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A Clear Picture: Leveraging Automated Technology to Gain Insight into Real-Time Workflows

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No disclosures
Introduction

• Limited transparency into the utilization of rooms and equipment causes many operational issues including:
  – Patient scheduling
  – Staff scheduling
  – Delays in care
  – Wasted time

• Current radiology information system (RIS) utilization is manually updated by technologists.
  – Slow and inaccurate

• We introduced an automated machine learning (ML) tool to evaluate interventional radiology procedural room utilization with the goal of increasing the transparency of patient flow within the procedural suite.

• Prior ML initiatives in the literature have only predicted case duration
Methods

• IRB approval was obtained.
• Two high volume interventional suites in our large academic center were evaluated.
• HIPPA compliant depth detection sensors installed in each room were trained to identify the following states:
  – “patient in (I)”
  – “patient on table (OT)”
  – “patient off table (FT)”
  – “patient out (O)”
• Still depth images were labeled by the study team and declared ground truth
Methods Continued

- ML algorithm generated timestamps for the states from the images.
- Timestamps from the RIS were accessed.
- We compared the ML and RIS data to ground truth data.
- Deviation is measured as minutes in excess of the ground truth average.
- Z-testing was used to determine significance.
Results

• 511 procedures performed in the IR suites between May 11, 2021 and December 9, 2021.

• Gaps in data in ML: 38%
  • Gaps in the ML data occurred due to unplugging and/or moving of the equipment and computer memory storage.

• Gaps in data in RIS: 48%
  • Gaps in the RIS data due to missing data entries, e.g. human error.
**Results - Room A**

At ground truth patients transited the room at the following average times

- room A $I=0$, $OT=6$, $FT=105$, $O=110$ minutes

**Deviation** from ground truth for each state was:

- ML: room A $[I=1$, $OT=3$, $FT=2$, $O=4]$ minutes $\rightarrow$ 5% error
- RIS room A $[I=1$, $OT=6$, $FT=21$, $O=17]$ minutes $\rightarrow$ 28% error

Data from the ML algorithm was closer to ground truth than from the RIS data

- Z-test confirmed that the mean differential of the ML data is lower than the mean for the institutional data source beyond 3 standard deviations ($P<0.001$).
At ground truth patients transited the room at the following average times

- room B [I= 0, OT = 3, FT= 76, O=78] minutes

**Deviation** from ground truth for each state was:
- ML: room B [I= 2, OT= 3, FT= 4, O= 3] minutes --> 8% error
- RIS room B [I=1, OT= 3, FT= 14, O= 13] minutes --> 24% error

Data from the ML algorithm was closer to ground truth than from the RIS data

- Z-test confirmed that the mean differential of the ML data is lower than the mean for the institutional data source beyond 3 standard deviations (P<0.001).
Conclusion

• This is a first of its kind study looking at operational workflows leveraging machine learning techniques.
• Leveraging a device to "see" inside the procedural suite allowed for increased transparency in room utilization and the ability to develop a ground truth.
• ML algorithm data was significantly more accurate than the manually entered RIS data in evaluating IR room utilization.
• Gaps in data in the ML generated data are solved by increased computing memory and device location redesign.
Clinical Relevance

• Automated monitoring of room utilization provides more accurate insight into room utilization than human inputs.

• This technology could be leveraged to do the following:
  • Improve procedural flow and patient access
  • Decreases burden of manual utilization tracking techniques.
  • Allow for immediate transparency into status of procedural suites and the ability to make on the spot operational changes.