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SUBJECT: Use of AI Imaging for Radiology Department Cancer Screening
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You asked me to investigate how Artificial Intelligence can be used for Cancer detection in your Radiology Department at Massachusetts General Hospital in Boston, MA. To provide a well-rounded analysis of the subject, I decided to touch on four main concepts in AI for Cancer detection:

1. A description of the AI algorithms used
2. Current capabilities of the field
3. Limitations / weaknesses of the technology
4. Future prospects and applications

How artificial intelligence can see things we can't

Artificial Intelligence is an umbrella term used to describe any technique where a computer tries to replicate human behavior. It splinters into many different subfields and techniques such as Machine Learning, which attempts to find patterns in data and doesn't always need explicit instructions; and Deep learning, a subfield of that which typically uses Neural Networks to create these patterns (Giraud et al). I will use these terms interchangeably to explain different strategies used by researchers.

The Neural Net:
A Neural Network is a deep technique that looks at a set "training" images and is able to recognize similar items in the future (Huang et al). For example—our Neural Net would look at 50 healthy brain scans and 50 unhealthy scans, then be able to decide if a new scan is healthy or not.

Neural Nets are frequently used in image detection and are the most common algorithm used in modern cancer screening. Kumar et al give an in-depth description of how these algorithms are constructed specifically for cancer screening, and the variation of these techniques. Essentially, by looking at the medical information from patients with cancer, AI algorithms learn to when cancer is present, or when it is likely to develop.

Modern Applications of AI for Cancer Research

Already machine learning has been applied to various aspects of Oncology (cancer study), including cancer risk stratification, diagnosis, and tumor characterization. Researchers have begun applying a science called Radiomics, which uses hospitals pathology profiles and imaging data to create models that aid in cancer prediction (Bera et al).

While AI applications are still very new for Oncology, we are already seeing some promising results from algorithms made to detect whether patients will develop the following forms of cancer:

- **Breast Cancer** – Researchers using the google Deepmind algorithm were able to outperform the best breast cancer specialists (McKinney et al).
- **Prostate Cancer** – University of Pittsburgh researchers have been able to predict prostate cancer with both a 98% accuracy (McKinney et al).

- **Colorectal Cancer** – Danee et al achieved a 96% detection rate of colon cancer
- **Skin Cancer** – Unimpressive algorithm performance of about 50-80% detection, compared to 90% from medical professionals
- **Lung Cancer** – Bebas et al achieved 97% prediction accuracy, while Kaiwen et al were able to predict death likelihood in patients with lung cancer; but no whether someone would develop it .

AI can also be used to differentiate between multiple types of cancer, and modern researchers have made impressive progress in this field as well:

- One study was incredibly successful at differentiating between the following 5 types of cancer: prostate and colon adenocarcinoma, breast invasive carcinoma, kidney renal clear cell carcinoma, and lung adenocarcinoma (Gupta et al)
- Another used a method called "DNA methylation analysis" paired with machine learning to correctly "reclassify more than 70% of human-labeled cancers" and provide more accurate and helpful diagnoses (Dlamini et al)
- A third by Capper et al was able to differentiate between 82 different kinds of brain tumors with 93% accuracy—an accuracy far higher than medical professionals.

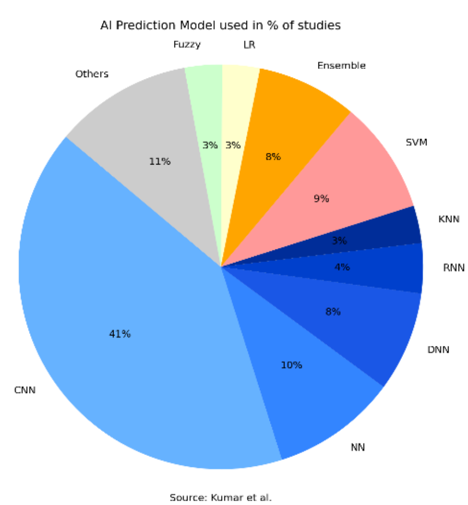
Struggles of Modern Cancer AI

While AI applications for Cancer care are becoming very promising, there are three main struggles that the field faces for widespread application:

1. Algorithm choice/Model creation
2. Data concerns
3. Implementation

1. Algorithm Choice:

Choosing the right algorithm is one of the most difficult parts of accurately detecting different forms of cancer. This is particularly challenging because almost every different variant of Cancer requires a different prediction strategy. Often variable forms of Neural Networks predict with the most accuracy, however, changing one test condition could favor other techniques such as random forest models and vector machines. This illustrates a fundamental problem within machine learning for cancer detection: <u>there is no universal algorithm to predict cancer</u>.



