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Determining Care Delivery Model Feasibility Using Discrete-Event-Simulation

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Determining a Care Delivery Model Feasibility Using Discrete-Event-Simulation

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I am sincerely grateful to my ancestors for paving the way for me to take this unforgettable doctoral journey. To be the first in my family to experience this achievement is an honor and one that requires direct acknowledgement of those who have supported me mentally and physically along the way. To my dearest husband, partner, and best friend Cowboy Ray whose unconditional love and encouragement have lifted me up and out when the challenges outweighed the opportunities, I thank you. To my phenomenal Chair, coach, and nursing colleague Dr. Mary Bittner, words cannot express how your steadfast encouragement, leadership, and guidance impacted my imagination and further ignited the disruptor within the disruption. To my second Chair, Executive exemplar, and innovative inspiration, I say, "thank you," Dr. Nicholas Webb for your unwavering confidence and support of my ability to grow, flourish, and be authentically me. To Dr. Mary Lynne Knighten for starting my journey off with a level of mental development never known, thank you for seeing through my "flowery" words and bringing out the scholarly writer. To Susan Spencer I remain in deepest admiration of your patience and wisdom and look forward to continuing our writing journey. I sincerely want to thank my entire ELDNP Cohort 12 for the friendship, love, and camaraderie. We are forever connected, and I will always be here for you, whenever and wherever you need me. Lastly, to my dad who without his love and example, I would not be here today.

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Care Delivery Model Feasibility Using Discrete-Event-Simulation

Abstract

Background: California has lost nearly 30% of its acute care psychiatric hospital beds, and most counties have no psychiatric beds for children. The need for inpatient pediatric psychiatric services to address the growing issue of pediatric mental health in a multi-state integrated hospital enterprise is straining the system's capacity to provide timely mental health care.

Local Problem: Lack of access to specialty pediatric psychiatric treatment for dual diagnosis medi-psychiatric care management is a patient quality and safety issue. Insufficient capacity contributes to longer emergency room boarding times and inpatient length of stay for patients who have a mental illness. This imposes a financial burden on patients, their families, and the healthcare organization. A plan was requested from nursing leadership to reduce the wait times and costs associated with management of the dual diagnostic concerns impacting the pediatric patient population.

Methods: Use digital simulation methodology to analyze the behavior of a dynamic event-driven care delivery workflow and to optimize quality patient outcomes by implementing a hub and spoke model of care.

Interventions: A discrete event simulation model was built using retrospective data to evaluate existing resources and "what if" scenarios based on patient movement through a hub-and-spoke regional patient transfer structure.

Results: Simulation of the patient flow determined that a decentralized hub-and-spoke model was for management of dual diagnosis volume in northern California was unnecessary. Simulation modeling results revealed an average daily census of 5 for dual diagnosis patient volume from 2019-2021. This indicated an ability to centralize all pediatric dual diagnosis

volume into one hub hospital instead of three. The single hub and spoke model can successfully decrease length of stay, reduce transportation costs, and maximize resources.

Conclusions: Simulation was a cost effective, predictive, and innovative approach to evaluating alternative care models at the nurse executive level**.** The project demonstrated that prudent strategy for use of capital project resources can be enhanced when contribution of the voice of nursing is included at the beginning of the design phase in project management. By expanding the collaborative partnership of data scientists, financial analysts and nurse executives, the design process, precision of concept, mitigation of costs, and clarity of scope is realized at the macro, meso, and micro levels every project, every time.

Key words: *boarding, discrete event simulation, emergency room, pediatrics, psychiatric*

Determining the Feasibility of Opening a Pediatric Dual Diagnosis Care Unit Using Discrete Event Simulation

Background

Since 1995, California has lost nearly 30% of its acute care psychiatric hospital beds (CalMatters, 2017). Almost half of California counties had no adult acute psychiatric beds in 2015, and the vast majority had no psychiatric beds for children (California Hospital Association [CHA], 2018).

The overall decrease in psychiatric bed availability has contributed to diversion of the remaining child and adolescent psychiatric beds to use for adults. From 2009 to 2017, the number of pediatric psychiatric beds in California decreased by 5.2%, leaving 42 counties or 72% of the state without pediatric psychiatric beds (CHA, 2018). Without adequate placement for inpatient pediatric psychiatric patients, the quality of specialty psychiatric care in health care systems would fall short of improving behavioral functionality outcomes for children contributing to later manifestations of psychotic crisis conditions in their adult lives (Taylor et al., 2018).

Problem Description

In a large northern California healthcare system, inpatient pediatric psychiatric admissions were on the rise, straining the system's capacity to care for pediatric psychiatric patients, increasing emergency department boarding time, and exacerbating competition among hospital systems for the few pediatric psychiatric community beds available for immediate placement. In 2020, there were 3,046,097 children and adolescents (aged 0 to 17) living in the healthcare system's 23-county northern California (NCAL) service area, with a minimum bed requirement of 1,523 pediatric psychiatric beds based on national health policy expert

recommendations (CHA, 2019). However, only 223 specifically designated pediatric psychiatric beds were available.

From 2019 through 2020, admissions for inpatient pediatric psychiatric patients increased by 23% in the healthcare system's northern California region. Inpatient days over the same time period increased by 13% from 15,362 to 19,950, with an average daily census increase of 28.6% from 42 to 54. The shortage of pediatric psychiatric beds in the northern California service area had increased the length of stay for pediatric psychiatric patients by 21%. The cost of treating pediatric psychiatric health patients in the regional system increased from $6.1 million in 2019 to $11.1 million at the end of 2020, a 35% increase year over year.

Setting

The northern California healthcare system portfolio for pediatrics comprises 139 beds, of which 125 are licensed pediatric beds and 14 are licensed flex beds. Three tertiary pediatric referral centers are located in Oakland, Roseville, and Santa Clara, with the Oakland facility servicing the most feeder hospitals in its catchment area. The Oakland Pediatric Care Center, the setting for this project, is the only facility with a psychiatric physician residency program. The program, established in 2018, has at least one child and adolescent psychiatrist on the faculty. The Oakland Pediatric Care Center also has a pediatric physician hospitalist residency program, a pediatric intensivist residency program, and a clinical psychology doctoral fellowship program.

The patient case population for the Oakland Pediatric Care Center consists of 60% oncology, 15% neurology, 10% orthopedics, and 15% general medical-surgical. The facility has 25 licensed inpatient acute care beds with an average daily census of 20 and a 12-bed pediatric overflow inpatient unit. The pediatric overflow inpatient unit is unoccupied over 90% of the year, and until a psychiatric patient presents who is not allowed admission to the general pediatric

acute care unit based on diagnosis. The combination of the largely unused pediatric inpatient unit and the expertise and resources of the Oakland Pediatric Care Center presented an opportunity to transform the unit to a hub-and-spoke model of care to better serve pediatric psychiatric patients in the northern California region.

Discrete event simulation (DES) was used to determine feasibility for reallocation of the dual diagnosis pediatric population into existing pediatric inpatient overflow space, This strategy aligned well with the executive leadership and operational strategy expectations for value-based care delivery. The project supported the interests of regional executives to improve hospital throughput and efficiency by leveraging existing spaces, standard work, systems enhancements, technology enablers, and partnerships.

Specific Aim (Purpose)

The purpose of the DNP project was to use digital simulation methodology to assess the feasibility of establishing a decentralized pediatric psychiatric hub-and-spoke model for pediatric dual diagnosis medical-psychiatric services. The feasibility assessment was an initial step in a larger project scope, which was to design and implement an alternative patient care delivery model within a 12-bed tertiary care overflow pediatric unit in the Oakland hospital. The specific aim of the project was to achieve 15% reductions in emergency room boarding, inpatient length of stay, and care costs over one year.

Available Knowledge

PICO(T) Question

A PICOT formulation of the project's purpose helped guide the search strategy to identify evidence-based practices to support a test of change. The PICOT question was: For (P) pediatric psychiatric patients in a tertiary care facility, (I) how does a pediatric medical-psychiatric crisis

unit designed using a hub and spoke model (C) compared to a decentralized care model (O) reduce patient length of stay, financial costs, and increase quality (T) over one year?

Search Methodology

A systematic search of the literature was performed in June 2021 on the PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), and APA PsychInfo databases. The terms for the initial search were *pediatrics, tertiary care, mental health, psychiatric health, integrated, suicide, eating disorders*, and *inpatient hospitals* using Boolean Operators "AND" and "OR." Inclusion criteria were peer-reviewed, published in English, evidence-based practice, and all child (i.e., pediatric only). The initial yield was 459,510 articles, most unrelated to the topic. A second, narrower search was performed with the terms *hub and spoke*, *children, adolescents, medical psychiatric unit, emergency room*, and *transfer* with the Boolean operators "AND" and "OR," and inclusion criteria of peer-reviewed, English only, all child, and published between 2011 and 2021. Studies were excluded if the populations were patients of small rural hospitals or not inpatients of acute care hospitals. This search yielded 298 articles, with 11 related to the topic. The 11 articles were then scanned for relevance to pediatric emergency room boarding, inpatient pediatric psychiatry, and hub and spoke models. Eight studies were selected based on their titles and abstracts, the full texts reviewed, and then appraised using the Johns Hopkins Nursing Evidence-Based Practice Research Evidence Appraisal Tool© (Dang et al., 2022). Seven studies were quantitative and appraised Level III B, Good Quality. One was a correlational quantitative Level II B quality study (see Appendix A for the Evidence Evaluation Table).

Integrated Review of the Literature

Two themes emerged from the review of evidence-based practices: models of care that promoted timeliness of psychiatric evaluation and the needs of dual diagnosis patients.

A persistent shortage of pediatric psychiatric health beds accelerated the demand for creative operational strategies and hospital care programs that removed pediatric behavioral health patients from the emergency department (ED) to a location able to provide more appropriate care at lower costs with shorter length of stays (LOS). In a retrospective study rated Level III B, Parwani et al. (2018), evaluated the effect of opening a 12-bed psychiatric observation unit in a tertiary academic medical center ED on reducing ED boarding and LOS for patients presenting with psychiatric complaints. The study design was a before-and-after analysis with 3,501 patients included before intervention and 3,798 after intervention. ED LOS was defined as the from ED arrival to ED departure. The pre-intervention group had a median ED LOS of 155 minutes (Md= 2.58 hours, [IQR]= 19-346 minutes), and the post-intervention group had a median LOS of 35 minutes (Md=35 minutes, [IQR]=9-209 minutes). All unadjusted differences between pre-and post-intervention median values were statistically significant at $p < 0.0001$. The creation of new bed capacity through the dedicated unit reduced ED LOS and inpatient psychiatric admissions through the ED. The findings demonstrated the effectiveness of an alternative model to improve ED throughput (measured as reduced LOS) and better allocated scarce mental health resources (demonstrated as more appropriate care at lower cost). This study could be replicated with a focus on pediatric psychiatric patients to investigate LOS and cost issues straining the current models of pediatric behavioral health care.

In a retrospective, observational level III B study, Bekmezian and Chung (2012) investigated ED boarding times and LOS for pediatric patients in a frequently overcrowded tertiary hospital ED without a psychiatric observation unit. ED boarding times (M=9.0 hours) were associated with longer inpatient length of stays (M=147 hours) for low acuity patients, especially those with psychiatric diagnoses such as suicidal thoughts or actions. The authors' findings were consistent with the Institute of Medicine 2006 report on ED overcrowding that an ED is not intended for boarding and prolonged care nor equipped to provide it, especially in cases complicated by adverse events, nosocomial infections, and patient or family dissatisfaction. Bekmezian and Chung acknowledged the benefit of adding a designated pediatric hospitalist and resident to monitor the care of pediatric ED-boarded patients in the study 24 hours a day, but did not address psychiatric provider availability or costs.

Bujoreanu (2015), in a level III B study, examined the impact of timing of a psychiatry consultation during pediatric hospitalization on hospital LOS and total hospitalization costs. The study was a chart review of 279 pediatric patients of a freestanding, tertiary pediatric hospital in Boston. The results suggested an association of timely psychiatric consultation with a marked reduction in admissions, LOS, and overall hospital costs, reflecting a positive correlation of 0.34 between referral time and observed-to-expected length of stay ($p = .0001$). The findings showed an intervention with direct impact on the quality of care, psychiatric consultation in this case, can ease the strain on scarce resources and decrease the economic burden on patients and families.

Hospitals around the world continue to work towards solutions for patient throughput and care flow to increase availability of beds, reduce the number of people waiting in EDs for those beds, and positively impact the patient's care experience. In a Level III B cross-sectional study of adult patients in an Italian "Hub & Spoke" hospital system, Chieregato et al. (2014) evaluated

the impact of care models on bed availability and how the models contributed to the patient and family care experience. The researchers surveyed the next of kin of patients transferred to spoke ICUs near their homes and evaluated preferences for a one-ICU or two-ICU model of care for the patient's entire LOS. Family members who chose the two-ICU model found it easier and less costly to visit the patient in an ICU near home; those who chose the one-ICU model were noted to be next of kin of younger patients who needed high-intensity care. The link between clinical factors (disease severity, age, outcome), and choice of the one-ICU model supported the study hypothesis that an appreciation of clinical conditions guides the choices made by relatives, an important factor to be considered for children and youth presenting to an ED in a mental health crisis.

Case et al. (2011) found pediatric psychiatric patients presenting to the ED were admitted or transferred far more frequently than other pediatric patients and were less likely to be discharged. In this level III-B study, the authors analyzed 2001-2008 data from the National Hospital Ambulatory Medical Care Survey. Laboratory studies and patient transfers appeared to explain the marked regional variation in LOS for emergency mental health visits. However, inability to move admitted patients from the ED to an inpatient bed was most frequently cited as the reason for ED crowding. Inability to directly admit mentally ill youth may have contributed to regional variations in ED LOS.

An additional level III-B quality study (Fahimi et al., 2015) used the same NHAMCS database to analyze data from 1997-2010, and identified visits for mental health, substance use and dual diagnosis. Both mental health and substance use were associated with admission or transfer as compared to other dispositions: mental health, odds ratio (OR) 5.93 (95% CI 5.14-

6.84), illicit drug use, OR 3.56 (95% CI 2.72-4.64), and dual diagnosis, OR 6.86 (95% 4.67-10.09). Substance use visits were often complicated by a co-existing mental health condition.

Another level III-B quality review of a study that looked at psychiatric patient presentation to the ED (Smith et al., 2019) used data from the Florida Agency for Healthcare ED discharge database revealing a significant increase of ED LOS to > 12 hours for patients requiring transfer to another facility and also demonstrated a significant difference in sociodemographic factors associated with ED LOS, indicating longer stays for females, 15-17 year old's, and for those identifying as Hispanic. Length of stay and ED boarding for pediatric psychiatric patients presenting to the emergency department has been noted in the literature to be understudied, despite evidence that children with psychiatric disorders experience longer LOS relative to those without (Smith et al., 2019) further suggesting implications for quality of care, patient safety, and pediatric health outcomes.

Dual Diagnosis

The addition of dual diagnosis patients created an opportunity for further exploration in three of the studies (Fahimi etal., 2015; Dazzi, 2015; Bujoreanu, et al.,2015) recognizing there were multiple needs for patients diagnosed with both a medical and psychiatric diagnosis. Dual diagnosed patients require special attention in the coordination of their care and the need for expert psychiatric evaluations as necessary to prevent an increase in their overall length of stay. A level II-B quantitative randomized study (Dazzi, 2015) evaluated dual diagnosis as a part of the psychopathology for predicting hospitalization by using surveys in a replication study to evaluate the clinician decisions for recommendation of hospitalization along with internally creating patient dimensional and categorical assessment tools to predict admission. The dimensional tool was found to be the stronger predictor for admission with a total of 123 patients

(39.4%) recommended for admission to the acute psychiatric ward, while 189 patients (60.4%) recommended for discharge. The patients who were recommended for hospitalization showed significantly higher mean scores on the following dimensions: anger/aggressiveness, apathy, impulsivity, reality distortion, thought disorganization and activation. Level III-B quality research reviewed on a study conducted in a tertiary freestanding pediatric hospital in Boston, (Bujoreanu, 2015) revealed by evaluating the number of pediatric patients hospitalized with a dual medical and psychiatric diagnosis, the designed model of care incorporating predictive analytics could allow health care systems to target program goals towards impacting the psychological conditions and traumas that affect children and exacerbate physical illness-associated symptoms as seen in patients with co-morbid medical diagnoses (Bujoreanu, 2015). A level III-B quality study (Fahimi et al., 2015) found that adolescent patients with substance abuse and mental health conditions as comorbidities overlapped in ED visits. The co-morbid mental health conditions were predominantly mood and anxiety disorders, which resulted in higher admission rates. The study gives understanding and direction for beginning to create links between substance abuse and mental health and assists in categorizing similarly seen ED variables in adolescents.

Outcomes workflow tools were explored in a level III-B study (Kovalchuk et al., 2018) with the use of simulation. A hybrid approach in a qualitative study utilizing data mining and predictive modeling to support simulation was implemented to automate models and scenarios, and to map clinical pathways through simulation application management. It identified essential requirements and a conceptual framework to support simulation models using electronic health records and alternative information sources in acute coronary syndrome (ACS) patients (Kovalchuk et al., 2018). The results revealed a scarcity of literature focusing on simulation in

complex care scenarios involving complex patients with multiple department consultations. The focus on mapping patient flow in a personalized patient-centered paradigm structure versus an evidence-based medicine model facilitated the conceptual integration of multiple data and knowledge sources. The sources included managing patient-centered data collections and building advanced tools for the analysis of available data and general model-based support viewed as integral to providing a proper simulation (Kovalchuk, 2018). The simulation constructed in the study identified a more accurate control of the flow of ACS patients with those waiting in queue and average queueing times decreasing when parallel operational actions were simulated. Complications of wait times could be predicted and expanded across length of stay, mortality, and cost utilization by varying complexity and resources during each simulation generating forecasting for future directions for the ACS patient population management.

Summary/Synthesis of the Evidence

In the evidence reviewed, four studies demonstrated the benefits of having expertly trained psychiatric staff available to evaluate and disposition patients within hours of presenting in psychiatric crisis (Bekmezian & Chung, 2012; Bujoreanu et al., 2015; Case et al., 2011; Dazzi et al., 2015;). Four studies evaluated pediatric ages or ethnicity as determinants for length of stay and cost (Case et al., 2011; Dazzi et al., 2015; Fahimi et al., 2015; Smith et al., 2019). Two of the articles discussed the value attributed to incorporating specialty units into the overall care model to facilitate expedient disposition, placing care in a location that fostered higher levels of team collaboration (Chieregato et al., 2014; Parwani et al., 2018) and one article detailed the experience of using data-driven simulation tools as predictors in outcomes associated with length of stay, resource management and value-based care (Kovalchuk et al., 2018). All the studies reviewed informed the PICOT question and provided evidence to support the proposed quality

improvement project. No significant gaps were noted that were a barrier to implementation of the model. The evidence suggested the potential for a 21st century paradigm for equity-centered models for pediatric care designed through a lens of quality improvement strategy implemented using innovation and technology decision-support.

Rationale

Donabedian Quality of Care Framework

The value and importance of incorporating pediatric behavioral health solutions into the standard care model of a hospital system begins with executive leaders' independent viewpoints. These independent points of reference are then considered through the lens of a conceptual or theoretical framework to support informed clinical decision making. The theory of quality in healthcare established by Avedis Donabedian and the Donabedian quality of care conceptual framework were chosen as the continuous quality improvement (CQI) approach for this project, as both focus on understanding structure, process, and outcomes within systems. Donabedian's theory of quality underpinned the central idea of the project, while the conceptual framework helped guide the project through its stages.

Avedis Donabedian (1919-2000) was a pioneer in health services research. His seminal work, *Evaluating the Quality of Medical Care* (Donabedian, 1966), established his authority on measurement and analysis. His subsequent work focused on developing methodology for measuring structure, process, and outcomes to assess and improve the quality of care. Although the Donabedian conceptual framework, with its "trinity" of measuring structure, process, and outcome, was the major source of Donabedian's reputation, he emphasized prioritizing governance and management, supported by measurement, as quality determinants in health service (Berwick & Fox, 2016).

Donabedian characterized systems as “enabling mechanisms only” with “[the]ethical dimension of individuals being essential to a system’s success” (Berwick, 2016, p. 237). According to Donabedian (1966), the quality, effectiveness, and efficiency of health care delivery stemmed from prioritizing governance and management, supported by objective measurement. A significant element of governance and management included maintaining value in care delivery. Cost containment was a result of examining structures, processes, and outcomes even if it was not the main driver of the strategy. The Donabedian quality of care conceptual framework emphasized that care should be organized and managed, which required healthcare systems to evaluate their hospital operations for clinical, process, and outcomes challenges in order to provide efficiency and ultimately quality, patient-centered care. Furthermore, Donabedian viewed the quality of care as a reflection of the prevailing values and aims of the medical care system and the larger society (Donabedian, 1966).

Donabedian (1966) suggested examining the care process rather than its outcomes where indicated. The DNP followed this course of inquiry. The structure and setting for patient care was assessed in the first phase of the program development process. The adequacy of facilities and administrative systems were evaluated, the qualifications of the medical staff analyzed, and fiscal responsibility and governance assessed. Donabedian’s conceptual framework guided the identification of variables as the project moved through phases. The conceptual framework established the context for relevance in measuring variables impacting the current system for treating the pediatric behavioral health population. Modeling a proposed care process using discrete event simulation made it possible to evaluate a medical-psychiatric (medi-psych) unit as an opportunity to reduce ED boarding times, inpatient LOS, and costs for dual diagnosis pediatric patients.

Hub and Spoke Organization Design

The hub-and-spoke model of organization design originated in the transportation industry in the 1950s and was best known as the logistics design initiated by air carriers to optimize facility locations in a distribution network (Skipper et al., 2016). The model had been adapted for use in many industries, including retailing, education, and healthcare. Its adoption in healthcare was first recognized as exemplary in addressing the needs of patients in rural and underserved communities (Govindarajan & Ramamurti, 2013; Switzer et al., 2013). Since then, it has come to be more broadly viewed as a framework to maximize efficiencies and effectiveness in a broad range of healthcare settings by reducing replication of operations across multiple sites. In healthcare, the hub-and-spoke model strategically organizes service delivery assets into a network (Elrod & Fortenberry, 2017). The most advanced medical services are offered at an anchor establishment (hub), complemented by basic healthcare services from secondary establishments (spokes). With basic services broadly distributed across the network in the spokes, the bulk of healthcare needs can be addressed locally (Appendix B). When complexities emerge or intensive services are required beyond the scope of what the secondary facilities can provide, patients are routed to the hub for treatment (Elrod & Fortenberry, 2017).

Methods

Context

The DNP project incorporated the core values of the healthcare system: respect, scientific discipline, integrity, pioneering spirit, and stewardship. Using Donabedian's quality of care conceptual framework in the project enabled the development of project design standards that demonstrated pioneering spirit and stewardship. In 2021, the Chief Financial Officer of the project hospital identified the need to reduce pediatric psychiatric inpatient admissions, length of

stay (LOS), and associated costs. The regional organization's directors of maternal child health throughout northern California and pediatric leaders expressed the need to identify a solution to pediatric psychiatric emergency department (ED) boarding and unnecessary pediatric inpatient psychiatric admissions across the northern California hospital system. For the regional organizational leaders, the desire to build a new pediatric psychiatric hospital was low, yet the expectation of mitigating the costs of care for pediatric patients was high.

