Investigating Cytology Order Processing for Cancer Patients at INTEGRIS Southwest Cancer Institute

Senior Design Project Report

Spring 2022

School of Industrial Engineering and Management
Oklahoma State University
Stillwater, Oklahoma 74078
United States of America

Kylie Dowers

Louisa Ivey

Tyler Wedel

Faculty Mentor: Dr. Katie Jurewicz

Submitted in partial fulfillment of the requirements of the course, IEM 4913, Senior Design and the Baccalaureate degree requirements of the School of Industrial Engineering and Management at Oklahoma State University

Table of Contents

List of Figures

List of Tables

1.0 Executive Summary

INTEGRIS Health was created in 1995 after the Oklahoma Health System and Southwest Medical Center in Oklahoma City merged. The INTEGRIS Southwest Medical Center, including their Cancer Institute, has been serving the community since 1965. Ranked in the 95th percentile inpatient experience in 2019, they focus on delivering the best possible care. The INTEGRIS Cancer Institute conducts a multitude of services including imaging and radiology, radiation oncology, cancer rehabilitation, integrative medicine, and much more.

Currently, the Cancer Institute is experiencing errors in its order processing system, leading to samples and results not being processed. Patient diagnosis and treatment can be delayed by more than two weeks when this happens. The patient then may need to undergo a second procedure to acquire another sample. This project aims to study cytology order processing at INTEGRIS Health's Cancer Institute and improve the cytology order process to reduce the loss of test results and improve the overall patient care process.

To achieve the objective, the team will be using the Systems Engineering Initiative for Patient Safety as the main theoretical framework, process analysis, and data collection through interviews and observations. The potential benefits will be to reduce patient retesting occurrences, reduce wait time for diagnosis and treatment, and reduce the instances of no test results. This will lead to improved patient experience, higher patient satisfaction, and decreased patient harm.

In our analysis, we interviewed several key players in this process, including nurses, physicians, and one lab technician. Taking their perspectives and the overall perspective of the executive nurse, we have created process maps, tables of information, and have been able to narrow our focus on potential issues. We found that process instability, miscommunication, and potentially software shortfalls are to blame for the missing tests.

In response to our observations, we've proposed several solutions that apply to various departments. These solutions include visual cues and queueing assistance for pathology, and a notification system within the EPIC software. We also suggested future-based solutions, such as a questionnaire, that aim to provide assistance further down the road. INTEGRIS will decide which, if any, of the solutions to implement in their hospital.

2.0 Introduction

INTEGRIS Health was created in 1995 after the Oklahoma Health System, and Southwest Medical Center in Oklahoma City merged. The INTEGRIS Southwest Medical Center has been serving the community since 1965. The campus is home to forty different medical specialties. One of those is the INTEGRIS Cancer Center.

The INTEGRIS Cancer Center includes a multitude of services. These include imaging and radiology, radiation oncology, cancer rehabilitation, integrative medicine, etc. Between testing methods and physical therapy, INTEGRIS Cancer Center has the capacity to help patients all the way through the process of surviving Cancer. The 200,000-square-foot center is among the best centers for cancer in the region. In 2019, INTEGRIS Cancer Center received the Guardian of Excellence Award, placing them in the 95th percentile or above inpatient experience nationally.

The INTEGRIS Cancer Center works with several types of adult cancer patients to diagnose and treat a variety of cancers. Patients that are being tested for cancer must undergo a procedure to collect a sample for testing. This sample becomes part of the patient's cytology report. The cytology sample is sent to the Diagnostic Laboratories of Oklahoma (DLO). If the sample is identified as a cytology order, it is passed to the AmeriPath lab to be tested. Once the specimen is tested, and a diagnosis has been made, a patient can begin treatment if necessary.

INTEGRIS Cancer Center runs cytology tests on their patients to test for malignant growth. When a patient undergoes their procedure, they are often sedated, and an oncologist or physician collects the necessary sample. Next, the physician or a nurse (with physician instruction) will describe what tests need to be performed on the collected sample in an EPIC report. Once a patient's order is complete, the order is "collected" in EPIC and physically transferred to the DLO, located within the Cancer Center. The DLO receives this information in CERNER and runs the requested tests. If prompted, they send the specimen to AmeriPath, where further testing (including cytology) is performed.

2.1 Problem Statement

The process described above has encountered errors that have consequently led to testing results not being recorded. This results in a delay in the process, and the cause of these delays is currently unknown. When the process breaks down, physicians cannot diagnose and treat their patients. These delays can often be two or more weeks in length. In two weeks, treatable cancers can become terminal. Additionally, retesting can be a harmful procedure for weaker patients, and sometimes the patient does not have enough tissue to provide the proper sample twice.

2.2 Objectives and Scope

The objective of this project is to determine where and why process errors occur and to develop solutions to reduce these occurrences. Locating the errors will require interviewing and observing multiple departments since this issue spans multiple areas. Reducing order processing errors may lead to fewer delays in diagnosis and treatment while diminishing the need to retest. It is important to note that DLO and AmeriPath are not part of the INTEGRIS corporate infrastructure. They are external laboratories that have been hired by INTEGRIS and reside within the INTEGRIS facility. We will determine the ideal

process for these departments to identify potential breakdowns. Our scope includes all departments involved in the process of cytology orders. Our scope does not include other INTEGRIS facilities outside of Southwest Medical Center, the restructuring of EPIC and CERNER electronic health record systems, types of tests outside of cytology orders, or nurse training.

2.3 Methodology

Our methodology includes our process and the Systems Engineering Initiative for Patient Safety (SEIPS). Our process spans the entire project, and SEIPS will be used in our Analysis stage to help us determine the best course of action in providing adequate feedback. Our process is broken down into four separate sections:

2.3.1 Gather Data and Information

The team interviewed knowledgeable staff to gain an insight into problem history, observe key departments to learn the process, and look at the Epic and Cerner interfaces. These sessions were conducted on-site and virtually.

2.3.2 Perform Analysis

We intend to use the Systems Engineering Initiative for Patient Safety (SEIPS) as a theoretical foundation to start our analysis. While collecting our data, we will document all steps dealing with cytology orders. Once this is complete, we will use both our theoretical foundation and obtained information to determine the root cause of delays.

2.3.2a System Engineering Initiative for Patient Safety (SEIPS)

SEIPS is the leading theoretical model in healthcare systems engineering and has been used in a multitude of reputable studies (Carayon et al., 2006; Carayon et al., 2021; Holden et al., 2013; Karsh et al., 2006). We will utilize SEIPS to translate our interviews and observations into data and, eventually, a comprehensive process. By analyzing the work systems, we will be able to identify defects in the system. Figure 1 displays each component of a working system forming relationships to create a process. This process then leads to patient, employee, and organizational outcomes.

