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Enhancing Patient Experience through Emergency Departments, Nursing, Radiology, and Medical Devices

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Abstract

1. Introduction

Although the healthcare system in developed countries is a multi-trillion-dollar industry, patient care often falls short of its goals. Following the implementation of the Affordable Care Act, patient satisfaction increasingly impacts hospital ratings and insurance reimbursements. Saudi Arabia has a population of 32 million, and emergency departments (EDs) record approximately 2 million visits annually, spanning a diverse population with varying income and education levels. While health crises are unavoidable, the treatment experience can be improved. The HCAHPS survey captures patient perceptions of their hospital experiences, but the ED often serves as the primary care provider for uninsured patients. This duality presents an opportunity: patients experiencing health distress are open to referrals, while EDs typically operate long hours without scheduling new appointments. This dissertation focuses on improving the patient experience during ED visits by improving communication with patients and staff. Key areas of interest include designing effective patient information tools and leveraging hospital information systems (HIS) to reduce frustration before, during, and after visits. Smartphone applications are emerging as valuable resources in healthcare. Long wait times can be frustrating for patients, especially as they repeatedly log in for surgeries. Implementing these technological solutions could significantly improve patient experiences and address chronic issues with hospital visits. Why haven't industries such as education and construction adopted these tools as quickly as healthcare methods

The intent of this study was to critically analyse innovations extending across hospitals care delivery systems that have been added for patient management in order to improve their experience, comfort, emotions and overall health care delivery systems in hospitals. Through

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this analysis developed new requirements to effectively introduce the patient management innovations in discussions with care providers, regulatory authorities and technology developers, in urgent need of new varieties of services considering the technological complexity and safety of patient management systems. The investigations and comparisons of each care delivery institution were carried out in hospitals.

conclusion

In conclusion, this thesis will outline both a number of approaches that have been studied, and a novel approach to enhancing patient experience in a crowded ED setting. The motivations for increasing patient satisfaction and experience will be outlined. An overview of the Emergency Department will then follow, describing what the ED visit entails, as well as what it means to a consumer of the service. Following this is a literature review for three main problem areas: nursing, patient experience in even less controllable environments, and an overview of devices and approaches in radiology and diagnostics. Using this knowledge as a foundation, a novel approach is presented. The approach involves collecting an abundance of unfiltered satisfaction data, and using it to develop predictive models of patient experience, based on clinic values and ED patient characteristics. The technical approach will be made clear, along with plans for evaluation.

Budget and hourly payment for staff in the ED caring for patients will be discussed, along with policy questions, costs of measurement instruments, and recommendations for future work. Emergency Departments in hospitals around the country are only growing busier, and this design is proposed as a timely intervention that can improve the health experience of consumers confronting EDs that have yet to be designed for patient volume indicative of their size and level of service. ED patients in particular need care that recognizes the stress of uncertainty around wait time and treatment, and providing an intervention that addresses this concern has the potential to head off loss of trust, seeking care elsewhere, and self-treatment of injuries, which can do irreparable harm both to individual patients and to the institution as a whole (James Hansen, 2018).

2. The Role of Emergency Departments

Despite healthcare in the United States being a multi-trillion-dollar industry, the service that patients receive is falling short of expectations. With the passing of the Affordable Care Act, customer satisfaction scores are becoming a larger part of the hospital rankings nationwide and impacting their reimbursement from insurance companies (James Hansen, 2018). There is a staggering 130 million ED visits each year. The Emergency Department of a hospital is a facility used to treat unplanned medical conditions. Many patients in the United States use the Emergency Department as their primary care because they don’t have insurance. Many patients are immediately treated and released but some patients wait for hours because other

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patients in the hospital require more immediate care. The primary objective of this thesis centers around improving the experience of patients during their hospital visit in the Emergency Department (ED) by providing information to the patients and staff. The staff would benefit from opening new lines of communication during their visit, and an easy way to plan an organized exit for the patient from the hospital.

Physicians, nurses, specialists, and other healthcare professionals lead the charge of ensuring quality service in EDs. Experience in the healthcare profession is very important, and sometimes may be required for obtaining proper healthcare certifications. Such healthcare experience can provide an environment for empathy for the patients who healthcare professionals serve. Two studies found that "emphatic engagement in patient care leads to improved patient outcomes" (B. Harrell, 2019). The populations in Hampton Roads emergency rooms are reflective of many who frequent the nation's EDs. Previous studies acknowledge evidence of disenfranchised patients relying on EDs and the safety-net impact of these facilities. It is important for ED caregivers to understand the complexity of these patients in order to provide the best possible care. But emergency departments face other battles as they struggle to provide care to patients each year in the United States. Among the diagnoses and treatment needs are everything from broken bones to heart attacks. Their emergency rooms often overflow with patients and their caregiver-to-client ratios fuel frustrations. Registered nurses (RNs) can play an integral role in ensuring that EDs are facilities that properly attend to the needs of the many populations that they serve. These healthcare providers can play a key role in the care and discharge of patients in EDs and thus can provide insight on the needs/struggles of these facilities. Surveyed participants note several challenges in the ED. Patients cited long waits as one of the biggest issues in EDs, opening the door to a missed communication opportunity to ensure that patients feel comfortable, respected, a priority, and important as they wait for their turn for care. Since staffing was cited by research subjects as the number one challenge that EDs face, more creative solutions must be considered to mitigate frustrations on the part of the patient and healthcare provider.

