Evaluation of Patient Engagement on Driveline Infection Rates in LVAD Patients through Digital Education

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Abstract

Mechanical circulatory support in the form of a left ventricular assist device (LVAD) can support patients with advanced Heart Failure (HF). The most common complication following LVAD implantation is driveline infection (DLI) leading to increased morbidity, mortality, and costs. Management of the driveline insertion site by the patient at home after discharge is critical in prevention of DLI. A quality improvement project utilizing the FADE model was conducted by leveraging video-based education delivered via an electronic health portal and evaluated the impact on infection rates, 30-day readmission rates in LVAD patients, and patient engagement. Post-implementation, the DLI rates remained unchanged, 30-day readmission rates improved slightly, and patient engagement was low with newly implanted patients although higher in prior implants. Limitations included types of delivery mechanisms within the electronic health portal and overall engagement and activation of the electronic health portal. The use of video-based education allowed for consistent delivery of educational material and has the ability to impact morbidity, mortality, and costs. A multi-modal approach to LVAD education supports enhanced patient education and earlier engagement may be more beneficial to enhance utilization. Future recommendations include evaluation of timing of delivery and other delivery methodologies such as QR codes.

Keywords: Ventricular assist device, VAD, driveline infections, patient education, digital education

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Section I. Introduction

Advancements in the management of Heart Failure (HF) in the form of mechanical circulatory support require heightened attention to patient education. Inaccurate management of the support device at home can result in increased morbidity, mortality, and costs for this patient population. Evaluation of digital strategies to enhance patient engagement with educational materials is explored as a method to promote patient outcomes.

Background

Almost seven million Americans are affected by HF, and it is predicted to continue to rise (Tsao et al., 2023). Although treatment of HF has improved over the years, almost 15% of patients still progress to advanced HF requiring heart transplantation; yet, this option is limited due to supply and eligibility requirements (Dunlay et al., 2021; Jorde et al., 2024). Mechanical circulatory support, in the form of a durable left ventricular assist device (LVAD), can support advanced HF patients as either a bridge to transplant or as destination therapy (Mehra et al., 2019). The internal LVAD pump is connected to an external power source via a driveline, which is maintained by patients at home post-discharge. Driveline infections (DLI) are the most frequent complication post-implantation and can result in increased morbidity, mortality, and costs (Krzelj et al., 2022; Trachtenberg et al., 2023). Proper management of the driveline and LVAD insertion site by patients' post-discharge is critical to decreasing infection risk and cost of care as well as improving patient outcomes (Pavlovic et al., 2019; Zhou et al., 2023).

Organizational Needs Statement

The target organization is a large academic quaternary care center located in the southeastern United States. The project site is the largest ventricular assist device (VAD) program in the country and is accredited by The Joint Commission (TJC). TJC monitors LVAD

infection rates as a component of accreditation based on the Endurance Supplemental Trial patients as the benchmark. At this organization, driveline infections are defined by erythema surrounding the driveline or exit site and purulent drainage from the LVAD driveline associated with a positive culture that necessitates antibiotic treatment. Per reporting instructions, infections are counted once per patient regardless of the duration of infection, are described as a rate-based phenomenon, and are expressed as infections per patient year on pump support. TJC benchmark for infection rates is 0.16 events/patient's year of support. The organizations' infection rate in 2023 was 0.10 events/patient's year of support. Of note, given that the definition is infections per patient's years of support, larger programs and those with more patients supported will have more dilute years of support resulting in lower infection rates. This prompted the LVAD program to participate in the Society of Thoracic Surgeons (STS) Interagency Registry for Mechanically Assisted Circulatory Support (INTERMACS). This registry collects and collates data on patients receiving LVAD therapy from participating centers, excluding clinical trial patients, allowing for programs to benchmark their outcomes (Jorde et al., 2024).

Early LVAD infection is defined as occurring within the first 3-months post-implant; whereas, a late infection is after three months (Jorde et al., 2024). Through the INTERMACS registry, the organization identified an increased risk of all-cause early infection, 30.61 per 100 patient month, compared to the INTERMACS cohort of 12.89 per 100 patient month. Specifically, early driveline infections rates in 2023 ranged from 0.95 to 2.86 per 100 patient month compared to the benchmark cohort rates of 0.79 to 1.03 per 100 patient month. Given that different patients are enrolled and evaluated in both sets of national data, the internal program also evaluated all of their patient data in aggregate. This identified between 2018 and 2022, driveline infection rates increased from 5.6% to 23.3%. Management of the driveline site is

critical to infection prevention yet variability in patient education related to driveline management is persistent across the care continuum (Harap et al., 2022). Given the rise of driveline infections, there was a need to evaluate patient education for management of the driveline site post-discharge.

LVAD infections can result in increased admissions, stroke rates, and mortality (Cho et al., 2019; Krzelj et al., 2022; Zhou et al., 2023). Not only is morbidity and mortality for patients impacted, but these infection rates are a component of national ratings, influence accreditation, and are a key focus of optimization for the LVAD program and organization. The Institute for Healthcare Improvement (IHI; n.d.) consists of three key goals: improving the experience of care, improving population health, and reducing per capita cost. Improving driveline infection rates would result in enhanced population health for this patient population and decrease costs associated with the treatment of the infection such as re-admissions. Moreover, by decreasing infection rates and enhancing patient education around management, the patient's experience with care increases. Finally, improving health literacy is a key objective for Healthy People 2030 as health literacy is associated with improve patient outcomes (U.S. Department of Health and Human Services [DHHS], n.d.). Enhancing patients' health literacy in driveline management supports meeting the Healthy People 2030 objectives.

Problem Statement

LVAD driveline infection rates have increased and are above the INTERMACS registry benchmark. Increased infections could impact readmission rates, healthcare cost, and TJC accreditation. Furthermore, although standards for patient education are in place, discharge resources at home for driveline management are minimal, inconsistently administered, and it is challenging to evaluate if materials are utilized.

