Summer 2022

Reduction of Order-to-Scan Times to Increase Patient Throughput and Improve Patient Outcomes: A Quality Improvement Project

Jason Harrington

University of New Hampshire, Durham, jpy84@unh.edu

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Reduction of Order-to-Scan Times to Increase Patient Throughput and Improve Patient Outcomes:

Outcomes:

A Quality Improvement Project

Jason Harrington, MSN, RN

University of New Hampshire

Department of Nursing

Faculty Mentor: Dr. Elizabeth Evans, DNP, RN, CNL

Date of Submission: August 1\textsuperscript{st}, 2022
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td>4</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>5</td>
</tr>
<tr>
<td>PROBLEM DESCRIPTION</td>
<td>5</td>
</tr>
<tr>
<td>LITERATURE REVIEW</td>
<td>7</td>
</tr>
<tr>
<td>RATIONALE</td>
<td>11</td>
</tr>
<tr>
<td>GLOBAL AIM</td>
<td>13</td>
</tr>
<tr>
<td>SPECIFIC AIM</td>
<td>13</td>
</tr>
<tr>
<td>METHODS</td>
<td>13</td>
</tr>
<tr>
<td>CONTEXT</td>
<td>13</td>
</tr>
<tr>
<td>INTERVENTIONS</td>
<td>14</td>
</tr>
<tr>
<td>STUDY OF THE INTERVENTIONS</td>
<td>15</td>
</tr>
<tr>
<td>MEASURES</td>
<td>16</td>
</tr>
<tr>
<td>ANALYSIS</td>
<td>17</td>
</tr>
<tr>
<td>ETHICAL CONSIDERATIONS</td>
<td>18</td>
</tr>
<tr>
<td>RESULTS</td>
<td>19</td>
</tr>
<tr>
<td>DISCUSSION</td>
<td>26</td>
</tr>
<tr>
<td>SUMMARY</td>
<td>26</td>
</tr>
<tr>
<td>INTERPRETATIONS</td>
<td>27</td>
</tr>
<tr>
<td>LIMITATIONS</td>
<td>29</td>
</tr>
<tr>
<td>CONCLUSIONS</td>
<td>31</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>34</td>
</tr>
</tbody>
</table>
TABLES OF FIGURES

FIGURE 1.................................................................................................................................................................21

FIGURE 2...................................................................................................................................................................23

FIGURE 3...................................................................................................................................................................24
Abstract

**Background:** Throughput is a key metric for both the emergency department and the hospital system. Diagnostic tests, such as CT scans, can lead to a large delay in patient throughput which can negatively impact patient satisfaction and patient outcomes. Finding ways to reduce delays in CT scan acquisition can positively impact patient satisfaction and patient outcomes.

**Aim:** The specific aim of this quality improvement project was to decrease the amount of time it takes to complete abdominal CT scans with IV contrast once ordered from 61 minutes to below 35 minutes by July 1st, 2022.

**Methods:** Plan was to implement the use of “CT ready” disposition into practice to increase communication between the ED and CT staff and reduce order-to-scan times. To do this, education would be provided to staff over a six-day period about how to use the disposition and the implications for using it. Prior to education, a pre-survey was given to staff to assess their prior knowledge of the intervention and their perceptions of it. After the education period and the conclusion of the intervention implementation, a post-survey was given to staff to assess their knowledge and perceptions of the intervention at that point. The pre- and post-surveys were compared to one another to assess perception changes and to assess the successfulness of the education provided. The order-to-scan times were also collected and compared to the times pre-intervention to assess for improvement.

**Results:** There was an overall reduction in order-to-scan times by 36% from the pre-education period to the education period. Order-to-scan times decreased from 73 minutes to 48 minutes over the six-day education period. The survey results showed increased staff knowledge regarding the intervention and positive staff perception of the use of the intervention and its benefit in practice.

**Conclusion:** Communication is a key aspect to reducing the order-to-scan times for CT scans. Other implications in practice of this quality improvement project, and the limitations, will be discussed. The sustainability of this quality improvement project and the implications for future work will also be discussed.

**Key words:** Order-to-scan times, emergency department, quality improvement, survey, throughput, length of stay (LOS), patient satisfaction, communication
Introduction

Problem Description

Patient throughput is an essential metric to emergency departments and hospitals everywhere. The amount of time a patient spends in the hospital is tracked from the moment they check-in until they are discharged from the facility. Within that metric, there are sub-metrics that measure different aspects such as time to triage, time to greet (when the provider makes first contact with the patient), and the amount of time it takes to perform diagnostic tests such as scans and labs once the provider puts the order in are just a few examples of these sub-metrics that are tracked. Patient satisfaction is increased when patients are seen and treated in shorter amounts of time. Billing is also based on time in the department and the time a provider must care for a patient, so reducing this time can help to reduce some patients’ bills. For these reasons, finding ways to maximize the efficiency of throughput is very important.

Abdominal pain is one of the most common symptoms that causes a patient to present to an emergency department (ED). According to Beaumont Emergency Hospital, “2000 people visit the emergency room every single day due to abdominal pains” (2021, para. 3). Since this chief complaint is so common, the metrics regarding this population are important and relevant. Regarding throughput, reduction of time spent in the department for this many patients might increase patient satisfaction as well as potentially assist staff and increase hospital revenue.

