Practical Applications of AI in Clinical Setting

Richard Friedland, MD, FACR
Pelu Tran, BS

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Conflict of Interest Disclosure

Richard Friedland, MD, FACR, reported no relevant financial relationships or relationships he has with ineligible companies of any amount during the past 24 months.

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Presenter

Richard Friedland, MD, FACR
President and Managing Partner
Hudson Valley Radiologists/DRA Imaging

Dr. Friedland is a practicing neuroradiologist, licensed in both New York and Connecticut. He's been President and Managing Partner of Hudson Valley Radiologists/DRA Imaging since 2010. He is also the CEO of Radloop, whose mission is patient safety by communicating and tracking actionable findings while reducing administrative tasks for radiologists and referrers.

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Presenter

Pelu Tran, BS

Pelu Tran is the Cofounder and CEO of Ferrum Health, an AI-powered peer review automation and monitoring solution that helps radiologists detect and correct errors before they affect patient care. He is a technology pioneer and expert contributor for the World Economics Forum and a Fellow of the UN World Summit on Innovation. He has studied both medicine and engineering at Stanford University.

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AI in Clinical Medicine:

Using Digital Health Data to Improve Outcomes

Coordinating Patient Follow Up: Closing the Care Gap

Richard Friedland MD, FACR

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Disclosure: Founder/Shareholder

radloop®

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Actionable Incidental Findings

- The Definition and Examples
- The Scope of the Problem
- Why Track Incidental Actionable findings?
- Factors that contribute to the problem
- The Tools needed
- The Community Health Grant
- Future Direction: The Future is now.

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Actionable Incidental Finding

- An incidental finding, also known as an incidentaloma, may be defined as “a discovered mass or lesion, detected by CT, MRI, or other imaging modality performed for an unrelated reason.”
- An increase in the utilization of cross-sectional imaging examinations over the past three decades, has led to a marked increase in the number of findings detected that are unrelated to the primary objectives of the examinations.
- An actionable finding (AF) is a finding on a medical imaging report that requires further evaluation. AFs include critical findings (CF) and non-critical incidental findings (IF).

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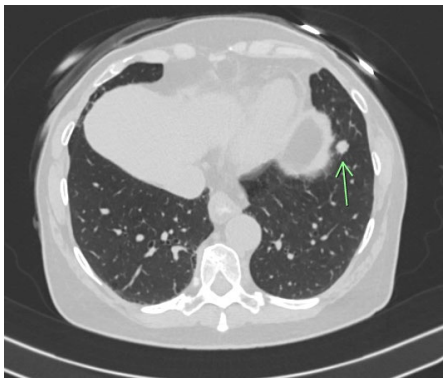
57-year-old male smoker comes to the ER for kidney stones **2015**, he is lost to follow-up, but returns to the ER for abdominal pain in **2018**



2015 - CT shows a small lung nodule, stage 1 cancer, with a **61%** - 5-year survival[1]

2018 - the small nodule is now a mass, stage 4 cancer with a **6%** - 5-year survival[1]

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1 American Cancer Society information from the SEER database, maintained by the National Cancer Institute (NCI)

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How Common is This ?

Missed opportunities resulting in preventable delay in diagnosis of malignancy related to non-compliance with follow-up imaging recommendations occurs in 1 in 7 lung cancer diagnoses.

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Lorincz CY, et. al. Research in Ambulatory Patient Safety 2000-2010. AMA
Singh H et al. J Clin Oncol 2010; 28:3307–3315
Siegal, D et al. Diagnosis 2017; 4(3): 125-131

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Incidental Actionable Finding

Incidental finding 2014
EVAR group, (1.5%) patients died, compared to (4.6%) patients who died in the open surgery group.

Critical finding in 2020
Ruptured abdominal aortic aneurysms are associated with an overall mortality rate of over 80%.

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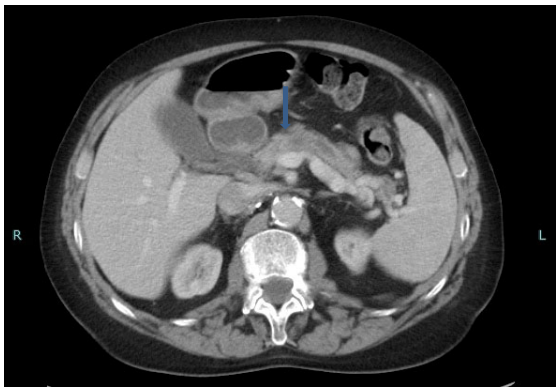
63-year-old man goes to the Urologist for Hematuria , R/O Bladder lesion

- Radiology report:
  - Impression: 1 cm polypoid mass in the bladder, no extension though the vesicular wall observed.
  - In the body of the report but not in the impression, dilated pancreatic duct, r/o pancreatic mass - recommend at follow up MRI with contrast of the the abdomen.



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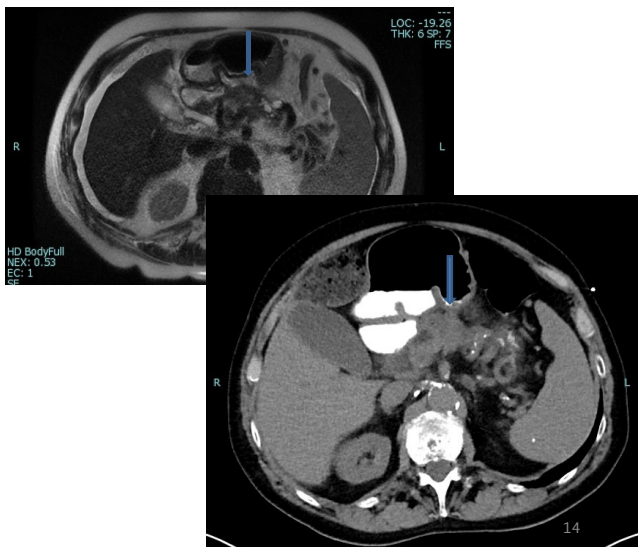
One year later the man returns to the ER with Abdominal Pain.

- Radiology report:
- Dilated pancreatic duct with a 3cm mass in the body of the pancreas. Peripancreatic lymph nodes and infiltration of the peripancreatic fat.
- He now has stage 4 disease. Median survival 4 months. 5-year survival 3%.



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Why Track Actionable Incidental Findings?

1/3 of all Actionable Incidental Findings lack documented completion in the medical record.

Follow up establishes the diagnosis in up to 45% of cases.

Cancer diagnosis in up to 4.5% of cases.

Early diagnosis can change outcomes.

How does this compare in terms of Cancer detection?

- Tracking Actionable Incidental Findings – 3.4-4.5%
- Screening Mammography – .051 %
- Colorectal Screening (fecal occult blood) – 1.1%
- Low dose CT Lung Cancer Screening – 2.9%

Irani N, Saeedipour S, Bruno MA. Closing the Loop-A Pilot in Health System Improvement. Curr Probl Diagn Radiol. 2020 Sep-Oct;49(5):322-325. doi: 10.1067/j.cpradiol.2020.02.006. Epub 2020 Mar 2. PMID: 32220539.
Mannix J, LaVoye J, Wasserman M, et al. Notification System for Overdue Radiology Recommendations Improves Rates of Follow-Up and Diagnosis. AJR Am J Roentgenol. 2021 Jun 2:1-6. doi: 10.2214/AJR.21.23173. Epub ahead of print. PMID: 34076452

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What will Tracking Follow Ups and Improved Communication Provide?

- Increases exam completion rate
- Identifies exam completions outside your institution
- Ensures closure
  - Biopsy or surgical excision
  - Limited life expectancy / palliative care
  - Specialist referral / management
  - Clinical resolution
  - Identification of additional studies
- Moves the needle on quality and safety/risk
- Down stages disease
- Increases revenue
- Decreases liability
- Creates a strategic advantages to your organization

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How Common are Actionable Incidental Findings?