Purpose Statement

The purpose of this project was to implement and evaluate a multimodal patient educational strategy focused on driveline management on early LVAD driveline infection rates and 30-day readmission rates post-discharge.

Section II. Evidence

Literature Review

A literature search was conducted via PubMed and CINHAL databases between June and July 2024. Search terms included “VAD” and “infection prevention”. This resulted in 88 articles. Only full text articles in English, with a publication year 2018 or more recent, and any level of evidence were included in this review. Once criteria were applied, 43 articles remained. Articles were screened for title and abstract with articles related to treatment of active infection excluded. Any articles related to infection prevention techniques were read in entirety to determine if they were appropriate and applicable. Given the low volume of articles, all levels of evidence were kept.

Current State of Knowledge

A review of the literature revealed that a multi-pronged approach to infection prevention in LVAD patients was standard of care. Pre-operatively, patients should utilize chlorhexidine (CHG) wipes for bathing the night before surgery (Krzelj et al., 2022). Intraoperative management of blood glucose was also identified as a standard recommendation. Pre-operative and intra-operative antibiotics to decrease risk of infections were identified as a best practice although there was a wide variation in the types of antibiotics utilized and length of time for prophylactic use (Krzelj et al., 2022; Mourad et al., 2020).

Management of the driveline and exit site was identified as a consistent key factor in prevention of DLIs (Krzelj et al., 2022; Mourad et al., 2020; Qu et al., 2021; Saeed et al., 2022). However, similar to prophylactic antibiotics, the strategy for managing this intra-operatively and post-operatively varied. Utilization of an anchoring device was identified as a best practice in multiple centers (Krzelj et al., 2022; Qu et al., 2021; Saeed et al., 2022). Standardized

recommendations for dressing changes consisted of utilization of sterile technique, cleansing of the site daily, and placing a protective dressing (Krzelj et al., 2022; Pavlovic et al., 2019; Qu et al., 2021). Although differences in management, findings from this review demonstrated that patient and caregiver education in management of the driveline site is a critical component of infection prevention (Krzelj et al., 2022; Qu et al., 2021; Pavlovic et al., 2019; Spielmann et al., 2021).

Current Approaches to Solving Population Problem(s)

Prophylactic antibiotic usage for 24-48 hours is a common strategy to reduce risk of DLI in the LVAD patient population (Mourad et al., 2020; Qu et al., 2021). Specifically, recommendations focus on coverage for both gram-positive and gram-negative organisms through the use of a cephalosporin (Qu et al., 2021). However, a large variety in the number of antibiotics utilized and the duration of use still widely varied in the practice setting (Mourad et al., 2020).

Intraoperatively, surgical techniques may have an impact on DLI. Some of these strategies include not allowing the velour of the cannula to be external, utilization of purse-string sutures, and anchoring devices (Qu et al., 2021). However, the evidence for these recommendations is largely based on expert opinion and case studies demonstrating the need for higher level or rigor prior to strong practice recommendations.

Driveline site management remains one of the top ways to prevent DLI (Krzelj et al., 2022; Pavlovic et al., 2019; Qu et al., 2021). However, there is not one evidence-based standardized method to a driveline dressing change. Consensus identifies strict sterility, antiseptic solution utilized on the exit site, and maintenance of an external dressing are all important in management of the driveline exit site (Krzelj et al., 2022; Pavlovic et al., 2019; Qu

et al., 2021). These devices are managed at home by the patients and their caregivers. Patient and caregiver engagement in training is, therefore, essential in the prevention of DLI (Krzelj et al., 2022; Pavlovic et al., 2019; Qu et al., 2021). Despite the importance of this, variability among education strategies and guidelines exists (Harap et al., 2022). Moreover, literature available online was found to be above recommended reading levels for the general population (Rouhi et al., 2022). Overall, a multi-pronged approach inclusive of simulation, teach-back, videos, and written instructions was the most consist of intervention found in a review of the literature (Barsuk et al., 2019; Krzelj et al., 2022; Qu et al., 2021; Pavlovic et al., 2019; Seretny et al., 2022; Spielmann et al., 2021).

Current practice as this organization included prophylactic antibiotic use, standard suturing technique and anchor placement intraoperatively, as well as a standardized process for the driveline dressing change. No specific literature had a strong enough recommendation to warrant altering current practice. Therefore, a renewed focus on patient education and engagement and utilization of a multi-modal strategy was selected as the approach to improving DLI.

Evidence to Support the Intervention

Current practice in the project site includes dressing changes in the hospital by the patient as well as a teach-back method. Moreover, written instructions with individualized steps are provided to the patients. However, other resources for patients and caregivers at home were lacking. Transition from discharge to home resources is a critical component of DLI prevention (Casida et al., 2018). Utilization of video-based education has been shown to be an effective tool in decreasing DLI (Barsuk et al., 2019; Barsuk et al., 2020; Seretny et al., 2022; Spielmann et al., 2021). Video based education and utilization of digital care platforms have also demonstrated

benefit in other patient populations including oncology, general surgery, cardiac surgery, lifestyle management, and many others (Kuwabara et al., 2019; Lopez-Olivo & Suarez-Almazor, 2019; Milliren et al., 2022; Oudkerk Pool et al., 2021; Turkdogan et al., 2021; van Steenbergen et al., 2022; Zhitomirsky & Aharony, 2023). Therefore, enhancing the current patient education program with a focus on discharge transition and utilization of digital patient education was the intervention chosen for this project. See Appendix A for literature matrix.

