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Implementing an Endocarditis Interdisciplinary Pathway in a Large Academic Medical Center: A Quality Improvement Project

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Keywords

endocarditis, interdisciplinary team, care pathway

Disciplines

Nursing

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Introduction

The rate of infective endocarditis (IE) has increased over the past several decades with an incidence of 10-15,000 new cases each year (Sexton & Chu, 2019). The treatment of patients with IE is complex and may involve prolonged hospitalizations and cardiac surgery leading to alterations in quality of life. Management of this patient population often necessitates a series of well-coordinated interventions from various staff and specialties such as cardiology, cardiac surgery, infectious disease, nursing, social work, and others (Habib et al., 2015). In addition, patients with IE often present with various comorbidities; thus, additional inpatient consultations and interventions may be necessary. For example, if the patient suffers a stroke, a potential complication of IE, further radiological imaging and a neurology consultation will be warranted (Pettersson et al., 2016). Similarly, incorporation of psychiatric and addiction specialty services may be indicated in order to coordinate treatment of patients with IE secondary to intravenous substance use disorder (IVSUD) (Pettersson et al., 2016). Due to the many clinicians involved in the provision of interdisciplinary care, centralized and timely management may be difficult to organize. Care fragmentation can lead to increased hospital length of stay (LOS), hospital-associated complications, and readmissions (Habib et al., 2015). Although clinical practice guidelines regarding standardized care of patients with IE exist, best practices are challenging to establish and adopt by large interdisciplinary teams. Evidence suggests that deviation from standardized interdisciplinary care in patients with IE has resulted in poor patient outcomes (Chirillo et al., 2013a). As such, increased access to and utilization of standardized

interdisciplinary practice guidelines benefit hospitalized patients with IE and assist interdisciplinary clinician teams in streamlining care.

Local Problem

The cardiac surgery team in a 791 bed academic medical center in Philadelphia, Pennsylvania provides medical and surgical services to patients with IE in the local region. Yearly IE admissions to the facility have increased. For years 2016 through 2018, IE-related patient admissions were 138, 184, and 194, respectively. Physicians, nurse practitioners (NPs), and physician assistants (PAs) on the cardiac surgery service collaborate with registered nurses (RNs), pharmacists, and social workers to care for patients with IE. Collectively, they form the interdisciplinary team. Individually, all members of the team serve in unique roles. Physicians, NPs, and PAs manage patients by diagnosing IE, ordering and interpreting diagnostic tests, prescribing medications, and performing surgery. Clinical nurses at the bedside provide daily nursing care and deliver patient education regarding disease management. Social workers provide a comprehensive psychosocial assessment of the patient and assesses discharge needs as they relate to available resources in the community and facilitate coordination of them. Lastly, pharmacists assist in appropriate medication selection along with pertinent pharmacological therapy management throughout admission.

The management of patients with IE has presented a growing challenge for the interdisciplinary team. For example, approximately half of the patients present with a history of IVSUD and consequently warrant complex discharge planning. Delays in coordinating diagnostic exams, discharge needs, and important consults may contribute to protracted LOS for the population. At the participating facility, the need for standardized guidelines in the interdisciplinary management of IE was identified by nurse leaders, clinicians of the cardiac

surgery service, social workers, and other staff. Despite the complexity associated with caring for patients with IE, no institutional pathway existed to facilitate standardized interdisciplinary care.

Problem Statement

Interdisciplinary team members at a large academic medical center lack access to standardized interdisciplinary care guidelines for patients with IE.

Available Knowledge

IE occurs when infection of the endocardium leads to formation of microbacterial vegetations on one or several heart valves; this may lead to heart failure, stroke, or sepsis (Copstead & Banasik, 2013). Mortality rates for IE vary between 20% and 50% depending on the type of infective organism (Copstead & Banasik, 2013). Additionally, approximately half of all patients ultimately require cardiac surgical interventions (Habib et al., 2015). They may also experience prolonged hospital admissions with costly and resource-intensive care as a result of treatment involving a multitude of health care specialties (Yanagawa et al., 2018). Epidemiological studies indicate that cases of IE are on the rise in the United States (U.S.) (Bor, Woolhandler, Nardin, Brusch, & Himmelstein, 2013; Pant et al., 2015). Admissions for IE increased from 25,511 to 38,970 in the U.S. between 1998 and 2009; additional studies reported a significant increase in its incidence, accounting for an estimated 457,052 hospitalizations from disease-related complications from 2000 to 2011 (Bor et al., 2013; Pant et al., 2015). Individuals at greatest risk for endocarditis are ones with: 1) a congenital malformation of the heart or heart valve, 2) heart valve damaged by rheumatic fever or calcified thickened valves, 3) artificial implanted heart devices such as pacemakers and artificial heart valves, and 4) history of intravenous drug use (Sexton & Chu, 2019). For example, the proportion of hospitalizations from IE in the setting of IVSUD increased from 7% to 12.1% between 2000 and 2013 (Wurcel et al.,

2016). Given current trends, healthcare systems are allocating more attention and resources to this patient population.