The healthcare system's Northern California Regional Pediatric Physician Chief agreed to the scope and aim of the DNP project and served as an executive sponsor. The project had strong support from the local Psychiatric Residency Program physician leaders, the Pediatric Residency and Hospitalist physician leaders, and the Chief Nursing Executive. The Chief Financial Officer provided a temporary regional financial analyst as a resource to query data systems across the health system enterprise to inform and provide direction for solutions, while the project site hospital financial management team fulfilled requests for year-over-year data. The Clinical Adult Services Director advocated to physician partners on the project's behalf. The Maternal-Child Health Nursing Managers and Clinical Child Life Specialists recognized the importance of a specialty care unit for pediatric medi-psych patients and lent their expertise to creating education and learning plans for the pediatric nurses.

Some care models in the published literature incorporate timely specialty care into emergency department evaluations of pediatric patients presenting with a psychiatric diagnosis. Specialty-care interventions have been shown to reduce the likelihood of a longer boarding time or length of stay (Bujoreanu, 2015). Incorporation of specialty clinicians into the emergency department has also prevented unnecessary inpatient hospitalizations when patients were treated for a psychiatric episode within defined target periods (Bujoreanu, 2015). However, health

system operational leaders for inpatient acute care in northern California did not have dedicated space in medical centers or permanent staff trained in psychiatric care to treat pediatric patients presenting with psychiatric diagnoses. Instead, hospitals relied on pediatric or medical-surgical staff working overtime or double-shifts to care for patients presenting in medi-psych crises. The lack of designated treatment space was driving up the costs of pediatric care, and clinical teams were missing opportunities to treat both medical and psychiatric needs in one hospital visit, thus mitigating both readmission and longer length of stay. The COVID-19 pandemic was a continual challenge for nurse leaders during project implementation as the pandemic was ongoing for the duration. The compounded the challenge for nurse leaders to address pediatric community population health and patient length of stay while controlling costs as the need for alternative bed space for COVID-19 patients was scarce as specialty nurses to provide care.

A multi-disciplinary operational demonstration pilot in the East Bay Hub, provides ED patient care coordination and management from clinical psychologists and trained pediatric psychiatry ED nurses, and establishes a crisis team response to evaluate immediate patient needs. The clinical psychology team, supported by social workers, maintains the ability to consult psychiatric residency hospitalists as needed. The Pediatric Hospitalists provide primary care for patients with acute medical conditions and partner with psychiatry residents when dual diagnoses present (Appendix C). The fully developed regional hub-and-spoke model in phase II provides support via telemedicine or transfer of care from smaller (spoke) facilities to a regional hub based on the results of the project discrete event simulation model.

Intervention(s)

The project setting was a pediatric unit within a 315-bed tertiary level referral center within a large regional health system. The DNP project manager identified an existing team at the regional level to collaborate on the digital simulation methodology. In identifying the team, the DNP project manager learned of the organization's existing strategic plan for digital twin throughput simulation, identified synergies between the proposed DNP project and the regional strategic plan, and obtained support for the DNP project. The regional financial analyst worked closely with the project manager to design the required data repository tableau and identify additional information systems where needed data was stored (Appendix D). The regional financial analyst navigated the programming, coding, and data pull system barriers associated with cross-enterprise information governance. A retrospective review of data for the last three years of pediatric psychiatric and dual diagnosis patient volumes for all of the healthcare system's northern California hospitals was conducted to extract data for the simulation.

Discrete Event Simulation

Discrete event simulation (DES) as a modeling concept analyzes the behavior of real-world dynamic systems by approximating them over time as a sequence of instantaneous occurrences (Velibor, 2021). An event-driven form of simulation, DES is widely used to model input details and identify detailed system outputs. It offers a high-level computational approach to answering questions concerning scheduling, resource allocation, and capacity planning. For the project, specific clinical actions or behaviors can be established as occurring during the pediatric patient experience at different points in time by simulating events. The simulation constructs a schedule of events executed sequentially with time as the artifact tracked. The simulation for this project centered on the patient care experience and movement of pediatric

medi-psych patients through the existing system and the alternative pathway of the hub-and-spoke model (see Appendix E). The DES model identified the pediatric patient initially sitting in queue in the ED. The patient was held in queue until an event permitted the patient's departure or move to the next phase of care, such as a physician order being written, a medical screening exam, triage evaluation, lab draw, psychiatric consult, or transport arrival. Once the patient was connected to an event, the server held the patient for a certain amount of time, which was the time it takes to get to the next phase of the process. The organization's artificial intelligence analysts and the DNP project manager continuously evaluated patient flow scenarios using retrospective data to understand the types of resources and amount of time required at each phase. Physician partners collaborated as key stakeholders to explain potential "bottlenecks" the simulation exposed, indicating opportunities for process improvement. The project manager and analysts involved in the design and implementation of the model established its validity in relation to its specific purpose and application in the project.

Gap Analysis

A gap analysis was performed using the healthcare system's Comprehensive Quality and Safety Project Strategy, Risk Reduction Program Element. The gap analysis evaluated the current state of pediatric medi-psych patient care placement and identified gaps between the current and desired states. Nursing management leaders were queried about throughput and physician consult processes for pediatric patients. Gaps and areas of opportunity were identified, and data transferred to a gap analysis table (see Appendix F). Four critical gaps were identified. The first was the lack of inpatient pediatric medi-psych beds. The under-utilization of the pediatric overflow unit offered a readily available solution in simulation with increased resource availability. The second critical gap was specialty psychiatric provider coverage. Currently

psychiatric residents leave the project location to gain experience in adolescent psychiatry. Simulation suggested collaboration by pediatric residents, hospitalists and psychiatric residents would provide synergistic learning experience for the provider team and enhance multi-specialty coverage. The third gap was nursing knowledge related to care of psychiatric patients. While some online courses for the staff existed, the core curriculum was inadequate for the specific pediatric patient population in the catchment area. Specialty trained pediatric psych nurses were added as a resource in the simulation to provide a knowledge foundation for the dual diagnosis unit. A plan for ongoing cross-training of existing pediatric floor nurses was developed. The fourth critical gap was timely psychiatric assessment that would allow evaluation for outside facility placement to occur early in the intake process, with a placement bed reserved. The patient process flow in simulation included a clinical psychology resource in the ED to facilitate the psychiatric evaluation process through case management.

Gantt Chart

The Gantt chart displayed the progress of the project as a timeline (see Appendix G). The assessment phase began in the Spring of 2021, with stakeholder meetings and a review of the literature. In November 2021, senior leaders were engaged to align organizational strategic objectives with the proposed plan, and resources were allocated to begin evaluating database designs. In March 2022, presentations to stakeholders were made on discrete-event simulation and modeling of data tableaus. Simulation model design in collaboration with artificial intelligence and machine learning analysts began in August 2022. Full simulation and validation were initiated in October 2022 with additional tableau data points added for future elements of analysis including equity, inclusion, and diversity of patient population, and cost of return readmissions.

Work Breakdown Structure

A work breakdown structure (WBS) is an effective way to establish synergy and maintain it when working with a team on a project. The elements of the WBS supported a strong work design with purposeful tasks, targeted communication, and control over resource allocation. Assembling the team was only the beginning; holding the team accountable, meeting the project objectives within defined timelines, and mitigating risk were necessary for team and organizational success. The WBS was divided into five approximately sequential elements, with some overlap: (a) gap analysis; (b) obtain buy-in; (c) finance; (d) tableau creation; and (e) evaluation (see Appendix H).

Each element of the WBS contained several critical tasks with deliverables, some undertaken simultaneously and others sequentially. The Pediatric Crisis Care Unit pilot team used the five-element level to identify areas of responsibility, and make assignments for tasks, including their deliverables. The WBS included work design elements established at project inception and carried through to the first day of the initial simulation run. The work design elements were broken down into levels of motivation requiring from 2 to 24 hours of work designated for completion over a six-month period. Due to the size, scope, and complexity of the data pulls and tableau build, a plethora of small tasks that were too granular for the WBS yet critical to keeping the perspective of the project were addressed in separate workflows for the analyst teams.

The DNP project manager met initially with the executive sponsor in June 2021 to finalize the pilot concept and identify barriers to deliverables at the leadership level. Meetings with the psychiatric residency program and pediatric physician leaders were held July through November to confirm deliverables required to move forward with the pilot and discuss any

program concerns. The DNP project team was selected in December 2021. The project team comprised the Regional Pediatric Physician Chief, East Bay Psychiatric Physician Chief, East Bay Psychiatric Assistant Physician Chief, Emergency Department Physician Informatics Director, Regional Maternal Child Health Director, Regional Maternal Child Health Pediatric Clinical Practice Consultant, Regional Financial Analyst, Chief Nurse Executive, East Bay Finance Director, East Bay Finance Analyst, and East Bay Program Director.

Responsibility/Communication Matrix

Building consensus with the stakeholders was an important part of ensuring buy-in for the project with all the stakeholders. The perspective of many leaders throughout the organization over the years had been to avoid establishing psychiatric service units**.** However, a psychiatric physician residency program was established in 2018, signaling recognition of the need for dedicated psychiatric services. The regional Pediatric Physician Chief encouraged the ongoing evaluation of establishing a unit and the propulsion of the project forward had come from consistent communication between the East Bay Program Director and each physician partner. Frequent conversations with the financial analysts and software engineers were critical for validation of roles, expectations, and specific data deliverables. A responsibilities and communication document was created to facilitate understanding of timeliness of communication to avoid misinformation or missed milestones (see Appendix I).

SWOT Analysis

Prior to initiation of the project, a thorough investigation and validation of the environment was performed to establish the readiness and need for the type of pediatric crisis care unit intended to modify, enhance, or change the existing care model for pediatric psych patients. A strengths, weaknesses, opportunities, and threats (SWOT) analysis was the tool used

in this project to ensure that all aspects of the environment were examined. A SWOT analysis evaluated internal and external factors at a macro level to reveal where gaps and opportunities existed and required further analysis. For the project, the SWOT illustrated various layers of organizational influence, such as laboratory wait times and no specialty trained nursing personnel, that affected implementation of the final phase II demonstration pilot needing to be addressed in the simulation model. The SWOT also indicated the strengths of physician and finance team approval, and supportive justification for proceeding with the overall simulation project strategy (see Appendix J).

Budget and Financial Analysis

The budget for the Phase II demonstration pilot, informed by the DES feasibility study in Phase I, was developed using the existing pediatric overflow unit in the Oakland hospital to minimize expenditures. A 3-year pro forma was developed based on current financial expenditures associated with the care of the existing population in the East Bay catchment (see Appendix K). A startup unit budget captured clinical unit costs based on the DES, which indicated cost reductions and supported moving forward with the real-time demonstration pilot. Anticipated upfront costs to implement the pilot after DES modeling included licensure, patient safety alterations and additions, staff training, and specialty security detail.

The financial analysis included a plan for revenue growth with expansion into a regional hub-and-spoke model to facilitate capture of all pediatric dual medi-psych diagnosed cases within the East Bay catchment area. The DES retrospectively incorporated data for 2019-2021 financial years and allowed an examination of reduction scenarios between 10% - 40% to determine alternatives to current staffing, transfers, and interventions that delayed maximum utilization of space and beds.

Between January and May 2022, the northern California hospitals held dual diagnosis patients in the inpatient pediatric units for 60,324 days in total. The pediatric psych referral holding comprised 40,354 days costing the health system an additional $20,177,000. Creating a Pediatric dual diagnosis was projected to reduce the patient days by a minimum of 10% annually and subsequently reduce the patient daily rate.

A return on investment (ROI) projection using cost avoidance was performed to determine the benefits of investment in DES modeling in lieu of moving forward with construction of a new pediatric medi-psych unit (see Appendix L). The areas evaluated were: DES personnel, software and analytic support, and training. Three years of expenses were evaluated using a 3% annual inflation rate for Years 2 and 3.

The DES modeling for Year 1 used historical data to project possible scenarios for maximizing throughput from emergency room to dual diagnosis unit. The benefit of DES was shown in the cost avoidance analysis associated with new construction. Normal new hospital development costs, barring equipment, is approximately $400 per square foot (AssetsAmerica, 2020). By evaluating timeliness of patient movement through the organization to the unit, a high probability of success and sustainability after go-live was indicated. Processes and workflows were repeatedly refined to ensure costs and areas of opportunity were addressed. Preliminary staffing analysis based on DES 12-bed simulation was provided for Year 1.

Subsequent DES modeling adjusted for an increase in patient bed capacity from 12 beds to 18 beds in Year 2, then to 24 beds in Year 3. Twenty-four beds is the standard unit size for all the NCAL organization's medical-surgical units. Additional regional financial analysis for the program would occur in Phase III after DES modeling was finalized and approval granted by senior executives to proceed with capital expenditures for a go-live demonstration project.

Study of the Interventions

An analysis of the barriers to moving pediatric dual diagnosis patients through the current care structure and process at the project setting revealed a gap in clinical bedside expertise in both the ED and inpatient pediatric unit. The Regional Pediatric Executive Sponsor identified a similar gap in expertise when touring other northern California hospitals. While the gap could be identified at a macro level, lack of data integration hampered the ability to evaluate costs of care and delays in patient flow. Without good data that integrated internal and external factors of the current care structure, there was no basis of justification for an alternative care model or ability to predict the probability of success and sustainability.

Choosing the Intervention Approach

Donabedian's conceptual framework emphasizes the importance of examining network environments and structures as an opportunity to impact quality outcomes and efficiency. Digital simulation presented an opportunity to examine the network environments and structures of the hospital system to assess the feasibility of an alternative care delivery structure for pediatric medi-psych patients. Digital simulation accommodates identifying variable inputs and outputs and reveals bottlenecks that emerge as variables are adjusted. The variables in the simulation were (a) clinical resource allocation, (b) transport times, (c) medical and psychiatric stabilization, and (d) regional scalability. The simulation was built on the existing collaborative medical provider relationship for clinical coverage shared among the pediatric hospitalist residency program, psychiatric residency program, and clinical psychology doctoral fellowship program. Additional resources were built into the model for partners in a continuum of care, including specialty-trained inpatient hospital-based pediatric-psychiatric nurses, patient care coordinators, and social workers. Modeling a demonstration unit allowed clinical staff behavior and resource

changes to be considered as process workflows and evaluative outcomes were produced from the pilot tableau data.

Discrete event simulation (DES) was chosen as the approach to design, evaluate, and modify a comprehensive model that optimizes existing resources, evaluates trade-offs between expanding alternatives to hospitalization at local facilities and avoids investment in additional "brick and mortar" pediatric psychiatric bed capacity within the health system. Discrete event simulation (DES) models the behavior and performance of a system as a series of independent occurrences in relation to time and assumes no changes within the system between events. Each event can be assigned specific attributes and resources which can be modified as the simulation runs. The complex decision logic in DES and the underlying statistical paradigm based on queuing theory allows many "what if?" scenarios to be tested and compared in a way that is not possible in other types of modeling (Allen et al., 2015).

Once DES was chosen as the approach to build the simulation, software selection was the next step. AnyLogic© software was chosen from several commercial options as it was the most robust for maintaining appropriate levels of data security within the health system and was already being used at the regional level to build a hospital throughput digital twin simulation. The DNP project manager met with the Regional Director of Analytics Center of Enablement and Innovation (ACEAI) in March 2022 to learn how the regional organization was using the software in the existing "regional digital twin project." The goal was to assess and propose the merging of the DNP pediatric psychiatric care simulation project into the standard work on the regional digital twin project. As nursing resources had not been considered in the digital twin simulation, it was agreed that the DNP project manager would contribute a nursing perspective to the digital twin simulation and the ACEAI innovation analysts would contribute their expertise to

the DNP project simulation build. A subsequent meeting was held with the physician lead and analysts on the digital twin project to identify any synergies between the two projects in simulating how nursing resources impacted the actual movement of patients through the hospital from unit to unit and thus influenced LOS and patient volume.

Building the Simulation

The next step was to build the simulation. A meeting was held with data scientists from the regional organization to discuss how pediatric medi-psych patients were moved through the care process in the current state. The discussion included (a) how a decision is made to transfer the patient from the ED to a new unit, (b) how long a patient stayed in the ED, and (c) the dispositions associated with the status of a patient to be served within the hub-and- spoke model of care. Preliminary models of the current and proposed workflow were created. The types of data needed to determine outcomes were established. Further details of the workflows and how to construct the simulation model to allow for predictions and "what if" analyses based on existing data and operational fluctuations were developed in subsequent simulation build sessions. Nursing union contract negotiations were underway at this time, which shifted resources and the analytical team's attention away from the simulation build.

In August 2022, with the potential of a nursing strike escalating the need to determine nursing contingency, the DNP project manager facilitated the exchange of nursing data for the digital twin simulation. This interaction at the regional level with the Director of ACEAI and the Regional Director of Patient care services signaled progress in the data analysts' recognition of the importance of modeling nursing resources in simulations. However, with the launch of the digital twin project rapidly approaching, analyst resources were directed away from the DNP project. Two high level data scientists were removed from the DNP project, a data science and

graduate student intern in data science and artificial intelligence was added, and a junior data scientist remained on the project. The loss of senior level data science and analytics expertise impacted development of the underlying simulation logic, data review, and the pace of the simulation build. Without senior key stakeholders and a shift to intermittent interactions, a new approach to conveying care process and workflow knowledge needed to be established. Decisions previously grounded in expert opinion, required an additional level of clarity with some being reworked at different points in the project.

Building the Tableau

A data tableau was needed to display data sources for analysis. The tableau was developed with the project team financial analyst and input from the project site ED and pediatric physicians. The collaborative approach facilitated identification of data on both hospital and provider servers, which was necessary to ensure all patients meeting the project criteria were adequately selected, analyzed and filtered.

The initial tableau customization had one tab entitled Pediatric Mental Health (PMH). Filter data elements built into the tab were hospital system service area (Area), data month and year (Month/Year), northern California medical center (MC), retrospective data years (Years), and patient age band (Age Band) with ranges aligned with system policy and physician standards, Hub model hospitals (Hub), patients having ED visits prior to hospitalization (ED Visits), type of hospital stay (Stay Type), diagnostic related groups (DRG Description), and the data legend (patient visits and days (Appendix M)). Data summary boxes were developed as a brief summation based on filtering important information, including total number of patient days, total care costs, total number of patient visits, and average LOS. The summation data was depicted in a bar graph below the data filter section with hover capability to facilitate instant

visualization of data for each individual medical center. An additional bar graph was placed below the individualized hospital data to display DRG data trends based on the initial filters. The remaining tableau page section showed the top five mental health DRGs, top five mental health ICD-10 codes, and the top five medical ICD-10 codes for all patients represented in the tableau database based on filter criteria. Due to the simulation build's complexity and project time constraints, retrospective data was extracted from the health system open-source ticket request system repository (OTRS) as opposed to using a continuous data feed. An additional tab was created to capture the Pediatric Inpatient Dual Diagnosis (PMED) data and was designed using the same template as the PMH tab (Appendix O). Outlier data was identified in the dataset that did not fall under either the PMH or PMED tabs requiring consultation from additional data analysts. The data consisted of patients that were unclassified having only been entered into the system as observation. A third tab titled Patient Observation Dual Diagnosis Data (PUnclass) was created in the tableau to capture these outliers (Appendix P).

Internal validity was established as an ongoing process of the model's intended purpose and output variables of interest. The small size of the simulation project team enabled the project manager and data scientists to collaborate closely to determine validity of the data being used for simulation scenarios and the continued refinement of the simulation tool. Repeated data verifications of project data throughout the simulation process increased confidence in the model and the credibility of results. As retrospective data were used, the project team determined that independent verification was not needed. Substantiation that the model was valid and verification that it was performing with respect to its developed and intended purpose was achieved for continued confidence in output simulation results.

Outcome Measures

The project's success was identifying feasibility for implementing a demonstration project for a hub-and-spoke model of care in an existing pediatric unit. The outcome variables evaluated, and targets were:

- Emergency Room Length of Stay (15% decrease by 4th quarter of year one)
- Inpatient Admission Length of Stay (15% decrease by 4th quarter of year one)
- Total Cost of Care (15% decrease by 4th quarter of year one)
- Patient Daily Rate (15% decrease by 4th quarter of year one)

Discrete event simulation (DES) was used to create a comprehensive model for optimizing resources to weigh trade-offs between investing in additional psychiatric beds within the health system and expanding community alternatives to hospitalization. Emergency room length of stay was defined as date and time of arrival to the emergency triage area to date and time of disposition to inpatient or observation status. Patients discharged to home were not included in the data sample. Inpatient admission length of stay was defined as the date and time of arrival to an inpatient unit to time discharged to home or another facility. The total cost of care for this project included costs billed for each individual distinct medical record number contained in the data sample. Patient daily rate was calculated using regional cost accounting standards associated with a reduction in overall patient days and daily rate.

CQI Method and Data Collection Tools

The Plan-Do-Study-Act method for continuous quality improvement method was used to conduct small tests of change throughout the DES modeling process. The simulation database extracted from the health system OTRS database contained 3,529 unique medical record numbers across all the NCAL medical centers in the system from 2019 through 2021 for

pediatric patients between the ages of 0 and 17 diagnosed with both medical and psychiatric conditions. Data was sorted by diagnostic related group (DRG) for psychiatric diagnosis using codes 800-857. The International Classification of Disease (ICD) codes 10th edition was used to further extrapolate and define psychiatric diagnoses using F00-F65 codes out to the fifth occurring place position. Medical DRG codes were added and the top 5 DRGs for medical diagnosis defined and used as a basis for evaluating cost.

Analysis Using Discrete-Event Simulation

Discrete-event simulation (DES) modeling was used to forecast performance and costs for the demonstration project. The modeling process defined the sequence of resource requirements and the means and variances of the variables. Process flow charts were created using graphical interfaces derived from AnyLogic® software (see Appendix E). Features used in the simulation model were (a) daily averages of number of discharges, (b) number of admissions, (c) number of registered nurses, (d) number of pediatric physicians, (e) number of psychiatric physicians, (f) number of mental health technicians, (g) number of clinical psychologists, (h) number of nurse practitioners, (i) number of triage minutes, (j) number of medical screening exam minutes, (k) number of minutes for lab turnaround time, (l) medical stabilization time in minutes, (m) psychiatric stabilization time in minutes, (n) ambulance transfer/travel time in minutes, and (o) number of ambulances. The simulations were stochastic (randomly determined). The simulation was run multiple times for any set of inputs to obtain a set of outputs. Comparisons were established using the output mean and standard deviation.

