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Algorithmic Performance Consistency Across Patient Demographics and Scanner Manufacturers

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Algorithmic Performance Consistency Across Patient Demographics and Scanner Manufacturers

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Disclosures

- Shirin Salehi: none

- Marlene Scudeler, Sarah Quenet, Angela Ayobi and Yasmina Chaibi are employees at Avicenna.AI

- Saba Chowdhry is an employee at Viz.AI

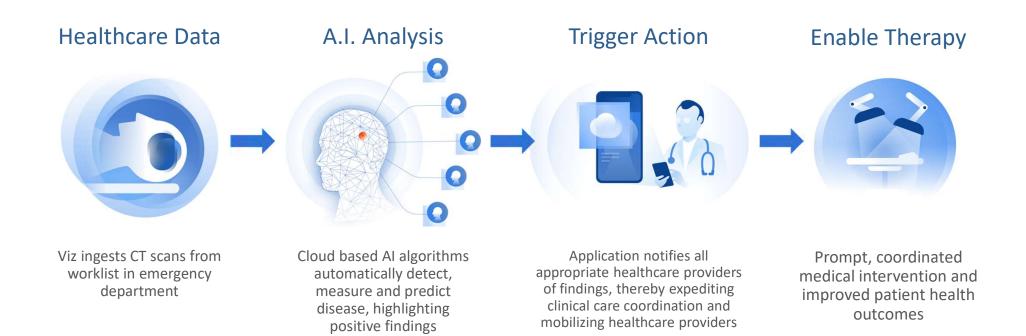- Peter Chang is a co-founder and CMO of Avicenna.AI

Clinical significance

- Aortic dissection is associated with high rates of morbidity and mortality → early diagnosis and prompt intervention greatly improve patient outcomes
  - Mortality rate of 1-2% per hour during first 48 hours
- Provide real-world validation of FDA 510(k)-approved software application in expediting detection, triage, and ultimately treatment of patients with suspected aortic dissection
  - Viz Aortic Dissection algorithm, in collaboration with Avicenna.AI (La Ciotat, France)
- Growing concern that algorithmic biases may perpetuate existing health inequities
- Objective: to assess the real-world performance of deep learning algorithm for detection of aortic dissection on computed tomography angiography (CTA) with a focus on evaluating differences in performance across age, sex, geography, and manufacturer
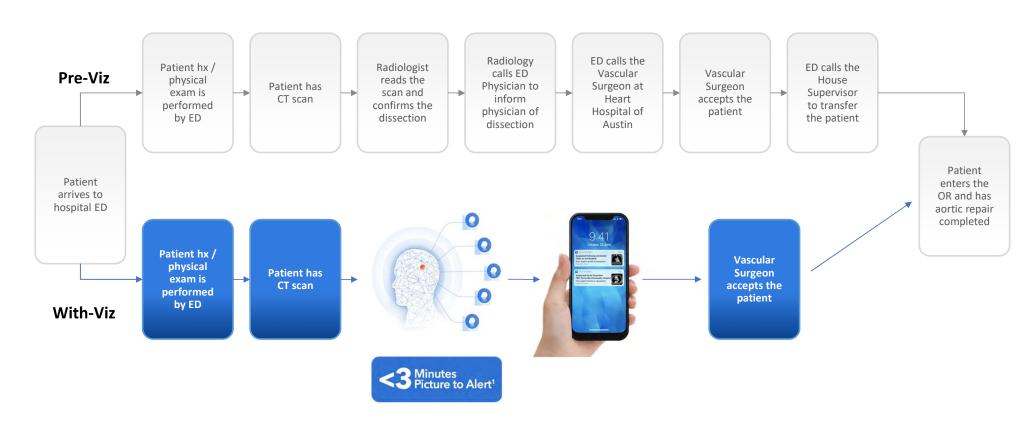
Workflow incorporating AI-based detection algorithm

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Healthcare Data

Viz ingests CT scans from worklist in emergency department

A.I. Analysis

Cloud based AI algorithms automatically detect, measure and predict disease, highlighting positive findings

Trigger Action

Application notifies all appropriate healthcare providers of findings, thereby expediting clinical care coordination and mobilizing healthcare providers

Enable Therapy

Prompt, coordinated medical intervention and improved patient health outcomes

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AI-based detection algorithm can expedite patient care

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[1] Nogueira RG, et al. ALADIN Trial. ISC 2019.