- Incidental findings are an inevitable consequence of increasing imaging volumes and have been found in as many as 55% of trauma patients undergoing whole-body CT.
- The estimated incidence of actionable findings ranges from 9% among screening patients to as high as 31% among patients with known cancer.
- At HVR, our rate of AIF is 12.7%

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Seah MK, Murphy CG, et. al Incidental findings on whole-body trauma computed tomography: experience at a major trauma center. Injury 2016; 47:691–694
Pickhardt PJ, Hanson ME, Vanness DJ, et al. Unsuspected extracolonic findings at screening CT colonography: clinical and economic impact. Radiology 2008; 249:151–159
Lardinois D, Weder W, et al. Etiology of solitary extrapulmonary positron emission tomography and computed tomography findings in patients with lung cancer. J Clin Oncol 2005;23:6846–6853

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The Geometric Growth of Imaging Studies and Number of Images per Study

- Approximately 630 million radiology procedures were performed in 2017, with an anticipated 2.3% compounded annual growth rate between 2014 and 2023.
- 80 million CT scans are performed each year in the U.S in 2015, up from 3 million in 1980.
- Between 2007 and 2017, age-adjusted ED neuroimaging utilization rates per 1000 ED visits increased 72% overall (compound annual growth rate [CAGR], 5%).
- This overall increase corresponded to an increase of 69% for head CT (CAGR, 5%), 67% for head MRI (CAGR, 5%), 1100% for head CTA (CAGR, 25%), 1300% for neck CTA (CAGR, 27%), 36% for head MRA (CAGR, 3%), and 52% for neck MRA (CAGR, 4%)

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McDonald RJ, Schwartz KM, Eckel LJ, Diehn FE, Hunt CH, Bartholmai BJ, Erickson BJ, Kallmes DF. The effects of changes in utilization and technological advancements of cross-sectional imaging on radiologist workload. Acad Radiol. 2015 Sep; 22: (9)1191-8.
Consumer Report 2015
Smith-Bindman R, Kwan ML, Marlow EC, et al. Trends in Use of Medical Imaging in US Health Care Systems and in Ontario, Canada, 2000-2016. *JAMA.* 2019;322(9):843–856. doi:10.1001
Increasing Utilization of Emergency Department Neuroimaging From 2007 Through 2017. Andrew ElHabr, Selin Merdan, Turgay Ayer, Adam Prater, Tarek N. Hanna, Michal Horný, Richard Duszak, Jr., and Danny R. Hughes
American Journal of Roentgenology 2022 218:1, 165-173

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The Clinician Corollary: Alert Fatigue A Clear and Present Danger

- The typical clinician reviews 1,000 test results per week. The most common missed results were imaging studies.
- Median number of alerts received by PCP each day = 63.

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Singh H, Giardina TD, Meyer AND, Forjuoh SN, Reis MD, Thomas EJ. Types and Origins of Diagnostic Errors in Primary Care Settings. JAMA Intern Med. 2013;173(6):418–425

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Lost Studies, No Follow up

7,438 Imaging studies were completed

622 (8.4%) had neither the images nor the imaging reports viewed in either the PACS or EMR the 8 months after the imaging order was placed.

- 247 cases (39.7%) classified as Grade 3 (findings requiring intervention or follow-up)
- 3 cases (0.5%) classified as Grade 4 (critical)

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Lost to Follow-Up: Analysis of Never-Viewed Radiology Examinations
Anthony Galinato, Matthew D. Alvin, David M. Yousem
Journal of the American College of Radiology
Published online: November 2, 2018

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Requirements of the Tracking Tool

System Requirements:

- Zero click solution so there is no impact on radiologist workflow
- Secure, HIPAA compliant solution
- Scalable – Zero on-site footprint
- Highly accuracy AI/NLU algorithm to identifying and extracting important findings and follow ups from radiology reports.
- Web platform – Provide Navigators with a customizable dashboard tool to organize their follow up strategies
- Mobile application – Provide clinicians with follow up recommendations and results on their mobile device so they can order follow up studies anytime, anywhere
- Application Programing Interface (API) as well as standard HL7 for bidirectional communication to ensure EMR remains the source of truth and networks the community.
- System analytics that offer real-time feedback to support for programmatic oversight and business intelligence
- Cost effective
- Return a significant ROI

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"Civilization advances by extending the number of important operations which we can perform without thinking of them."

- Alfred North Whitehead

(1861–1947) was a British mathematician and philosopher best known for his work in mathematical logic and the philosophy of science.

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The ED is the "Perfect Storm" for Test Tracking Errors

- The ED is particularly challenging for test-result follow up due to the focus on rapid and high-volume patient throughput, team-based care, handoffs and lack of continuous relationships between patients and clinicians.
- EMR's seem particularly vulnerable to longitudinally following patients from different settings.
- Discharge summaries are often cumbersome to both patient and Doctors.
- One review of emergency department discharge instructions revealed that only 50% of radiologists' follow-up recommendations were conveyed to patients.

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Dutta S, Long WJ, Brown DF, Reisner AT. Automated detection using natural language processing of radiologists recommendations for additional imaging of incidental findings. Ann Emerge Med 2013; 62:162–169

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Coverys Community Healthcare Foundation (CCHF) Grant with Strategic Radiology®

Program was developed as a result of a grant funded by Coverys Community Healthcare Foundation (CCHF) to research methods to ensure that patients are aware of incidental findings identified in imaging exams acquired in the ED, a setting fraught with communication challenges.

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The Goal:

Improving Diagnostic Accuracy through Improved Communication to Patients with Incidental Findings on ED Medical Imaging Studies

The Coverys Grant began in January 2019 and concluded March 2021.

Reviewed 138,603 ED-based imaging reports with a high probability of having incidental findings.

Identified 9,577 studies with follow-up recommendations.

5,999 incidental findings needed communication.

Results were communicated to 4,962 patients and 300 PCPs.

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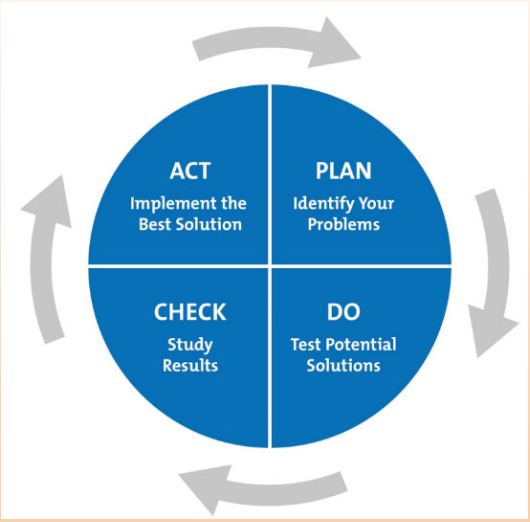
Project Process



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Step 1: Plan/Analyze

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Step #2: Do

- Planned the intervention and the outreach
- Assessed technology tools for automating the process
- Tested the technological parts of the process:
  - Transmission of reports to the SR-PSO
  - Identifying the studies with incidental findings
- Letters were developed and individualized by each practice for both patient outreach and primary care physician (PCP) contact
- In partnership with the practices to identify those reports by exam code believed to be most likely to include incidental findings
- Exam codes were filtered by SR IT
- Focus on **four** types of incidental findings: lung nodules, renal cysts/masses, adrenal nodules, and pancreatic lesions

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Step 3: Check/Monitor

- Exams were reviewed and navigated
- Monitored dashboards ensured cases were loaded, filtering, and being processed by the algorithm as planned
- Dashboards used to track and tag cases for the purposes of sending letters and creating data for education, analysis, and deliberation
- Letters were updated based on feedback from patients
- Data was analyzed to ensure that study codes had a high chance of incidental findings
- Ongoing navigation of cases identified opportunities for improving report structure and radiologist education, and to assess volumes for outreach

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Step 4: Act/Improve

- Continuous improvement and learning occurred during project implementation
- Recommendations to standardize reporting protocols for incidental findings were gathered
- A review of cases with recommendations to improve vague statements
- Dissemination of best practices across member groups ongoing
- Additional dissemination of findings is planned throughout the rest of the year

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Project Aim No. 1

Review the current state of the incidental findings in the ED communication process beginning with the report structure, communication mechanisms, and the involvement of the patient in the process.

- The executive director of the Strategic Radiology Patient Safety Organization (SRPSO) completed a review of current literature regarding incidental findings including an assessment of the positions and recommendations from the American College of Radiology and the American College of Emergency Physicians.
- Site visits were conducted by the executive director of the Strategic Radiology Patient Safety Organization and included an overview of the initiative, current state of the issue, discussion of current processes, feedback on how best to improve the process, and how to access the required reports for patient identification and communication.

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Project Aim No. 2

Develop a program that ensures patients receive communication about the incidental findings from their ED visit and the need to follow-up with their provider.