Ethical Considerations

The focus of this DNP was process improvement using a quality and value-based lens. The project was approved by the sponsoring organization (see Appendix Q). The organization's Institutional Review board verified exemption from IRB review (see Appendix R). The project was approved by the University of San Francisco School of Nursing and Health Professions and determined to be non-research (see Appendix S). No conflicts of interest were identified. Data security is an important consideration for any clinical inquiry project and requires a protocol to protect patient data (Moran, 2017). All data was de-identified and contained within an encrypted system tableau developed in conjunction with the senior financial data analysts who collaborated on the project. Hospital information governance protocols were observed, including adherence to appropriate disposal of all information obtained using corporate technology and supplies.

The DNP project aligned with the Jesuit value of *cura personalis*—care of the whole person (Chin, 2016). The pediatric medi-psych demonstration project kept the pediatric patient's condition, needs, and interests at the center of all care decisions. This demonstration project puts children of all backgrounds and demographics first in the prioritization of treatment, thinking about the totality of mind, body, and spiritual health. The need for pediatric mental health services that are timely and complete, rendered by experienced clinicians is paramount for children to be healthy and thrive.

The American Nursing Association (ANA) Code of Ethics Provisions 2 and 4 provided a foundation for guiding the ethical perspective and nursing practice application for the DNP project. Provision 2 states the primary nurse's commitment is to the patient, whether an individual, family, group, community, or population (ANA, 2015). The demonstration pilot was developed in response to an established need within the pediatric medi-psych population the

healthcare organization serves. The ethics of care set forth in Provision 2 required accepting a share of responsibility for responding to this need, and therefore determining an appropriate approach. In Provision 4, the nurse has authority, accountability, and responsibility for nursing practice, taking action to promote health and optimal care (ANA, 2015). Placing pediatric psychiatric patients on inpatient medical units to be cared for by nurses without specialized psychiatric competencies does not meet the intent of Provision 4. The demonstration project in Phase II provides the specialty training needed to care for a consistent volume of patients in a safe, central location.

Results

Simulation was a way to assess a centralized model of care delivery. The project simulation was structured around hospital locations with the highest level of available resources to contribute to simulation solutions attributable to events within the patient care workflow process. The three identified hubs all had pediatric and psychiatric residency program rotations to facilitate optimization of operational queue management with one having flex access to 12 beds on a 24-bed overflow unit. By simulating the patient flow through the unit, it was determined the three-hospital referral hub-and-spoke care delivery model was unnecessary to manage all the pediatric dual diagnosis patient volume in northern California. The simulation of 2021 PMED tableau data revealed that only one major hub for this patient population was required, which allowed for the clinical resources to be maximized (Appendix T).

To test simulated approaches to the hub-and-spoke model, pediatric dual diagnosis patient flow from 2019-2021 was simulated using 6 scenarios. A baseline initial simulation was run for each of the (3) individual hubs using a 12-bed unit and 24-bed unit models testing the simulation flow (See Table 1).

Table 1.

Simulation Scenario Results

Scenario	Year	PMED Patient Input Volume	ALOS Pre-Simulation	Mean LOS Post-Simulation	Standard Deviation (SD)	PMED Patient Output Volume	Unit Bed Size
1	2019	1300	3.31	2.91	0.354	1288	12
2	2019	1222	3.31	2.97	0.425	1209	24
3	2020	2260	3.67	51.51	24.373	1733	12
4	2020	2221	3.67	3.05	0.492	2204	24
5	2021	1336	3.36	2.99	0.464	1326	12
6	2021	1268	3.36	2.82	0.297	1263	24

Scenario #1 included total patients for the 2019 year combined for the three hubs establishing a beginning patient flow simulation volume of 1300 patients with an ALOS of 3.31 run over 365 days. The implementation framework included specific steps in the patient flow process in the emergency room, including transport from outside spoke facilities to final disposition on the newly proposed medi-psych dual diagnosis care unit. A transfer rate of 0.09 was included in the centralized hub hospital simulation equating to a patient daily arrival rate of 3.6 and increasing total patient care costs to $30,433,425 (Appendix U). Analysis of the simulation results showed a decrease in the mean LOS total to 2.91 with a standard deviation of 0.354. A total decrease in costs to $27,865,560, and a volume simulation outflow of 1288 indicated a potential “bottleneck” or patient flow delay of 12 patients due to Pediatric Physician resource utilization at 97% (Appendix V). Bed utilization was 73% and emergency room resources remained at 72% for physician resources and 36% for RN resources. Scenario #2 simulation using a patient flow volume of 1222 and 24 beds over 365 days demonstrated a continued patient delay of 13 patients and high Pediatric and Psych Physician utilization at 98-99%. There was an under-utilization of bed resources at 36% indicating favorability of a smaller unit for this level of volume, further supporting the centralized hub model for all service areas.

Scenario #3 simulated an increased combined hub patient volume in data year 2020 with 2260 patients and an ALOS of 3.67. Using the 12-bed simulation model, bed resource utilization was high at 99% along with all Pediatric and Psych Physician resources, Nurse Practitioner, Mental Health Technicians, and PediPsych Bedside Nurse Resources at 99%. Mean LOS total increased to 51.5 with a standard deviation of 24.373 and 527 patients delayed in the patient outflow queue. An increase in new unit beds to 24 for scenario #4 for the 2020-year resulted in a decrease in total mean LOS to 3.1 with a standard deviation of 0.492, and bed utilization of 64%. Patient outflow delays were decreased to 17 patients in queue with clinical resources maintaining 99% utilization. Analysis of the 2020 simulated data indicated, with increases in yearly patient dual diagnosis volume of greater than 2200, the number of new unit patient beds would need to flex up above 12 to accommodate the volume and prevent delays in patient flow.

Scenario #5 and #6 simulated patient data for 2021with an ALOS of 3.36. Patient volume decreased to 1336 and simulation of patient flow demonstrated an outflow delay of only 10 patients in the queue over 365 days. Bed resource utilization was optimized in the 12-bed simulation at 75% and decreased in the 24-bed unit to 36%. All clinical resources in the two scenarios remained between 81-98% and the total mean LOS in scenario #5 was 3.0 with a standard deviation of 0.464. In scenario #6 the total mean LOS was 2.82 with a standard deviation of 0.297. Further analysis of unit bed size was discussed and deferred for this current project.

From an executive nursing lens, a traditional brick and mortar unit would not be cost-effective for a volume of patients under an average daily census of six in this hospital system. The average daily census based on the project volume data simulated over the three years retrospectively was determined to be 1.5 to 2 patients per day and would not justify the building

of a new unit. The Oakland project site has a 12-bed pediatric overflow unit that would not require full initial build costs; however, those costs would be indicated for the hub and spoke model spread to Roseville and Santa Clara. The simulation data for all three hub hospitals indicated the ability of the Oakland project site to accommodate dual diagnosis patients from all three hubs based on an average daily census of 5 patients for the combined hub data. This new alternative care model based on the simulation analysis would integrate care delivery into one centralized location servicing the northern California region enabling the standardization of policy and procedure associated with outpatient assessment, initial ED stabilization, treatment and transfer, admission criteria and psychiatric consultations. It would also eliminate the need to board this patient population in emergency rooms by providing a unit where both medical and psychiatric care could be initiated immediately. Operational costs would be mitigated by maintaining the bulk of specialty trained personnel in one tertiary hub hospital location. Capital building costs would be limited to only behavioral safety renovations and updating existing room behavioral specifications to prevent co-mingling of certain adult and pediatric populations. This simulation demonstrated the ability to limit system delays using transport from all three original hub service areas establishing a new care experience model for the patient, family and caregivers without the over-expenditure of costs.

The inability to extract emergency physician order times due to variations in obtaining psychiatric consults directly impacted the simulation calculations for LOS. Emergency room physicians did not have a standardized process for contacting the psychiatrists therefore some would place an order into the computer while others would make a phone call to the patient referral center to have the psychiatric physicians notified. The lack of structured data prevented this outcome variable from being added to the simulation, decreasing the concise predictability

of the workflow process. Since the emergency room data is outpatient data, an immediate strategy to identify alternative ways to obtain this information was limited.

Discussion

In an integrated, large healthcare system, discrete event simulation (DES) has the capacity to improve the value-based proposition for care delivery when nursing executives are invited into the discussions to give voice to innovation impacting patient care, especially where nurses are closest to care delivery in workflows and resourcing. Establishing a foundation for nursing collaboration with information systems and technology resources at every level of the organization provides a pathway for strategy development that opens the door to new and disruptive care models in simulation design.

The DNP project findings emphasized the value of an inclusive team dynamic. Outcomes where the opportunity for achievement are maximized predictably decrease when nursing executives and projects focused on patient care are denied the same level of leadership input as projects led by physicians recommending or leading the change. Healthcare delivery engineering designed by nurse executives that uses simulation tools can model systems to focus on quality outcomes, efficient care delivery, and system sustainability when aligned either with existing structured approaches or new systems-thinking modalities.

The DNP project highlighted the nurse executives' lack of access to data. While the elements of care delivery and patient information may be integrated in the enterprise system, nursing leaders do not always have access to the required data to inform large projects. Access to data through the right collaborative partnership, gives nursing leaders who manage patient populations with touch points in outpatient, inpatient, and continuum of care, the ability to identify barriers, look at historical data, and address capacity issues more readily. A system by

collaborative design incorporating data scientists and analysts is more capable of sharing data in protected ways that informs patient flow solutions preventing challenges to understanding the entire patient experience.

Discrete event simulation (DES) used in this project underscored the value of embedding predictability tools into executive level feasibility modeling to ask and answer the “what if " questions at various levels that cost millions of dollars if unaddressed. Being analytically bilingual in operational and informatics systems is key to achieving long-term cost savings when deciding on the need to expand or alter the service delivery model. This project demonstrated the impact of constant change within the organization shifting resources unexpectedly which was seen during nurse contingency planning consequentially contributing to knowledge gaps and delays in logic interpretation. The placement of a Chief Nurse Informatics Executive (CNIE) in hospital systems to support the importance of nurse executive communication in the informatics and artificial intelligence space can facilitate the use of data, information, knowledge, and wisdom to improve healthcare delivery. When strategically positioned, the CNIE can assist nurse executives with mitigating time lost in projects or rework due to lack of nursing presence or voice at the table. This important role can make recommendations to the organization, inform important stakeholders of necessary process changes for optimal care delivery, and lead the way for new innovative systems thinking to expand simulation projects.

Summary

The Donabedian theory recognizes outcomes as the ultimate validators of effectiveness and quality medical care. In the DNP project, simulation of an alternative care delivery structure to determine its feasibility was a cost effective and predictive way to analyze a complex organizational project with the potential to impact multiple facilities, allocation of critical resources, and quality of patient care. Positioning nurse executive engineers, an emerging role, at the forefront of alternative care delivery design and operational strategy optimizes health system decisions by mapping expanded care paradigms and innovative pathways using the tools of advanced technology. Complex health processes demand a highly skilled response that uses teams of professionals from various disciplines.

Future programs in higher education should include considerations for joint nursing-engineering degree programs that can provide the ideal preparation for a well-informed nurse-engineer capable of exploring new and innovative solutions to improve care and patient outcomes (Glasgow et al, 2018). Bringing together nursing practice, organizational planning, and modeling via simulation, as this project demonstrated, opens a door to better executive decision-making by including consideration of systems engineering, system transformation, and connected care foundations.

Interpretation

No information on nursing resources had been included in the regional digital twin simulation project as nursing was not represented on a project team tasked with designing and building a new patient care system. Lack of inclusion represents a devaluation of nursing expertise for input to the process. Though the analysts and lead physician could synthesis how LOS and volume impacted projected capacity, there remained a crucial gap for expertise

regarding patient flow and direct care clinical resource needs during patient throughput within the clinical setting. Inclusion of nursing expertise surrounding care delivery is paramount to safe patient care, this holds true in the realm of strategic planning and project management. Systems improvement at all levels of care delivery to patients requires an interdisciplinary approach. The key discipline needed for patient care expertise is nursing.

The simulation project findings aligned with the Donabedian conceptual framework, which considers evaluation of structure as an opportunity or barrier. Through the interrogation of processes related to structure and care, the DNP project team was able to uncover unknown barriers in the information and process structures. Previously, no one had understood how workflows between the outpatient physicians impacted the inpatient physicians and led to unanticipated admissions emanating from lack of communications. Care delivery modeling in the future should include an initial collaboration between nurse leaders and the innovation team prior to logic builds where time is spent examining the operational flows that can impact clinical decision-making.

Limitations

Elements that could have been added to the simulation, and which may have provided different outcomes, were not included as the participation of experts knowledgeable in simulation builds was reduced over the course of the project. The ability to extract reliable and consistent psychiatric consultation data was impacted by process variations in emergency room and pediatric physician practice. The variability contributed to incomplete timed datasets for the project population and could not be used. The specificity of the project site, the distinctive characteristics of the pediatric medi-psych patient population, and the presence of highly skilled and specially trained personnel through the medical residency programs limit

the generalizability of the findings to other healthcare settings. The hub-and-spoke model as designed and tested in this project would not be applicable to hospital systems without transport hubs and transport teams.

Conclusion

Organizations that invest in pediatric dual diagnosis services establish the foundation for preventive mental health care, quality of life, and sustainability. Mental health conditions that go untreated or only partially addressed in children and adolescents can lead to significant adult conditions and chronic concerns over a lifetime. Without adequate capacity to place pediatric psychiatric patients in specialty psychiatric care, health systems fall short of improving behavioral functionality outcomes for children. The loss of pediatric psychiatric beds statewide in California over several years has strained the capacity of healthcare organizations to provide timely mental health care. In a large northern California health system, access to specialty psychiatric treatment for dual diagnosis medical-psychiatric pediatric patients was inadequate for care management, increasing the number and duration of hospitalizations and imposing higher costs on the healthcare system. A feasibility study using discrete event simulation validated implementing a hub-and-spoke demonstration project using existing unoccupied beds. Local and regional leaders within the healthcare system saw the opportunity to impact the patients, families, and northern California/East Bay market, and supported the project.

Discrete event simulation provided an opportunity to use advanced technology to evaluate a patient population historically and develop a plan that leveraged existing, unused space. The project demonstrated the potential to transform resource management for patients and their families and establish a more effective care model for pediatric dual diagnosis medi-

psych care. The project outcome suggested the hub-and-spoke demonstration project would not need to be replicated in two other large hospital markets within the healthcare system. Transportation of patients between hub-and-spoke hospitals in simulation showed bottlenecks in the process with delays due to transport times, however resolved when a centralized model for hub-and-spoke was tested at one hospital.

Providing pediatric medi-psych care in a centralized location may mitigate costs of care and LOS, yet will not address the socioeconomic and personal challenges parents encounter. A centralized model would require patients and families in northern California to travel greater distances for treatment and increase costs for parents wanting to stay in close proximity to their child. For the health system to provide care to the patient population in its catchment area and establish access to quality services in a cost-effective way, creating unique community partnerships is important along with enhancing service capability in existing smaller spoke hospitals. With pediatric adolescent beds in communities continuing to be converted to adult beds, the health system can better serve its patients by allocating beds within at least one of its hub facilities and developing resource training programs to better assist spoke hospitals to manage the care of those patients until they can be safely transferred to a designated dual diagnosis bed.

The DNP project established the foundation for data retrieval for pediatric medi-psych dual diagnosis patients by creating a repository for future care delivery modality simulation scenarios. Simulation introduces nurse executives to a new way to evaluate resource cost and value and design ways to improve existing system workflows and resource utilization. Future research opportunities include investigating diagnosis-specific care management training

programs for individual spoke patient populations in relation to rate or frequency of readmissions to the pediatric medi-psych dual diagnosis unit.

The future of sustainability for healthcare systems is directly impacted by the holistic care we provide to pediatric patients. This patient population will become the future adult patient population cared for which means building operational care systems that support all medical and psychiatric conditions being addressed timely and completely especially during inpatient admissions. This level of focus in care design incorporates the thought of adult quality of life within a pediatric foundation.

Funding

No outside funds were used for this project. Staff who contributed time and expertise to the project were salaried employees and did not receive any additional compensation. The DNP project aligned with the Maternal Child Health department scope of work and enterprise hospital operational artificial intelligence and machine learning initiatives; thus, associated project costs were absorbed by the respective budgets.

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Appendix A. Evidence Evaluation Table

Purpose of article or review	Design / Method / Conceptual framework	Sample / setting	Major variables studied with definitions	Measurement of major variables	Data analysis	Study findings	Level of evidence (critical appraisal score) / Worth to practice / Strengths and weaknesses / Feasibility / Conclusion(s) / Recommendation(s) /
APA reference: Bekmezian A, Chung PJ. Boarding admitted children in the emergency department impacts inpatient outcomes. Pediatric Emergency Care. 2012 Mar;28(3):236-42. doi: 10.1097/PEC.0b013e3182494b94. PMID: 22344211.							
Purpose: Assess the relationship between boarding of admitted children in the emergency department (ED) and cost, inpatient length of stay (LOS), mortality, and readmission	**Design:** -Retrospective Observational Study **Method:**	**Timeframe:** 2/20/2007-6/30/2008 **Sample Size:** -1,792 pediatric inpatients -All peds patients admitted through the ED -Discharged from the hospital **Setting:** -70 bed Peds Ward -19 bed PICU -3,000 admits annually - Teaching Hospital (UCLA) -International Referral Center -Annual Volume: 40k adult & Peds	**Independent Variable(s):** - Boarding Time (Adm. Decision to Bed- Standard) -Pt. Age -Payer Group -ED-LOS Arrival Times to ED & Inpt. Bed(true-LOS) -Triage Acuity -Type of Inpt.Svs -ICU Admit -surgery -Severity of Illness **Dependent Variable:** -Cost (dollars) -I-LOS (hours) *Secondary:* -Mortality	-Log transformed -Multivariate Linear Regression *Secondary:* -Logistic regression -UCLA EHR Finance Database -UCLA ED EHR Database -Data merged by MRN and admit date -Discrepancies were reviewed	-Mean ED LOS for admitted patients *M*=9.0 -Boarding Time: *M*=5.1hrs -Mean Cost: *M*=$9893 -Mean Inpt. LOS: *M*=147hrs >80% power	-Boarding Time associated with cost and I-LOS, not mortality or re-admit -Longer Boarding times lead to longer inpatient stays among low acuity patients	**Critical Appraisal Score:** III-B **Worth to Practice:** -Great model for managing volumes -Can be incorporated into standard operations **Strengths:** n/a **Weaknesses:** -This was a general ED not a Pediatric ED -No randomization to short or long boarding times **Feasibility:** -This is easily expanded into an observational unit concept **Conclusions:** -results indicate moving forward with project pilot **/Recommendations:** -Having a Peds hospitalist in the ED to monitor care showed better process outcome

Definitions: Inpatient Length of Stay (I-LOS), Electronic Health Record (EHR),

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APA reference: Bujoreanu S, White MT, Gerber B, Ibeziako P. Effect of timing of psychiatry consultation on length of pediatric hospitalization and hospital charges. Hospital Pediatrics. 2015 May;5(5):269-75. doi: 10.1542/hpeds.2014-0079. PMID: 25934811.							
Purpose: To evaluate the impact of timing of a psychiatry consultation during pediatric hospitalization on length of hospital stay and total hospitalization charges.	**Design:** Retrospective Study **Timeframe**: 1/1/2010 – 6/30/2010 -Tertiary Freestanding Pediatric Hospital -395 licensed beds, 150 Outpt. Clinics -Serves inpt. >25,000/yr -Pediatric age up to 18 yrs -referred to the psychiatry consultation liaison service	**Sample**: 513 total inpat. consults 279 pediatric patients (totaling *N*=308 consultations) (2-18 yrs) *Md*=15yrs [IQR 12-16] -Inpatient psychiatry consultation requests from the medical and surgical units were considered for subject selection; -CCU and solid organ transplant excluded	**Independent Variable:** 1.) dates of admission, and demographic characteristics -psychiatric consultation, & discharge; 2.) psychiatric treatment disposition; 3.) psychiatric diagnoses based on the DSM-IV-TR axis I and II; 4.) psychiatric functioning based on global assessment	Descriptive Statistics used to analyze DSM-IV-TR diagnoses, demographics, medical discharge dx APR-DRG -Path Analysis to evaluate hypothesis -Univariate statistics used to reveal skew of physical illness severity,	-73% female -76% white -Anxiety (30%) and Depressive Disorders (29%) most common -global assessment of functioning score M=49$\pm$ 11.5 -43% with >1 co-morbid diagnosis -25% required inpatient	-Earlier psychiatry consultation is associated with shorter length of stay and lower hospitalization charges after adjusting for psychiatric functioning, physical illness severity, and psychiatric disposition -Poorer psychiatric functioning and milder physical illness were associated with shorter referral time	**Critical Appraisal Score:** III-B **Worth to Practice:** -Findings are a direct impact on quality of care -Can decrease burden on patient/family and resources -Should be duplicated in other markets **Strengths** -Clearly written and relevance to EBP PICOT is ideal -Relationships well-defined and explorable in other studies -Good sample size **Weaknesses:** -Social determinants of

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	-3 Child & Adolescent Psychiatrist's -1.5 FTE Child Psychologist's 1.0 FTE Child & Adolescent Psychiatry Residents -1.5 FTE predoctoral psychology interns 2.0 FTE postdoctoral psychology fellows	-log-transformed value for LOS was >4 SDs from the mean and removed	score, DSM-IV-TR axis V; 5.) primary medical diagnosis at discharge based on APR-DRG & ICD-9 6.) physical illness severity 7.) total charges associated with hospitalization **Dependent Variables:** -LOS -Hospital Charges	referral time, LOS, and total charges and log transformed for analysis. -Mean and SD's for normally distributed variables -frequency and percentages for categorical variables -Spearmen's correlation was used to assess referral time	psych tx programs at discharge -59% discharged to outpt. Therapy and/or psychotropic med mngmt. -PCLS Stay *Md*=1 day, [IQR: 1-3] Then after admission LOS Md=4 days [IQR: 2-7] -Expected	-findings indicate that the model fits reasonably well (root mean square error of approximation: 0.02 [95% confidence interval: 0–0.12]; comparative fit index: 0.99; Tucker-Lewis index: 0.99). -The model accounts for 43% of the variability in LOS and 76% of the variability in total hospital charges. -patients who	health not a part of study -Retrospective chart review data not collected prospectively -exclusion of CCU patients- unclear if applies to PICU -6 month vs. 12 year study **Feasibility:** -Model exists in other specialty areas so could be duplicated for pediatric **Conclusions:** -Positive findings suggest moving forward with evaluation in organization -Psychiatric residency will be effective for

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			(Cost)	and LOS -2 Sided with sig, level of 0.05. Data analysis by either IBM SPSS ver. 21(for the univariate analyses [IBM SPSS or MPlus version 7.11 (for the path analysis [Muthén & Muthén, Los Angeles, CA]).	LOS adjusted based on DRG and severity of illness -A 10% decrease in referral time to PCLS was associated with a 7.9% shorter length of stay (95% confidence interval: 6.4–9.5; *P* < .001).	required inpatient psychiatric treatment programs at discharge had lower total hospital charges;	model **Recommendations:** -Educate Peds providers about early psych consults regardless of severity of illness -Strong partnership between psychiatry and pediatrics is important to reduction in LOS and total cost

