Evaluation of an AI-Based Platform for Patients with Actionable Incidental Radiological Findings

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Tables and Figures

Incidental Radiology Findings as Recognized by Artificial Intelligence

In speaking with the director of clinical operations for my organization it became clear that an opportunity to serve as a lead analysis resource for a new AI-driven dashboard project was available. Eager to explore this, no time was wasted in volunteering for that role, and in preparing for what that analysis would look like. This manuscript will explore the clinical problem and its significance for the student's organization, and a detailed literature review will substantiate the need for this capstone project, which is aimed at analyzing the dashboard for effectiveness. A discussion on project problem identification will describe how gaps were identified, followed by project recommendations. The project implementation plan and project measurement plan will be described before attention is paid to the IRB proposal process, and a conclusion is provided.

Problem Statement

Between 20% and 40% of x-rays capture incidental findings, and follow-up rates for those patients are not ideal (Kwan & Singh., 2017; Liang et al., 2020; Zaki-Metias et al., 2023). When a mass, lesion, or nodule is detected radiographically for reasons that do not pertain to their presence, the finding is considered incidental (Baccei et al., 2018; Kadom et al., 2022; Kwan & Singh., 2017; Mabotuwana et al., 2018; Makeeva et al., 2021; Zaki-Metias et al., 2023). An incidental finding that requires follow-up is commonly referred to as an actionable incidental finding (AIF). Very often these AIFs occur when a patient presents to an emergency department for an unrelated medical issue. In cases where AIF follow-up is indicated, that determination is made once a radiologist has had the time to review the finding, which usually occurs after the patient has left the service area (Cyphers et al., 2023; Zaki-Metias et al., 2023).

Given this time delay, the use of closed loop patient tracking and outreach systems has been shown to increase follow-up numbers significantly, sparing diagnostic delays and improving patient outcomes (American College of Radiology, 2020; Baccei et al., 2018; Hanna et al., 2016; Irani et al., 2020;

Kadom et al., 2022; Kwan & Singh., 2017; LeMense et al., 2020; Liang et al., 2020; Mabotuwana et al., 2018).

From a regional, national and global perspective, timely communication regarding patients' personal health information (PHI) is a major focus. Governing bodies and regulatory agencies have struggled to ensure PHI transparency and timely information sharing through information blocking rules via the 21st Century Cares Act, and to ensure patient centered care via the promotion of portals and personal health records. The issue of un or under-communicated AIFs has always been problematic, but the topic has amassed greater attention over the last several years. Technologies capable of recognizing and triaging AIF recommendations are now available, thanks to artificial intelligence and advanced data analytics. Finding a solution to the AIF communication gap is a top priority as it has the potential to save lives, improve patient outcomes, reduce financial burdens on organizations, and positively impact outreach-related burnout for physicians and navigation teams.

Significance of Clinical Problem at the Organizational Level

For the student's organization and other prodigious healthcare systems, the assurance of timely outreach to AIF patients is arduous if not unachievable using traditional methodologies. Many patients that present for emergency services are not ambulatory patients of the healthcare systems they utilize for urgent services, and their contact information may be insufficient for proper outreach. Another organizational problem is in how AIFs recommendations are made. Vague verbiage on the need for follow-up can leave emergency providers, primary providers, and other outreach members struggling to relay clear messages (American College of Radiology, 2020; Mabotuwana et al., 2018). For a recommendation to be fully actionable, the follow-up parameters must be specific, which is challenging to ensure in a system with thousands of imaging centers in their domain. Because closing the loop of communication is so important, a system with clear outreach documentation is crucial.

The solution for the organizational problem was in the roll out of a pilot using a software program by Nuance, which marries artificial intelligence (AI) with mPower advanced data analytics. Through the Nuance platform, AI can scan thousands of radiology records and identify patients with AIF recommendations. That information is analyzed and sorted by mPower, ultimately being converted into an alert dashboard entitled Follow Up Manager (FUM). With a goal of exploring and working within the FUM alert dashboard, a volunteer from each region of the first wave of the pilot was requested. The clinical problem of less-than-optimal outreach numbers could be solved through the use of a multi-system tracking mechanism (Cyphers et al., 2023, Kadom et al., 2022; LeMense et al., 2020; Liang et al., 2020; Mabotuwana et al., 2018; Makeeva et al., 2021)

PICO(T) Question

For patients with incidental radiological findings in a primary care clinic, how does the use of Nuance technology (AI and mPower analytics) for radiological finding management, compared to the standard practice without Nuance technology, impact the rate of clinical outreach tracking completion within a 3-month period, as measured by response time for patient follow-up and patient compliance with recommended clinical follow-up?

Purpose Statement

The purpose of this project is to demonstrate that the use of a closed-loop, multi-system tracking platform can address the problem of poor clinical follow-up in patients with AIF. Timely outreach has been shown to positively impact patient adherence to AIF recommendations. Therefore, use of the Nuance platform by the student, who is serving as the regional pilot analyst, will illustrate significant increases in AIF follow-up rates compared to rates of AIF follow-up prior to the use of the Nuance platform. The FUM project will be conducted remotely in Southern California. Upon pilot completion, the student will continue to analyze outreach data until three months of data has been collected and meaningful analysis can be conducted.

Review of Literature

The process for literature search and critique of evidence started with the creation of a filterable literature matrix in Excel. This tool was a recommendation from NUR 614 and has proven to be an excellent way to organize key research article elements, discover new and important evidence-based research (ERB) concepts, and compare similarities in research findings. Once the frame of the matrix was created, a keyword search using EBSCOhost was conducted.

Typing in "incidental findings" made it possible to locate an article that spoke to the management of AIFs and to perform a background citation search to identify other pertinent articles. Each article that was reviewed was added to the literature matrix, the highlights and key concepts recorded methodically. Once an adequate literature review was completed, and a critical analysis of the best practices was performed, project recommendations, implementation plan strategies, and measurement plan strategies were identified. A synthesis of findings followed this work and culminated in a thorough and thematic integration of concepts.

Synthesis of Current Literature

Lost To Follow UP

In studies exploring AIF follow-up failure in the absence of structured, multisystem tracking, a failure rate of 30-40% was noted (Makeeva et al., 2021, Mohen et al., 2018, Oren et al., 2021). As many as 70% of AIF patients failed to achieve timely follow-up (Baccei et al., 2018; Irani et al., 2020) and up to 65% of incidental findings were determined to be actionable (Makeeva et al., 2021). Patients with a "lost to follow up" (LTFU) status may have missed recommended care due to a variety of issues (Baccei et al., 2018; Kadom et al., 2022; Mabotuwana et al., 2018; Mannix et al., 2020) Health disparity, ambiguous ownership of outreach responsibility, unclear recommendations from radiology, and tracking and communication failures and some of the most frequent causes of a LTFU status. Subsequent sections of the literature

review will examine these themes in greater detail, just as technological innovations and ethical considerations will be discussed.

Health Disparity

A disparity in healthcare resources in the United States poses significant safety concerns for patients, and resource inequities increase the likelihood that a patient will be lost to follow-up (Amat et al., 2021; Kadom et al., 2022; Ramkumar et al., 2019, Sisodia et al., 2021). Patients that are non-Caucasian are at a particularly high risk for being LTFU (Amat et al., 2021; Mannix et al., 2020; Ramkumar et al., 2019; Sisodia et al., 2021). Increased disparities are also noted in patients of low socioeconomic status, lower levels of education, limited English proficiency, and rural geographical areas of residence (Amat et al., 2021; Lee et al., 2020; Ramkumar et al., 2019).

Test Result Ownership and Urgency

As previously mentioned, it is not uncommon for radiologists to review and record incidental findings after the patient has left the imaging facility. What's more, the physician responsible for test result outreach can be a source of disagreement between ordering provider and imaging provider, essentially causing result notifications to become delayed or orphaned (Irani et al., 2020; Kwan & Singh, 2017; Murphy et al., 2014). While some healthcare organizations (HCOs) have attempted to solve this problem by implanting dual notification processes, such efforts have only exacerbated the issue as each notified provider may assume that the other notified provider would respond (Kwan & Singh, 2017; Mannix et al., 2020; Murphy et al., 2014). The perception of the nature of the result is also an issue, as the perception that an AIF is not technically critical can lead to providers not adhering to the Joint Commission's critical result notification mandate (Iran et al., 2020; Kwan & Singh, 2017; Murphy et al., 2014).

Ambiguous Recommendations

Variations on recommendation verbiage may seem like a minor issue, but disparities in follow-up language are a problem for many reasons. For patients, a sentence like "further evaluation recommended"

can be perceived as insignificant or minor. As the 21st Century Cures act has resulted in patients receiving test results and comments in their patient portals, concise verbiage is essential. Language that offers clear and direct recommendations for diagnostic next steps has been shown to correlate with better follow-up rates (ACR, 2020; Makeeva et al., 2021; Zaki-Metias et al. 2023). Furthermore, when standardized, clear recommendations are given, it is easier for natural language processors to identify and properly imbed the recommendation data into alert boards (Hammer et al., 2019; Zaki-Metias et al. 2023).

Communication Failure

According to the American College of Radiology (ACR, 2020) and many other notable references, assuring that AIFs are clearly communicated to patients in a timely manner corresponds to earlier follow-up and improved patient outcomes (Baccei et al., 2018; Hanna et al., 2016; Mabotuwana et al., 2018; Wandtke & Gallagher, 2017; Zaki-Metias et al., 2023). Communication is the cornerstone of managing AIF, and it is not complete without rigorous, structured tracking (LaMense et al., 2020; Mannix et al., 2020; Mohan et al, 2018).

Tracker Failure

Closing the loop and ensuring patient follow-up is an essential component of the communication process (Baccei et al., 2018; Hammer et al., 2019; Irani et al., 2020; Mohan et al., 2018; Wright et al. 2020; Zaki-Metias et al., 2023). Follow-up recommendation must be clear, timely, and acted upon for a communication loop to be considered closed. Even when communication is excellent, patients can be LTFU if sufficient tracking and outreach measures are not in place. “While some NLP-based methods have been developed, dashboard review, closed-loop provider and/or patient messaging systems, and scheduling tools, and comprehensive tools supporting the entire tracking process for the breadth of incidental finding types remain lacking” (Mekeeva et al, 2021, p.25.) Outreach tracking must be structured and formidable enough to allow proper care navigation (Baccei et al., 2018; Hammer et al., 2019; Makeeva et al., 2021; Zaki-Metias et al., 2023).

Recent Innovations

Machine learning has been identified as an excellent way to identify AIF recommendations and, when used in tandem with data analytic software, can ease the way for nurse navigators and ensure rigorous, standard outreach processes (Hammer et al. 2019; Liang et al., 2020.)

Ethical Considerations

This paper would be incomplete without a discussion on ethics, given the evidence that the use of machine learning has significant health benefits to patients with AIFs. It can be argued that use of artificial intelligence in medicine will have deleterious effects on the future of healthcare. Cypher et al. (2023) reported that for lawsuits regarding incidental nodules in pulmonary cases alone, $43 million dollars is lost on an annual basis. Further, proponents of AI argue that there is a duty to easy rescue (Cypher et al., 2023). Even those supportive of AI in AIF admit that natural language, which can offer care that is in many ways patient centric, cannot consider patient beliefs, values or preferences (Zaki-Metias et al., 2023). Though health disparity was covered earlier in this paper, it is an ethical concern that must remain top of mind, as it has been demonstrated that certain vulnerable groups require more assistance than others in acquiring care and follow-up (Ramkumar et al., 2019).