2.1. Overview of Emergency Department Functions

The Emergency Department (ED) is often viewed as the first step in the treatment of unplanned medical emergencies. EDs are generally open 24 hours per day and field both ambulance and walk-in patients, both of which arrive with a range of planned and unplanned medical conditions that need to be accepted and cared for. EDs must perform triage on incoming patients to determine the severity of the presenting problem. They must also be adaptable to accept a changing population of incoming patients with a wide variety of conditions (James Hansen, 2018). EDs serve a mixed population of patients who are received by an organized system of hardware, software, and human resources. This responsibility of

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treatment is part of the American social contract in that defects in care received in the ED are often written off and treated at a loss to hospitals. There is a reverse patent triage process in that the vast majority of patients who present for care are treated and released faster than the few patients who are admitted.

In order to understand the situation for patients, it is necessary to understand some of the details regarding a large urban hospital's ED. At this ED, there are several separate waiting and treatment areas and although the waiting area is split into groups based on acuity, stretchers do not separate incoming patients by age or presenting problem. Adults with gunshot wounds wait in triage lines next to toddlers with red wxaes on their cheeks and respiratory distress due to allergy or infection. EDs are often filled with patients who have few if any options for care. Insurance decisions and health options are revealed in EDs due to socioeconomic status and other addictions. Many patients present in a state of no care or on the verge of economic failure: long-held stars of industries suddenly defunct.

Because of this, many patients in an ED come to care with a certain desperation. Many are homeless and waiting for primary care, a good number are street psychiatric care and not receiving it, as many are very young, concerningly elderly, or displaying an array of possibly undiagnosed medical conditions. Because of this patient population who are frightened and care, the ED has a highly trained staff that addresses geriatric care, psychiatric care, pediatrics, chronically ill patients, and obstacles that rose from this (B. Harrell, 2019).

2.2. Impact on Patient Outcomes

Improving the emergency services using quality improvement project and Donabedian model in a quaternary teaching hospital in South India (Goenka et al., 2024). Current Scenario Emergency department (ED) services are essential in delivering timely and effective care in emergency conditions. The EDs play a key role in clinical decision-making and the timely management of emergent cases in a tertiary care hospital. Measures of ED services that can be implemented are accreditation, benchmark measures, performance audits, and clinical governance. Performance audits are designed to monitor and evaluate services delivered against the expected standards. They can be further assessed by the three main types of measure; structure, process, and outcome. The Donabedian model provides scientists a framework to categorise the indicator types. Employing a project via the plan-do-study-act (PDSA) cycle and the Donabedian model, Key performance indicators pertaining to service delivery in the ED were defined and measured. The key indicators of the project included the time to response after a cross-consultation call, time taken to transfer patients from the ED after treatment, time taken to perform various investigations, appropriateness of ED consultations, and correlation between complaint; provisional diagnosis and final diagnosis. In a quaternary teaching hospital in South India, the emergency department (ED) plays a key

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role in the timely assessment and delivery of life-saving treatment for critical patients. The ED can accommodate ~1000 patients per month. The department receives more than 50% tertiary referrals accounting to a high case complexity. The facility comprises different sections, including an adult, paediatric, obstetric ED, trauma unit, FAST scan room, procedures room, industrial casualty section, isolation room, and acute ward. The urology department had the longest response time to cross-consultation calls. Departments like medicine and surgery showed reduction in this time post implementation but still averaged ~25 min. The overall TAT was improved post implementation, as evidenced by the decrease in TAT for various investigations. TAT for X-ray reduced by 12 min, CT by 14 min, MRI by 8 min, and other tests also showed improvements. Average transfer time from the ED to other hospital areas showed improvements post implementation. Clinical correlation between the type of complaint and diagnosis was enhanced in the postimplementation phase. In preimplementation phase, correlation between type of complaint and provisional diagnosis was 79%, increasing to 84% after implementation. Similarly, correlation between the provisional diagnosis and final diagnosis increased from 92% to 95% post implementation.

2.3. Challenges Faced by Emergency Departments

Emergency Departments (ED) present a tumultuous setting as people enter at all hours of the day and night seeking help. These attendees are often very ill, in pain, or unable to interpret their surroundings. Consideration of person-centered care becomes paramount in this chaotic environment. To provide patient-centered care, one must understand the expectations of those who will be receiving services. ED patients are unique and differ from patients that attend for scheduled treatments. They have all made one common choice: the ED was the best option available to them. Why is understanding this choice of venue so important? In many cities, if the ED were closed, the majority of these patients would be unable to seek care. The average ED patient has a lower socioeconomic status, has no insurance or poor coverage, and/or is otherwise considered marginal (B. Harrell, 2019). For them, a visit to a hospital is not a routine occurrence. In examining the setting of these locations, these characteristics and challenges provide insight into the care experience.