The current problem is that abdominal computed tomography (CT) scans are taking 61 minutes on average to complete at Wildcat Hospital’s emergency department, when the current target time is aimed for 35 minutes. The reason for the current delay needs to be
identified and corrected. Observed reasons for these delays include a lack of communication between the emergency department staff and the CT technicians, a lack of standard process, and short-staffing issues. Regarding the issue of process, when a patient comes in with abdominal pain, an intravenous (IV) catheter is not always started right away. This is partly due to the possibility of lack of necessity. The patient may receive an ultrasound to diagnose the underlying problem, which would not require the use of an IV. However, an abdominal CT scan is usually ordered to diagnose the problem. The abdominal CT, when done with contrast, can identify many abdominal problems such as diverticulitis and bowel obstructions. The contrast is normally essential, and the patient needs an IV to receive the IV contrast. However, while changing the process to include that every patient who comes in with abdominal pain receive an IV could reduce the amount of time it takes for the patient to receive the scan, not all patients that come in for this complaint receive a CT scan. Patients with abdominal pain might get an ultrasound or Xray instead, so this is not likely to be implemented. Looking at the metrics for the month of February at Wildcat Hospital ED, there were many patients who came in with abdominal pain and received CT scans of their abdomen. As such, there is a lot of data to show that the target metrics are not being met.

For patients with abdominal pain requiring a CT scan with IV contrast, there are many factors leading to the failure to reach target metrics for order to scan times. These factors need to be better understood so that solutions can be identified. If solutions are not identified, the hospital runs the risk of never meeting their target metric in this area which could lower patient satisfaction and reduce throughput. Since throughput is important for patients, staff, and hospital revenue, finding a solution to this problem is essential and important.
Available knowledge

A review of literature was performed to identify evidence and information related to reducing order-to-scan times for CT scans in the emergency department. Current literature regarding this topic was found by searching the UNH Database, Google Scholar, PubMed, and Cochrane. The keywords and phrases that were used to search the databases were “CT scan with IV contrast”, “emergency department”, “reduction” and “reduced order to scan times”. The keywords “abdominal”, “abdominal CT scans”, and “abdominal pain” were all excluded due to the lack of focused research and the search yielding no results on this very specific type of scan. Studies that were conducted and only focused on non-contrast CT scans or CT scan times for strokes or traumas were also excluded as these did not accurately represent the focus of this quality improvement endeavor. Further criteria included only full-text articles, articles that were in English, and articles that were published between 2018 and 2022. The use of the inclusion criteria and keywords yielded nine results. Six of those nine articles were excluded after the full text was read due to multiple factors including duplication and lack of relevance. The remaining three research studies fit the criteria and accurately demonstrated the current literature needed to support this quality improvement project.

The first study titled “Improving Emergency Department Flow: Reducing Turnaround Time for Emergent CT scans” (Perotte et al., 2018) highlights successful methods that were used to reduce the turnaround time for CT scans using LEAN methodology. According to the Perotte et al. (2018), an interprofessional team was created to assess and analyze the current process for CT scans in the emergency department as well as identify any barriers. Four barriers that were identified were with the visual analytics, communication, automation, and
education/feedback (Perotte et al., 2018). Solutions to these barriers were also strategized and tested. Data was analyzed from the pre-period and the post-period of intervention implementation and even though there was a 13% increase in scans in the post-period, overall turnaround time (TAT) for CT scans decreased by almost 23% (Perotte et al., 2018). When looking specifically at the time between CT order to CT scan begin, the time decreased from 155 minutes to 143 minutes which is about an 8% decrease in time. According to Perotte et al., “the three-level communication strategy has been one of the major successes of the project” (2018, p. 903). The three-level communication strategy included the implementation of weekly meetings to identify barriers with one member from each discipline being present, four-time daily huddles by the ED nursing and CT staff to analyze current state and identify “real-time resolutions of any problems”, and implementation of secure messaging across disciplines (Perotte et al., 2018, p. 899).

The researchers also appreciate and mention the difficulty of a study like this being done in the emergency department due to situations such as strokes and traumas skewing the data and taking priority over other CT scans, causing those other scans to go below them on the queue. They also discuss limitations, such as the Hawthorne effect, which is the potential for individuals to change their behavior when they know they are being observed and tracked but they also refute this as having much impact since the study was conducted over an eight-month period and that the “Hawthorne effect is unlikely to fully explain the strength of the outcomes” (Perotte et al., 2018, p. 905). The researchers discuss the implications this study has on future work and the benefits it could produce. The researchers conclude that through the
implementation of these interventions, they were able to reduce TAT for CT scans and that this has “improved the flow of an often-crowded ED” (Perotte et al., 2018, p. 906).