Project Problem Identification

Internal Evidence

In performing a SWOT assessment, it was apparent that Providence was committed to spending a great deal of financial resources on the Nuance platform. Despite having a pre-existing contractual relationship with the Microsoft-owned Nuance, the cost of procuring the platform was substantial. The enthusiasm of stakeholders gives a great deal of strength to the project. One notable weakness is the organization's size, as the HCO serves 2.6 million patients (Providence, n.d.). Cascading information and providing training to caregivers in multiple states requires a great deal of strategic thinking and planning.

A needs assessment was performed and the 5 essential elements were considered. The first step was gathering data. Tragically, gaps related to AIFs were identified in 2012 after 14 patients, over the course of the year, presented to a Providence hospital with advanced cancers. Of these patients, 12 had advanced lung cancer, one had pancreatic cancer, and one had renal cancer.

The second step involved analyzing evidence. A root cause analysis (RCA) investigation ensued, and it was determined that the cancers had been detected as AIFs months to years earlier, though the patients had not been informed, and radiologists' recommendations for urgent follow-up were never cascaded. The patients took legal action, and the resulting lawsuits settled for between 200 and 600 thousand dollars each. An estimate of total financial ramification to the organization related to medical dollars spent on treatment of advanced cancers was between 2.8 and 8.4 million dollars. There was no way to estimate the ramifications of lost years of life for patients or their families.

To understand and brainstorm contributing factors, the third step in the needs assessment, the radiology department was tasked with the development of a "safety net" to avoid situations like this in the future. During this endeavor, various themes were realized as contributing factors. The fourth step was getting to the root cause. Though many individual themes contributed to the gap in care, closed-loop communication and tracking failures were identified as the root cause of the breakdown.

Finally, it was time to determine the next steps for improvement. In 2014, SEMI radiology and oncology initiated the initial incidental lung nodule program utilizing a homegrown system of flagging AIF records that had follow-up recommendations. It was essentially radiologists that invited AI to the table. Nurse navigators (NN) contacted patients and tracked actions on the recommended follow-up. In 2017 it became clear that the flagging system was no longer rigorous enough to meet the high-volume needs of the program. Providence engaged a local software solution, purchasing Primordial. In 2020, a grant was awarded to expand the incidental lung nodule program to all radiology incidental findings of oncologic significance, giving birth to the FIND program.

External Evidence

The FIND program was an integrated care model that married nurse navigators with health information technology. The goal was to improve care and outcomes for patients with AIFs on radiology exams, while curtailing legal burdens for providers and the HCO. The FIND program provided evidence-based data demonstrating improved care at lower cost compared to the cost of illness, treatment, and financial settlements associated with poor outcomes. It also designed a system that ensured patient retention by mitigating LTFU, ensured earlier interventions for AIF patients, and extended patient years and quality of life. Improving provider and patient communication meant that patient-centered care was being provided.

Using SWOT analysis, this project has the potential to attract a significant number of patients and providers, as this safety measure is highly beneficial and prodigious. Because of the cost associated with the platform, it is not commonly offered by HCOs. This fact gives the student's organization a competitive edge in the market, affording many marketing opportunities. One noteworthy threat includes the certainty that ensuring more follow-ups will cause an increase in radiology services, impacting those centers and departments. This could have a negative impact as patients may turn to other HCOs for faster service.

Project Recommendations

As the student's organization has already decided to roll out the Follow Up Manager project in California, Texas and New Mexico, the first recommendation is to have an informaticist serve as the Southern California lead for analyzing the pilot, which has been approved. A nurse informaticist is the ideal person to serve in an analytical capacity on this new technological platform.

FUM Initiation- Pilot

Having volunteered to serve in this capacity, this student will be taking note of the pilot's effectiveness, and documenting any hurdles or pain points that need to be addressed prior to the proceeding waves of project go-lives. The student will carefully track all AIF cases, documenting salient

data points such as de-identified patient demographics like age, gender, and ethnicity, as well as nodule-specific data like type of nodule, nodule size, opacity, and follow-up recommendations. The student will also indicate issues with regard to radiology recommendations, noting instances when incomplete or unclear recommendations were documented. As a greater understanding of the platform is appreciated, more data elements may need to be included in data collection and analysis.

FUM Analysis

Over the course of three months, the student will perform detailed analysis of the effectiveness of the FUM dashboard's ability to steer patient follow-up and assure that patients are compliant with recommendations. Research indicates that patient's follow-up approximately 70% of the time without structured outreach software. The FUM analysis will compare this to the percentage of follow-up compliance when the patient is tracked using the FUM platform.

Identify Hurdles or Pain Points

This student will take note of patient-related challenges that contribute to follow-up failure, such as a lack of an assigned healthcare provider, a lack of health insurance, amount of time that has gone by since AIF was identified, and the like. The student will also take note of any dashboard-related challenges that make follow-up difficult, like interface issues or design flaws.

Ensure Patient Centered Care

Amat et al. (2021) concluded that patients are often LTFU related to how a provider approaches their interactions, indicating that patient-centered care must be considered when attempted to connect patients with recommended follow-up. This student will therefore analyze the dashboard for opportunities to utilize patient preferences in performing outreach activities and will document those opportunities.

Ready Program for Go-Live and Subsequent Waves

Because the FUM go-live dates for other states will not begin until the fall of 2024, the student will be able to share the analytics performed during this project with Providence, and with other stakeholders

including the Nuance development team. This will benefit the teams supporting the proceeding waves and will contribute to a smoother outreach workflow.

Recommendation Conclusion

Internal and external evidence demonstrates that a structured, multisystem tracking system can guide communication via nurse navigators, reduce patients LTFU, and preserve quality of life, patient years lived, and financial waste in the form of more aggressive treatments or settlements caused by treatment delays. The importance of patient-centered care is also appreciated by internal and external evidence, giving validity to the need to look for opportunities as part of the recommendation plan.

Project Implementation Plan

Key Stakeholders

Key stakeholders include the principal information services (IS) project manager for all seven states that Providence serves, the director of clinical operations for the Providence Clinical Network, the principal planning and strategic consultant, the VP of IS applications, the senior manager of IS radiology applications, the senior IS applications analyst, the senior Epic application analyst, the supervisor of IS applications interfaces, the principal cloud engineer architect, the principal cloud engineer, the Nuance account executive, the alliance manager, the customer service executive, the technical account manager, the production manager, the application consultant for Nuance, the sales engineering manager, the interface engineer, and the field engineer. While this list includes many of the individuals key to this project, the patients are the most important stakeholders.

Barriers and Facilitators/Drivers and Resistors to Change

Due to the profound cost of the FUM program software, additional fiscal resources are scarce. Therefore, the decision was made to invest the preponderance of available capital in the software and ask core leaders to identify their own full-time employees (FTEs) that could be repurposed for the duration of the pilot, as well of the first year of the go-live. Providence plans to hire dedicated NNs once project stability

has been demonstrated across the enterprise. Adoption of this program is easy until there is a request for action by core leaders. Few feel that their staffing is such that they can spare FTEs, and most are reluctant to offer them up to the FUM program. The factor that most frequently affects this type of adoption with regard to FTE offerings, is the hope that such a gesture will result in favorable optics with regard to the leader's promotional potential.

As it is with most altruistic improvements, whether it be increased education for FTE's, repurposing of FTEs for special projects, HCOs struggle with parting with staffing resources. If the FUM program came at the expense of no core leaders, adoption would be elementary. It would be a struggle to find a core leader, provider, patient, or caregiver against such a beneficial program. The readiness of the institution to accept the FUM program is marred only by staffing shortages. It is, however, the opinion of the student that as global finances improve and a fiscally pandemic-torn world recovers, the hiring of NNs will commence. Readiness, outside of staffing concerns, is excellent and excitement over the benefits of the program are palpable in planning meetings and during Townhall presentations.

Organizational Impact

Having already described the impact on staffing, the focus will be on patient satisfaction, internal and external marketing, and financial bottom lines. Provider burnout will be added to this list as research indicates that it will be positively impacted. There is every indication that patient satisfaction will be enhanced because of this change. Patients that experience early, clear communication report improved perception of care. Scripting should take advantage of the excellent opportunity to express Providence's commitment to patient safety and protection, as those being alerted to AIFs are bound to experience comparatively greater prosperity and well-being than those who were not recipients of quality outreach. Internal marketing, as previously mentioned, has brought with it significant elation for core leaders and providers. In reviewing recordings of earlier meetings, the student noticed that some of the oncologists in virtual attendance sounded emotional as they commented on the possibilities they were hearing.

External marketing is likely to be met with similar excitement. Providence has a reputation for being a leader in compassionate, patient-centered care and FUM is one of many remarkable innovations the organization has introduced this year. Regarding the financial bottom line, assumptions from Providence fiscal leaders have calculated an assumed ROI to be upwards of nearly 3 million dollars annually. This figure comes from an increase in studies and imaging as a result of patients' compliance with recommended follow-up. It does not consider the cost savings associated with avoiding legal settlements related to diagnostic delay, which has been historically significant. Research indicates that provider burnout will be positively impacted from the FUM program (Kwan & Singh., 2017; Liang et al., 2020; Murphy et al., 2014).

Organization Planning Process

The vision of Providence is Health for a Better World. It would be difficult to disagree that the initiation of a project like the FUM program will need to contribute to the creation of a healthier, better world. In their mission statement, Providence declares a steadfast commitment to serving all, "especially those who are poor and vulnerable". Having an actionable mass or nodule that, and not being aware of the need to seek further care, makes AIF patients profoundly vulnerable. This project is therefore highly relatable and congruent with the organization's mission and vision.

Implementation Plan

The work of participating in the pilot and analyzing the success of the FUM program will be conducted remotely. The analysis of the dashboard will continue for a three-month period. This work will similarly be conducted remotely and will cover patients served by Southern California Providence imaging facilities. Early estimates for the number of incidental findings are in the millions, though it is unclear how many of those will be actionable, just as it is unclear as to how many of those patients will be included in Southern California data.

The rationale for a remote setting is due to the fact that the nurse navigators serving the FUM project will be remote workers and may need to cover patients from other states. Because they will not be assessing or offering advice, and will only be reiterating follow-up recommendations from radiologists, this work will not require registered nurse licensure reciprocity. Once the pilot has been completed, the project will go live in California. Southern California patients will be the project participants for the FUM analysis.

FUM Pilot Initiation and Analysis

The technical and hardware requirements will be a laptop with a docking station and two monitors. This has already been procured by the director of clinical operations. The hardware was delivered to the student's residence so that remote work could begin. FUM by Nuance will need to be utilized, necessitating the granting of access under the student's Providence account. This has been granted by the Nuance account representative so that remote work could begin. Administrative support will include Nuance IT support as well as Providence IT support should any records be identified as problematic. IT support for Providence had been granted prior to this project, but the Nuance account representative did secure Nuance IT support before the pilot was initiated.