Definitions: Psychiatry Consultation Liaison Services (PCLS), Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR), All Patient Refined Diagnostic Related Groups (APR-DRG), International Classification of Diseases, Ninth Revision (ICD-9), Critical Care Unit (CCU)

Purpose of article or review	Design / Method / Conceptual framework	Sample / setting	Major variables studied with definitions	Measurement of major variables	Data analysis	Study findings	Level of evidence (Worth to practice / Strengths & weaknesses Feasibility / Conclusion(s) / Recommendation(s) /
APA reference: Case, S. D., Case, B. G., Olfson, M., Linakis, J. G., & Laska, E. M. (2011). Length of stay of pediatric mental health emergency department visits in the United States. *Journal of the American Academy of Child and Adolescent Psychiatry*, *50*(11), 1110–1119. https://doi.org/10.1016/j.jaac.2011.08.011							
Purpose: To see if the LOS of pediatric mental health visits exceeds that of non-mental health visits. Secondarily, to compare patient, hospital, and treatment characteristics of pediatric mental health and non-mental health ED visits and assess factors associated with extended LOS of mental health	**Timeframe:** 2001-2008 **Method:** Compared the LOS of pediatric mental health ED visits to non-mental health visits and identified predictors of extended stays for mental health visits. -age range reflects eligibility for most child and	**Sample:** NHAMCS -83,015 patients -18 years or younger National representative sample of ED visits in US hospitals -Probability Samples of primary sampling units ~ 500 short stay or general hospitals within these units -ESA within hospital EDs -patient visits within these areas	**Independent Variables:** -Age(s) a.) 0-1, b.) 2-5, c.) 6-13, d.)14-18 -Female Gender -Race White, Black, Other -Hispanic Ethnicity -Primary Payer Public Insurer Private Insurer Self-Pay Free Care & Other -Mode of Arrival Ambulance Public Service Walk-In -Time of Arrival 8am-3:59pm 4pm-11:59pm 12am-7:59am	-SUDAAN 10 statistical software -A $\chi 2$ statistic was used to test for differences between mental health and other visits in the distribution of patient, hospital, and treatment characteristics at the 5% level. - differences for each level of the characteristic were tested	-Mental health visits more likely to arrive by ambulance (21.8% vs. 6.3%, p<.001), be triaged to rapid evaluation (27.9% vs. 14.9%, p<.001), and be admitted (16.4% vs. 7.6%, p<.001) or transferred (15.7% vs. 1.5%, p<.001).	Higher rate of ED use by adolescents aged 14–18 years with almost 1/5 of mental health visits being dual diagnosis Mental health visits were less likely to be seen by a physician within the time recommended at triage Mental health visits resulted	**Critical Appraisal Score:** III-B **Worth to Practice:** Significant findings to validate worth in evaluating model of care (Crisis Unit) at the organizational level **Feasibility:** Highly feasible and can be duplicated using existing organizational ED data **Strengths:** -suggests areas for administrative and clinical reform

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visits.	adolescent inpatient and community mental health services. -ICD-9-CM-290-316 - Principal mental disorder diagnoses were grouped into eight categories: psychotic, bipolar, depressive, anxiety, disruptive behavior or attention-deficit/hyperac	-40,000 annual visits -multiple visits by the same patient may be included -Data from contiguous surveys included for stability	-Weekend Arrival (Saturday-Sunday) -Summer Arrival (June-August) - Immediacy with Which Should be Seen (Triage) <15 Minutes 15-60 Minutes >1 Hour to 2Hours >2 Hours -Injury, Poisoning, or Adverse Effect Not Injured Intentionally Self-Injured Assaulted by Others Unintentionally Injured Injured, Unknown Intent -Co-morbid Mental	using a Bonferroni-adjusted $\chi 2$ statistic (based on the number of categories) to maintain a familywise error rate of 5%. - Kaplan-Meier estimates of distributions of LOS for mental health visits and non-mental health visits were calculated - logistic	The median length of stay for mental health visits (169 minutes) significantly exceeded that of other visits (108 minutes). - extended stay beyond four hours for mental health visits was almost twice that for other visits (adjusted odds ratio 1.9, 95%	in admission or transfer far more frequently than other visits and were less likely to be discharged without a referral - Depressive disorders were the most common principal diagnoses followed by anxiety and disruptive behavioral	-efforts to reduce LOS proved cost-effective -telepsych identified as an opportunity when partnered with rapid psych consultation **Weaknesses:** - Extended LOS was noted in Hispanic youth-language barriers or use of interpreters should be a part of future study to prevent bias **Conclusions:** -Model of Care is important in

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	tivity (ADHD), substance use, adjustment, and other psychiatric.		Disorder -Co-morbid General Medical Condition -Seen Same ED in Prior 72 Hours *Hospital Characteristics* -In Metro Area -Region Northeast, Midwest, South, West -Hospital Ownership Private Non-Profit Public Non-Federal Private For Profit **Dependent:** -LOS Mental Health Visits (n=1,476) -LOS Non-Mental Health Visits(n=71,539)	regression to model LOS as a dichotomous outcome. - Two sets of logistic regression analyses were used to identify significant predictors of extended LOS - All potential predictors were modeled as categorical covariates with the exception of calendar year of visit, which was modeled as a	CI 1.5–2.4) and was not explained by observed differences in evaluation, treatment or disposition. Among mental health visits, advancing calendar year of study, intentional self-injury, age 6–13 years, Northeastern, Southern, and metropolitan	disorders or ADHD. -Diagnosis grouping not a sig. predictor	decreasing LOS and cost -Sociodemographic nuances will show up when studied. **Recommendations:** -Predictive modeling demonstrated option for LOS and admission reductions

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				continuous variable. ----------Potential predictors were eligible for inclusion if they predicted extended LOS at P<.25 in a univariate regression. - Estimates based on fewer than 30 visits were considered unreliable	hospital location, use of laboratory studies, and patient transfer all predicted extended stays.		

Definitions: Length of Stay (LOS), National Hospital Ambulatory Medical Care Survey (NHAMCS), Emergency Service Areas (ESA), Emergency Department (ED), International Classification of Diseases, Ninth Division, Clinical Modification (ICD-9-CM)

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Purpose: Gauge the opinions of patients' next of kin regarding transfer of patients from the specialist 'Hub' intensive care unit, to 'Spoke' intensive care units near home. **Secondary Purpose:** to identify the reasons given by patients' next of kin for their choices, and determine	**Design:** Retrospective cross-sectional observational study **Method:** -Retrospective data Obtained from the ICU database -Single telephone follow up interview with patients next of kin one year after hub admission -Questionnaire mailed to patients next of kin presenting either one-ICU or two-	**Timeframe:** September 2006- May 2008 (21 months) **Sample:** 213 consecutive patients with severe trauma or severe acute neurological conditions admitted to the Hub intensive care unit over a 21-month period, who were repatriated to Spoke intensive care units for ongoing	**Independent Variables:** Satisfaction of the next of kin **Dependent Variables:** included one ICU model vs. two ICUs model	-Questionnaire for patients' next of kin -Intensity of specialized care for intracranial hypertension was measured with the local therapeutic intervention level -Intensity of Care during ICU stay was measured with the nine equivalents of nursing	One ICU vs. Two ICUs model were subject to descriptive analysis - Factors related to diagnosis and treatment univariate analysis ($p < 0.10$) - Patient outcome with comparative analysis	-Next of kin perceived Hub ICU important -Preferred relative be hospitalized in hub until intensive treatment complete -Dissatisfaction regarding transfer from Hub ICU to Hub Ward Seventeen patients (8%) were lost to follow-up at 12 months, and consequently data for 196 patients were analyzed.	**Critical Appraisal Score:** III-B **Worth to Practice:** High worth to practice and determining viability for care models. **Strengths:** -Well-defined area, -Well-defined healthcare organization -Credibility **Weaknesses:** -Study only asked next of kin moved to a spoke ICU not all who could have been moved -Closed analysis -No feedback beyond answer to question

which clinical factors were associated with the above choices.	ICU model Sample size chosen after postulating a 60% preference for the one-ICU model, with values for a of 0.05, and b of 0.20; each group needed 95 patients to achieve adequate power -Participants were one year after Hub admission -	intensive care. -Included survivors who did not live in the Hub area		manpower use score - included: -patient's Age (years); -APACHE Chronic score; -ICU length of stay (LOS) longer or equal to 6 days; brain disease (neurosurgical or not) vs extra-cranial injuries with mild traumatic brain injury (TBI); intracranial pressure (ICP) monitoring; intensity of care to manage high ICP; and disability at one year.	using parametric tests for scalar variables and chi-squared tests for categorical variables. - Binary logistic regression used for variables analysis for independence in the univariate analysis (IBM SPSS Statistics, Version 19) Multivariate analysis confirme	196 patients who were repatriated, a majority of respondents (n = 132, 67%) preferred the one-ICU model, whereas the remainder (n = 64, 33%) preferred the two-ICUs. Patient top responses: 1. Physicians treating patients from the onset know the patients and what improvement can be expected' 2. The specialist ICU manages patients in the more difficult phase, and it is a better ICU'. The above two choices accounted for 65% of preferences.	-Ethnic, cultural, social, economic, and geographical factors not reviewed -Further study needed around perceptions of continuity of care and the spoke to determine causal factors impacting care experience **Feasibility:** **-**Results are presumably applicable to other Hub & Spoke systems affected by bed shortage -Hub & Spoke Model would work for regional management of patients -patient satisfaction could be maintained with patients remaining in service area using this model **Conclusion(s):** -Hypothesis supported identifying a link between clinical factors (*disease severity, young age*, outcome) and choosing the one ICU model

					d older age, LOS>6 days, serious neuro disease, death, vegetative state, or disability preferred one ICU model Logistic regression analysis of patient data associated with patient or next of kin preferred the one-ICU scenario	Patients' next of kin who chose the one-ICU model rarely selected reasons related to trust: answer (2): 'because otherwise it is impossible to establish a doctor-patient-next of kin relationship based upon trust' (n = 1, 0.7%) and answer (7) 'because we felt abandoned' (n = 3, 2.2%). Pt. Nxt of Kin One ICU if -pt. younger -longer LOS -a high intensity of care -patients that died after discharge Two ICU if: -pt. had chronic disabling diseases -Living far away from the hub ICU	-Findings suggest moving forward with project to evaluate model in the NCAL organization **Recommendation(s):** Centralizing patients to hubs with high volumes of activity is associated with better patient outcomes and is the basis for the hub & spoke model. For the model to work, patients need to be repatriated as soon as possible. The strong preference by family for the one ICU model highlights areas of importance for them such as: -Continuity of Care -Continuation of high standards and individualized care -Mailed to participants one year after admission & was not anonymous

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Definitions: Acute Physiology And Chronic Health Evaluation (APACHE), Intensive Care Unit (ICU), Intracranial Pressure (ICP), Length of Stay (LOS), Statistical Package for the Social Sciences (SPSS), Traumatic Brain Injury (TBI)

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Purpose: To identify which patient factors predict psychiatric hospitalization in patients presenting to the emergency department and to examine the role of the dimensional approach to psychopathology in comparison to the categorical diagnosis in predicting hospitalization.	**Design:** Randomized Quantitative Study **Timeframe**: 6 months-Jan.-Jul., 2008 -Hospital in downtown Rome -Emergency Department of Policlinico Umberto I -Largest University hospital in Italy -Admits	**Sample**: *N*=419 312 patients undergoing psychiatric eval in ER -16 unevaluable due to negative barriers -91 had missing SVARAD data Standardized collection form -Filled out by Psychiatrist within 12 hrs	**Dependent Variables:** - Recommendation of psychiatric admission **Independent Variable:** -Age -Gender -Nationality -Ethnicity -Marital Status -Proposal for compulsory admission -previous psychiatric hospitalization	SVARAD -- observer rated scale -rapid assessment of the main psychological dimensions -created by researcher - psychopathological assessment -SPSS for Statistical Analysis for 20.0 -Descriptive Analysis -Chi-square test	**Main Study** -159 men -153 women -Age: *M*=40.1 yrs. (S.D.=14.3) -Ethnicity: -Most were white and unmarried and Italian -123 (39.4%) recommended for admission -189 (60.4%) recommended for discharge -Univariate analysis – higher mean scores: on anger/aggressiveness, apathy, impulsivity, reality	- -A systematic assessment may compliment a categorical assessment -Operational assessment model recommended for future study -No significant diff. b/w main & replication samples.	**Critical Appraisal Score:** II-B **Worth to Practice:** -High relevance to practice in the area of Artificial Intelligence today -The predictor model is easily transferable to technology concepts for predictive analytics **Strengths:** -Dimensional assessment was effective in the ED -provided a global picture of acute

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	134,000/yr -1% require psych evals **Secondary Design:** Replication Study **Timeframe:** Jul.-Oct., 2014 **-**randomly sampled patients -all patients requiring psych evals **-**10 senior scientists -avg. yrs. Of	**Replication Study** N=313 **Sample Size:** 118 patients -San Filippo Neri Hospital ED -Northern Rome **-**no sig. difference in any of the sociodemographic or clinical variables	-cat. Diagnosis in ED based on DSM-IV-MD -recommendation of hospitalization -SVARAD scores **Replication Study** -Decision to recommend admit: 1.) sociodemographics 2.) psych hx and clinical characteristics	or Fisher's exact test -Student's t test used to test differences between groups in categorical or continuous variables -Multiple logistic regression analysis to identify independent predictors of rec. hospitalization -hierarchical	distortion, thought disorganization and activation -Lower mean scores on somatic preoccupation/ somatization **Sociodemographic** **-**Recommend Psych Admit -Age identified as predictor -Sex, ethnicity, marital status and nationality showed no sig. association with admit recommendation	-Dimensional Assessment found to be the strongest predictor of hospitalization -the tool showed a lack of focus on longitudinal illness and lacks some standardized definition - SVARAD was strongest predictor of	patient **Weaknesses:** **-**A higher amount of missing data was noted in the study -study relied on a clinical diagnosis approach -The assessments were not independent in that the same individual did both categorical and dimensional evaluations deciding on admission **Feasibility:** **-**The study could be replicated and is

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	exp. 9.1 (S.D.=9.0) -Survey on both samples of clinicians -to investigate the extent of decision to recommend hospitalizatio n		(categorical/diagn osis approach) or 3.) a dimensional approach (symptom profile)	logistic regression models -three main sets of predictors -All tests were two-tailed, with alpha set at .05 *Secondary* **-SVARAD** -10 items -5 point scale -IRR-Cohen's kappa 0.48-0.68	**Multivariate Logistic Regression** -Main predictors of recommend admit were reality distortion, impulsivity, apathy, categorical, dx. Of psychotic and mood disorder and proposal for compulsory admission - **Replication Study** -50 men & 68 women -Age: M=45.2yrs	admission independent. of order of entry.	generalizeable -The tool used was designed internally and not a part of the study information **Conclusions:** -in ED, systematic dimensional assessment may be useful as a predictor for psychiatric hospitalization -can provide a more timely assessment and could be an electronic application **Recommendations:** -The systematic dimensional review is an assessment

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					(S.D.=16.7) -Mostly White; Unmarried		worth exploring. -Translating the information into a pediatrics framework is ideal for the project and lends to opportunity to expand the operational process in the future.

Definitions: Scala per la Valutazione Rapida Dimensionale (SVARAD), Diagnostic and Statistical Manual of Mental Disorders Fourth Edition (DSM-IV-MD),

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APA reference: Fahimi, J., Aurrecoechea, A., Anderson, E., Herring, A., & Alter, H. (2015). Substance abuse and mental health visits among adolescents presenting to US emergency departments. *Pediatric emergency care*, *31*(5), 331–338. https://doi.org/10.1097/PEC.0000000000000421							
Purpose: To identify factors associated with adolescent emergency department (ED) visits for substance abuse - complicated by mental health (dual diagnosis) - to analyze their effect on ED length of	**Design:** Cross-sectional, secondary analysis of NHAMCS data - Collected by CDCPNCHS for years 1997 through 2010 **Method:** Secondary analysis of ED visits by adolescents (aged 11-24)	**Sample:** Specifics: -Adolescent -Age 11-24 -Chief Complaint or Diagnosis related to substance abuse and/or mental health condition **Settings:** - all visits to US EDs excluding - federal hospitals - hospital units of	**Independent Variable:** **-**Demographic and visit-level factors, factors associated with substance use and dual diagnosis visits, and the effects of substance use and mental health conditions **Dependent Variable:** - LOS - Disposition	Descriptive statistics for demographic and visit-level factors Tool: National Hospital Ambulatory Medical Care Survey (1997-2010) Two multivariate survey-weighted logistic regression models	87,855 visits for patients aged 11-24 - 2,157 Substance Abuse (2.1% weighted) - 4,906 mental health (4.3% weighted) - 542 Dual Diagnosis (0.4% weighted) Substance Abuse -48.1% (95% CI 45.1-51.1%) involved alcohol, -58.8%	Both 14-18 year old and 19-24 year old age categories had increased odds of substance use and dual diagnosis visits. -Males with more dual and SA visits -Blacks half likely to present	**Critical Appraisal Score:** III-B **Worth to Practice:** Gives understanding and direction for beginning to create links between Substance abuse and mental health. Assists in categorizing similarly seen ED variables in adolescents **Strengths:** -Study points out specific factors working together to impact LOS and Disposition **Weaknesses:** -Causation statements cannot be made in cross-sectional studies -Cannot ascertain burden on

Purpose of article or review	Design / Method / Conceptual framework	Sample / setting	Major variables studied with definitions	Measurement of major variables	Data analysis	Study findings	Level of evidence (critical appraisal score) / Worth to practice / Strengths and weaknesses / Feasibility / Conclusion(s) / Recommendation(s) /
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stay (LOS) and disposition.		institutions -hospitals with 6 beds or fewer		-adjusted odds ratios (ORs) for: (1) any substance use visit and (2) a dual diagnosis visit. - all a priori variables remain in the model regardless of statistical significance Three survey-weighted linear regression models for: (1) substance use and mental health general	(95% CI 55.8-61.8%) involved illicit drugs, -6.9% (95% CI 5.4-8.5%) involved both -Univariate and multivariate statistics -demographic and visit-level factors Univariate analysis reveals counts of observations -survey-weighted proportions - 95% confidence intervals (CIs)	for one or both - Uninsured more likely to present -Medicaid higher SA=79.32 minutes more for adolescent ED visit (95% CI 49.82-92.84 minutes) MH= 89.77 minutes more	healthcare workers and clinicians **Feasibility:** -We now use ICD-10 so to duplicate the study may have different results **Conclusion(s):** -Substance abuse and dual diagnosis increase hospitalization and cost -Medicaid patients would experience higher dual diagnosis **Recommendation(s):** -Study allows for further analysis in future studies looking at less stratifications to increase statistical power

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				categories, (2) individual substance use, mental health, and suicide/self-harm subcategories and (3) dual diagnosis designation on ED LOS with controls. Three similar survey-weighted logistic regression models were used to calculate ORs associated with admission or transfer.		(95% CI 66.25-113.29 minutes) Psychotic = 156.43 minutes (95% CI 99.90-212.96 minutes) the most time to the ED LOS DD=118.68 minutes (67.48-169.88 minutes)	

Purpose of article or review	Design / Method / Conceptual framework	Sample / setting	Major variables studied with definitions	Measurement of major variables	Data analysis	Study findings	Level of evidence (critical appraisal score) / Worth to practice / Strengths and weaknesses / Feasibility / Conclusion(s) / Recommendation(s) /
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						Dual diagnosis visits= an additional 139.97 minutes (95% CI 77.78-202.17 minutes)	

Definition of abbreviations: Centers for Disease Control and Prevention's National Center for Health Statistics (CDCPNCHS) Confidence Interval (CI), Emergency Department (ED), Depressive Disorders (DD), Length of Stay (LOS), Mental Health (MH), National Hospital Ambulatory Medical Care Survey (NHAMCS), Odds Ratio (OR), Substance Abuse (SA)

Purpose of article or review	Design / Method / Conceptual framework	Sample / setting	Major variables studied with definitions	Measurement of major variables	Data analysis	Study findings	Level of evidence (critical appraisal score) Worth to practice Strengths and weaknesses / Feasibility / Conclusion(s) / Recommendation(s) /
APA reference: Kovalchuk, S. V., Funkner, A. A., Metsker, O. G., & Yakovlev, A. N. (2018). Simulation of patient flow in multiple healthcare units using process and data mining techniques for model identification. Journal of Biomedical Informatics, 82, 128–142. https://doi.org/10.1016/j.jbi.2018.05.004							
An approach to building a hybrid simulation of patient flow is introduced with a combination of data-driven methods for automation of model identification.	Combination of design techniques and queueing theory for the simulation of patient flow **Method:** **D**ata, text, process mining & machine learning for analysis of electronic health records (EHRs) with discrete-event simulation (DES) **Timeframe**: 2010-2015	**Sample**: 3434 Acute Coronary Syndrome patients **Setting:** Simulation	Resources - surgery facilities, ICU beds -Ward beds human resources, medications, materials, -flow of patients with multiscale periodic patterns (day, week, year),	-Analysis of the ACS patient flow -Patients are delivered by ambulance or transferred from another hospital/department. -variation in LoS -Patient in flow mean/stdev -Number of surgeries -Common Complications	Identification of complex processes Multiple events described by date, time, a place, a title, and the staff -Encoding of departments and sub departments -Identification of clinical pathways -Simulation of data	-simulation using a combination of clinical pathway classification and DES enabled more realistic patient flow -simulation showed Kolmogorov-Smirnov stats decreased by 51% -More accurate control of patient flow and better fit for long term patient stays	**Level III-B** **Worth to Practice:** - Can be used in clinical decision support effectively -Can move with complex patient flow **Strengths & Weaknesses:** -Requires knowledge and expertise in design **Feasibility:** - Feasible for use in hospitals of various size and complexity of flow **Conclusions/Recommendations:** -Use predictive modeling in the future with

Purpose of article or review	Design / Method / Conceptual framework	Sample / setting	Major variables studied with definitions	Measurement of major variables	Data analysis	Study findings	Level of evidence (critical appraisal score) Worth to practice Strengths/weaknesses Feasibility Conclusion(s) Recommendation(s) /
APA reference: Parwani, V., Tinloy, B., Ulrich, A., D'Onofrio, G., Goldenberg, M., Rothenberg, C., Patel, A., & Venkatesh, A. K. (2018). Opening of psychiatric observation unit eases boarding crisis. *Academic emergency medicine: journal of the Society for Academic Emergency Medicine*, *25*(4), 456–460. https://doi.org/10.1111/acem.13369							
Purpose: To evaluate the effect of a psychiatric observation unit in reducing emergency department (ED) boarding and length of stay (LOS) for patients presenting with primary psychiatric chief complaints. **Secondary Purpose:** A secondary outcome was to determine the effect of a	**Design:** Pre/Post Retrospective Analysis **Method:**	**Timefram e**: February 2013-July 2014 **Sample Patients:** Pre-3,501 Post-3,798 - Adults Age >17yrs -Requiring eval by acute psych service -in crisis interventio n unit (CIU) Exclusions:	**Independent Variable:** 12-bed locked psychiatric Observation Unit **Dependent Variables:** -ED LOS -CIU LOS -TTL LOS -Hospital Throughput *Secondary Outcome:* -Hold rate	-ED LOS (ED arrival to departure to CIU) - CIU LOS (measured as the time interval from CIU arrival	**Primary Analysis:** ARIMA Regression models- the adjusted change in the weekly median of each outcome was –126 minutes ($p < 0.0001$) for ED LOS, –514 minutes ($p < 0.0001$) for CIU LOS, and –279 minutes ($p < 0.0001$) in total LOS -Sensitivity analyses found	-CIU improved ED throughput -Inpatient admissions decreased -Mental health resources in general were better utilized -Complex behavioral health patients were evaluated properly without rush	**Critical Appraisal Score:** III-B **Worth to Practice:** As mental health continues to increase ED volume this study analysis identifies an option to decreasing the impact on hospitals across the country. **Strengths:** -The study focused on creating unique patient beds versus attempting to increase general patient beds or flex beds that only are absorbed by more patient general

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psychiatric observation unit on inpatient psychiatric bed utilization.		-patients LWBS/LWOT - patients left AMA -pediatric patients -cancer patients -hospice -court/law enforcement -diverted **Setting:** -1,541 bed tertiary care academic medical center			statistically significant differences in median ED LOS (197 minutes vs. 32 minutes, $p < 0.0001$), CIU LOS (898 minutes vs. 372 minutes, $p < 0.0001$), and total LOS (1,210 minutes vs. 880 minutes, $p < 0.0001$) as well as in the inpatient psychiatric admission rate (42.1% vs. 23.1%,	-Better assessment and medication management potentially reduced patients requiring longer-term hospitalizations.	admissions. -Timeliness of psychiatric evaluations was noted as an opportunity to further decrease hold rates. **Weaknesses:** -Social determinants not a part of the variables analyzed -Cost-effectiveness not evaluated **Feasibility:** The study could be duplicated with focus on the pediatric population **Conclusion(s):** -Observation beds can

Purpose of article or review	Design / Method / Conceptual framework	Sample / setting	Major variables studied with definitions	Measurement of major variables	Data analysis	Study findings	Level of evidence (critical appraisal score) Worth to practice Strengths/weaknesses Feasibility Conclusion(s) Recommendation(s) /
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		including and adult ED -ED Visits – 90,000/yr general volume 10,000/yr psychiatric volume			p < 0.0001). -Pre ED LOS – *M*=155 minutes [IQR] = 19–346 minutes -Post ED LOS *M*=35 minutes [IQR] = 9–209 minutes, p < 0.0001 -Pre CIU LOS *M*=865 minutes -Post CIU LOS *M*=379 minutes p < 0.0001 -Pre TTL LOS *M*=1,112 minutes -Post TTL LOS *M*=920 minutes p = 0.003		be incorporated into the hub and spoke concept **Recommendation(s):** -this study's findings are inline with other literature associated with the creation of observation units to alleviate the throughput issues due to increasing behavioral health volumes. -New revenues were generated unrealized previously by this volume captured in an OBS unit.