An emergency department provides acute care for illness or injury. Such settings must treat all patients on arrival with stability and safety. After triage, patients can be treated, moved, or sent on in a new direction for health. In the modern healthcare model, EDs are simultaneously a safety and security net for communities while being an unfortunate consequence of a fragmented system. Each ED organization begins by defining their customer segment through a business model and gathering demographic information seeking how to more effectively serve that group’s needs. The role of the ED presents itself as both a point of entry and a service delivery platform for hospitals, and more importantly, a treatment venue for patients. If the service experience is examined through the eyes of an ED patient, it

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is clear that patients have all entered with common purpose. Yet they arrive from a myriad of motivations, expectations, and experiences with EDs. These characteristics determine the patient experience and represent hurdles to surmount if efficiency, access, safety, satisfaction, and/or clinical outcomes are to be improved.

3. Nursing in Emergency Care

A significant challenge facing both human and technological agents in emergency departments (EDs) is resolving conflicts that arise through care delivery to patients. The most important one is negotiation, which takes place between the ED staff and patients (B. Harrell, 2019). Patients seeking care often attempt to pressure or overly coerce the emergency staff into providing care for something outside of the bounds of the available healthcare resources. For instance, a patient may withhold their insurance credential after signing in at triage so that they are no longer triaged and assumed to be an indigent. Another example is a patient returning to an ED soon after discharge and either expressing that they feel “worse” or display signs of severe somatic exaggeration and begging ED staff to do something or give a specialist appointment. Both involve negotiation by the staff either to compel them to accept routing or decline. Such conflicts are generally resolved verbally, such as invoking a fully concerned chief medical officer or nurse supervisor to assist in resolving such cases.

For healthcare to be holistic, nurses must create a genuine connection with patients in between taking vital signs and assessments. Nurses provide education, handle medication, and address fears, while streamlining patient flow and management with all the technologists, admitting services, and disposition. These human-to-human interactions positively impact patient experience. Creating personal connections builds rapport and fosters increased trust and comfort. Understanding the care process can reassure anxious patients when 10 to 12 things must be done in a hurry. Filling in core vital sign tasks, understanding the role of each forensic specialist, and remaining calm can provide support and education. Initial nurse assessments, when brief and able to clear the schedule for noncritical but still urgent cases, act as system control mechanisms. Respecting the sense of humor in both staff and patients reminds staff to empower patients and share lively moments.

3.1. Nursing Responsibilities in Emergency Settings

Emergency nursing is both an art and a science. It is about expertly caring for patients as they participate in the magnificent, and sometimes tragic, theatre of life. It is a complex and dynamic profession that employs hyper-specialized skills to provoke some of the most challenging, stimulating, and sad situations in health care. ED nurses employ a vast number of evidence-based practices, standards, and protocols in the emergency treatment of acutely ill patients across all stages of the life span. Furthermore, the apparently limitless patient population in terms of biological exam, triage acuity, and treatment contributed to the

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uniqueness of EDs and resulted in the development of a specialization that is on par with critical care nursing and midwifery (B. Harrell, 2019). However, the inexperience of working in an ED has been reported by a number of recent studies to be a barrier to achieving independent, expert practice.

Regardless of practice area, it is evident that factors associated with inpatient units restrict the development of advanced cognitive and technical skills for novice emergency nurses. Thus, patient-centered care by nursing in ED is challenged, and also should be positively enhanced. Patient-centered care, the concept that examines nurses' care needs and health outcomes in light of their life situations, is at the forefront of emerging approaches to healthcare. It specifies the importance of 95 elements, as well as the critical roles of nursing care functions, priorities, service quality, patient characteristics, and organizational factors and privacy for patients, families, and their companions in achieving health goals. Decision making, risk assessment, and surveillance may be necessary if patients are to develop effective coping methods and self-care behaviors.

An emergency health and treatment organization is an ED. It has an edge in delivering immediate care to acutely contaminated patients. ED nursing practice is a second-class specialty. However, eight emergency nursing practice skills have been described: 1) the acquisition of extensive, general clinical knowledge; 2) the knowledge and skill gained through preceptor functions; 3) triage evaluation and treatment; 4) monitoring patients' treatment and treatment-related responses; 5) organizing work and processes; 6) self-maintenance; 7) team and collaboration; and 8) situation awareness.

