8-2024

Implementation of Synchronous and Asynchronous CAR-T Education For Emergency Room and Intensive Care Unit Nurses in Non-Oncology Units

Kylie Kuck
kylie.kuck001@umb.edu

Implementation of Synchronous and Asynchronous CAR-T Education For Emergency Room and Intensive Care Unit Nurses in Non-Oncology Units

Kylie Kuck, DNP, AGCNS-BC

College of Nursing and Health Science, University of Massachusetts Boston

July 29, 2024

Submitted in Partial Fulfillment of the Requirements for the Doctor of Nursing Practice Degree

Project Committee

Faculty Advisor: Joanne Roman Jones, JD, PhD, RN

Practice Site Mentor: Alexandra Dormal, BSN, RN

Committee Mentor: Joyce Larson, DNP, ANP-BC

Abstract

Background: Chimeric antigen receptor T cell (CAR-T) therapy is a novel and promising cancer treatment for hematologic malignancies. This treatment is highly regulated by the Food and Drug Administration (FDA) and The Foundation for the Accreditation of Cellular Therapy (FACT) because of the known toxicities associated with treatment.

Local problem: In 2022, FACT published guidelines requiring formal education for both oncology and non-oncology nurses who care for these patients, including emergency room and intensive care unit nurses.

Methods: This quality improvement project provided education to emergency room and intensive care unit care nurses who are caring for CAR-T cell therapy patients using synchronous and asynchronous education sessions.

Interventions: This quality improvement project focused on providing education to emergency room and intensive care unit nurses caring for CAR-T cell therapy patients outside of the oncology unit regarding documentation and identification of Cytokine Release Syndrome (CRS) and Immune Effector Cell Associated Neurotoxicity Syndrome (ICANS), grading of toxicities, and subsequent triage, and appropriate interventions according to clinical guidelines published by the American Society for Transplantation and Cellular Therapy.

Results: In total, 141 staff from the medical intensive care unit and emergency room completed the education and post-survey. Pre and post intervention survey results showed an increase in learner knowledge and skill in CAR-T cell therapy, CRS, and ICANS. There was not a substantial difference between learner outcomes when synchronous and asynchronous learning was compared. Continuing education opportunities were identified from the post data survey.

Conclusion: Both synchronous and asynchronous education are an effective means of proving education. However, when given the option, more learners chose to participate in synchronous education rather than asynchronous. Both methods should be offered to learners in the future and embedded into unit orientation.

Introduction

Problem Description

Chimeric antigen receptor T cell (CAR-T) therapy is a novel and promising cancer treatment for hematologic malignancies. To date, there are six Food and Drug Administration (FDA) approved therapies and more are expected to come on the market in the near future. Additionally, there are hundreds of clinical trials continuing the study of CAR-T cell therapy for various hematologic and solid tumor malignancies (Lee et al., 2019).

As with most cancer treatments, CAR-T cell therapy carries a risk of serious adverse reactions and toxicities. As such, patients receiving CAR-T cell therapy require close monitoring for, and rapid intervention when, adverse reactions or toxicities develop. The two most common toxicities associated with CAR-T cell therapy are Cytokine Release Syndrome (CRS) and Immune Effector Cell-Associated Neurotoxicity Syndrome (ICANS). Both CRS and ICANS are expected toxicities. The American Society for Transplantation and Cellular Therapy (ASTCT) has issued guidelines that outline standardized grading of CRS and ICANS as well as recommended treatment guidelines for these toxicities. To reduce mortality and avoid negative patient outcomes such as intubation or coma, it is imperative that clinical staff caring for patients receiving CAR-T cell therapy are educated on the processes of screening, identifying, assessing, and grading both CRS and ICANS, as well as the components for rapid interventions required for treatment (Lee et al., 2019).

CAR-T cell therapy is a highly regulated treatment. In 2019, The Foundation for the Accreditation of Cellular Therapy (FACT) published regulations for all FACT accredited organizations stating, “the clinical program shall have nurses formally trained and experienced in the management of patients receiving cellular therapy” (Foundation for the Accreditation of

Cellular Therapy [FACT], 2022, p 64). The educational standards set by FACT state the education should focus on "cytokine release syndrome, tumor lysis syndrome, cardiac dysfunction, respiratory distress, neurologic toxicity, macrophage activation syndrome, renal and hepatic failure, disseminated intravascular coagulation, anaphylaxis, neutropenic fever, infectious and noninfectious processes, mucositis, nausea and vomiting, and pain management" (FACT, 2022, p. 65).

Local Problem

At one large tertiary academic hospital, the CAR-T cell therapy program is embedded into the FACT accredited Bone Marrow Transplant (BMT) program. This structure is comparable to other CAR-T cell therapy programs and was embedded mainly due to the BMT service having the infrastructure to support regulatory requirements, cell processing, clinical care delivery, and data reporting required for treatment of these patients (Taylor et al., 2019).

The current standard of care is that patients receiving CAR-T cell therapy are admitted to the inpatient unit for a minimum of seven days for CAR-T product infusion and monitoring of toxicities. This organization is creating infrastructure to move CAR-T cell therapy infusion to the ambulatory setting. During this process, it was identified that there is a need for education on units that are outside of the oncology service. This need has become apparent because as CAR-T cell therapy and its management move to the ambulatory setting, there will be an increased probability of patients developing toxicity at home outside of oncology clinic hours and they are likely to present to the emergency department for evaluation. As such, it is critical that emergency room nurses receive targeted education regarding CAR-T cell therapy toxicities, including how to document screening and assessment, and how to manage these toxicities.

Having emergency room nurses who are adequately trained will prevent delays in the identification and management of CAR-T cell therapy that could lead to poor patient outcomes.

During the grading process, if a patient is determined to have grade 3 or 4 toxicity, they are transferred to the intensive care unit for monitoring and care. In the original protocol, the Nursing Professional Development Specialist (NPDS) or Program Manager was notified of the transfer to provide just-in-time education to the intensive care unit staff upon transfer. There was also a unit resource guide that included protocols and medical staff information for off-shift hours when neither the NPDS nor Program Manager were available. From January 1, 2019 to December 31, 2022, twenty-five CAR-T cell therapy patients required transfer to the intensive care unit with an average length of stay of 7.2 days. As CAR-T cell therapy patient volume and product availability increase, transfer rates may also increase. In the existing workflow, if patients are admitted to the intensive care unit from the emergency room, notification of the patient's admission may inadvertently not be provided to the NPDS or Program Manager, further increasing the chance of delay in documentation and intervention. It is important to develop and standardize education for both emergency room and intensive care unit nurses who may care for CAR-T cell therapy patients, to equip them with the knowledge necessary to adequately recognize and respond to these complications to avoid potentially serious or fatal complications.

Available Knowledge

A PRISMA-guided review of the literature was conducted to explore effective teaching strategies for experienced nurses. Thirteen studies were chosen for this review, as well as two guidelines from the American Society for Transplantation and Cellular Therapy and the Foundation for the Accreditation of Cellular Therapy. To review these articles, the Johns Hopkins Nursing Research Appraisal tool was utilized. Of the 13 identified articles, 7 were studies with 3

being quantitative studies and 4 qualitative studies. Six articles comprised of expert opinions, clinician experience, and integrative reviews were also reviewed. Four of the 13 articles focused on medical, nursing, or post-graduate student populations and 9 focused on experienced nurses from oncology, critical care, and established cellular therapy programs. A summary table was created (Appendix A) and potential interventions extracted from the literature search included e-learning and virtual learning; active learning using case studies and visuals; synchronous and asynchronous learning; blended learning; and traditional didactic learning.

Although a majority of available literature within the last five years focuses on e-learning and virtual learning as a result of the COVID-19 pandemic, all of the selected studies regarding virtual learning for this review focused on virtual learning for students rather than experienced nurse learning; a systematic review in one article identified decreases in student motivation, peer collaboration, cognitive problem solving, interacting with instructors, and community support as barriers to virtual learning (Naciri et al., 2021). Blended learning was also found to be a prominent teaching method, although was noted to have mixed results. According to an integrative review completed by Coyne and colleagues (2018), blended learning improved knowledge transfer and student satisfaction when compared to didactic teaching. In other studies, reviewed by Coyne and colleagues, researchers found that the inclusion of videos allowed participants to review information as many times as needed and allowed for more flexible learning (Coyne et al., 2018). However, Coyne and colleagues (2018) found that when offered a blended learning option and an in-person learning session, 68% of the nurses included in the study participated in an in-person training and discussion versus 64% in the pre-recorded modules, demonstrating that more staff participated in in-person learning activities (Coyne et al, 2018).

Two expert opinion articles focused on utilizing a didactic method for standardized teaching regarding management of CAR-T cell therapy patients and associated toxicities. Taylor and colleagues (2019) explained that didactic courses may be appropriate for general information and a skills checklist for procedural tasks but should also meet the needs of the learner. Standardized preparation of nurses should include treatment side effects (CRS and ICANS), recognition and management of oncologic emergencies, and blood product and chemotherapy administration (Taylor et al., 2019). Similarly, Beaupierre and colleagues (2019) wrote about their experience in offering dedicated educational sessions for patients, caregivers, and clinical providers on the multidisciplinary team to ensure optimal treatment of CAR-T patients. According to the authors' outline of education to include at the post-infusion stage, nurses "should have a thorough understanding of how to assess, monitor, and treat patients for CRS, neurologic events, cytopenias, hypogammaglobulinemia, infection, and secondary malignancies" and know how to treat toxicities using pharmacologic and non-pharmacologic methods (Beaupierre et al., 2019, p. 36).

Active learning, which incorporates case studies and visuals into teaching strategies, was found to be effective among both postgraduate oncology nursing students and also experienced nurses. A study by Bi, Zhao, Yang, and Wang (2019) found an increase in examination scores among students who utilized case-based learning compared to those who had a didactic lecture. In this study, students who were taught using traditional methods scored an average of 74.58 ± 6.87 on exams whereas the students who participated in case-based learning scored an average of 86.39 ± 7.15. Furthermore, students who participated in case-based learning reported a satisfaction score of 92.5%, whereas traditional learners reported a satisfaction score of 70%.

Another study explored the utilization of case studies and discussion as a method to bridge communication and learning between oncology and critical care nurses and received positive feedback (Hull & O'Rourke, 2007). Mangold, Kunze, Quinonez, Taylor, and Tenison (2018) surveyed 2,071 nurses from all levels and departments at a tertiary academic medical center to assess their preferred learning styles and found that learning activities should implement educational activities for both visual and sensory learners as they were the preferred learning styles among those surveyed regardless of age, gender, or experience. These three studies (Bi, et al., 2019; Hull & O'Rourke, 2007; Mangold et al., 2018) support the proposition that active learning (including case studies) is an effective teaching method for experienced nurses as it is associated with increased performance and satisfaction scores.

Boespflug (2022) used synchronous and asynchronous learning to improve nursing participation in continuing education by using Microsoft teams, which allowed for real-time chats, interactive participation, and a recording function. Post activity confidence survey scores improved from an average of 2.49 to 3.15, with 4 being highest possible confidence score. Attendance improved from 28 learners during in person sessions to 408 learners using virtual or recorded format. Synchronous and asynchronous learning with a virtual and recorded option allowed learners to participate during work time or from home by accessing materials after the live session.

Rationale

This quality improvement project focused on providing education to nurses working in the emergency departments and intensive care units regarding onset, severity, and management of CAR-T cell therapy and its associated toxicities. These units are fast-paced, dynamic units and after completing an external mapping tool (Appendix B) and considering unit needs and the time

required as detailed in a cause-and-effect model (Appendix C), the intervention provided education via a synchronous and asynchronous method to engage learners and to allow flexibility of learner participation. As there is strong evidence supporting integration of active learning methods for nurses regardless of age, gender, or experience, these synchronous and asynchronous education sessions incorporated visual and case-based learning in addition to the content outlined by the FACT standards, ASTCT guidelines, and other expert opinion articles. The intensive care units and emergency departments had staff with a wide range of experience spanning from novice nurses to nurses with over 30 years of experience. The synchronous and asynchronous education format was the best intervention to meet as many learning needs as possible and allowed for necessary flexibility.

Although there were no intervention theories that appeared in the articles reviewed, there was an opportunity to incorporate a change model with this project. This quality improvement project incorporated Lewins's Change Management Model which focuses on three stages to implement change: unfreezing, change, and refreezing (MindTools, 2023). During the unfreezing stage, the learners are prepared to accept that change is necessary. In the change stage, learners begin to understand the benefit, accept the change, and implement it into practice. Finally, in the refreezing stage, the change has been fully incorporated into daily practice and learners feel confident and comfortable with the information and change. This change theory was chosen as the education intervention focused on the specific toxicities and management of CAR-T cell therapy which may be incorrectly diagnosed as a more common cause of illness. For example, medical professionals who are not trained in CAR-T cell therapy toxicities may have a patient who presents with or develops a fever and hypotension or confusion and aphasia and may consider neutropenic fever or stroke rather than CRS and ICANS, which could delay appropriate

treatment for the patient. Additionally, upon transfer to the intensive care unit currently, required documentation screening for CRS and ICANS is often missed until the staff is educated on its importance in identifying early changes to provide appropriate interventions. It was important to "unfreeze" the participants and explain the reasoning for screening tools and the severe outcomes of a potential delay in treatment for CAR-T patients. During the change phase, case studies were used to help reinforce management guidelines to show the benefit to patients (Zaccagnini & Pechacek, 2021). In the refreezing stage, learners were given a scenario and patient assessment and asked to choose the appropriate interventions based on the information given. This was incorporated into the learner evaluation and assessed for understanding of the unique toxicities associated with this therapy. Further, learners were asked about their comfort in caring for CAR-T patients after this education.

Specific Aims

The purpose of this quality improvement project was to improve care of the CAR-T patient being cared for in non-oncology settings. The overarching aim of the project was to develop, implement and evaluate an online learning program about CAR-T therapy, associated toxicities, and interventions for emergency room and intensive care unit nurses. The specific aims of this project included:

- Convene stakeholders to gather input regarding education needs for emergency room and intensive care unit nurses on non-oncology units and outline education session.
- Design course materials including case studies to be used in synchronous and asynchronous online education sessions that follow FACT standards.
- Develop an electronic survey (KeySurvey) to be used pre and post intervention to assess knowledge and perceived comfort levels when caring for CAR-T patients.

- Educate 75% of participating emergency room and non-oncology intensive care unit nurses through synchronous and asynchronous education sessions.
- Emergency room and intensive care nurses who participate in either synchronous or asynchronous education session will have an increase in knowledge and skills in assessing and treating side effects of CAR-T.
- Emergency room and intensive care unit nurses who participate in either synchronous or asynchronous education session will report an increase in comfort when caring for patients who have undergone CAR-T therapy.
- Analyze online education format using KeySurvey and assess need for continuing education opportunities.

Methods

Context

This project was implemented at a tertiary medical center in Connecticut. The institution is the only National Cancer Institute (NCI)-designated comprehensive cancer center in Connecticut and one of only 54 centers in the nation. The organization offers a Stem Cell Transplant and Cellular Therapy program that includes CAR-T cell therapy. This microsystem is further detailed in Appendix B: External Mapping Tool.

Executive and local leadership is transparent in their communication with staff and fosters a positive culture. Town Halls, which outline new programs and goals of the organization while allowing staff a platform to inquire about these efforts or other initiatives, are held regularly. At the local level, departments are supported in sharing information throughout units within their service line. Service lines are multidisciplinary and made up of all inpatient and outpatient units which treat a population or disease state. Service lines allow for better continuity

of care for patients as they move through the healthcare system. Electronic platforms, such as Microsoft SharePoint, have been created for each service line as well as other departments which allows the sharing of pertinent information and resources impacting staff. As these platforms are created by individual service lines, they are not often utilized by staff outside the service line within which they are developed, causing a lack of knowledge sharing when patients are admitted to units outside their intended medical specialty.

Education, staff training, and development is valued at the organization. There are a multitude of classes offered within service lines including continuing education classes and professional development courses. Within the oncology education and practice department, there are a variety of oncology fundamentals classes offered monthly, as well ongoing continuing education sessions offered monthly that are open to all staff. Oncology patients can be admitted to other service lines depending on their primary problem and, often, the oncology education practice and development office will collaborate with other service lines for skills such as port-a-catheter access, chemotherapy administration, and cancer specific education.

