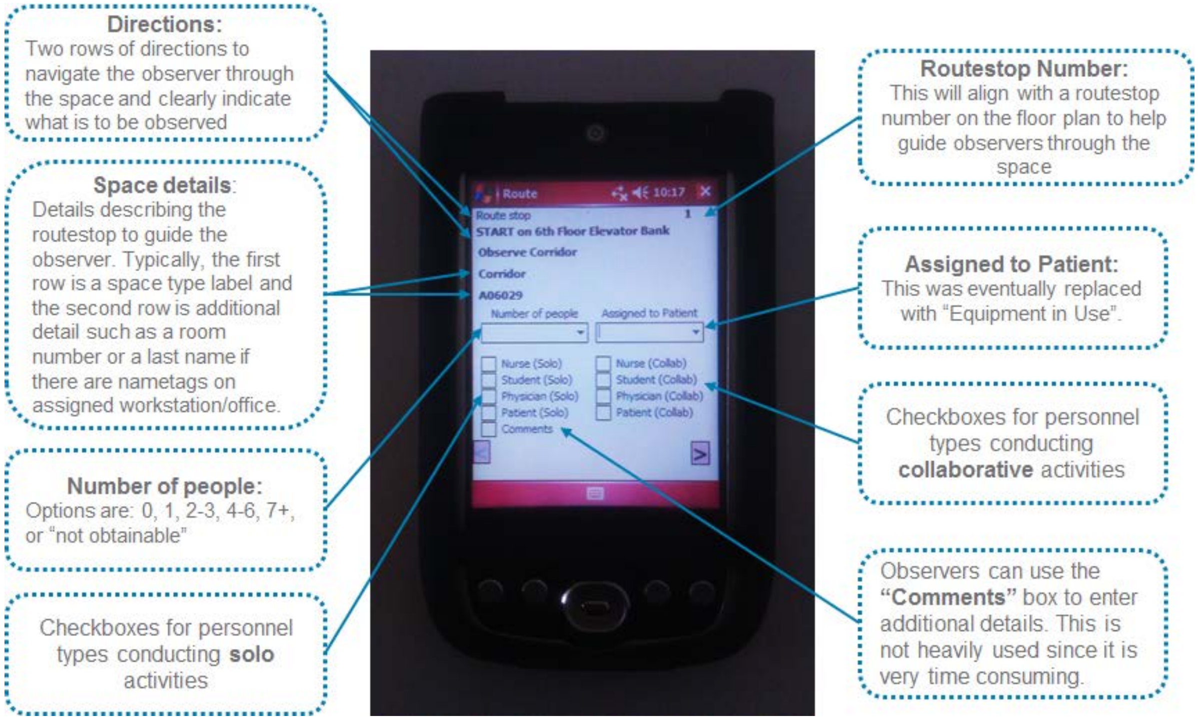
Comments?

____

Appendix 4: Focus Group Questions for Studying Patient Lifts

1) Can you describe for us the times the lifts should be used?
2) How do the patient lifts help prevent injuries?
3) Why do you think some people consistently use the lifts?
    a. Training?
    b. Supervisor?
    c. Peer pressure?
    d. Prior injury?
4) What could UK do to promote the use of the patient lifts?
    a. Supplemental equipment such as different slings or floor-based lifts?
    b. Peer leaders or product champions?
    c. Including safe patient handling as part of performance evaluations?
    d. Anything that might reduce the amount of time needed per lift?
5) Where do you feel your supervisors fall in terms of the speed vs. safety balance?
6) Our survey found that as the number of times a person reported helping to move a patient into or out of a bed or chair went up, their percent of patient moves where they used the lifts went down. Any ideas why that might be the case?
7) If UK could make it faster for you to gather the equipment needed to use the lifts, how fast would they have to make it for you to use the lifts each time?
8) Should slings be placed under the patient as part of the bed make-up? Why or why not?
9) Ignoring policies and oversight, is there enough time in the day for you to do your job safely?
10) How would you go about obtaining additional instruction or training on safe patient handling equipment and procedures if you felt you needed it?
11) What criteria do you use to determine if you need to use equipment for safety when handling a patient? For instance, is there an approximate weight or mobility level you use as a guideline?