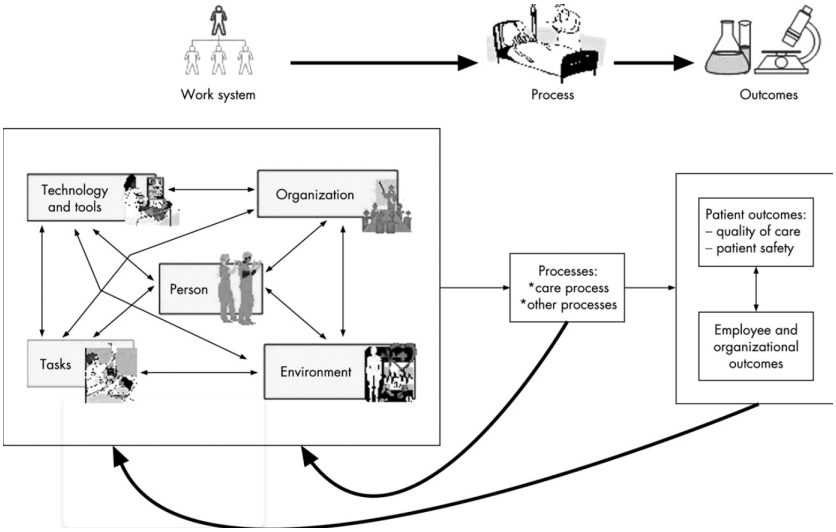

Figure 1: SEIPS Analysis

Work systems are composed of five components: people, tasks, technology and tools, organization, and the physical environment. Each of these components will be investigated in our analysis. In order to apply SEIPS to our project, we will follow the approach described in Figure 2. We will conduct interviews and observations to gather data. The data will then be analyzed and translated into one of the five components of work systems.

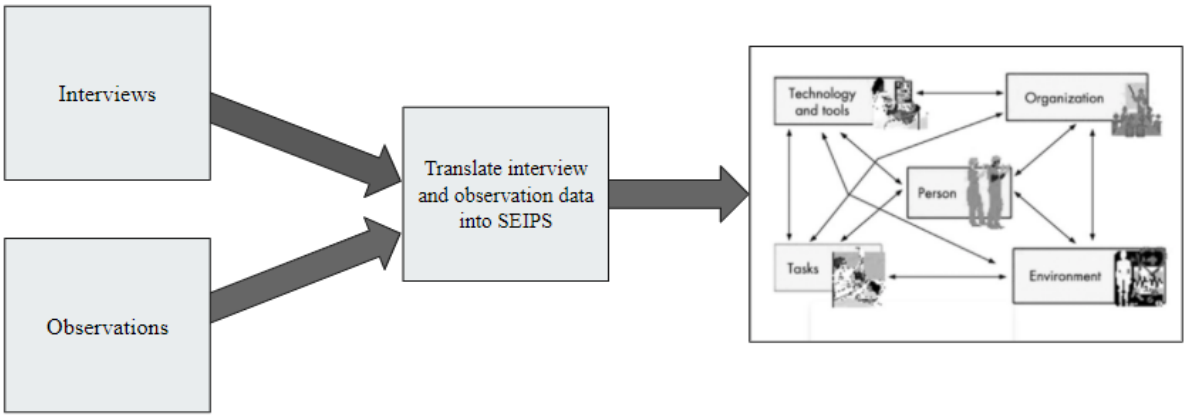

Figure 2: Initial Approach to Establish the SEIPS Model

2.3.3 Explore Alternatives

Once our analysis is completed, we will begin exploring possible alternatives. These begin with our process maps, which will provide a foundation for communicating between departments. Process maps will also help us identify the root cause(s) more effectively. Another possible alternative is some degree of standardization. While true standardization may not be possible, or in scope, an effort to improve standardization may help reduce errors that result in retesting. Our main focus is to improve interdepartmental communications to allow the experts to mold the complete process, ensuring that no

department is overlooked or given more unnecessary work. Once these ideas are compiled, we will share the possible ideas with the client.

2.3.4 Create Recommendations

Our recommendations will come as a direct result of alternative exploration. Our deliverables would include the aforementioned documentation in section 2.3 (Flowmap, standardization materials, etc.) We will offer these recommendations as suggestions for the current system based on our observations. In the end, INTEGRIS reserves the right to use any, all, or none of our recommendations to whatever degree they deem appropriate.

3.0 Data Collection

To collect data, we conducted interviews and observations with multiple departments in the Southwest Medical Center. The areas included oncology, AmeriPath Lab, DLO, surgery, radiology, and the inpatient floors. We spoke with nurses, physicians, pathologists, and lab technicians to gain a clear understanding of the process and what each person had experienced. Table 1 shows a summary of what each interviewed individual mentioned when related to cytology orders.

Table 1: Issues and Experiences of INTEGRIS Employees

Roles	Issues Brought Up	Experiences
Physician 1	● Not receiving test results ● Has been a problem for 10 years	● Specimen sent to lab, no results return
Physician 2	● Not receiving test results ● Wonders why cytology orders are more difficult ● Wonders why talking to many nurses is necessary	● Order didn't go through; specimen sat in lab for 10 days (had to call and ask about it)
Ameripath Pathologist	● Nurses may not be pushing collect	● Receives either specimen or order, doesn't always get instructions. May have to place a phone call.
Nurse	● Never received a call from lab ● Lacked test results	● Seen troubles in lab consistency
Head Nurse	● Multiple problems on both sides ● Nurses may not know how to correctly order Cytology ● EPIC is difficult ● Pathology needs to be firmer	● Has seen many errors of many types ● Experienced pitfalls of EPIC, Cerner, and other hospital infrastructure

3.1 Data and Process Analysis

The data was difficult to collect due to scheduling conflicts, variable response times and the lack of numerical data. However, from the data we were able to collect, we were able to create meaningful and insightful questions for further interviews along with creating in-depth process maps outlining the system. Table 1 contains all of the major topics discussed with each individual in the system. This compilation of the data allows us to quickly compare what each person is saying and experiencing and gain a better understanding of what each person believes to be a failure. Additionally, we were able to create Table 2, which is our SEIPS Analysis, which will be discussed in section 3.1.2. In the coming weeks, we will

conduct further interviews and observations with the pathology department which will allow us to update and complete the process maps. With the completed maps, we will be able to identify the true failure modes and categorize the failure as either human, technology, task, environment, or organization. From there we wish to develop multiple solutions to mitigate the failure modes.