Analysis will require 2-3 months of data collection, as well as several weeks in which to review and report on the data. The student will complete data collection, obtaining at least 20 hours' worth of data weekly, so that enough information can be evaluated. De-identified patient data as well as respective dashboard information will be documented on an analysis spreadsheet.

De-identification

To ensure that de-identification has been performed in a manner that thoroughly protected health information, the student utilized the Guidance on De-Identification of Protected Health Information from the Department of Health and Human Services (2012). Typically a medical record number is used when patient identity is a concern, but each image is associated with an accession number, which was used in data collection to further ensure information safety.

Identify Hurdles or Pain Points

Danny Martin, the director of clinical operations for Providence, is the champion for this project, as is Jessica Moran, the principal IS project manager, and Cal Freundt, the Nuance account representative. Each of these stakeholders is looking forward to obtaining FUM project feedback. The student will be using evidence-based research to look for hurdles and pain points so that project efficacy can be confirmed, and any changes to the system can be implemented prior to future go live waves.

Ensure Patient Centered Care

Because patient-centered care is a value of Providence and this project's key stakeholders, and because evidence-based research has indicated that patient centered care reduces the chances of patients being LTFU, the student will be looking for opportunities to perform outreach that is aligned with patient-centered care. Communication with patients will include inquiries as to their communication preferences, which will be honored and documented whenever possible. Communication with Danny Martin and Jessica Moran will be weekly or as needed, as both have graciously agreed to offer unrestricted feedback and assistance.

Ready Program for Go-Live and Subsequent Waves

Performance improvement opportunities may be realized as a result of performing FUM analysis. The student will prepare a presentation that will explore the actions and findings of this project, and present it to Danny Martin, as he is the executive stakeholder, and to University of Mary educators following the completion of the analysis in April 2024. Any recommendation for technical remediation or the sharing of lessons learned will be a part of the presentation.

Project Measurement Plan

A postimplementation review immediately after the completion of the pilot should be undertaken. As radiology recommendation completeness and clarity is paramount, an evaluation of how often a radiological recommendation was insufficient for mPower to thoroughly populate the alert dashboard should

be analyzed. This will be compared to patients that are refusing recommendations, in an effort to determine how often clarity and completeness may be affecting follow-up compliance.

Due to the strength of the FUM platform, and its potential to attract patients and new provider talent to the student's organization, a full understanding of the platform's ability to ensure closed-loop communication is necessary. This means that for all patients that appear on the alert dashboard, outreach documentation should be noted in 100% of cases. The key performance indicator should be that 100 % of tracked exams were closed with notification to the patient or provider. Since internal evidence identified the student's organizational size as a weakness, it is critical that the FUM platform makes it easy to ensure that patients follow-up as recommended. For those that do not, analysis of why recommendations were not followed should be completed during the weeks after data collection.

For the duration of the project, the student will measure the number of closed-loop outreach endeavors, where the denominator is the number of patients with incidental findings, and the numerator is the number of closed-loop outreach endeavors. Similarly, the student will measure the number of patients that were compliant with follow-up recommendations, where the denominator is the number of patients with incidental findings, and the numerator is the number of patients that successfully followed radiologists' recommendations.

Because the research shows there are many reasons for patients to be noncompliant with follow-up recommendations, the student will collect cases of follow-up failure and look for causes. This information will be tracked, calculated, and reported to stakeholders at the end of the project. As this information will be relevant to future waves of the FUM program, obtaining and sharing this information in a timely manner will be important.

Human Subject Protection Statement

Though this project will not include physical interactions with human subjects, the submission of this project to the University of Mary's Institutional Review Board is an important part of ensuring the

protection of human subjects. This analysis project will involve viewing patient records, and collecting de-identified information in an effort to evaluate Nuance platform efficacy. The history of research in and outside the United States compels researchers to do all that they can to protect human subjects from harm and ensure that their PHI is managed safely.

Implementation and Measurement

Implementation

As described in the implementation plan, the work of participating in the pilot and analyzing the success of the FUM program was successfully conducted remotely. The dashboard data collection was conducted over a ten-week period, wherein 1399 imaging studies were explored. The work ended up covering patients served by Southern and Northern California Providence imaging facilities, as well as some facilities in Texas and New Mexico. Although early estimates for the number of incidental findings were in the millions, those projections were for ambulatory as well as acute care patients. For the pilot, the focus was limited to ambulatory patients. For this population, the number of actionable findings totaled an average of 40 patients per weekday, and little to no imaging was completed on weekends.

FUM Pilot Initiation and Analysis

The implementation plan was accurate in assuming that technical and hardware requirements could be limited to a laptop with a docking station and two monitors. Access to the Nuance system was granted under the student's Providence account with little effort, and remote work began on 1/10/2024. Administrative support included Nuance IT team support, and the student was able to ask questions and share issues via Teams chat at any time during the day. The student met with the project manager and the Nuance application consultant biweekly for the first month. Similarly, the student and the student's executive sponsor met with the physician team every other week to discuss workflow preferences.

Eight weeks of data were documented and analyzed over a ten-week period. This work was paramount in identifying some unpredicted pain points, which were discovered and shared with the Nuance team. Corrections of obvious problems were made along the way.

De-identification

The student utilized the Guidance on De-Identification of Protected Health Information from the Department of Health and Human Services (2012). Patient information was limited to age, gender, and medical record number. The student created a locked spreadsheet which was password protected.

Identify Hurdles or Pain Points

The student utilized evidence-based research to look for hurdles and pain points so that project efficacy could be confirmed, and any changes to the system could be implemented prior to future go live waves. While patient-centered care was noted to be a vulnerability to automated processes, and it was the student's intention to perform outreach aligned with patient-centered care, the limitations of the Nuance software as it pertains to radiology final reports took the preponderance of the student's efforts. A list of pain points and hurdles are outlined in Table A.

Ready Program for Go-Live and Subsequent Waves

What worked well was the stability of the dashboard, meaning that data could be manipulated without erroneous deletion. The student learned that the FUM daily workflow should begin with exploration of the alert board. The alert board lists all patients that were identified the day before as having an incidental finding. The NN must go through the alert board and decide if the finding is actionable, and if so, must add it to the tracking board. Once all of the alert board patients are removed from the system or added to the dashboard, the NN can start to work on the tracking board. The student created a quick daily workflow aid to guide the actions of the NNs, see Appendix A. On the tracking board, the NN must click the "communication date" column to filter all of the patients slated for outreach or chart audits on that day.

Unlike that which is possible using a traditional spreadsheet for data collection, patients on the dashboard cannot be accidentally lost due to keystroke or other forms of user error.

It was, however, devasting to learn of three mission-critical limitations of the platform, see Table 7. The first issue was mentioned in the evidence-based research, though its significance was initially underappreciated by the student, and by Providence stakeholders. EBP warned that patients could be LTFU due to vague follow-up recommendations, but the student found that there is a pervasive omission of follow-up time parameters on radiology final reports. It's true that the FUM dashboard in and of itself can function as an effective tracking platform, but its efficacy is reliant on a radiological practice absent in 80% of final impressions. Only one-fifth of the imaging reports the student reviewed contained a specific follow-up date or range, making the dashboard obsolete. The enormity of this discrepancy was not expected, and has proven most deflating for all stakeholders involved in this project.

Another mission-critical limitation to the dashboard was in its inability to signify the nature of the finding. The dashboard functioned well calendrically when a follow-up date was included on the final report, but the dashboard did not offer a way to view critical versus non-urgent imaging studies. It only listed next steps by date and study type, not by severity, see Appendix B. Like the first mission-critical issue, this was not anticipated. To correct this, the student asked the application consultant to create new pulldown options, favoring a priority rating over the type of study needing to be repeated, see Appendix C. It was easy to place patients on the tracker by follow up date when these were offered, but again, this only occurred in 20% of final studies. To account for this omission, the student determined that the workflow for the navigator will be to triage the patients added each day to the alert board, and decide if they need a chart audit in 7 days (Priority 1), 14 (Priority 2), 30 days (priority 3) based on the type and size of the AIF, see Appendix A. Once the new day's patients are sorted, the NN will go to the tracking board and revisit the patient identified as needing chart audit follow up, first based on their initial triage priority, and if time permits, by date.

The third mission-critical limitation was discovered when the student tried to teach a colleague how to utilize the dashboard. It was immediately clear that only one user could work in the alert section of the dashboard at one time. This issue was immediately reported to all stakeholders, and the design team was tasked with its correction. The solution took weeks to be finalized by Nuance engineers.

Other profound performance improvement opportunities were realized as the result of performing FUM analysis. Because so many issues were identified, the student listed all issues by severity in a spreadsheet so that progress could be monitored and prioritization of solutions managed, see Table7. For instance, it became clear early in the analysis that the use of hedging language and other practices by radiologists were making it difficult for the Nuance analytics to correctly identify actionable incidental findings. In instances of hedging language, which is described in the American Journal of Radiology as the "communication of findings that are uncertain using terms that are ambiguous, vague, or imprecise" (Mezrich, 2019, para. 16). Hedging language occurs when a radiologist uses words like maybe, unclear, possible, etc. Use of hedging language makes it difficult for navigators and providers to appreciate the impression and take appropriate next steps, see example in Appendix D. Because of the EBP discovered during the student's research, radiological reading ambiguity was anticipated, though the breadth was unknown.

Confounding reporting practices have also been found to be problematic. This occurs when a radiologist lists all the types of incidental findings not seen, as opposed to limiting impressions to actual findings. Because the Nuance AI technology uses natural language recognition to identify key words that may indicate the presence of AIF, comments like "No masses, lesions not seen, no nodule noted" etc. causes the AI to highlight non-findings and inappropriately add the imaging studies to the alert board, see Appendices E and F. The Nuance platform also suffered from increased sensitivity because of inappropriate inclusion criteria. The engineers included "ct" in the search criteria, hoping that this would lead the AI to identify recommendations for CT. Instead, it identified every word which contained a "C"

followed by a “T”, see Appendix G. They also allowed studies like ECHOs to make it to the dashboard, which just created extra work as incidental findings cannot be seen via ECHO.

For the issues of hedging and confounding, the student reported the issue to the Nuance team, project manager, and the executive sponsor. To manage these issues, Providence leadership will cascade radiology best practice recommendations based on the FUM platform. It is expected that the issue of radiologists using hedging and confounding language will take months to correct, and that there will never be 100% compliance with this practice. In the meantime, the student will direct navigators to navigate through the noise of this language to the best of their abilities. The student also asked the Nuance team to adjust exclusion verbiage to reflect when a study was incorrectly on the alert dashboard because of hedging or confounding. The student requested several changes to make removal and suspension language more appropriate, thereby ensuring better documentation and more accurate disposition data, see Appendices H-K.

Recommendations for follow-up have been defined by the American College of Radiology, see Appendix L. For lung nodules, Fleischner’s guides are available. Similarly, a number of “RADS” are available. The acronym “RADS” stands for reporting and documenting systems, and RADS include radiology guidelines for various systems. An example is O-Rads, which guides ovarian and adnexal findings. Li-RADS offer liver finding guidelines. Interestingly, there are no RADS for renal lesions, though the ACR indicates that they may be developed in the future.