Multidisciplinary rounds are an organization standard and are held daily. Participants in multidisciplinary rounds include, but are not limited to, physicians, advanced practice providers, nursing, and pharmacy. One limitation to multidisciplinary rounds is that consulting teams such as hematology, Bone Marrow Transplant/CAR-T, and neuro-oncology, are not always present, which can potentially cause delay in recommendations and treatment for patients. For patients who require transfer to the intensive care unit, the primary team becomes the Critical Care team, and the Bone Marrow Transplant/CAR-T team becomes a consult team. Although the critical care providers are educated on CAR-T cell therapy monitoring and guidelines, they often depend

on guidance from the Bone Marrow Transplant/CAR-T team to ensure optimal care for these patients.

As a FACT accredited site for stem cell transplant and cellular therapy, safety reports and performance metrics are reviewed regularly. An oncology safety huddle is held on weekday mornings where leadership reports out any safety reports from the past 24 hours. This process exists to raise awareness of trends in safety concerns and to share improvements which are instituted as a result of safety events. Additionally, a monthly quality improvement meeting is held for the stem cell transplant and CAR-T program. This meeting is attended by all leadership and disciplines within the cellular therapy program and performance metrics are shared. The informatics team has worked collaboratively with the stem cell transplant and CAR-T cell therapy providers to develop reports for tracking any program data. This allows for real time data that is easily accessible and available for sharing data metrics with the program stakeholders. For CAR-T patients, this includes how many infusions were completed, length of stay, and review of any patients who required transfer to the intensive care unit.

A cause-and-effect model (Appendix C) of the current state outlines factors that lead to gaps in compliance with CAR-T monitoring and providing interventions per guidelines. Contributing factors include a large turnover of nursing staff during the COVID-19 pandemic leading to nurses who were previously trained in caring for these patients leaving the bedside for other opportunities, a lack of nurse and patient experience with CAR-T therapy on non-oncology units, and no standardized nurse and provider education leading to a need for just in time education upon patient transfer. There is also a low volume of CAR-T patients who are transferred outside of oncology to non-oncology units; however, once transferred, they are considered high acuity.

This quality improvement project provided education to emergency room and intensive care unit care nurses who are caring for CAR-T cell therapy patients who may experience treatment toxicities. A force field analysis was created (Appendix D) to consider driving and restraining factors of this quality improvement project. Driving forces for this project were the requirement by FACT to provide formal education to nurses caring for cellular therapy patients and compliance requirements for the ASTCT guidelines regarding monitoring and grading of toxicities. Further, there was leadership support from both nursing and physicians within oncology, the intensive care units, and the emergency rooms to improve non-oncology nurses' knowledge and skill in caring for CAR-T cell therapy patients. Intensive care unit nurses, including those on the hospital "SWAT" team who respond to rapid responses and medical emergencies, had also expressed interest in learning more about CAR-T cell therapy patients and the toxicities associated with these treatments. By utilizing both synchronous and asynchronous learning, there was flexibility for a wide variety of staff to participate in this critical education.

Barriers to this education included a low volume of patients and a large number and variety of practice areas. At the main hospital campus, most CAR-T cell therapy patients receiving care outside of the oncology units are admitted to the medical intensive care unit; however, there are three emergency department locations and four intensive care units that could potentially care for CAR-T cell therapy patients. Another barrier was time to complete education. As the intensive care unit is usually at full capacity, staff would need to plan their shifts in a way which allowed them the time to participate in either a live or recorded education session in order to be allowed to care for CAR-T cell therapy patients. Future potential barriers to maintaining this education program include the need to provide annual competency assessment of nurses to ensure knowledge regarding care of CAR-T cell therapy patients is maintained, as well as the

need to update education as new CAR-T cell therapy products become FDA approved and new recommendations are made for clinical practice.

Intervention

This quality improvement project focused on providing education to emergency room and intensive care unit nurses caring for CAR-T cell therapy patients outside of the oncology unit regarding documentation and identification of CRS and ICANS, grading of toxicities, and subsequent triage, and appropriate interventions according to clinical guidelines. Hospital policy requires documentation on a tool that screens for CRS twice daily as well as identification of CRS grading and early interventions including but not exclusive to antibiotics, intravenous fluids, tocilizumab, vasopressors, oxygen, and steroids. Additionally, policy required documentation on a tool that screens for ICANS every eight hours and with any change in mental status, as well as identification of ICANS grading and early interventions including steroids as outlined in clinical guidelines. A logic model was created (Appendix F) to capture the relationships among the available resources, activities, outputs, outcomes, and overall impact on the CAR-T Program and organization. Pre-implementation interventions involved review of patients' charts, a review of both the FACT Standards and ASTCT guidelines outlining grading and management of CRS and ICANS, and meeting with intensive care unit and emergency room leadership to review these guidelines and gather input regarding the education intervention. Outputs of these reviews included the development of an education program with patient case study questions for non-oncology nurses caring for CAR-T patients, and development of an online "toolkit" for non-oncology nurses.

During the implementation phase, in-person education sessions were held within one of the medical intensive care unit conference rooms and in the break and huddle room of the

emergency department. In the medical intensive care unit, there was a virtual link for those staff who were not scheduled to work but were willing or able to participate in the live sessions. Due to the equipment available in the emergency department, there was no virtual link available for those sessions. A session was also recorded for staff who were unable to participate in the live sessions. The recorded session was also included in a toolkit of resources that was posted on the oncology SharePoint site. Previously, a unit resource binder was utilized that required re-printing of materials when there was a change in practice guidelines or a new CAR-T cell therapy product became available. Using an electronic platform for this toolkit allows for the most current education and resources to be updated and available to staff immediately. Additionally, huddles were implemented when patients were transferred to the intensive care unit or presented to the emergency room. These huddles allowed the project lead to assess knowledge and skill and allow staff the opportunity to ask questions regarding management of and interventions for toxicities. Qualitative data in the form of huddle notes were collected for evaluation.

A pre-test was completed prior to the educational intervention using an electronic survey platform, KeySurvey. This pre-test measured staff's baseline knowledge regarding CAR-T cell therapy toxicities, grading of CRS and ICANS and appropriate interventions, as well as staff confidence in caring for CAR-T cell therapy patient and managing associated toxicities.

The educational intervention as outlined in the intervention map (Appendix E) included a brief overview of what CAR-T cell therapy is, how it works, and the products available to patients based on their cancer diagnosis. The ASTCT consensus grading were reviewed for both CRS and ICANS and the education discussed interventions as outlined in the clinical guidelines for patients depending on their grading. Case study questions were created in which a patient develops CRS and ICANS. This case study was utilized to practice appropriate documentation

utilizing the tools in the electronic medical record as well as to identify appropriate interventions within the intensive care unit. The education was expected to be completed within one hour including time to complete the pre and post survey.

Post implementation interventions included dissemination of a post-test which mirrored the pre-test to assess improvement in knowledge and confidence and was administered directly after both the live and recorded sessions. The post survey was not anonymous as attendance records are a FACT regulatory requirement and staff needed to complete the post survey as well as the education. However, the administrative assistant who extracted the data from KeySurvey removed staff names from the surveys and placed them on a separate log for attendance records, keeping the survey results anonymous to the reviewer. For participants who participated in the recorded course, a QR code with the pre-survey was included in the beginning of the presentation and a QR code with the post-survey was included at the end of the presentation.

Study of the Interventions

Deming's Plan-Do-Study-Act (PDSA) improvement theory was utilized and allowed for modifications to be made to the educational intervention based on participant feedback and staff questions at the huddles (Langley et al., 2009). During the planning phase, program stakeholders were convened to identify education needs of the emergency room and intensive care unit nurses, objective were identified, and a plan was created for data collection. In the Do phase, the synchronous and asynchronous education sessions, as well as unit huddles, were implemented and problems as well as unexpected observations were documented, allowing for the start of data analysis. The Study phase involved complete analysis of the pre and post intervention data and comparison of the data to predictions which could then be summarized. Finally, the Act phase allowed the project lead to assess any opportunities or necessary changes to implement with new

cycles which would then begin the cycle back at the plan phase. By collecting data as the quality improvement project was ongoing, it allowed the project lead to complete early data analysis and identify any changes that needed to be made prior to additional education sessions.

Measures and Analysis

A measures table was completed to identify the process, outcomes, and measures of the quality improvement project as detailed in Appendix G.

Objective 1: *Convene stakeholders to gather input regarding education needs for emergency room and intensive care unit nurses on non-oncology units and outline education session.* To meet this objective, stakeholders including nursing managers, Nursing Professional Development Specialists from the emergency room and intensive care units, CAR-T cell therapy medical providers, cell therapy management, and cell therapy quality improvement, were convened to identify education needs and investigate optimal times for on-unit education as well as frequency of the education. A qualitative review was completed to review meeting minutes from meetings with stakeholders in which education needs were gathered. Baseline data of compliance with guidelines was also obtained by reviewing incident reports and deviation reports in which guidelines were not followed or deviated from. A data tracking tool (Appendix H) collected and managed the data for analysis.

Objective 2: *Design course materials including case studies to be used in synchronous and asynchronous online education sessions that follow FACT standards.* The educational intervention was built using published guidelines, internal policies, and FACT standards to meet the identified education needs of non-oncology nurses in the emergency room and intensive care units. Once the education course was developed, content analysis was completed to ensure the

education incorporated FACT standards and clinical practice guidelines including internal policies. A data tracking tool (Appendix I) was used to collect and manage the data for analysis.

Objective 3: *Develop an electronic survey (KeySurvey) to be used pre and post intervention to assess knowledge and perceived comfort levels when caring for CAR-T patients.* A pre and post intervention survey was developed to assess knowledge, skill, and comfort in caring for CAR-T patients. KeySurvey, an electronic survey tool, was utilized for pre-intervention, post intervention, and 6 month follow up data. Although mandatory completion of the survey may have caused participants to rush completion, time was taken to explain that survey results would help identify needs and recommendations from participants for future education. The survey link was also converted to a QR code which allows participants to access the survey link quickly from their phones. The tools were tested by a small group of participants to analyze feasibility of the tool including that the QR code worked. Surveys were also analyzed for clear content and improvement in knowledge and skills before disseminating to all eligible staff. Once the survey had been determined to be appropriate for data collection, it was implemented pre-intervention and post-intervention. The pre-intervention data collection tool and post-intervention data collection tool allowed tracking of survey responses. Within an excel document, individual responses were collected for pre-intervention responses (Appendix J) and summarized within another sheet (Appendix K). This was repeated for post-intervention responses with individual results being collected (Appendix L) and summarized on another sheet (Appendix M).

Objective 4: *Educate 75% of participating emergency room and non-oncology intensive care unit nurses through synchronous and asynchronous education sessions.* Attendance was recorded to measure participation. This quality improvement project aimed to educate at least

75% of nurses in the emergency room and intensive care units using either the synchronous or asynchronous learning option. Huddles were implemented on the unit when a CAR-T patient is admitted to the emergency room or intensive care unit. The huddle was a means of identifying any barriers to practice or outstanding nursing education needs. A huddle data tool (Appendix N) was utilized to capture discussion and could be reviewed to trend themes or identify other educational opportunities.

Objective 5: *Emergency room and intensive care nurses who participate in either synchronous or asynchronous education session will have an increase in knowledge and skills in assessing and treating side effects of CAR-T.* Utilizing KeySurvey, patient scenario questions were asked in both the pre and post survey. These scenarios remained the same in both surveys. Improved knowledge and skill in identifying and grading CAR-T cell therapy toxicities and providing interventions per guidelines was analyzed by comparing the number of correct responses against the number of questions on the survey. Aggregate data was compared using the pre and post intervention data tools between pre and post intervention surveys to assess an increase in knowledge post education. Data tracking tools (Appendices J, K, L and M) were used to collect and manage the data for analysis.

Objective 6: *Emergency room and intensive care unit nurses who participate in either synchronous or asynchronous education session will report an increase in comfort when caring for patients who have undergone CAR-T therapy.* Emergency room and intensive care unit nurses participating in this education session were also asked to rate their comfort in caring for CAR-T patients using a self-efficacy tool. Aggregate data collected from this question on the KeySurvey was analyzed via the pre and post intervention data tool to assess for an increase in score on the

self-efficacy tool following participation in the education. Data tracking tools (Appendices J, K, L and M) were used to collect and manage the data for analysis.

Objective 7: *Analyze online education format using KeySurvey and assess need for continuing education opportunities.* The KeySurvey tool also allowed for participants to suggest any other opportunities for education or areas where they feel they need continued education. This data was analyzed and reported to the unit educators for continuing education opportunities. Data tracking tools (Appendices J, K, L and M) collected and managed the data for analysis.

Ethical Considerations

In consideration of ethical concerns, all participant surveys completed for this quality improvement project were kept anonymous upon completion although attendance was recorded as maintaining documentation of education is a regulatory requirement. Names were collected from the surveys to ensure post surveys were completed but were eliminated from survey results and kept blinded to the project lead. The project lead, although in a leadership position, is not responsible for staff performance reviews or merit increases and participation in this education would not impact any future staff performance reviews which was also reviewed with participants.

The University of Massachusetts Boston Clinical Quality Improvement Project Checklist was completed (Appendix O) and demonstrated that this project met the criteria for clinical quality improvement and not human studies research. The project “Implementation of Synchronous and Asynchronous CAR-T cell therapy Education for Emergency Room and Intensive Care Unit Nurses” is quality improvement and did not meet the definition of human subjects research because it was not designed to generate generalizable findings but rather to provide immediate and continuous improvement feedback in the local setting in which the

project was carried out. The University of Massachusetts Boston IRB had determined that quality improvement projects did not need to be reviewed by the IRB.

The health care system requires all post graduate nursing students to meet with the Nurse Researcher prior to implementing a project to present the quality improvement project and objectives. Once it was determined that this quality improvement project did not require Investigational Review Board approval, the project lead was given a nursing research application which was completed and reviewed by the Nursing Scientific Review Sub-Committee of the Nursing Research and Evidence-Based Practice Steering Committee prior to implementation. The first step of this process was a letter of intent application which was submitted and presented to the committee for approval. After the letter of intent was approved, a scholarly project application was then submitted and presented for final approval for implementation. Final approval was granted in October 2023 and was valid for one calendar year.

Results

Gather Stakeholders

The first aim of this quality improvement project was to *convene stakeholders* to gather input regarding education needs for emergency room and intensive care unit nurses on non-oncology units and outline education session. This aim was achieved by maintaining notes from these sessions with unit leadership regarding what exposure staff had previously had to CAR-T patients, what the focus of the education would be, and the best times and places to deliver the education.

Meetings with the emergency room and medical intensive care unit stakeholders took place separately. For the medical intensive care unit, a conference room was identified as the best location and there were three time slots that were preferred for providing the education. A total of

twenty sessions were offered. A flyer was created and sent to the staff with the dates and times of the synchronous education as well as a link to the asynchronous education option. Emergency room educators identified that shift change huddles were the most appropriate time for synchronous education. Twenty sessions were also offered in the emergency room at three shift huddle times. An email was sent to staff from their educator informing them of the dates and times as well as the link to the asynchronous education option.

Design Course Materials

The second aim was *to design course materials* which could be used in both the synchronous and asynchronous education. A PowerPoint presentation was developed to review toxicities associated with CAR-T therapy, interventions, and required documentation. Case study questions were incorporated into the education and reviewed throughout the presentation to reinforce toxicity grading and interventions. The PowerPoint presentation was then narrated using a recorded Zoom session and uploaded to Vimeo where it was password protected and a link for sharing the video was generated.

A toolkit was developed which included a unit resource guide with an overview of CAR-T therapy, toxicities, and resources; the recorded PowerPoint education video; and pertinent policies and guidelines regarding care and management of CAR-T patients. This was posted to the Oncology SharePoint site, which is easily accessible to all staff in the healthcare system through the organization's intranet. It was decided to keep the toolkit under Oncology in one centralized location for quality control rather than on both the Medicine and Emergency Service Lines pages as this would require materials to be updated in more than one location.