- IT members and the vendor tested the transmission of reports and the processing of reports through the algorithm to identify both incidental findings and follow-up recommendations.
- Each practice provided files that included radiology reports and demographic data captured by the emergency department systems.
- Over 138,000 radiology reports were reviewed.
- Software made the reviewing of cases efficient for navigation.
- Patients were provided a contact number within the practices and directly to the reviewer to address any questions.
  - Sixty-three (63) patients contacted the reviewer to request records with one complaint that a patient had passed away. Reviewer provided a review of the project to all callers and discussed their experience. Patients were grateful for the reminder and did not recall that they needed follow-up.
  - Forty-seven (47) were responding after inpatient hospital stays related to the emergency visit.

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Project Aim No. 3

Develop a system that can be replicated across the country and address the concerns about the financial and personnel resources needed to fill the gap in care currently experienced.

- As part of the planning phase, a review of current technology that could assist with the intervention and testing phase of the project was also reviewed. The SR-PSO executive director and director of IT and analytics reviewed and developed a method for data collection from the practices and the integration of outside technology into the process. This process can be utilized and replicated in each practice or health care system.
- Based on the projects results, the RadReach™ program was developed to provide a low-cost system that addresses concerns about the financial and personnel resources required to fill this care gap.

RadReach™

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Key Grant Findings

- 6.91% of all cases reviewed included follow-up recommendations for the 4 actionable incidental findings.
- 68% were not aware/unsure of a follow-up recommendation for incidental findings associated with their ED visit.
- 86.8% said they would contact their physician for follow up based on the letter you received.
- The ED chart contained the patient's PCP only 7.18% of the time.
- Stakeholders agreed that there is a great opportunity to improve the process resulting in improved communication, increased compliance with follow up on recommended exams, increased patient engagement, and ultimately better outcomes through outreach.

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Additional Significant Findings

- Radiologists are open to feedback on opportunities to improve documentation in reports.
- Patients shared that they had been to ER for events that led to longer hospital stays or extended stays in rehabilitation. Patients provided the letter to their physicians resulting in physicians reaching out to reviewer to request findings.
- Patients were satisfied with being contacted following an ED visit that informs them of a need to follow up.

Issues with the Grant

- Due to the pandemic, opportunities for additional site visits were cancelled.
- Standardization of recommendations based on guidelines lacks full adoption within the coalition.
- One of our hospitals had a change in administration and emergency department physicians group coverage and was unable to participate beyond the testing of data.
- Patients may also fall through the cracks when demographic data is missing, which was commonly associated with trauma patients. This is an opportunity for further evaluation and process improvement.
- Due to the length and scope of the project, accessing follow up compliance was not assessed; this would require additional study and may identify reasons for lack of follow up.

- HVR Data 1st Q

  (1/17/22 - 4/17/22)

- Non-Imaging recommendations: 798 (Majority are a combination of colonoscopy / surgical consult & lab)
- 9.6% of our recommendations were for non imaging follow up.

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Imaging Recommendations: 1/17/2022 - 4/17/2022 - (Excluded exams include: 'MR breast', 'Dexa', 'US Breast', 'MG)

Summary	Value	Notes
➢ Total Number of Imaging Category Recommendations with exclusions(filters)	8,295	
➢ 100% of recommendations due to close during this timeframe (Exam Completed, Completed outside Nuvance, Different Exam Performed, Linked Order)	2,151	
➢ 91% of the imaging orders due with closure reason of(Exam Completed, Completed outside Nuvance, Different Exam Performed, Linked Order)	1,957	
➢ National Avg: 26% of 91% of the imaging orders due with closure reason typically loss to follow up	508	Expected loss
➢ Exams closed with 1 encounter and closure reason: Exam Completed, Different Exam performed, Completed Outside Nuvance, or Linked Order	240	HVR navigator Intervention with patient only
➢ Exams performed with 2 encounters and closure reason: Exam Completed, Different Exam performed, Completed Outside Nuvance, or Linked Order	+ 76	HVR navigator Intervention with patient only
Total exams completed with HVR Intervention	316	
Total exams completed without intervention.	1,633	
➢ Exams Closed as Lost to Follow Up	19	
➢ Parked Exams	2,432	
➢ Pending follow up or call	1,332	

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Expanding our Role? Value Added

What else can we do?

- Supporting IR Clinic?
- How about developing and/or supporting other clinics?
- Enhancing screening programs?
- Developing new screening programs?

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New, Expanded and Growing Programs Using Digital Health Data to Improve Outcomes and Add Value

Screening Programs
- Lung Screening
- Abdominal Aortic Aneurysms
- Liver & Hepatocellular Carcinoma
- Pancreatic cyst
- High-Risk Breast Screening

Oncology
- New Cancer Dx
- Thyroid
- Prostate
- Adrenal
- Pancreatic
- Urology
- Head & Neck
- Melanoma
- Lung
- Lymphoma
- Etc.

Interventional Radiology
- Kyphoplasty
- DVT treatment
- UFE
- Hepatic ablation (Y90)
- Renal tumor ablation
- Cryoablation/RF
- IVC filter Management
- Prostate Embolization
- Etc.

Neurosurgery
- Pituitary Tumor
- Glial Tumor
- Etc.

Emergency Department
- Addended reports
- Sending Incidental nodules to nodule clinic
- Pairing Patients with PCP

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What will Tracking Follow Ups and Improved Communication Provide?

- Increases exam completion rate
- Identifies exam completions outside your institution
- Ensures Closure
  - Biopsy or surgical excision
  - Limited life expectancy / palliative care
  - Specialist referral / management
  - Clinical resolution
  - Identification of additional studies
- Moves the needle on quality and safety/risk
- Increases revenue
- Decreases liability
- Creates a strategic advantages to your organization

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Using Digital Health Data to Improve Outcomes

"Good quality is less costly because of more accurate diagnoses, fewer treatment errors, lower complication rates, faster recovery, less invasive treatment, and the minimization of the need for treatment. More broadly, better health is less expensive than illness."

- Michael E. Porter

Bishop William Lawrence University Professor at HBS

Redefining Health Care: Creating Value-Based Competition on Results

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Ferrum

Let's end medical errors

AI in Quality and Patient Safety

Pelu Tran
CEO, Ferrum Health
President, Ferrum Health National PSO

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What is artificial intelligence (AI)

What is machine learning (ML)

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AI: When a computer is able to perform tasks that normally a human would perform

ML: When an AI program is trained on sample data to make predictions without explicit direction

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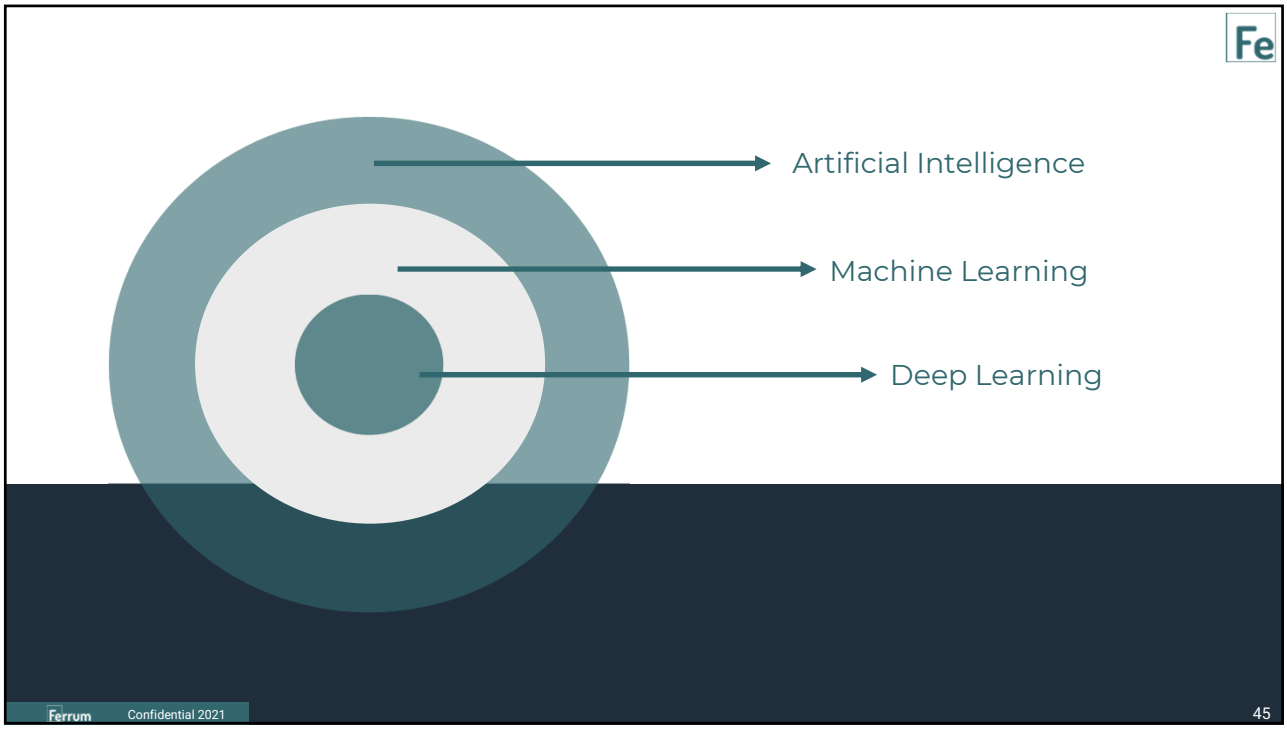
Artificial Intelligence
Machine Learning
Deep Learning
Ferrum
Confidential 2021
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About Me
Stanford Engineering and Medicine
Previously founded Augmedix (NASDAQ : AUGX)
Stanford MEDICINE
WORLD ECONOMIC FORUM
Forbes 30 UNDER30
ASPEN IDEAS FESTIVAL
FC FAST COMPANY
ROCK HEALTH
University of California Berkeley Haas School of Business
JOHNS HOPKINS UNIVERSITY
citi
StartXMed
ENTREPRENEURSHIP AT UCSF CENTER
World Summit on INNOVATION & ENTREPRENEURSHIP
UNITED NATIONS UNCTAD
(Selected awards and speakerships)