Evidence-based Practice Framework

The quality improvement model utilized in this project was the Focus, Analyze, Develop, and Execute (FADE) model. The FADE model was developed at Duke University utilizing concepts of LEAN and Six Sigma (Garlejo et al., 2023; Gee, 2024). In the *Focus* stage, the team identifies the problem statement, generates a list of problems, selects one problem to focus on, and defines that specific problem (Wiseman & Kaprielian, n.d.). During *Analyze,* evaluation of baseline data and influential factors and the team determines any other information that is needed to evaluate areas of opportunity. In *Develop*, generation of various solutions is completed, selection of one solution to try, and an implementation plan is completed. During *Execute,* the plan is implemented, and evaluation of the impact is completed.

The Health Promotion model, developed and tested by Nola J. Pender, describes how cognitive-perceptual and modifying factors are directly proportional to the likelihood of a patient engaging in health promoting behaviors (Pender et al., 1988). Specifically, the concepts of perceived benefits, barriers, and self-efficacy were utilized as a framework to guide this project. Enhancing patient's knowledge regarding care they provide at home and providing tools to do so, support perceived benefits of action and self-efficacy and may decrease perceived barriers.

Ethical Consideration & Protection of Human Subjects

This project was reviewed by the organization's and university's Institutional Review Board (IRB). This project was determined exempt as quality improvement by the university's IRB (see Appendix B). The project was also determined exempt as quality improvement by the health systems IRB (see Appendix C). The intervention was equitable to all in the target population as multiple modalities were utilized to ensure all materials were received. No potential harm was identified.

Section III. Project Design

Project Site and Population

The targeted project site was a large academic quaternary care facility in the southeastern United States. The facility has over 1,000 beds, numerous operating rooms, level one trauma center emergency department, and a large ambulatory platform. Patient populations cared for at this facility include cardiology, cardiothoracic (CT) surgery, oncology, general medicine, neurology, orthopedic, trauma, obstetric, pediatrics, and many others. Patients from every race and over 30 different ethnicities are represented in the patients served.

Description of the Setting

This project took place within the CT surgery departments. This included three CT stepdown units consisting of 86 patient care beds. The CT surgery units consisted of over 150 nurses and 60 advanced practice providers involved in the study. Additionally, the 32 bed CT intensive care unit (CTICU) staff were also informed of the project given patient education can begin in the intensive care unit (ICU) setting.

Description of the Population

Patient populations included in this project were adult patients 18 years old or older with a durable LVAD implanted and discharged between January 1, 2025 and March 31, 2025. Newly implanted or re-implant patients were included. Patients were excluded if not discharged by March 31, 2025, were not English speaking, and had no access to the patient portal or valid email address.

Project Team

The project team consisted of multiple key stakeholders including one LVAD clinician, the Director of the Heart Failure Program, one CT surgeon, two advanced practice providers

(APPs), two patient advisors, two clinical nurse educators, three nursing leaders, one internal registry data analysis team member, and two informational technology team members. The LVAD clinician served as a content expert and assisted with drafting of video scripts. Additionally, they were the featured voiceover in the educational materials developed. The APPs, CT Surgeons, nursing leaders, and the Director of the Heart Failure Program served as content reviewers and provided feedback prior to educational content submission. The nurse educators supported the development of the content and submission to the Patient Education Governance Committee (PEGC) for approval of materials. Moreover, they assisted with the recording of the content for uploading to the digital platform. The information technology team members provided guidance on submission of materials to the digital platform and built the logic for automated delivery. Lastly, our data analysis team member supported aggregating data metrics for both pre and post intervention groups.

Project Goals and Outcome Measures

A quality improvement project utilizing the FADE model was conducted to evaluate the impact of a multimodal patient education strategy including digital health technologies on patient engagement, infection rates, and 30-day readmission rates in LVAD patients. During *Focus,* the interprofessional stakeholder team identified that DLIs were a specific opportunity for the program. In *Analyze,* evaluation of all the factors impacting DLI prevention were reviewed, and feedback was received by the various stakeholder teams. During the *Develop* stage, the team identified an opportunity to enhance patient education and engagement through the utilization of video-based education delivered via the electronic health portal.

Description of the Methods and Measurement

In 2023, INTERMACS early driveline infection rates of 0.95 to 2.85 per 100 patient month were higher than the benchmark cohort rates of 0.79 to 1.03 per 100 patient months. Moreover, upon internal review, driveline infection rates increased from 5.6% to 23.3% between 2018 and 2022. Driveline infection rates were evaluated for the intervention period.

Internal database review in 2023, identified 5.1% of newly implanted LVAD patients were readmitted within 30 days due to a driveline infection. This was increased from 2021 and 2022 which saw 0% of patients readmitted within 30 days due to a driveline infection. For newly implanted or re-implanted patients discharged from January 2025 to April 2025, 30-day readmission rates were evaluated.

The digital platform captures each unique patient's access of digital education through their patient portal via opening of the content. Moreover, the amount of the video that is watched is captured in a range of less than 9%, between 10%-24%, 25%-49%, 50%-75%, 75%-99%, and 100% completion. Patient engagement with the digital educational material was evaluated via percent of patients who accessed the material as well as the amount of the video that was watched.

Discussion of the Data Collection Process

LVAD infection rates during the project period were sent to the project lead in aggregate by the Heart Failure Director and data analysis team members via internal registry databases. This data was collected via an internal review team through the electronic health record (EHR) and sent to the INTERMACS registry. STS INTERMACS incidence of infections are the number of events/ the number at risk multiplied by 100 which is reported as an infection rate per 100 patient month. Infection rate per 100 patient month was calculated via the benchmarking agency and provided to the internal teams in aggregate.

Thirty-day readmission data was captured through a standardized internal registry database. Readmission reasons were documented in the EHR and reconciled by project lead to validate accuracy. Percent of readmissions within 30-days of discharge due to driveline infections were calculated.

Engagement with the digital platform was reviewed in aggregate through an internal dashboard. Engagement of the content was defined as any opening of the educational materials sent to the patient. De-identified individualized data for project participants was evaluated to determine specific levels of engagement through the internal dashboard. The percentage of video completion was collected via the dashboard in ranges of less than 9%, between 10%-24%, 25%-49%, 50%-75%, 75%-99%, and 100% completion.