Purpose of article or review	Design / Method / Conceptual framework	Sample / setting	Major variables studied with definitions	Measurement of major variables	Data analysis	Study findings	Level of evidence (critical appraisal score) Worth to practice Strengths/weaknesses Feasibility Conclusion(s) Recommendation(s) /
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					-Hold rate increased Pre-42% Post-50% $p < 0.0001$ -Psych Adm. Rate decreased Pre-42% Post-25% $p < 0.0001$ **Secondary Analysis:** -Hold rate >48 hours, patients requiring inpt admissions,		

Definition of abbreviations: Autoregressive integrated moving average (ARIMA), Crisis Intervention Unit (CIU), Emergency Department (ED), Inpatient Psychiatric Admission Rate (IPAR), Length of Stay (LOS), Total (TTL), Observation(OB

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APA reference: Smith, J. L., De Nadai, A. S., Petrila, J., & Storch, E. A. (2019). Factors associated with length of stay in emergency departments for pediatric patients with psychiatric problems. *Pediatric emergency care*, *35*(10), 716–721. https://doi.org/10.1097/PEC.0000000000001651							
Purpose: Examined correlates of LOS and boarding among youth with psychiatric disorders presenting to the ED in a large, statewide database.	**Design:** -Retrospective generalized linear mixed models **Method:** -descriptive analysis to determine association between LOS and patient and hospital characteristics among pediatric patients (<18 years) who presented with a primary psychiatric diagnosis	**Timeframe:** -2010-2013 Florida Agency for Healthcare ED discharge database -Versions of SEDD database warehoused by the HCUP under the AHQR -28,749,452 patient encounters. Of these 7,391,915 were <18 years, and 44,830 encounters were associated with a well-defined primary	**Independent Variable(s):** -*Diagnosis* Anxiety Disorders Attention-Deficit Disruptive Behaviors Impulse Control Mood Disorder Schizophrenia Other Psychotic Disorders Alcohol-related Disorders Substance-Related Disorders Intentional Self-Injury Suicidality -*Gender* Male Female -*Age* (limited to <18 years)	-ICD-9 codes measured diagnosis variables was calculated by subtracting arrival hour from discharge hour using 24 hour notation *Psychiatric Primary Problems Predictor Variables* -grouped based on contemporary classification systems	-mean ED LOS of (*M*=5.96± 8.64 hours) -mean age *M*=14.1±3.3 years -52.5% female - *M*= LOS for patients was 5.96 hours standard deviation SD =8.64 hours. -10,896 transferred to another facility, -58% had LOS > 6 hours (boarded) - 22.7% had	Patient variables associated with increased LOS: -female gender, -Age (15-17 years old), -Hispanic ethnicity, -Insurance Medicaid or VA/TriCare, - impulse control problems, -mood or psychotic disorders, -exhibiting self-harm behaviors. -Patient transfer, -large hospital size, -rural designation -Psychiatric diagnosis LOS (p<.01)	**Critical Appraisal Score:** III-B **Worth to Practice:** -Pediatric study that included many possible contributors to pediatric LOS **Strengths:** -did not exclude patients with comorbid ASD or intellectual or developmental disabilities. **Weaknesses:** -unable to distinguish within the dataset between self-harm intended to result in death versus non-suicidal self-injury -excluded patients with first-listed diagnoses of

Purpose of article or review	Design / Method / Conceptual framework	Sample / setting	Major variables studied with definitions	Measurement of major variables	Data analysis	Study findings	Level of evidence (critical appraisal score) / Worth to practice / Strengths and weaknesses / Feasibility / Conclusion(s) / Recommendation(s) /
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	(n=44,328). -	psychiatric diagnosis that was not due to physical or birth abnormalities. -Missing Data records deleted (*n*=501). Limited dataset to: -Discharged home -Transferred to another facility -Left AMA -Final Sample Size: 44,328	-*Race/Ethnicity* Caucasian African American Asian Hispanic other/unknown (which included none reported, multiple reported or Alaskan or Hawaiian Native) -*Payer* (expected primary payer at time of discharge) Commercial Medicare Medicaid Medicaid MCO KidCare VA/TriCare Uninsured Other/Unknown -Disposition Transferred Discharged		LOS ≥ 12 hours. linear mixed models (GLMMs) - lme4 package in the R statistical programming environment -a negative binomial distribution for the GLMMs to account for LOS behaving as a count variable, - random intercepts used. -models with fixed effects	-Suicidal thoughts or actions had the longest LOS Short LOS: -Males -Hospitals <25 beds compared to hospitals with >400 beds (p<.01) -25-100 beds shorter LOS compared to hospitals with 200-300 beds (p<.01) and >400 beds (p<.001). Shortest LOS: -anxiety disorders -5-9 ages Teaching hospital	Autism Spectrum Disorders (ASD), and intellectual and developmental disabilities --may not be generalizable beyond treat and release-and-transfer **Feasibility:** -Unable to determine causation through randomization -Only 30% of pediatric patients seen in Ed admitted to same hospital -not appropriate to use inferential statistics to investigate boarding **Conclusion(s):** - LOS for pediatric psychiatry patients in the

Purpose of article or review	Design / Method / Conceptual framework	Sample / setting	Major variables studied with definitions	Measurement of major variables	Data analysis	Study findings	Level of evidence (critical appraisal score) / Worth to practice / Strengths and weaknesses / Feasibility / Conclusion(s) / Recommendation(s) /
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			Psychiatric Facility LAMA -*Size* <25 beds 25-100 beds 100-200 beds 200-300 beds 300-400 beds >400 beds -*Teaching Status* Teaching Non-teaching -*Rural Status* Rural Non-rural -*Ownership* For-Profit Non-Profit **Dependent Variable:** *Patient LOS* -arrival hour from discharge hour using		predictors were compared to intercepts-only models by comparing the deviance of each fixed-effects model to the - generalized deviance of the intercept-only model, which follows a X^2 distribution with degrees of freedom corresponding to the difference in number between	status and profit status were not significantly associated with LOS -Inconsistent with hypothesis – uninsured patients were not different from insured patients in terms of mean LOS -Consistent with our hypothesis, schizophrenia and psychosis were associated with longer LOS	ED varies significantly by psychiatric presentation, patient disposition and hospital factors - large hospitals and non-rural hospitals were associated with longer LOS compared to small and rural hospitals -study is generally consistent with the findings of other research examining LOS and boarding in pediatric patients. **Recommendation(s):** -Findings have implications for quality of care, patient safety, and health outcomes. -a basis for inclusion and examination of additional variables related patient

Purpose of article or review	Design / Method / Conceptual framework	Sample / setting	Major variables studied with definitions	Measurement of major variables	Data analysis	Study findings	Level of evidence (critical appraisal score) / Worth to practice / Strengths and weaknesses / Feasibility / Conclusion(s) / Recommendation(s) /
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			24 hour notation; if the LOS was longer than one day, the LOS was calculated as (LOS days*24) + (hour discharge-hour arrival). **Predictor Variables** -Primary psychiatric -included anxiety orders -attention deficit hyperactivity disorder (ADHD) -impulse control disorders -mood disorders -schizophrenia and other psychotic disorders -alcohol and substance disorders -intentional self-harm and suicidality		models -Post-hoc group pairwise comparisons computed using the Tukey Honestly Significant Difference test via the multcomp package in R. Statistical significance was defined by $p<.05$.		and hospital characteristics in future research

Purpose of article or review	Design / Method / Conceptual framework	Sample / setting	Major variables studied with definitions	Measurement of major variables	Data analysis	Study findings	Level of evidence (critical appraisal score) / Worth to practice / Strengths and weaknesses / Feasibility / Conclusion(s) / Recommendation(s) /
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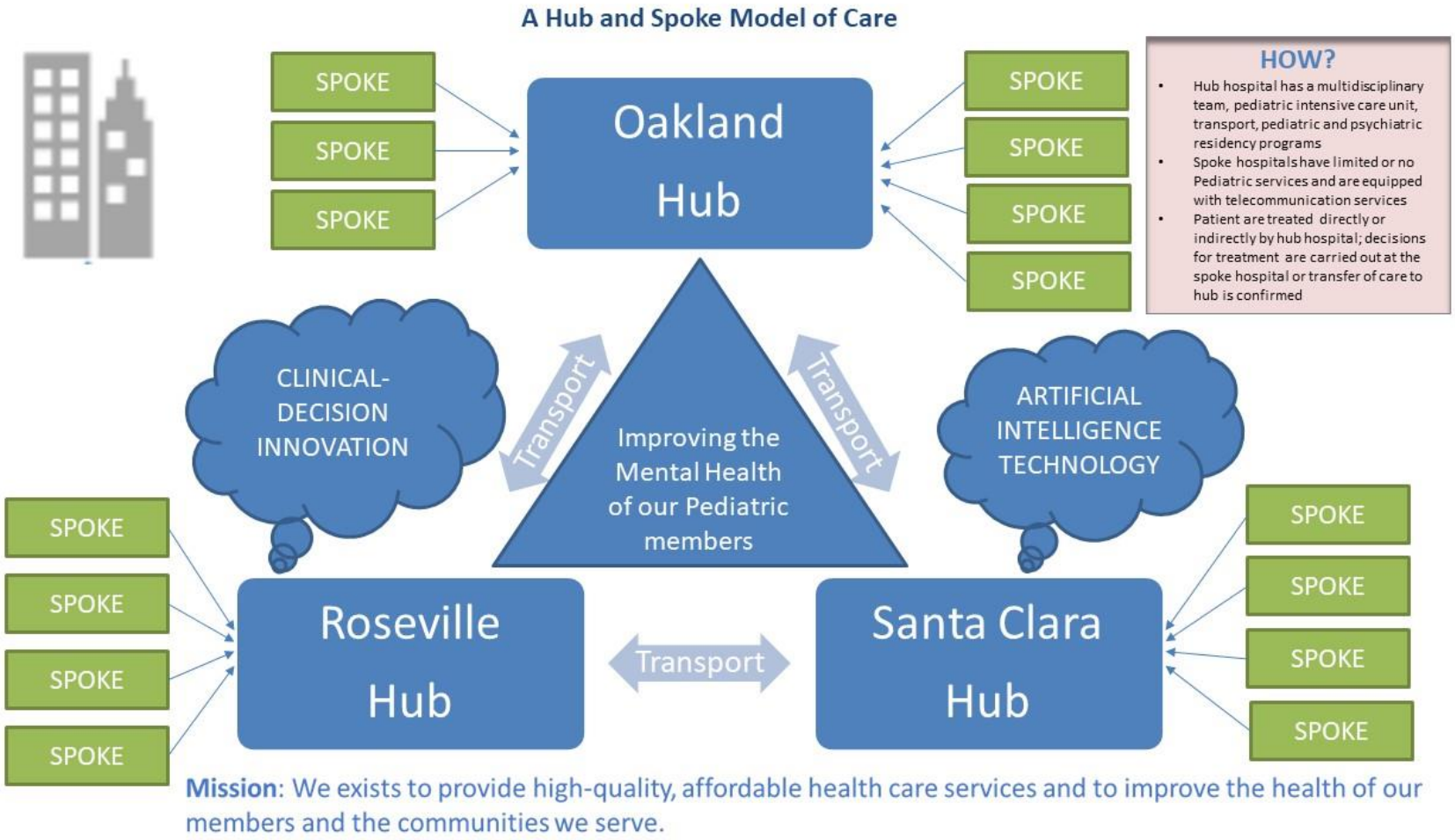
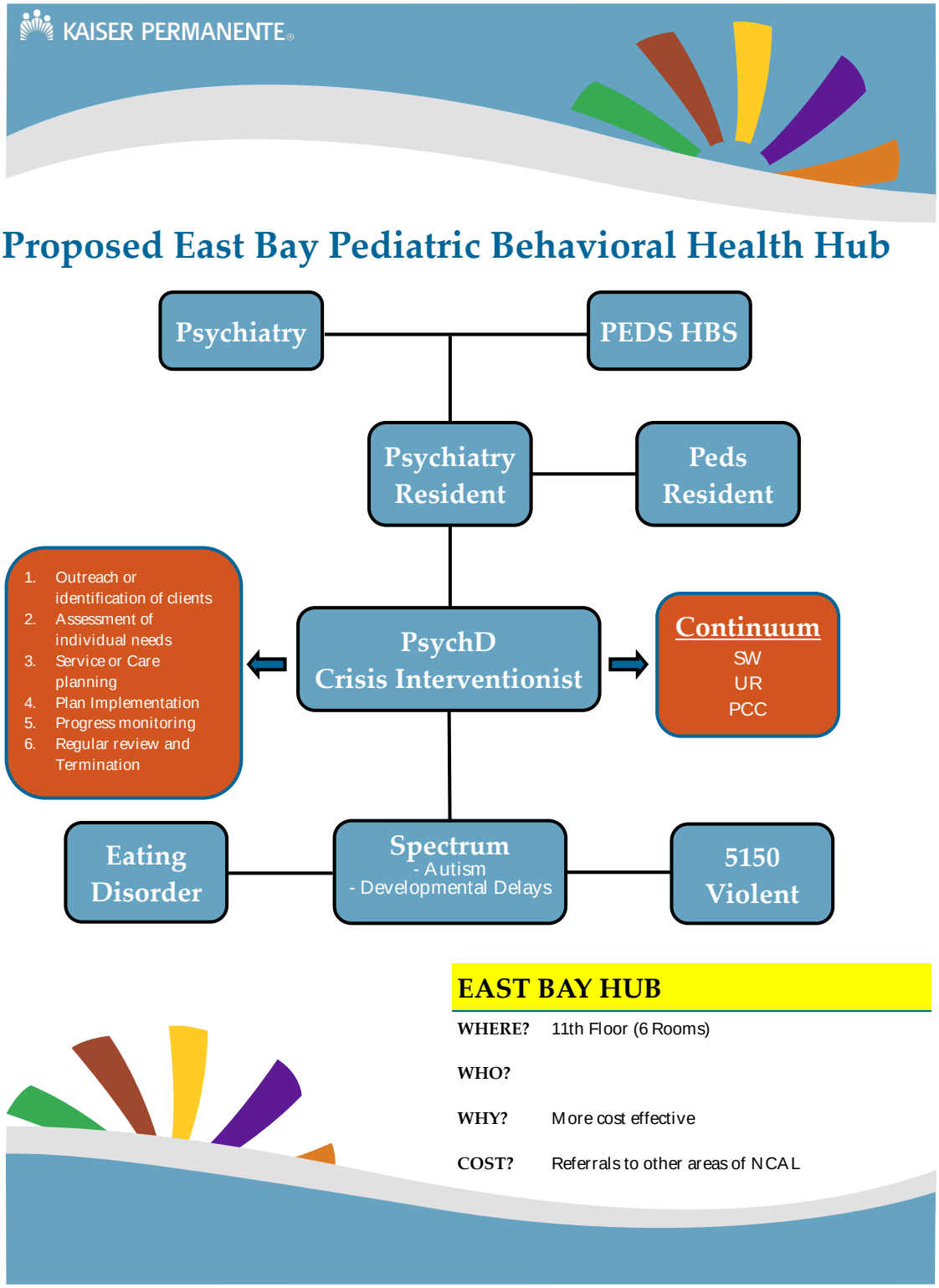
			-Hospital characteristics were obtained from the AHCA 'Florida Health Finder' online query tool				

Definition of abbreviations: Agency for Healthcare Quality and Research (AHQR), Attention Deficit Hyperactivity Disorder (ADHD), Emergency Department (ED), Healthcare Cost and Utilization Project (HCUP), Left Against Medical Advice (AMA), Length of Stay (LOS), State Emergency Department Databases (SEDD), Veterans Administration (VA)

Appendix B. Regional Hub and Spoke Model



Appendix C. East Bay Hub and Spoke Model of Care

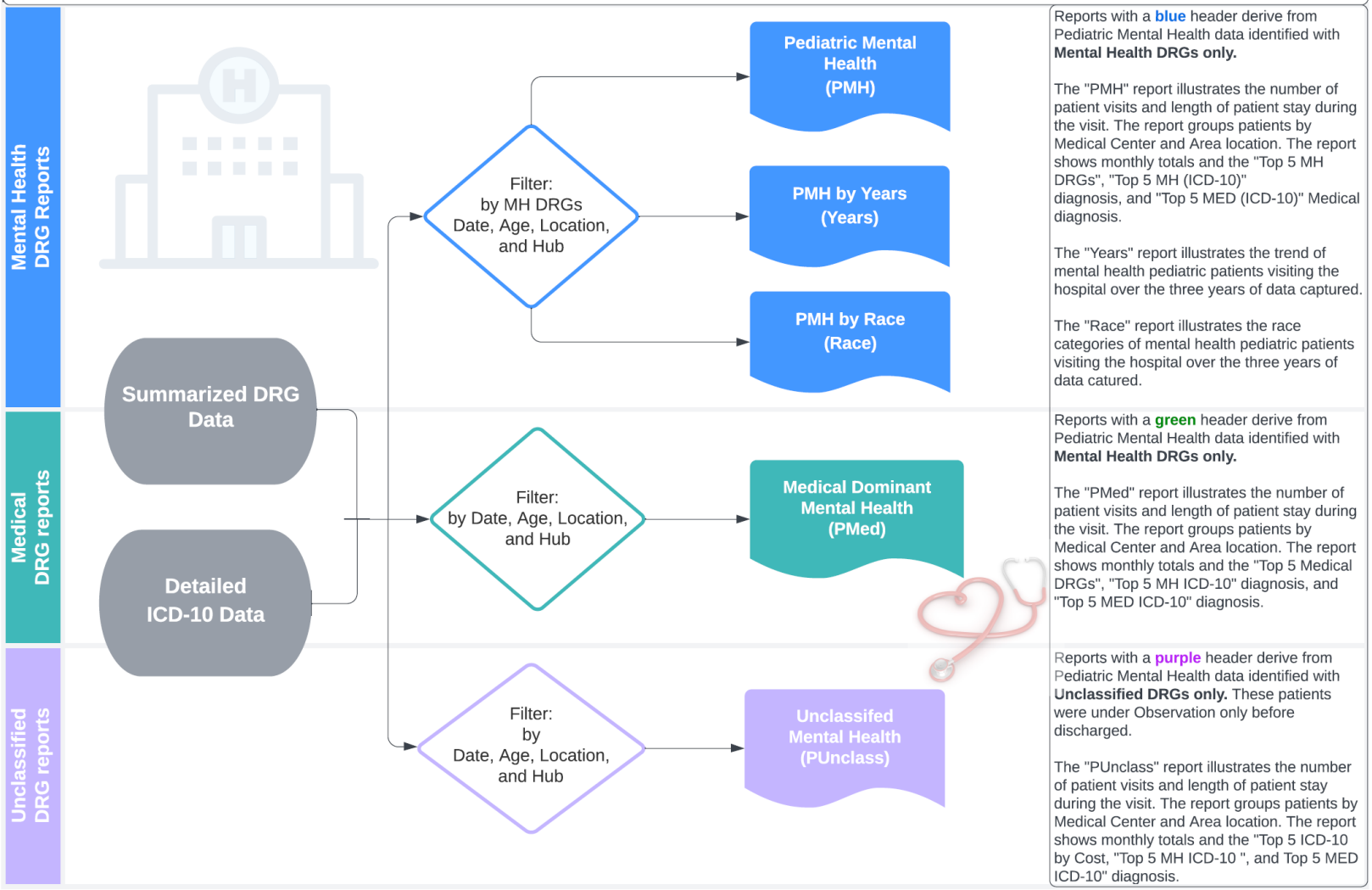


Appendix D. Data Collection Algorithm

Pediatric Mental Health Project

Executive Sponsor: Dr. Yeseli Arias | Project Director: Tanya Scott | Project Analyst: Cecil Grimes

“PMH was created to study the volumne of Northern California Mental Health(MH) pediatric patients and the amount of time it took to safely discharge the patient. For a three year period, we analized NCAL data for all mental health pediatric patients, by selecting MH ICD-10 codes in the 1st through 5th position, under the age of 17 to review the length of stay, mental health diagnosis, and location of admittance. The data was filtered to illustrate reports showing the top 5 Pediatric Mental Health DRGs, Medical DRGs, and undetified DRGs for patients under observation only. We added a filter for a future state of centralized care throughout the NCAL region called HUBs. We included a way to filter the reports by location, year, age, type of stay, DRGs, and HUB.