Appendix 5: Observational Tool for Studying Teamwork



Appendix 6: Focus Group Questions for Studying Teamwork

1) Please tell us what you do, how long you have worked in Pav. A, and how long you have worked in healthcare.
2) What do you think of the decentralized nurse stations?
    a. How does it affect teamwork and communication?
    b. How do you think it affects patient outcomes?
    c. Do you think it can lead to feeling isolated?
3) How have the decentralized nurse stations affected your face-to-face communication with others that you work?
    a. Has it affected communication with patients?
4) Tell us a little about interdisciplinary communication, how it occurs, what it looks like.
    a. Can you give us an example from your experience when it works well?
    b. Can you give us an example from your experience when it does not work well?
5) Tell us about communication during patient handoffs.
    a. Is there a standard place that you communicate during handoffs every time?
    b. Is there a standard place for that communication at shift changes?
    c. Is that different in Pavilion A than it was in your prior location?
6) Please tell us about collaboration on the patient floors.
    a. Can you give us an example from your experience of good collaboration?
    b. Can you give us an example from your experience when it did not work well?
7) Within the context of the existing structure of Pavilion A, what changes would you suggest to the layout of the floor?
8) Please tell us about your experiences and thoughts with regard to the team stations.
9) How is interdisciplinary communication initiated?
    a. Is there typically one group (e.g., RNs, MDs) that initiates it?
    b. Do you feel you can be successful at initiating interdisciplinary communication when you want to?
10) Tell us about communication technology that you work with- I guess that would be things like phone, pagers, email, SCM/charting, alarms, cameras in patient rooms - does it work for you, has it changed the way you work?
    a. Does it take the place of face-to-face communication? If so, how effectively? Do you feel that you are dependent on alarms when you are working?
    b. Do you trust the alarms to alert you when your attention is needed, or do you think the alarms fail sometimes (don't sound or cannot be heard from parts of the floor)?
11) If patient doors are closed, does that mean staff are not in the room (for the acute side)?
12) If privacy curtains are drawn, does that mean staff are in the room (for the ICU side)?
13) What do you think about the resident workroom?
14) Are the classroom and conference room space adequate?
15) Are there times when you work with another healthcare discipline and you are simply receiving (or giving) orders? Are there times when you are having a discussion?
16) Talk to us about the computers on the floor. Who can use the ones out in the hallway?
    a. Should they be for universal use or restricted just to nurses?
17) Do you have specific things you communicate about each patient during handoffs?
18) Is there an order to patient handoffs (i.e., do you go by room number or patient severity)?
19) How has the layout of Pavilion A affected communication between staff and their supervisors?

Appendix 7: Survey Instrument for Studying Teamwork

Confidential

Teamwork & Communication Perception Survey

Please answer the questions below in the context of your experiences in your current position in Pavilion A.

Thank you!

Please select your professional category.

- ☐ Physician - 6th Flr
- ☐ Physician - 7th Flr
- ☐ Nurse - 6th Flr
- ☐ Nurse - 7th Flr
- ☐ Nurse Tech - 6th Flr
- ☐ Nurse Tech - 7th Flr
- ☐ Pharmacy
- ☐ PT/OT
- ☐ Respiratory
- ☐ Nutrition
- ☐ Patient Care Facilitator
- ☐ Social Worker
- ☐ Other

What is your professional category? ________________________________

How many years have you worked in your profession? ________________________________

How long have you worked in Pavilion A?

- ☐ < 1 month
- ☐ 1-6 months
- ☐ 7-12 months
- ☐ 13-18 months
- ☐ >18 months

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I feel isolated from my coworkers.	☐	☐	☐	☐	☐
I am typically aware of when coworkers need help.	☐	☐	☐	☐	☐
I am aware of events going on in other rooms in my unit.	☐	☐	☐	☐	☐
It is easy to collaborate with others on my unit/floor.	☐	☐	☐	☐	☐
I have difficulty finding people when I need help.	☐	☐	☐	☐	☐
I feel like I am a valued member of my patient care team.	☐	☐	☐	☐	☐
I am satisfied with the amount of interaction I have with staff during my work day.	☐	☐	☐	☐	☐
It is easy to communicate with other members of the patient care team.	☐	☐	☐	☐	☐
Privacy is a concern in the locations where we meet as teams.	☐	☐	☐	☐	☐
I have sufficient access to quiet space for doing solo work.	☐	☐	☐	☐	☐

I am satisfied with the space we use for small group (2-3 people) discussions.	☐	☐	☐	☐	☐
I am satisfied with the space we use for large group (4+ people) discussions.	☐	☐	☐	☐	☐
The layout of the floor supports positive patient outcomes.	☐	☐	☐	☐	☐
The layout of the floor helps me do my job efficiently.	☐	☐	☐	☐	☐
The layout of the floor supports team-centered patient care.	☐	☐	☐	☐	☐
I am satisfied with the layout of the unit.	☐	☐	☐	☐	☐
I am satisfied with my ability to visualize what is going on within my unit.	☐	☐	☐	☐	☐
My computer is located in a place that helps me chart immediately after seeing a patient.	☐	☐	☐	☐	☐

What percent of your communication with other UK employees regarding patients takes place face-to-face (as opposed to through phone, email, etc.)?

0% 50% 100%

(Place a mark on the scale above)

In the space provided, please elaborate on any of your responses or share other thoughts you have about your unit.

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