3.1.1 Analysis of Qualitative Data

Taking a deeper look at Table 1, we were able to determine that there is some discrepancy in whether the lab had a sample but no order. One individual claimed that the lab would call the nurse or physician if there was no order with the sample. Conversely, three individuals claimed that the call was not made in this instance while the last individual had no comment. We also determined that none of the nurses complete cytology orders frequently enough to remember all the necessary steps to complete the order. They also revealed that there was no formal training for the nurses on the EMR. And finally, four individuals said that AmeriPath does not always test samples in a timely manner. We were able to use this information to identify potential failure points in the system.

3.1.2 SEIPS Analysis

Table 2: SEIPS Analysis

People	Task	Tools and Technology	Physical Environment	Organization
● Patients ● Nurses ● Physicians ● Labs (DLO and AmeriPath)	● Cytology Ordering ● Cytology Testing ● Walking sample to the lab ● Signing in at DLO	● Epic ● Cerner ● Lab Processing ● DLO Log Sheet	● Cancer Center ● DLO ● AmeriPath	● Physician giving the nurse a task ● Pathologists receiving orders and performing testing ● Chain of command for specimen

Table 2 separates the components of the SEIPS analysis. Each column shows the people, tasks, tools and technology, physical environment, and organization within the work system. The SEIPS Analysis will be used in the process maps to identify where in the work system possible errors are occurring.

3.1.3 Process Maps

Figure 3 and Figure 4 are the task flow and information flow maps of the process. The orange box shows where a failure point may occur.

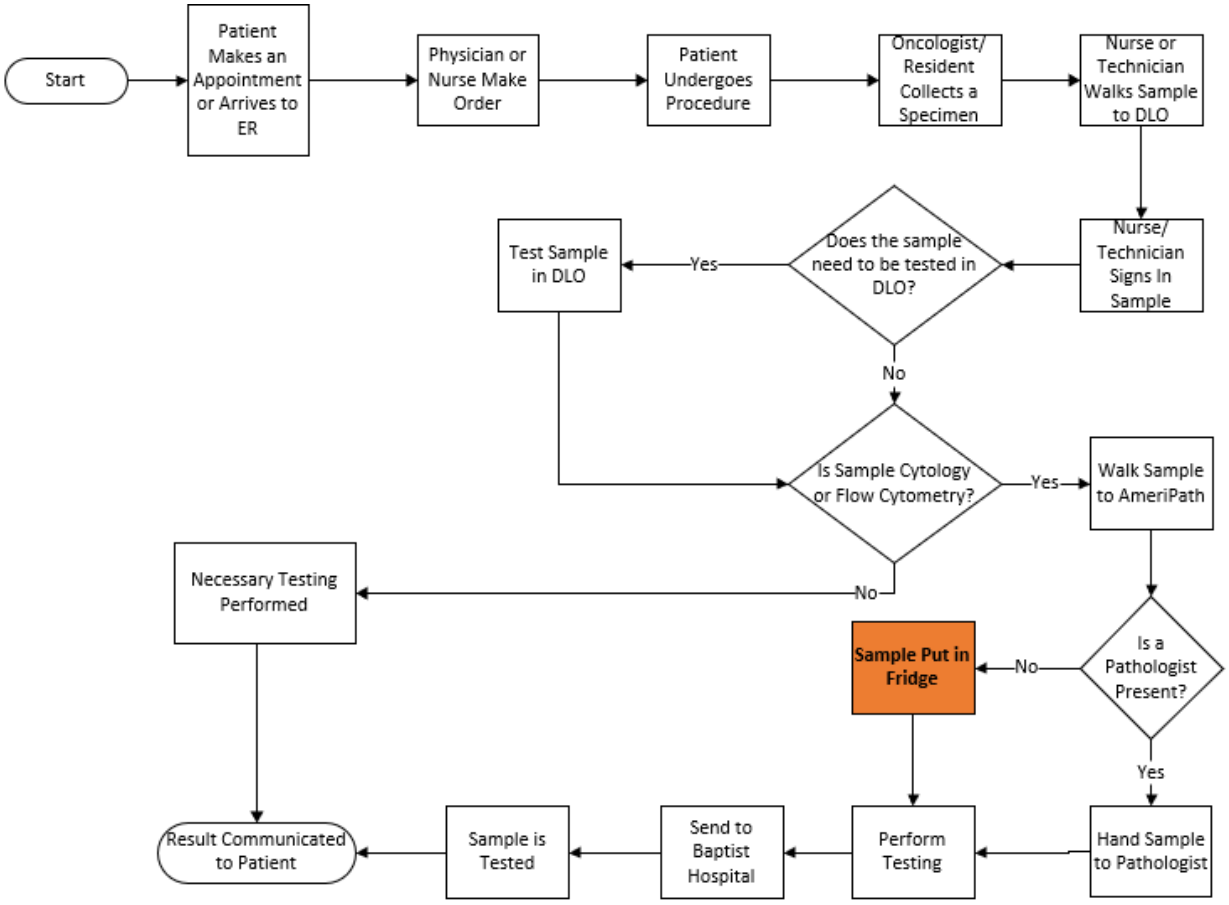

Figure 3: Task Flow Map

In the task flow map, the step “Sample Put in Fridge” is a possible failure point. If the sample is placed in the fridge without a pathologist knowing, the sample is at risk of not being tested.