Implementation Plan

The interprofessional project team was engaged in the review of current materials and creation of digital education materials validating that content was at the appropriate level for patient education through the organization's patient education governance council. Current education methods of simulation-based learning with teach back for the dressing change as well as written instructions for the dressing changes remained the same for the implementation period. New digital content was created consisting of an LVAD dressing change video as well as a specific video on sterile gloving technique.

Upon completion, the videos were uploaded to Xealth, the organization's digital platform for patient education. International Classification of Diseases (ICD) codes were utilized to identify which patients should receive the education. Automation logic was built within the digital platform to deliver the content to the patient's digital portal upon discharge from a CT stepdown unit. If the patient had not engaged with the content within seven days of discharge,

the platform automatically sent a reminder to the patient. Multiple education sessions including individualized rounding, staff meetings, emails, and huddles were utilized to provide education to the interprofessional teams of the new educational content and automation process. Moreover, teams were educated on the digital education component of the EHR to determine if their specific patient had engaged with the content.

Timeline

Historical program data was reviewed and evaluated in May of 2024 indicating an opportunity with driveline infections in the LVAD patient population. A literature review was conducted between June and July 2024 to identify evidence-based strategies to prevent driveline infections. In August of 2024, patient education scripts for the video content were created and submitted for review to the organization's patient education and governance committee with approval of materials in September of 2024. Between September of 2024 and October of 2024, educational materials were finalized and submitted electronic educational platform team for evaluation. Approval of educational materials from the PEGC was received in October of 2024 for an upload date of January 1, 2025. Education of inpatient teams including bedside nursing, LVAD clinicians, CT surgeons, and advanced practice providers was completed throughout November and December of 2024. Driveline infection data was collected on the targeted patient population between January and March 2025 as this cohort of patients is provided via the national benchmarking registry. Post-implementation data collection and evaluation occurred between May and June 2025 for 30-day readmissions and patient engagement with final analysis and dissemination in July of 2025.

Section IV. Results and Findings

Results

One hundred and nineteen patients received the dressing change video through the electronic health portal between January 2025 and April 2025. Patients were excluded due to initial error in automation build resulting in non-receipt of the material (n=5), deceased prior to discharge (n=1), prior implant (n=84), and no access to digital portal or email on file (n=2). Ultimately, 27 patients met inclusion criteria for the project.

In 2023, INTERMACS early driveline infection rates of 0.95 to 2.85 per 100 patient month were higher than the STS LVAD sites benchmark cohort rates of 0.79 to 1.03 per 100 patient months. Moreover, upon internal review, DLI rates increased from 5.6% to 23.3% between 2018 and 2022. DLI rates during the intervention period were 2.56 per 100 patient month.

In 2023, 5.1% of newly implanted LVAD patients were readmitted within 30 days due to a driveline infection. This increased from 2021 and 2022 which saw 0% of patients readmitted within 30 days due to a driveline infection. For newly implanted or re-implanted patients discharged between January 2025 to April of 2025 30-day readmission rates were 0.

The digital platform captured each unique patient's access of digital education through their patient portal via opening of the content. Moreover, the amount of the video that was watched was captured in a range of less than 9%, between 10%-24%, 25%-49%, 50%-75%, 75%-99%, and 100% completion. Overall, patient engagement with the digital educational material was 15.97% (n=19). PDSA cycle 1 showed 0% engagement with the targeted patients. After including patient reminders in regular follow up calls and routine visits, engagement in the targeted cohort increased to 8.3% (n=1). The amount of content watched ranged from less than

9% to 100%, with 68.42% (n=13) watching less than 9% and 15.97% (n=3) watching 100%, respectively.

Discussion of Major Findings

LVAD infection rates remained unchanged in the pre-implementation group compared to the post-implementation group. Thirty day-readmission rates improved but engagement with the content was low throughout the PDSA cycles. Barsuk et al. (2019) and Casida et al. (2018) noted improved patient outcomes with the utilization of simulation and multi-modal education techniques for LVAD patients. Multi-modal patient education can enhance patient outcomes and reduce costs (Fitzpatrick, 2023; Fleisher et al, 2023; Knudsen et al., 2024b). Specifically, digital strategies can enhance patient knowledge/competency (Fleisher et al., 2023).

Despite the benefits of digital strategies, engagement with various educational platforms can be varied which was seen in this project utilizing only automatic delivery (Kakhki et al., 2025; Knudsen et al, 2024a; Walker et al., 2020). Other challenges included limited access to the digital education content or low e-health literacy resulting in less engagement (Kakhki et al., 2025; Knudsen et al, 2024a; Walker et al., 2020). Follow up calls or appointments post-discharge can improve patient outcomes (Gebeyehu et al., 2024; Lukanski et al., 2023). Although these strategies were leveraged in the second PDSA cycle, only minimal increases in engagement were seen. Utilization of multi-modal strategies during time in the hospital in addition to access to content delivery post-discharge may improve engagement and outcomes in this patient population.

Section V. Interpretation and Implications

Costs and Resource Management

Direct costs of digital health platforms are hard to determine but often consists of one-time integration fees and monthly subscription fees (Altynpara & Khodukina, 2024). In this organization, the digital platform one-time fees had already been paid for over an eight-year period and the monthly maintenance fees of the platform cost the organization at $1,000 per month. However, this platform is used throughout multiple service lines and for numerous patient conditions, so it is not a direct cost to the project itself as there are not individual charges for each type of content. Additionally, the salaries of the digital strategy team would be a cost to the organization although this direct information is not available. However, the median salary for a digital analyst in North Carolina is $83,000 (Glassdoor, 2025). The bulk of the project is related to the creation of educational materials. LVAD driveline dressing change kits had to be utilized to demonstrate the dressing change. Many hours were dedicated to filming and editing in addition to approvals through various counsels. A few other educational projects did have a lower prioritization to ensure this project was completed.