An outline of the required education was created and used to ensure all items were included in the synchronous and asynchronous education. Once all items were included in either

the PowerPoint or toolkit on the Oncology SharePoint and this aim was achieved, the materials were shared with the Program Manager for feedback and endorsement before presentation to staff.

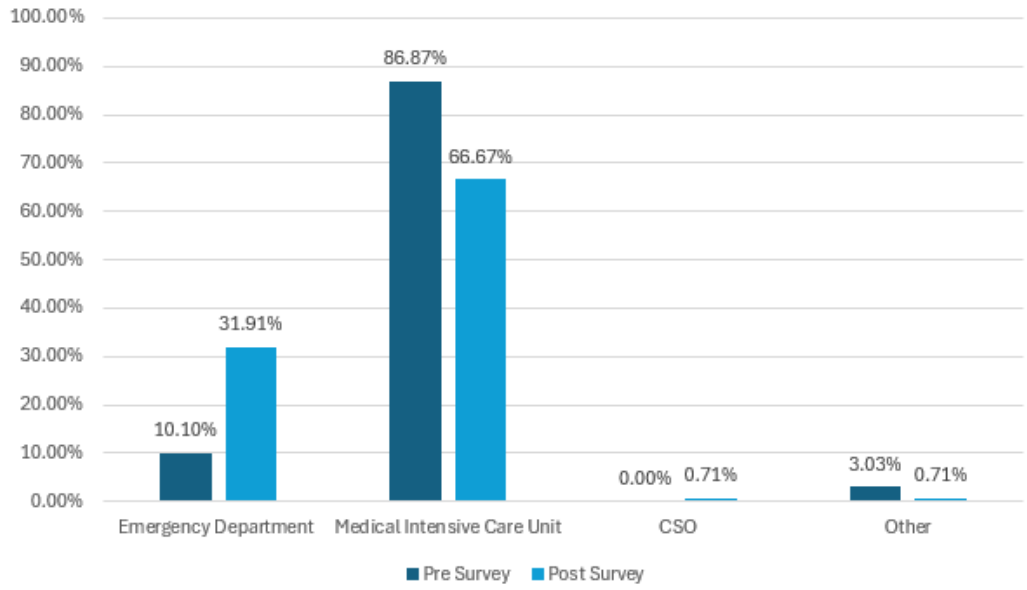
Electronic Survey

The third aim focused on *development of an electronic survey* using the platform KeySurvey *to assess knowledge and perceived comfort levels when caring for CAR-T patients* that could be used for the pre and post intervention survey. This aim was accomplished by creating two separate surveys, one for pre-intervention and one for post-intervention. The questions assessing knowledge and skills were kept the same in each survey and perceived comfort level was included in the post survey. Demographic questions were also added to the post survey as well as questions pertaining to the method of learning the learner chose. Once created and published, each survey link was also converted to a QR code that participants could easily access on either their personal or work phone to complete both the pre and post survey.

KeySurvey results at the end of the quality improvement project showed that there was a total of 99 respondents for the pre survey and 141 respondents for the post survey. As shown in Figure 1, of the pre survey responses, 86.87% were from the medical intensive care unit, 10.10% were from the emergency department, and 3.03% were from outside one of the listed units. In the pre-survey, 0% were from the central staffing office. This unit was included as their staff are often assigned to the intensive care units or emergency departments to provide extra nurses and support based on patient acuity and unit census. In the same graph, of the total number of post survey responses, 66.67% were from the medical intensive care unit, 31.91% were from the emergency department, 0.71% were from the central staffing office (CSO) and 0.71% were from a unit outside of the previously listed units.

Figure 1

Pre and Post Survey Participants

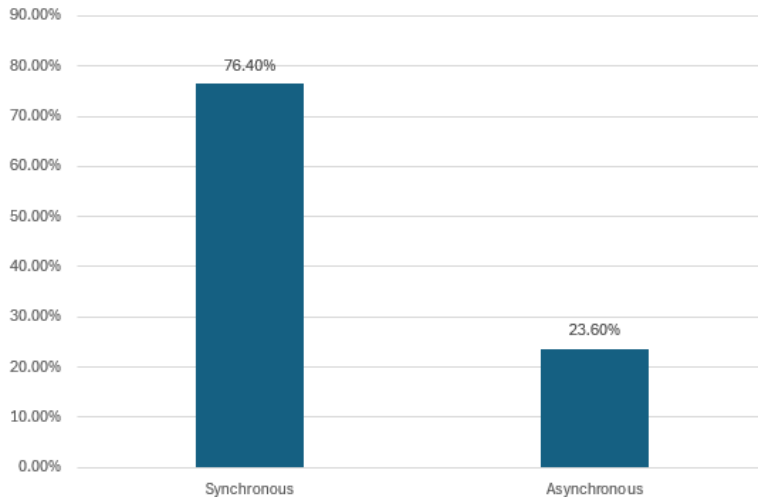


Educate 75% of Emergency Room and Medical Intensive Care Unit Nurses

Another aim of this quality improvement project was *to educate 75% of both medical intensive care unit nurses and emergency room nurses*. A goal of 75% of staff from each unit was chosen because of the regulatory requirement set by FACT. Although this aim was achieved in the medical intensive care unit, it was not able to be achieved in the emergency room. Participants were able to self-select which education format they would participate in. The dates and times for synchronous sessions as well as a link to the asynchronous education option were emailed out to staff by unit leadership two weeks in advance so staff could choose their preferred option and, in the case of synchronous education, a session to attend. Overall, there were 141 post survey participants with 114 completing synchronous education and 27 completing asynchronous education as outlined in Figure 2.

Figure 2

Synchronous vs. Asynchronous Participation in Education



In the medical intensive care unit, there were 161 total staff of which 45 previously completed education. Of the 116 staff members who had not completed education prior to this project, 94 total staff completed the education for a total of 81% of previously untrained staff. Of these staff, 75 completed synchronous education and 22 completed asynchronous education. Of the 94 participants from the medical intensive care unit, 100% completed the post survey.

In the emergency room, at the time of implementation, there was a total of 276 hospital employed staff members. Based on the number of employees, paper attendance records were added which included both hospital employed staff and travelers. These records showed 121 staff attended education sessions, with 117 attending in person, however only 45 nurses completed the post survey for a total of 16%. Of the 45, only 4 completed asynchronous education.

Based on the KeySurvey report, there were two additional staff who completed the education. One nurse from the central staffing office completed a synchronous education session and one nurse completed the asynchronous education session and listed her unit as “other”

meaning she was not from the central staffing office, medical intensive care unit, or emergency department.

Increase Knowledge and Skills

Five questions were asked in both the pre and post survey to assess participants' *increase in knowledge and skills*. The same questions were asked in the post survey to evaluate improvement when comparing pre and post survey results. The questions were asked in case study format with clinical assessment incorporated. For each question that measured knowledge and skill in caring for CAR-T patients, there was a clear improvement in knowledge and skills between the pre and post survey. However, the method of learning, synchronous or asynchronous, did not remarkably impact learner outcomes.

The first question assessed learners' ability to identify CRS from other differential diagnosis common in oncology patients. The learner needed to identify the toxicity based on the patients presenting symptoms and history. The correct response was cytokine release syndrome which improved between the pre, and post survey as shown in Figure 3. In the pre survey, only 50.51% of respondents chose the correct answer compared to the post survey where 90% chose the correct answer of cytokine release syndrome. When comparing synchronous and asynchronous education, slightly more participants in the asynchronous option chose the correct answer as compared to their peers who completed the synchronous education as shown in Figure 4. Of the participants who chose to participate in the synchronous education, 89% selected the correct answer as compared to 92.5% of the asynchronous participants selecting the same answer.

Figure 3

Identification of CRS: Comparison of Pre and Post Survey

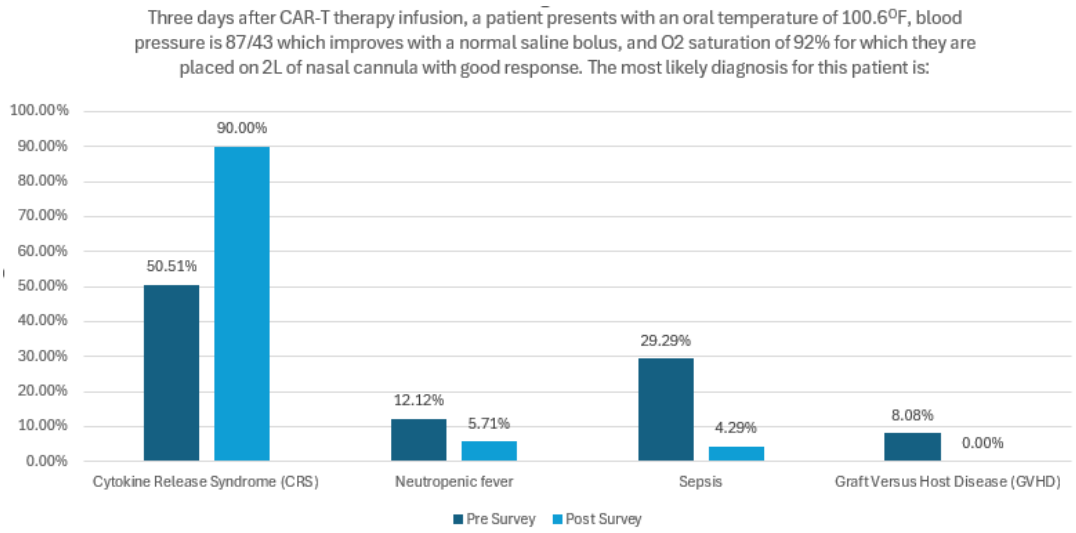
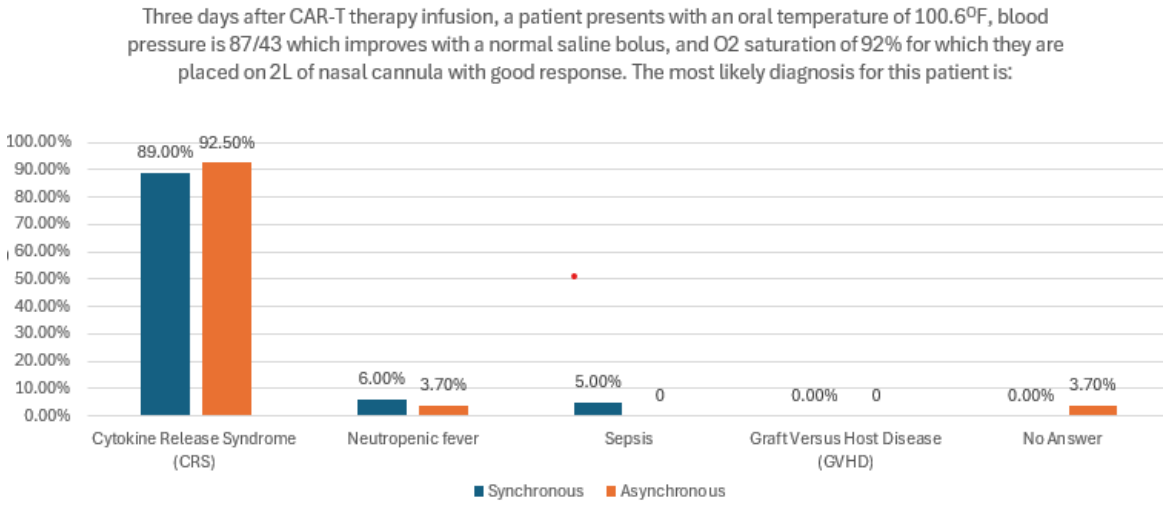


Figure 4

Identification of CRS: Comparison of Synchronous and Asynchronous Education



The second question assessed participants' ability to identify the correct management of CRS. The learner needed to grade the toxicity based on the patient scenario and clinical symptoms and then select the most appropriate interventions. This question also saw an improvement from pre to post survey as shown in Figure 5 with only 40.4% of participants choosing the correct answer of "All of the Above" on pre survey which improved to 75.54% on

post survey. When comparing the method of learning for this question, 75.4% of learners in the synchronous education sessions chose the correct answer where 66.6% of learners completing the asynchronous education chose the same answer. Results are shown in Figure 6. Approximately 18% of participants in both the synchronous and asynchronous education selected the same incorrect answer which excluded the administration of tocilizumab, a necessary medication for this toxicity.

Figure 5

Management of CRS: Comparison of Pre and Post Survey

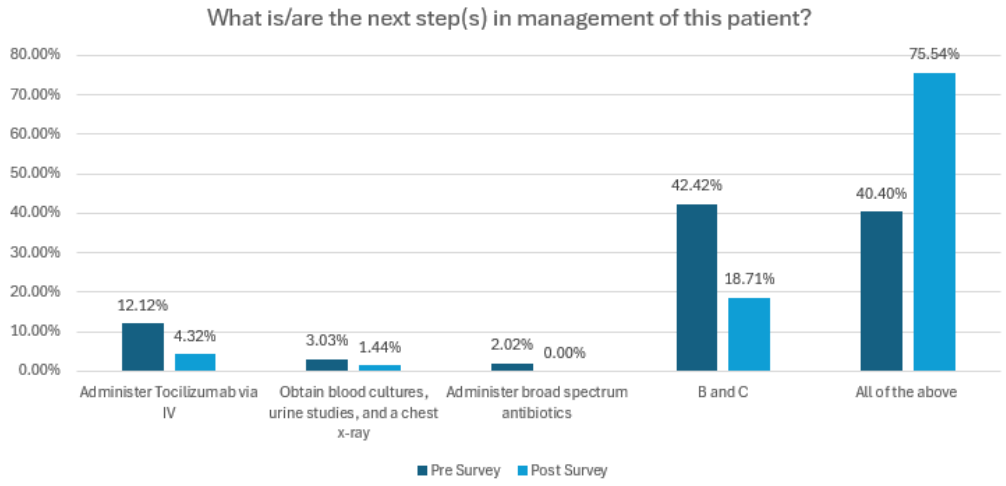
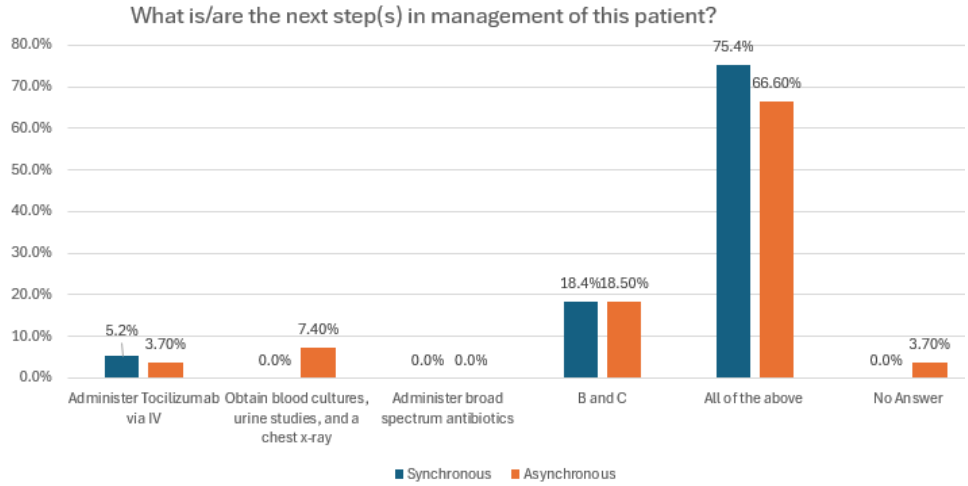


Figure 6

Management of CRS: Comparison of Synchronous and Asynchronous Education



Another question on the survey assessed learners' knowledge of identification of ICANS. This question also followed the case study format and gave clinical symptoms the patient was presenting with. The learner needed to identify and grade the toxicity and then select the most appropriate interventions. This question showed an improvement between the pre and post survey, as shown in Figure 7, with an improvement from 35.35% answering correctly on the pre survey to 77.86% on the post survey. In Figure 8, post survey results compared synchronous and asynchronous outcomes. As with other knowledge questions, outcomes between the two methods were similar with 76.3% of synchronous education learners answering correctly as compared to 81.4% of asynchronous learners. 22.8% of synchronous learners answered "All of the Above" which included a medication which is not given for ICANS. Similar to the assessment question focusing on management of CRS, this data shows an opportunity to review management of ICANS in more depth in future education sessions.