Instead every study and AI application must be specifically catered for the particular cancer variant it's made to address. This problem is illustrated by the figure to the right—which shows what % of studies use each different form of algorithm for cancer detection.

2. *Data Concerns:*
AI systems require access to vast amounts of high-quality data to be effective. However, data privacy concerns and breaches have made data collection controversial, especially in healthcare where patient confidentiality is paramount (Zhang et al). This also prevents AI models created by one organization to transfer information to another and work together to improve (Basu et al.).

The exponential growth of patient data has also made it challenging to manage and analyze within reasonable timeframes. Medical imaging systems are often isolated, limiting their use in machine learning applications. (Rowe)

Data concerns hinder the effectiveness of AI in cancer detection since the performance is only as good as the training data. The current healthcare data laws seriously constrain the rate at which Medical AI grows, but will not prevent their creation.

3. *Implementation:*
B implementing AI in cancer treatment we are giving them the power to save or end lives, and these algorithms must be tested rigorously if they are ever going to have the power to influence medical decisions. There is a serious concern about trusting peoples' medical care to a machine that is too complicated to be explained to the average person. Therefore, convincing people to trust AI is a serious hurdle for it to be realistically by any hospital.

None of the algorithms discussed have been used in the real world to make decisions, and hospitals are rightly skeptical to be trailblazers and incorporate new technology ahead of their peers. There is a massive amount of liability involved, and at the moment the legal process isn't even clear. The FDA currently has an over complicated process for approving AI for hospital work, and they have yet to approve any AI based screening or predictive tools. (Bera et al.)

We face serious challenges in making useful cancer detection algorithms; however they have not prevented us from being successful. So, it seems that the biggest challenge is convincing people to use life-saving cancer AI.

Future Applications

Within the near future AI will be applied in countless new ways in healthcare. As machine learning algorithms become more accurate, hospitals will eventually start implementing AI cancer imaging allowing them to catch cancer cases far sooner and provide better treatment for patients. A few fields are experiencing rapid changes at the moment and have impressive future prospects:

Pancreatic Cancer Prediction
Pancreatic Ductal Adenocarcinoma (PDAC) is the 4th leading cause of cancer death in the US and is predicted to become the 2nd by 2030. Its survival rate is below 10%, and medical professionals can't detect it in the early stages. However, a team of researchers from Kaiser Permanente showed reasonable success in predicting early stage PDAC (Chen et al.) Researchers at CSMC LA reported an accuracy of 86%, a staggeringly high rate for PDAC prediction (Qureshi et al).

Targeted therapy

Current algorithms can identify cancer subtypes and predict responses to targeted therapy in breast and liver cancer. Researchers have been able to predict with reasonable certainty how cancers will react to different drugs, and it will be even easier to specialize care for people with different diagnoses (Bera et al).

Will AI replace Radiologists?

Some experts believe that AI will be able to completely replace Radiologists in the near future. However, this optimism has tempered, and experts are now collaborating with radiologists to develop AI algorithms; instead the popular assumption is that AI in radiology will likely change how radiologists practice but not replace them entirely. Instead, radiologists who incorporate AI into their work will likely replace those who don't, and AI has the potential to democratize access to radiology expertise, particularly in underserved areas (Curtis).

Conclusion

The fusion of Artificial Intelligence and cancer detection stands at an exciting crossroad, promising the potential to dramatically reshape the landscape of oncology and diagnostics at Massachusetts General Hospital. Your hospital has one of the largest and most advanced Radiology departments in the country, so you will be at the forefront when AI cancer detection algorithms finally come into hospitals.

Despite the challenges of algorithm selection and data availability, the current capabilities of these algorithms are impressive—evident from their success in detecting various types of cancers with remarkable accuracy. The true problem is convincing people to accept these algorithms and legalize their use.

Their future prospects are optimistic, specifically in the fields of PDAC cancer screening and targeted therapy predictions. And despite the buzz around AI replacing radiologists, the reality suggests a future where radiologists and AI work hand-in-hand, complementing each other's strengths.

AI's potential in the field of cancer screening is undeniable, and you will hopefully have the chance to apply this revolutionary technology in the coming years. By embracing such algorithms as tools for knowledgeable medical professionals, hospitals will be able to save countless lives and take another step toward eliminating cancer.

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AI Attestation

Usage	**Tool**	**How I edited/used the output**	**Most/Least useful info**
Research	ChatGPT-4	Used it to target statistics within long articles	Highlighted the key numbers and where they were found
Outlining	ChatGPT-4	Told it exactly what I wanted to talk about in list form and asked for a better order	Gave me great order
Polishing	ChatGPT-4	Gave it my sentences that had good info but sounded odd and asked for new phrasing	Sometimes just said exactly the same thing as me