Treatment for a DLI can vary greatly depending on multiple factors such as patient condition and extent of the infection (Juraszek et al., 2021; Yarboro et al., 2014). This can range from oral antibiotics to pump replacement. Given the invasive nature of this device, it is not uncommon that more extensive infection either at the site or even in the bloodstream can occur requiring intravenous (IV) antibiotics, surgical debridement, or in extreme cases, pump replacement and hospitalizations. On average, the cost of care for a patient with a DLI is approximately $43,000 more than the cost of care for a patient that does not experience a DLI (Peleg et al., 2023). This is based on many factors including the type of treatment, readmission to

the hospital if needed, and follow-up appointments. It is estimated that direct hospital costs for a readmission are approximately $11,500 per episode with one hospital noting over one million dollars in the cost of readmission (Seretny et al., 2022). Given the current rate of DLI within the organization, the annual costs incurred by the organization is estimated to be over $500,000 a year. It is important to note that if the infection becomes more extensive or chronic, the patient can be readmitted multiple times in the same year for a recurrent infection further increasing the costs.

In addition to the costs of the treatment for DLI, DLI rates can also impact accreditation and rankings through TJC or INTERMACS. Overall, accreditation is associated with improved quality, hospital performance, and costs (Alhawajreh et al., 2023; American College of Cardiology, n.d.; Hussein et al., 2021; The Joint Commission, 2024). An organization would want to avoid loss of accreditation from poor performance as it would risk the quality and financial benefits of accreditation.

Implications of the Findings

Management of a LVAD at home requires complex care by patients and families. A standardized approach to educational delivery and methodology is critical to patient outcomes. Management of this device can impact overall patient outcomes and organizational metrics such as cost and accreditation.

Implications for Patients

LVAD care is complex and can result in increased patient and caregiver anxiety (Barsuk et al., 2020). Increased anxiety can result in diminished understanding of resources provided which can result in decreased patient satisfaction and compliance with care (Benson et al., 2022; Melholt et al., 2018). Moreover, consistent education delivery is impactful for patient outcomes

(Benson et al., 2022; Cutilli, 2020). The ability to access the education materials in a consistent fashion and allow caregivers to review education provides enhanced support for patients caring for this device at home. Although a designated caregiver is present for training during the hospitalization, this methodology allows additional caregivers to review the educational materials as well. Additionally, the platform allows for more real time adjustments to practice changes that may be necessary related to the educational material provided ensuring that the patients have the most up to date material quickly.

Implications for Nursing Practice

Variation naturally exists between nurses teaching content to patients. A standardized video for education ensures a consistent approach to patient education. This consistent approach to education enhances the delivery of the education materials and supports patient outcomes (Benson et al., 2022; Cutilli, 2020). Moreover, leveraging technology at the bedside can decrease the burden of education while maintaining consistency of education (Mohammadnejad et al., 2023). As with all educational materials, regular validation of accuracy of content should be evaluated and updated accordingly. Unlike paper educational materials, this content can be updated more regularly and provided to the nurses, patients, and caregivers in a timelier manner.

Impact for Healthcare System(s)

Patient education and engagement are essential in promoting improved patient outcomes and digital strategies can promote patient engagement (Fitzpatrick, 2023; Fleisher et al., 2023; Knudsen et al., 2024b). Enhanced patient outcomes can result in decreased morbidity, mortality, and costs. Therefore, despite the initial costs of digital education, organizations could realize a large cost savings. In addition to cost savings related to improved care, process improvement work and sustaining accreditation can result in overall quality improvement, increased revenue,

and reduced costs (Alhawajreh et al., 2023; American College of Cardiology, n.d.; Hussein et al., 2021; TJC, 2024). Lastly, Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) Surveys are a way for patients to provide feedback on their experience with care (CMS, 2024). There are numerous questions on patient education contained in this survey. Additional approaches to enhancing patient education, such as digital automation and availability, could lead to enhanced scores. Higher HCHAPS scores can lead to better reimbursement as well as improve the reputation of an organization and increase referrals (CMS, 2024).

Sustainability

This digital education platform promotes sustainability of educational materials as it supports one local place for education storage allowing for easier management and updates to education as needed. The LVAD program has dedicated nurse clinicians who are able to continue reviewing education and promoting processes to support patient engagement. A dedicated team of technology specialists are also in place to update content or automation as needed. However, the triggers within the system are limited to certain parameters such as a scheduled procedure or ICD codes that could make further dissemination of the materials challenging.

Dissemination Plan

The results and learnings from this project were shared at the East Carolina University (ECU) College of Nursing on July 8, 2025, as part of the defense for the Doctorate of Nursing Practice in Leadership capstone course. Additionally, a review and discussion of the project and next steps was completed on July 11, 2025, at organization's interprofessional Ventricular Assist Device Operations meeting. This paper was submitted to "The ScholarShip", which is a digital

archive for scholarly work created through programs at ECU. The authors submitted a publication to the Journal of Nursing Care Quality as this journal supports the mission of quality improvement work at the bedside and has objectives that align with leveraging technology for enhanced patient care. Additionally based on acceptance, the authors submitted to the Computer/Informatics/Nursing journal as this journal has a focus on utilization of informatics for improving patient care and nursing workflow. Lastly, a poster presentation abstract for evidence-based was submitted to the American Association of Critical Care Nurses National Teaching Institute, due by September 15, 2025.

Section VI. Conclusion

Limitations and Facilitators

This project had several facilitators and limitations. Facilitators included clinical engagement, expert resources, and strong data management. Limitations also existed including technology barriers and process limitations.