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The AI Effect

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THINK
DENKE
$24,000
Who is Stoker?
(I FOR ONE WELCOME OUR NEW COMPUTER OVERLORDS)
$1,000
$77,147
Who is Bram Stoker?
$ 17,973
$21,600
WHO IS BRAM STOKER?
$5600

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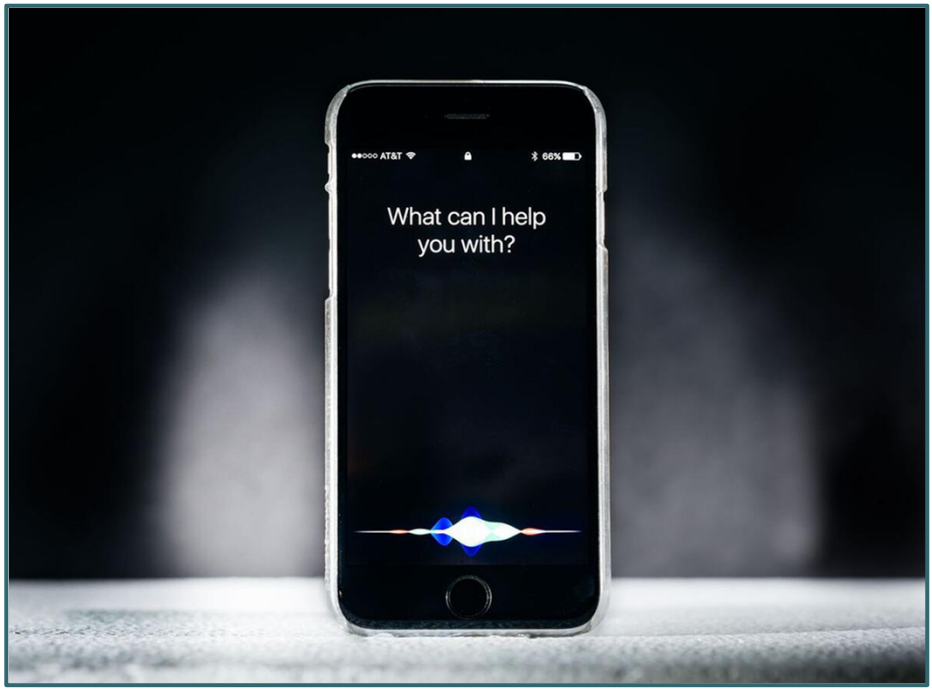
AT&T
66%
What can I help you with?

50

80%

Health care leaders that believe AI will be required to stay competitive

51

+ 1%

Growth in health systems using AI (2019)
(2018: **21%** | 2019: **22%**)

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Who will start using AI first?

Look at …

Financial Services
Cybersecurity
Manufacturing
Self-driving Cars

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Do you own a car with AI?

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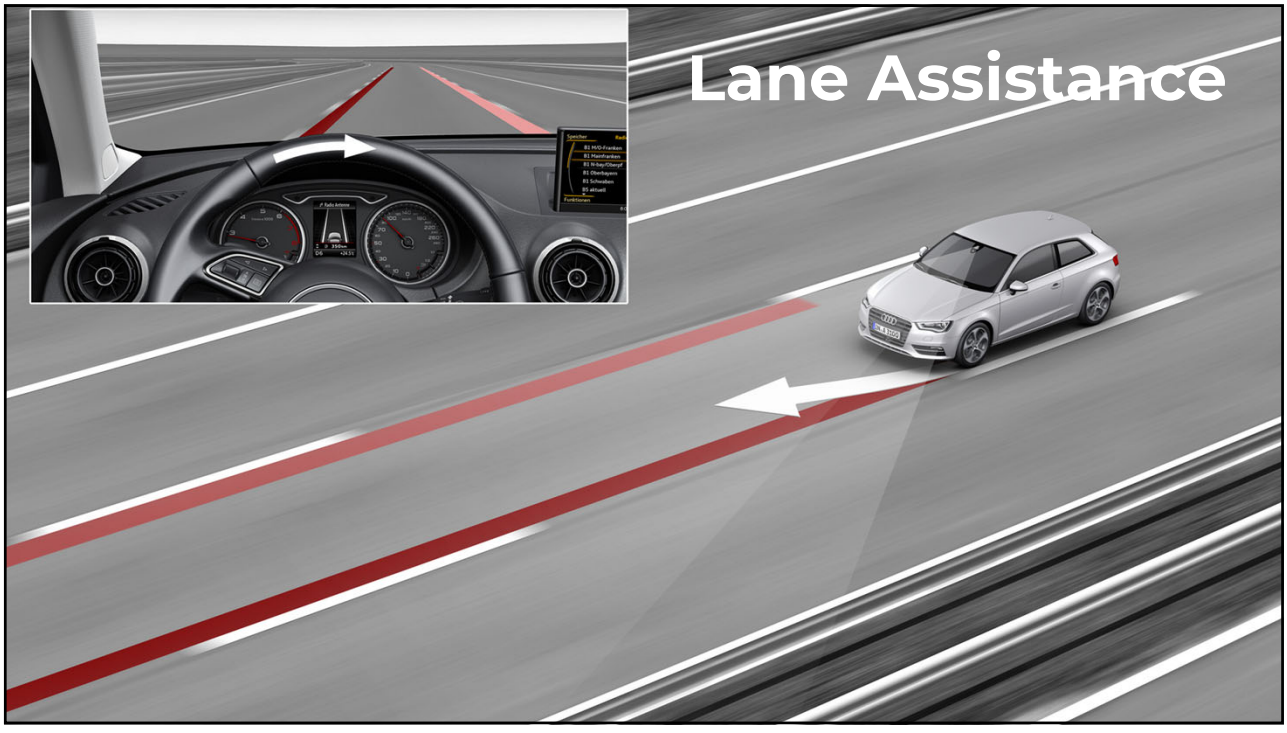

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Automatic Braking
AUTO
SCENIC
RENAULT

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Fully Autonomous Driving
LEFT REARWARD VEHICLE CAMERA
MEDIUM RANGE VEHICLE CAMERA
RIGHT REARWARD VEHICLE CAMERA
MOTION FLOW
LANE LINES
LANE LINES
ROAD FLOW
IN-PATH OBJECTS
ROAD LIGHTS
OBJECTS
ROAD SIGNS