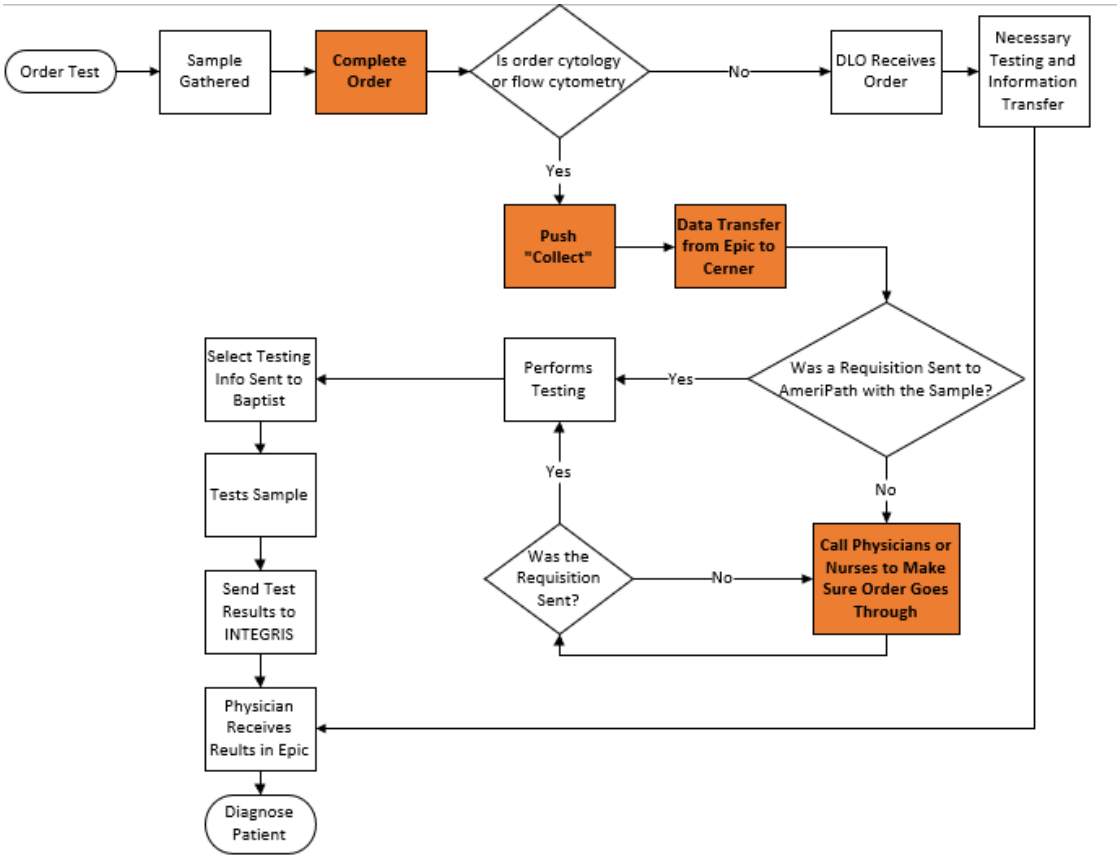

Figure 4: Information Flow Map

In the information flow map, there are several areas of possible failures. Firstly, there is a failure point at "Complete Order." A nurse is instructed to complete an order by a physician once the sample has been taken from the patient. The nurse is required to fill out the information about the specimen type, the specimen source, and the clinical history of the patient. Because of the vast amount of information the nurse needs to enter, the order may not be completed fully. They may not know the exact information needed to fill out the order correctly. Also, nurses have fewer options for types of specimens which could also lead to an incomplete order. The next failure point is "Push Collect." If a nurse does not click collect for a cytology order, the sample will not be sent to the AmeriPath Lab from the DLO. This can be detrimental to completing the order.

The next possible failure point is the data transfer from Epic to Cerner. INTEGRIS utilizes Epic for its electronic medical record system, whereas AmeriPath utilizes Cerner. There may be an error as the information is handed off between two systems. The next failure point could occur on "Call Physicians or Nurses to Make Sure Order Goes Through." According to several physicians and nurses, the pathology lab has made a phone call if they receive a specimen without an order. This could also lead to the sample not being tested.

4.0 Preliminary Solutions and Alternatives

The preliminary solutions and alternatives are ideas that may be introduced to the client to gain their insight on what would be useful to propose at the end of the project. The goal is to provide multiple alternatives to discuss and compare.

Following the analysis and construction of flow charts, we took into account the areas of greatest concern within the process. Based on the activities performed in the flowchart, we began brainstorming possible solutions to help make the process easier to complete. Since the process is largely human, we're looking to prioritize solutions from a human factors perspective.

4.1 Visual Cues

In order to reduce human error in handoffs of the sample, visual cues are useful to eliminate errors. One visual cue would be a sticker that says pathology. The sticker would be applied to the physical sample. This would inform the DLO that the sample must go to the AmeriPath Lab. If "collect" is not pressed during the ordering process, the sample will still make it to the correct lab. Another visual cue would be a printer that sends an order notification to AmeriPath that would easily notify someone of a pending order. This visual cue would ensure that AmeriPath technicians and pathologists are aware of an incoming specimen. And finally, having multicolored bins that indicate if a sample has completed its ordering process could be a useful tool for nurses to know if they have completely finished the order on a specimen. Also, have different colored bins in the AmeriPath lab to indicate if a sample has been tested or not.

4.2 Log Sheet

The DLO has a log sheet for every sample that enters its lab. However, AmeriPath does not. It would be useful to have a log sheet with the date and type of sample that is brought into the lab. This would allow for specimens to be tested in an appropriate time frame.

4.3 Electronic Medical Record Notification System

In the current EPIC interface, orders have to be manually "collected" before the information goes to the labs. This is because patients may need multiple tests within a single order, depending on what is being tested for. This is an example of a failure point in the order process, but there are other places where things could easily be forgotten in the natural busyness of healthcare.

Implementing a notification system can help reduce human error by notifying applicable physicians and nurses about missing information. Notifications could be sent via email, pop-ups within EPIC, and/or a cellular notification. Due to time constraints, specific technical implementation would be handled by the Integris IT team.

5.0 Analysis

For the analysis of our data, we created a finalized process map integrated with the SEIPS analysis to see where in the work system the process could be improved. The organization, physical environment, tools and technology, and people were identified.

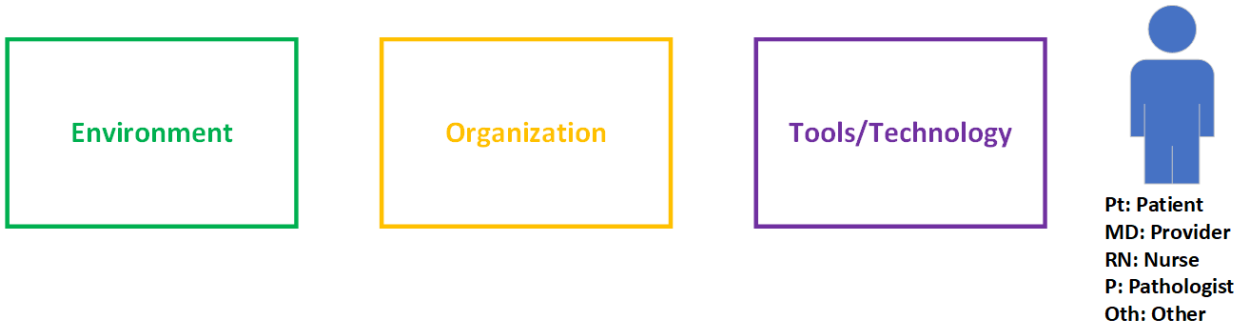

Figure 5: SEIPS Process Map Key

Figure 5 shows the key that is used in the process maps. The green boxes represent where in the environment of the work system, the yellow boxes represent what part of the organization the tasks take place, and the purple boxes represent the tools and technologies that are used in the tasks. The person symbol shows how many people are possibly involved in each step. The abbreviations under each person identify who is involved. Each step in the map is a task, therefore there is no identification for tasks.