Final radiology recommendations that were described as “per Fleischners”, “Per C-rads”, “per Ni-rads”, or the like were challenging initially. It became clear that guidelines such as these should be added to the standard work guidelines for the NN’s, see Appendix M. Similarly, through research on these issues the student discovered that there is an app from the American College of Radiology, that can be downloaded free of charge, and can serve as a quick guide for navigators wishing to view guidelines on incidental findings and verbiage (Maurer, 2020).

Project Outcomes Measurement

As part of the implementation plan was to pilot the project, and the other part was to analyze the platform and make changes and recommendation, analysis began with all of the imaging studies the Nuance software identified as having an incidental finding from December 2023 through January 2024. In all, 1399 studies were triaged over the course of several weeks, and were sorted by age range, see Table 1. Duplicative studies, as well as those belonging to minors, were removed, bringing the overall number of studies to 1359, see Figure 1 and Table 2.

Follow-up recommendations were analyzed for how frequently they included specific follow-up dates, see Table and Figure 2. As the PICO question was asked to inform follow-up tracking successes of studies with incidental pulmonary findings, all non-pulmonary findings were removed, bringing the core studies total to 234 images, see Table 3. Follow-up recommendations were analyzed for how frequently they included specific follow-up dates for pulmonary findings studies specifically, see Figure 3 and Table 4. In implementing this pilot, the student quickly discovered that not only were follow-up dates seldom given by radiologists, see Figure 3 and Table 4, but a surprising number of studies were not appropriate for FUM tracking. Figure 4 illustrates many of the reasons a navigator must reject images. In performing the function of pilot, the student realized that if rejection reasons were made more specific, it would be possible to use rejection data as a key performance indicator for how well the platform was identifying studies that warranted surveillance.

Figure and Table 5 represent how many of the pulmonary findings studies were truly appropriate for movement to the tracking board. While the analytical platform is far from being sophisticated enough to remove patients based on all of these factors, the list of removal reasons could certainly serve as a future state for Nuance architects. Finally, for active patients that need follow-up, reasons for communication delays were analyzed, see Table 6. A pattern may have emerged, but because there were so few active patients remaining, a larger population would be needed for deeper analysis and future research. As

indicated in Table 6, delays of 6 days or more were examined, with the most frequent cause of delay being a competing diagnosis. Potential causes for communication delay were graphically represented by percentages in Figure 6. A chart review by the student revealed that patients with significant cancers or critical new issues had less timely communication about their pulmonary findings. The student advised the executive sponsor that an additional column to the dashboard would be beneficial, as navigators could indicate instances of patients being at risk for LTFU based on some of the delay reasons highlighted in Figure 6.

Handoff Plan

After collaborating with the executive sponsor, a handoff plan was created. The student has been asked to manage the ambulatory FUM program and will be hiring nurse navigators who will continue this work. This is an exciting opportunity for the student and the organization to continue to work toward patient safety. This will of course only be for the ambulatory patients. The handoff for the rest of the project, which will serve millions of patients spanning across four other states, will include a video-supported slide deck with detailed education on how best to manage FUM. For this, the cameo feature will be utilized so that revieing the deck feels more personal and dynamic. A proper workflow guide will also accompany this material so that triage, tracking, and outreach can be performed in a way that is consistent throughout the various regions.

A separate deck for imaging leadership will be created so that those managers can reproduce the data and statistics needed to ensure quality measurement can continue. The American Hospital Association (n.d.) provided a helpful handoff guide on their website. They stressed the importance of verbal communication and information, clarity of information, transfer of responsibility accountability, acknowledgement by receiver, and opportunity to review. While we cannot personally offer to witness the acknowledgement by receiver or their opportunity to review, we will make it clear to Providence leaders for the various regions that that will be a part of their expectation when orienting their leaders to this platform.

Conclusion

Two decades ago, a rash of advanced cancers rocked a small hospital, challenging the HCO to understand why and, more importantly, to do something about it. The body of this paper commenced with a distressing problem statement and its significance to a large, faith-based HCO. A burning PICOT question and purpose statement followed. A thorough synthesis of literature provided evidence-based recommendations to address the clinical problem, validating the course of the HCO's decision to adopt the Nuance platform. Gaps were identified as described in the project problem identification section, and project recommendations were synthesized from the exploration of internal and external evidence. Finally, a project implementation plan was outlined, a measurement plan described, and a statement on human subject protection was included prior to this conclusion.

This project represents a perfect illustration of how a patient-centered HCO can use an RCA to search for innovative solutions to an identified problem. Due to the actions of a group of committed stakeholders, tragic losses were met with ingenuity and technological advancement. While there are many issues still being addressed by the HCO, over time this platform has the potential to be a wildly instrumental tool in ensuring patient safety and offering value-based care. Being a part of this project as both student and caregiver has been an amazing experience. I never imagined that this incredible opportunity would lead me to a new role, and I look forward to hiring an ambulatory FUM team of navigators so that I can focus on training acute care leaders and their navigators as we go live across the country.

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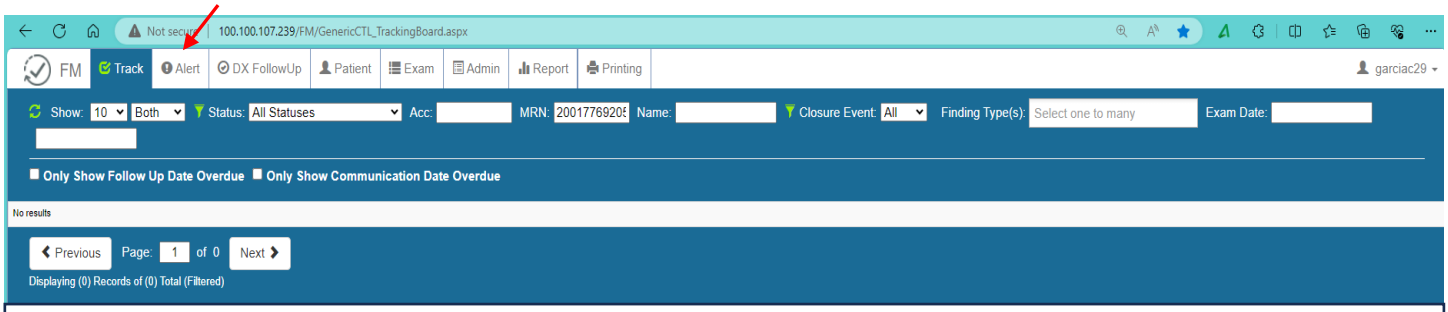
Track Alert

Appendix A

Alert Board Illustrated



Alert Board
Track or Reject

Starting on Alert tab, click "F" next to patient name. Review, then decide to track or reject. If rejecting, click lightening bolt. If tracking, click "tracking". Complete entire list before clicking Track tab and switching to triaged patients.

F/U Interval Given by Rad	Enter communication due date as one day after interval end
F/U Interval Not Indicated	Enter communication due date based on guide below

Priority 1- 7 days:

Pancreatic Findings
New lesions in patients with Hx of cancer
Dissecting aneurysms
Studies with "follow up urgently, immediately, short term attention"

Priority 2- 14 days:
Lung nodules > 6 mm
Multiple new lung nodules

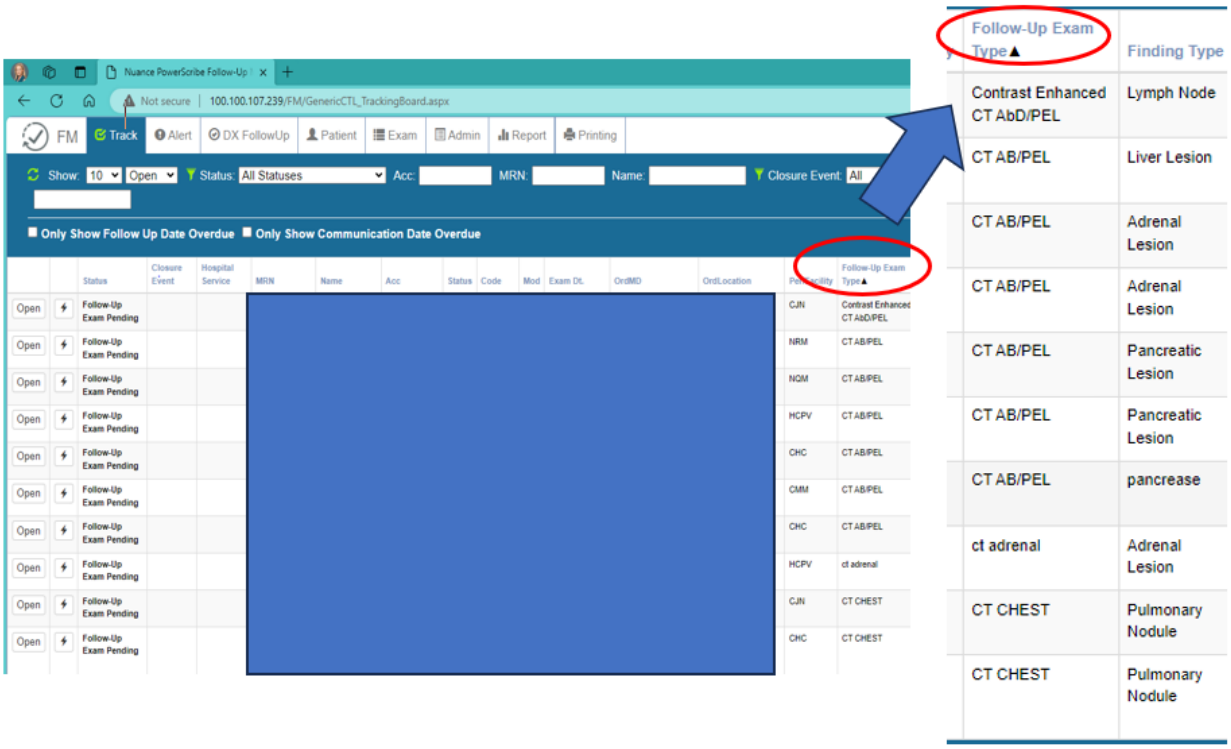
Priority 3 – 30 days
All others

Tracker
Monitor or Suspend

On track tab, click column heading "communication by date" to sort to a view of patients due for chart review or follow up. Document all monitoring actions in FUM notes. If ready to suspend surveillance, click "close finding" and select reason.