3.2. The Importance of Communication

Communication, or a lack thereof, plays an essential role in the patients' experience during times of emotional distress. Research has shown that patients have a preference for increased communication with staff during their visit in the ED. The Emergency Department (ED) is a facility used by hospitals to treat unplanned circumstances of illness. During an ED visit, patients are typically in a bumpy state of emotional distress awaiting information about their health and the health of their family members. Many patients expressed going for long periods of time without having any communication from staff. Patients want to know where staff has been and information about any potential delays. Despite the crucial need for communication during this type of situation, staff does not communicate on an as-needed basis. A patient suggestion consists of sizing up waits as delays and based on research understanding a different metric they should have something to communicate about. In that way keeping the patients informed provides them with greater insight into how their visit will go (Aguirre et al., 2021). The current mode of communication used by hospital EDs typically includes, "A nurse will be with you shortly" or "They are taking care of you." But patients

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want to know: Who is taking care of me? Where are they? This is often not relayed to patients in an adequate amount of detail. In fact, letters written to patients connected with both wait-time feelings of uncertainty. Patients primarily want to know if they should be concerned about their condition, where the staff has been, and information about if there is any delay (James Hansen, 2018). One suggestion for a pool of satirical language, signs, and videos that can be delivered to patients is to provide information about the emotional state of the staff and what kind of things they have been dealing with and then gently educate the patients, “Be good to us and we will be good to you.” Plus, animated videos displaying very real information about how patients should not criticize staff or question as to why they have not gotten care in a while but rather to generally reflect on how every piece of equipment and movement is on high alert will likely help.

3.3. Patient Advocacy in Emergency Nursing

Even the most sophisticated of care is wasted on a patient if they leave feeling invalidated and unimportant. An indicator of the service a hospital can provide is if the patient is treated with dignity and respect, feels safe and secure, and has their emotional needs met. Educating the patient takes precedence over all of the logistics of care (James Hansen, 2018). The emergency treatment and services provided would be irrelevant if the patient visits the Emergency Department and receives a rapid assessment but chose not to remain. Therefore emotions need to be managed first. A myriad of studies on waiting room behavior outline guidelines for tailoring emotional management based on theoretical constructs of emotional responses. An attempt to gather clinical waiting behavior and patient responses in an Emergency Department was made, though some data on patient responses were unable to be gathered due to constraints including issues in the data availability and accuracy. Though advocating for patients is normally seen as a nurse’s duty, there is limited knowledge on what a nurse does to advocate for patients in the Emergency Department as well as how nursing students and RNs in training are equipped to advocate for patients in ambiguous emergency situations they may encounter. The goal is to identify ways in which nurses advocate for patients in Emergency Department (Chapnick, 2017). It is important to recognize that patients may have different needs than their family members and advocate for those needs. It is critical to include the patient in conversations even while unintentionally excluding them because they may not be able to interject. It is also the advocate’s duty to ensure that the physician thoroughly discusses discharge instructions, prescriptions, and follow-up care with the patient, rather than simply with the family. It is advisable to provide educational materials that incorporate pictures, diagrams, and vocabulary suitable for the patient.

4. Radiology's Contribution to Patient Care

In the continuum of patient care, delivery of quality and timeliness of service is being recognized as a key aspect to enhance satisfaction. But there are hot spots in health care

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delivery which still need improvement. Emergency departments, nursing, radiology, and medical devices were identified high impact areas contributing to enhancement of patient experience in public hospitals. At the service level, each area works to enhance the patient experience. What needs to be done at the hospital level to address the findings?

The emergency department (ED) is historically an overcrowded locality with long waiting times and poor patient experiences. Recent reforms have improved the experiences of public patients in EDs by providing better communication, signage, and waiting areas and by better processing of patients during busy periods. Most importantly it is about culture change—an intrinsic change in the behavior of individuals within the ED and a broader recognition of the area's role within the hospital and community. The changes have improved ED patient journey, enhanced the patient experience, and in the short term have improved ED waiting times.

Emergency department reforms are a major success for patient experience enhancement in public health services. Much of this success comes down to clear and frequent communication, in particular with waiting patients. But in part it comes down to the hospital's acceptance that the ED is a traditional ambulance at the bottom of the cliff which locally delivers service with minimal effort but contributes substantially to the hospital bed blockade, pressure on upstairs wards, and patient complaints. Nursing is acknowledged as a genuine professional field of its own with cultures, complexities, and challenges that are different to those in the behavioral sciences. The risk to patients and that to the profession must be acknowledged, understood, and addressed at all levels to avoid catastrophic consequences. Management must be clear about the priorities for addressing the hot spots and allocate the appropriate resources to do so (R. Reid, 2022).

In radiology, there is much that can be learned and gained by improving communication in, about, and concerning radiology—between radiologists and others. Anything that enhances communication between colleagues adds value (Lau, 2007). Timely high-quality health care is predicated on effective, accurate, and safe communication among health care providers. Inadequate or failed communication of errors, disagreements, or differences of opinion about previously reported imaging studies is the root cause of many, if not most, events reported to health care quality and safety review committees. Many recommended remedies for these shortcomings are archetypal of what is expected from health care. Several have been successfully implemented in various systems and successfully tailored for radiology. Health care practices and systems throughout the world suffer similar breakdowns in communication. The burden and blame do not rest solely with radiology and radiologists.

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4.1. Role of Imaging in Diagnosis

Medical imaging is fundamental in diagnosing. Diseases are diagnosed via a patient-oriented analysis of medical images obtained using imaging modalities. Initially, simple imaging modalities such as X-rays or optical imaging were utilized. This enabled the detection of gross anatomical anomalies but did not assist in diagnosing physiological or cellular-level anomalies. New technologies have enabled the development of various medical imaging modalities for imaging from the anatomical level to the molecular level (K. M Shadekul Islam et al., 2023). The contribution of imaging modalities in the diagnosis of various ailments with diverse clinical cases, discussing the principle of imaging modalities, followed by its contribution in diagnosis, was discussed in detail.