Another study titled “Decreasing CT Acquisition Time in the Emergency Department Through LEAN Management Principles” (Rachh et al., 2021) aimed to reduce turnaround times (TAT) for CT scans in the emergency department (ED) to ultimately reduce overall length-of-stay (LOS) for patients. The goal of this study was to identify areas that were creating delays in the TATs for CT scans and to come up with interventions that will increase the percentage of CT scans performed in under 120 minutes from time of order. According to Rachh et al., “61% of ED CT examinations were completed within 120 minutes of order” prior to this study being conducted (2021, p. E83). A team was formed, gaps in the process were identified, and the gaps were “grouped into four main categories: barriers to error-free examinations, communication errors, examination prioritization gaps, and system limitations” (Rachh et al., 2021, p. E83).

When focusing on the communication errors aspect of the study, the researchers state that the ED currently used walkie-talkies for communication within the microsystem and they equipped the CT control room with a walkie-talkie so that CT technologists could communicate issues and delays directly with the ED staff easier when previous they had to “physically walk to the individual nurses” to do this (Rachh et al., 2021, p. E84).

Other aspects that were changed included optimizing CT technologist staffing model, review and update of the CT contrast material screening form, CT passport, and prioritization of head CT exams (Rachh et al., 2021, p. E84-E85). After identifying these gaps and applying changes to them, researchers found that they were able to increase the percentage of CT scans performed in under 120 minutes from time of order from 61% to around 70%, which shows
improvement. One issue identified with this study is that individual process changes are not quantified separately, so it is hard to say which of the interventions were the most successful in increasing this percentage and whether individual interventions implemented by themselves would be as successful. The researchers do go on to state that “the challenge of ED CT image acquisition is not unique to our organization, and the countermeasures we instituted are applicable to other hospital systems” (Rachh et al., 2021, p. E89). This study shows success in implementation and has implications for further research and future studies.

The final study titled “Applying LEAN Management to Reduce Radiology Turnaround Times for Emergency Department” (Verbano & Crema, 2019) displays a potential framework that could be used as a model to reduce the turnaround time (TAT) for CT scans in the emergency department by identifying and reducing areas that are wasteful. While this article does not specifically focus on CT scans alone, it does focus on reducing radiology TAT in the ED as a whole and the interventions used to achieve this could be applied to just CT scans. In this article, the researchers define that the objective of the study was to reduce TAT for radiology examinations from 60 minutes to 90 minutes by first forming an “inter-functional project team” who would be using a variation of the define-measure-analyze-improve-control (DMAIC) approach to address the issue (Verbano & Crema, 2019). The researchers were able to identify five areas of waste as well as solutions to resolve these issues, which lead to them reaching their goal of 60-minute TATs within the first few months, which was sooner than expected. The researchers go on to explain that for a change project like this to be successful, “employee involvement and diffusion of the significant sociotechnical results are fundamental” (Verbano & Crema, 2019, p. e1720). They also explain that “continuous improvement of lean processes
requires long-term commitments from top management and employees” to be successful (Verbano & Crema, 2019, p. e1720).

These three research studies demonstrate the current evidence available to support this quality improvement project. The interventions presented in these studies were taken into consideration for use on this quality improvement project. One theme that stood out between the studies was the need for structured communication between staff members and departments. Effective communication is essential in a hospital setting, such as an emergency department. The goal of this quality improvement project will not only be to reduce the order-to-scan times for abdominal CT scans with IV contrast through the implementation of an intervention, but also to increase communication among the ED and CT staff members. This increased communication will not only benefit the intended target of this quality improvement project, but it will also benefit the microsystem as a whole and will hopefully improve other areas simultaneously.

**Rationale**

Improving throughput and reducing patient’s length of stay (LOS) is an important metric that is measured at every single hospital around the world. According to Perotte et al., “the number of patients visiting emergency departments continues to increase every year. One highly successful method of overcrowding reduction is to streamline patient care and improve patient flow” (2018, p. 897). As mentioned previously, abdominal pain is one of the most common complaints that leads a patient to present to an emergency department. One of the methods for evaluating the cause of the patient’s abdominal pain is to perform an abdominal
CT scan with intravenous (IV) contrast. However, these scans are not being performed in the targeted amount of time, causing a reduction in throughput and an increase in a patient’s LOS.

The model best used to explain the problem is the Plan-Do-Study-Act (PDSA) model (AHRQ, 2020). The Agency for Healthcare Research and Quality (AHRQ) endorses the use of the PDSA model to improve patient flow by providing the framework for implementation of small changes for improvement. Based off observations made in the emergency department (ED), lack of structured communication between ED nurses and CT technicians appears to be one cause leading to the effect of increased time for abdominal CTs with IV contrast to be performed. Following the PDSA model, the plan was to increase communication between these two teams by increasing the use of the “CT ready” disposition on the electronic medical record (EMR) when a patient is ready to have their CT scan performed. This would hopefully reduce delays in patient care and increase communication between the ED and CT staff in a simple way. This plan was implemented, studied, and then evaluated to see if this leads to an improvement of process or if the plan needed to be revised based off new findings. The benefit of using the PDSA model for this study is that it could be implemented in a short amount of time and results could be evaluated quickly to see if future changes need to be made.