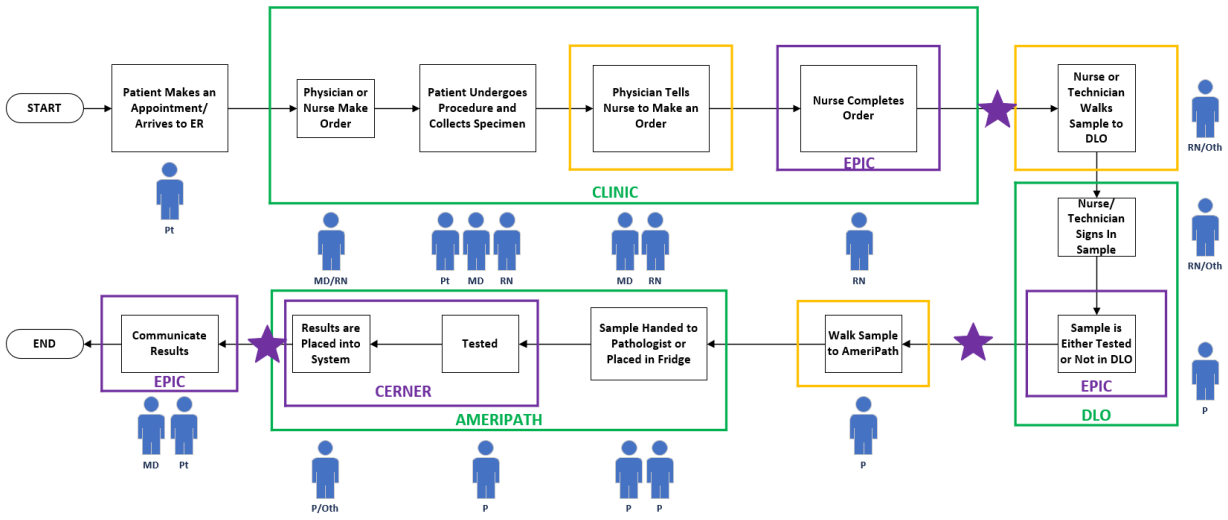

Figure 6: SEIPS Task Process Map

In the task process map in Figure 6, there are five task blocks involving tools and technology, and there are only two types of tools and two information handoffs. There are three environments: the clinic, DLO, and Ameripath. There are two physical handoffs of the sample. Three tasks are organization-defined and involve up to four different people. The people involved are the patient, physician, nurse, and pathologist.

The stars show where a tool could be useful. They would occur during the handoffs between environments.

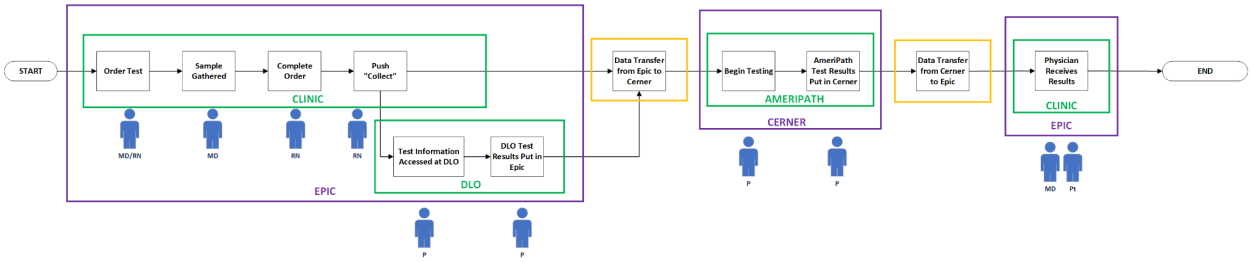

Figure 7: SEIPS Information Flow Process Map

In Figure 7, the information flow process map has two task blocks for tools and technology that consist of two EMRs. There are three environments with two information handoffs. There are also two organizational tasks with up to 2 different people involved. There are three instances that a physician is present, two instances that a nurse is present, and three instances that a pathologist is present.

In the event of handoffs, errors are more likely to take place. In the next section, solutions will be offered to minimize errors where handoffs take place.

6.0 Solutions

The following sections explain our preliminary solutions that have been approved by both our faculty advisor and the INTEGRIS Continuous Improvement department.

Our analysis provided a narrower scope to apply specific solutions within the process. Based on these areas, we formulated a series of recommendations that fill specific needs detected in our analysis. These solutions will be implemented as seen fit by INTEGRIS. There is one short term solution, three long-term solutions, and one continuous improvement solution that can be implemented in the future.

6.1 Visual Cues

Visual cues are critical in any industry because they serve as reminders for specific actions. In INTEGRIS's case, it is to signal nurses or technicians to do some task with the specimen, whether it is to push "collect" on the order, send the specimen to AmeriPath, or prepare for an incoming order on the AmeriPath side. We have developed multiple visual cues that will be described below.

6.1.1 Specimen Check-List Label and Buckets

The label and the buckets are visual cues to be a reminder of what should be checked or completed and to have a visual cue if a sample needs another step to be taken before it is brought to the next environment.

Each physical sample will have a label that stays with the sample through the entire process. The label acts as a visual cue for tasks that have been completed. Furthermore, the list can also act as a reminder to what needs to be checked before moving on to the next step.

Two colored buckets will be placed at each physical environment. The red bucket will hold the samples that need to be completed. The green bucket will hold samples that have completed the required tasks in that physical environment. The green bucket would not be present in the Cancer Clinic because once the sample is done being ordered and collected, it is immediately walked or sent to the DLO. The buckets provide a redundancy gain for visual perception to support situational awareness.