Increasing diagnostic capacity is a national priority to expedite the timeliness and appropriateness of treatment interventions for patients entering health systems. Imaging, encompassing a range of technologies including X-ray, Computer Tomography, Magnetic Resonance Imaging, and ultrasound, is a key diagnostic service used at the front end of pressing patient pathways and central to decision making in the majority of all disease pathways (McIntosh, 2017). It is an expensive discipline accounting for an estimated 3-5% of the annual NHS budget. It is imperative that applicable healthcare systems maximize service efficiency while optimizing patient outcomes as this is inherently difficult given that every patient is unique (and must be dealt with as such). Demand for diagnostic imaging examinations has, on average, increased annually by 5-10% across the last 20 years. Although many systems have successfully met this challenge to agreed quality targets, the projected figures anticipate continued growth in demand due to NHS screening programs, JCVI mandates, and demands of cancer plans prompting an urgent call for greater capacity. This is evident across UK regions, with 9 out of the 11 largest trusts having an outstanding 18-week backlog for imaging. Imaging must also meet targets associated with treatment wait times for key front-door services, chronic demands associated with musculoskeletal problems, and manage referrals from every other medical specialty.

4.2. Technological Advances in Radiology

In the last decades, medical imaging has undergone rapid changes, and the following decades are expected to witness further advances in technology and clinical applications. In particular, the constant advances in US, CT, and MRI technologies, such as “dual-energy” and “photon-counting” techniques (in CT), mapping, strain, and 4D flow MRI, and hybrid PET-MRI, are expected to have a great impact on imaging. The improvements in these technologies are expected to be associated with several short-, medium-, and long-term issues. First, radiologists’ education and training will need constant updating to take a step forward with the newer technologies and to improve image acquisition protocols. Second, as new imaging technologies are introduced, information is often obtained in a relatively new modality and at

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a higher amount as well as complexity. Thus, information that is dispersed by far among multiple sources is more difficult to gather, and there is a necessity on the side of radiologists to know how to integrate and report the novel information on advanced imaging (Pepe et al., 2023).

Quality will become a major and crucial issue in specialized care. Radiologists can play a critical role in the management and follow-up of patients affected by diseases that require IBD or LVAD. Thus, there will be a need for tools to optimize the quality of the care offered to patients. Concepts of risk and uncertainty have been gaining importance in the standardized text models of quality framework. In fact, failure to prevent risks can cause unpredictable and even negligible consequences. It seems that more problems than benefits arise from omitting quality measures in one patient's journey with imaging. If such a missed event occurs, reduced liability is not enough to compensate for the bad consequences that can occur to a patient (R. Reid, 2022).

The imaging community will need to respond to new and challenging professional issues arising from rapid changes in imaging. As newer proprietary processes and protocols replaced older ones with a different mode of operation, some radiologists may find themselves obsolete, especially if they did not have time to catch up and were not motivated to do so. In the later years, new proprietary processes and protocols will continue to emerge, and imaging will be limited unless radiologists comply with such proprietary metrics or interpretation concerns. In recent years, focus and attention have slowly shifted from imaging techniques to the reporting process of the imaging workflow. More recently, emphasis on the modality of imaging is expected to fade.

4.3. Collaboration with Other Departments

Emergency departments offer patients transport services, provide the ability to speak to someone familiar with the medical device, and help facilitate getting in contact with a family member. These departments work with nursing in decreasing the pre-procedure wait time of CT scans in the emergency department. It also continues to collaborate with nursing, radiology, and the medical product departments to create an educational presentation on MRIs for patients. This presentation uses both video animations of the movement of the MRI process and the voices of the doctors performing the procedure, which helps calm patients before the procedure (James Hansen, 2018).

Collaboration with the radiology department occurs in monitoring the start of pre-procedure preparation times, treatment times, and procedure times. These times are correlated with department congestion and present the data on a PowerPoint to help clear down times throughout the day. Other time monitoring happens with the laboratory department and monitors different waiting times in an effort to assist in directing patient traffic and

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decreasing the night-time overflow holding patients in the emergency department. These departments also work with the EHR department in obtaining access to and assisting in research on home monitoring devices used by patients that come to the emergency department. Some of the projects mentioned in collaboration are also partnered with other departments including nursing, radiation therapy, and interventional radiology.

