R5B-QI-1

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

A Abunimer MD, M Heilbrun MD, A Prater MD, M Davis MD

Emory University School of Medicine
Interventional Radiology and Image-guided Medicine
Department of Radiology

No disclosures

EMORY UNIVERSITY SCHOOL OF MEDICINE

Introduction

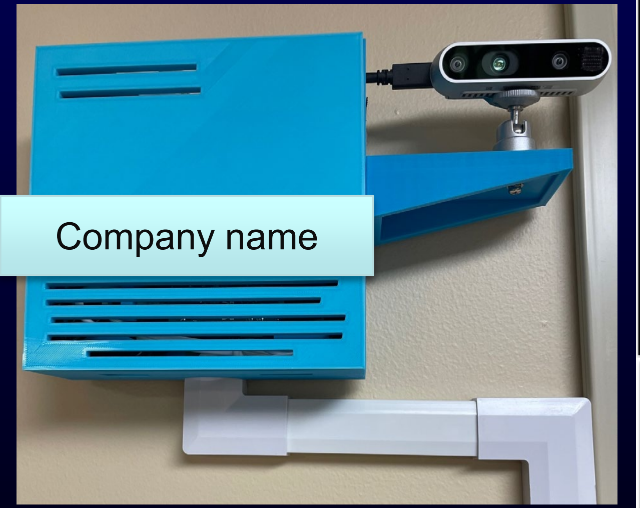
- Limited transparency into the utilization of rooms and equipment causes many operational issues including:
  - Patient scheduling
  - Staff scheduling
  - Delays in care
  - Wasted time
- Current radiology information system (RIS) utilization is manually updated by technologists.
  - Slow and inaccurate
- 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

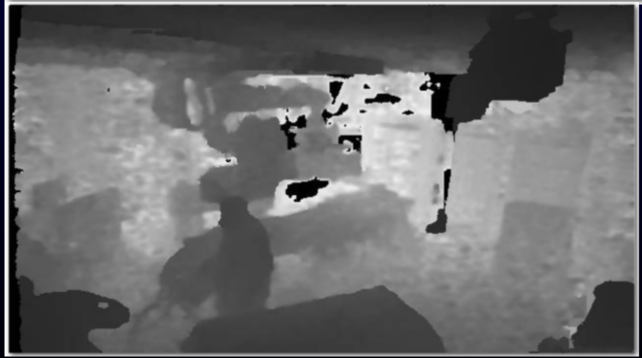
Methods

- 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 <u>A</u>

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

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

patient in (I)
patient on table (OT)
patient off table (FT)
patient out (O)

<u>**Deviation**</u> from ground truth for each state was:

- ML: room A [I=1, OT=3, FT=2, O = 4] minutes ---> 5% error
- RIS room A [I=1, OT=6, FT= 21, O=17] minutes --> 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).

Results-Room B

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

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

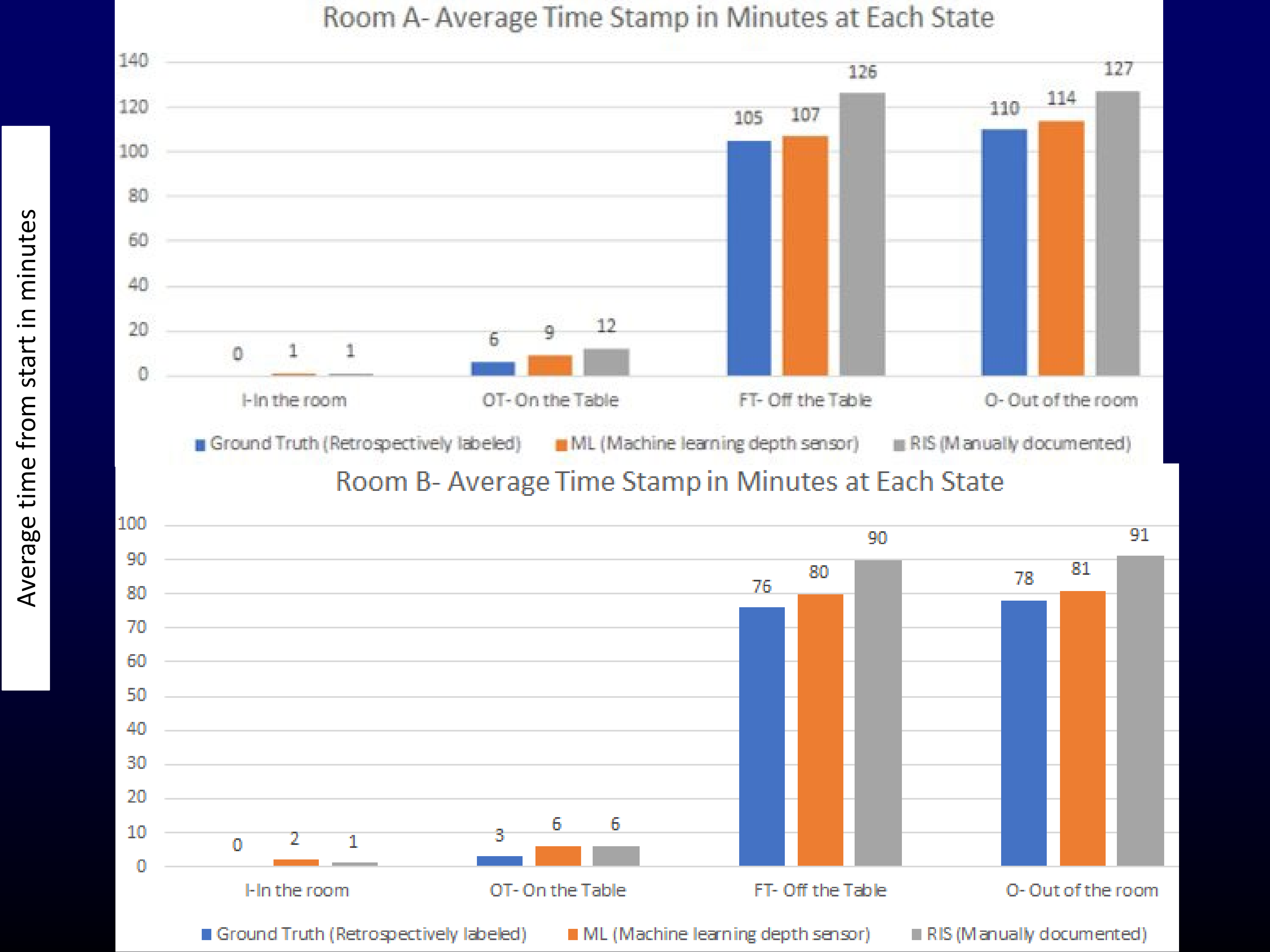
patient in (I)
patient on table (OT)
patient off table (FT)
patient out (O)

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).


Average time from start in minutes
Room A- Average Time Stamp in Minutes at Each State
140
120
100
80
60
40
20
0
0
1
1
6
9
12
105
107
126
110
114
127
I-In the room
OT- On the Table
FT- Off the Table
O- Out of the room
Ground Truth (Retrospectively labeled)
ML (Machine learning depth sensor)
RIS (Manually documented)
Room B- Average Time Stamp in Minutes at Each State
100
90
80
70
60
50
40
30
20
10
0
0
2
1
3
6
6
76
80
90
78
81
91
I-In the room
OT- On the Table
FT- Off the Table
O- Out of the room
Ground Truth (Retrospectively labeled)
ML (Machine learning depth sensor)
RIS (Manually documented)

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.