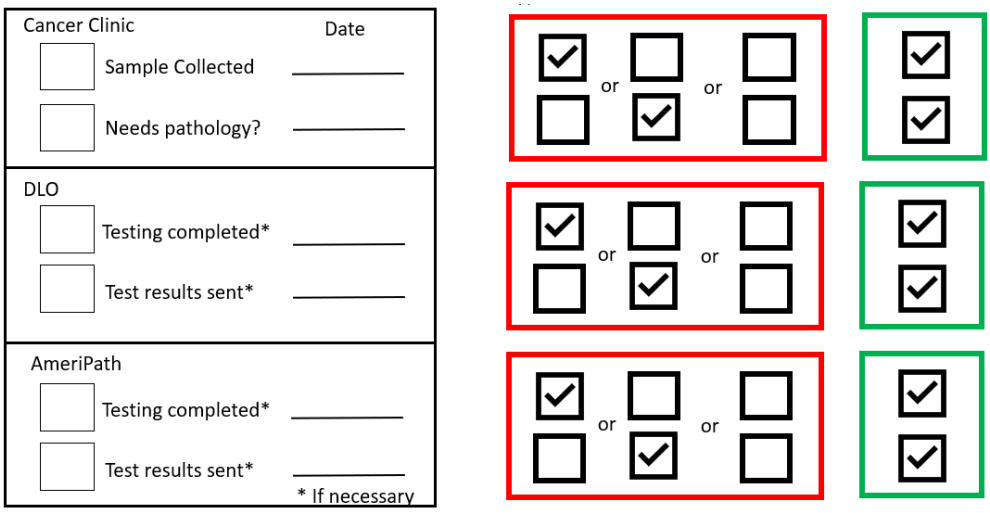

Figure 8: Check Off List and Buckets

Figure 8 shows how the list and the buckets would work together. In each physical environment section, the sample will start in the red bucket. If one or none boxes are checked, then the sample will remain in the red bucket. The red bucket indicates that the sample is not ready to be sent to the next environment in the process. If both boxes are checked or signed by the person doing the task, then it is placed in the green bucket indicating that it can be brought to the next environment. It is important that the date in which each step is completed should be recorded on the date lines.

The use of the check-list label will act as a reminder to complete all necessary steps before the physical sample is sent to the next physical environment. Whoever is handling the sample can easily check off the steps when they are completed. The bucket will also act as a visual cue to make sure that samples are attended to if needed. If a sample is in a red bucket, it informs the user that the sample needs to be looked at. This will also help in the process to ensure that all samples are accounted for in the process.

6.1.2 Stickers

Our next solution is stickers that will act as a reminder to nurses to order a pathology test, for nurses to collect the order, and DLO technicians to send the specimen to AmeriPath. The stickers shown in Figures 5-10 were created in makestickers.com but could be developed in any design software such as Cricut Design Space. Additionally, most sticker websites like makestickers.com sell rolls of stickers in bulk for relatively cheap. INTEGRIS may also use their own label design software and printer to eliminate the cost of purchasing rolls of stickers in bulk or purchasing a different printer. Labels like this should be as salient as possible, meaning easily detected and easy to read. Thus the bright background colors and the simple font type.

Figure 9 shows the sticker that will be used on larger specimen containers. Since containers can range in size, it is important that the stickers be easily detected on the containers. By making this sticker larger, it will be more easily seen by nurses, technicians, or physicians.

Figure 9: Pathology Label Sticker for Larger Specimen Containers

Figure 10 shows the sticker that will be used on smaller specimen containers. We chose a circle design so that it will fit on a round cap or tube.

Figure 10: Pathology Label Sticker for Smaller Specimen Containers

And lastly, the date sticker, seen below in Figure 11 , can be used to identify when a specimen was drawn.

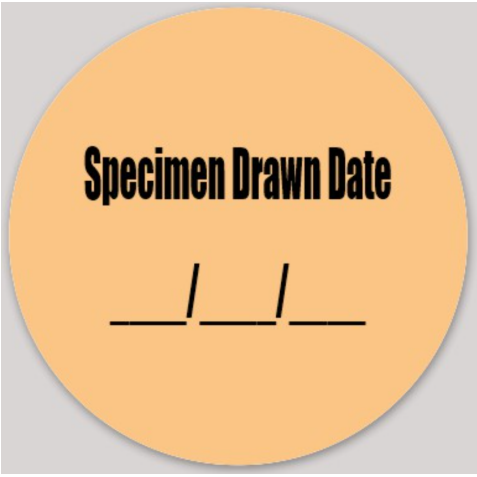

Figure 11: Specimen Collection Date Stickers for Specimen Containers

The visual cue of the pathology sticker will contribute to bringing information throughout the process. Because there are physical handoffs where information can be lost, this will ensure that the sample is easily identified as needing to go to AmeriPath. The "Specimen Drawn Date" sticker will also ensure that information on when the specimen was collected makes it to AmeriPath if the EMR systems have a lapse in data transfer.

6.2 AmeriPath Specimen Check-In Log

Another issue that AmeriPath has experienced is not knowing when a specimen has been placed in their fridge. If no one is in the lab when a DLO technician drops off a specimen, there is a chance that the AmeriPath technicians will not know to check the fridge for a specimen unless they have an order. Implementing a physical specimen check-in log that sits outside of the AmeriPath lab will reduce the number of potentially missed samples. This check-in log is similar to the one used by DLO at their front desk.

ATTENTION: Must have complete order and have pushed "Collect"

AmeriPath Specimen Check-In Log

Patient Name	Specimen ID	Unit ID	Drop-Off Personnel Signature	Date

Figure 12: AmeriPath Specimen Check-In Log Sheet

Figure 12, shown immediately above, is the check-in log for specimens going to AmeriPath. Even if a technician is in the lab, this document will need to be filled out to act as an additional record keeping system for AmeriPath.

The check-in log will ensure that information is not lost between the handoff of the sample from DLO to AmeriPath. It will also ensure that if there is a data loss because of the data transfer between Epic and Cerner, AmeriPath will know about information concerning the specimen.

6.3 Electronic Medical Record (EMR) Notification System

In medicine, the Best Practice Alert has been used to assist physicians in providing the best care to patients. This system alerts physicians when a patient requires a certain type of treatment and informs them of steps to be taken. We created this solution to replicate the Best Practice Alert for Epic.

Within the Electronic Medical Record (EMR) System, we would like to implement a notification system for nurses and physicians. All parties who come in contact with the patient will be able to receive these notifications. Notifications can come in the form of an email, text notification, or notification screen on Epic. This system will notify involved individuals if an action has not been made for a specimen after a given amount of time. More specifically, if the order has not been completed or "collected". The suggested amount of time is 6 hours. To simulate a pop-up notification, we used VBA in Excel, shown below in Figure 13.