Figure 7

Identification and Management of ICANS: Comparison of Pre and Post Survey

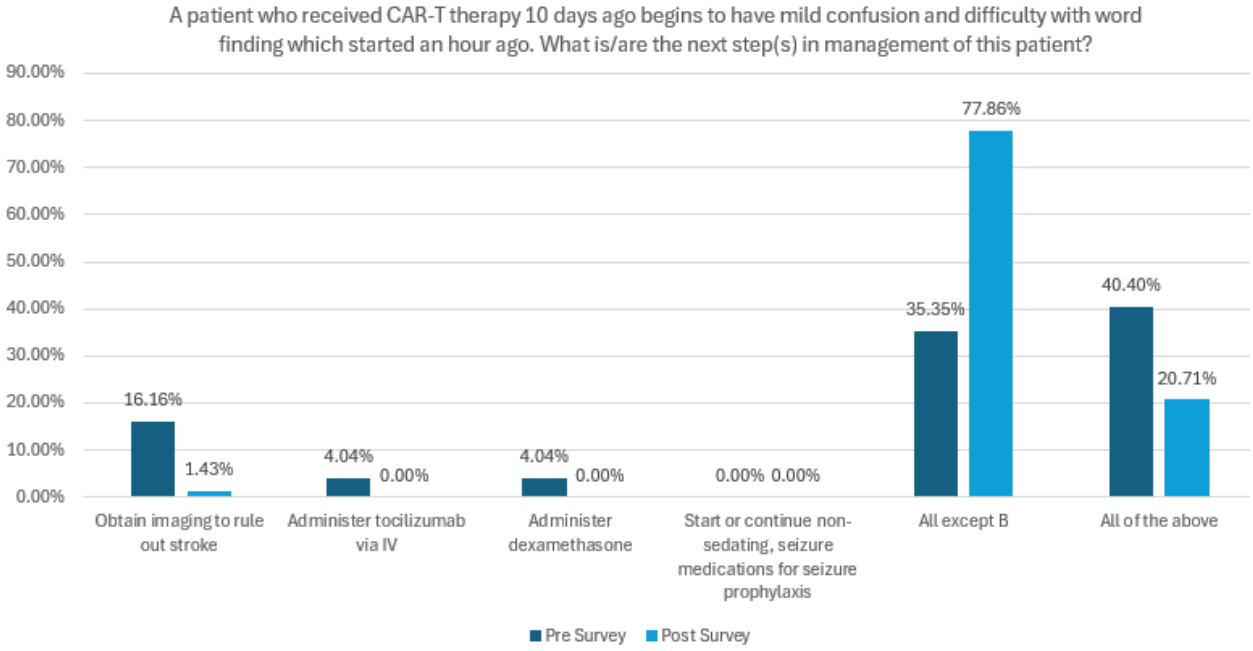
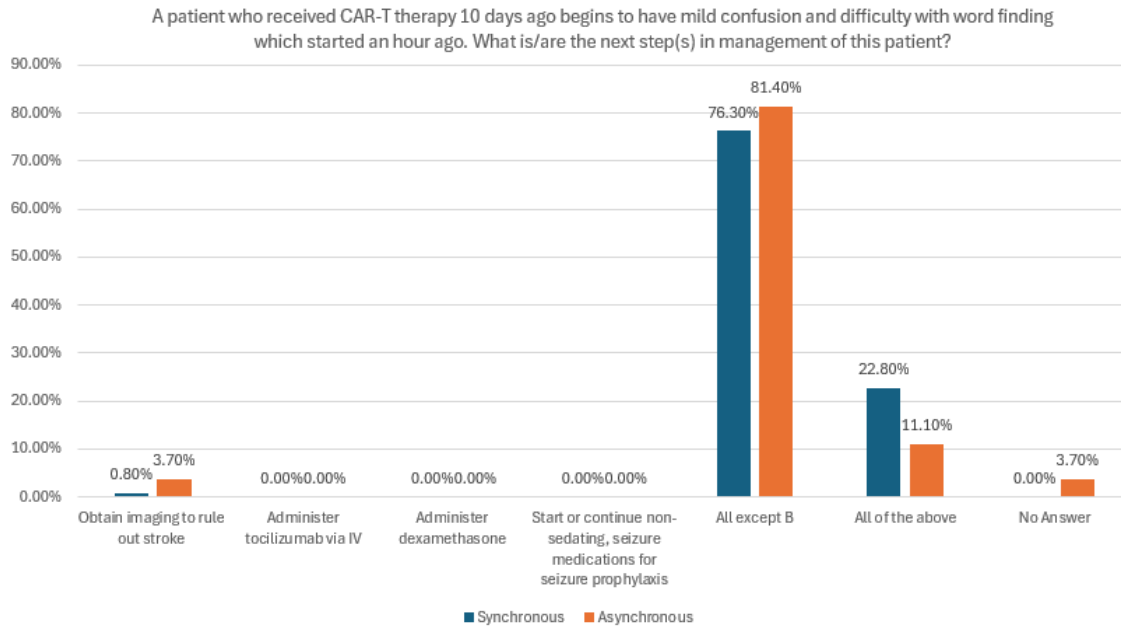


Figure 8

Identification and Management of ICANS: Comparison of Synchronous and Asynchronous Education



The next assessment question inquired about appropriate disposition for a patient requiring hospital admission based on their grading of ICANS in the previous question. This patient was experiencing a Grade 2 toxicity and would be appropriate for admission to the oncology unit based on their presentation rather than the intensive care unit. Figure 9 illustrates that although there was an improvement between the pre and post survey with a correct response rate increasing from 29.29% to 45.71%, on the post survey, 37.86% of staff still selected the medical intensive care unit as the appropriate unit, 15.71% chose the neurosciences intensive care unit, and 0.71% chose a neurology unit.

When comparing the responses of synchronous and asynchronous learners, learners were divided between the correct answer of oncology and the medical intensive care unit. As shown in Figure 10, 46.4% of those who participated in synchronous education correctly selected the

oncology unit as compared to 35.9% who chose the medical intensive care unit. Comparatively, 40.1% of asynchronous learners chose oncology where 44.4% selected the medical intensive care unit. This was the only knowledge assessment questions in which the asynchronous learners were more likely to choose the wrong answer.

Figure 9

Disposition for Hospital Admission: Comparison of Pre and Post Survey

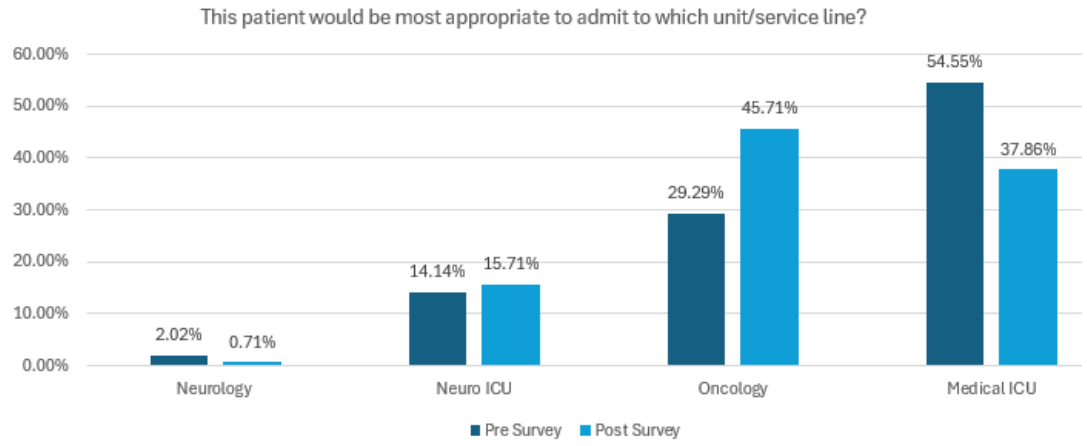
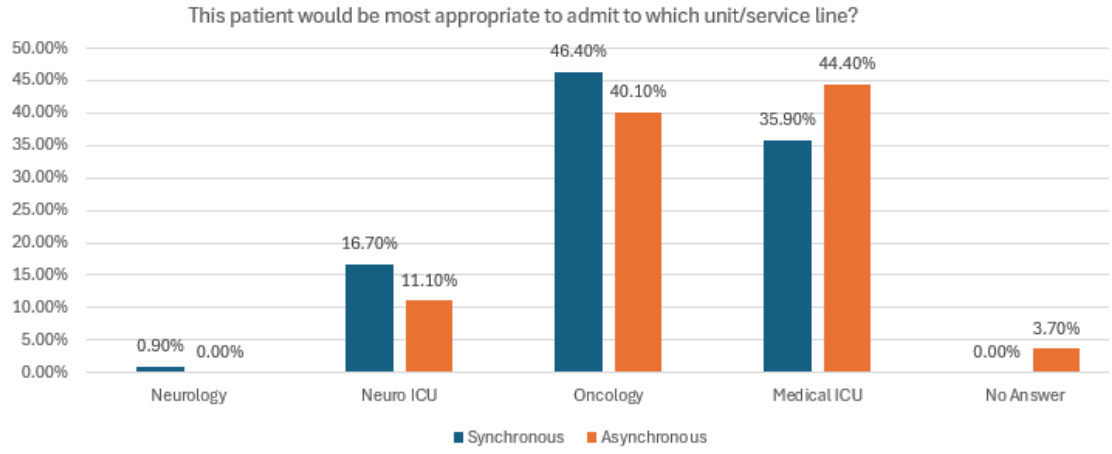


Figure 10

Disposition for Hospital Admission: Comparison of Synchronous and Asynchronous Education



The final knowledge and skills assessment question focused on the required time period of administration of a medication, tocilizumab, to the CAR-T patient once CRS is identified and

tocilizumab is ordered by a provider. Figure 11 outlines the data of pre and post survey collection. Although this is included in the healthcare organizations policy regarding maintenance of patients with CRS, it is also an FDA requirement that tocilizumab is administered within two hours. The organization requires the nurse to have completed infusion of the medication within two hours of the order being placed. Initially, 63.64% of pre survey respondents selected that tocilizumab had to be administered within one hour and 26.26% responded that it needed to be administered within two hours. In the post survey, 83.57% responded correctly that it needed to be infused within two hours whereas only 15% believed that it had to be administered within one hour. These results showed an improvement in knowledge of the learners between the pre and post survey. In comparing synchronous and asynchronous education results, over 80% of learners for both synchronous and asynchronous education methods selected the correct answer of two hours to administration as outlined in Figure 12. The second most common answer was one hours with 15.8% of synchronous learners and 11.10% of asynchronous learners selecting this option.

Figure 11

Administration of Tocilizumab: Comparison of Pre and Post Survey

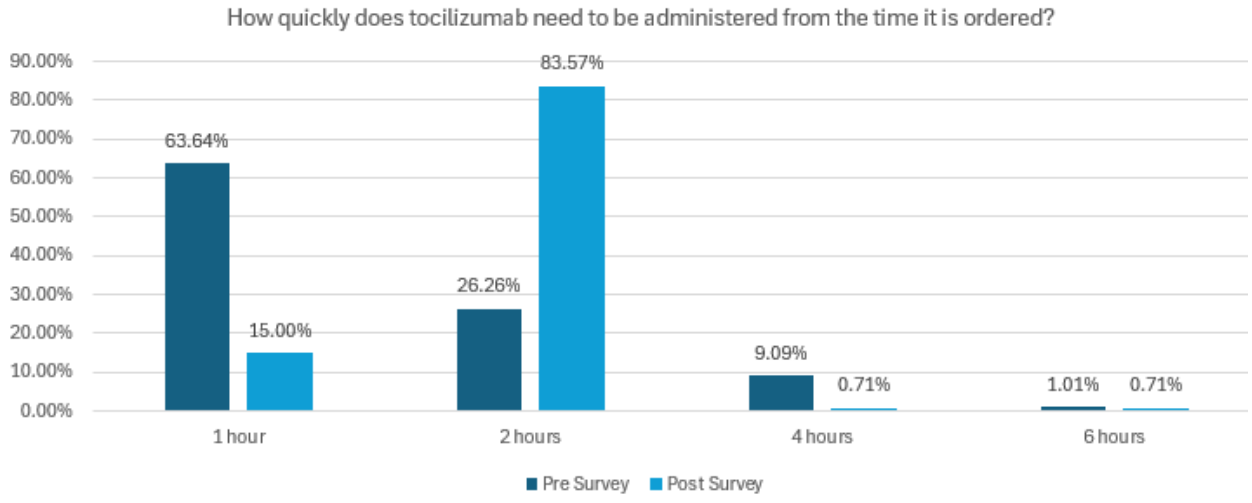
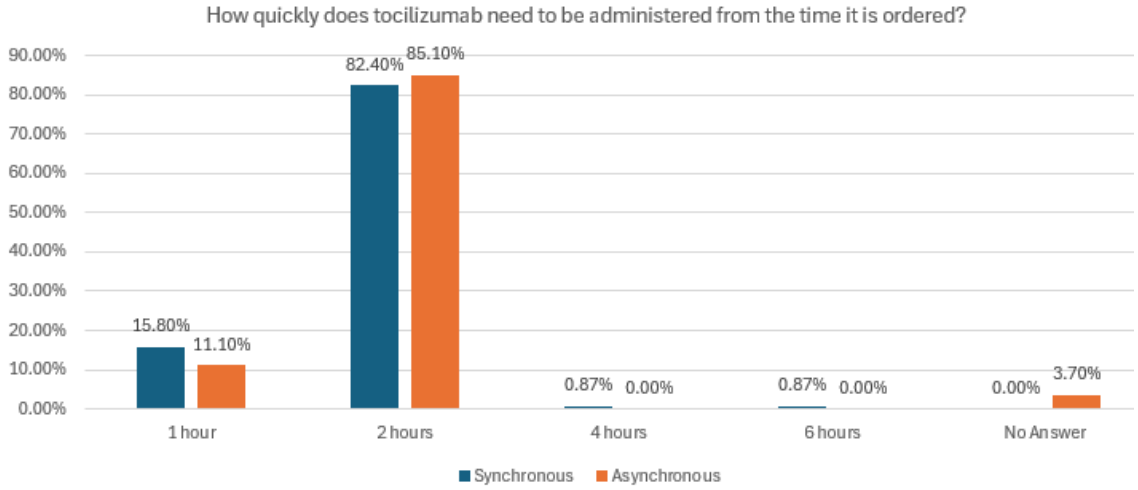


Figure 12

Administration of Tocilizumab: Comparison of Synchronous and Asynchronous Education



The huddle tool which had been created to utilize when a patient was being cared for in either the medical intensive care unit or emergency room, was only used once in the emergency room. No CAR-T patients were admitted to the medical intensive care unit during the time of this quality improvement project. Items that were reviewed during the huddle in the emergency room included clinical presentation, identification of concurrent CRS and ICANS, grading of CRS and ICANSs, and management of each toxicity. Other items that were reviewed included the patient's history of pancytopenia and potential need for blood products as well as the patient's neutropenic status and requirement to be placed in a private room within the emergency department. Once the plan of care was established and interventions were implemented, bed management was made aware of the patient and she was prioritized for admission to the oncology unit.

Increase in Comfort

Another aim of this quality improvement project was to *increase the self-report of comfort in caring for CAR-T patients* amongst participants of both synchronous and asynchronous education. Prior to this education, non-oncology nurse participants may have had

limited, or no, previous experience with caring for CAR-T patients and the known toxicities and management. It is important that participants feel prepared and comfortable with identifying known toxicities such as CRS and ICANS and the management of these toxicities after the education sessions. This aim was successfully met as a result of this quality improvement project. When comparing pre and post survey data, there was a positive overall response to the question assessing perceived comfort with nurses who participated in either synchronous or asynchronous education self-reporting an increase in comfort when caring for CAR-T patients. This data comparison is reviewed in Figure 13.