A recent review of the literature regarding the management of hospitalized patients with IE suggests that the best approach involves standardized treatment by interdisciplinary teams. Standardized interdisciplinary care has been shown to reduce in-hospital, 30-day, and one-year mortality as well as LOS (Botelho-Nevers et al., 2009; Carrasco-Chinchilla et al., 2014; Chirillo et al., 2013a; Chirillo et al., 2013b; Kaura et al., 2017). Additionally, the European Society of Cardiology (ESC), American Heart Association (AHA), and the American Association for Thoracic Surgery (AATS) emphasize the incorporation of interdisciplinary team management strategies in their independently published IE clinical guidelines (Baddour et al., 2015; Habib et al., 2015; Pettersson et al., 2016). For example, recommendations from the ESC state that IE requires collaborative management by an interdisciplinary team that meets regularly to establish goals of care (Habib et al., 2015). Similarly, the AHA reports that surgical interventions should be managed with a team-based approach, bringing together specialists in cardiology, cardiothoracic surgery, and infectious disease (Nishimura et al., 2014). Lastly, the AATS adds that the interdisciplinary team should include psychiatry and social work to address a comorbidity of IVSUD which may involve the coordination of rehabilitative and medication-assisted therapy services (Pettersson et al., 2016). Ultimately, meetings of interdisciplinary teams should begin immediately upon the patient's admission and subsequently occur at regular intervals. These meetings should address patient progress, care coordination, referrals, and management protocols, all while promoting collaboration and collegiality among the involved disciplines (Chambers et al., 2014). Evidence-based practice supports standardizing care and interdisciplinary collaboration with the use of a tool known as a care pathway (Lavelle, Schast,

& Keren, 2015). A care pathway is a management tool that illustrates the sequence of treatment interventions for a specific patient population; as a result, it incorporates and standardizes evidence-based guidelines into the plan of care (Schrijvers, Hoorn, & Huiskes, 2012). Thus, a care pathway is an effective strategy for streamlining and facilitating interdisciplinary care.

Rationale

In order to understand the problem at the local site and explore possible interventions, a conceptual framework was utilized. The authors used the seven steps of The Revised Iowa Model of Evidence-Based Practice to assist in designing a project that addressed the lack of standardized interdisciplinary care guidelines for patients with IE (Iowa Model Collaborative, 2017). First, the clinical issue of the unstandardized and disjointed care was clearly identified as a topic of priority by members of the interdisciplinary team. Second, a team was formed to address the issue. Third, a literature search was performed to identify interventions for standardizing interdisciplinary care. Fourth, the literature and evidence were appraised. Fifth, an intervention was developed using recommendations found in the literature. Sixth, the intervention was implemented. Seventh, evaluation was conducted and discussed herein.

Specific Aim

The purpose of this quality improvement project was to develop a pathway for management of IE and thus streamline the care of patients with IE. Long-term aims of the pathway are decreased hospital LOS, patient mortality, and cost. However, this project focused on the short-term aim to increase clinician access to interdisciplinary care guidelines for the management of patients with IE in three adult acute care units. This project was reviewed and approved by the local Institutional Review Board (IRB) on January 22, 2019, and the proposal was deemed to be a human subjects research-exempt quality improvement project.

Methods

Sample & Setting

The study setting is a 791 bed academic medical center that serves the greater Philadelphia, PA region. The facility serves a high volume of patients with complex cardiovascular disorders. The setting for this project was a 32 bed adult intensive care unit and two adult step down units with 62 combined beds. The sample targeted for this project included 18 physicians, 235 RNs, 4 social workers, 33 combined PAs and NPs, and 1 cardiac specialty pharmacist, N = 291.

Interventions

Pathway development. While a variety of clinical pathways have been adopted for several different patient populations at the medical center, one dedicated to patients presenting with IE did not exist. Thus, the first objective was to build an IE care pathway informed by published guidelines from the AHA, AATS and ESC. Additionally, other discipline-specific recommendations were integrated after a series of formal meetings with site physicians, surgeons, NPs, PAs, nurses, and social workers who regularly care for patients with IE. In addition to the authors, the following staff members participated in the pathway development, review, drafting, and vetting: two attending cardiac surgeons, two social workers, one PA, two NPs, one cardiology pharmacy specialist, one psychiatrist, one infectious disease physician, and one nurse informaticist. Meetings with stakeholders and subject matter experts provided further comprehensive pathway content based on institutional expert opinion. Moreover, these discussions supplied pathway developers with information regarding the institution's resources so that the pathway could be specifically tailored to the project site. Participation in the pathway development was voluntary and no compensation was offered.

