More Bang for the Healthcare Buck: Addressing the Emergency and Urgent Care Elephant in Pulmonary Nodule Follow-up Loss with Smart HL7 Workflow

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Abstract: M5B-QI-5

RSNA® 2023
LEADING THROUGH CHANGE

NOVEMBER 26-30, 2023
CHICAGO, IL

FINANCIAL DISCLOSURE

LIST ALL DISCLOSURES FROM PAST 12 MONTHS

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Patent pending on related technique for listed authors

BACKGROUND/OBJECTIVE

Background

- The overwhelming **majority of incomplete** imaging incidental findings **follow-up** results from **emergency (ED)** and **urgent care (UC) visits**.
- While there have been extensive talks about the need for automated imaging tracking and provider notification systems in healthcare, the **complexity of the ED/UC setting has prevented hospitals from addressing this majority** contributor to lost follow-up.

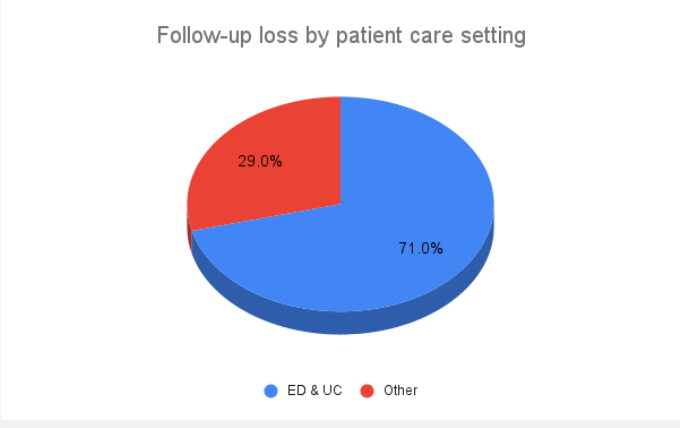
Objective

- We present **ED/UC-capable system architecture managing HL7 workflow for pulmonary nodule incidental findings** that may be paired with a knowledge-based AI or be used in conjunction with a nurse navigator, depending on hospital infrastructure.
- We address lack of high-level performance evaluation of published tools in the clinical setting by **evaluating clinical performance** within a large academic medical center.

METHODS AND MATERIALS

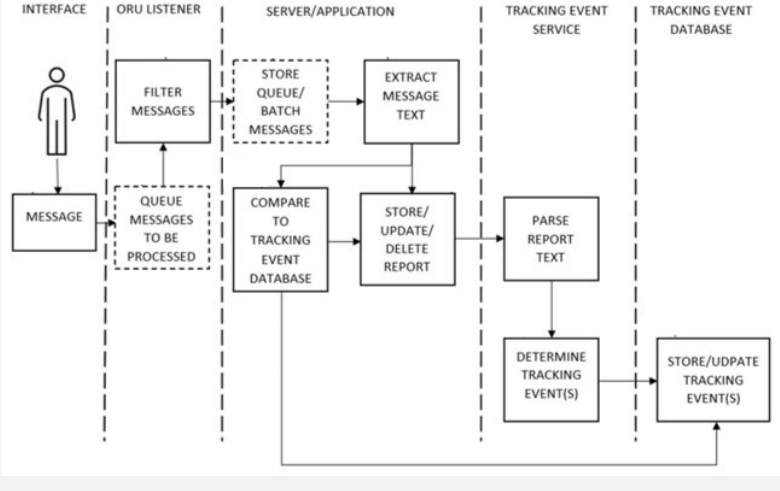
Follow-up loss

Monitoring at a southeastern academic medical center interpreting 1.2 million imaging exams annually revealed **most lost pulmonary nodule follow-up exams were from ED and UC settings**.



Automated System Configuration

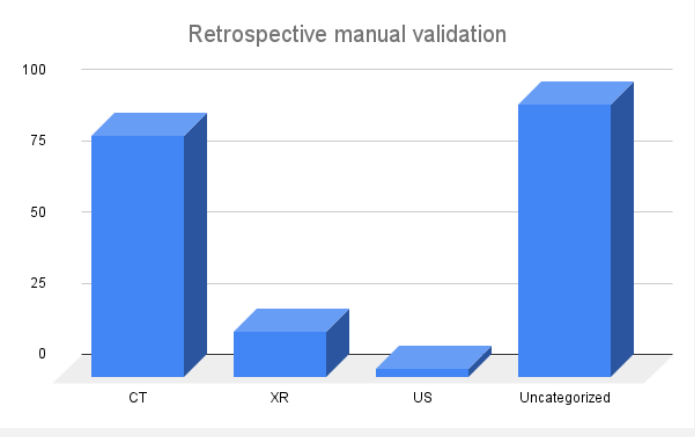
Novel **ADT, ORU, ORM and SIU data streams** were designed to configure to all types of clinical recommendations.