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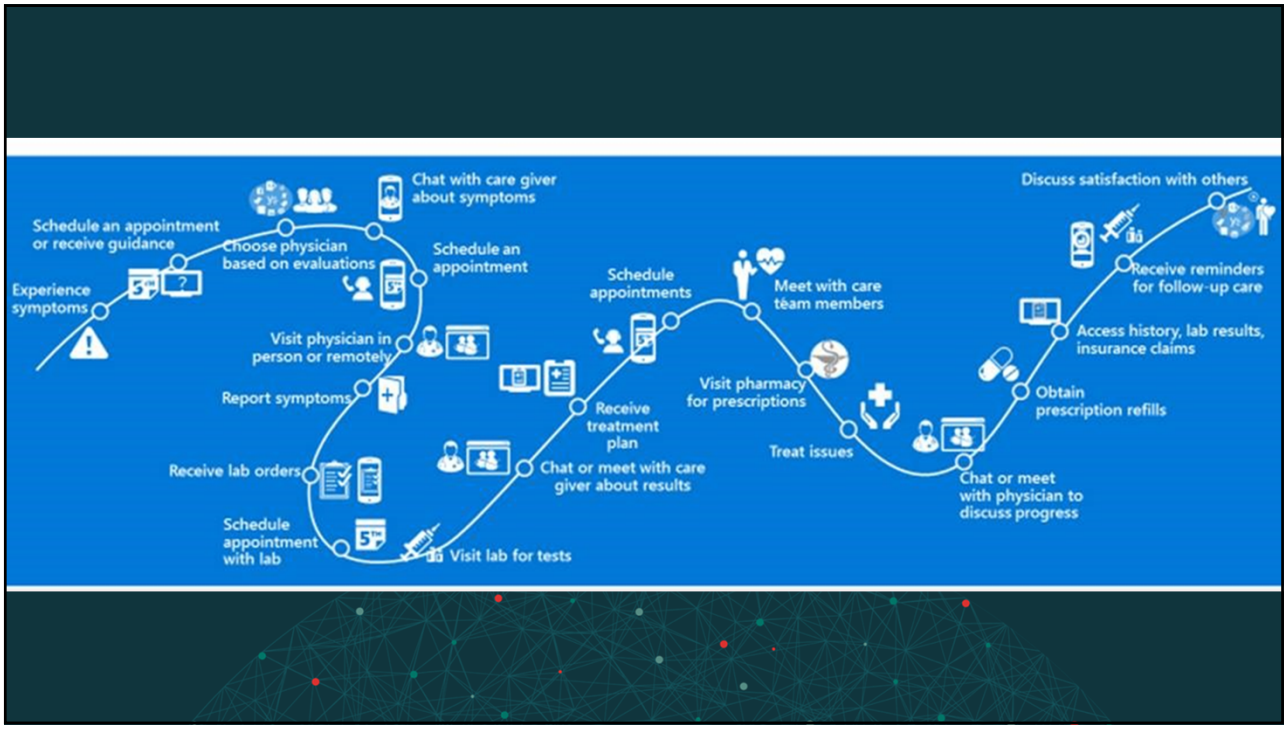
Experience symptoms
Schedule an appointment or receive guidance
Choose physician based on evaluations
Chat with care giver about symptoms
Schedule an appointment
Visit physician in person or remotely
Report symptoms
Receive lab orders
Schedule appointment with lab
Visit lab for tests
Chat or meet with care giver about results
Receive treatment plan
Schedule appointments
Meet with care team members
Visit pharmacy for prescriptions
Treat issues
Chat or meet with physician to discuss progress
Obtain prescription refills
Access history, lab results, insurance claims
Receive reminders for follow-up care
Discuss satisfaction with others

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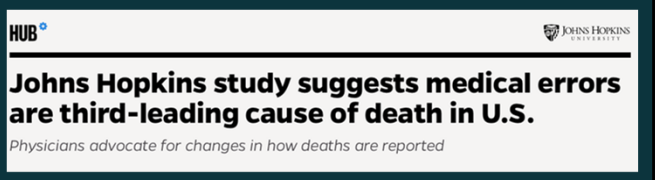
Death from medical care itself



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Some metrics

- 10-15% of all diagnoses are incorrect
- 0.22% of all hospitalized patients and 0.81% of primary care patients suffer serious permanent harm from diagnostic error
- 30% of abnormal studies have errors
- 3.5-4% of all studies have errors

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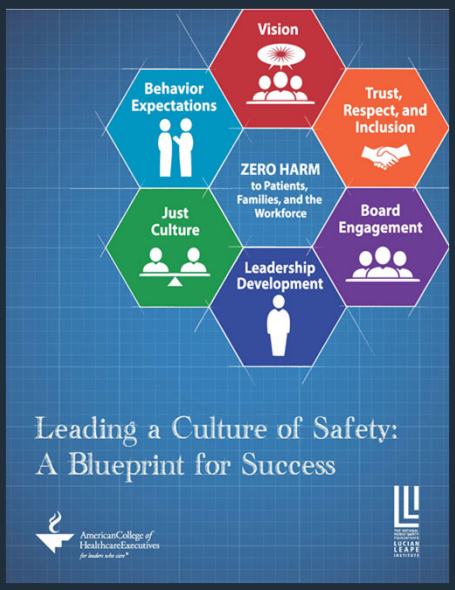
Current state of patient safety - process not tech



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Most errors are omission, not commission

- **Primary care**: Doesn't order clinically indicated imaging
- **Scheduling**: Inadequate outreach, follow-up, or rescheduling
- **Imaging**. Suboptimal scan quality or patient positioning
- **Radiologist**. Missed findings on imaging
- **Referral**. Abnormal radiology report not noticed by primary doctors
- **Follow-up**. Poor tracking of patients who need follow-up tests

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Table 1 Sample of published studies of radiological error

Year	Author	Ref	Material	Key points	Comments
2001	Goddard et al.	[11]	Various	Clinically significant error rate of 2–20%, depending on radiological investigation	
1981	Forrest et al.	[12]	Retrospective review of previous chest x-rays (CXRs) in patients subsequently diagnosed with lung cancer	False-negative rate of 40% **CXR**	Lesions visible but not reported on prior studies
1983	Muhm at al	[13]	Lung cancers detected by plain radiography screening	90% of cancers detected visible in retrospect on prior radiographs going back months or, in some cases, years (53 months in one case)	
1993	Harvey et al.	[14]	Review of prior mammograms in patients in whom impalpable breast cancer subsequently diagnosed by mammography	Evidence of carcinoma identifiable on prior studies in 41% when blindly reinterpreted, and in 75% when reviewers were aware of subsequent findings **Mammography**	
1999	Quekel et al.	[15]	Non-small cell lung cancer diagnosed on plain CXR	19% missed diagnosis rate	16-mm median diameter of missed lesions, median delay in diagnosis of 472 days
1949	In Robinson (1997)	[3]	CXR in patients with suspected TB	Interpreted differently by different observers in 10–20%	
1990, 1994	Markus et al., Brady et al.	[16, 17]	Barium enema	Average observer missed 30% of visible lesions	Supposed gold standard of colonoscopy also subject to error
1999	Robinson	[18]	Emergency dept. plain radiographs	Major disagreement between two observers in 5–9% of cases	Estimated error incidence per observer of 3–6%
1997	Tudor et al.	[19]	Plain radiographs	Mean accuracy: 77% without clinical information, 80% with clinical information. Modest improvements in sensitivity, specificity and inter-observer agreement with clinical information	Five experienced radiologists reported mix of validated normal and abnormal studies 5 months apart. No clinical information on first occasion, relevant clinical information provided on second occasion
2008	Siewert et al.	[20]	Oncologic CT	Discordant interpretations in 31–37%, with resultant change in radiological staging in 19%, and change in patient treatment in up to 23% **CT**	
2007	Briggs et al.	[21]	Neuro CT & MR	13% major & 21% minor discrepancy rates (undercalls, overcalls & misinterpretations)	Specialist neuroradiologist second reading of studies initially interpreted by general radiologists

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Historical Approaches to Quality: Radiology

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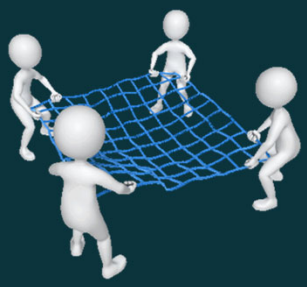
Peer review



- 1-3% of scans
- Expensive labor
- No guarantee of performance
- Reviewers can be biased