Pathway accessibility. The second objective was to make the pathway easily accessible to clinical staff and other members of the interdisciplinary team. Once the pathway was published, it was made available on the pre-existing clinical pathway repository site (Dorsata, Washington, DC) accessible from the facility's intranet on every hospital computer. For offsite interdisciplinary team members, the pathway was also available remotely on the institution's intranet via a secure authenticated log-in. Additionally, the pathway could be accessed via secure log-in on personal electronic devices such as smartphones and tablets.

Pathway education. The third objective was for the authors to educate providers on the pathway. Dissemination entailed informing staff and members of the interdisciplinary team on how to access the pathway online, its major content, and its applicability to clinical practice when caring for patients with IE. Education sessions were held onsite. Unit RNs, physicians, NPs, PAs, social workers, and a cardiac specialty pharmacist were invited to attend via email either directly or through respective department heads. Attendance to the on-site education sessions and participation in this project was optional with no compensation offered. An attendance sheet was created.

Measures

Pathway views. Our primary outcome of interest was the number of pathway views. A pathway view was defined as an instance when the pathway is accessed electronically by a member of the interdisciplinary team. We assumed that the pathway would be accessed when a member of the interdisciplinary team required guidance with patient management. For example, a clinician could access the pathway to identify guidelines for appropriate antibiotic therapy for a patient with IE. Therefore, pathway views served as a proxy for clinician utilization of the pathway. Views were tracked and monitored from July 2 to September 30, 2019. Data were

captured electronically and obtained from the institution. As no interdisciplinary IE pathway existed at the site prior to the project, no baseline data were collected.

Pathway education attendance. Another primary outcome of interest was the amount of attendance at the IE pathway on-site education sessions. A standardized sign-in sheet was created by the authors to record attendance and attendee role at education sessions. The total number of session attendees was delineated by specific clinical role: registered nurse (RN), social worker, pharmacist, NP, PA, and physician.

Data Analysis

Pathway views were captured on the institution's cloud-based software (Dorsata, Washington, DC) and subsequently stored on a password encrypted laptop. Daily pathway view counts were aggregated to the monthly level and compared across the months of July, August, and September of 2019 using a Kruskal-Wallis test. Post-hoc comparisons were conducted using the Dunn's test, a multiple comparison test for non-parametric data. Significance was set to $p \leq .05$ and all analyses were conducted in R Studio (Boston, MA). Daily views were plotted over time with dates of the on-site education sessions superimposed to visually analyze potential trends in the frequency of views in relation to dates of education sessions. The goal of this analysis was to assess the impact of education sessions on pathway viewership. To better contextualize viewership, we also extracted the number of IE admissions from month-to-month over the project period. All patient data were obtained de-identified and stored in a password encrypted laptop. The goal of this was to determine if the number of patients admitted with IE was associated with trends in pathway viewership from month-to-month. Lastly, we evaluated our sample's exposure to pathway education by comparing total attendance to total sample size. Additionally, this comparison was stratified by interdisciplinary team member role. We obtained

this data by using the on-site education session sign-in sheets. Given the large interdisciplinary team sample targeted for this project and the quality improvement nature of this project no power analysis was conducted.

Results

Pathway Development

Four months were dedicated to the IE pathway research and development. A cloud-based pathway building software (Dorsata, Washington, DC) was used to design the physical layout of the pathway. Formal vetting took place by presenting multiple drafts to stakeholders and hospital administrative staff including a nurse with expertise in informatics and use of the cloud-based software, a process which took two months to complete. Ultimately, one pathway with two subsections was constructed for ease of use and organization of content: IE diagnosis (see Figure 1), and management and discharge of patients with IE (see Figure 2). The pathway was published on the platform on July 2, 2019. No amendments were made to the pathway after publication.

The pathway included several critical elements based on published guidelines and meetings with stakeholders. The critical elements included: 1) diagnostic criteria for IE was provided, 2) recommendations for facility-specific antibiotic administration were imbedded into the pathway, 3) guidance regarding diagnostic testing and imaging pertinent for patients with endocarditis, such as echocardiography, was incorporated, 4) suggestions for consultations with relevant specialties were included, such as social work, infectious disease, and psychiatry, 5) a recommendation for mandatory interdisciplinary team meetings to address the management of patients with IVSUD as a comorbidity was added, and 6) early and continued evaluation of discharge capability.

Pathway Accessibility

There were 191 pathway views between July 2 and September 30. There was variability in pathway views throughout each month. Views in July, August, and September were 123, 29, and 39, respectively (see Table 1). The maximum amount of views on a given day during this time period was 30, while the minimum was zero. We also noted variation in the amount of days with views across the three months. For example, less than half of the days in August had views compared to approximately two-thirds in July (see Table 1). Kruskal-Wallis test indicated that there was a statistically significant difference in the median number of daily views across the three months (p = .003) (see Table 1). Post-hoc pairwise comparisons conducted using the Dunn's test found that the number of daily pathway views statistically significantly decreased from a median of 4 [IQR: 3, 6] when launched in July to a median of 2 [IQR: 1, 2] in August, p = .006. Similarly, the number of median counts of daily views decreased from July, when the median was 4 [IQR: 3, 6], to a median of 2 [IQR: 1, 3.5] in September, p = .017. The number of views were not statistically different between the months of August and September.