As previously noted, the PDSA model will be used for the framework of this project. The PDSA cycle would allow testing of each of these proposed interventions, either one at a time or all together. The planning has been done through this proposal of how the interventions were implemented into practice and how they were studied. The next steps were to implement them, study their effectiveness, and then act accordingly to adjust or keep the intervention depending on its success and effectiveness in practice.
Global Aim

The global aim of the quality improvement project was to increase throughput and decrease the amount of time it takes for patients to receive an abdominal computed tomography (CT) scan with intravenous (IV) contrast once it has been ordered by the emergency department (ED) provider.

Specific Aim

The specific aim of this quality improvement project was to decrease the amount of time it takes to complete abdominal CT scans with IV contrast once ordered from 61 minutes to below 35 minutes by July 1st, 2022. The expected outcome of the project is a 42.6% reduction in the amount of time it takes for an abdominal CT scan with IV contrast to be performed after it is ordered.

Methods

Context

The cost-benefit analysis has been investigated for the proposed intervention of increasing the use of the “CT ready” disposition for patients. Since this function is already available and able to be readily used in Meditech, the electronic medical record (EMR) system used by the hospital, there is no monetary cost needed to include this function. Regarding opportunity costs, the order to scan time is important because it can represent a delay to patient care. Delays to patient care can have costly effects, such as increased mortality and morbidity rates. Delays to CT scans for strokes, for example, every minute matters and delays need to be minimized to increase the chance of the patient having a successful outcome. This is true for patients receiving abdominal CT scans with IV contrast due to the potentially that the
results lead to the patient needing emergent surgery, for example. The benefits of implementing this intervention to potentially reduce order to scan times greatly outweighs the opportunity costs that could be associated with delays to patient care. When analyzing the amount of time this intervention would take, the benefits still outweigh the costs since providing the education to staff will be done in short, two-minute education sessions. Since changing the patient disposition could be done in a matter of seconds on the EMR while a nurse is charting, there was no significant cost of time for the nurses to use this intervention.

**Interventions**

The intended improvement in reduction of the order to scan times for abdominal CTs with IV contrast was achieved by implementing increased use of a “CT ready” disposition for patients on the EMR, Meditech, which would in turn increase communication between the ED and CT staff. This ability to use this disposition was already in place, however, it was currently under-utilized or not used at all. By utilizing this function, communication is increased between the two department because this allows the ED nurse to mark the patient ready to receive their CT scan, which means that all prerequisites to getting the scan have been complete. Previously, the only way for the CT technician to know if a patient was ready for their CT scan was to walk over and check that the patient was ready or find the patient’s nurse and ask if they were ready. This is creating a delay since the CT technician might find that the patient was, in fact, not ready for their scan at that time, requiring the CT technician to walk back to the office and identify another patient to bring to CT that was ready instead. Use of the “CT ready” disposition by the ED staff communicates to the CT staff that the patient is ready for the scan, potentially reducing delays and increasing patient throughput.
The first step to implementing this intervention will be to have ED and CT staff take a survey to assess their knowledge and perception of this intervention. The survey will be sent out to the employee’s work email, as this will be the easiest way to reach most of the staff in both departments. The second step will be to provide education to the ED staff and the CT staff regarding the ability to use this disposition and how to use it properly and effectively. For the ED staff, the ED Director has provided permission to attend one of their daily huddles for five days straight to disseminate this education information to the staff; within a five-day period, all staff members of the ED should have worked at least one day, so doing this will, in theory, reach 100% of the ED staff. The educational information will be presented briefly and efficiently, as only two minutes of the huddle time has been granted to give the presentation. When it comes to providing the education to the CT staff, the director of the CT technicians will hopefully provide the best way to accomplish this to reach most of their staff. Along with the in-person educational sessions, small prompts will be placed at the RN workstations to remind them to use the “CT ready” disposition when their patient is ready for CT. There will also be a sign posted in the CT control room near their tracker board to remind them to check for the “CT ready” disposition. The final step will be to have the ED and CT staff take a post-survey, identical to the pre-survey, in which they once again provide information on their knowledge of the intervention and perception of the intervention.

**Study of the Interventions**

The proposed intervention will be assessed for its effectiveness in reducing the amount of time it takes once the order is placed for a patient to receive their abdominal CT scan with IV contrast. This will be measured by using the hospital’s EMR to assess the number of patients
that presented with some abdominal complaint that had a CT with IV contrast ordered and how long it took from the time the order was placed to when the scan was performed. The ED director is a key stakeholder for this quality improvement project. The data obtained will be compared to previous data (data prior to intervention implementation) to see if there was a decrease in the order to scan time. The validity of these interventions working will be based on whether the order to scan times were decreased when the intervention(s) were in place. The survey data will also be used to assess the effectiveness of the intervention. The survey will be a five-point Likert scale which will assess staff perceptions regarding several specific, intervention-related questions. The Likert scale will assess staff perception as:

1 – Strongly disagree
2 – Disagree
3 – Neutral/no opinion
4 – Agree
5 – Strongly agree

A five-point Likert scale was chosen over a three-point Likert scale to allow staff who might have strong opinions on the matter to be represented. By assessing the survey data and the order to scan time data, it will be possible to identify if the intervention was successful and if a quality improvement was indeed made in practice.