During the pre-survey assessment of perceived comfort levels in caring for a CAR-T patient amongst learners, only 14.14% of learners had a positive response of either agree or strongly agree when asked “I would feel comfortable caring for a CAR-T patient with toxicities”. 33.33% of learners responded with a neutral response and 52.52% self-reported they would disagree or strongly disagree with the statement. Comparatively, when asked again in the post survey, the largest number of responses were in the agree category with a 54.29% response rate. Further, 7.14% selected strongly agree and 32.86% selected neutral. Combined, only 5.72% responded negatively with strongly disagree or disagree which was a large shift from the 52.52% who selected the same negative options in the pre survey.

When considering the two methods of synchronous and asynchronous education, the highest response selection was a positive response of “agree” for both synchronous and asynchronous learners. Results comparing the learning methods are included in Figure 14. Comparison of the two methods demonstrated that 62.2% of synchronous participants reported with a positive response of agree or strongly agree compared to 55.5% of asynchronous participants reporting the same positive responses. More asynchronous than synchronous

participants reported a neutral assessment of their confidence level. Thirty-seven percent of learners report a neutral self- report of confidence level as compared to 31.5% of synchronous learners. Both synchronous and asynchronous learners had under 6% select a negative response of disagree or strongly disagree. The data collection demonstrated that overall, learners reported less negative confidence scores and although both methods of education were effective, synchronous education was associated with a higher positive self-report of confidence when compared to asynchronous education.

Figure 13

Comfort Level: Comparison of Pre and Post Survey

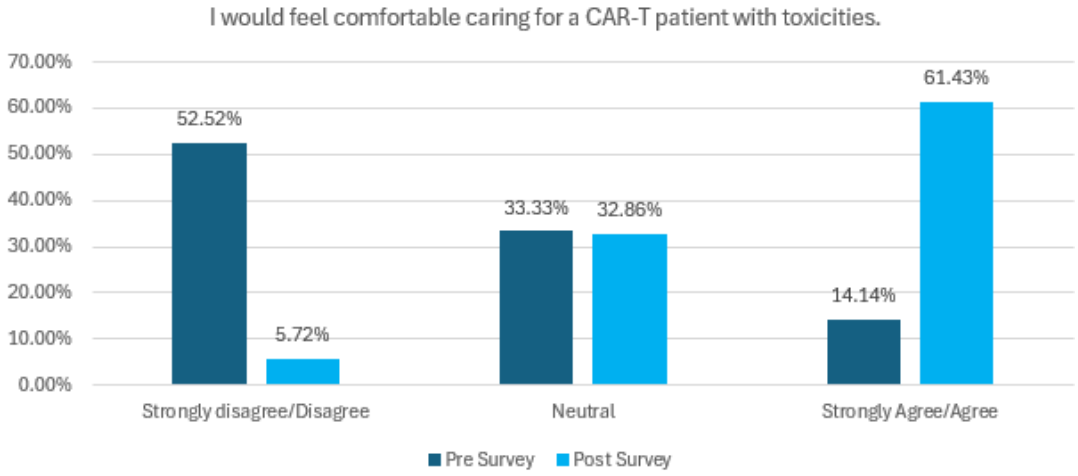
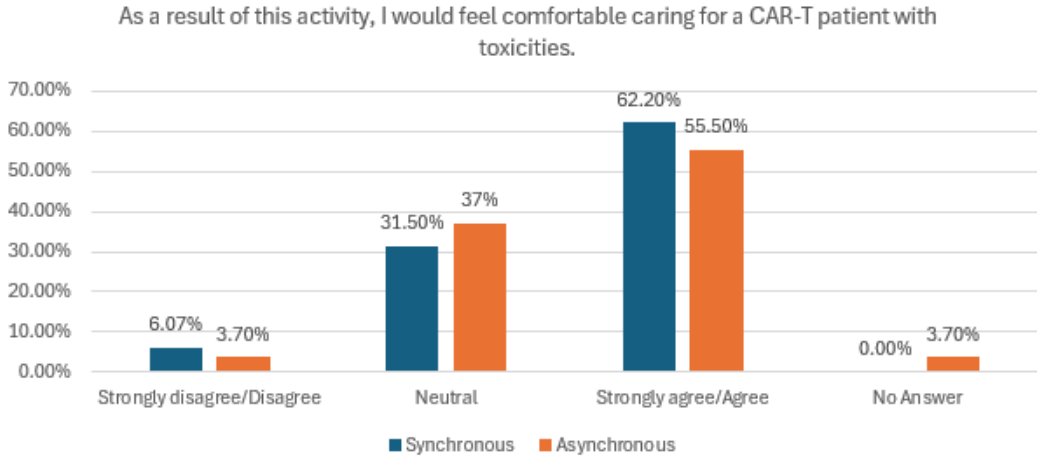


Figure 14

Comfort Level: Comparison of Synchronous and Asynchronous Education



Continuing Education Opportunities

The final aim of this quality improvement project was to *assess the need for continuing education opportunities* for non-oncology nurses caring for CAR-T patients. This aim was accomplished by surveying participants for suggestions and by data review. One item on the post-survey asked for suggestions for future education sessions and allowed for learners to provide an open response. Most responses from both synchronous and asynchronous learners were left blank or learners stated they did not feel they needed anything additional. Of the few additional comments, learners requested more case studies and one suggested mandatory completion of this education on a yearly basis. There is an opportunity with future education to include either high or low fidelity simulations into training to reinforce education and provide the learners additional opportunities to practice assessment and grading of toxicities.

Data review identified that there were opportunities to provide continuing education specifically around management of toxicities such as CRS and ICANS, as well as disposition to the appropriate unit for patients requiring inpatient admission. As these patients may be seen infrequently on non-oncology units, continuing education opportunities may help improve self - reported comfort levels in caring for CAR-T patients amongst non-oncology nurses. It will also be important as more products come to the market, to provide education to non-oncology nurses in the medical intensive care unit and emergency room about product specific toxicities or considerations.

As recommended by the Nursing Scientific Review Sub-Committee of the Health Nursing Research and Evidence-Based Practice Steering Committee, participants were also asked if, at the completion of education, they planned to participate in the other method of education as well. As shown in Figure 15, 50% of learners who participated in the synchronous

education reported they did not plan to repeat the education with the asynchronous method however 45.6% reported they did plan to repeat the education. 4.3% of learners did not respond with either answer. Comparatively, in Figure 16, 70.3% of learners reported they did not plan to complete the synchronous education as well and 25.9% reported they did plan to attend the synchronous education option. 3.7% of respondents did not respond with either answer to this question. There was no item on the post survey that assessed why a learner may or may not choose to repeat the education in the other format.

Figure 15

Participants of Synchronous Education Planning to Complete Asynchronous Education

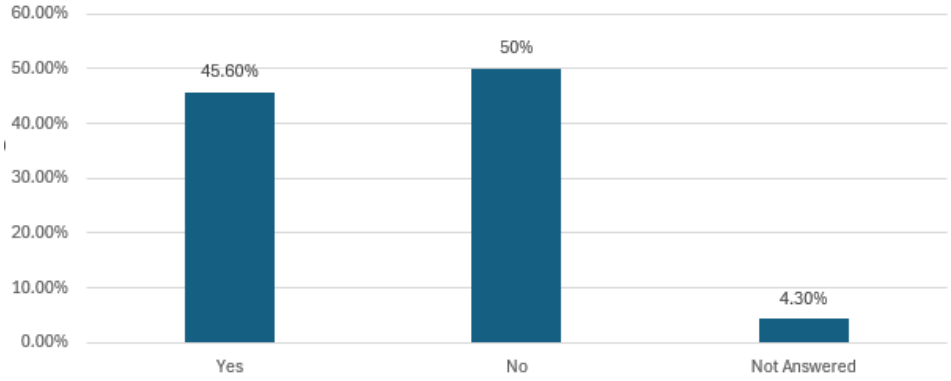
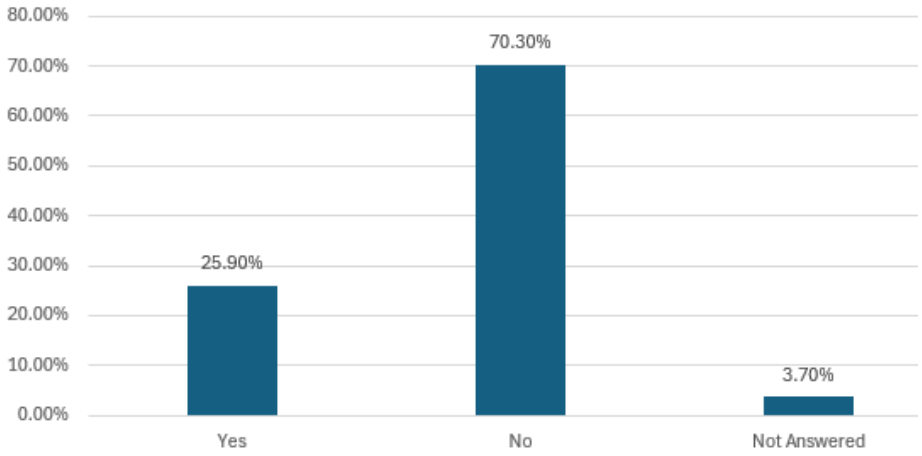


Figure 16

Participants of Asynchronous Education Planning to Complete Synchronous Education



Discussion

Summary

Overall, this quality improvement project was successful in developing education and course materials that contributed to increasing non-oncology nurses in the medical intensive care unit and emergency room knowledge, skills, and reported comfort levels in caring for CAR-T patients. Further, continuing education opportunities were able to be identified for future sessions. Pre and post survey data showed improvement in the identification and management of both CRS and ICANS toxicity as well as the time to administration of tocilizumab.

There were identified opportunities for continuing education specifically regarding management of CRS and ICANS and unit disposition for a patient who is experiencing toxicity and requiring inpatient admission. When considering where to admit a CAR-T patient experiencing toxicities, asynchronous learners were more likely to unnecessarily transfer the patient to the intensive care unit then those who completed synchronous education although there was 35.9% of synchronous learners who also selected the medical intensive care unit. These results demonstrate that, especially with asynchronous education, reinforcement of grading and disposition of CAR-T patients being admitted inpatient is mandatory in the future when providing education. It is important for learners to understand proper disposition and admission for these patients as it is important not to unnecessarily use an intensive care unit bed or admit to a unit that has not received education about management of these patients. Future education should include a higher focus on disposition and may consider using multiple patient case descriptions or build in a scaffolding case study question in which the patient has worsening symptoms and required intensive care unit transfer to reinforce grading and correct bed admission.

Results of the post survey were filtered to compare synchronous and asynchronous education and evaluate learning outcomes of each. Improvements in knowledge and skill in assessing and treating side effects of CAR-T were similar between the two learning methods and both proved to be effective at providing education for non-oncology nurses. This demonstrated that both synchronous and asynchronous learning is an effective means of providing education.

Interpretation

In this quality improvement project, only 27 participants chose to participate in asynchronous learning. The literature review was mixed with one article by Coyne and colleagues (2018) showing that when given an option between blended learning and live sessions, more participants chose live sessions over blended learning. However, in another article by Boespflug (2022), more learners participated in asynchronous education than synchronous. During this quality improvement project, 114 medical intensive care unit and emergency room nurses chose to participate in synchronous learning rather than the asynchronous education which reflected the findings by Coyne and colleagues (2018). However, both synchronous and asynchronous learning was found to be beneficial by the participants. During discussions during sessions, learners reported that they chose to participate in synchronous sessions as it allowed them the opportunity to discuss previous experiences they had with caring for CAR-T patients as well as the ability to ask questions as part of their learning.

The post survey included an item to assess if learners felt that the education was beneficial. Overall, 95% of participants felt that either the synchronous or asynchronous education was beneficial with 0.71% of participants reporting it was not beneficial and 4.29% of participants not responding with either answer. These results are shown in Figure 17. When comparing synchronous and asynchronous education individually, 93.8% of synchronous respondents and

96.2% of asynchronous respondents reported the education was beneficial. Less than 10% of combined respondents reported the education was not beneficial, felt neutral about the learning, or did not respond as shown in Figure 18.

Figure 17

Reported Benefit of Education: Overall

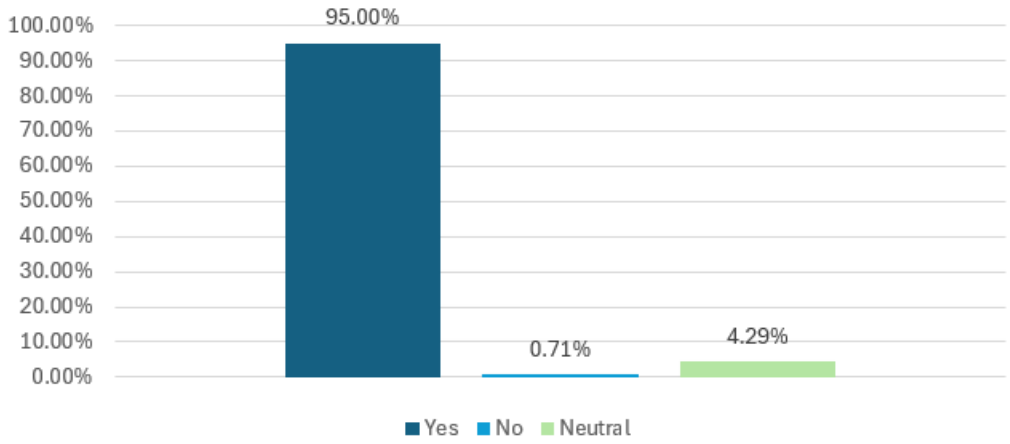
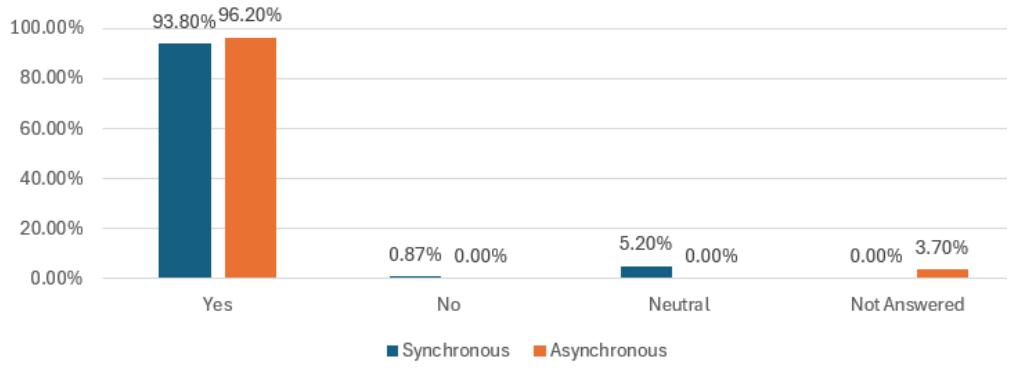


Figure 18

Reported Benefit of Education: Comparison of Synchronous and Asynchronous Education



The emergency room leadership team has requested that the CAR-T education be continued. Synchronous session frequency for both the medical intensive care unit and emergency department will be determined and then shared with the nurses. Reminders of the asynchronous option and referral to the toolkit on the oncology website will also be provided to

staff. The post-survey report will continue to be transferred from KeySurvey on a regular basis to capture synchronous and asynchronous learning participants and continue to identify opportunities for continuing education.

Limitations

Limitations of this quality improvement project included attendance, especially in the emergency room. This education was first administered in the medical intensive care unit. Sessions took place in the morning after shift change, midafternoon, and early evening. In the emergency room, sessions took place at unit huddles which happen at shift change. This timing may have caused nurses to be distracted or to have missed sessions if they were not in attendance for huddle. The medical intensive care unit leadership team also allowed their staff who completed either the synchronous education during their time off, or the asynchronous learning, to submit one hour of education pay. This was exclusive to the medical intensive care unit and not the emergency department. If staff had been incentivized to participate from home during a day off to complete either method of education, it may have helped improve attendance numbers in the emergency room.

Another identified limitation to attendance in the emergency room was that emergency room nurses rotate through three hospital system emergency departments. During the month that this education was administered, it is possible that there were nurses who were not assigned to work at the campus location where education was completed. Education could have been implemented at all three emergency departments to make education more accessible to staff.