Pathway Education

All members of the interdisciplinary staff that care for patients with IE in the three units were invited to attend on-site education sessions between July 15 and September 15, 2019. In addition, we developed a three-minute video live screen tour which informed the audience on how to access the pathway and its content. The video was emailed to the nurse managers of the three inpatient units who then forwarded it to their nursing staff. The initial plan was to conduct uniform 10-minute PowerPoint presentations including the project description and background, the video, and the pathway's short and long-term goals. However, unit leadership requested that the on-site education sessions be shortened in light of time constraints because sessions were

scheduled during patient care hours. The attendees were asked to specify their role via a sign-in sheet. Each session's content varied slightly based on the attending interdisciplinary staff's roles and responsibilities.

Nine total education sessions were conducted onsite. The amount of education sessions conducted in July, August, and September were five, three, and one, respectively. Due to time constraints for several of the sessions, the presentation was reduced to mainly include key takeaways for the staff along with an overview of the pathway and its access. In total, 87 of 291 team members, or 30%, attended on-site education sessions. This included: 78 RNs (33% of total), two social workers (50% of total), two PAs and four NPs (18% of combined advanced practice providers), and one physician (6% of total). The cardiac specialty pharmacist and one social worker confirmed the receipt of education session content including the PowerPoint presentation and video by email.

Views Over Time

Visual inspection of the data demonstrated that overall pathway views were variable over the project's timeline. Forty-eight days out of a total 91 observation days had pathway views recorded. The largest peaks in pathway views took place during July, the month when the majority of on-site education sessions were conducted and pathway launch took place (see Figure 3). Throughout project duration, overall views trended downward over time (see Figure 3). In several instances, increases in pathway views were observed on days when education sessions were delivered or in the days following (see Figure 3). This was the case for six out of seven days. However, not all large peaks of views were observed on days in which education sessions were provided. Of note, the largest peak of views took place before any of the education sessions were delivered (see Figure 3). A possible explanation for this peak could have been that

e-mail correspondence from the authors to nursing leadership regarding pathway publication and the embedded three-minute video on how to access it was disseminated during this time. This could have then prompted nursing staff in the respective units to access the pathway prior to the education sessions.

Discussion

Summary

Evidence-based practice supports that patients with IE should be managed by interdisciplinary care teams using standardized guidelines. In this project, interdisciplinary team members in three adult acute care units at a large academic medical center lacked access to standardized guidelines for patients with IE. Thus, an evidence-based, interdisciplinary care pathway was developed with the aim of increasing access to and organizing guidelines. Results indicated that access to standardized guidelines was increased in the three units after pathway roll-out and on-site education sessions for the interdisciplinary team. Prior to the intervention, no clinical care pathway existed. After implementation, 191 pathway views over three months were observed. Furthermore, education sessions appeared to have a positive influence on pathway viewership. The month in which most education sessions were provided had a statistically significantly higher number of median daily views than the other two months. Additionally, spikes in views were observed on or immediately following days on which on-site education sessions were conducted and around the same time the three-minute education video was emailed to staff. As such, nurse-led education may in fact influence clinical care pathway access and continued educational efforts are valuable in maintaining pathway visibility.

Interpretation

The first intervention was the construction of an IE care pathway. This objective was the result of interprofessional collaboration and highlights the value of interdisciplinary teamwork. The outcome was the publication of one IE pathway with two subsections on the hospital's intranet via the cloud-based software (Dorsata, Washington, DC) which did not exist prior to the project. We surmise that without consultation of interdisciplinary team members throughout pathway development, subsequent pathway adoption would lack stakeholder buy-in and sustainability. Previous studies have mirrored this methodology. In a study of a pathway for the early diagnosis and treatment of *Clostridium difficile* infection, the authors recruited an interdisciplinary representative stakeholder group to develop the pathway (Flores, Jue, Girardi, Schoelles, & Umscheid, 2018). Similarly, in another study examining the elements of successful implementation of several evidence-based clinical pathways, the authors mentioned key stakeholder involvement in pathway development as being critical to its short-term and long-term uptake by providers (Flores et al., 2019). This continued buy-in by providers is crucial in asserting a pathway's implications for improving long-term outcomes. For example, a quality improvement study investigating the impact of an interdisciplinary pathway on red blood cell transfusion practices demonstrated a statistically significant reduction in transfusions after its implementation (Wong et al., 2017). The collaboration of the interdisciplinary team throughout pathway development and maintenance is vital to its sustainability and subsequent improvement in outcomes.