**Measures**

When studying the effectiveness of the “CT ready” button, the indirect data collected will be the order-to-scan times after the intervention to see if there is improvement or reduction of the times. The direct data collected will be a survey that is provided to all ED and
CT staff, before and after the intervention, to see their thoughts and perceptions on the intervention. The survey will be comprised of questions regarding the ED and CT staffs’ knowledge of the “CT ready” button, if staff utilized this intervention regularly, and if the staff found it to be useful or effective in practice if it was used. Gathering this direct data of staff opinions and usage of the intervention will help increase the validity of the intervention and the reliability that the intervention promoted improvement in practice.

Variation in the indirect data collection is possible due a wide variety of uncontrollable factors. These factors should be considered and mentioned when discovered, and there should be a disclaimer if one of these factors makes a significant impact on the data. For example, if a large amount of trauma or stroke cases come in on one day, they will take priority and cause other CT scans to be delayed. A large amount of these types of cases on one day might skew the data significantly regardless of the intervention being in place. This information will be presented in situations where the order to scan times for CT scans did not meet the target times as possible reasons for the delays, among others that might present themselves through the implementation of this quality improvement project.

Analysis

The order to scan time data will be measured and evaluated through quantitative means by first assessing baseline data, or the amount of time it took for scans to be done after the order was placed before any interventions were used. The next data set will be the order-to-scan times once the intervention was in place. The average order-to-scan time prior to intervention will be assessed and compared to the average order-to-scan time after implementation of the intervention. Along with the averages, other continuous data that will be
assessed will be the standard deviation and ranges of the order-to-scan times. All of this will be compared to see if there was a reduction in time, which will indicate an improvement. Other factors that could affect the times will also be assessed, such as daily census numbers and staffing averages to identify any uncontrollable delays that may have caused variations.

Other data that will be analyzed will be the results of the pre- and post-surveys that the ED and CT staff take. The numerical value (1-5 on the Likert scale) for each question will be averaged and assessed. The standard deviation and ranges will also be assessed like the first data set. The information acquired here will represent the ED and CT staffs’ perception of the intervention and their utilization of it in practice after receiving education on it, which will help to validate the results found in the previous data set as being legitimate and not coincidental. Both the order-to-scan times and the Likert scale results will be compared to one another to show the association between them. The goal of this quality improvement project is to see if order-to-scan times for abdominal CT scans with IV contrast are decreased after the intervention is implemented, whether staff used the intervention over this period, and whether staff are satisfied with the intervention.

**Ethical Considerations**

Ethical aspects or possible ethical issues involving this quality improvement project were considered and addressed. Foremost, all efforts will be made to protect private patient information through due diligence. This project will be reviewed by the University of New Hampshire (UNH) Department of Nursing Quality Review Committee to confirm that is exempt from full Institutional Review Board (IRB) approval required of research. When it comes to gathering data from the survey answers provided by staff regarding their perceptions of the
intervention, informed consent from each staff member will be acquired prior to them taking the survey. Any conflicts of interest were also considered and addressed. At the time of implementation of this quality improvement project intervention, I have accepted an offer to work as ED RN at Wildcat Hospital. Considering I will be an employee at the hospital in which I am implementing this quality improvement project, in the same department in which I am implementing it, this creates a conflict of interest. This conflict of interest will be addressed to ensure that the CT staff do not feel like they are being blamed for the current delay in order-to-scan times by an ED employee through reassurances and education on the background of this project. All staff will be reassured that this project is a team effort intended to improve the overall communication within the microsystem as well as improve patient care and patient outcomes.

Results

Results

For this quality improvement project, two different data sets were analyzed. The first data set is regarding the order-to-scan times for abdominal CT scans with IV contrast. The second data set is regarding the pre- and post-survey given to the employees of the microsystem to assess their personal feelings and knowledge about the “CT ready” disposition intervention both before being provided with education on the intervention as well as after education was provided on the intervention. To start this process, the pre-survey was given to employees in the microsystem over two days, with participation being completely voluntary. After the pre-survey, education was provided to all employees of the emergency department through utilization of providing the education during the daily huddles. Daily huddles occur
twice daily at 0645 and 1845 to communicate important information to both the oncoming and
the off going healthcare team. Understand the three-day work schedule, which is common in a
hospital, creates the assumption that within a 6-day period all employees must have worked at
least once (in lieu of vacations or illness). Utilizing the 3-day work schedule, education on the
intervention was provided during both daily huddles over a 6-day span from June 9th, 2022, to
June 14th, 2022. After the educational period, time was allowed for the intervention to be
implemented and utilized (which should have begun on the first day of education). The final
step was distributing the post-survey to employees, which was the same as the pre-survey and
was also voluntary, to see how employee perception of the statements changed post-education
and compare those results to the pre-survey. No modifications were made to the intervention
through the entire process. The education provided was the same for each day and huddle with
no changes made so that everyone received the same information.