5. Medical Devices in Emergency Settings

Medical devices are ubiquitous in emergency settings, as they are used for patient monitoring, imaging, emergency diagnosis, routine laboratory tests, and treatment approaches. Despite their widespread proliferation, integration of biomedical engineering principles in the design and production of emergency medical devices is crucial to ensure their usability, acceptability, and safety. Hundreds of millions of people are treated in emergency departments (EDs) each year, at significant capital expense to hospitals. Currently, most EDs use an anomaly detection system only at the network switch level, while transport network monitoring is manual and periodic when issues are only observed after issues arise. Improving the patients' experience within hospital EDs can provide benefits through enhanced patient satisfaction, reduced patient anguish, better delivery of care, and reduced staffing needs. However, improvement of the patient experience is difficult as interactions with EDs are complex, consist of multiple commodity interactions, are contingent on bi-directional communication, high variability across the system, and limited interactions that are poorly depictable as a block diagram system (James Hansen, 2018). Most human-mediated service systems are decomposed into operating resources and service channels, where resources are processes that transform people or products as they progress through the system and channels are sites where an interaction travels across a resource.

A novel interface that spatially depicts the patient experience within an ED is proposed, connecting the patient and the ED to better deliver the service. The interface uses a touch screen displayed on a wall-mounted monitor located near the ED entrance and in the ED waiting area. Additionally, a symptom checker planned after the recording of the patient identifier completes the interface. This device allows patients to input demographic information and symptoms and schedule an appointment while viewing the ED environment prior to entering. It displays a floor plan of the ED with surgery rooms, nurse stations, waiting areas, and bathroom locations. The interface also shows real-time information about the waiting situation, including the number of people on the patient list, the estimated throughput time, check-in time, examination time, lab test duration, and scheduling and results reporting. Raw information is processed and represented according to how patients receive the information, resulting in an improvement to patients' understanding of their ED experience, which can alleviate their mindset of anxiety.

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5.1. Types of Medical Devices Used

Today there are an estimated 200 million medical imaging devices available worldwide, with more than half of those in the United States. Imaging devices such as X-ray machines, computed tomography (CT) scanners, ultrasound machines, mammography units, and magnetic resonance imaging (MRIs) have become integral parts of the health care system, enhancing the capabilities of health care workers. Because of these devices' wide use in the health care industry, it is imperative to consider patient experience in their design. The team designed devices that achieved the ultimate goal of creating medical devices that improved the patient experience. To accomplish this, researchers focused on X-ray, CT, and MRI devices. These relevant devices represented different imaging types, different modalities, and different types of patient engagement to encompass a broad range of insights. Between each workshop, input was gathered from patients using a survey to better characterize individual situations. This input would ultimately guide concepts and product design refinement.

Initially, in workshop 1, participants took part in a collaborative design exercise to provide general input on patient experience and imaging devices. A brainstorming session generated a wide variety of concepts to address different aspects of the patient experience. Ideas included allowing patients to conveniently check in on devices, giving them the ability to control the imaging device remotely, and allowing them to select display options. Similar aspects of the concepts were compiled into themes of thoughts that were subsequently organized via an affinity diagram. Gathering insights from academic literature expanded on these ideas even further. Clustering certain themes led to a focused brainstorming session in workshop 2 that generated low-fidelity concepts aimed at enhancing the patient experience. Similar to before, these ideas were clustered to find a hierarchy of concepts before sharing out to gather feedback (James Hansen, 2018).

5.2. Impact on Patient Monitoring

Monitoring patients for deterioration and ensuring timely treatment in a crowded ED is more challenging, and this drives researchers to develop better solutions. Encoder interfaces are usually available for cameras to detect faces in the crowded areas, and deep-learning techniques are used to reuse such interfaces to allow recognition of patient monitoring devices worn by ED patients. Systems detecting such devices improve monitoring accuracy, increase patient safety, and allow hospitals to cope better with increasing patient loads. A prospective cohort study was conducted at a tertiary hospital to monitor the deterioration of vital signs of patients in the ED waiting area. Adult patients (≥18 years) requiring immediate nursing and/or medical attention were monitored. The monitoring data were systematically recorded for analysis.

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The device monitoring patients' deterioration at the ED was single-wearable, which is equipped with a wide range of sensors, with at least wearers' heart rates and temperatures being monitored. Various situations in which the device was worn were divided into one minute segments with and without cases of detected deterioration. When data were detected by one or more motion sensors during a segment, it indicates that it is a segment during which the device was being worn. For each class, non-deterioration samples were randomly selected to match the number of deterioration segments, and segments where the device was unavailable were excluded. The modified CRNN was used to classify the segments as to whether the device was available. The softmax normalized scores of the modified CRNN were divided into eight clusters with at least two members to identify types for improvement. Further classification models were trained for combinations of such identified types on all deterioration signals.

Interpretability is one of the future challenges for deep learning methods in medicine. It refers to trying to understand and explain the rationale behind the prediction of deep learning-based black-box approaches. It has become a trend, and many interpretable deep learning approaches are examined in a health sense. Using Temporal Convolutional Neural Networks to analyze the physiological signals, the model could estimate a high interpretability score. In addition, class-specific explanations were provided in the health sense, and improved interpretability on which segments at what points triggered which output predictions was presented.