Definitions: Pediatric Mental Health (PMH), Northern California (NCAL), International Classification of Disease (ICD), Diagnostic Related Group (DRG), Medical (MED)

Appendix E. Discrete Event Simulation Process Flow Diagram

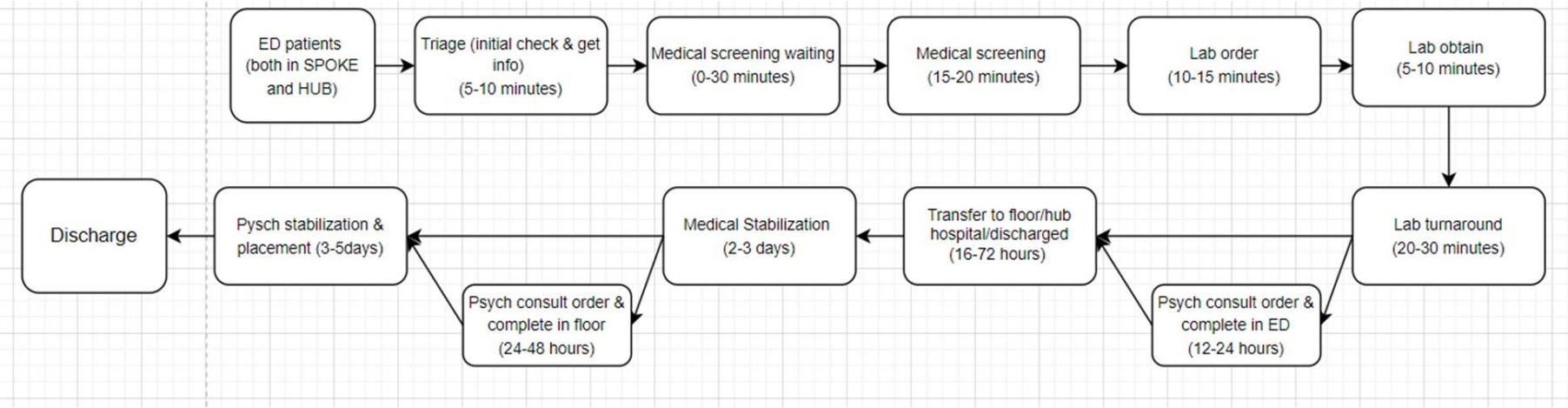


Diagram 1. Process Flow Before Simulation - > 10 days to discharge

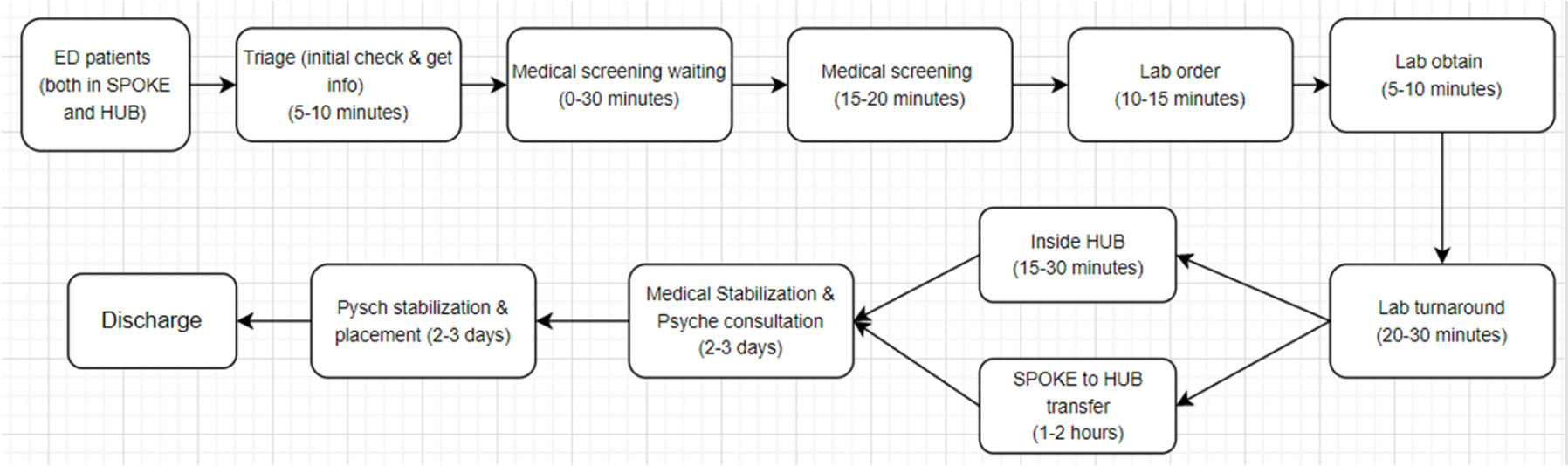


Diagram 2. Process Flow Using Simulation - < 5 days to discharge

Appendix F. Gap Analysis

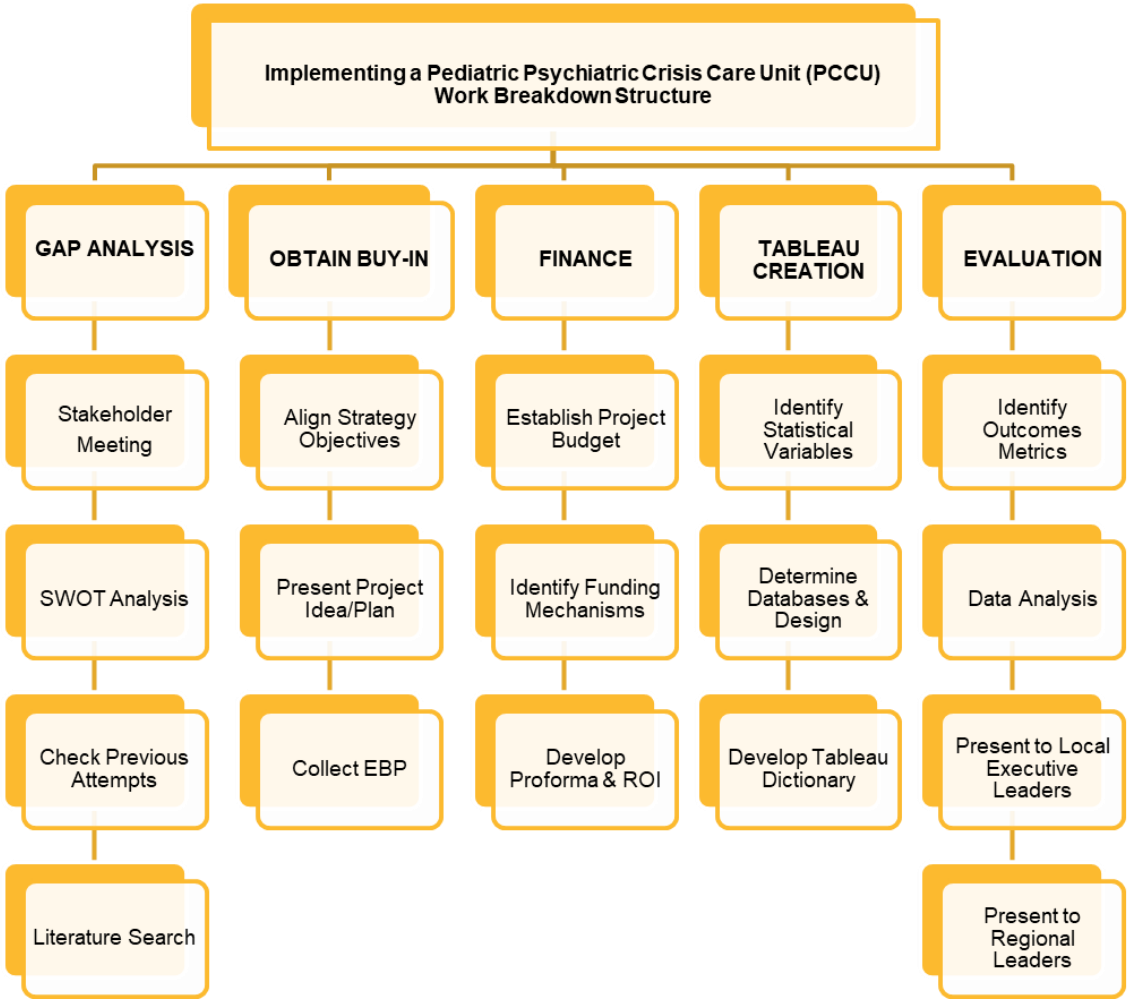
Area under consideration: A Hub and Spoke Demonstration Project on 11th Floor		
Desired State	**Current State**	**Action Steps**
Established behavioral safety/equipment planning committee and/or process to assist with PCCU safety	Global understanding of the magnitude of behavioral safety in the organization	Review systematic issues related to safety and behavioral patients with Safety team
Established standard methods for evaluation of pediatric psychiatric status prior to inpatient admission	Documentation ineffective for behavioral health patient management	Develop Care Management Program Incorporate Psychiatry Residency into care collaboration
Incorporated behavioral development tools, patient behavioral classifications and required actions	Undertake an analysis of the capabilities and cost of systems for monitoring adverse events, critical incidents and near misses	Review current resources with HC team for improvement opportunities
Facility/region has a Psychiatric curriculum design team responsible for the development, implementation, and evaluation of the education of nurses	Regional acquired escalation/de-escalation online modules. No specific patient population specific training	Develop regional pediatric psychiatric nurse training program
Psychiatric bed availability provides access to medical/psychiatric patients in large markets	No dedicated unit to admit dual diagnosis patients. No adolescent psychiatric specialty	Work with physician providers in residency to establish plan for large markets
Uses existing or created metrics to measure program performance	No current outcomes measures or audits to evaluate pediatric mental health utilization and resource management	Develop outcomes measures and performance expectations for pediatric psych population
Consistent timely evaluation of medical/psychiatric patients when presenting to hospital	Pediatric patients receive medical evaluations but must wait for psychiatric eval	Conduct time study via simulation to evaluate and establish performance metrices

Appendix G. Gantt Chart

DNP GANTT-Responsibility-Status Chart

ID #	DNP Phases and Steps	Responsible Party(ies)	2021 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2022 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2023 Jan	Feb	Mar	Apr	May	Jun	Status & Date
1	**Assessment Phase**																																
1.1	Conduct gap analysis	Tanya																															COMPLETE
1.2	Stakeholder Meeting	Tanya																															COMPLETE
1.3	SWOT Analysis	Tanya																															COMPLETE
1.4	Review Previous Work	Tanya																															COMPLETE
1.5	Literature Search & Review	Tanya																															COMPLETE
2	**Design Phase**																																
2.1	Obtain Buy-In	Tanya																															COMPLETE
2.2	Align Strategy Objectives	Tanya																															COMPLETE
2.3	Present Project Plan Idea/Plan	Tanya																															COMPLETE
2.4	Collect Evidence-Based Practice	Tanya																															COMPLETE
2.5	Review and Synthesize Evidence	Tanya																															COMPLETE
2.6	Establish Project Budget	Tanya																															COMPLETE
2.7	Identify Funding Mechanisms	Tanya																															COMPLETE
2.8	Develop Proforma & ROI	Tanya																															COMPLETE
3	**Implementation Phase**																																
3.1	Tableau Creation	Cecil																															COMPLETE
3.2	Identify Statistical Variables	Tanya																															COMPLETE
3.3	Determine Databases and Design	Cecil/Tanya																															COMPLETE
3.4	Develop Tableau Dictionary	Cecil/Tanya																															COMPLETE
3.5	Develop Discrete-Event Simulation Model	Nima/Tanya/Tam																															COMPLETE
3.16	Finalize Demonstration Pilot Model	Tanya/Yeseli																															COMPLETE
4	**Analysis Phase**																																
4.1	Meet with Psychiatric and Pediatric Physician Leaders	Tanya																															COMPLETE
4.2	Analyze Throughput and Cost for DES model	Tanya																															COMPLETE
4.3	Meet with Project Site Senior Leaders to share analysis	Tanya																															COMPLETE
4.4	Meet with Regional Leaders to share analysis	Tanya/Yeseli																															COMPLETE
5	**Culmination/Sustainability Phase**																																
5.1	Assess milestones	Tanya																															COMPLETE
5.2	Prepare Referral Playbook for Hub & Spoke	Tanya/Yeseli																															In Progress
5.3	Discuss Go-Live Dates for Demonstration Pilot	Tanya/et al																															In Progress
5.4																																	
5.5																																	

Appendix H: Work Breakdown Structure



Appendix I: Responsibility/Communication Matrix

Stakeholder Analysis							
Identify the key stakeholders:							
☒ Manager or direct supervisor ☒ Finance department ☒ Vendors ☒ Patients and/or families; patient and family advisory committee ☐ Professional organizations ☒ Committees				☒ Organizational leaders ☒ Interdisciplinary colleagues (e.g., physicians, nutritionists, respiratory therapists, or OT/PT) ☒ Administrators ☒ Other units or departments ☐ Others: _____			
Stakeholder analysis matrix:							**(Adapted from http://www.tools4dev.org/)**
Stakeholder Name and Title:	**Role:** (select all that apply) Responsibility, Approval, Consult, Inform	**Impact Level:** How much does the project impact them?	**Influence Level:** How much influence do they have over the project? (minor, moderate, significant)	**What matters most to the stakeholder?**	**How could the stakeholder contribute to the project?**	**How could the stakeholder impede the project?**	**Strategy(s) for engaging the stakeholder:**
Chief Nurse Executive	Responsibility, Approval, Consult, Inform	Significant	Significant	Quality of Care and Proper Placement	Support positively the demonstration pilot	Not approve the demonstration project	Provide timely updates on the project; Align organizational goals
Chief Financial Officer	Approval, Inform	Significant	Significant	LOS and Cost Mitigation	Approve financial resources	Not provide data resources	Give financial updates
Regional Pediatric Physician Chief	Approval, Consult, Inform	Moderate	Significant	Psychiatric Program Ownership	Facilitate the collaborations with physicians	Not take lead on physician communication	Provided data and progress updates

Stakeholder Name and Title:	**Role:** (select all that apply) Responsibility, Approval, Consult, Inform	**Impact Level:** How much does the project impact them?	**Influence Level:** How much influence do they have over the project? (minor, moderate, significant)	**What matters most to the stakeholder?**	**How could the stakeholder contribute to the project?**	**How could the stakeholder impede the project?**	**Strategy(s) for engaging the stakeholder:**
Regional Psychiatric Chief	Approval, Consult, Inform	Moderate	Moderate	Approval for implementation	Facilitate the collaborations with physicians	Rely solely on historical attempts to create a unit	Provided data and progress updates; Have Regional Peds Chief facilitate jointly
EBY Psychiatric Residency Chief	Responsibility, Approval, Consult, Inform	Significant	Significant	Patient volume for residency	Design a robust plan for the residents based on data for inclusion in demo	Decide not to proceed with residents	Provide timely progress updates and encourage feedback
EBY Pediatric Residency Chief	Responsibility, Approval, Consult, Inform	Significant	Significant	Psychiatric Residency Ownership	Collaborate with Psych Residency to align goals	Psych residency unwilling to own program	Have regional Chief continue to communicate benefits and partnership goals
Emergency Room Medical Director	Consult, Inform	Significant	Minor	Timely disposition of pedi-psych patients	Provide emergency room data and process information	Not provide ED data for collaborative approach	Invite to meetings and reenforce goal alignment
Clinical PsychD Program Director	Responsibility, Approval, Consult, Inform	Significant	Minor	Experience for the fellows	Design a robust plan for the residents and demo	Decline participation in the program	Align PsychD program goals with demo pilot objectives

Stakeholder Name and Title:	**Role:** (select all that apply) Responsibility, Approval, Consult, Inform	**Impact Level:** How much does the project impact them?	**Influence Level:** How much influence do they have over the project? (minor, moderate, significant)	**What matters most to the stakeholder?**	**How could the stakeholder contribute to the project?**	**How could the stakeholder impede the project?**	**Strategy(s) for engaging the stakeholder:**
Continuum Director	Consult, Inform	Minor	Minor	LOS	Establish a strong outpatient relationship with outside placement facilities	Limited staff to cover demo pilot	Keep updated on timeline and collaborate to identify alternative options
Software Engineers	Consult, Inform	Minor	Minor	Accurate modeling	Collaborate to recommend a dynamic discrete-event sim model	Limited scope capability due to funding	Leverage existing systems and programs to build model
Financial Analyst	Consult, Inform	Moderate	Minor	Accurate data	Collaborate effectively to identify correct data repositories for required discrete-event simulation model	Unavailable to participate in the project	Remain flexible with meetings and requests

Communication Planning

Refer to this section to guide your communications to stakeholders throughout and after completing the EBP project.

What is the purpose of the dissemination of the EBP project findings? (check all that apply)

☐ Raise awareness
☐ Change practice
☒ Inform stakeholders
☒ Engage stakeholders
☐ Other:_____
☒ Promote action

☐ Change policy

What are the 3 most important messages?

1.) Milestone successes (i.e., Tableau build, cost confirmations)
2.) Building a model of collaboration across the system - OneKP
3.) Escalate any ideas, questions, or concerns

Align key message(s) and methods with audience:

Audience	Key Messages	Method	Timing
Interdisciplinary stakeholders	1.) Milestone successes (i.e., Tableau build, cost confirmations) 2.) Building a model of collaboration across the system - OneKP 3.) Escalate any ideas, questions or concerns	Email, Teams meetings	Bi-Weekly
Organizational leadership	1.) Milestone successes (i.e., Tableau build, cost confirmations	Email	Monthly;or As needed
Frontline nurses	1.) Milestone successes (i.e. Tableau build, cost confirmations) 2.) Building a model of collaboration across the system - OneKP 3.) Escalate any ideas, questions or concerns	Email, Teams meetings, Direct Report Rounding	Bi-Weekly
Departmental leadership	1.) Milestone successes (i.e. Tableau build, cost confirmations) 2.) Escalate any ideas, questions or concerns	Email, Teams meetings, Direct Report Rounding	Bi-Weekly
External community	1.) Milestone successes (i.e., Tableau build, cost confirmations	Email	Quarterly

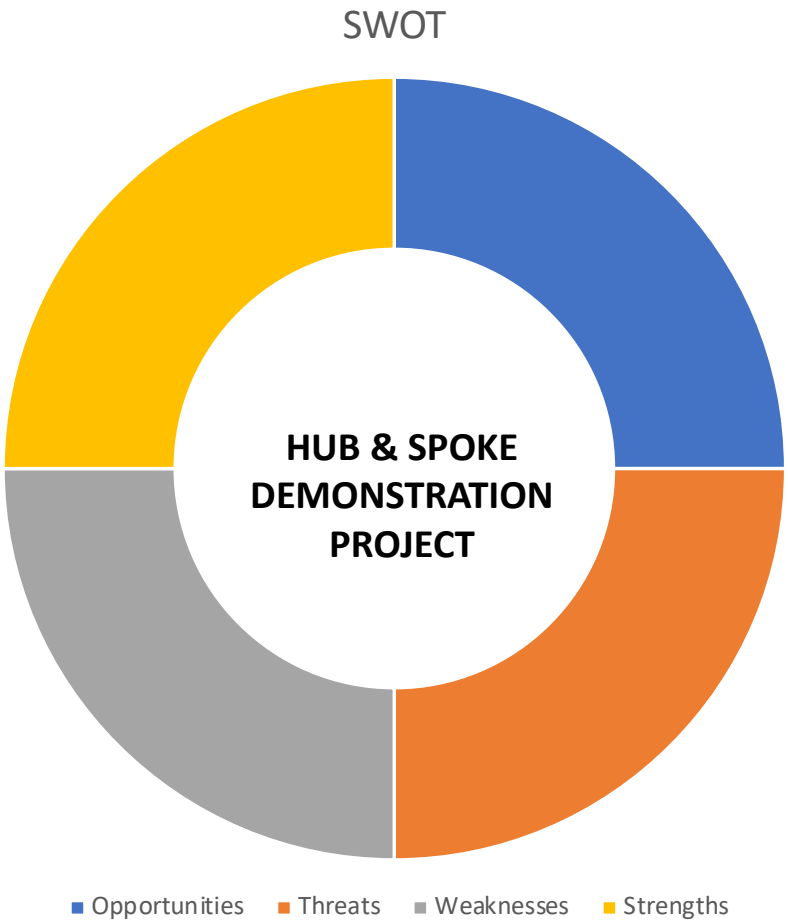
Appendix J: SWOT Analysis

STRENGTHS

- Existing Pediatric Clinical Overflow Unit
- Existing Psychiatric Residency Program
- Existing Pediatric Residency Program
- Existing Clinical Psychology Fellowship Residency
- Regional Referral Site
- Provider Support
- Nursing Support
- Senior Executive Support
- Regional Executive Sponsor

WEAKNESSES

- Nursing Knowledge of Psychiatric Care
- No existing pediatric psychiatric care budget
- Nurses lacking direct psychiatric patient experience
- Residents currently rotating offsite at other facilities
- No existing child and adolescent specialty in Residency program



OPPORTUNITIES

- Pediatric/Psychiatric Provider Collaboration
- 11th floor budgeted into Peds overall for medical patients
- Psych Residents can rotate at home facility for child and adolescent experience
- Dual diagnosis patients able to be treated in same facility at the same time
- Regional Director/Local Director partnership

THREATS

- COVID-19 overflow patients being placed on unit currently
- No national corporate desire to have any psychiatric care component
- Increasing number of COVID related psychiatric diagnoses
- Internal staff not interested in working on both units
- Have to hire specialty psych travel nurse staff to cover demonstration project time