Daily views were variable throughout the data collection period. We surmise that pathway view variability could be due to similarly irregular IE patient admissions. It is possible that the pathway was not accessed when there were no patients with IE for which to provide care. Admissions of patients with IE during July, August, and September were four, seven, and four,

respectively; meanwhile, pathway views for these months were 123, 29, and 39 respectively. These pathway views demonstrate the possibility that the pathway was accessed multiple times for a given patient or perhaps other confounding factors. It is possible that as a patient progresses through the phases of his or her initial work-up and treatment, providers of the interdisciplinary team may have accessed the pathway multiple times. This is suggestive that the pathway may be accessed by various providers at different times throughout the patient's admission to assist in decision making. Another explanation for view variability may be that not all members of the interdisciplinary care team had exposure to pathway education sessions. Clinicians and staff that were not exposed could have all been working on the units on the same day and not have had the knowledge to access the pathway. This could potentially explain why some of the observation days did not yield any views.

Another point of interest was the potential influence of IE patient census on pathway views and education session attendance. Over the span of three months, the total admissions of patients with IE were 15: four in July, seven in August, and four in September. Compared to 2018's average monthly IE patient admissions, there was a lower monthly average of admissions during this project's observation period, 16 versus 5 respectively. We speculate that higher numbers of IE patient admissions could have prompted increased pathway viewership. Similarly, we surmise that not as many members of the interdisciplinary team may have been motivated to attend education sessions given the low IE patient census. In fact, out of the total 291 interdisciplinary team members, only 87 attended the on-site education sessions, or 30%.

On average, visual inspection of overall views notably decreased over the duration of the project timeline (see Figure 3). As the majority of education sessions occurred during the month of July, we speculate that decreased pathway access may be attributable to decreased pathway

education sessions. However, this does not explain the slight increase in total viewership during September, which had the least on-site education sessions. One possible explanation for decreased viewership overall may be that clinicians who attended education sessions and accessed the pathway felt competent in their knowledge of the guidelines insomuch that they did not subsequently re-access it for other patient care during the remainder of the observation period. Our short observation period also restricted the amount of potential pathway views. Other researchers have reported pathway viewership trends that slowly gain viewership overtime indicating promising momentum in the IE work. In a study examining viewership of clinical pathways, Flores et al. (2019) reported a steady increase in monthly pathway views over the course of the 27-month observation period. Therefore, a more protracted observation period could also similarly result in a more robust pathway view count.

Overall, reasons for variability in guideline viewership over time is beyond the scope of this project and could be examined in future studies on IE pathway adoption.

Strengths

This project has several facilitators worthy of noting. First, the academic medical center had a large stakeholder investment in the project's development and implementation. With buy-in from key disciplines and services, similar care pathways can be developed to provide interdisciplinary care team members with access to clinical care guidelines. Second, the existence of an established clinical care pathway repository was invaluable for providing a platform through which the project intervention could be carried out. Interdisciplinary care team members were familiar with the pathway building cloud-based software (Dorsata, Washington, DC). As such, knowledge of an established system's process facilitated pathway development and subsequent provider access.

Limitations

The influence of design limitations and the presence of other confounding elements throughout the project are worth noting. First, the observations and results of the project are not generalizable to other hospitals since the project was limited to the cardiac service team in three inpatient units in a single facility. For example, other hospitals and interdisciplinary teams may seek alternative interventions to standardizing interdisciplinary care at their sites. Nevertheless, the scope of this project focused solely on interventions within one hospital.

Second, while the purpose of adopting a standardized IE interdisciplinary pathway is to ultimately improve the care of patients by enhancing care coordination, reduce patient LOS, and decrease in-hospital mortality, measurement of these outcomes was not feasible during the short project timeline. Consequently, the authors decided to instead measure pathway views after introducing it to the site as a way to indirectly measure use of the tool. Similarly, it was not possible to determine whether or not the pathway was viewed in the context of direct IE patient-related care due to its existence outside of the electronic medical record (EMR). For example, the pathway might be accessed by a clinician for educational purposes and not necessarily to seek out recommendations for a specific patient. Nevertheless, while the amount of pathway views possibly demonstrates how the interdisciplinary team adopted this intervention, it does not directly inform on longer term outcomes for patients with IE such as mortality or LOS. A longer observation period would be needed to assess the effects on these outcomes.

Third, while evidence supports health care teams caring for patients with IE adopting a standardized interdisciplinary management strategy, there was no validated and published IE pathway found in the literature. As such, the project pathway that was built through incorporation of the three clinical practice guidelines and expert opinion from site stakeholders

have limited reliability and validity. The authors addressed this limitation by ensuring that all of the pathway content was submitted for review and vetting by site administrators and stakeholder clinicians with subject matter expertise.

Fourth, since no IE pathway existed at the institution prior to this project, no baseline data regarding pathway views was available for comparison. Similarly, no previous studies examining online views of an IE pathway were found in the literature. This limited the ability to assess whether the frequency of views was different to that seen in projects of a similar scope.