Facilitators

This project had many facilitators throughout its duration. First, a strong team of experts were engaged in utilizing the FADE Model to determine the scope of the project. The faculty and preceptor advisor had a large volume of experience with conducting quality improvement projects and supported the project through several iterations to implementation. Additionally, subject matter experts in the LVAD dressing change were able to participate in ensuring content was accurate. Moreover, patient education experts were available to support the creation of the content. Second, this organization had leveraged digital education portals for other projects. As such, the platform and technology experts were readily available to support the project. This platform was also already a component of the EHR and eased the burden of educating the bedside teams. Third, data experts within the organization were already engaged in reviewing similar metrics related to accreditation of the program and this made it easier to collate and review data throughout the project.

Limitations

Despite the many facilitators mentioned above, this project did encounter some barriers. First, Computerized Procedural Technology (CPT) code was the preferred method for creating the logic for the digital education trigger as this would send the education only to patients newly implanted or re-implanted. However, the system was unable to accurately send using CPT codes

during testing requiring ICD codes to be utilized. This resulted in less specificity of the education dissemination and included LVAD patients that were already implanted leading to more complex data mining requirements. Second, utilization of the platform required access to the digital patient portal or a digital email on file. This excluded some patients from the ability to view or see the content. Third, as the project continued, the project team identified that there was not a strong system approach around ensuring access to the patient portal or standardized contact information in the EHR. This further limited the number of individuals that were able to access the content provided.

Recommendations for Others

When creating educational content, patient feedback is crucial to the development of those resources, the delivery methodology, and the timing of receipt (Barsuk et al., 2020; Benson et al., 2022; Cutilli, 2020). For instance, the delivery of the content noting that the LVAD team wanted to the patient to watch this material rather than a generic "your healthcare provider" was a motivator for patients to more likely engage in this content. To promote scalability and sustainability, processes to ensure patients have access to the patient portal or an alternative method of receiving information should be conducted prior to a patient's discharge at minimum. Reconciliation of this information could be performed by many team members based on patient population, organizational structure, and resources. Opportunities for regular review and feedback from both the end users (patients) and subject matter experts is critical (Walker et al. 2020; Van Steenbergen et al., 2022; Zhitomirsky & Aharony, 2023).

Recommendations Further Study

Given the large life changes with the implantation of this device, digital automation after discharge was not engaged with as originally anticipated. This was still seen after inclusion in the

post-follow up call and discharge meeting although a slight increase in engagement was seen in this second PDSA cycle. Per patient feedback, the sterile gloving aspect of the driveline dressing was one of the most challenging pieces. Next steps for this project will include bundling a specific sterile gloving video with the LVAD dressing change video. This project also transitioned to another PDSA cycle with the LVAD clinicians beginning June 1, 2025. The LVAD began to manually send the digital content to the patients during their hospital stay during their initial meet and greet with the patient (Barsuk et al., 2019; Casida et al., 2018). This occurs before the formal training day. They instructed the patients and their caregivers to watch the dressing change video prior to their formal teaching day. Learnings from this cycle informed the next steps for this project.

This type of education could be leveraged for other care as well. For instance, a need for sterile gloving videos is seen for many of our patients providing care at home such as central line dressing changes or other wound changes. Moreover, entire dressing change videos could be created for central line dressings or wounds in addition to other care at home such as tube feeding care. There are currently no proactive strategies in place to ensure patients have access to the patient portal. System approaches to ensuring all patients have access to digital portal or have an alternative method for receiving the education material is imperative to enhance the success of engagement (Walker et al. 2020; Van Steenbergen et al., 2022; Zhitomirsky & Aharony, 2023).

Final Thoughts

DLI and readmissions lead to increased morbidity, mortality, and costs. Moreover, these scores can impact accreditation for a program which could ultimately result in decreased revenue. Given the critical role of patients in prevention of infection, strategies to enhance education, increase patient comfort, and improve patient competency are essential. The use of the

digital platform is an innovative way to address this although it does incur some cost. Moreover, operational components can be barriers and continued engagement, and patient feedback is essential in utilization of the resources. Despite the challenges of engagement with this project, strategies to promote patient education and engagement through digital platforms can impact patient and organizational outcomes and warrants further exploration.