The first data set that was evaluated was the order-to-scan time for abdominal CT scans.
This was the key metric that was being evaluated after the implementation of the intervention.
Figure 1 displays this data by presenting the average order-to-scan times overall, as well as the
average time differences between day shift (0700-1900) and night shift (1900-0700). The data is
further broken down to show the two weeks of data prior to education/intervention
implementation, during the educational period, and the post-educational period. This was an
interesting distribution since the lowest average times were during the six days of education
implementation. The “CT ready” disposition was utilized the highest amount during the
education phase, and in turn the order-to-scan times decreased significantly. However, once
the education period ended and employees were not being reminded before their shift to use
this intervention, it was not utilized nearly as much, and order-to-scan times increased again. The average times post-education period was still lower than the average times pre-education period, and the intervention was still being utilized just not nearly as much, which shows some association that this intervention was successful in lowering the order-to-scan times. While the decrease was not as significant as originally hoped, it was still a 34% decrease in the average time during the education period from the period pre-education/intervention. A modification that could have made to the project would have been to place laminated cards around the nurse’s workstations reminding the staff to utilize the “CT ready” disposition. These reminders would have helped to ensure that the disposition was being utilized more, especially in the post-education period. This might have seen a greater improvement of the order-to-scan times during this period.

**Figure 1**

*Order-to-Scan Times for Abdominal CTs with IV Contrast*

![Bar chart showing order-to-scan times for abdominal CTs with IV contrast](image_url)
The second data set that was evaluated was the results of the pre- and post-survey given to employees. While both surveys had the same number of responses, the employees that were surveyed for each are presumed to not be the same. The assumption that the nine people who responded to the pre-survey were not the same as the nine who responded to the post-survey since 9 people only represents about 40% of the total employees that were asked to be surveyed. Without 100% compliance, there is nowhere to be certain which 40% responded to each survey. In both figures, the number displayed inside the bars of the graph are the number of people who responded the corresponding answer that the color aligns with in the legend to each provided statement. While some answers stayed consistent, the post-survey results show that employees had a greater understanding of the intervention and had more confidence in the ability of the intervention to improve order-to-scan times. The post-survey showed a greater utilization of the intervention when compared to the pre-survey results, which could help to justify that the intervention was used and contributed to the improvement of the order-to-scan times seen in the previously mentioned section. The last question of the survey was an open response statement where employees could voice comments/concerns about the intervention or ideas/comments about the proposed or current process of obtaining timely CT scans. There were no comments on the post-survey, but there were quite a few on the pre-survey. These included comments such as “having a protocol and prioritizing CT makes the process smooth, especially knowing what is expected”, “‘CT ready’ can increase throughput if used correctly but not all members of the team are engaged in using it; sometimes there is resistance”, and “this is a great communication tool that should be utilized more”. Some concerns expressed were “CT techs have to communicate when they don’t take
patients over and why”, “sometimes delayed due to IV access”, and “lab value delays have changed the process for some staff due to the knowledge required by staff”. The comments from the pre-survey show that staff were willing to be engaged in the use of the “CT ready” disposition intervention and that some found it would be useful as a communication tool to increase throughput. The concerns expressed are valid, and while this project did not focus on interventions changing processes with the lab or difficult IV access, these propose good ideas for topics that could be focused on for future projects.

![Figure 2](image-url)

**Pre-Survey Results**

Survey Statements

<table>
<thead>
<tr>
<th>Survey Statements</th>
<th>Strongly disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree or disagree</th>
<th>Somewhat agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowing that &quot;CT ready&quot; disposition exists</td>
<td>3</td>
<td>0</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Know when and how to use &quot;CT ready&quot;</td>
<td>2</td>
<td>0</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;CT ready&quot; disposition is easy to use</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>&quot;CT ready&quot; is useful in practice</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Communication is important</td>
<td>1</td>
<td>0</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;CT ready&quot; can increase communication</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Timeliness is an important aspect of patient care</td>
<td>1</td>
<td>0</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;CT ready&quot; disposition can improve patient throughput</td>
<td>1</td>
<td>0</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I regularly use the &quot;CT ready&quot; disposition</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>
Not displayed by the above figures, but still an interesting unintended benefit, was that the order-to-scan times for all CT scans decreased significantly during the education period. While this quality improvement project focused on reducing the order-to-scan times for CT scans with IV contrast, there was no way to implement the use of the “CT ready” disposition intervention to just these scans, so it was implemented to be used for all CT scans. Because of the use of the disposition for all CT scans, the average order-to-scan times decreased for all CT scans performed during this period, with the most significant improvement of times seen during the education period, like the order-to-scan times for abdominal CT scans, as mentioned previously. Since the order-to-times decreased for all CT scans, including the abdominal CT scans, the key stakeholder would like to continue implementation of this intervention into practice even after this quality improvement project has concluded.
Another unintended benefit that resulted from this project was the profound interest by employees of the microsystem to be involved in other change projects. According to the key stakeholder, the ED Director, many employees expressed interest in being involved in projects of their own to improve key metric areas as well as overall patient care. According to the ED Director, 14 people have signed up for 14 different projects so far that are intended to improve key metrics that are not currently at their target goals. Along with improving patient care and improving patient throughput, these projects will also hopefully improve employee retention and employee satisfaction since many employees have expressed interest in wanting more responsibilities in their department. Having a project like this helps to increase staff engagement and gives employees something to work towards and feel more accomplished and fulfilled in their positions.