Sample images of in-app AI-based findings

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Study methods

- 1,303 chest and thoracoabdominal CTA exams from 200+ U.S. hospitals
- Ground-truth classification for presence or absence of aortic dissection determined through consensus evaluation by three board-certified radiologists
- Exams analyzed using FDA 510(k)-approved Viz Aortic Dissection algorithm
  - Deep learning model trained on a representative, diverse cohort across age, sex, disease prevalence, race, and clinical settings
- Algorithmic performance stratified by
  - Age (18-40, 40-60, 60+)
  - Sex (male, female)
  - Geographic region (Continental, Northeast, Pacific, Southeast)
  - Manufacturer (GE Medical Systems, Philips, Siemens, Toshiba)
- Measured algorithmic fairness across subgroups using equalized odds (EO) differences across true positive rates (TPR) and false positive rates (FPR)
  - Also report overall accuracy, sensitivity, specificity, PPV, and NPV

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Study results

- 1,166 (89.5%) dissection-negative exams, 137 (10.5%) dissection-positive exams

- Overall accuracy: 97%

- Sensitivity: 94.2%
  - [95% CI: 88.8% - 97.5%]

- Specificity: 97.3%
  - [95% CI: 96.2% - 98.1%]

- PPV of 80.1%, NPV of 99.3%
  - 8 false negatives, largely complex cases
  - 32 false positives, largely result of imaging quality

- Overall mean EO differences across subgroups was 0.031, with individual EO values noted to be small and consistent for:
  - age [18-40: 0.0584, 40-60: 0.0294, 60+: 0.0368]
  - sex [M: 0.0227, F: 0.0359]
  - geographic region [Continental: 0.0584, NE: 0.0487, Pacific: 0.0227, SE: 0.0314]
  - manufacturer [GE: 0.0111, Philips: 0.013, Siemens: 0.0047, Toshiba: 0.0274]

- In general, small decreases in TPR or FPR often balanced by small increases in the complimentary metric for most subgroups.

Table 1

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Group	Subgroup	Acc[1]	Sen[2]	Spe[3]	EO-max[4]	EO-TPR[5]	EO-FPR[6]
Age	18 ≤ age < 40	0.98	1.00	0.98	0.0584	0.0584	0.0049
	40 ≤ age ≤ 60	0.98	0.97	0.98	0.0294	0.0294	0.0093
	age > 60	0.96	0.90	0.97	0.0368	-0.0368	-0.0075
Sex	Male	0.97	0.96	0.97	0.0227	0.0227	-0.0031
	Female	0.97	0.91	0.98	0.0359	-0.0359	0.0024
U.S. geographic region	Continental	0.98	1.00	0.97	0.0584	0.0584	0.0014
	Northeast	0.96	0.89	0.97	0.0487	-0.0487	-0.0019
	Pacific	0.97	0.96	0.97	0.0227	0.0227	0.0024
	Southeast	0.97	0.97	0.97	0.0314	0.0314	0.0018
Scanner manufacturer	GE Medical Systems	0.96	0.95	0.96	0.0111	0.0065	-0.0111
	Philips	0.97	0.93	0.97	0.013	-0.013	-0.0042
	Siemens	0.97	0.94	0.98	0.0047	-0.0022	0.0047
	Toshiba	0.99	0.92	1.00	0.0274	-0.0185	0.0274

- [1] Accuracy, [2] Sensitivity, [3] Specificity, [4] Equalized Odds Difference (Max), [5] Equalized Odds Difference (TPR), [6] Equalized Odds Difference (FPR)

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Clinical takeaways

- Real-world validation of a deep learning AI-based detection algorithm for suspected aortic dissection
  - Sensitivity: 94.2%
  - Specificity: 97.3%
- Allows for rapid patient triage → earlier diagnoses → accelerated care coordination → timely initiation of life-saving interventions → better patient outcomes
- Generalizability across demographics and clinical parameters is critical in preventing algorithmic biases and promoting equitable health outcomes
- Deep learning tool for aortic dissection detection yields no significant biases across patient demographics and scanner manufacturers from 200+ U.S. hospitals

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Citations

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