Appendix B

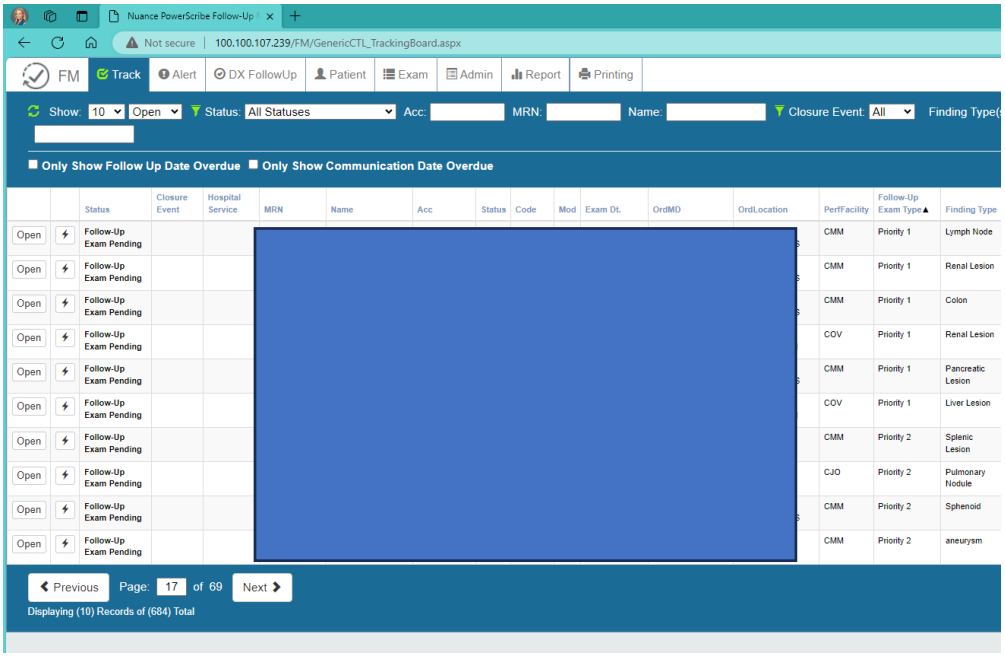
Follow Up Type- Prior State



Prior to student's intervention, follow up exam type was limited to a study with no mention of urgency. This was unnecessary from a tracker perspective, as any outreach being done would necessitate the opening of the image findings, which would make study type known. It was more beneficial to reallocate follow up exam type to a priority system until a growth and expansion project could be completed by Nuance.

Appendix C

Follow Up Type- Current State



Follow-Up Exam Type▲	Finding Type
Priority 1	Lymph Node
Priority 1	Renal Lesion
Priority 1	Colon
Priority 1	Renal Lesion
Priority 1	Pancreatic Lesion
Priority 1	Liver Lesion
Priority 2	Splenic Lesion
Priority 2	Pulmonary Nodule
Priority 2	Sphenoid
Priority 2	aneurysm

Note. Reallocating the follow up exam type to a priority system allows NNs to filter by next d
date, but then quickly see patients that require more urgent attention. The student felt this w
beneficial if there were days when not enough NNs were available to close out a full day of
chart review.

Appendix D

Hedging Language

Free Fluid/Ascites: None .

Vascular Structures: Mild common iliac artery calcified plaquing.

Reproductive Organs: Within normal limits .

Abdominal/Pelvic Wall and Surrounding Tissues: Within normal limits .

IMPRESSION:

There is no evidence of metastatic disease to the abdomen or pelvis.

Surgical changes in the lower back with probable bilateral seromas. This could be confirmed with ultrasound scanning.

Stable probable hepatic cysts.

Actual final impression= “probable” and “could be”

The top 30 hedge phrases most frequently appearing in the study corpus

Hedge Phrase	Total number of Documents	Hedge Phrase	Total number of Documents
may	24,036	could be	4,739
possible*	23,002	most likely*	4,625
likely*	21,307	appear	4,301
positive	21,126	necessary	4,220
several	14,737	seems	3,882
no evidence of	13,283	probably*	3,836
evidence of	12,350	frequent*	3,580
most	12,293	never*	3,419
consistent with*	11,189	many	3,368
unremarkable	10,374	sure	3,368
few	9,769	suggest	3,328
usual	6,174	apparently	3,302
think	5,352	occasionally*	3,269
possibly*	5,350	possibility of	3,046
potential	5,116	diagnostic*	2,813

Phrases most frequently explored in research (Hanauer et al., 2012).

Appendix E

Confounding Narrative

FINDINGS:Minimal linear atelectasis or scar right lower lung. Fatty changes seen in the liver diffusely with no definite mass in the liver, spleen, and no definite pancreatic mass. There is an area of mildly prominent common bile duct in the pancreatic head of pancreas is somewhat limited by motion artifact as is the abdomen in general. Small fat-containing umbilical region hernia. NG tube is present in the stomach. Parapelvic cysts left kidney. There are no precontrast images. On bolus contrast images, there is RAD contrast in the collecting system such that any kidney stones may be covered by this. No large exophytic renal masses seen. No lymphadenopathy is seen. Bladder RAD has contrast in it on the bolus images. Some free fluid is seen in the pelvis and there is diverticulosis of the sigmoid colon and scattered throughout the colon to lesser degree. Mild stranding seen throughout the mesentery and around the colon making it difficult to exclude mild diverticulitis or colitis but not focally intense area. A normal appendix is not definitely seen. Correlate as to appendectomy. If there is high clinical concern of appendicitis then exam with oral and IV contrast may be helpful for further evaluation given the motion. I do not see an abscess adjacent to the cecum. Stomach is decompressed but there are dilated loops of fluid in air-filled small bowel with differential air-fluid level suggesting possible small bowel obstruction seen involving the upper and mid small bowel. More distally, there are decompressed loops of small bowel that are small and this is suspicious for a mid to distal small bowel obstruction. A well-defined obstructing mass is not seen. There are arthritic changes in the hips and spine,

Confounding narrative – radiology using “mass”, “pancreatic mass”, “renal mass”, well-defined obstructing mass”, each time to indicate that there is actually no mass at all, wins the “I confuse AI” t-shirt award.

Appendix F

Confounding RADS

IMPRESSION:

Extensive colonic diverticulosis. No definite colonic polyps visualized. C1.

Several subcentimeter bilateral renal stones. No hydronephrosis.

Moderate sized hiatal hernia.

Note: CT colonography has limited detection for diminutive polyps less than or equal to 5 mm in size, the presence or absence of which would likely not change the clinical management of the patient.

C0: Inadequate study. Awaiting prior comparisons, inadequate prep or insufflation, or need for comparison studies.

C1: Normal benign lesion, continued screening every 5-10 years. No visible abnormalities of the colon, no polyp greater than or equal to 6 mm, lipoma or inverted diverticulum, or non-neoplastic such as colonic diverticula.

C2: Intermediate polyp (6 - 9 mm, < 3 in number) or indeterminate finding. Surveillance at 3 years or colonoscopy recommended.

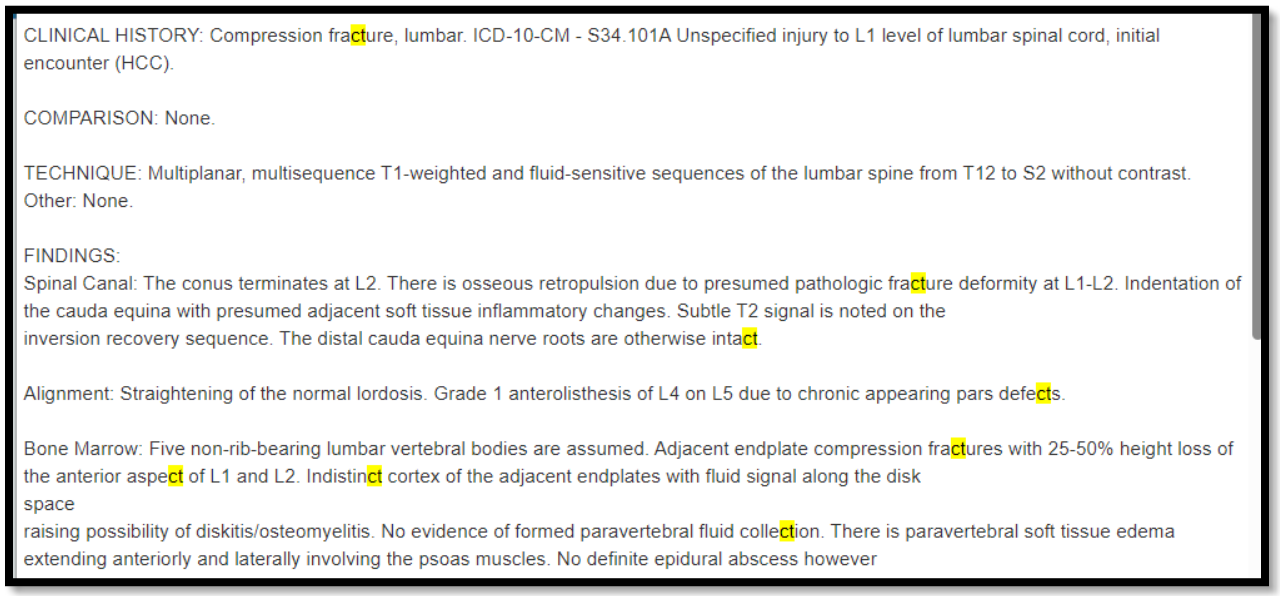
C3: Colonic polyp, possibly advanced adenoma, colonoscopy recommended. Colon polyp greater than or equal to 10 mm, 3 polyps each 6-9 mm.

C4: Colonic mass, likely malignant, surgical consultation recommended.

Confounding RADS inclusion- when the radiologist added this guide, the system interpreted words as findings rather than recommendation criteria.

Appendix G

Incorrect Inclusion Criteria



CLINICAL HISTORY: Compression fracture, lumbar. ICD-10-CM - S34.101A Unspecified injury to L1 level of lumbar spinal cord, initial encounter (HCC).

COMPARISON: None.

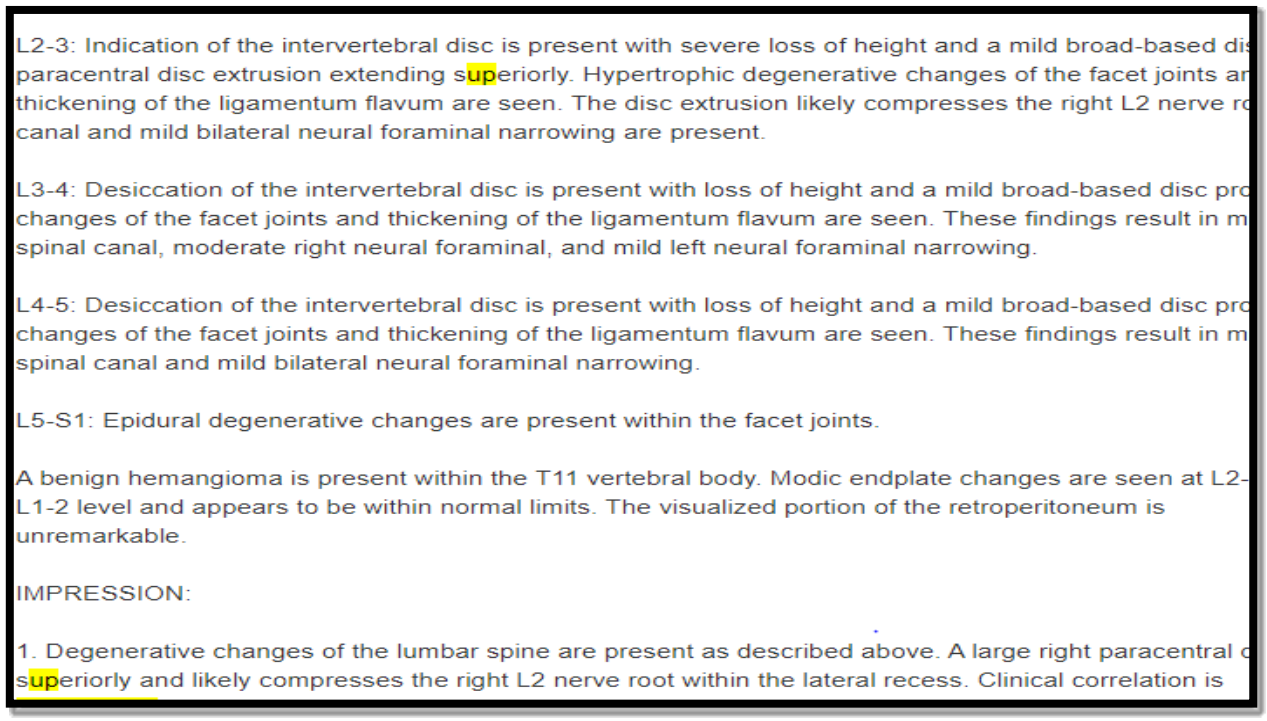
TECHNIQUE: Multiplanar, multisequence T1-weighted and fluid-sensitive sequences of the lumbar spine from T12 to S2 without contrast. Other: None.