5.3. Challenges with Medical Device Integration

The current methods of logging and tracking data are disconnected, inconsistent, and unverified. Pen and paper logs are usually taken down before the information is sent in to be typed up, losing an important verification step. Information is transmitted through a series of trails, sometimes becoming murky and unverifiable at the end. For example, an EKG that is verbally sent to a nursing supervisor only to have the report to the emergency specialist nurse get misreported into the EMR. In order to properly assess the pacing and decision-making of specialists, a chain and data gathering system would need to be composed of at least two different departments, if not more. Getting interfacing software up and running is resource-intensive. The optimal situation would be to have a single interface for all data in the event triage, or a chain of interfaced systems that would save everyone time and decrease the chances of human error.

Medical device integration spans many disciplines and types of devices. Automatic device integration of diagnostic POC devices adds accuracy and efficiency to the process of collecting test results for further interpretation and decision-making. These systems negate the potential human error associated with point-of-care devices. Each of these devices has its

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own vendor-supplied software that would preferably send data to a department or hospital-wide system. Device data could then be sent to the EMR as reports, with the time and identifiers of the origin changed to match AHMH standard formatting (James Hansen, 2018).

6. Patient Experience and Satisfaction

Healthcare in the United States is a multi-trillion-dollar industry, where patients pay cash, cash equivalent, or pay through insurance for treatment. Hospitals and providers are multi-billion-dollar businesses, where patients decide whose service they would want to pay for. Despite this, the service that patients receive is still falling short of expectations. Customer satisfaction scores are becoming a larger part of hospital rankings nationwide and impacting the reimbursement from insurance companies. Publicly available surveys have started rating hospitals based on patient experience. Efforts of improvement have been put into place, but still fall short of expectations. Emergency Departments (ED) are places where patients arrive due to a crisis situation. It is a place that no one wants to go, yet almost every single person has had an ED experience in their lifetime. Events happen, out of the blue, that may require an emergency treatment. Many of these times, it is a serious health concern that cannot wait until a convenience time. Health crises cannot be eliminated from happening, but the treatment experience can be improved. This is where the ED can step in. The purpose of this thesis is to explore how the ED can better serve patients in improving the experience of patients while in the hospital during an emergency visit. Currently, this practiced survey does not reflect what happens in the ED. The ED is intended for emergency situations, and therefore has to be very adaptable to whatever arrives through its doors. Day-in and day-out, the ED sees a range of patients that cover the full spectrum of why someone should go to the ED. Many patients in the United States use the ED as their agency of primary care because they don't have insurance. Therefore, developing a survey to investigate the patient's experience during their visit to the ED is difficult. The average ED visit is under three hours long, but there is a significant amount of variability on how long patients will be stuck in the ED. The ED is not merely a miniature version of the hospital, and it must be approached differently.

7. Interdisciplinary Collaboration

Interprofessional collaboration (IPC) is essential in Emergency Departments (EDs) for improving patient care and safety. Improving healthcare service quality through better teamwork among providers is crucial for successful EDs and better health outcomes. In the ED, communication and collaboration among nurses, physicians, and other disciplines is particularly important for ensuring the timely and safe delivery of appropriate patient care. Poor communication and collaboration among emergency service providers has been linked to negative patient safety outcomes, and IPCP improvements have been previously identified as one solution to improving the patient experience of care and care safety. However, poor

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physician engagement has previously been described as a major barrier to improving IPCP in EDs, and physician engagement in IPCP is vital to improving health care delivery systems (Leeman et al., 2017).

As the time spent in EDs continues to rise, it is as important as ever for patient experience to receive attention and energy. The patient visit to the ED is the beginning of a chaotic, stressful time for them and their families, filled with unknowns and countless questions. This product was developed with the patient in mind. Something that can improve the patient experience is necessary, and it needs to be affordable and cost-efficient as well. There are currently many programs and services geared towards improving the patient experience, but none so far have addressed these needs in an effective manner. On top of the health and emotional benefits of this product, the patient gains access to more amenities, information, and services than ever in a hospital. It gives patients the ability to communicate in ways they are more comfortable with, like texting. It gives them a resource to communicate with people outside of the ED to help alleviate the stress of an ED visit. Instead of having to walk across an entire hospital, specialists could check in with patients via video chat, saving considerable time. Events such as waiting for test results would be rendered nearly obsolete.

This is a product that fulfills many of the needs that people have when they visit the ED, needs that aren't currently a priority of the staff. The experience when a patient visits the ED is that the priority of the staff is on the health of the patient, and this product helps free up doctors and nurses from mundane tasks to spend more time at the bedside helping patients (James Hansen, 2018). The end goal is for patients that have to visit an emergency department to not have to worry about anything but improving their health, and when they get there, the quality of the experience can improve greatly.

8. Future Directions in Emergency Care

The discussion of future directions in emergency care would have to begin with a gap in technology. After all that has been mentioned previously, High-Definition Video and free national Wi-Fi are a few things that are part of socialized healthcare countries. HD video exudes professionalism and therefore limits the quantity of videos and memes nurses must joke around about. In concert with the Wi-Fi roll-out, gifts like Metro Clippers and an array of charging ports across buildings would be welcome additions to emergency settings. It is no mystery that emergency departments are cramped, and the idea of iPads, screen time, and responsibilities given to patients instead of just nurses and clinicians seems to see antiquated. However, at this point, each and every patient should have their own waiting room-themed screen when entering the facility.