There was no missing data for the average order-to-scan times for abdominal CT scans with IV contrast. All average times were able to be accessed and reviewed from the period of this quality improvement project. There was, however, missing data from the survey. While nine employees responded to both the pre- and post-surveys, these were potentially not the same employees that responded to each. Since the survey was anonymous, there is no way to know for sure which employees responded to each survey, but it can be assumed that it was not the same employees since 100% of the staff did not respond. The survey was given out over two days in person, with participation being completely voluntary. Because of this, not all staff members were present to respond to the survey and some may have opted not to. Regardless of this missing data, the data that was collected gave brief insight into a small percentage of the
staffs’ perceptions and opinions regarding the intervention both before and after being educated on it.

Discussion

Summary

The specific aim of this quality improvement project was to decrease the order-to-scan times for abdominal CT scans with IV contrast from 61 minutes to below 35 minutes, which would have been a 42.6% reduction.

Key findings of this project included the reduction of order-to-scan times for abdominal CT scans with IV contrast, as well as staff feelings and knowledge towards the intervention using pre- and post-survey data. Regarding the reduction of the order-to-scan times, this connects to the rationale such that the total LOS for the patient would be decreased if the order-to-scan times decreased. The overall total reduction of order-to-scan times was 25 minutes. This is a significant amount of time for a patient that could be saved for the patient and the staff just by utilizing this simple intervention. Continued use of this intervention is advised as a concise and easy way to reduce a patient’s overall LOS. While the specific numbers in the results changed and the pre-intervention time used was 78 minutes (instead of 61 minutes), the order-to-scan time was still decreased by 34% during the education period of the intervention implementation. While the intervention did not reach the target goal of 42.6% reduction, a 34% reduction is still a significant amount of time saved for both the patient and the staff. If utilization of this intervention were to continue in practice, greater staff participation would be needed to potentially elicit greater results or a further reduction of the
order-to-scan times down to the target goal of 42.6%. A reduction of this scale is possible, but further education and proof of efficacy might be needed to garner greater staff participation.

Strengths of this project included the education that was provided to staff members regarding the “CT ready” disposition intervention. The education was concise and informative, with the minimal amount of information being provided to staff so that they could effectively and efficiently use the intervention in practice. The strength of the education is supported by the results of the quality improvement project. During the period when education was being provided to staff members twice-daily, the order-to-scan times for abdominal CT scans with IV contrast decreased significantly when compared to the pre-education period. Another strength of this project is the potential for reproducibility and continued utilization in practice. The intervention, the “CT ready” disposition, is an easily accessible and readily available intervention if the hospital’s EMR has the functionality. If the functionality is present, it is easy to use and utilize in practice with little education needed to be provided to staff. This QI project could easily be done at another hospital that has this functionality but is not utilizing it in practice to reduce the order-to-scan times for not only abdominal CT scans with IV contrast, but for all CT scans as a communication tool between different departments.

**Interpretation**

The intervention for this quality improvement project directly correlated with the outcomes that were described in the results section. Because of the intervention, order-to-scan times decreased for abdominal CT scans with IV contrast. This correlation can be made since no other changes to the process or procedure were made during this time. Without the intervention, order-to-scan times would have remained at what they were pre-intervention
implementation. While there are other factors that could influence this, one major influence would have been the census data. If the census was lower during the intervention implementation, the order-to-scan times would have decreased on their own due to less demand. However, when evaluating the number of patients who required abdominal CT scans during the intervention period, the numbers were almost the same as the number of scans performed prior to intervention implementation. Since this removes one of the potential major influences, the correlation can be strongly made the intervention itself heavily influenced the improvement of the order-to-scan times.

The results of this study are like the results of the study done by Perotte et al. (2018) titled “Improving Emergency Department Flow: Reducing Turnaround Time for Emergent CT scans”. The researchers in this article implemented a new communication tool to improve the turnaround time for CT scans, among other interventions. The intervention implemented in this quality improvement project was a way to increase communication between the ED staff and the CT staff using a disposition to identify patients that are ready to have their CT scan performed. The studies are similar since the research study by Perotte et al. (2018) and this quality improvement project included the usefulness of increasing communication to reduce the order-to-scan times for CT scans. In both cases, the order-to-scan times were decreased when the intervention was implemented. This shows that communication is essential to improve patient care and patient throughput.

This quality improvement project had a significant impact on both the patients and the microsystem. The microsystem was impacted in the way that a new intervention was implemented that improved the workflow and LOS for patients requiring abdominal CT scans.
with IV contrast. The reduction of patients’ LOS lead to less strain on the system from both the employee side and the patient side. Patients were also positively impacted by not only having a shorter LOS but also gaining access to treatments in a timelier manner since the diagnostics were performed sooner. In certain situations, the reduction of any amount of time for diagnostics tests to be performed and treatments to be initiated sooner could mean better outcomes for the patients overall. Better outcomes for the patients lead to lower times in the hospital if admission is required and reduces the potential rate of readmissions in the future.