Another consideration of this education was that there was no way to identify hospital employed staff from traveling nurses. Accepted practice is to not assign a CAR-T patient to a traveler for regulatory reasons. Although only 45 nurses in the emergency room completed the

post survey which was used for attendance for regulation, a paper sign in sheet that was also used showed that 121 nurses completed the education. Of the 121, it is not possible to tell who hospital staff were as compared to traveling nurses. It is possible that the other 76 participants were travelers and therefore did not complete the survey knowing that this was also serving as attendance for regulatory accreditation.

Conclusion

There is a continuing need for education for non-oncology nurses in the medical intensive care unit and emergency room as this is a safety and regulatory requirement. CAR-T patients who may be experiencing toxicities require rapid identification, grading, and interventions to treat toxicities. Based on the results of this quality improvement project, education should continue to be offered both in a synchronous and asynchronous method. This education should be built into new hire orientation which would allow the educator to present on a regular basis to a smaller volume of nurses. By using KeySurvey, learning can continue to be tracked for mandatory attendance records and asynchronous education attendance can be tracked as well. Although the paper attendance in the emergency room captured that there were more staff who completed the program than participated in the post survey, paper records are challenging to keep track of and, in the event of an audit, identify a staff member from if the records have not been transcribed into another document that allows for a search function.

The post survey questions should also be continued as this survey allows the cellular therapy program to continue to trend learning outcomes and opportunities for improvement as well as continuing education. On the post survey that was utilized, there was an option for staff from outside the medical intensive care unit, emergency room, or central staffing office to select. An open response or free text option should be added to the post-survey to identify units that

may also benefit from this education. As it has been established that the education is effective, the pre survey could be eliminated as compliance was lower than with the post survey and would not contribute any new knowledge or information. As new cellular therapy products are FDA approved, this education and post survey could be easily adapted to include other therapies or treatments.

A CAR-T toolkit was uploaded on the organization's intranet as a resource for staff that is easily accessible and always available. Feedback should be collected regarding the toolkit and how nurses perceive its helpfulness in assessment and management of CAR-T patients. As part of the education sessions, this toolkit was reviewed but no data was collected on if it had been utilized.

References

Beaupierre, RN, BSN, OCN, A., Kahle, MS, RN, OCN, BMTCN, N., Lundberg, PA-C, MPAS, R., & Patterson, MSN, APRN, AOCNS, BMTCN, A. (2019). Educating multidisciplinary care teams, patients, and caregivers on car T-cell therapy. *Journal of the Advanced Practitioner in Oncology*, *10*(4). https://doi.org/10.6004/jadpro.2019.10.4.12

Bi, M., Zhao, Z., Yang, J., & Wang, Y. (2019). Comparison of case-based learning and traditional method in teaching postgraduate students of medical oncology. *Medical Teacher*, *41*(10), 1124–1128. https://doi.org/10.1080/0142159x.2019.1617414

Boespflug, D. (2022). "Lounge & Learns." *Journal for Nurses in Professional Development*. https://doi.org/10.1097/nnd.0000000000000935

Coyne, E., Rands, H., Frommolt, V., Kain, V., Plugge, M., & Mitchell, M. (2018). Investigation of blended learning video resources to teach health students clinical skills: An integrative review. *Nurse Education Today*, *63*, 101–107. https://doi.org/10.1016/j.nedt.2018.01.021

Foundation for the Accreditation of Cellular Therapy. (2022). *Hematopoietic Cellular Therapy Accreditation Manual.* Eighth Edition FACT-JACIE Hematopoietic Cellular Therapy Accreditation Manual, 8.2-UpdatedLinks v.3 (policytech.com)

Lewin Change Management Model. MindTools. (2023). Retrieved February 14, 2023, from https://www.mindtools.com/ajm9l1e/lewins-change-management-model

Hull, C. S., & O'Rourke, M. E. (2007). Oncology-critical care nursing collaboration: Recommendations for optimizing continuity of care of critically ill patients with cancer. *Clinical Journal of Oncology Nursing*, *11*(6), 925–927. https://doi.org/10.1188/07.cjon.925-927

Langley, G. J., Moen, R., Nolan, K. M., Nolan, T. W., Norman, C. L., & Provost, L. P. (2009). *The Improvement Guide*. John Wiley & Sons.

Lee, D. W., Santomasso, B. D., Locke, F. L., Ghobadi, A., Turtle, C. J., Brudno, J. N., Maus, M. V., Park, J. H., Mead, E., Pavletic, S., Go, W. Y., Eldjerou, L., Gardner, R. A., Frey, N., Curran, K. J., Peggs, K., Pasquini, M., DiPersio, J. F., van den Brink, M. R. M., Komanduri, K.V., Grupp, S.A., Neelapu, S. S. (2019). ASTCT consensus grading for cytokine release syndrome and neurologic toxicity associated with immune effector cells. *Biology of Blood and Marrow Transplantation*, *25*(4), 625–638. https://doi.org/10.1016/j.bbmt.2018.12.758

Mangold, K., Kunze, K. L., Quinonez, M. M., Taylor, L. M., & Tenison, A. J. (2018). Learning style preferences of practicing nurses. *Journal for Nurses in Professional Development*, *34*(4), 212–218. https://doi.org/10.1097/nnd.0000000000000462

Naciri, A., Radid, M., Kharbach, A., & Chemsi, G. (2021). E-learning in Health Professions Education during the COVID-19 pandemic: A systematic review. *Journal of Educational Evaluation for Health Professions, 18*, 27. https://doi.org/10.3352/jeehp.2021.18.27

Taylor, L., Rodriguez, E. S., Reese, A., & Anderson, K. (2019). Building a program: Implications for infrastructure, nursing education, and training for car T-cell therapy. *Clinical Journal of Oncology Nursing*. https://doi.org/10.1188/19.cjon.s1.20-26

Appendix A

Summary Table

Intervention	Studies	Significant Outcomes	Sample Size and Description	LOE & Quality
E-learning/Virtual Learning	a. Naciri, Radid, Kharbach, Chemsi (2021)	a. Equal or higher motivation to attend e-learning than classroom learning in most studies. This study also found lower motivation levels was associated with worse cognitive engagement	a. 15 studies selected (out of 250) evaluating a total of 111,622 students. One third of studies were in high-income countries and 2/3 were in low and middle income countries. Sample sizes ranged from 30 to 99,559 students.	a. V(B)
	b. Saab, Hegarty, Murphy, Landers (2021)	b. Perceived that VR could serve as a refresher on previously acquired skills and knowledge. Negative feedback included lack of in-person feedback, VR was antisocial and isolating, age is a challenge, as well as sight problems, vertigo, dizziness and motion sickness.	b. 26 third year undergraduate nursing students in a large public university	b. V(B)
	c. Bradley (2020)	c. QR codes used for just in time education. A way to ensure training updates and new information is disseminated and can be updated as needed. QR codes linked to either a tips sheet or a short video, QR codes do not allow for in depth explanation or resource for staff to ask questions.	c. Tertiary teaching hospital. No sample size described.	c. V(C)
	d. Dahlke, Hunter, & Amoudu (2020)	d. E-platform increases nurses motivation and satisfaction because it shifts learning to learners' time and motivation, engaged in an active form of learning, and educator acts as a facilitator of learning. Majority of studies reported on more tradition and linear styles of education where content was provided via e-platform but was read in formal format similar to didactic face to face presentation.	d. 77 articles from acute care organizations about eLearning were reviewed	d. V(A)

Active Learning (Case Studies, Visuals)	e. Bi, Zhao, Yang, Wang (2019)	e. The CBL group scored significantly higher in the self-evaluation questionnaire and examination compared to traditional teaching groups. Satisfaction score was 92.5% compared to 70%.	e. 80 post graduate oncology nursing students. 28 males and 52 females ages 23-28 years old. No statistical different between the two groups in terms of gender, age, entrance achievement, self-study ability and subject preference	e. I (B)
	f. Hull & O'Rourke (2007)	f. Recommends case studies which will facilitate discussion and collaboration between oncology and critical care nurses. Collaborative relationships that involve face to face meetings or teleconference to improve communication and to provide a setting where both specialties can offer input into care of oncology patients.	f. No sample size described. Hospitals with ICU and oncology specific units	f. V(B)
	g. Mangold, et al. (2018)	g. Overall nurses preferred sensing over intuitive learning and visual over verbal learning by 11%. Those with <26 years of experience had a 6-13% stronger preference for visual learning over verbal learning then those with $\geq$ 26 years of experience. Supports that learning activities should implement educational activities for visual and sensing learners as they were the preferred learning styles among those surveyed regardless of age, gender, or experience. Results show a trend towards visual over verbal teaching methods	g. 2, 071 nursing staff members of all levels at a tertiary and quaternary academic medical center with adult inpatient, ambulatory, procedural, and emergency services were eligible and invited to participate. 67.55% responded (1,399/2,071)	g. V(A)
Synchronous and Asynchronous Learning	h. Boespflug (2022)	h. Used Microsoft teams which allowed for real-time chats, interactive participation, and a recording function. Post activity confidence survey scores improved from avg of 2.49 to 3.15 with 4 being highest confidence score. Attendance improved from 28 learners during in person sessions to 408 learners using virtual or recorded format. Allowed learners to participate during work time or from home or to access materials at a later time when live session was not offered	i. 408 learners participated in live/ virtual education	h. V(B)
Blended Learning	i. Coyne, Rands, Frommolt, Kain, & Plugge (2018)	i. In comparison to didactic teaching, blended learning improved knowledge, transfer, and student satisfaction across many studies. Blended	i. Reviewed 10 database articles pertaining to blended learning in health care students of different	i. V(A)

		learning accommodates different learning styles, allows for repeated viewing, and enables links between theory and practice. Blended learning defined as face to face learning with online learning using video assisted teaching. Videos allow opportunity to review repeatedly and allow flexible learning	levels using the Mixed Methods Appraisal Tool	
	j. Oberai, et al. (2021)	j. The unit based Inservice sessions which included formal education through PowerPoint and practice discussions was the most often attended. Significant improvement in scores regarding risk factors and recognition of delirium in post survey compared to pre survey	j. Of 55 eligible nurses, 35 (64%) completed the self-directed online modules; 37 (68%) attended the Inservice/practice discussion and 3 (6%) attended the workshop	j. II(B)
	k. Taj, et al. (2022)	k. Blended learning was an effective tool to improve knowledge, skills.	k. 21 nurses from inpatient and outpatients oncology units from 4 hospitals in Kenya and Tanzania	k. V(B)
Traditional/didactic learning	l. Taylor, Rodriguez, Reese, and Anderson (2019)	l. Didactic course may be appropriate for general information and skills checklist for procedural tasks but should meet needs of learner. Standardized preparation of nurses should include treatment side effects (CRS and NT), recognition and management of onc emergencies, and blood product and chemotherapy administration. Nurses should know protocols to follow to guide monitoring of immunotherapy patients.	l. Established CAR-T programs in both inpatient and outpatient setting. No sample size described.	l. V(B)
	m. Beaupierre, Kahle, Lundberg, Patterson (2019)	m. Dedicated educational sessions for patients, caregivers and clinical providers on the multidisciplinary team is warranted for optimal treatment of CAR-T patients	m. Authorized treatment sites for CAR-T administration. No sample size described.	m. V(B)

Appendix B

External Mapping Tool

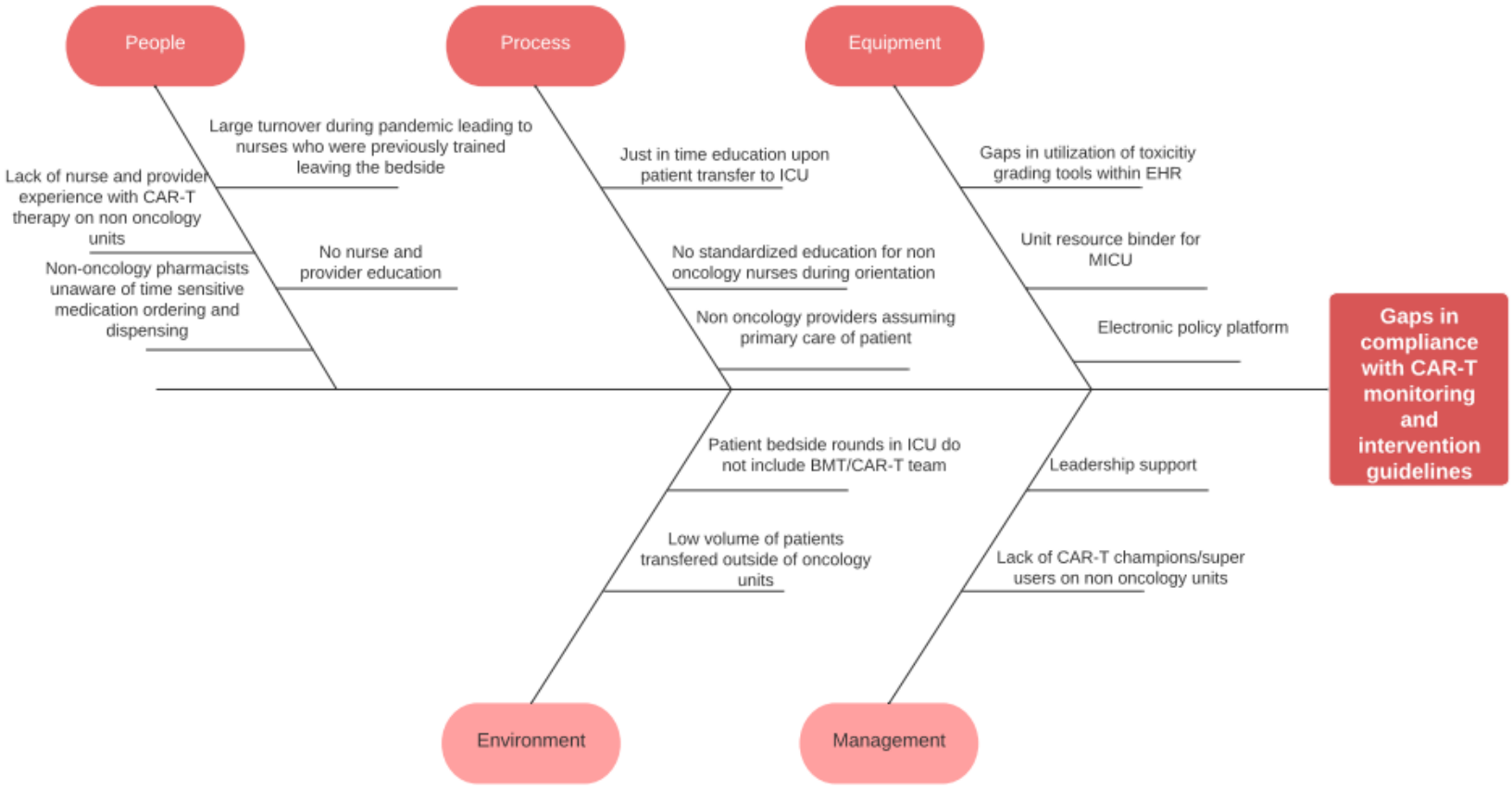
Subpopulation of patients: Oncology patients treated with Chimeric Antigen Receptor T-Cell Therapy (CAR-T)

Specific Health Care Needs
1. Documentation of monitoring for CRS twice daily within EPIC
2. Identification of CRS grading and early interventions including antibiotics, IVF, tocilizumab, vasopressors, oxygen, steroids, etc. as outlined in clinical guidelines
3. Documentation of monitoring for ICANs every 8 hours using ICE score within EPIC
4. Identification of ICANS grading and early interventions including steroids as outlined in clinical guidelines
5. Monitoring and assessing for other CAR-T toxicities such as HLH, cardiac arrhythmias, pancytopenia

Improvement Ideas
Provide education to acute care nurses caring for CAR-T patients outside of the oncology unit. Improve knowledge and skill of nurses surrounding documentation and identification of CRS and ICANS and understanding of appropriate interventions per clinical guidelines.