FINDINGS:
Spinal Canal: The conus terminates at L2. There is osseous retropulsion due to presumed pathologic fracture deformity at L1-L2. Indentation of the cauda equina with presumed adjacent soft tissue inflammatory changes. Subtle T2 signal is noted on the inversion recovery sequence. The distal cauda equina nerve roots are otherwise intact.

Alignment: Straightening of the normal lordosis. Grade 1 anterolisthesis of L4 on L5 due to chronic appearing pars defects.

Bone Marrow: Five non-rib-bearing lumbar vertebral bodies are assumed. Adjacent endplate compression fractures with 25-50% height loss of the anterior aspect of L1 and L2. Indistinct cortex of the adjacent endplates with fluid signal along the disk space
raising possibility of diskitis/osteomyelitis. No evidence of formed paravertebral fluid collection. There is paravertebral soft tissue edema extending anteriorly and laterally involving the psoas muscles. No definite epidural abscess however

Search criteria “CT” originally included to capture recommendations, but much more commonly only incorrectly places patient on alert board as it interprets this impression as a patient needing CT.



L2-3: Indication of the intervertebral disc is present with severe loss of height and a mild broad-based dis
paracentral disc extrusion extending superiorly. Hypertrophic degenerative changes of the facet joints ar
thickening of the ligamentum flavum are seen. The disc extrusion likely compresses the right L2 nerve ro
canal and mild bilateral neural foraminal narrowing are present.

L3-4: Desiccation of the intervertebral disc is present with loss of height and a mild broad-based disc pro
changes of the facet joints and thickening of the ligamentum flavum are seen. These findings result in m
spinal canal, moderate right neural foraminal, and mild left neural foraminal narrowing.

L4-5: Desiccation of the intervertebral disc is present with loss of height and a mild broad-based disc pro
changes of the facet joints and thickening of the ligamentum flavum are seen. These findings result in m
spinal canal and mild bilateral neural foraminal narrowing.

L5-S1: Epidural degenerative changes are present within the facet joints.

A benign hemangioma is present within the T11 vertebral body. Modic endplate changes are seen at L2-
L1-2 level and appears to be within normal limits. The visualized portion of the retroperitoneum is
unremarkable.

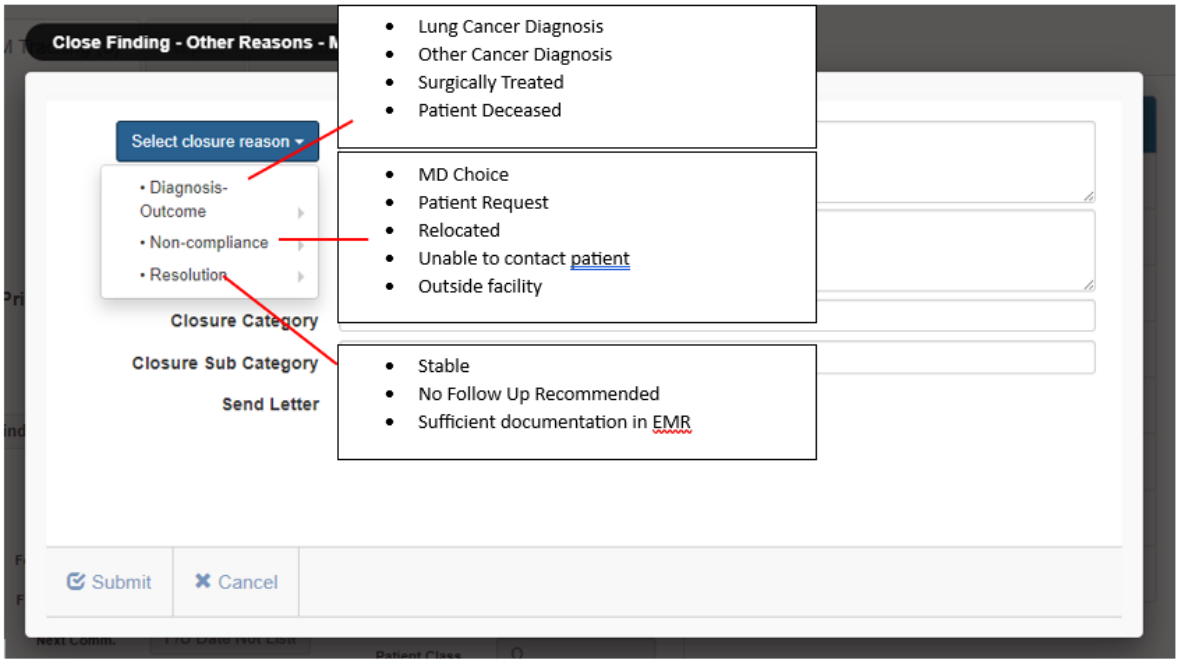
IMPRESSION:

1. Degenerative changes of the lumbar spine are present as described above. A large right paracentral d
superiorly and likely compresses the right L2 nerve root within the lateral recess. Clinical correlation is

Search criteria “up” as in follow up, originally included to capture recommendations, but much more commonly only incorrectly places patient on alert board as it interprets this impression as a patient needing follow up, rather than the word “superiorly” which just contain up in its spelling.