Appendix K. Budget and Financial Analysis

Figure 1

Project Budget

STARTUP EXPENSES	Date Due	Budget	Actual	(Under) / Over
Administrative / General				
Permits		$ 1,500.00	$ -	$ (1,500.00)
Professional Fees & Insurance		$ 3,400.00	$ -	$ (3,400.00)
Psych Unit Business Consultant		$ 2,500.00	$ -	$ (2,500.00)
Other		$ -	$ -	$ -
Total		$ 7,400.00	$ -	$ (7,400.00)
11th Floor Unit				
Advertising-Promotional Materials		$ 2,500.00	$ -	$ (2,500.00)
Dietary Supplies and Utensils		$ 410.00	$ -	$ (410.00)
Furniture		$ 50,000.00	$ -	$ (50,000.00)
Medical Equipment		$ 1,500.00	$ -	$ (1,500.00)
Laboratory Supplies		$ 8,000.00	$ -	$ (8,000.00)
Housekeeping Supplies		$ 7,500.00	$ -	$ (7,500.00)
Repairs & Maintenance-Other Supplies		$ 2,500.00	$ -	$ (2,500.00)
Office Supplies		$ 1,000.00	$ -	$ (1,000.00)
Non-Injectable Drugs		$ 10,000.00	$ -	$ (10,000.00)
Disposable Patient Linen		$ 1,500.00	$ -	$ (1,500.00)
Hardware		$ 10,000.00	$ -	$ (10,000.00)
Software (CRM, etc)		$ 7,000.00	$ -	$ (7,000.00)
Installation Fees		$ 5,000.00	$ -	$ (5,000.00)
Start Up Inventory (Pharma)		$ 25,000.00	$ -	$ (25,000.00)
Medical Supplies (Gloves, Etc)		$ 5,000.00	$ -	$ (5,000.00)
Miscellaneous		$ 10,000.00	$ -	$ (10,000.00)
Other		$ -	$ -	$ -
Total		$ 146,910.00	$ -	$ (146,910.00)
Marketing				
Advertising-Promotional Materials		$ 300.00	$ -	$ (300.00)
Branding / Identity Development		$ 500.00	$ -	$ (500.00)
Website		$ 700.00	$ -	$ (700.00)
Promo Materials		$ 500.00	$ -	$ (500.00)
Listing Fees		$ 300.00	$ -	$ (300.00)
Internet Marketing		$ 500.00	$ -	$ (500.00)
Trade Shows		$ 5,000.00	$ -	$ (5,000.00)
Networking Events		$ 200.00	$ -	$ (200.00)
Other		$ -	$ -	$ -
Total		$ 8,000.00	$ -	$ (8,000.00)
Labor Expenses				
Job-Listing Fees		$ 2,500.00	$ -	$ (2,500.00)
Payroll		$ 200,000.00	$ -	$ (200,000.00)
Training		$ 5,000.00	$ -	$ (5,000.00)
Other		$ -	$ -	$ -
Other		$ -	$ -	$ -
Other		$ -	$ -	$ -
Total		$ 207,500.00	$ -	$ (207,500.00)
Other				
Contingencies Reserve		$ -	$ -	$ -
Launch Party		$ 500.00	$ -	$ (500.00)
Other		$ -	$ -	$ -
Other		$ -	$ -	$ -
Other		$ -	$ -	$ -
Total		$ 500.00	$ -	
Total Startup Expenses		**$ 370,310.00**	**$ -**	**$ (370,310.00)**

Figure 2. Forecasted scenarios

	Scenario				
	0% Reduction	10% Reduction	20% Reduction	30% Reduction	40% Reduction
Hospital Pedi Psych	19,970	19,970	19,970	19,970	19,970
Referral Pedi Psych	40,354	40,354	40,354	40,354	40,354
Total	60,324	60,324	60,324	60,324	60,324
% patient day reduction	0%	10%	20%	30%	40%
Patient Days reduction	-	6,032	12,065	18,097	24,130
	365	365	365	365	365
Facility Days	1,112,160	1,112,160	1,112,160	1,112,160	1,112,160
Non Partner	(84,158)	(84,158)	(84,158)	(84,158)	(84,158)
Observation	(137,674)	(137,674)	(137,674)	(137,674)	(137,674)
Cross In	(324,946)	(324,946)	(324,946)	(324,946)	(324,946)
Pedi Psych reduction	-	(6,032)	(12,065)	(18,097)	(24,130)
Cross Out	324,946	324,946	324,946	324,946	324,946
Plan					
Claims	60,671	60,671	60,671	60,671	60,671
Referrals	146,887	146,887	146,887	146,887	146,887
Area Days (PDR)	1,097,885	1,091,853	1,085,821	1,079,788	1,073,756
Membership Projection	53,691,198	53,691,198	53,691,198	53,691,198	53,691,198
ADC Reduction	-	(17)	(33)	(50)	(66)

	2021 Projection based on YTD May	0% Reduction	10% Reduction	20% Reduction	30% Reduction	40% Reduction
ADC	3,047	3,047	3,047	3,047	3,047	3,047
Area Days	3,008	3,008	2,991	2,975	2,958	2,942
Partnership	4,474,266	4,474,266	4,474,266	4,474,266	4,474,266	4,474,266
Days in Year	365	365	365	365	365	365
PDR	245.4	245.4	244.0	242.7	241.3	240.0
PDR Change		-	(1.3)	(2.7)	(4.0)	(5.4)

Membership forecast	
YTD May var to budget	224,044
Annual projection var	537,706
2021 Budget	53,153,492
2021 projection	53,691,198

Based on sample partial year data extraction for purposes of modeling preparation. *Average Daily Census (ADC), Year to Date (YTD), Patient Daily Rate (PDR)*

*Patient Days Reduction (Inpatient Referral Days) (Regional)
Cost/Day = $500

ROI = (40,354 Pediatric Referral Days = $20,177,000) – (Reduction of Days by 10%(6,032)= $3,016,000) = 34,322 Pediatric Referral Days = $17,161,000
ROI = (40,354 Pediatric Referral Days = $20,177,000) – (Reduction of Days by 20%(12,065)= $6,032,500) = 28,289 Pediatric Referral Days = $14,144,500
ROI = (40,354 Pediatric Referral Days = $20,177,000) – (Reduction of Days by 30%(18,097)= $9,048,500) = 22,257 Pediatric Referral Days = $11,128,500
ROI = (40,354 Pediatric Referral Days = $20,177,000) – (Reduction of Days by 40%(24,130)= $12,065,000) = 16,224 Pediatric Referral Days = $8,112,000

*Inpatient Area Patient Days (PDR) (Regional)
Facility Days – (Service Reduction) + Cross Out + Claims + Referrals = Area Days (PDR)

- Area Days Reduction
  - 10% - 1,091,853
  - 20% - 1,085,821
  - 30% - 1,079,788
  - 40% - 1,073,756

Appendix L. Return On Investment

Pediatric Discrete Event Simulation	Budget		
REVENUE	**Year 1**	**Year 2**	**Year 3**
Cost avoidance	12 bed	18 bed	24 bed
New Unit Construction	$1,426,400	$1,853,600	$2,280,800
Total revenue	$1,426,400	$1,853,600	$2,280,800
EXPENSES			
Salaries and Wages (Benefits at 35%)			
Program Director	$154,440	$159,073	$163,845
Financial Analyst	$126,360	$130,150	$134,055
DES Simulation Technician	$77,220	$79,537	$81,923
Data Scientist	$105,300	$108,459	$111,713
Physician Executive Sponsor	$70,200	$72,306	$74,475
Admin Assistant	$8,424	$8,677	$8,937
Subtotal S/W	$541,944	$558,202	$574,948
Supplies Expense			
Training -	$24,680	$8,100	$8,100
Software License Computer Program	$14,000	$14,420	$14,853
Subtotal supplies	$38,680	$22,520	$22,953
Total revenue/cost-avoidance	$1,426,400	$1,853,600	$2,280,800

Total expenses	$580,624	$580,722	$597,901
Total revenue or cost-avoidance– expenses (profit)	$845,776	$1,272,878	$1,682899

Cost Avoidance

New Construction Cost Table			
Area	**Square Feet**	**Cost/Sq. Ft**	**Total Cost**
Patient Rooms (12)	168 x (12) = 2,016	$400	$806,400
Nurses Station, Med Prep	250	$400	$100,000
Clean Utility	120	$400	$48,000
Soiled Utility	120	$400	$48,000
Exam/Treatment Room	140 + (8)(12) = 236	$400	$94,400
Physicians Office	120	$400	$48,000
Nurse Supervisors Office	120	$400	$48,000
Clean Linen Room	60	$400	$24,000
Supply Room	40	$400	$16,000
Storage	80 + (2)(12) = 104	$400	$41,600
Consultation Room	300	$400	$120,000
Clerical Office	80	$400	$32,000
TOTALS	**3,566**	**$400**	**$1,426,400**
New Construction Cost Table			
Area	**Square Feet**	**Cost/Sq. Ft**	**Total Cost**
Patient Rooms (18)	168 x (18) = 3,024	$400	$1,209,600
Nurses Station, Med Prep	250	$400	$100,000
Clean Utility	120	$400	$48,000
Soiled Utility	120	$400	$48,000
Exam/Treatment Room	140 + (8)(18) = 284	$400	$113,600
Physicians Office	120	$400	$48,000
Nurse Supervisors Office	120	$400	$48,000
Clean Linen Room	60	$400	$24,000
Supply Room	40	$400	$16,000
Storage	80 + (2)(18) = 116	$400	$46,400
Consultation Room	300	$400	$120,000
Clerical Office	80	$400	$32,000
TOTALS	**4,634**	**$400**	**$1,853,600**
New Construction Cost Table			
Area	**Square Feet**	**Cost/Sq. Ft**	**Total Cost**
Patient Rooms (24)	168 x (24) = 4,032	$400	$1,612,800
Nurses Station, Med Prep	250	$400	$100,000
Clean Utility	120	$400	$48,000

Soiled Utility	120	$400	$48,000
Exam/Treatment Room	140 + (8)(24) = 332	$400	$132,800
Physicians Office	120	$400	$48,000
Nurse Supervisors Office	120	$400	$48,000
Clean Linen Room	60	$400	$24,000
Supply Room	40	$400	$16,000
Storage	80 + (2)(24) = 128	$400	$51,200
Consultation Room	300	$400	$120,000
Clerical Office	80	$400	$32,000
TOTALS	**5,702**	**$400**	**$2,280,800**

Phase II Project Implementation and Cost Assumptions

2023 Oakland Hub Projection Based on YTD June 2022	Budget	Actual 10% reduction	Actual 20% Reduction	Actual 30% Reduction	Actual 40% Reduction
Average Daily Census (12 Bed Unit)	12	12	12	12	12
Patient Days (Service Area Days)	7	6.3	5.6	4.9	4.2
Payroll Dollars (1:3 ratios)	$ 6,012.00	$ 6,012.00	$ 6,012.00	$ 6,012.00	$ 6,012.00
Cost / Patient Day	$ 3,507.00	$ 3,156.30	$ 2,805.60	$ 2,454.90	$ 2,104.20
Days in Year	365	365	365	365	365
Patient Daily Rate					
PDR Variance					

Staff	RNs (12 hrs)	Avg. Rate	Total Cost Per Day	Sitters (12 hrs)	Avg. Rate	Total Cost Per Day
Days	4	$ 65.00	$ 3,120.00	2	$ 15.00	$ 360.00
Nights	4	$ 70.00	$ 3,360.00	2	$ 17.00	$ 408.00
Total	8	$ 67.50	$ 6,480.00	4	$ 16.00	$ 768.00

Management	NM (8 hrs)	Avg. Rate	Total Cost Per Day	ANM (12 hrs)	Avg. Rate	Total Cost Per Day
Days	1	$ 92.00	$ 736.00	2.1	$ 84.00	$ 2,117.00
Nights	0	$ -	$ -	2.1	$ 87.00	$ 2,192.00
Total	1	$ 92.00	$ 736.00	4.2	$ 85.50	$ 4,309.00

Total Management Daily Cost	$ 5,045.00	Total Staff Daily Cost	$ 7,248.00
Total Management Annual Cost	$ 1,841,425.00	Total Staff Annual Cost	$ 2,645,520.00

Cost Per Patient Day (CPPD)				
Total Staff	Hrly Rate	MN Census		CPPD
12	$ 41.75	12	$ 6,012.00	$ 501.00

(1) Personnel

i. Planning phase
   a. Executive sponsor 208 hours x $250/hr + 35% benefits = $70,200
   b. Project Director 1040 hours x $110/hr + 35% benefits = $154,440
   c. Admin Assistant 208 hours x $30/hr + 35% benefits = $8,424

ii. Training phase
   a. Project Director 9 hours x $110/hr +35% benefits = $1,337

iii. Start-up
   a. Executive sponsor 208 hours x $250/hr + 35% benefits = $70,200
   b. Project Director 1040 hours x $110/hr + 35% benefits = $154,400
   c. Admin Assistant 208 hours x $30/hr + 35% benefits = $8,424
   d. Financial Analyst 208 hours x $45/hr + 35% benefits = $12,636
   e. DES Simulation Tech 1040 hrs x $55/hr +35% benefits x 3 = $77,220
   f. Data Scientist 1040 hrs x $75/hr+ 35% benefits = $105,300

iv. Year 1
   a. Executive sponsor 208 hours x $250/hr + 35% benefits = $70,200
   b. Project Director 1040 hours x $110/hr + 35% benefits = $154,400
   c. Admin Assistant 208 hours x $30/hr + 35% benefits = $8,424
   d. Financial Analyst 2080 hours x $45/hr + 35% benefits = $126,360

e. DES Simulation Tech 1040 hrs x $55/hr +35% benefits x 3 = $77,220
f. Data Scientist 1040 hrs x $75/hr+ 35% benefits = $105,300

v. Year 2 and Year 3
a. Personnel salaries/benefits adjusted by 3% for inflation
a. Personnel salaries/benefits adjusted by 3% for inflation

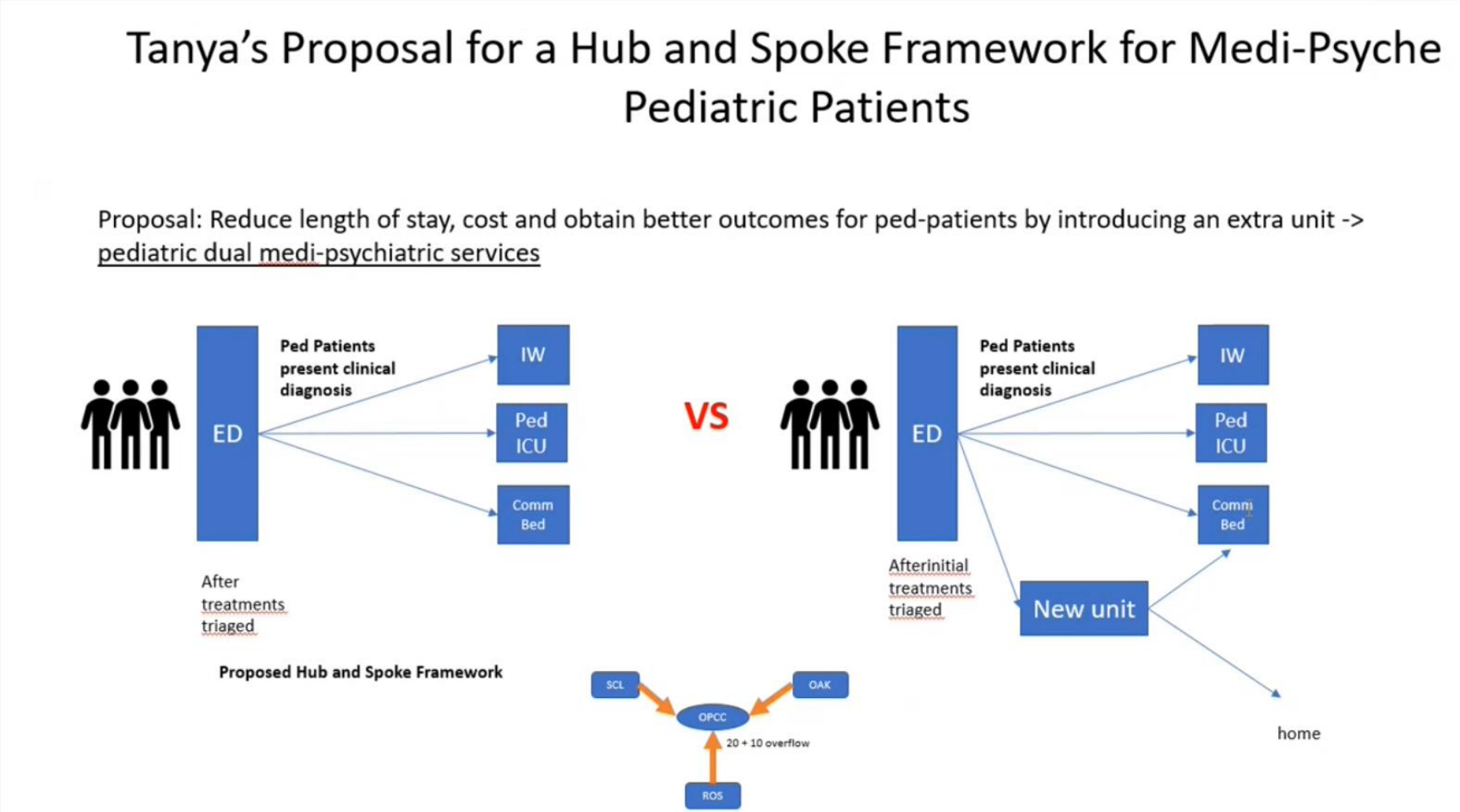
(2) Supplies
i. Planning
a. General meeting supplies = $500
ii. Start-up and Years 1 – 3
a. General meeting supplies = $2000

(3) Data fees
i. Year 2 and Year 3
a. Update Anylogic Program data sets for advanced analysis = $10,000

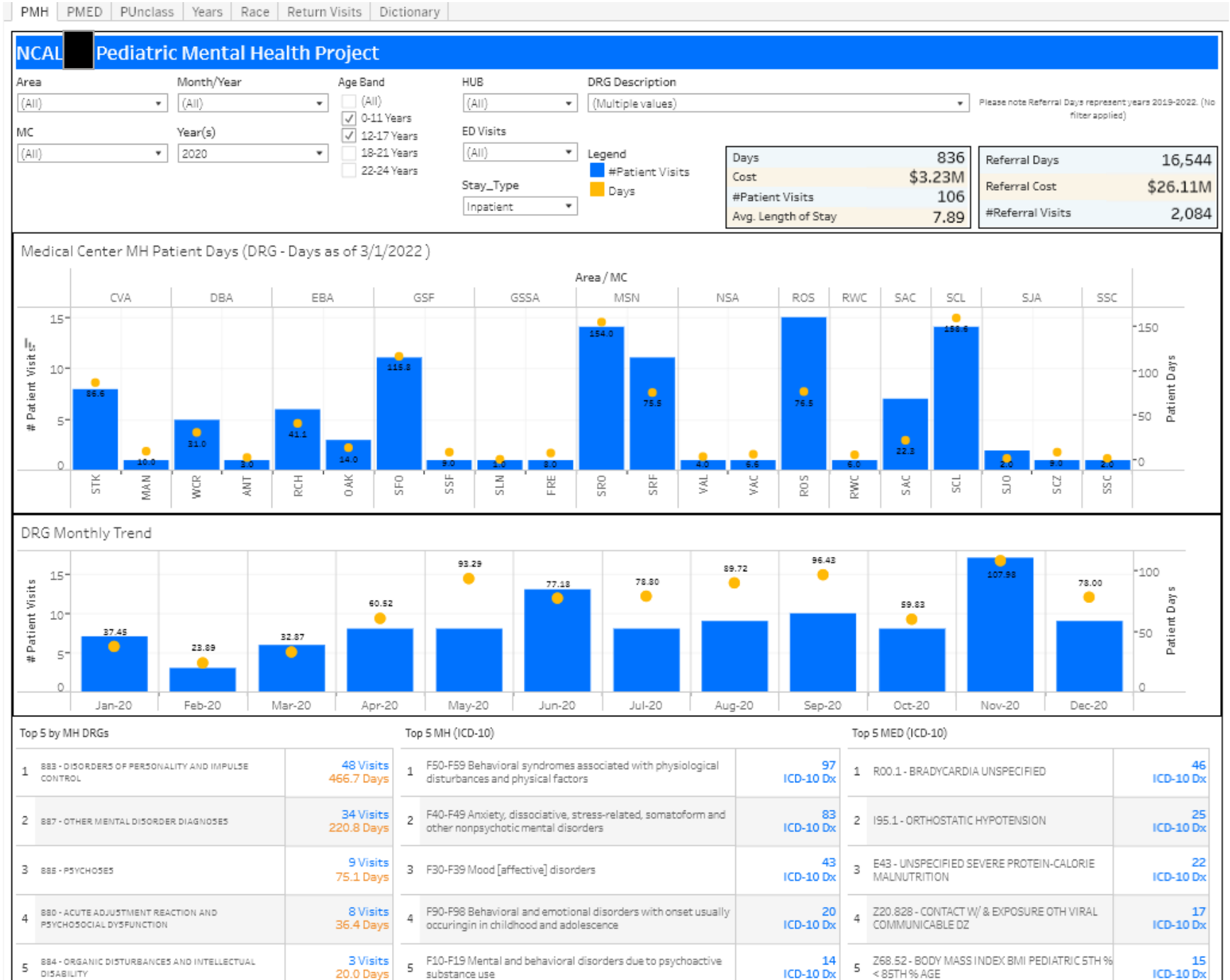
(4) Training
i. Training
a. Curriculum development 40 hrs x $60/hr + 35% benefits = $3,240
b. Material development 40 hrs x $60/hr + 35% benefits = $3,240
c. Printing = $2,000
d. Train the trainer 4 hrs x $75/hr+35% benefits x 20 = $8,100
ii. Year 1
a. Ongoing training -new staff 4 hrs x $75/hr+35% benefits x 20 = $8,100
iii. Year 2 and Year 2
a. Personnel salaries/benefits adjusted by 3% for inflation

(5) Information Systems and Data Management
i. Start-up
a. Any Logic Software license $500 / license x 20 = $10,000 / 2 for 6 months = $5,000
b. Data table programming 40 hrs x $100/hr + 35% benefits = $5,400
ii. Year 1 – Year 3
a. Annual software license fee $10,000
b. Data maintenance $4,000 Y1, 3% adjustment for inflation Y2 and Y3