The anticipated outcome was that the “CT ready” disposition would work seamlessly and devoid of any issues. However, without any buy-in from the CT manager, this caused some anticipated outcomes to not be achieved. The CT department did not seem as informed about this disposition as originally planned. Many employees did, however, recognize this new disposition and take it upon themselves to learn about it and understood the benefits of it. If given more context behind it, it might have been utilized more and might have had a more significant impact on the order-to-scan times.

The use of this intervention did not have any opportunity costs. The use of this intervention required seconds of the ED RNs time to use, so there was no need to allocate unnecessary resources or time to using this intervention. The disposition was also already functional in the EMR before the start of this quality improvement project, so there was no cost needed to make the intervention functional. The only cost that can be evaluated was the cost of time spent educating staff on the intervention and researching to see if the intervention was successful. This was an anticipated cost, however, and it was not very substantial.

Limitations
There were several limitations to the generalizability of this quality improvement project. Overall, this project would be easy to replicate at another hospital with similar results. However, the use of the “CT ready” disposition limits this project since not all hospitals might not have this functionality already available in their EMR. This means that the information technology (IT) department would need to implement this function into the hospital’s EMR, which may cost money or more time than what occurred during this quality improvement project since the functionality was already available to use. However, the overall use of a communication tool to decrease the order-to-scan times for CT scans is something that would be easy to replicate and could benefit almost any hospital system in multiple ways.

While steps were taken to limit the factors that might have limited internal validity of this QI project, complete elimination of these factors was not entirely possible. One limit was the stakeholder buy-in from the radiology department. Due to staff shortages in part, the stakeholder was unable to provide a definitive way to reach 100% of the CT staff to partake in the pre-intervention survey. Some education was provided to staff that were present on two days, and surveys were provided but were never returned. This led to the limitation of not having the CT techs as involved in the intervention as originally planned which may have contributed to the results not being as significant as originally planned. Another limitation to the internal validity was not continuing the education period longer. During the intervention education period, the order-to-scan times decreased significantly. After the intervention education period ended, the order-to-scan times returned close to what they were pre-education. The use of reminder cards on the workstation computers might have worked well to reinforce the education, but time was a limiting factor, so this did not occur.
There were several efforts made to minimize and adjust for limitations that were noted during this QI project. When it came to the lack of buy-in from the radiology department, this was adjusted for by having the ED staff continue to use the intervention and educate the CT staff themselves whenever possible or whenever questioned about why the intervention was being used. An adjustment for the differing results between the pre, during, and post-education phase was to collect data from all three periods separately instead of just collecting pre- and post-intervention data. This led to more inclusive results that showed the importance of continued education and reinforcement as a tool to drive a quality improvement project.

Conclusions

This quality improvement project was very useful for both the microsystem and for the patients that the microsystem serves. The intervention that was implemented was able to reduce the order-to-scan times for CT scans, which subsequentially lowered patients’ LOS. This means the patient would get admitted or discharged quicker after receiving a faster diagnosis, which would increase patient satisfaction. The intervention was also implemented to increase communication among the microsystem and to improve communication with other microsystems. This was achieved by the intervention by reducing delays that lack of effective communication might cause in a busy ED. Patients were taken to get their scans faster with the simple non-verbal communication tool of informing the CT tech when the patient was ready to get their scan, instead of the CT tech having to track the ED RN down to find if their patient was ready or not. As stated previously, effective communication is very important in a highly functioning microsystem.
This QI project is highly sustainable and something that could be continued in practice with minimal effort and potentially significant benefits. With the intervention already in place, it could continue to be used by the microsystem to further improve times or set a new standard for times. Re-education might be necessary for staff that might have viewed this as a short-term project, with emphasis on the continued use of the intervention having beneficial effects not only for the patients, but also for the staff and their limited time. If the employees see the benefit of using the intervention from this quality improvement project, it could easily be sustained in practice.

This QI project also had a high potential to spread to other contexts, and it did just that. Because of the success of the project when it came to reducing order-to-scan times, the ED Director has identified other areas where target times or metrics are not being met and have allowed employees to volunteer their time to come up with possible improvement projects of their own to improve these areas. Because of this quality improvement project and its impact on the employees of the microsystem, greater focus has been placed on improving other areas and this project showed that there is potential of success to be achieved when effort is applied.

The implications for practice of this QI project highlight the importance of communication between microsystems and the potential benefits effective communication can have on the whole system. This QI project was also able to reduce order-to-scan times effectively through the intervention, so this means it has great implication for use to assist other microsystems struggling with a similar problem. Further study into other interventions to improve this area of focus could still be made as there are numerous other ways a microsystem
could improve communication and reduce the order-to-scan times. It also has implications for further study into other QI projects, especially since this QI project was successful.

The next steps following the conclusion of this QI project would be to continue to utilize the “CT ready” disposition intervention in practice to increase communication within the microsystem. The intervention was successful in reducing order-to-scan times over a short period of time, so continued use over a greater period might lead to greater results and a further reduction in times overall. Other next steps would be for the microsystem to continue to identify areas where targets are not being met and come up with ideas to improve these metrics or areas. Improving other areas, based on the results of this quality improvement project, would greatly improve patient care and patient satisfaction, as well as staff satisfaction.
References