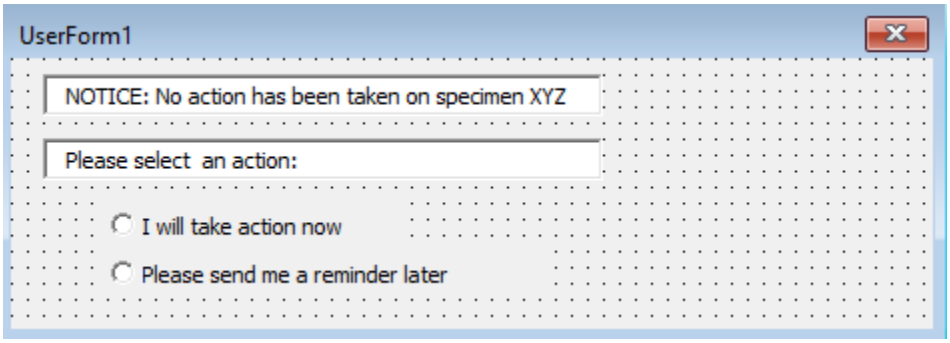

Figure 13: EMR Notification for a Physician or Nurse.

The user may decide to take action or can ask for a reminder later. By selecting the first option, "I will take action now," the nurse, technician, or doctor will physically go into Epic and see what actions need to be taken. The second option, "Please send me a reminder later," indicates that the order is not ready to be completed and sent to DLO and AmeriPath. Additionally, a new reminder will be sent automatically in 6 hours after the latter option has been picked. Once the user has selected an option, the notification will go away.

Because so many people may be involved in the process as seen in the process maps in Figures 6 and 7, a notification system would act as an extra step to ensure a sample order is completed and collected. A nurse may create and order in the morning, and then another nurse may complete the order in the evening.

This notification would allow information to easily be seen by those in charge of the sample and for the information to not be lost between “handoffs” of those going on and off shifts.

6.4 Continuous Improvement Solution

For continuous improvement on the Epic and Cerner systems, we suggest implementing a barcode reading system for not only cytology specimens but for all specimens that might pass through DLO or AmeriPath. Barcodes are already used throughout INTEGRIS and in the DLO for patient care and specimen information.. We would like to also use the barcode for an electronic check-in and out system and information transfer system. Electronically checking in a specimen instead of handwriting information will eliminate human error when copying down the patient's name or identification number. This would also eliminate the need for the paper check-in logs currently used at DLO and AmeriPath that were introduced in Sections 4.2 and 6.2. However, the log sheets should be kept in case of electronic failures. If the order is done correctly, an email or notification will be sent to AmeriPath to instruct them to be looking out for the specimen. Shown below is an example of the current specimen labeling system.

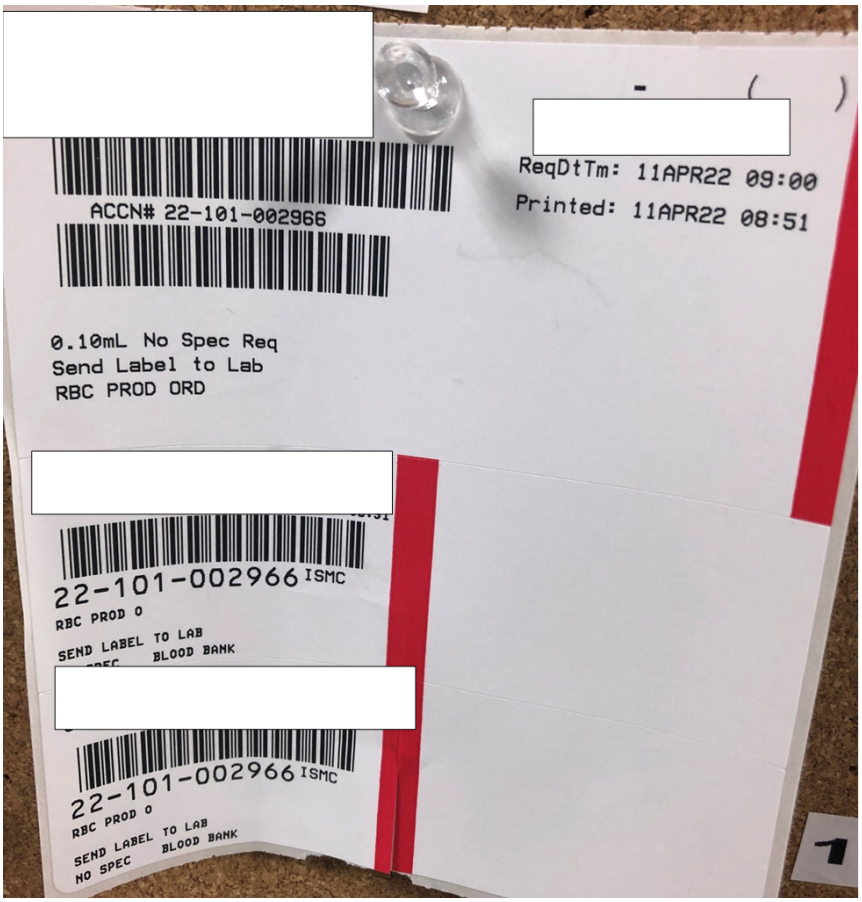

Figure 14: Current Specimen Label Used at INTEGRIS

In Figure 14 above, the white boxes are where a patient’s name, ordering physician name, and other patient information would be. Integris is already using a barcode system on the specimen label, and it could be implemented in not only DLO and AmeriPath but other departments for specimen tracking, patient information, and to reduce information clustering.

The barcode would act as a way to ensure information is not lost throughout the process. It would reduce the effect that handoffs may have on the transfer of the sample and information from each physical environment and EMR system.

6.5 Solutions Application

The following sections will explain the recommended implementation of each of the solutions described above.

6.5.1 Specimen Check-List Label and Buckets Implementation

As stated in Section 6.1.1, these buckets will be located in every environment with the exception of the red buckets not being in the nurses station or operation hall. From the interviews with nurses, the green buckets would not be beneficial due to the sample being immediately transferred to the next section once all the procedures are completed. Once at the DLO, the nurse will transfer the specimen into DLO's red bucket and check the specimen in. The specimen is now in the care of DLO, and they will take any actions required on the specimen. When DLO is finished with their testing and has checked off the boxes on the label, the technician may place the specimen into the green bucket and transport the specimen to AmeriPath. Once there, the DLO technician will place the specimen in the AmeriPath red bucket and perform any specimen check in procedures. Finally, AmeriPath will complete any and all tasks required of them for the specimen, check the boxes on the label as they are completed, and place the specimen in the green bucket. At this point the specimen will be either transported to the Baptist hospital or disposed of properly.