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Appendix A

Literature Review Spreadsheet

Authors	Year Pub	Article Title	Theory	Journal	Purpose and take home message	Design/Analysis/Level of Evidence	IV DV or Themes concepts and categories	Instr. Used	Sample Size	Sample method	Subject Charac.	Comments/critique of the article/methods GAPS
Barsuk, Cohen, Harap, Grady, Wilcox, Shanklin, Wayne, & Cameron	2019	Patient, caregiver, and clincian perceptions of ventricular assist device self-care education inform the development of a simulation-	None	*Journal of Cardiovascular Nursing*	To explore patient, caregiver, VAD coordinator, and physician perspectives and perceptions of existing VAD self-care training to inform development of a simulation-based mastery learning curriculum to teach patients and caregivers VAD self-care skills and knowledge	Level VI qualitative research	Content, standardization, training modalities, repetition, refresher training	Semi-structured interview questions	46	Interviewed patients, caregivers, VAD coordinators, physicians currently at organization	Age 50s, White, high school or higher, medicaid,	The authors found that repetition, simulation, and multiple modalities is helpful for patient education for LVADs Limitations: single center, self-selection bias Usefulness: describes multiple perspectives for items that can benefit education Synthesis: simulation based learning is helpful for training but multiple modalities is needed for multiple learning styles
Barsuk, Wilcox, Cohen, Harap, Shanklin, Grady, Kim, Nonog, Schulze, Jirak,	2020	Simulation-based mastery learning improve patient caregiver ventricular assist device self-care	None	*Circulation: Cardiovascular Quality and Outcomes*	To evaluate utilize of videos and simulation based training on knowledge acquisition, competence, and self-confidence compared to usual training	Level II RCT pilot Independent t test Wilcoxon rank test	IV: simulation based training DV: knowledge, self-confidence, competency	Written exams (pre/post test) VAD self-care skills Self-confidence scale adapted	40 caregivers and 40 patients (20 in intervention and 20	Scheduled to receive LVAD and have an available caregiver and radomized to the control or	Patients: 50s, males, white, high school or higher; caregivers, similar	Simulation trained patients and caregivers improved their knowledge acquisition, self-confidence remained the same, Limitations: single center, low volume for one type of VAD implanted, discharge testing unable to be completed for some patients Usefulness: reinforces simulation based and multimodal strategies needed
Seretny, Pidborochynski, Buchholz, Freed, MacArthur, Dubyk, Cunliffe, Zelaya, & Conway	2022	Decreasing driveline infections in patients supported on ventricular assit devices: a care pathway approach	None	*BMJ Open Quality*	To determine if standardized care pathways would reduce driveline infections (DLI) and related admissions within 1 year post-implant	Level VI QI project Retrospective Descriptive	IV patients with care pathway DV: DLI rates	INTERMACS registry data	55 (34 non CP retrospective group; 21 CP intervention group)	Adult patients undergoing VAD implantation between 8/1/2018 and 7/31/2019	Median age 56; 87% male;	Higher portion of intervention group with DLI but decreased during index admission and overall decrease within 1st year post-implant Limitations: single center, COVID pandemic and resource availability, small sample size, bundled program so unable to evaluate individual components Usefulness: demonstrates importance of patient engagement and standardized approach Synthesis: Multi-pronged program consistenting of many attributes currently seen identifies video based education as additional method to support patient education and engagement.
Spielmann, Seemann, Friedrich, Tigges-Limmer, Albert, Semmig-Konze, Spitz-Koberich, & Kugler	2021	Self-management with the therapeutic regimen in patients with venticular assist device (VAD) support - A scoping review	None	*Heart & Lung*	Literature review of current state of evidence related to VAD self-management	Level V Scoping review PRISMA-ScR		PICOS scheme	20	Identification of articles, screening, eligibility, inclusion critiera	narrative reviews, observational designs, experimental designs, theory based/opinion	Described overall results for various components such as device management, symptom management, infection prevention, etc. Limitations: only included adult patients, no critical appraisal of the documents, narrow search requirements Usefulness: described infection prevention strategies and digital technology for patient education Synthesis: standardized high quality training for patients is essential and patient support/education is critical; additional research needed to better understand patient preferences and needs
Kuwabara, Su, & Krauss	2019	Utilizing digital health technologies for patient education in lifestyle medicine	None	*Lifestyle Medicine*	To describe various methods of digital engagement	Level VII Expert review	Text messaging Mobile Social media Wearable devices Telehealth	None	NA	NA	NA	Digital health technologies can improve patient education and implementation of skill acquisition Limitations: not a true review of literature just expert opinion review Usefulness: describes various methods of digital strategy engagement Synthesis: digital strategy can enhance patient education and additional evaluation is needed to verify accuracy
Lopez-Olivo & Suarez-Almazor	2019	Digital patient education and decision aids	None	*Rheumatic Disease Clinics of North America*	To describe and define decision aids, what digital aids are, advantages and disadvantages, and criteira for development	Level VII Expert review	Evidence Based Education Decision Aids Digital decision aids Advantages and Disadvantages Criteria for development	None	NA	NA	NA	Decision aids are critical in patient care and digital decision aids should reach the highest rigor as well. Implementaiton success is multi-factoral and is important to include patients. Limitations: only a consensus statement Usefulness: important conecepts for designing digital education aids Synthesis: digital patient education strategies can be useful but must meet the high standards of evidence-based care and education