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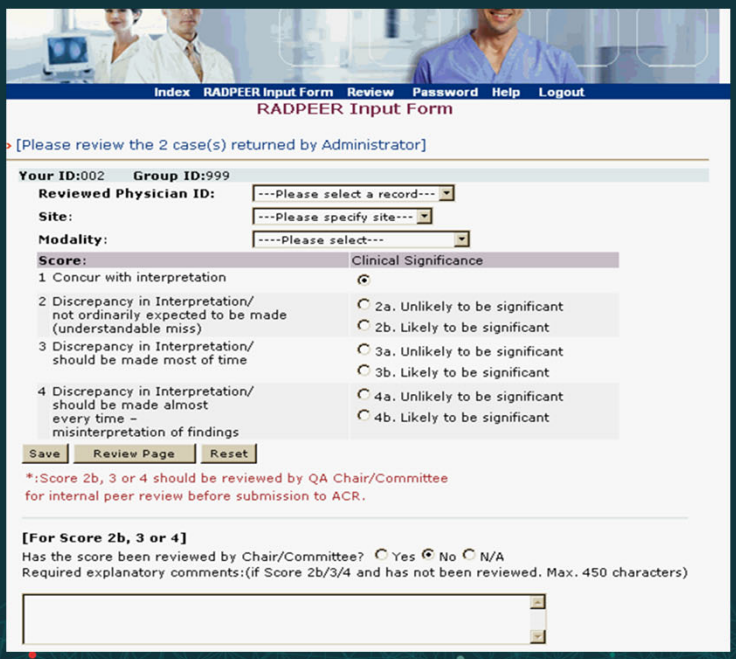

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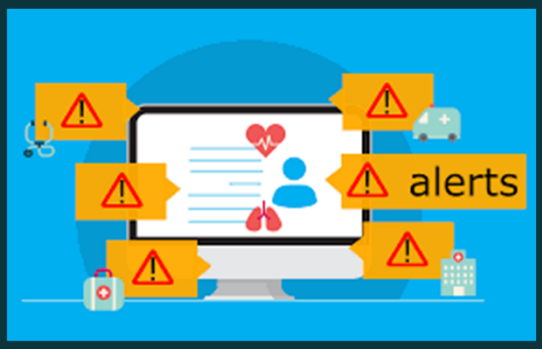
Rules-based alerts



- Only on quantitative data
- Useless if data is inaccurate
- Costly to modify or update
- Creates alert fatigue

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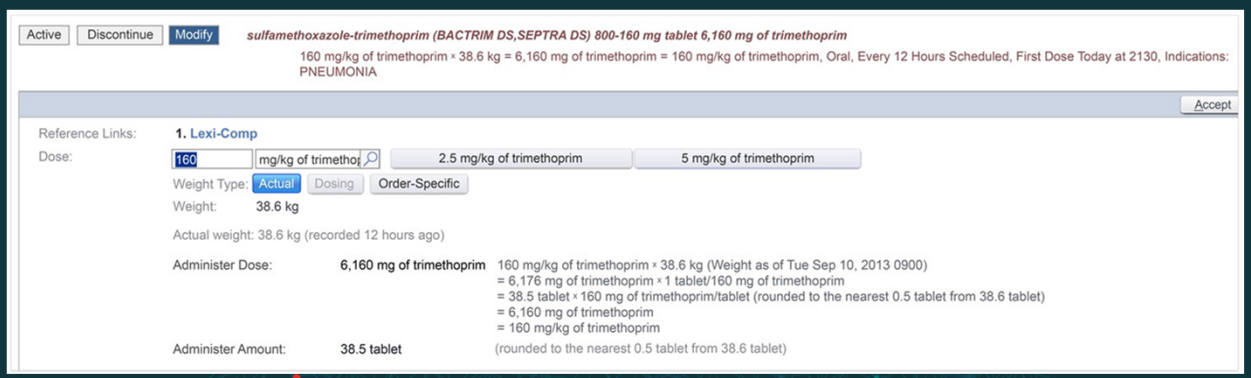

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Care coordination / patient navigation

- Expensive
- Mind-numbing
- Slow
- Not scalable
- The current gold standard

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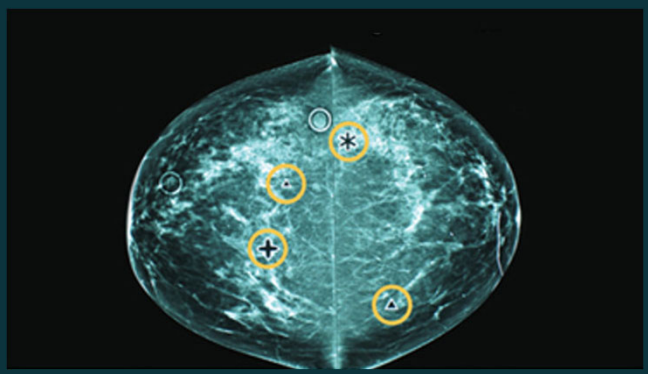
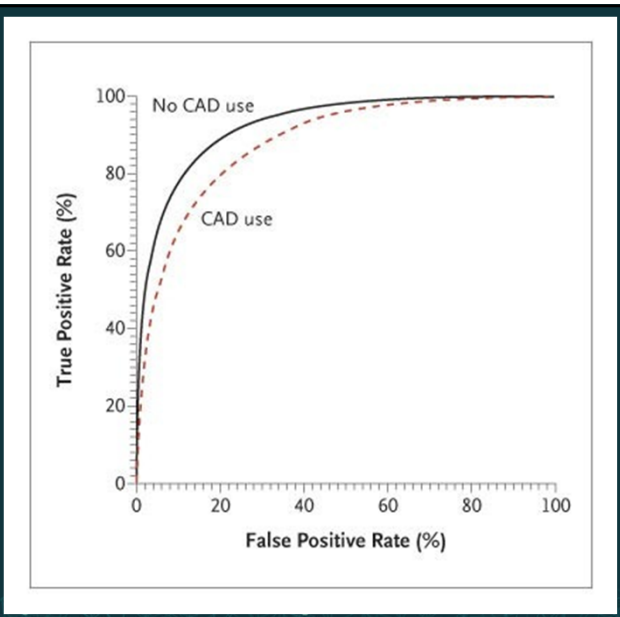
Computer aided detection



- Overlays on workflow
- High false positive rate
- 12% slower reads
- Risk of overreporting

72



NEJM 2007
https://www.nejm.org/doi/full/10.1056/NEJMoa066099

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Where Radiology Quality is Headed

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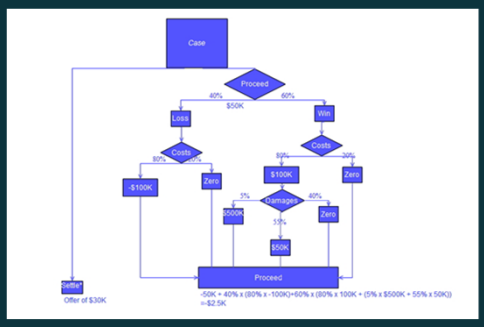
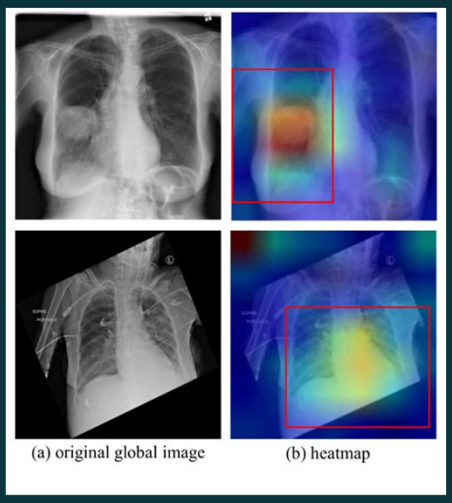
From rigid to learning





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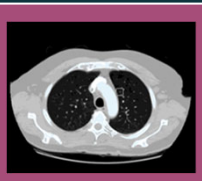
Machine learning building blocks

"6mm perifissural nodule in LUL"

Text
Natural Language



Imaging
Machine Vision

[DATE:2018-01-05]

Structured Data
Feed Forward

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Machine learning building blocks

"6mm perifissural nodule in LUL"

Text
Natural Language

- Left/Right mismatch
- Male/Female mismatch
- Follow-up recommendation
- Stat routing of critical diagnoses