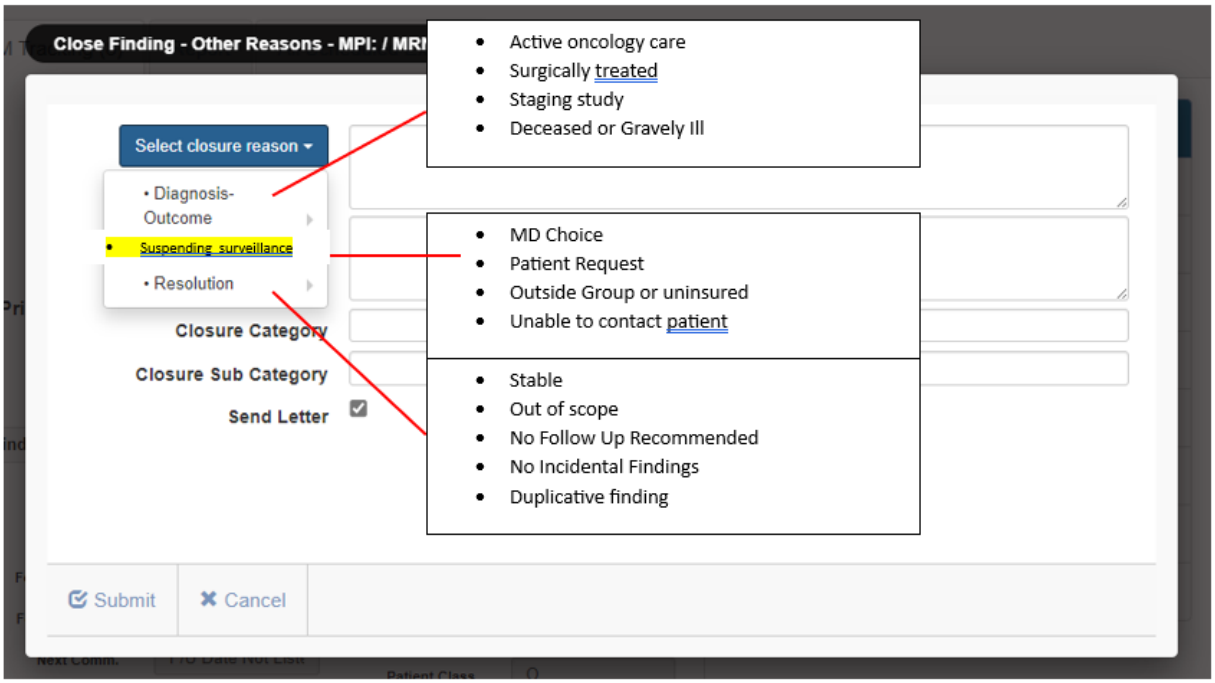
Appendix H

Suspension Reasons Prior State



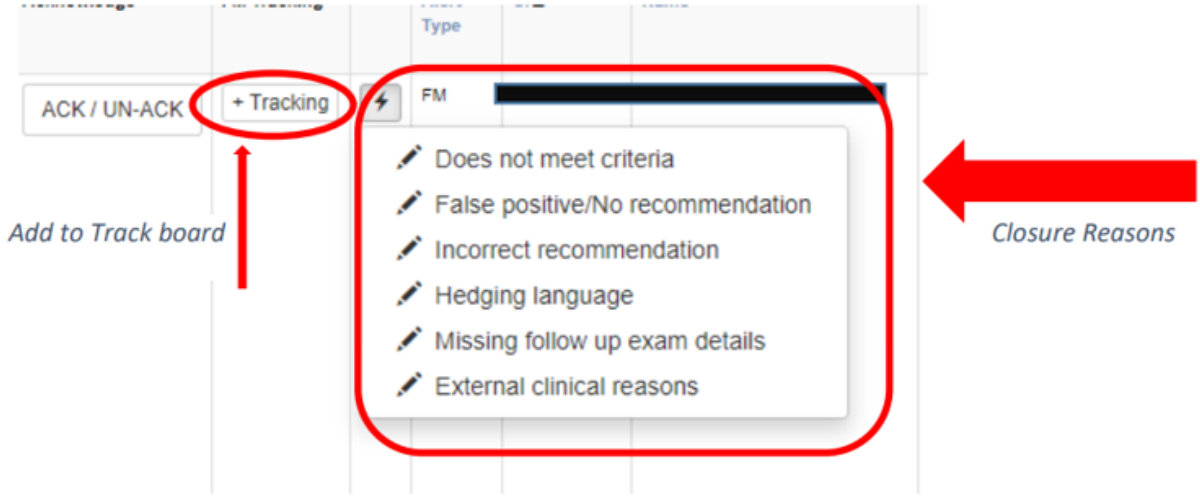
Appendix I

Suspension Reasons Current State



Appendix J

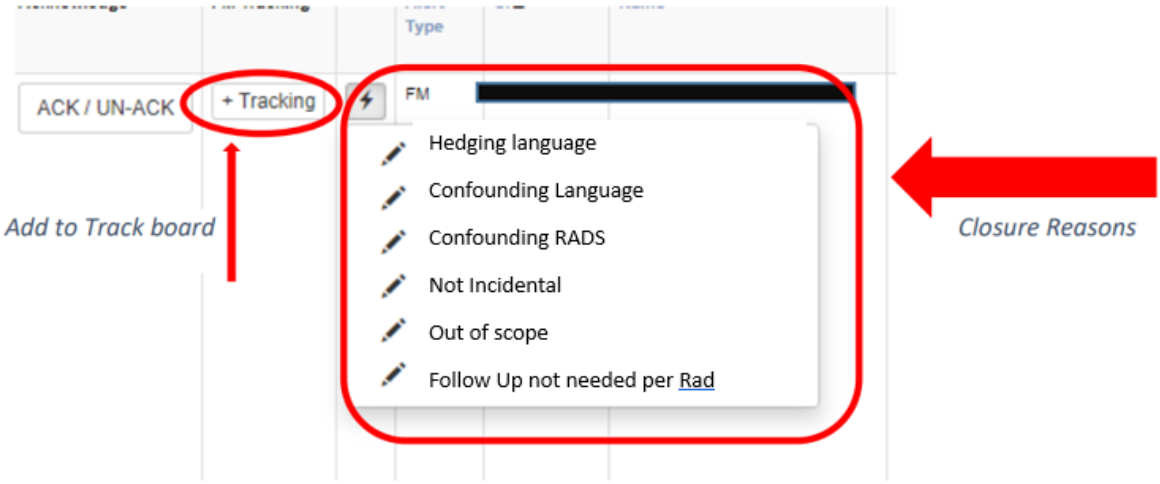
Rejection Reasons Prior State



"Does not meet criteria" – too vague, no useful data gleaned, potential safety issue. "False positive" doesn't make sense. No recommendation would be 80% of studies. Incorrect recommendation would likely not be known by a NN. Missing exam follow up details would again be 80% of patients. External clinical reasons too vague, no useful data. Choosing any of these other than hedging language is not recommended.

Appendix K

Rejection Reasons Prior State



Student asked Nuance to populate almost all new verbiage for studies being stricken from the alert board. This should only be done if the study should not have been on the alert board in the first place. In those cases, it would be beneficial to understand if it populated the alert board due to AI limitations or because of radiology not using best practices.

Appendix L

Current Rads- American College of Radiology

B-rads- Breast – no need- out of scope
Bone rads- osseous
C- Rads – CT colo
LI-rads- liver
Lung rads- pulm
NI rads- head and neck
O-rads – Ovarian or adnexal
PI-rads – Prostate
Ti-Rads- Thyroid

Appendix M

Fleischner's Criteria

IMPRESSION: Evaluation is suboptimal due to absence of IV contrast.

1. Air-fluid filled pendulous esophagus with wall thickening in the mid to lower thoracic segments suggestive of esophagitis. Small sliding hiatal hernia.
2. 3 mm pulmonary nodule in the apical posterior left upper lobe. 13 mm groundglass nodule in the posterior right upper lobe. Recommend follow-up per Fleischner criteria.

Solid	Size	Follow up		
	< 6 mm ($<100 mm^3$)	Single	Low risk High risk	No routine follow Optional CT at 12 months
		Multiple	Low risk High risk	No routine follow Optional CT at 12 months
	6-8 mm ($100-250 mm^3$)	Single	Low risk High risk	CT at 6-12 mo, then consider CT at 18-24 CT at 6-12 mo, then CT at 18-24
		Multiple	Low risk High risk	CT at 3-6 mo, then consider CT at 18-24 CT at 3-6 mo, then CT at 18-24
	> 8 mm ($> 250 mm^3$)	Single	All	Consider CT at 3 mo, PET/CT or Biopsy
		Multiple	Low risk High risk	CT at 3-6 mo, then consider CT at 18-24 CT at 3-6 mo, then CT at 18-24

As a common finding was for radiologists to recommend follow up "according to Fleischner's criteria", this criteria was added to NN job aids. Providence will be cascading recommendations to radiology, indicating that we would rather supply Fleischner's guides and RAD guides to NNs rather than have radiology include them in final impressions.

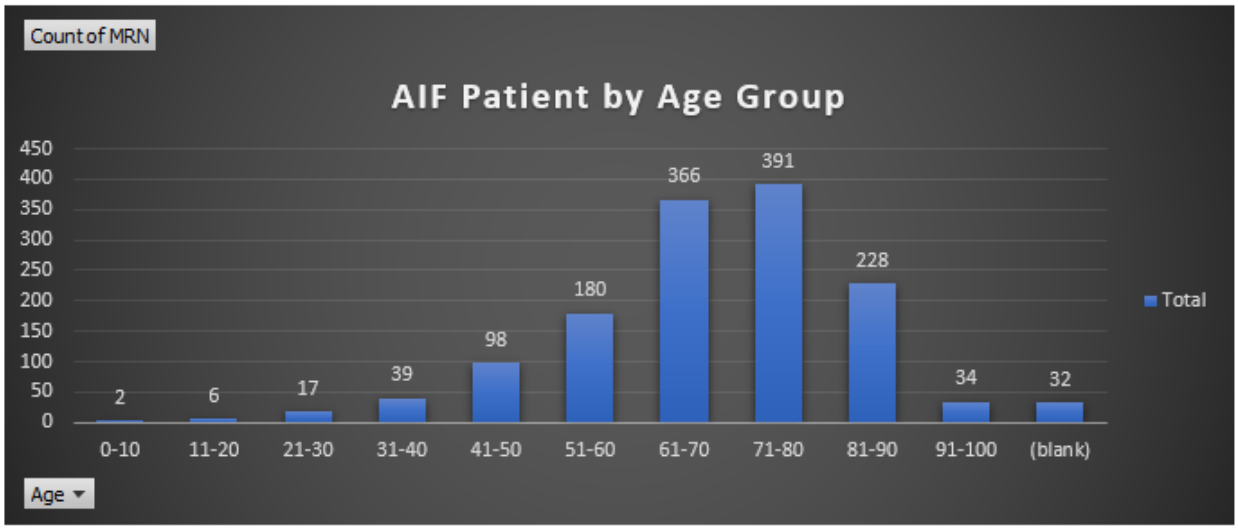
Table 1

Incidental Findings by Age Range- All Studies Sent to Follow Up Manager December 2023- January 2024

0-10	2
11-20	6
21-30	17
31-40	39
41-50	98
51-60	180
61-70	366
71-80	391
81-90	228
91-100	34
Blank	32
	Total: 1399

Figure 1

Incidental Findings by Age Range- All Studies Sent to Follow Up Manager - Graph



Note. 32 studies were left "Blank" as they were duplicative studies. 32 duplicative studies, as well as studies of minors, were removed before calculating Table 2.

Table 2

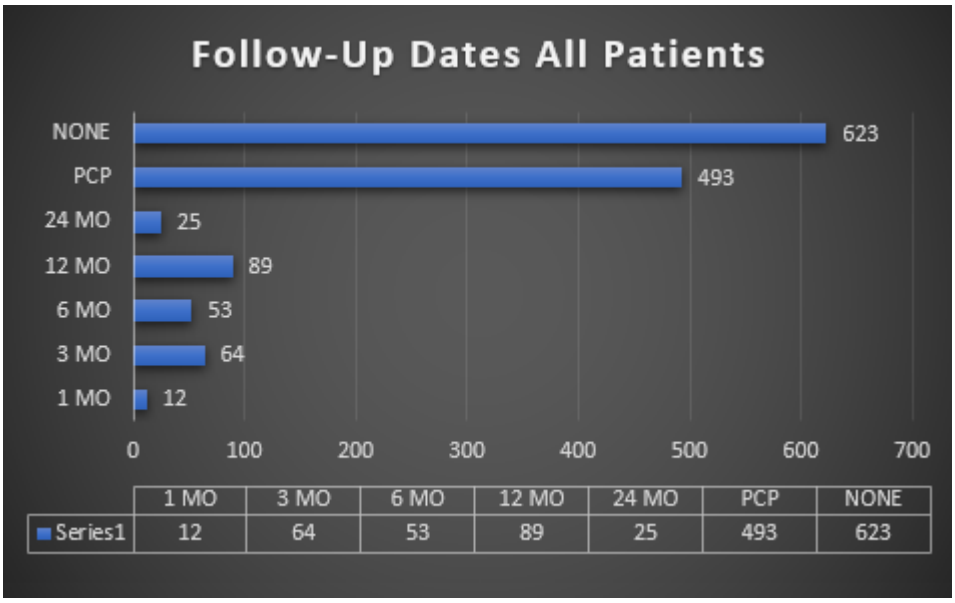
Follow Up Recommendations for All Incidental Findings December 2023 - January 2024

1 MO	12
3 MO	64
6 MO	53
12 MO	89
24 MO	25
PCP	493
None	623 = 1359

Note. 1359 patients after removal of minors and duplicative studies.

Figure 2

Follow Up Recommendations for All Incidental Findings December 2023 - January 2024- Graph



Note. 623 patients had no recommendation, and 493 indicated that follow-up was needed but that date or range was left to the primary care provider (PCP), meaning that 82% of pulmonary nodule patients had no follow-up date provided by radiology.