Fifth, the need to access the pathway could be influenced by the volume of IE admissions to the cardiac surgery service. Unfortunately, we could not collect enough IE admission or census data to statistically analyze the effect of IE patient volume on pathway views. The number of patients with IE admitted to the hospital varied across three months, but this was too short of an observation period to adequately assess any relationship. Thus, to accurately evaluate the effect of IE patient volume on pathways views, a longer observational period is required.

Sixth, the individual pathway views could not be stratified by team member role. Therefore, it was not possible to determine or compare the degree to which specific members of the interdisciplinary team were accessing the pathway. This information would have been useful in evaluating which providers required additional outreach or educational interventions in order to positively influence pathway use and ultimately patient care outcomes. Similarly, every member of the interdisciplinary team could not be formally instructed on pathway access as demonstrated by the percentage of attendees stratified by role. The sessions were offered on multiple days at different times with the goal of accommodating potential attendees' varying schedules. E-mail communication regarding the sessions was employed both by the authors and, in some instances, unit leadership staff in order to maximize attendance. In spite of this,

scheduling meetings with the irregular and demanding schedules among team members presented a logistical barrier to full implementation potential. The limited timeframe of the data collection period additionally contributed to the finite amount of staff educated.

Conclusions

The absence of coordinated care and interdisciplinary collaboration can lead to poor outcomes for patients with IE. Clinical pathways have the potential to increase access to interdisciplinary guidelines by serving as visual and cognitive aids to direct necessary steps in the management of patients with IE. While the implementation of these pathways can be challenging, with ample stakeholder buy-in, a standardized evidence-based clinical pathway can be created to increase their access and usage. Furthermore, advanced practice nurse (APRN)-led education can garner and facilitate such access and utilization.

The observations in this project suggest pathway sustainability through stakeholder buy-in and APRN-led education. With continued APRN-led education, there is the potential for further pathway use to ultimately aid interdisciplinary team members in streamlining care. The recruitment of some interdisciplinary team members as pathway champions to augment educational efforts could possibly promote the sustainability and success of the pathway beyond this project's purview. There is limited cost to maintaining the pathway since the hospital's intranet is available to all providers with an existing repository for clinical care pathways. Should favorable outcomes eventually be demonstrated, there is promise for spread to not only other hospital services caring for patients with IE, but other institutions as well. As cases of IE in the U.S. continue to rise, interdisciplinary teams at other facilities can implement this methodology in an attempt to incorporate evidence-based clinical guidelines.

These results indicate that APRN-led education is paramount in encouraging interdisciplinary team members to access clinical care pathways. Nurse inquiry into evidence-based means of providing such education over the long-term to obtain sustainability is essential. Further investigation is needed to address patient-specific outcome measures of LOS, mortality, and readmission rates as they relate to IE pathway use over time, and correlation to outcomes.

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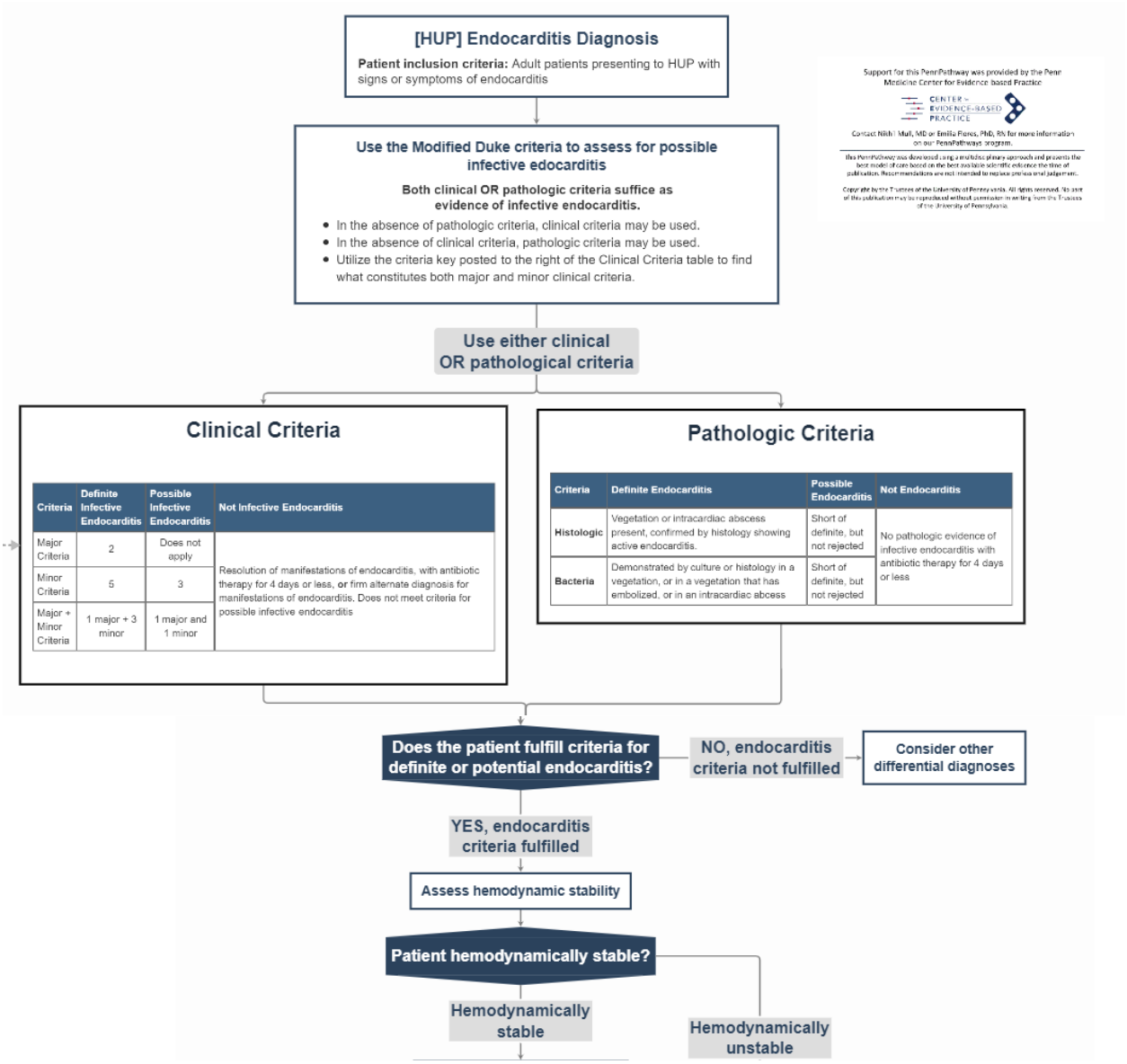