6.5.2 Pathology and Date Stickers Implementation

As stated in Section 6.1.1, the pathology and cytology stickers, shown in Figures 5, 6, and 9, would be placed on the specimen container at the nurse's station before they are sent to DLO. The circle sticker will be used if it is a smaller container such as a test tube. It needs to be placed on the specimen such that it is visible but does not interfere with the identification label. For larger containers, the rectangle sticker should be used. Like the smaller sticker, the large one should be placed in a visible location and should not interfere with the identification label. The recommended location of the stickers should be near or next to the identification label.

The date sticker, shown in Figure 7, will be used in a similar fashion. It should be placed on the specimen prior to leaving the nurse's possession and be in a highly visible location. It should be filled out as Month-Day-Year with leading zeros (MM/DD/YYYY).

In the future, INTEGRIS seeks a universal sticker that includes a "Pathology" denotation as well as the date the specimen was collected.

6.5.3 AmeriPath Specimen Check-In Implementation

The check-in log sheet should be located in a hanging bin, shown below in figure 14, on the door of the AmeriPath office. The DLO personnel that drops off the specimen must fill out the log sheet, including the patient ID number, the ordering doctor or physician's name, their ID number, and the date and time the specimen was dropped off. This should be done prior to the specimen being placed in the fridge.

Figure 15: Organization Bin to Store the Specimen Check-In Log at AmeriPath

Similar to the fridge, the specimen log bin should be checked multiple times per day, especially after AmeriPath personnel have been away from the lab or their office space.

6.5.4 Epic Notification System Implementation

The physician and nurses will choose their preferred form of notification or they may receive all three notification types; text, email, and Epic notification. The notification should be sent if, after 6 hours, no action has been made with the order. More specifically, if it has not been completed or "collected". This will remind the nurse or physician to check to see if the specimen has been taken from the patient or to push complete/"collect" on the order. The Integris Epic IT team shall be responsible for implementing the notification system.

6.5.5 Continuous Improvement Implementation

The identification label will be placed on the specimen as usual and scanned by the nurse or physician to indicate that it is ready to be transported to DLO. Once at DLO, the nurse will scan the barcode to check the specimen, and it will be placed into DLO's care. An information pop-up will appear on the computer screen for the DLO technician, telling them which tests need to be done and if the specimen needs to go to AmeriPath. After completing all of the required tests, the DLO technician will scan the specimen barcode again to check out the specimen. The specimen will then be transported to AmeriPath. If an AmeriPath technician is in the lab, they will take the specimen from the DLO personnel and scan the specimen barcode. This checks in the specimen at the AmeriPath station.

If there is no AmeriPath technician, the DLO personnel will need to manually check-in the specimen using the AmeriPath Specimen Check-In Log as described in sections 6.2 and 6.5.3. When a technician is available, they will check in the specimen by scanning the barcode. The technician will see a similar pop-up on their computer screen informing them of which tests need to be performed. After the required tests are completed, the technician will scan the barcode to check it out. If the specimen needs to be sent to Baptist Hospital, it will be transported to them. After all required tests have been performed, the results will be put back into Epic for the physician to view.

By including this barcode system, in conjunction with the solutions described above, INTEGRIS can reduce the number of missed specimens and the resulting missing test results.

7.0 Recommendations

Per the analysis conducted throughout the survey, the team has prepared recommendations based on the solutions mentioned above. Our recommendations include

- Short-Term recommendations to be implemented within days
- Mid-Term recommendations to be implemented in the following weeks or months
- Long-Term recommendations that could provide benefit in years to come
- Further input and commentary from the team's observations over the last semester

7.1 Short-Term Recommendations: Visual Cues

One of our main objectives was to simplify the process of Cytology as much as we were able. To address this, we think the sticker solution (6.1), AmeriPath check-in list (6.2), and EPIC notifications (6.3) will best suit this.

As described in the applications section (6.5), these solutions are expected to have simple implementations. They will also provide immediate benefits due to the speed at which they can be implemented.

Potential risks include users forgetting to apply stickers or sign-in samples due to the newness of the process.

Overall, we believe these solutions can simplify the process of Cytology within Integris Cancer Center at the SouthWest location because of its benefits to human factors.

7.2 Mid-Term Recommendations: EPIC Notifications and Survey Insight

Our mid-term recommendations are projected to require more time than short-term, but they are also expected to provide immediate benefits upon their implementation.

7.2.1 EPIC Notifications

We placed this solution as a mid-tier because direct modifications in EPIC fell out of the scope of our project. Should the solution be adopted, implementation is left to the Integris IT department. However, we believe that the time needed to implement this solution is justifiable with the benefit it would provide. Such a system can alert physicians and nurses to incomplete orders via text messaging, email, or another form of notification.

This solution will have some lead time. The exact time depends on how long IT needs to complete the programming for such a device.

Potential risks include issues with EPIC software, which may limit the capacity to implement this solution, and HIPAA infractions if patient information is included in a notification sent to the wrong party.

7.2.2 Survey Insight

While not a direct solution to the Cytology problem, our short questionnaire can offer insight into continuous improvement and other parties about what other staff are seeing and thinking about the current

problem. Giving employees an anonymous opportunity to share their opinions about the issues at hand may be a good way to collect input.

This solution will have a short lead-time dependent on how long it takes respondents to complete the survey,

We do not see any potential risks, as the survey is anonymous and results are exclusive to the administer of the form.

7.3 Long-Term Recommendations: Barcode Reading System

If similar problems to the Cytology issue appear in the future, or if Cytology issues persist, the eventual implementation of a barcode system can reduce factors of human error and promote simplicity of information. This barcode system is not currently applicable to Integris Cancer Center at the Southwest Medical location, but it is a major opportunity for growth if and when it is available in the future.

7.4 Additional Commentary

While observing Integris and conducting our project, we felt that Integris could benefit from a more structured form of data collection. Exact dates and times of past Cytology errors, as well as explicit details of the case that was lost, would provide a lot of useful information to the hospital. The main emphasis in collecting good data is standardization, meaning that gathered data should be formatted the same way and include the same details. This would help paint a very clear picture once correlations began to form between incidents.

8.0 Works Cited

Carayon, P et al. “Work system design for patient safety: the SEIPS model.” Quality & safety in health care vol. 15 Suppl 1,Suppl 1 (2006): i50-8.doi:10.1136/qshc.2005.015842

“Cytology.” Johns Hopkins Medicine, https://www.hopkinsmedicine.org/health/treatment-tests-and-therapies/cytology

Health, INTEGRIS. “Our Mission, Vision and Values.” Integris, https://integrisok.com/about-integris/mission-vision-values

Holden, Richard J et al. “SEIPS 2.0: a human factors framework for studying and improving the work of healthcare professionals and patients.” Ergonomics vol. 56,11 (2013): 1669-86. doi:10.1080/00140139.2013.838643