Table 3

Studies Excluded to Those Informing PICO (t) Question

Total Studies Explored		1399
Removal reasons:	Not Pulmonary Finding	-1125
	Duplicate Findings	-32
	Minor	-8
Studies remaining		234

Table 4

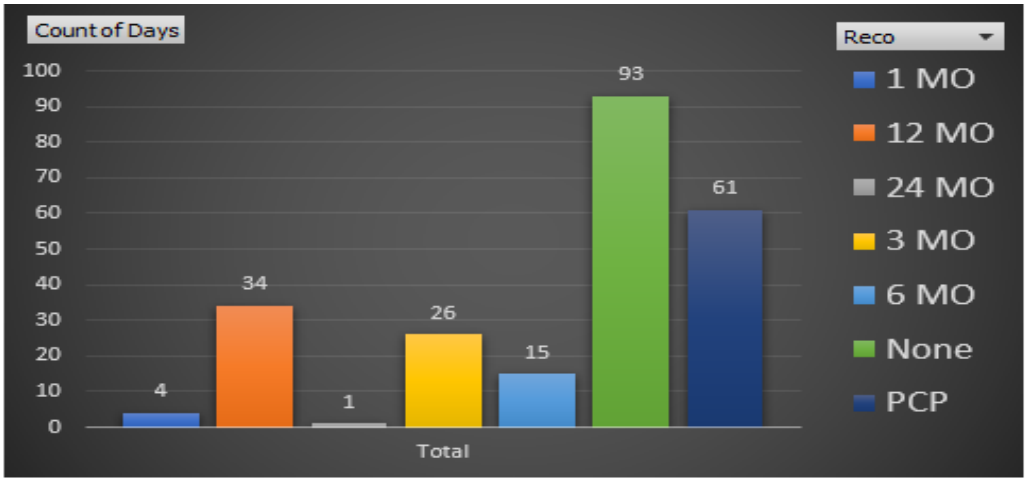
Follow Up Recommendations for Pulmonary AIF's

1 MO	4
3 MO	26
6 MO	15
12 MO	34
24 MO	1
PCP	61
None	93 = 234

Note. Imaging studies now parred down to incidentally found pulmonary nodules

Figure 3

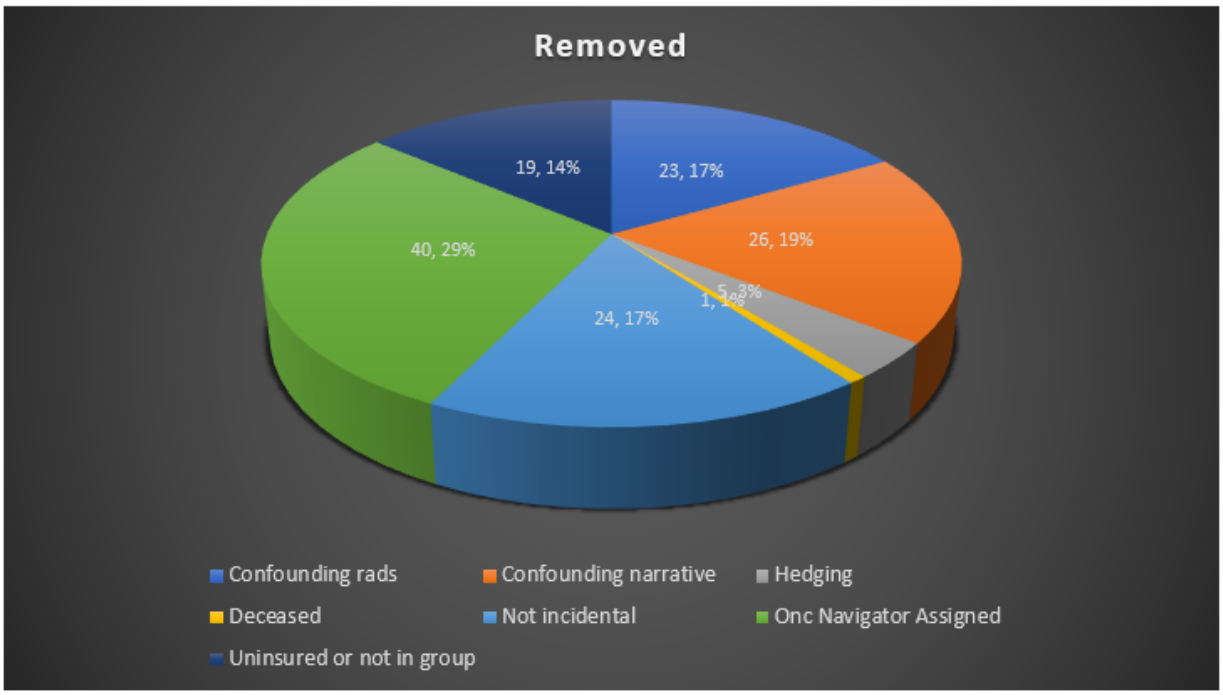
Follow Up Recommendations for Pulmonary AIF's - Graph



Note. 93 patients had no recommendation, and 61 had follow-up indicated, but that date or range was left to the primary care provider (PCP), meaning that 66% of pulmonary nodule patients had no follow-up date provided by radiology.

Figure 4

Pulmonary Findings Rejected by Reason



Note. Because the student was able to change the rejection reasons, this metric was able to serve as a key performance indicator when looking at the platform's ability to accurately determine which studies were actionable.

Table 5

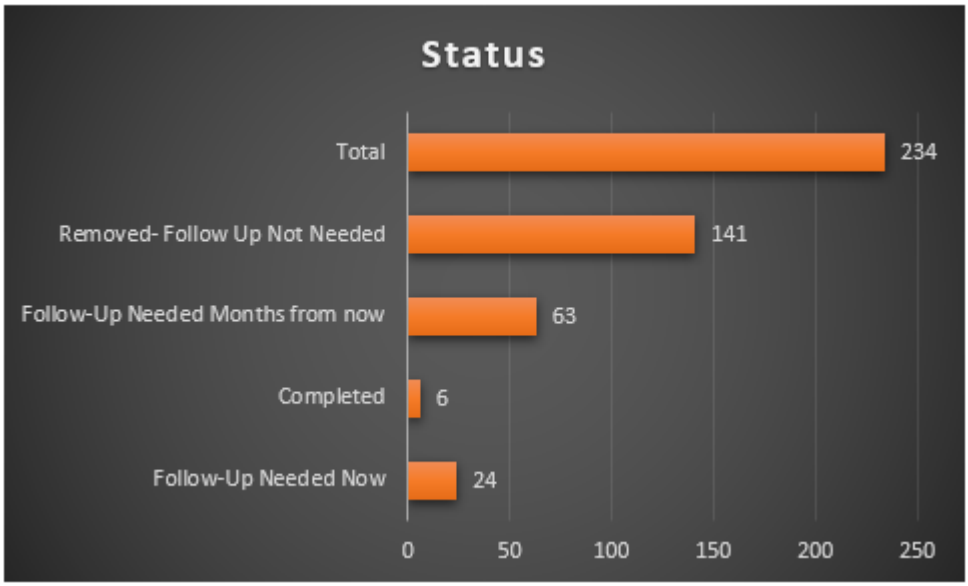
Pulmonary Findings -Sorted by Follow Up Status

Completed	6
Follow-Up Needed Now	23
Follow-Up Needed Months from Now	36
Removed- Follow-Up Not Needed	142
Total	234

Note. Patients that have completed follow-up recommendations, that need follow-up months from now, or that were removed for never having been candidates for FUM navigation, were removed from delay analysis, see Table and Figure 6.

Figure 5

Pulmonary Findings -Sorted by Follow Up Status – Graph



Note. Patients that have completed follow-up recommendations, that need follow-up months from now, or that were removed for never having been candidates for FUM navigation, were removed from analysis on

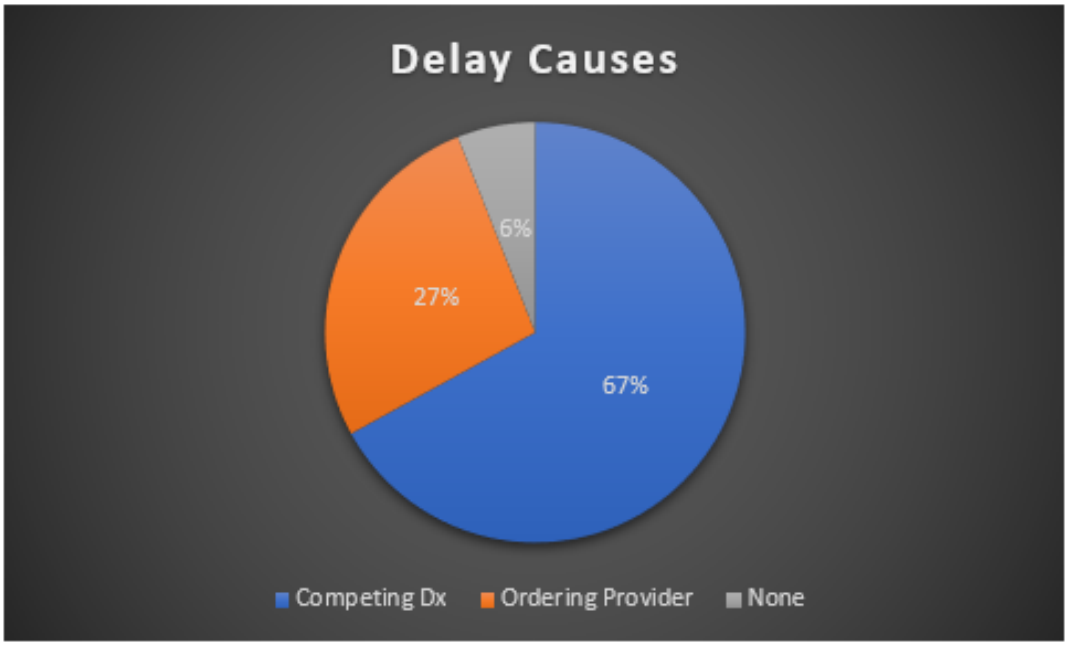
Table 6

Days Until Patient Notified and Potential Causes for Delay

Days Until Notified	Competing Diagnosis	OPA	None
1			
2			
3			
4			
6	3		
7	1		1
8	1		
9		2	
10	3		
14		2	
20	1		
30	1		

Figure 6

Potential Causes for Communication Delays in Percentages



Note. Delay was considered to be at least 6 days after imaging study

Table 7

Project Management Tracking Tool

	Severity	Issue	Problem	Solution	Owner	Resolved
Week 1	1	Very few studies include follow up date	Dashboard cannot function as intended	Bring to sterring committee	Cara	Parking Lot
Week 1	3	ECHOs hitting dashboard	Inflating numbers	Remove ICD code- ECHOs	Cal F.	Week 3
Week 1	3	LCS hitting dashboard	Out of scope	NN sorts	Cal F.	Resolved week 3
Week 1	1	No priority indications on tracker	NN can't assess urgency	Verbiage change; G & E req	Cara and Cal	Week 2
Week 2	3	Many patients not in group	Inflating numbers	NN sorts	PCN	Workaround
Week 2	2	Hedging language	Inflating numbers	Educate rads	PCN	Parking Lot
Week 2	2	Confounding language	Inflating numbers	Educate rads	PCN	In progress
Week 2	2	Confound RAD guidelines	Inflating numbers	Educate rads	PCN	In progress
Week 2	1	Dashboard only allows one NN at same time	System not sustainable	Nuance Repair	Engineers	Red Status Week 4
Week 3	1	Results only route to ordering provider	May not concer ordering provider; safety	NN sorts	Cara	Workaround
Week 3	3	Superfluous inclusion criteria, i.e. "ct" & "up"	Inflating numbers	Remove superfluous search	Cara and Cal	In progress
Week 3	2	Tracking suspension verbiage inadequate	Skewing data; patient safety risk	Change verbiage	Cara and Cal	Resolved week 3
Week 3	2	Surveillance suspension verbiage inadequate	Unlear or improper documentatiom	Change verbiage	Cara and Cal	Resolved week 3
Week 4	2	Many studies with no AIF hitting dashboard	Inflating numbers	RCA	Cal F.	In progress
Week 4	3	Staging studies hitting dashboards	Inflating numbers	NN Sorts	Cara	Workaround
Week 4	2	Patients with risk for LTFU not easily ID'd	Even if low priority AIF, extra attn needed	Verbiage change; G & E req	Cara	Parking Lot
Week 5	2	Findings type dropping after editing dates	We cannot edit withoout losing data	Nuance Repair	Cal	In progress

Note. Pain Points and Status of Resolution Throughout Project