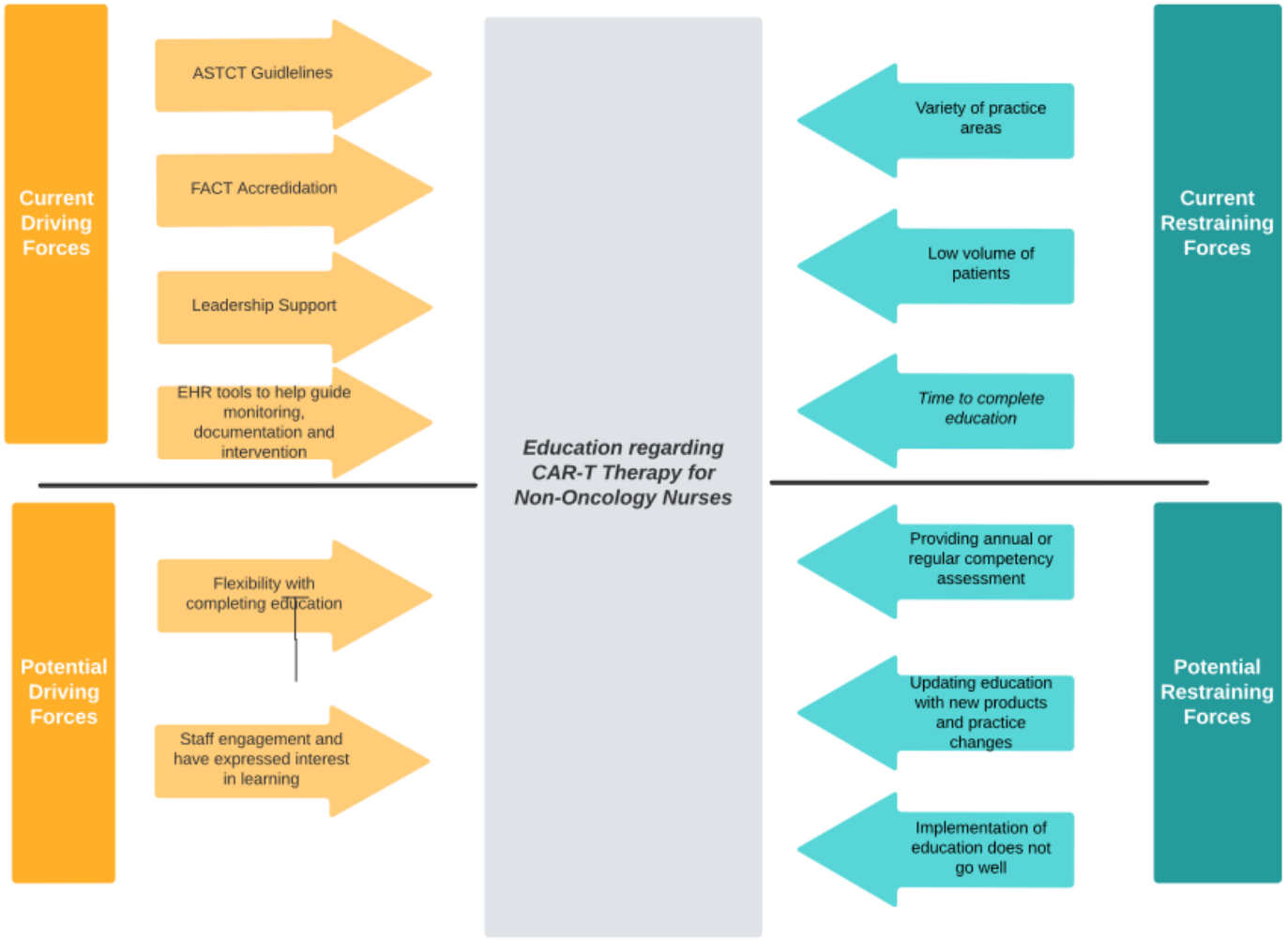
Appendix C

Cause and Effect (Fishbone) Model



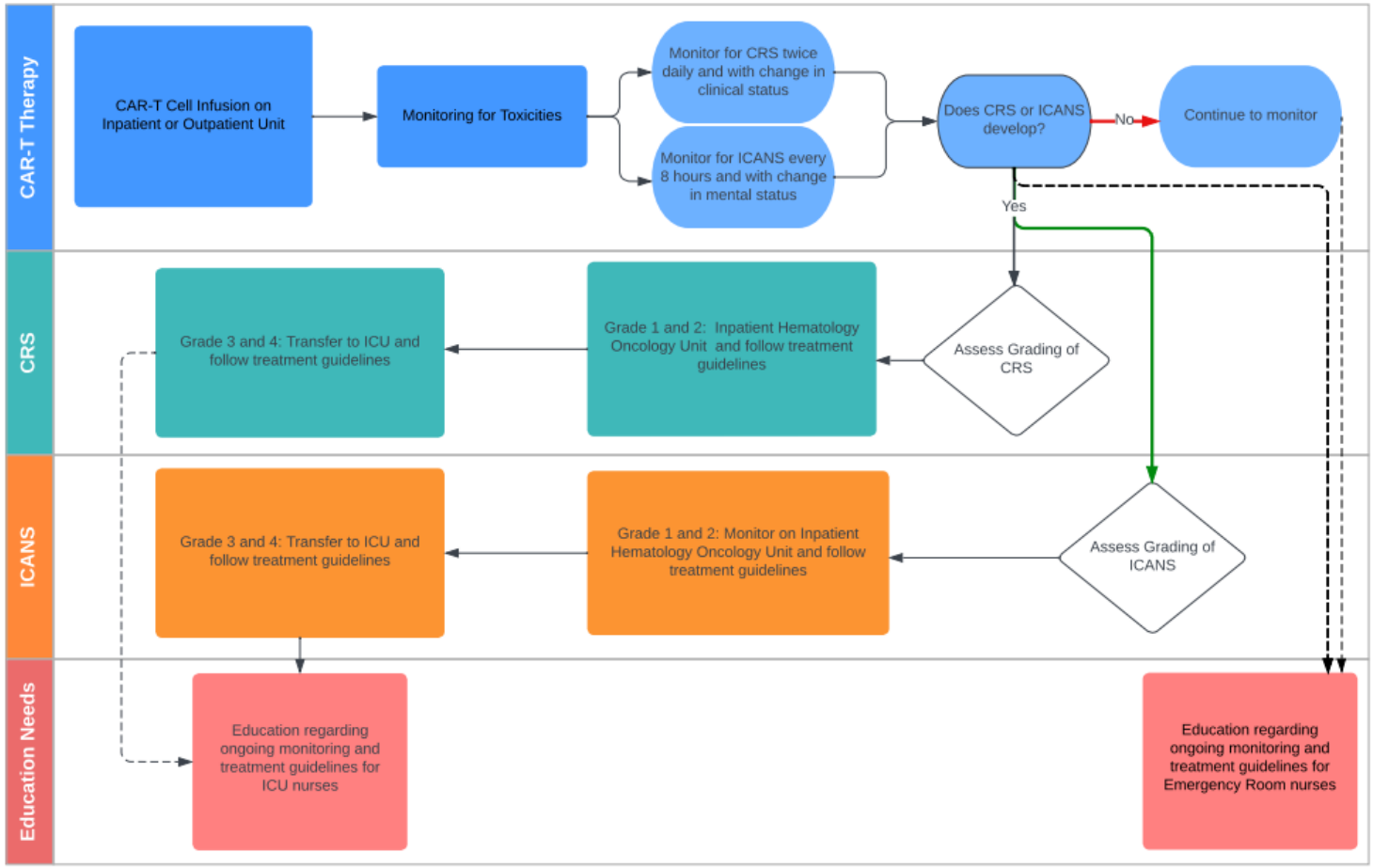
Appendix D

Force Field Analysis Diagram



Appendix E

Intervention Map



Who: Non-oncology acute care nurses caring for CAR-T patients
What: CAR-T education focusing on CAR-T therapy, toxicities, and management of toxicities
Where: Tertiary Academic Medical Center
When: Scheduled on unit trainings and recorded sessions
Why: Compliance with regulatory standards and optimization of patient care

ASTCT CRS Consensus Grading

CRS Parameter	Grade 1	Grade 2	Grade 3	Grade 4
Fever*	Temperature ≥38°C	Temperature ≥38°C	Temperature ≥38°C	Temperature ≥38°C
		With		
Hypotension	None	Not requiring vasopressors	Requiring a vasopressor with or without vasopressin	Requiring multiple vasopressors (excluding vasopressin)
		And/or†		
Hypoxia	None	Requiring low-flow nasal cannula‡ or blow-by	Requiring high-flow nasal cannula‡, facemask, nonrebreather mask, or Venturi mask	Requiring positive pressure (eg, CPAP, BiPAP, intubation and mechanical ventilation)

Organ toxicities associated with CRS may be graded according to CTCAE v5.0 but they do not influence CRS grading.

* Fever is defined as temperature ≥38°C not attributable to any other cause. In patients who have CRS then receive antipyretic or anticytokine therapy such as tocilizumab or steroids, fever is no longer required to grade subsequent CRS severity. In this case, CRS grading is driven by hypotension and/or hypoxia.

† CRS grade is determined by the more severe event: hypotension or hypoxia not attributable to any other cause. For example, a patient with temperature of 39.5°C, hypotension requiring 1 vasopressor, and hypoxia requiring low-flow nasal cannula is classified as grade 3 CRS.

‡ Low-flow nasal cannula is defined as oxygen delivered at ≤6 L/minute. Low flow also includes blow-by oxygen delivery, sometimes used in pediatrics. High-flow nasal cannula is defined as oxygen delivered at >6 L/minute.

ASTCT ICANS Consensus Grading for Adults

Neurotoxicity Domain	Grade 1	Grade 2	Grade 3	Grade 4
ICE score*	7-9	3-6	0-2	0 (patient is unarousable and unable to perform ICE)
Depressed level of consciousness†	Awakens spontaneously	Awakens to voice	Awakens only to tactile stimulus	Patient is unarousable or requires vigorous or repetitive tactile stimuli to arouse. Stupor or coma
Seizure	N/A	N/A	Any clinical seizure focal or generalized that resolves rapidly or nonconvulsive seizures on EEG that resolve with intervention	Life-threatening prolonged seizure (>5 min); or Repetitive clinical or electrical seizures without return to baseline in between
Motor findings‡	N/A	N/A	N/A	Deep focal motor weakness such as hemiparesis or paraparesis
Elevated ICP/ cerebral edema	N/A	N/A	Focal/local edema on neuroimaging§	Diffuse cerebral edema on neuroimaging; decerebrate or decorticate posturing; or cranial nerve VI palsy; or papilledema; or Cushing's triad

ICANS grade is determined by the most severe event (ICE score, level of consciousness, seizure, motor findings, raised ICP/cerebral edema) not attributable to any other cause; for example, a patient with an ICE score of 3 who has a generalized seizure is classified as grade 3 ICANS.

N/A indicates not applicable.

* A patient with an ICE score of 0 may be classified as grade 3 ICANS if awake with global aphasia, but a patient with an ICE score of 0 may be classified as grade 4 ICANS if unarousable.

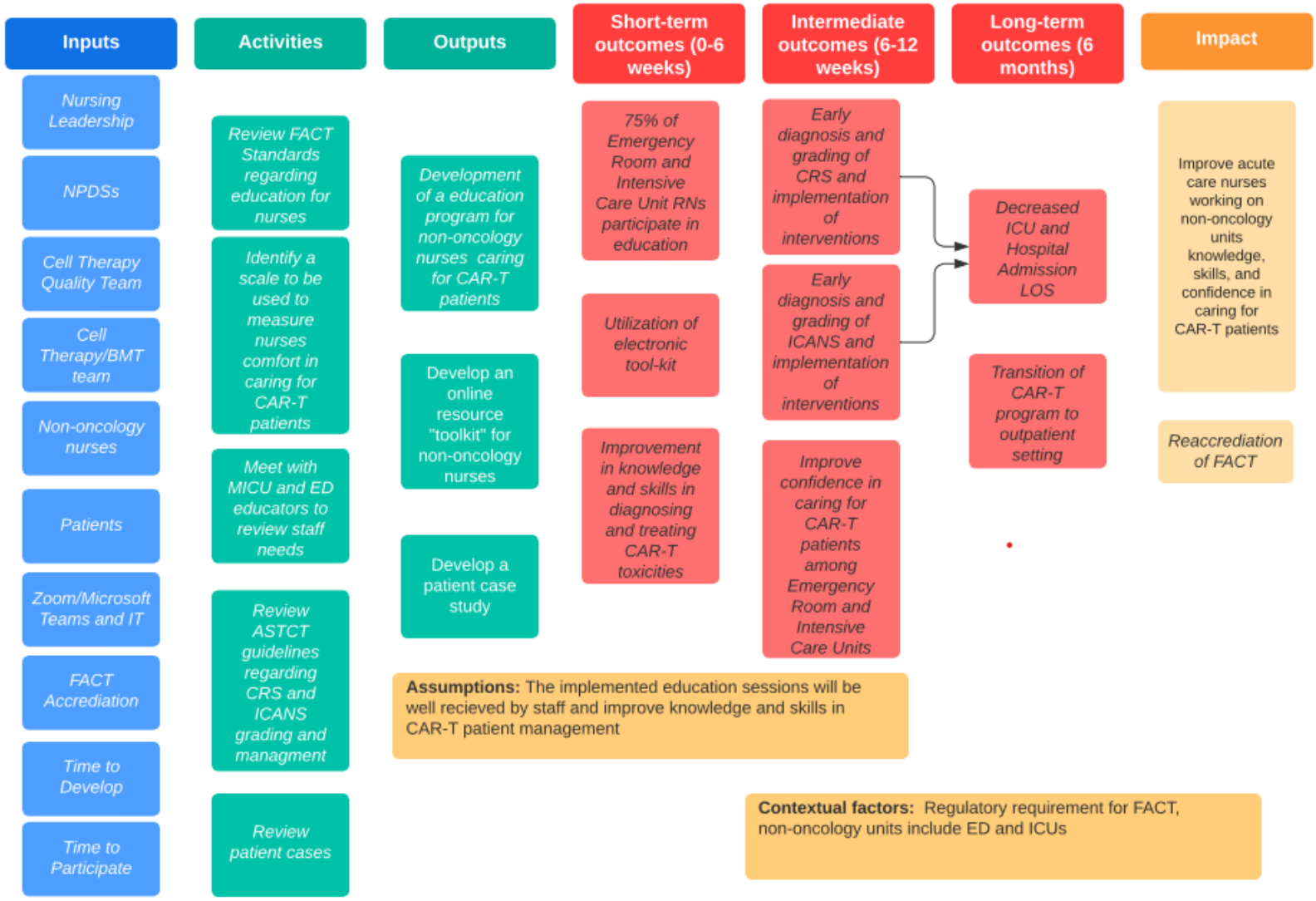
† Depressed level of consciousness should be attributable to no other cause (eg, no sedating medication).

‡ Tremors and myoclonus associated with immune effector cell therapies may be graded according to CTCAE v5.0, but they do not influence ICANS grading.

§ Intracranial hemorrhage with or without associated edema is not considered a neurotoxicity feature and is excluded from ICANS grading. It may be graded according to CTCAE v5.0.