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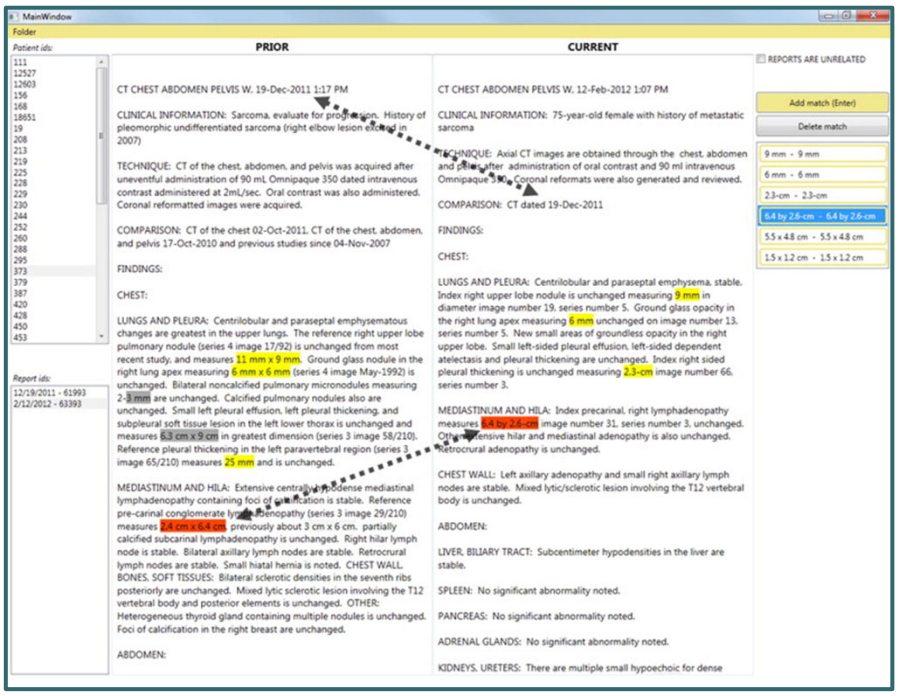

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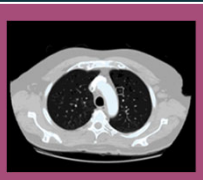
Machine learning building blocks



Imaging
Machine Vision

- Lesion detection
- Triage of urgent findings
- Image positioning / quality
- Dose standardization

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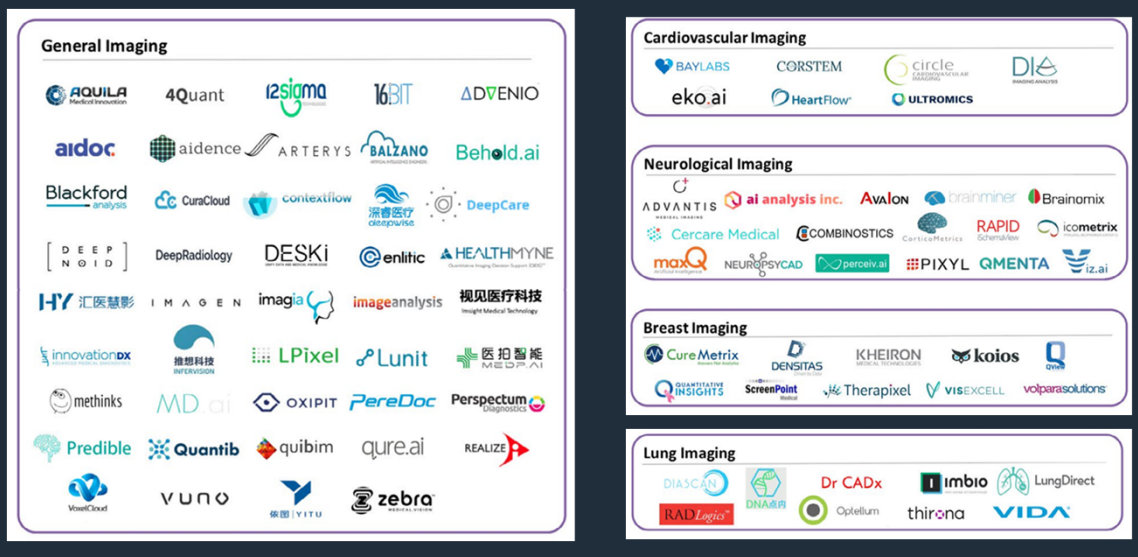
Machine learning landscape



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Machine learning building blocks

[DATE:2018-01-05]

Structured Data
Feed Forward

- Implantable device tracking
- Follow-up scheduling confirmation
- Radiation dose tracking
- Computerized provider order entry systems (CPOE)

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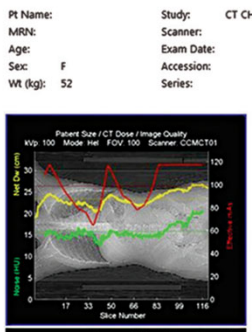
Figure 1

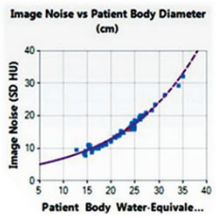


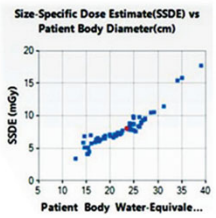
	Mean	Min	Max	Target
Diam (cm):	23.5	20.3	26.8	
kVp:	100			
mA:	164	108	195	
Eff mAs:	99	65	118	
Noise (HU):	15.7	12.5	20.8	16.0

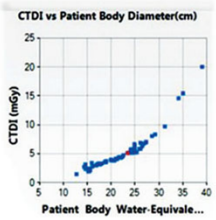
Body 01.2012

Dose Summary:
CTDI vol-32 Mean: 5.2mGy
SSDE Mean: 8.1mGy
Z: 57.5cm
DLP: 296.4mGy-cm

Diagnostics:
Max mAs%: 28%
Resid Noise: 0.3







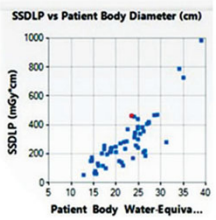


Figure 1: Screen capture from the study analysis page that displays section-by-section effective mAs, patient size, and image quality data mapped to the topogram image, and summary data listed in the text and graphed relative to the target noise curve and relative to the noise and dose of similar examinations. SSDLP has not been approved by the American Association of Physicists in Medicine and is used for internal purposes only. *CTDI* = CT dose index, *SD* = standard deviation, *SSDLP* = size-specific dose length product.

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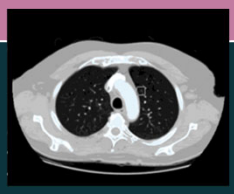
Automating error detection for commonly missed findings

1
AI on **imaging**
to detect commonly missed findings



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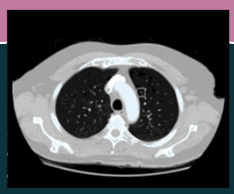
Automating error detection for commonly missed findings

1
AI on **imaging**
to detect commonly missed findings



→

2
AI on **report**
to determine if finding was included

"No lung nodules appreciated."

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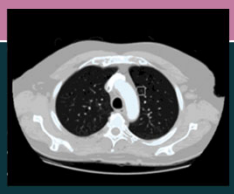
Automating error detection for commonly missed findings

1
AI on **imaging**
to detect commonly missed findings



→

2
AI on **report**
to determine if finding was included

"No lung nodules appreciated."