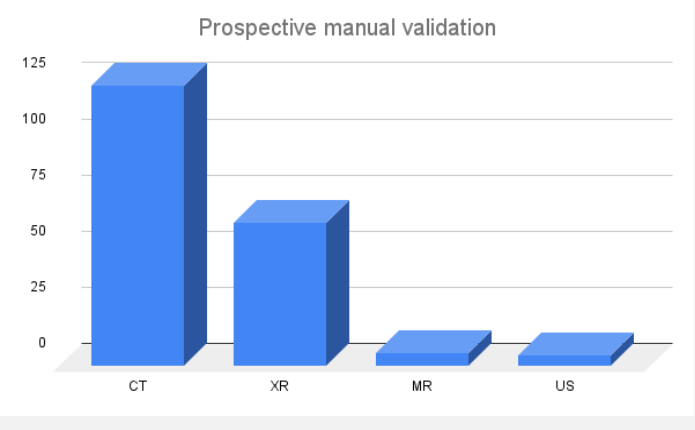


METHODS AND MATERIALS

AI Study Design

- We previously reported on a LSTM AI model recognizing pulmonary nodule follow-up recommendations (1,970 retrospectively annotated reports, 60/20/20% training/validation/test split, accuracy 94%).
- **To generate ED/UC-capable workflow, we paired this LSTM with a knowledge-based AI** to assign patients into follow-up intervals: high risk (≤ 3 months), medium risk (> 3 months but ≤ 6 months), and low risk (> 6 months and ≤ 12 months).
- Clinical performance was assessed by **retrospective manual validation of 200 reports** followed by key word inclusion/exclusion modifications. Real-time clinical performance was again assessed by **prospective manual validation of 200 reports**.
- **Fleischner Society Guidelines** and logic governing NLP system-to-EMR communication were leveraged to develop **risk-stratified ED/UC-capable HL7-based workflow**.

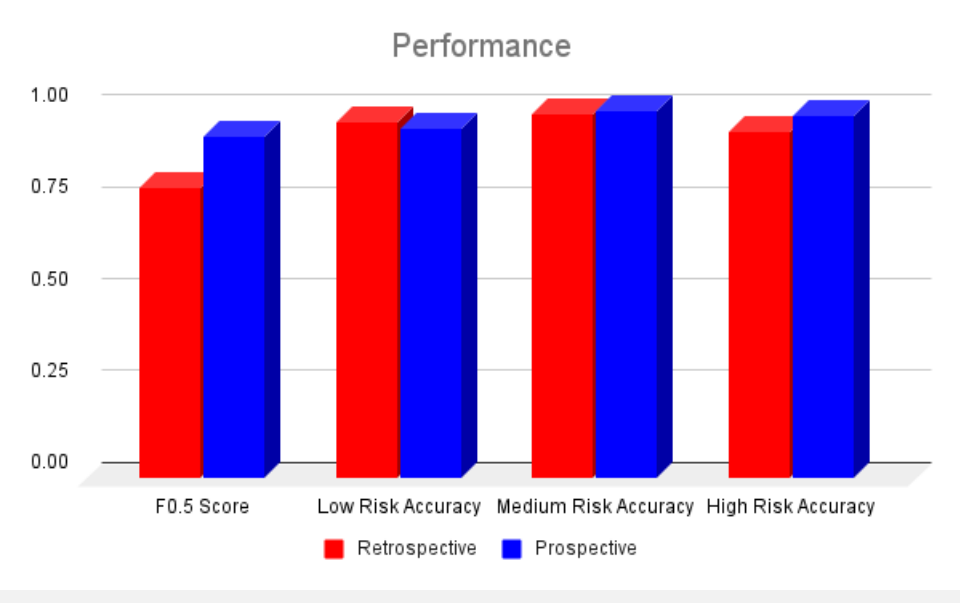




SUMMARY OR RESULTS

AI performance evaluation

- **F0.5 score was selected to optimize clinical practice performance** by **penalizing false positives more than false negatives**, where false reminders would undermine provider system use.
- The macro-averaged F0.5 score for retrospective performance was **0.79** (accuracy by risk class: high risk 94.5%, medium risk 99%, low risk 97%) and for prospective performance was **0.93** (accuracy by risk class: high risk 98.5%, medium risk 100%, low risk 95%).
- Knowledge-based AI modifications resulted in **14% improvement** in prospective performance.



Conclusion or Discussion

Strengths

- **Prospective** study design
- **Real world performance evaluation** for AI models
- **Explainable AI (XAI) as opposed to "black box"** approach of typical machine learning models (e.g. deep neural networks)
- AI system automation with **human-in-the-loop reminders**
  - Physicians receive reminders and can verify accurate predictions for pulmonary nodule follow-up recommendations originating from ED and UC patient care settings.

Limitations

- **Small sample size**
- **Single healthcare system**

Conclusion

- There are **no published automated system workflows** addressing the **safety gap presented by ED/UC settings**.
- The proposed **ED/UC-capable HL7 logic and knowledge-based AI can help hospitals implement tracking and reminder systems** capable of capturing the overwhelming majority of lost follow-up and meet ACR-issued Closing the Recommendations Follow-Up Loop measures.
- **High-level clinical performance evaluation underscored the validity of this approach**.