Understanding the Potential of AI in Clinical Testing: Opportunities and Considerations

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Introduction

An overview of the current progress, challenges, and opportunities that AI in healthcare presents. Progress: Machine learning (ML) models can detect, diagnose, and analyze images with increasing accuracy. The push for FDA approval and increased number of clinical trials demonstrates receptiveness to AI systems and a shift from testing to deployment. Opportunities: The development of ML systems that can train on unlabeled data and/or analyze non-image data sources (e.g., signals and audio) reflects increased opportunities for AI collaboration and autonomy.

Challenges: Addressing concerns related to privacy, data security, and ensuring medical professionals' trust in AI-enabled solutions is paramount to successful deployment and integration of AI technologies into existing healthcare systems.

Opportunities:
- Increased accuracy in diagnosis and analysis
- Improved patient outcomes
- Enhanced resource allocation
- Increased efficiency in workflow

Challenges:
- Data privacy and security
- Trust in AI models
- Bias in AI systems
- Regulatory hurdles

An overview of the various ethical challenges and concerns that prevent AI models from being implemented, along with a proposed solution to combat each challenge. A comprehensive understanding of the ethical considerations and challenges for AI in medicine is essential for developing responsible and trustworthy AI systems.

Collaboration Between AI and Humans

Role of Molecular Geneticists at CHLA (for brain tumor cases):
- Goal: make a molecular diagnosis
- Review test results (from somatic next-generation sequencing panel, DNA methylation profile, RNA-seq, etc.)
- Look for DNA sequencing variants, RNA fusions, gene amplifications, etc.
- Discuss results with neuropathologists & neuro-oncologists before making diagnosis
- Write and sign out reports

Role of DKFZ Heidelberg Random Forest Classifier for CNS Tumors at CHLA:
- Goal: accurately classify and distinguish different types of Central Nervous System (CNS) tumors
- Uses the random forest algorithm to classify and distinguish CNS tumors based on the distinct features and characteristics of the tumor
- Aids Molecular Geneticists in diagnosing the patient

Conventional Workflow vs New Opportunities:
- Making diagnoses and interpreting brain tumor cases is a nuanced, time-consuming process. ML models have the potential to aid molecular geneticists in diagnosing patients more accurately and efficiently.
- The current workflow reflects low levels of collaboration: a classifier is fed data and gives the human an output for them to interpret. The molecular geneticist then interprets the classifier's results, writes a report, and signs out the case.
- When using current algorithms, such as the DKFZ classifier, humans are retrospectively analyzing results rather than producing real-time, actionable insights that encourage collaboration.
- ML models are capable of handling growing data sets and operating off of fully/unlabeled data sets, a skill that should be taken advantage of.

Ethical Considerations and Challenges

Ethics (professional and practice)
1. Data Management
2. Model Development
3. Deployment and Monitoring

Goverance (organizational policy)

Regulation (legal policy)

Ethical Challenges for AI in Medicine

Uncertainty and limitations of predictions
Regulation and oversight of medical AI
Skills in responsibility mandated by using AI in Practice
Concerns about data privacy and security
Biased results that hurt marginalized groups

Fairness:
- Develop frameworks for determining responsibilities in a legal liability
- Build infrastructure for safe data sharing

Transparency:
- Develop explainable algorithms and transparent model reporting
- Share standards for AI practices and establish transparency

Interpretability:
- Close collaboration: a classifier is fed data and gives the human an output for them to interpret. The molecular geneticist then interprets the classifier's results, writes a report, and signs out the case.
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Augmented AI Approach for CHLA Molecular Diagnostics

Patient data is processed for machine-learning operations

Ethical AI

Transparency in Augmented AI Model at CHLA

1. Safety:
- All predictions made by model will undergo expert review to prevent misdiagnosis
- Clinicians can accept, reject, or modify predictions to train the model

2. Explainability:
- Clinicians understand that CHLA's model will be trained off large sets of patient data
- System works by making brain tumor predictions based off its training
- Confidence score will be given along with prediction

3. Fairness:
- Model will be trained for use at CHLA, and should thus be trained off data representative of the population who may visit CHLA
- CHLA's greater population of Hispanic individuals creates biases
- Debugging & bias assessments in place so that model does not perpetuate racism
- Costs to run the model must not interfere with its accessibility to patients

4. Accountability:
- Clinicians and laboratory directors are responsible for ensuring that mistakes are caught before the final report is signed out, thus taking liability

5. Interpretability:
- Explanations should be understandable to humans
- System should clearly outline its design, purposes, intentions, and procedures
- Limitations should be explicitly communicated to patients, stakeholders, and directors

Reflection

Two Concerns:
1. Monopolization of Software: Large tech-companies have much more money and manpower to implement AI technology at a large scale. How do we keep trained medical professionals at the forefront of AI development in healthcare? Is preventing tech-companies from developing monopolies feasible? Are monopolies an advantage or disadvantage?

2. Equality: Is it possible for technology to be "equal" or accessible to all? How will the release of ML models impact disadvantaged or marginalized communities? Will shareholders find ways to make novel technology more accessible to the wealthy to increase profit margins?

I worry about the inherently individualistic nature of our society. There is no doubt that one will profit and another will suffer. While I hope that artificial intelligence will help bridge inequalities, I don’t know if its implementation actually will.

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