→

3
Likely misses flagged for second review by a radiologist

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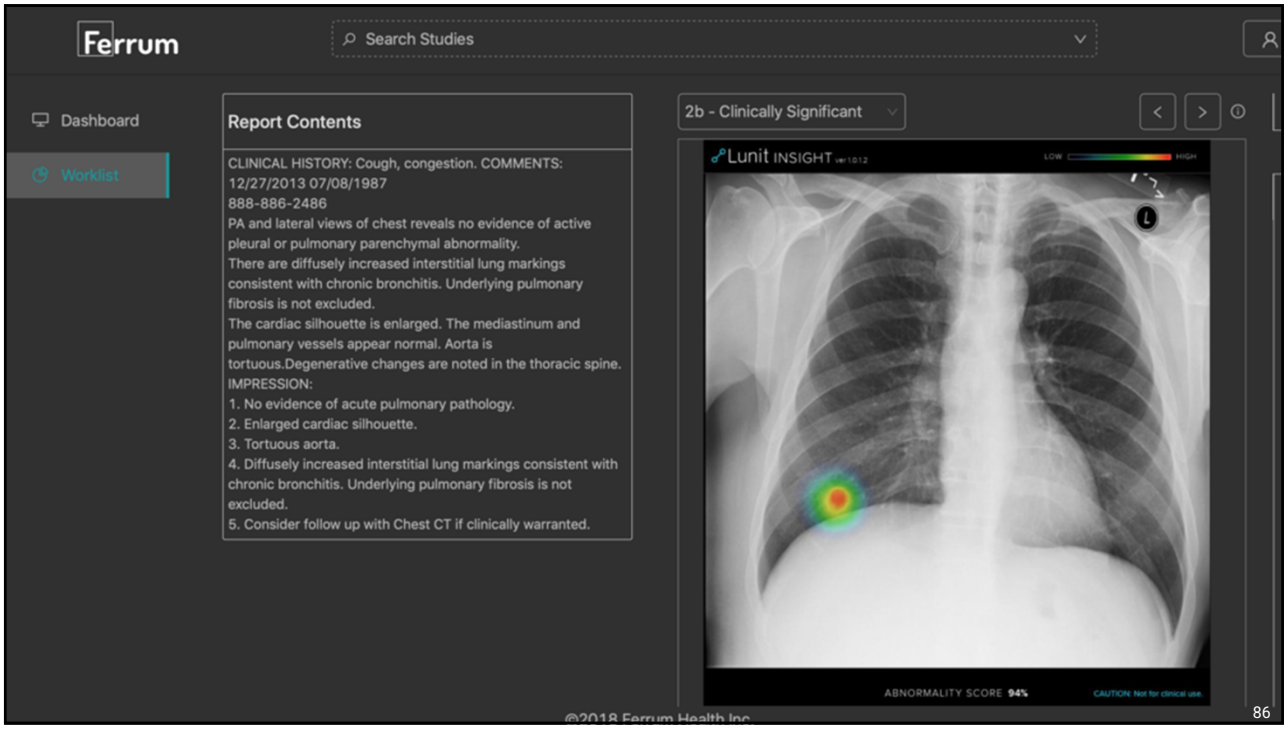

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Results of an NLP / MV CT Lung Nodule Monitoring System

No Action Needed 98% of the time

(RadPeer 2b/3b: O.3% of the time)

Total Studies
3,231 CT Scans
(chest, abdominal, cardiac, head + neck)

→

Flagged Studies
45 Flags
2 hours to review
(1.5% of studies)

→

True Misses
2 RadPeer 3b
10 RadPeer 2b
(27% of flags)

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Capabilities needed in the enterprise AI lifecycle

Updates and Replacement
Version Control
A/B Testing
Best in Breed Assessment

System Integration
Hybrid vs Cloud
PHI Exposure
Vendor Management

Monitoring and Intelligence
Model Drift
Clinical and Business impact
Technical Metrics / Uptime

Local Validation
Demographic Bias
Technical Bias
Clinical and Business Impact

Training and Deployment
Workflow variance
Interface integrations
User preferences

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CAD vs. Quality workflows

Point of Care / CAD

Results of machine vision classifier pushed back to radiologist at point of initial interpretation; assists in initial dictation

- ✓ Acute findings
- ✓ Urgent action required

Not as helpful if:

- × High prevalence rate -and- already well documented

Quality (Ferrum Proprietary safety net)

Radiologist completes report. Study and report are then reviewed by classifiers and only highlighted if a potential discrepancy exists

- ✓ Well documented
- ✓ Longer follow-up tolerance

Not as helpful if:

- × Quick action required

Ferrum supports both workflows and will help recommend the best option for each application use case

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Ferrum Health National PSO

Establishment

- Listed in Jan 2020
- Component PSO with Ferrum health as parent organisation

Mission

The Ferrum Health National PSO aims to be the leading advocate for the use of technology by health care systems to close clinical care gaps and advance patient safety.

Vision

To create an ecosystem to educate and train healthcare systems in the application of technology in quality and patient safety.

Partnered with SR PSO
No additional paperwork required

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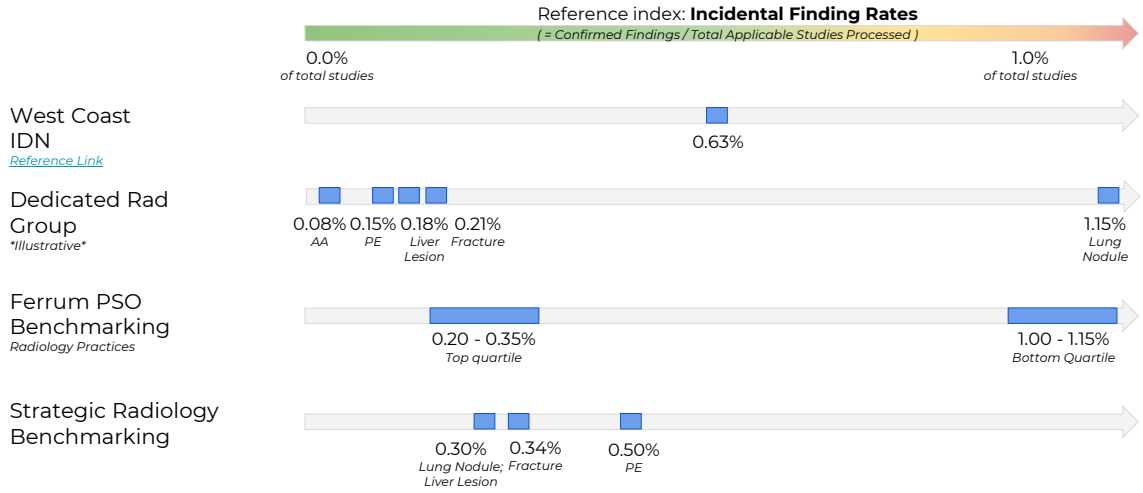
Insights into performance relative to peers



Ferrum continues to partner with additional practices to expand this reference index

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Ferrum's Growing Library of AI Algorithms

For algorithms available now **(bolded)**, we can assess its performance and share those results with you before rolling it out for your team to start using. If coming soon (all else), we can prioritize it in our roadmap to make available if you're interested in deploying it.

Oncology

- **CT Lung Nodule**
- **CXR Lung Nodule**
- **CT Liver Lesion**
- **CT Renal / Kidney Lesion**
- Bone Metastasis
- CT Pancreatic Lesion
- CT Fatty Liver Lesion

MSK / Ortho

- **XR Fracture** *(CE marked)*
- **XR Knee Osteoarthritis** *(CE marked)*
- MRI Lumbar Spine *(CE marked)*
- XR Hip Positioning *(CE marked)*
- XR Pediatric Bone Age *(CE marked)*
- XR Leg Measurement *(CE marked)*

Women's Health

- Breast Density *(CE marked)*
- Breast Risk Assessment *(CE marked)*
- **3D Mammo Breast Lesion** *(CE marked)*
- **CT Breast Lesion** *(CE marked)*
- **US Breast Lesion** *(CE marked)*
- **ABUS Breast Lesion** *(CE marked)*
- MRI Breast Lesion *(CE marked)*
- US Ovarian Lesion *(CE marked)*

Men's Health

- MRI Prostate Mass *(CE marked)*

Cardiovascular

- **CT Pulmonary Embolism**
- **CT Aortic Aneurysm**
- **CT Aortic Dissection**
- **CT Coronary Artery Calcium (CAC) Scoring** *(CE marked)*
- **CT Right Ventricular Dilation (RV/LV Ratio)**
- **CXR Pneumothorax**
- Thoracic Aneurysm
- Epidural Lesion
- SMA Occlusion
- Free Pleural Air
- Free Pleural Liquid

Neuro

- **MRI Brain Volumetry** (CE marked)
- **MRI Brain White Matter Lesion** (CE marked)
- **MRI Brain Tumour** (CE marked)
- **MRI Brain Aneurysm** (CE marked)
- **CT Intracerebral Hemorrhage** (ICH)
- MRI Multiple Sclerosis - Progression Tracking (CE marked)

Administrative

- **Patient Registry for Follow-Up**
- **Discharge Planning**
- Scheduling Workflow
- Scheduling Scanner / Machine
- Follow-up Tool

Bold indicates algorithms available now

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Discussion

What are the priorities in your particular sector of health care where AI could be used?

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Questions

Hospital Quality Institute

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Thank you

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Hospital Quality Institute

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