Appendix F

Logic Model



Appendix G

Measures Table

Measures					Analysis
Aim or Objectives	**Outcomes/ outputs**	**How operationalize/ measure**	**Where will you get the information**	**Will you have a comparison**	**Analysis**

Convene stakeholders to gather input regarding education needs for emergency room and intensive care unit nurses and outline education session	Gather input regarding education needs for emergency room and intensive care unit nurses to be included in education sessions	• Gather stakeholders together to discuss
		  ○ Nursing leadership
		  ○ NPDSs (emergency room, intensive care units, cell therapy)
		  ○ BMT/CAR-T providers
		  ○ Cell therapy manager
		  ○ Cell therapy quality team
		• Identify education needs from stakeholders
		• Gain baseline data from incident reports
		• Review with ICU/ED NPDS teams for optimal times for on-unit education and frequency
			• Meeting minutes
			• Review of incident reports in which guidelines were not followed
			• Review of deviation reports from quality team
				No	Qualitative review of meeting minutes, notes, baseline data, and deviation reports

Design course materials including case studies to be used in synchronous and asynchronous online education sessions that follow FACT standards	• Develop an education course	• Developed course meets the education needs of non-oncology nurses identified by stakeholders • Email will be sent to staff informing them of both in person and recorded sessions • Asynchronous session will be recorded and posted on unit SharePoint website with pre and post survey information	• Course materials • FACT Standards	N/A	Qualitative review to ensure course meets education needs and FACT Standards

Develop an electronic survey (KeySurvey) to be used pre and post intervention to assess knowledge and perceived comfort levels when caring for CAR-T patients	Develop QR code which can be embedded in education	• KeySurvey will be used • Pilot completed to assess feasibility of survey	Electronic survey data will be exported into excel report for analyzing	N/A: There is currently no survey used as oncology nurses are required to complete FDA REMS Knowledge Assessments	• Survey was feasible • QR code was utilized to access survey • Content was clear and improvement in knowledge and skill was demonstrated
Educate 75% of emergency room and intensive care unit nurses through synchronous and asynchronous competency-based education sessions	Over 75% of nurses working in MICU and the emergency room will participate in either synchronous or asynchronous education session	Attendance sheets will be used to record participants	Attendance sheets	No	Attendance records- number of staff who participate out compared to number of staff who are eligible to participate
Emergency room and intensive care nurses who participate in either synchronous or asynchronous education session will have an increase in knowledge and skills in assessing and treating side effects of CAR-T	Improve knowledge and skills regarding toxicities associated with CAR-T	• Participants will have an increase in knowledge of CAR-T toxicities and interventions to be implemented per guidelines, skills in identifying and grading toxicities, and comfort	Electronic survey data will be completed immediately after course and then repeated 6 months after education sessions	Yes- Compare pre and post intervention survey data	• Improvement in percentage of correct responses in relation to number of questions • Aggregate scores and frequency for Likert scale questions in relation to highest score of comfort

Emergency room and intensive care unit nurses who participate in either synchronous or asynchronous education session will report an increase in comfort when caring for patients who have undergone CAR-T cell therapy	Post survey data will show emergency room and intensive care nurses will self-report an increase in comfort in caring for CAR-T patients	Confidence will be assessed in relation to identifying CAR-T toxicities, providing interventions per guidelines, and following internal guidelines and policy.	Adapt a self-efficacy tool and use within KeySurvey	Yes-Compare pre and post intervention survey data	Pre/post survey- Aggregate scores and frequency for Likert scale questions in relation to highest score of comfort
Identify ongoing education needs post intervention	Assess the need for continuing education for emergency room and intensive care unit nurses	Identification of barriers or continued education needs	• A survey will be disseminated 6 months after education has been completed and staff have had the opportunity to implement education. Survey will assess retained knowledge and if staff feel they need continuing education opportunities • Implementation of huddles to assess barriers to implementing guidelines	Yes- compare post intervention data with 6-month survey data	Post survey results compared to 6-month survey results- number of correct answers compared to number of questions

Appendix H

Stakeholder Meeting Data Collection Tool

Topics to Include in Education	• • • •
Optimal Times to Hold Education	• • • •
Frequency of Education	• • • •

Appendix I

Education Outline Data Collection Tool

	A	B	C	D
1		**Topic**	**Incorporated into Education (Y/N)**	**Location of Topic Within Education**
2	**FACT standards**	B3.6.1 The Clinical Program shall have nurses formally trained and experienced in the management of patients receiving cellular therapy		
3		B3.6.2.4 Administration of blood products, growth factors, and other supportive therapies.		
4		B3.6.2.5 Care interventions to manage cellular therapy complications, including, but not limited to, cytokine release syndrome, tumor lysis syndrome, cardiac dysfunction, respiratory distress, neurologic toxicity, macrophage activation syndrome, renal and hepatic failure, disseminated intravascular coagulation, anaphylaxis, neutropenic fever, infectious and noninfectious processes, mucositis, nausea and vomiting, and pain management.		
5		B3.6.2.6 Recognition of cellular therapy complications and emergencies requiring rapid notification of the transplant team.		
6	**ASTCT Guidelines**	CRS Grading		
7		CRS Interventions		
8		ICANS Grading		
9		ICANS Intervention		
10	**YNHH Policies**	IEC 1.0 IEC Therapy Assessment and Mangement		
11		IEC 1.2 CAR-T CRS and ICANS Management Guidelines		
12				
13				

Appendix J

Pre-Intervention Data Tool: Results

CAR-T Non Onc Pre-Survey			Report title									
Please complete this survey prior to receiving the CAR-T education.			Report introduction									
Respondent #	Overall Respondent #	Submit date	Unique URL	Report by respondent	Email/Password	Q1	Q2	Q3	Q4	Q5	Q6	Q7
						Three days after CAR-T therapy infusion, a patient presents with an oral temperature of 100.6OF, blood pressure is 87/43 which improves with a normal saline bolus, and O2 saturation of 92% for which they are placed on 2L of nasal cannula with good response. The most likely diagnosis for this patient is:	What is/are the next step(s) in management of this patient?	A patient who received CAR-T therapy 10 days ago begins to have mild confusion and difficulty with word finding which started an hour ago. What is/are the next step(s) in management of this patient?	This patient would be most appropriate to admit to which unit/service line?	How quickly does tocilizumab need to be administered from the time it is ordered?	I would feel comfortable caring for a CAR-T patient with toxicities.	Department:

Appendix K

Pre-Intervention Data Tool: Summary

Q1

Three days after CAR-T therapy infusion, a patient presents with an oral temperature of 100.6OF, blood pressure is 87/43 which improves with a normal saline bolus, and O2 saturation of 92% for which they are placed on 2L of nasal cannula with good response. The most likely diagnosis for this patient is:	Response percent	Response total
Cytokine Release Syndrome (CRS)	0.00%	0
Neutropenic fever	0.00%	0
Sepsis	0.00%	0
Graft Versus Host Disease (GVHD)	0.00%	0

Total of respondents	0
Statistics based number of response	0
Filtered	0
Skipped	0

Q2

What is/are the next step(s) in management of this patient?	Response percent	Response total
Administer Tocilizumab via IV	0.00%	0
Obtain blood cultures, urine studies, and a chest x-ray	0.00%	0
Administer broad spectrum antibiotics	0.00%	0
B and C	0.00%	0
All of the above	0.00%	0

Total of respondents	0
Statistics based number of response	0
Filtered	0
Skipped	0

Q3

A patient who received CAR-T therapy 10 days ago begins to have mild confusion and difficulty with word finding which started an hour ago. What is/are the next step(s) in management of this patient?	Response percent	Response total
Obtain imaging to rule out stroke	0.00%	0
Administer tocilizumab via IV	0.00%	0
Administer dexamethasone	0.00%	0
Start or continue non-sedating, seizure medications for seizure prophylaxis	0.00%	0
All except B	0.00%	0
All of the above	0.00%	0

Total of respondents	0
Statistics based number of response	0
Filtered	0
Skipped	0

Q4

This patient would be most appropriate to admit to which unit/service line?	Response percent	Response total
Neurology	0.00%	0
Neuro ICU	0.00%	0
Oncology	0.00%	0
Medical ICU	0.00%	0

Total of respondents	0
Statistics based number of response	0
Filtered	0
Skipped	0

Q5

How quickly does tocilizumab need to be administered from the time it is ordered?	Response percent	Response total
1 hour	0.00%	0
2 hours	0.00%	0
4 hours	0.00%	0
6 hours	0.00%	0

Total of respondents	0
Statistics based number of response	0
Filtered	0
Skipped	0

Q6

I would feel comfortable caring for a CAR-T patient with toxicities.	Response percent	Response total
Strongly disagree	0.00%	0
Disagree	0.00%	0
Neutral	0.00%	0
Agree	0.00%	0
Strongly agree	0.00%	0

Total of respondents	0
Statistics based number of response	0
Filtered	0

Skipped	0

Q7

Department:	**Response percent**	**Response total**
Emergency Department	0.00%	0
Medical Intensive Care Unit	0.00%	0
CSO	0.00%	0
Other	0.00%	0

Total of respondents	0
Statistics based number of response	0
Filtered	0
Skipped	0

Appendix L

Post-Intervention Data Tool: Results

CAR-T Non Onc Post-Survey			Report title								
Please complete this survey after receiving the CAR-T education.			Report introduction								
Respondent #	Respondent #	Submit date	Unique URL	Report by respondent	Q1.A1	Q2	Q3	Q4	Q5	Q6	Q7
					Name:	Three days after CAR-T therapy infusion, a patient presents with an oral temperature of 100.6OF, blood pressure is 87/43 which improves with a normal saline bolus, and O2 saturation of 92% for which they are placed on 2L of nasal cannula with good response. The most likely diagnosis for this patient is:	What is/are the next step(s) in management of this patient?	A patient who received CAR-T therapy 10 days ago begins to have mild confusion and difficulty with word finding which started an hour ago. What is/are the next step(s) in management of this patient?	This patient would be most appropriate to admit to which unit/service line?	How quickly does tocilizumab need to be administered from the time it is ordered?	As a result of this activity, I would feel comfortable caring for a CAR-T patient with toxicities.

Q8	Q9	Q10	Q11	Q12.A1	Q13.A1	Q14
How did you participate in the CAR-T education?	Did you find the education session you participated in beneficial?	If you participated in the live education, do you plan to also watch the recorded education?	If you participated in the recorded education, do you plan to also attend the in person/live education?	List one thing you learned today that you will implement in your practice:	Suggestions for future education sessions:	Department:

Appendix M

Pre-Intervention Data Tool: Summary

Q1

Name:	Response total
	0

Total of respondents	0
Statistics based number of response	0
Filtered	0
Skipped	0

Q2

Three days after CAR-T therapy infusion, a patient presents with an oral temperature of 100.6OF, blood pressure is 87/43 which improves with a normal saline bolus, and O2 saturation of 92% for which they are placed on 2L of nasal cannula with good response. The most likely diagnosis for this patient is:	Response percent	Response total
Cytokine Release Syndrome (CRS)	0.00%	0
Neutropenic fever	0.00%	0
Sepsis	0.00%	0
Graft Versus Host Disease (GVHD)	0.00%	0

Total of respondents	0
Statistics based number of response	0
Filtered	0
Skipped	0

Q3

What is/are the next step(s) in management of this patient?	Response percent	Response total
Administer Tocilizumab via IV	0.00%	0
Obtain blood cultures, urine studies, and a chest x-ray	0.00%	0
Administer broad spectrum antibiotics	0.00%	0
B and C	0.00%	0
All of the above	0.00%	0

Total of respondents	0
Statistics based number of response	0
Filtered	0
Skipped	0

Q4

A patient who received CAR-T therapy 10 days ago begins to have mild confusion and difficulty with word finding which started an hour ago. What is/are the next step(s) in management of this patient?	Response percent	Response total
Obtain imaging to rule out stroke	0.00%	0
Administer tocilizumab via IV	0.00%	0
Administer dexamethasone	0.00%	0
Start or continue non-sedating, seizure medications for seizure prophylaxis	0.00%	0
All except B	0.00%	0
All of the above	0.00%	0

Total of respondents	0
Statistics based number of response	0
Filtered	0
Skipped	0

Q5

This patient would be most appropriate to admit to which unit/service line?	Response percent	Response total
Neurology	0.00%	0
Neuro ICU	0.00%	0
Oncology	0.00%	0
Medical ICU	0.00%	0

Total of respondents	0
Statistics based number of response	0
Filtered	0
Skipped	0

Q6

How quickly does tocilizumab need to be administered from the time it is ordered?	Response percent	Response total
1 hour	0.00%	0
2 hours	0.00%	0
4 hours	0.00%	0
6 hours	0.00%	0

Total of respondents	0
Statistics based number of response	0
Filtered	0
Skipped	0

Q7

As a result of this activity, I would feel comfortable caring for a CAR-T patient with toxicities.	Response percent	Response total
Strongly disagree	0.00%	0

Disagree	0.00%	0
Neutral	0.00%	0
Agree	0.00%	0
Strongly agree	0.00%	0

Total of respondents	0
Statistics based number of response	0
Filtered	0
Skipped	0

Q8

How did you participate in the CAR-T education?	**Response percent**	**Response total**
In person/live education	0.00%	0
Recorded Session	0.00%	0

Total of respondents	0
Statistics based number of response	0
Filtered	0
Skipped	0

Q9

Did you find the education session you participated in beneficial?	**Response percent**	**Response total**
Yes	0.00%	0
No	0.00%	0
Neutral	0.00%	0

Total of respondents	0
Statistics based number of response	0
Filtered	0
Skipped	0

Q10

If you participated in the live education, do you plan to also watch the recorded education?	**Response percent**	**Response total**
Yes	0.00%	0
No	0.00%	0

Total of respondents	0
Statistics based number of response	0
Filtered	0
Skipped	0

Q11

If you participated in the recorded education, do you plan to also attend the in person/live education?	Response percent	Response total
Yes	0.00%	0
No	0.00%	0

Total of respondents	0
Statistics based number of response	0
Filtered	0
Skipped	0

Q12

List one thing you learned today that you will implement in your practice:	Response total
	0

Total of respondents	0
Statistics based number of response	0
Filtered	0
Skipped	0

Q13

Suggestions for future education sessions:	Response total
	0

Total of respondents	0
Statistics based number of response	0
Filtered	0
Skipped	0

Q14

Department:	Response percent	Response total
Emergency Department	0.00%	0
Medical Intensive Care Unit	0.00%	0
CSO	0.00%	0
Other	0.00%	0

Total of respondents	0
Statistics based number of response	0
Filtered	0
Skipped	0

Appendix N

Huddle Data Collection Tool

Topic	**Description of what was discussed**	XX/XX/XX	XX/XX/XX	XX/XX/XX
Review of patient clinical assessment and current toxicity grading (if any)				
Risk for CRS and review of grading tool				
Management of CRS toxicity				
Risk for ICANS and review of ICE grading tool including nursing documentation				
Management of ICANS toxicity				
Address any other differential diagnoses or concerns (HLH/MAS, organ toxicity, prolonged cytopenia, B-cell aplasia, neuropathy, etc.)				
Any follow up needed?				

Appendix O

Clinical Quality Improvement Checklist

CLINICAL QUALITY IMPROVEMENT CHECKLIST		
Date: 3/29/2023	**Project Leader:** Kylie Kuck AGCNS-BC	
Project Title: Implementation of Synchronous and Asynchronous CAR-T Education for Emergency Room and Intensive Care Unit Nurses		
Institution where the project will be conducted: Tertiary Academic Medical Center		
Instructions: Answer YES or NO to each of the following statements about QI projects.	**YES**	**NO**
The specific aim is to improve the process or deliver of care with established/ accepted practice standards, or to implement change according to mandates of the health facilities' Quality Improvement programs. There is no intention of using the data for research purposes.	**X**	
The project is **NOT** designed to answer a research question or test a hypothesis and is **NOT** intended to develop or contribute to generalizable knowledge.	**X**	
The project does **NOT** follow a research design (e.g. hypothesis testing or group comparison [randomization, control groups, prospective comparison groups, cross-sectional, case control]). The project does **NOT** follow a protocol that over-rides clinical decision-making.	**X**	
The project involves implementation of established and tested practice standards (evidence based practice) and/or systematic monitoring, assessment or evaluation of the organization to ensure that existing quality standards are being met. The project does **NOT** develop paradigms or untested methods or new untested standards.	**X**	
The project involves implementation or care practices and interventions that are consensus-based or evidence-based. The project does **NOT** seek to test an intervention that is beyond current science and experience.	**X**	
The project has been discussed with the QA/QI department where the project will be conducted and involves staff who are working at, or patients/clients/individuals who are seen at the facility where the project will be carried out.	**X**	
The project has **NO** funding from federal agencies or research-focused organizations, and is not receiving funding for implementation research.	**X**	
The clinical practice unit (hospital, clinic, division, or care group) agrees that this is a QI project that will be implemented to improve the process or delivery of care.	**X**	
The project leader/DNP student has discussed and reviewed the checklist with the project Course Faculty. The project leader/DNP student will **NOT** refer to the project as research in any written or oral presentations or publications.	**X**	
ANSWER KEY: If the answer to **ALL** of these questions is **YES**, the activity can be considered a Clinical Quality Improvement activity that does not meet the definition of human research. **UMB IRB review is not required**. **Keep a dated copy of the checklist in your files.** If the answer to ANY of these questions is NO, the project must be submitted to the IRB for review.		