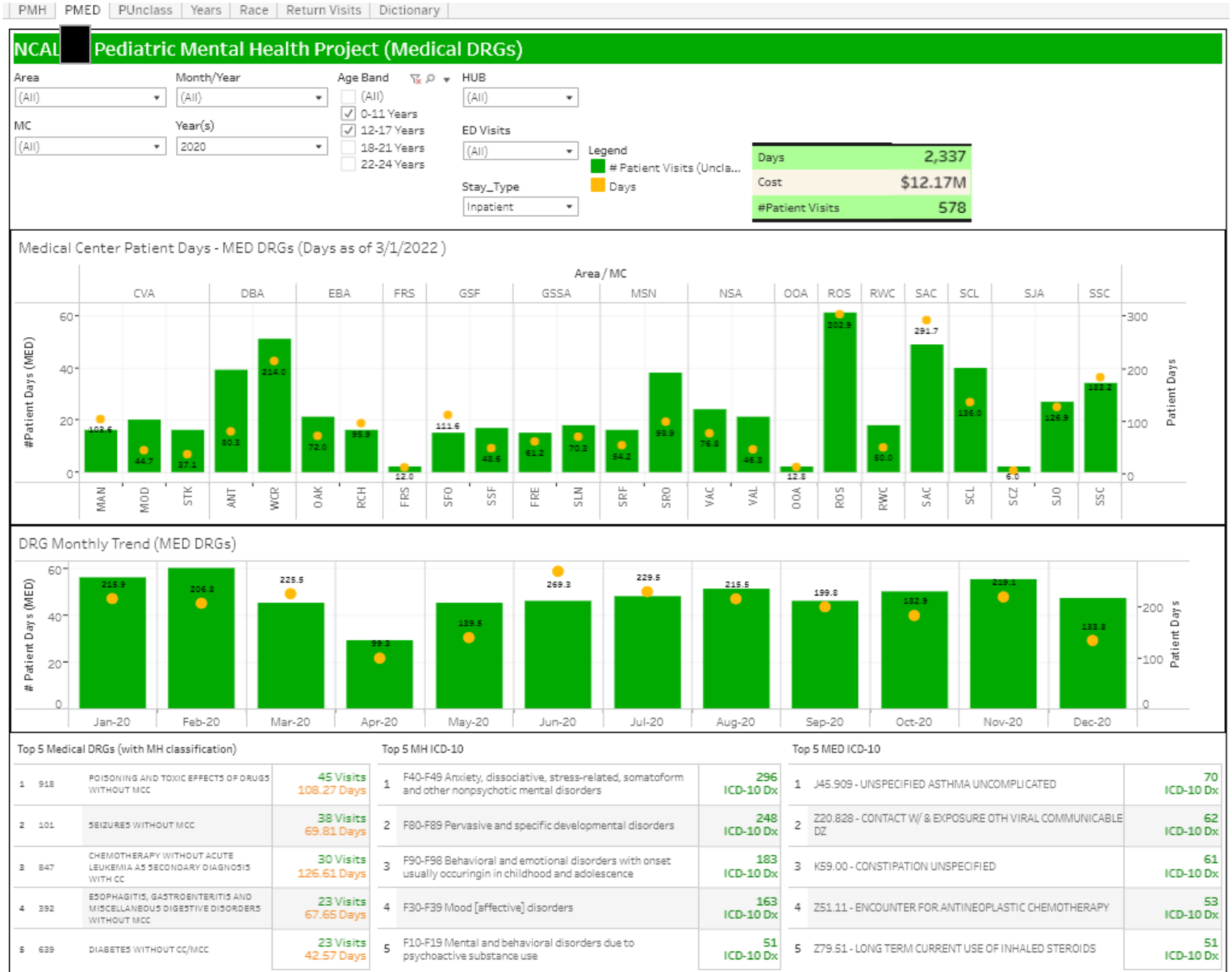
Appendix M. Proposed Workflow



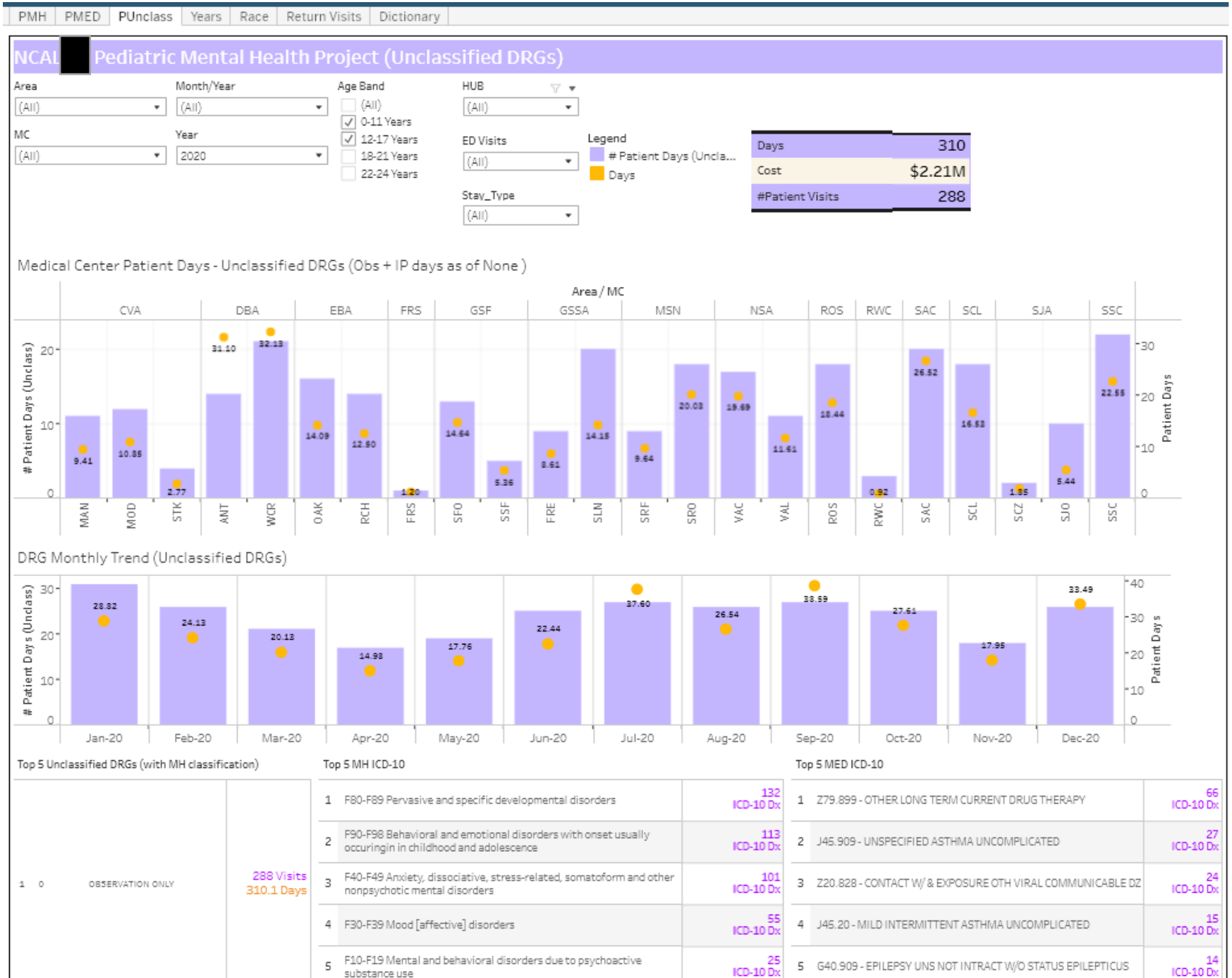
Appendix N: Pediatric Inpatient Psychiatric Data Tableau



Appendix O: Pediatric Inpatient Dual Diagnosis Data Tableau



Appendix P: Pediatric Observation Dual Diagnosis Data Tableau



Appendix Q: Letter of Organizational Support

KAISER PERMANENTE

PATIENT CARE SERVICES

Darina Kavanagh, DNP, RN, CPHQ, NEA-BC
Chief Nurse Executive
3600 Broadway
Oakland, CA 94611
Telephone Number: 510-752-2974
Email: darina.kavanagh@kp.org

November 30, 2021

To the Members of the Kaiser Permanente Research Innovation Academy and Research Determination Office,

REGARDING: University of San Francisco School of Nursing Doctor of Nursing Practice (DNP) Project

Title of DNP Project: An Integrated Strategy to Impact the Quality-of-Care Delivery for Pediatric Behavioral Health in Northern California

Organizational Mentor: Ifeoma Nnaji, DNP, RN, RN-BC (Informatics), NPD-BC, NE-BC

Student: Tanya Scott, DHL, MHR, RN, NEA-BC, CPHIMS

I am the Chief Nurse Executive who oversees the Patient Care Services Departments at Kaiser Permanente Oakland. The above-named project will be conducted in the Maternal-Child Health (MCH) department.

I support this:

☒ Quality Improvement Project (local need/impact) that is not meant to create generalizable scientific knowledge

☐ Human Subjects Research

The purpose of this activity:

This project will be used to improve the services provided to our pediatric population by providing further evidence and outcomes to our health care team.

Please contact me if you have any questions.

Yours sincerely,

Darina Kavanagh, DNP, RN, CPHQ, NEA-BC
Chief Nurse Executive

Appendix R: Exemption from Institutional Review Board Review

KAISER PERMANENTE®

Date: May 23, 2022
Subject: RDO KPNC 22 - 061
Title: An Integrated Strategy to Impact the Quality-of-Care Delivery for Pediatric Behavioral Health in Northern California

Dear Dr. Nnaji:

The Research Determination Committee for the Kaiser Permanente Northern California region has reviewed the documents submitted for the above referenced project to be used by Tanya Scott for her DNP program. The project does not meet the regulatory definition of research involving human subjects as noted here:

Not Research

The activity does not meet the regulatory definition of research per 45 CFR 46.102(d): Research means a systematic investigation, including research development, testing and evaluation, designed to develop or contribute to generalizable knowledge.

This determination is based on the information provided. If the scope or nature of the project changes in a manner that could impact this review, please resubmit for a new determination. The word "research" should not appear in any posters or publications resulting from this project. Further, if publications, presentations or posters are generated from this project the following wording must be used to reference to the project research determination outcome:

"The Research Determination Committee for the Kaiser Permanente Northern California region has determined the project does not meet the regulatory definition of research involving human subjects per 45 CFR 46.102(d)"

You are expected, however, to implement your study or project in a manner congruent with accepted professional standards and ethical guidelines as described in the Belmont Report (http://www.hhs.gov/ohrp/humansubjects/guidance/belmont.html).

Additionally, you are responsible for keeping a copy of this determination letter in your project files as it may be necessary to demonstrate that your project was properly reviewed. Provide this approval letter to the Physician in Charge (PIC), your Area Manager, and Chief of Service, to determine whether additional approvals are needed.

Finally, all manuscripts/case series/case studies must receive written approval prior to submission to a journal or book. The Principal Investigator (PI) or first author (if different) must request their PIC[1], or the Division of Research (DOR) Director[2], or the Research & Innovation Academy (RIA)[3] or an equivalent level leader[4] review and provide written approval for publication submission. The PI is responsible for retaining a copy of the approval.

Sincerely,

The Research Determination Committee
KPNC-RDO@kp.org

[1]PIC approval is required for all manuscripts/case series/case studies that do not include a DOR employee as an author; including but not limited to medical students, residents, and fellows.
[2]DOR Director approval is required for all manuscripts/case series/case studies that include DOR employees as authors.
[3]For all nurse-authored manuscripts/case series/case studies, approval by the Research & Innovation Academy is required.
[4] If you are not sure who this would be, please contact the Research Determination Office (KPNC-RDO@kp.org)

Appendix S: Statement of Non-Research Determination

UNIVERSITY OF SAN FRANCISCO | School of Nursing and Health Professions

Doctor of Nursing Practice
Statement of Non-Research Determination (SOD) Form

The SOD should be completed in NURS 7005 and NURS 791E/P or NURS 749/A/E

General Information

Last Name:	Scott	**First Name:**	Tanya
CWID Number:	20663343	**Semester/Year:**	Spring 2022
Course Name & Number:	792E-E7 Practicum III Focus: MesoSystem -E7		
Chairperson Name:		**Advisor Name:**	
Second Reader Name	Dr. Mary Bittner Dr. Nicholas Webb		

Project Description

1. **Title of Project:**

An Integrated Hub Strategy to Impact the Quality-of-Care Delivery for Pediatric Behavioral Health Patients in Northern California

2. **Brief Description of Project** *(Clearly state the purpose of the project and the problem statement in 250 words or less):*

California has lost nearly 30% of its acute care psychiatric hospital beds, and most counties have no psychiatric beds for children. The need for inpatient pediatric psychiatric services to address the growing issue of pediatric mental health in an extensive hospital system is straining the system's capacity to provide timely mental health care. Access to specialty psychiatric treatment required for care management is a patient quality and safety issue, and the absence of immediate specialty care in the acute care setting is contributing to the increased boarding of pediatric patients in emergency rooms, increased length of stay, and financial costs of care for those system patients suffering from mental illness. The project's purpose is to evaluate the feasibility of implementing

a hub-and-spoke pediatric psychiatric program to improve the length of stay and financial costs to both the health system and members as defined by the patient daily rate for Pediatric Behavioral Health patients.

3. **AIM Statement: What are you trying to accomplish?**

Demonstrate a reduction in patient length of stay, financial costs, and increase access to care for pediatric psychiatric patients in northern California by 15% over one year by implementing a pediatric hub-and-spoke model of care

4. Brief Description of Intervention (150 words)**:**

The proposed project includes implementation of a feasibility study to retrospectively review the last three years of pediatric psychiatric patient volume for all hospitals in the NCAL region then develop and propose a hub model for referral of care where the Pediatric Care Tertiary Centers would establish a care framework that provides emergency room patient care coordination and management. Care coordination would come from clinical psychologists, specialty trained pediatric psychiatric residency nurses, the collaboration and partnership of two physician residency programs (Pediatric Hospitalist Residents & Psychiatric Hospitalist Residents) providing support via telemedicine or transfer of care to a 10-bed Pediatric Psychiatric Crisis Care Unit (PCCU) and inpatient nursing leadership.

4a. How will this intervention be implemented?

The intervention project will focus on the Pediatric Tertiary Care Centers and will include data for all three proposed hub locations. The focus of the intervention are pediatric behavioral health patients in Northern California. Informing stakeholders will take place with monthly meetings to share data and bring the care team executive leaders together to build the framework for the collaboration of specialties.

5. Outcome measurements: How will you know that a change is an improvement?

The measure of success is defined by the identification of feasibility for implementation of the PCCU as a pilot to eliminate pediatric psychiatric patient emergency room boarding, improve care quality and reduce financial costs in the hub regions. All data will be de-identified and contained within the encrypted system tableau developed in conjunction with senior financial data analysts selected for the DNP pilot feasibility project. Outcome variables to be evaluated include the following:

- Decreased Emergency Room Length of Stay by 20% by 4th quarter of year two
- Decreased Inpatient Admission Length of Stay by 20% by 4th quarter of year two
- Decreased Total Cost of Care by 15% by 4th quarter of year two
- Decreased Patient Daily Rate by 15% by 4th quarter of year two

This feasibility project will be a supply and demand analysis to offer a more comprehensive model for optimizing resources to calibrate trade-offs between investing in additional psychiatric beds within the health system and expanding community alternatives to hospitalization.

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DNP Statement of Determination
Evidence-Based Change of Practice Project Checklist*

The SOD should be completed in NURS 7005 and NURS 791E/P or NURS 749/A/E

Project Title:

An Integrated Strategy to Impact the Quality-of-Care Delivery for Pediatric Behavioral Health

Mark an "X" under "Yes" or "No" for each of the following statements:	**Yes**	**No**
The aim of the project is to improve the process or delivery of care with established/ accepted standards, or to implement evidence-based change. There is no intention of using the data for research purposes.	X	
The specific aim is to improve performance on a specific service or program and **is a part of usual care**. All participants will receive standard of care.	X	
The project is **not** designed to follow a research design, e.g., hypothesis testing or group comparison, randomization, control groups, prospective comparison groups, cross-sectional, case control). The project does **not** follow a protocol that overrides clinical decision-making.	X	
The project involves implementation of established and tested quality standards and/or systematic monitoring, assessment or evaluation of the organization to ensure that existing quality standards are being met. The project does **not** develop paradigms or untested methods or new untested standards.	X	
The project involves implementation of care practices and interventions that are consensus-based or evidence-based. The project does **not** seek to test an intervention that is beyond current science and experience.	X	
The project is conducted by staff where the project will take place and involves staff who are working at an agency that has an agreement with USF SONHP.	X	
The project has **no** funding from federal agencies or research-focused organizations and is not receiving funding for implementation research.	X	
The agency or clinical practice unit agrees that this is a project that will be implemented to improve the process or delivery of care, i.e., **not** a personal research project that is dependent upon the voluntary participation of colleagues, students and/ or patients.	X	
If there is an intent to, or possibility of publishing your work, you and supervising faculty and the agency oversight committee are comfortable with the following statement in your methods section: *"This project was undertaken as an Evidence-based change of practice project at X hospital or agency and as such was not formally supervised by the Institutional Review Board."*	X	

Answer Key:

- If the answer to all of these items is "Yes", the project can be considered an evidence-based activity that does not meet the definition of research. IRB review is not required. Keep a copy of this checklist in your files.
- If the answer to any of these questions is "No", you must submit for IRB approval.

*Adapted with permission of Elizabeth L. Hohmann, MD, Director and Chair, Partners Human Research Committee, Partners Health System, Boston, MA.

To qualify as an Evidence-based Change in Practice Project, rather than a Research Project, the criteria outlined in federal guidelines will be used: http://answers.hhs.gov/ohrp/categories/1569

UNIVERSITY OF SAN FRANCISCO | School of Nursing and Health Professions

DNP Statement of Determination
Evidence-Based Change of Practice Project Checklist Outcome

The SOD should be completed in NURS 7005 and NURS 791E/P or NURS 749/A/E

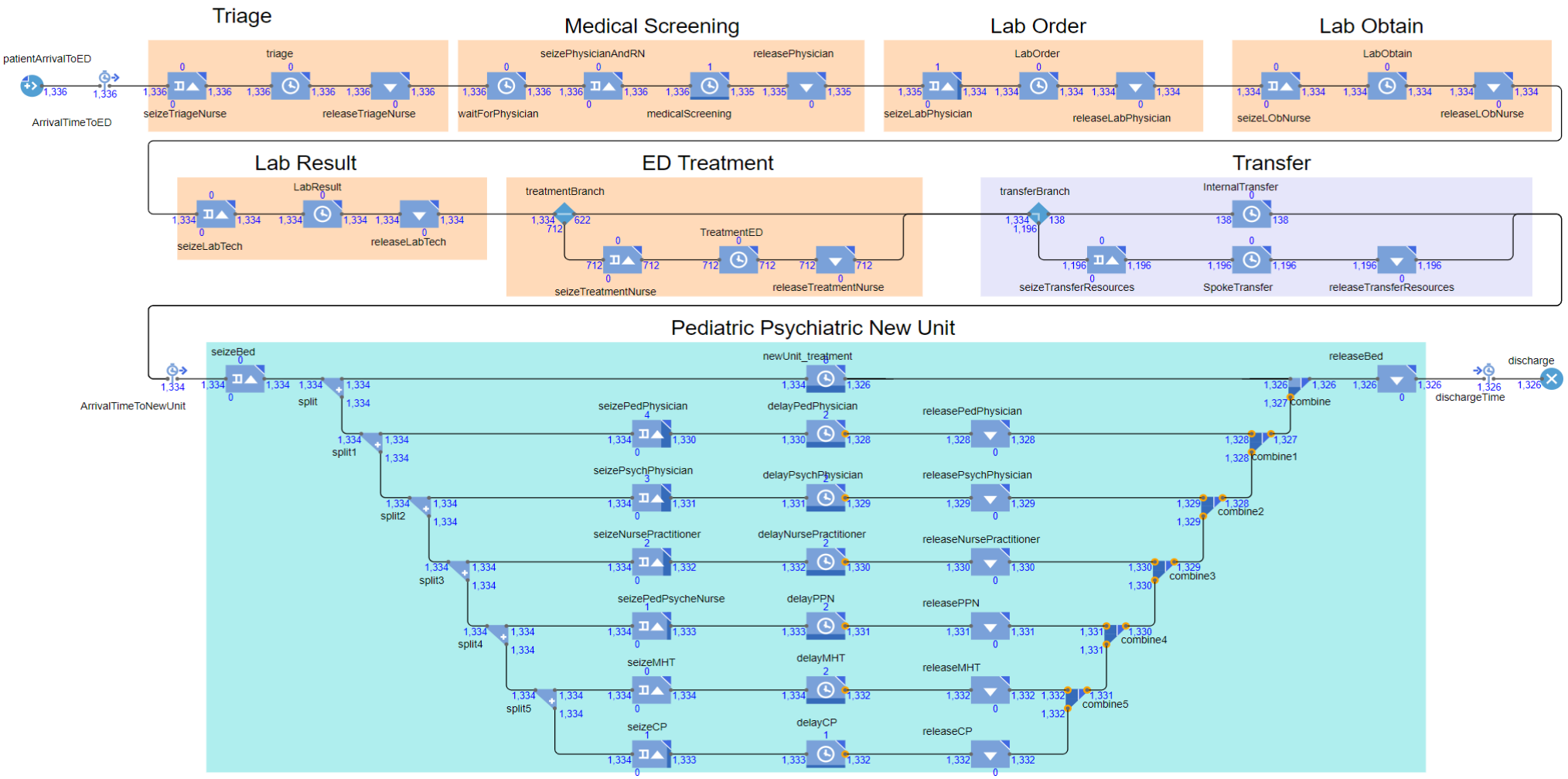
X This project meets the guidelines for an Evidence-based Change in Practice Project as outlined in the Project Checklist (attached). **Student may proceed with implementation.**

☐ This project involves research with human subjects and **must be submitted for IRB approval before project activity can commence.**

Comments:

Student Last Name:	Scott	**Student First Name:**	Tanya
Student Signature:	Tanya Scott	**Date:**	4/3/2022
Chairperson Name:	Dr. Mary Bittner		
Chairperson Signature:	Dr. M. Bittner	**Date:**	4/4/2022
Second Reader Name:	Nicholas Webb	**Date:**	4/6/2022
Second Reader Signature:	Nicholas R Webb		4/6/2022
DNP SOD Review Committee Member Name:			
DNP SOD Review Committee Member Signature:		**Date:**	

Appendix T. (3) Hospital Hub and Spoke PMED Scenario Simulation



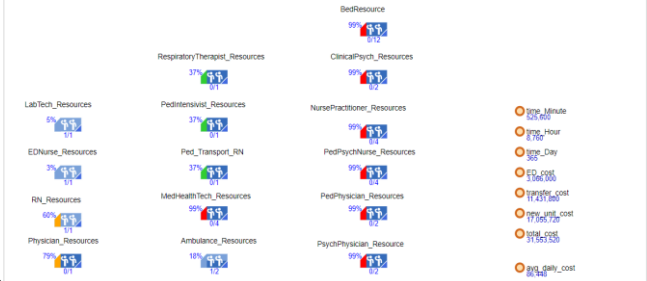
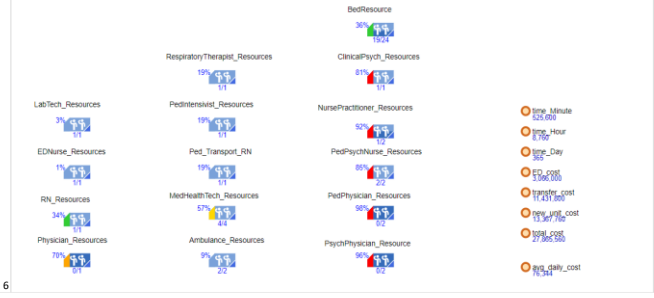
Appendix U. PMED Dual Diagnosis Scenario Data Analysis

Figure 1

OAKLAND HUB PMED Scenario Simulation

Scenario	Year	Patient Daily Arrival Rate	Transfer Rate	Ambulance	Transfer Resource	Pediatric/Psychiatric	Nurse Practitioner	Ped-psych Nurse	MHT	Clinical Psychologist	Number of Beds
1	2019	3.6	0.09	2	1	2	2	2	4	1	12
2	2019	3.6	0.09	2	1	1	2	2	4	1	24
3	2020	6.1	0.02	2	1	2	4	4	4	2	12
4	2020	6.1	0.02	2	1	2	3	3	4	2	24
5	2021	3.6	0.1	2	1	2	2	2	4	1	12
6	2021	3.6	0.1	2	1	2	2	2	4	1	24

Appendix V. Simulation Scenarios Results

scenario	resource and cost	length of stay histogram	num patients in	num patients out
1			1300	1288
2			1222	1209
3			2260	1733
4			2221	2204
5			1336	1326
6			1268	1263