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AI in Research
Lessons Learned and Future Directions

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AI Research to date…

- Reproduces the abilities of human observers in medical imaging, and enhances their performance. Similar to CAD as used in mammography.
- Requires the collection of very large numbers of validated cases with known ground truth. Truth can be established through pathology or through expert panels. Similar to how we validate new technologies in clinical trials.

AI to Detect Diabetic Retinopathy

- A study published by the Google AI Research Group in *Ophthalmology* (April 2019) demonstrated that physicians working with AI algorithms increased their accuracy in diagnosing diabetic retinopathy compared to either AI or physician interpretations alone.
- The study expanded on research that previously showed that the Google AI algorithm was as good as human screening in diabetic eye disease.

AI to Detect Diabetic Retinopathy

This technology could expand access to screening for this disease.

Perhaps primary care doctors could do this in their offices?

Perhaps resource-limited places could improve screening for this condition?

AI to Detect Intracranial Hemorrhage (ICH)

- Aidoc, an Israeli company, received FDA approval in 2018 for an AI-based workflow that flags acute ICH cases in head CTs.
- The company promotes the product as a deep learning tool that assists radiologists with workflow triage.
- The tool analyzes medical images right after the patient is scanned, and then alerts the radiologist to suspected findings to assist with prioritization of time-sensitive, potentially life-threatening cases of ICH.

AI to Detect Incracranial Hemorrhage

- This might allow quicker treatment.
- Potentially valuable in environments where radiologists are not routinely available to interpret the studies before treatment is rendered.
- Is there really a market for this sort of tool?

AI for improved lung cancer screening

- Google used the NLST lung cancer screening dataset (6716 cases) and 1139 additional cases to test a deep learning algorithm to predict lung cancer risk (published in Nature Medicine, 2019)
- When prior exams were available for comparison, the algorithm performed similarly to radiologist readers
- Without prior exams, the algorithm outperformed 6 human readers, with 11% reduction in false positives and 5% reduction in false negatives.

AI to Detect Lung Cancer

- Perhaps using machine learning might allow lung cancer screening technology in under-resourced environments?
- Is there a market for this?
- Will it cause more false positives when disseminated in the real world?

AI of the Future… "Predictive" AI

A new way to do research (and develop products) in AI. Use the 0s and 1s in the raw image data to extract information not available to human vision.

Combine that with clinical information in the EHR.

Create a model that predicts probability of disease given the data unique to each patient.

Adapt imaging to allow humans to "see" the findings, when appropriate.

For example, predicting subarachnoid hemorrhage in patients with “sentinal” headache

- 15-60% of patients who present with subarachnoid hemorrhage have a sudden severe headache weeks before CT-visible subarachnoid blood - a “sentinal” headache, believed due to small amount of blood leaking into the subarachnoid space.
- If small leaks are in fact present, these CT-negative sentinal headaches are “false negative” CT scans.
- Maybe AI could identify which patients with really bad headache should undergo more careful CT evaluation and potentially curative treatment before catastrophic bleeding occurs (“screening” for SAH risk in patients presenting with bad headaches). (50% mortality rate for SAH.)

How New “Imaging” findings could be discovered through AI

- Collect CT scans of patients who had really bad headaches who were imaged for “R/O SAH” but that were read as negative.
- Some will have later SAH (say within 6 weeks to 6 months). Some will have no subsequent SAH.
- Collect additional pertinent clinical data on all these patients – age, gender, race, blood pressure, family history, labs, other symptoms, genetic information, etc.
- Create an AI model that distinguishes those without subsequent SAH from those without subsequent SAH.

How New “Imaging” findings could be discovered through AI

- Apply the AI algorithm to patients with bad headache prospectively to see how it works.
- For those the model calls ”at risk”, do more intensive imaging of their neurovascular systems at the time of their really bad headaches to assess for aneurysms, AVMs and other vascular anomalies that might predispose to imaging.

Final thoughts….

All new tools perform ideally in their first testing by the companies commercializing them. Real world implementation and ongoing testing is essential to know whether a tool actually adds value for patients

AI tools are only as helpful to patients as the datasets that are used to produce them allow them to be….

Algorithms that “learn” may not improve over time.

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Please email with questions and comments.