Figure 1. Endocarditis pathway: Endocarditis diagnosis subsection. The pathway organizes and prompts interdisciplinary interventions. Interventions include diagnostic criteria, consults, blood tests, diagnostic imaging, and antimicrobial therapy. HUP = Hospital of the University of Pennsylvania. Images provided and permission for use courtesy of Penn Medicine Center for Evidence Based Practice.

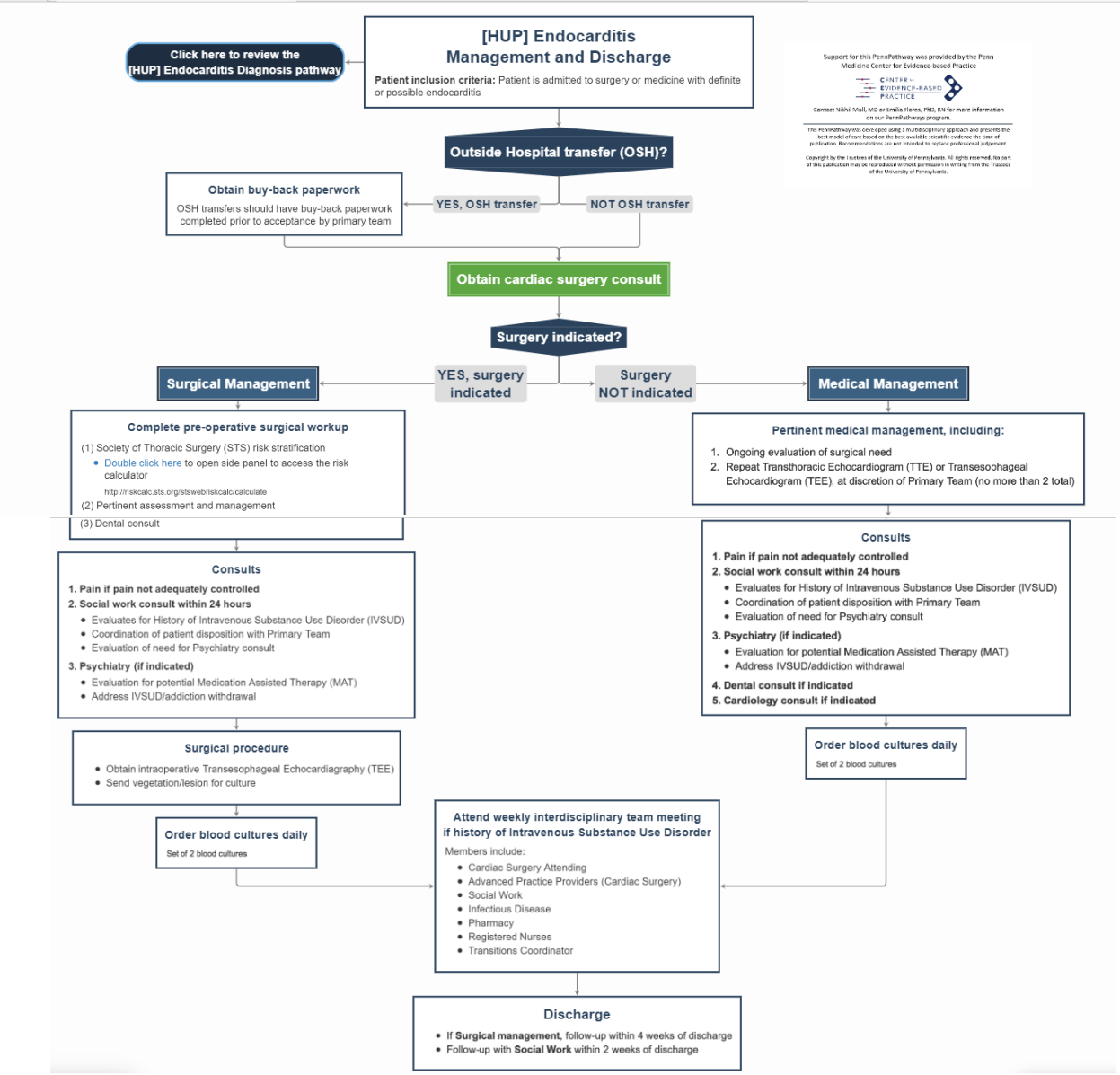

Figure 2. Endocarditis pathway: Management and discharge subsection. The pathway organizes and prompts interdisciplinary interventions. Interventions include consults, blood tests, diagnostic imaging, and interdisciplinary team meetings. HUP = Hospital of the University