An easy answer for how to improve the emotional experience of emergency department visits is to try and ease the fears of parents and loved ones. The app will be unique to each practice,

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allowing each practice to connect their app by giving patients a code. One open idea is synthesizing the app with existing systems to provide information about the arrival of a baby or their condition in the stand-alone app instead of having two separate ones. If the connecting feature works, then patients will be able to see a basic summary of lab results, prescriptions, and other information given to patients verbally at their discharge time. Patients will have access to information on what times the various doctors visit but will not be able to mess up the timing of important work by interactively sending messages. Be it an ED walking room, a ride home, or even a necessary comfort snack, the in-app service can start an order. However, while in-room calling should always be available to find questions, nurses and clinicians will be limited in outside world contacts. Bursting through the walls and borders of hospitals, the app can also connect patients with their own primary care physician or institution on hold, with lawyers filing a restraining order against the guy sitting next to them in triage.

8.1. Emerging Trends in Patient Care

Emerging trends in patient care are focused on improving patient experience and satisfaction when interacting with healthcare systems. The emergency department (ED) in particular poses many challenges that can cloud the patient experience, leaving patients feeling anxious and vulnerable. Electronic health communication tools including a patient messaging platform named ConnectED are gaining traction amongst healthcare systems to improve the patient experience in the ED (James Hansen, 2018). Empowering patients with the knowledge and tools to advocate for their own care and keep them informed can ease anxiety during ED visits. The ConnectED app gives patients the ability to communicate in ways they are more comfortable with, like texting. It gives them a resource to communicate with people outside of the ED, like family members, lawyers, primary care physicians, or a babysitter. The app could guide you around the hospital to different departments, or help you find a ride home. Specialists could check-in with patients via video chat saving considerable time. Other potential developments include nutrition services facilitating food and beverage services by communicating with the ED patients. Finally, the app could notify ED staff of relevant patient information, such as transportation needs, so that it can be handled more smoothly.

The ConnectED app investigates key patient needs that other systems have not addressed. This app fulfills many needs that people have when they visit the ED, needs that aren't currently a priority of the staff. The priority of the staff is on the health of the patient, and it should stay that way. This app helps free up the doctors and nurses from mundane tasks to spend more time helping patients with their health. Ultimately, patients that visit an emergency department should not have to worry about anything but improving their health. When they get here, the quality of the experience can improve greatly. Additionally, care evaluation has focused on a narrow set of quality indicators over the past several years.

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However, without including the patient perspective in presenting care, undesired outcomes may inadvertently remain ignored or unnoticed. One way to help bridge this gap is to incorporate qualitative methodologies in investigating patient experience. It allows an unobtrusive probing into undesirable aspects of care that are not often reported, especially in emergency medicine where rapidity has prioritized essential elements of care through explicit categories of quality indicators. However, many implicit aspects pertaining to the subjective patient experience remain ignored.

Taken together, these services would fill knowledge gaps patients experience when visiting the ED. Communication is crucial to the patient experience. Already having limited access to health information leaves ED patients feeling even more vulnerable than usual. Providing emotional and status updates can ease anxiety and further comfort patients. Additionally, these new services would free nursing staff from mundane clerical tasks to focus on patient care. A system that allows patients to communicate their needs independent of nursing staff would greatly enhance the patient experience.

9. Conclusion

Emergencies can happen at any time; consequently, patients usually have no choice over their hospital selection. Multiple hospitals often take over a medical center over time, an acquisition, or during a merger, with ED taking the brunt of appointment calls to transfer patients. Interface designs can be changed overnight, affecting only the buildings, not the equipment. Procedures can also be streamlined, saving a lot of time, and reducing over-time costs. New protocol implementations can improve patient outcomes, changing to the new system and accepting staff reluctance to this change. A new, better-resourced, and technologically-stacked hospital often leaps through hoops to entrench itself in a community with what is often poorly-designed systems. Because of limited space and time, only four main systems were set upon for review: the ED, radiology, nursing, and medical devices (James Hansen, 2018). On their hospital transfer page, emergency departments can be categorized into sending it to the emergency room or here. A particular portion of a hospital's population arrives via the ED. If medical center A is more qualified or well-resourced to take in some department, ideally patients can be shifted over for urgent emphasis. To facilitate oversaturation in one department, or provide patients access to other hospital CC services, in-bound transfer systems were considered.

Nursing was decided upon for the protocol review. As healthcare is faced against insufficient staff to fill positions and an increasingly older population that requires more care, models that automate duties already done by RNs already exist. For the main body, the current ICUs, emergency departments, and ward nurse devices were implemented in the medical center of consideration which allows bedside protocol/radio use of medical devices without needless

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duplication. Stakeholder interviews can be directly quoted as far more aware and effective behavior changes. Nurses themselves will be able to see answers or updates to questions other staff may know, engendering smooth continuity. By providing at-a-glance job ticketing for all interactions, nurse workstations can identify issues posing a reasonable time factor to the site, with a simple explanation and expected time of arrival being all that would need to be filled.

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