Milliren, Lindsay, Biernat, Smith, & Weaver	2022	Can digital engagement improve outcomes for total joint replacements?	None	*Digital Health*	Evaluation of digital delivery patient education materials on surgical cancellation, length of stay, and discharge disposition	Level III Quasi-experimental Descriptive	IV: 22 sequenced digital prompts delivered via email or text through the perioperative period DV: surgery cancellations, day of surgery cancellation, LOS, discharge disposition, ED visits, and readmissions	Electronic health record used to abstract data	2027 overall (stratified by hip versus knee and pre/post intervention)	Retrospective prior to implementation; implementation group of patients scheduled for total join replacement surgery in the facility	Majority of females in their 60s or higher with a variety of payor mix	Post-intervention group more likely to have a cancelled surgery but not the day of, LOS was shorter, and those with higher engagement were associated with higher odds of discharge home and shorter stays. Limitations: single center setting and may not be gneralizable, quasi-experimental, limited data collection Usefulness: ties digital strategy to outcomes Synthesis: Utilization of digital patient engagement can result in enhanced patient and operational
Oudkerk Pool, Hooglugt, Schijven, Mulder, Bouma, de Winter, Pinto, & Winter	2021	Review of digitalized patient education in cardiology: A future ahead?	None	*Cardiology*	Review of literature to evaluate status of innovative, digitalized means of patient educaiton in cardiology and assess the impact on various patient outcomes	Level V Literature review (Medline and EMBASE)	Digital education platforms impact on: patient knowledge, QoL, depression/anxiety, patient satisfaction	Heatmaps to review and describe outcomes of articles	279 initial (34 kept with final analysis on 16)	Medline and EMBASE with inclusion/exclusion critiera applied	Application, web-based, videos	Overall, digital education helped patients with lower health liteacry and knowledge. Video based education has the highest impact in all categories. Limitations: only cardiology populations involved; small number of articles able to be included Usefulness: describes key factors in supporting success of digital education and positive impacts on patients Synthesis: video-based education was the largest studied category and most helpful related to patient outcomes such as satisfaction, QoL, etc. and importance of ensuring content is presented clearly
Turkdogan, Schnitman, Wang, Gotlieb, How, & Gotlieb	2021	Development of a digital patient educaiton tool for patients with cancer during COVID-19 pandemic	None	*JMIR Cancer*	To describe the development and implementation of a web-based patient educaiton tool and it's impact on hospital operations and patient satisfaction	Level VI Descriptive	IV: digital education DV: patient feedback	None described	1,244 viewers of the 4 videos	Convience sample of those scheduled for clinic visit	Majority of participants female between 25-34	Clinicans and patients should be engaged when designing digital tools. Limitations: single cneter, no statistical tests, lack of description of instruments used Usefulness: point of ensuring patient feedback is provided; framework for development Synthesis: digital tools could enhance patient engagement and decrease hospital resource needs but futher evaluation warranted from this study
van Steenbergen, van Veghel, van Lieshout, Sperwer, ter Woorst, & Dekker	2022	Effects of video-based education and consultation on unplanned health care utilization and early recovery after coronary artery bypass surgery (IMPROV-ED):	None	*Journal of Medical Internet Research*	Evaluation of an eHealth program to decrease readmissions and improve mental/physical health 6 weeks after CABG	Level II RCT intention to treate principle Descriptive	IV: eHealth program DV: volume and costs of unplanned healthcare, anxiety, adepression	Anxiety subscale of HADs Recovery Index - 10 Technology Assessment Medical Consumption Questionnaire	280 enrolled after attirtion 135 control and 128 intervention	All patients > 18 on waiting list for CABG surgery were asked to participate based on inclusion/exclusion criteria	Groups homogenous with age in 60s, mostly male, multiple combordities, intermediate education lelve, and BMIs of 27	Cost was signficantly reduced for intervention group and RI-10 was higher for intervention group. Anxiety and depression were not impacted. Limitations: some selection bias of who chose to participate, intervention in addition to standard care, occurred during COVID-19 pandemic so multiple confoudning variable for participation Usefulness: describes how digital programs can impact unanticipated returns of care Synthesis: costs of care and patient report improvements in outcomes can be seen with digital strategy
Zhitomirsky & Aharony	2023	The effect of a patient education multimodal digital platofrm on knowledge acquisition, self-efficacy, and patient satisfaction	Theory of self-efficacy	*CIN: Computers, Informatics, Nursing*	To examine the impact of digital training instrument for self-injection	Level II-III Two-arm controlled trial with randomized cluster sampling Mann-Whitney U tests and Chi squared tests; variance analysis	IV: four digital modalities for learning of self-injection DV: patient knowledge, self-efficacy, patient satisfaction	Enoxaparin sodium self-injection knowledge questionnaire New General Self-Efficacy Scale Patient Satisfaction Questionnaire	176 initial randomized to control/intervention (40 in each arm completed all parts of study	Randomized based on patients planned for home self-treatment in 3 random units within facility	No statstiscal differences in groups (mean age of 20; majority male with higher education)	Knowledge acquisition was improved with digital tools although there was no difference in self-efficacy. Patient satsifaction was higher in the control group receiving standardized provider education. Limitations: single medical institution, one language included, Usefulness: demonstrates increased knowledge acquisition pre/post test and enhances need to keep other components of program the same Synthesis: digital education strategies can enhance patient knowledge but may not improve self-efficacy or satisfaction
Casida, Combs, Pavol, & Hickey	2018	Ready, set, go: How patients and caregivers are preared for self-management of implantable ventricular asist device	None	*American Society for Artificial Internal Organs*	To explore the process of preparing patients and caregivers for VAD self-management before hospital discharge and to describe their perceived experiences of discharge process	Level VI Descriptive	Describing types of materials used and patients perceptions of usefulness of resources	VAD Hospital Discharge Survey	218 (102 patients and 116 caregivers); based on inclusion and exclusion criteria	recurited from support group members	Mean age of 50, White, married, with college education	Majority of centers utilized simulation/hands on, additional materials consisted of handbooks, manuals, videos, and self-monitoring Limitations: self-selection bias given all tools were voluntary and participants chose to be in the study, valdity of tools not described Usefulness: describes common findings and patient feedback Synthesis: hands on education is the highest satisfier but video based information is also highly ranked

Appendix B

University Institutional Review Board Determination

Based on your responses, the project appears to constitute QI and/or Program Evaluation and IRB review is not required because, in accordance with federal regulations, your project does not constitute research as defined under 45 CFR 46.102(d). If the project results are disseminated, they should be characterized as QI and/or Program Evaluation findings. Finally, if the project changes in any way that might affect the intent or design, please complete this self-certification again to ensure that IRB review is still not required. Click the button below to view a printable version of this form to save with your files, as it serves as documentation that IRB review is not required for this project. 9/9/2024

Appendix C

Organization Institutional Review Board Determination

[redacted]

[redacted]STITUTIONAL REVIEW BOARD DECLARATION OF EXEMPTION FROM IRB REVIEW

IRB has determined that the following protocol meets the criteria for a declaration of exemption from further IRB review as described in 45 CFR 46.104(d), satisfies the Privacy Rule as described in 45 CFR 164.512(i), and satisfies Food and Drug Administration regulations as described in 21 CFR 56.104, where applicable.

Protocol ID: Pro00116205
Reference ID: Pro00116205-INIT-1.0
Protocol Title: Improving Driveline Infection Rates in LVAD Patients through Patient Engagement & Digital Strategy
Principal Investigator: Deborah Allen
Review Date: June 28, 2024
Expiration Date: **Does not expire*
Exempt Category: N/A

*This Declaration of Exemption from further IRB Review is in effect from June 28, 2024 and does not expire. However, changes to the proposed research will require an amendment requesting re-review for exemption. Reportable serious adverse events and unanticipated problems related to the research that place subjects or others at risk of physical, psychological, economic, or social harm must be promptly reported to the IRB and will result in reconsideration of the activity's exempt status.

[redacted]