of Pennsylvania. Images provided and permission for use courtesy of Penn Medicine Center for Evidence Based Practice.

Table 1

Comparing Daily Number of Views by Month

Measurement	Month			*p*
	July	August	September	
Days in month with views	20	13	15	
Total number of views	123	29	39	
Daily number of views, Median [IQR]	4.00 [3.00, 6.00]	2.00 [1.00, 2.00]	2.00 [1.00, 3.50]	.003

Note. IQR = interquartile range

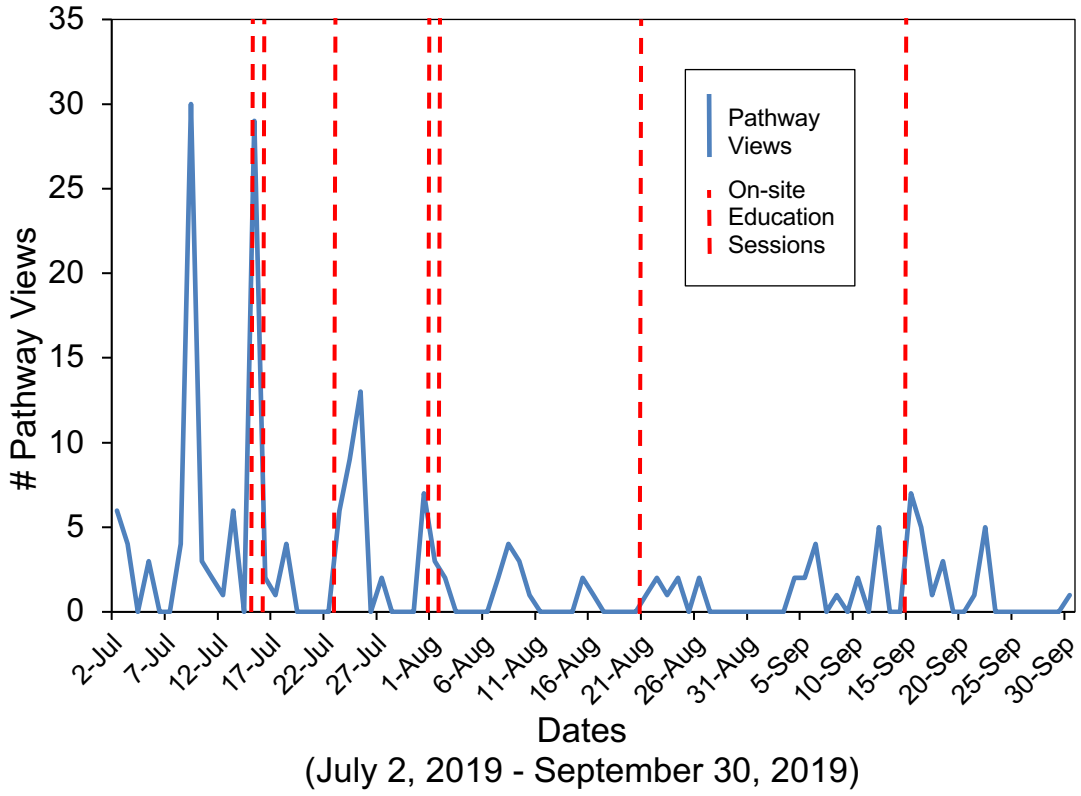

Figure 3. Graph of endocarditis pathway views plotted over a period of three months. Members of the interdisciplinary team that were educated included registered nurses, nurse practitioners, physician assistants, social workers, and a physician.