Artificial Intelligence in Medicine: Panacea or Snake Oil?

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Objectives

• Define artificial intelligence and augmented intelligence in medicine
• Identify the current and future uses of AI tools in medicine
• Discuss how AI could lead to healthcare disparities
• Discuss the legal, ethical, and liability concerns of AI applications in medicine
AI Armageddon?

Elon Musk: ‘Mark my words — A.I. is far more dangerous than nukes’

Or Fake News?

Facebook CEO Mark Zuckerberg: Elon Musk’s doomsday A.I. predictions are ‘pretty irresponsible’
Definitions

- **AI**: When computers do things that normally require human intelligence
- **ML**: Rapid automatic construction of algorithms from data
- **NN**: Powerful form of machine learning
- **DL**: Neural networks with many layers

Applications of AI in Medicine

- Symbolic Systems: Rule-based systems
- Machine Learning: Predictive models
- Neural Networks and Deep Learning: Complex models with many layers
Dermatology

- AI capable of classifying skin cancer with a level of competence comparable to dermatologists.
- Mobile devices can potentially extend the reach of dermatologists outside of the clinic.
- Potentially provide low-cost universal access to vital diagnostic care.

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*Dermatologist-level classification of skin cancer with deep neural networks*

Alexis Kollias, John H. Hopkins, Roberto A. Noyola, Laura A. Susan H. Bois, Andrea M. Bisson, Michael A. Sabo, Michael T. Fine. *Journal of Investigative Dermatology*

*DOI: https://doi.org/10.1016/j.jid.2018.11.019*

Dermatology

- In a head-to-head comparison, the AI outperformed 136 of 157 participating dermatologists.
- AI outperformed dermatologists of all hierarchical subgroups (from junior to chief physicians) in dermoscopic melanoma image classification.


Ophthalmology

- Prevalence of diabetic retinopathy is approximately 28.5% in the United States and 18% in India.
- Annual screening for those with no retinopathy or mild diabetic retinopathy.
- Repeat examination in 6 months for moderate diabetic retinopathy, and an ophthalmologist referral for treatment evaluation within a few weeks to months for severe or worse diabetic retinopathy or the presence of referable diabetic macular edema.
Ophthalmology

Artificial Intelligence Can Support Ophthalmologists, Not Replace Them

Eye Predicts the Heart

- AI can use retinal images to predict...
  - Patient’s age
  - Gender
  - Smoking status
  - Systolic blood pressure
  - Cardiovascular risk factors
  - Risk of major adverse cardiac events occurring over the next five years

Cardiology

- Detect asymptomatic left ventricular dysfunction, silent atrial fibrillation, hypertrophic cardiomyopathy and an individual’s age, sex and race on the basis of the ECG alone.
- Detect other cardiac conditions, such as aortic valve stenosis and amyloid heart disease, are in active development.
- Standard 12-lead ECG or data obtained from single-lead or multilead mobile or wearable ECG technologies.
Framework for AI–ECG applications in clinical practice

Radiology and Radiomics (pixel biopsy)

- Radiomics (as applied to radiology) is a field of medical study that aims to extract a large number of quantitative features from medical images using data characterization algorithms.
- Data is assessed for improved decision support.

Will #AI replace radiologists? The answer is NO. But rads who use #AI will replace rads who don’t @RSNAInformatics @BIM_Tweets

12:56 AM - Feb 8, 2017 - Mooresville

58 Retweets 13 Quote Tweets 113 Likes
Neurology/Stroke

Viz.ai Granted Medicare New Technology Add-on Payment

Viz.ai, the leading AI stroke platform, is the first AI software to receive a Medicare New Technology Add-on Payment, helping hospitals adopt advanced technology to improve stroke care.

- In the US, stroke is the number one cause of long-term disability but is a treatable condition if identified early enough.
- CMS has granted Viz.ai the first New Technology Add-on Payment (NTAP) for artificial intelligence software. NTAP, part of the CMS Inpatient Prospective Payment System (IPPS), was set up to support the adoption of cutting-edge technologies that have demonstrated substantial clinical improvement and ensure early availability to Medicare patients.
- Viz LVO has been granted a New Technology Add on Payment of up to $1,040 per use in patients with suspected strokes.
Artificial vs Augmented Intelligence

Artificial intelligence constitutes a host of computational methods that produce systems that perform tasks normally requiring human intelligence.

In healthcare, a more appropriate term is augmented intelligence, reflecting the enhanced capabilities of human clinical decision-making when coupled with these computational methods and systems.

Augmented Intelligence

Original Investigation | Imaging
March 2, 2020
Evaluation of Combined Artificial Intelligence and Radiologist Assessment to Interpret Screening Mammograms
Thoai Schuffner, MD; Diana A. Bar, MD; Marc J. Schusterman, MD; Waters, PhD; Christopher I. Lee, MD, MPH et al.

JNHO Open. 2020;0(0):000000. doi:10.1001/jnamopen.2020.0000
Leverage its ongoing engagement in digital health and other priority areas for improving patient outcomes and physicians' professional satisfaction to help set priorities for health care AI.

Identify opportunities to integrate the perspective of practicing physicians into the development, design, validation and implementation of health care AI.

Promote development of thoughtfully designed, high-quality, clinically validated health care AI

- Is designed and evaluated in keeping with best practices in user-centered design, particularly for physicians and other members of the health care team
- Is transparent
- Conforms to leading standards for reproducibility
- Identifies and takes steps to address bias and avoids introducing or exacerbating health care disparities, including when testing or deploying new AI tools on vulnerable populations
- Safeguards patients' and other individuals' privacy interests and preserves the security and integrity of personal information

Encourage education for patients, physicians, medical students, other health care professionals, and health administrators to promote greater understanding of the promise and limitations of health care AI

Explore the legal implications of health care AI, such as issues of liability or intellectual property, and advocate for appropriate professional and governmental oversight for safe, effective, and equitable use of and access to health care AI.
Embedding Values into Autonomous and Intelligent Systems

• Society has not established universal standards or guiding principles for embedding human values and norms into autonomous and intelligent systems (A/IS) today.

• If systems are instilled with increasing autonomy in making decisions and manipulating their environment, it is essential that they are designed to adopt, learn, and follow the norms and values of the community they serve.

• Actions should be transparent in signaling their norm compliance and, if needed, they must be able to explain their actions.
Embedding Values into Autonomous and Intelligent Systems

- Not all norms of a target community apply equally to human and artificial agents (one size does not fit all)
- A/I/S can have biases that disadvantage specific groups
- Biases may still emerge from imperfections in the norm identification process itself, from unrepresentative training sets for machine learning systems, and from programmers’ and designers’ unconscious assumptions
- Unanticipated or undetected biases should be further reduced by including members of diverse social groups in both the planning and evaluation of A/I/S and integrating community outreach into the evaluation process
- Ensure A/I/S works with different races, ethnicities, genders, ages, body shapes, or to people who use wheelchairs or prosthetics

Safety and Beneficence of Artificial Intelligence

- As AI systems become more capable, as measured by the ability to optimize more complex objective functions with greater autonomy across a wider variety of domains, unanticipated or unintended behavior becomes increasingly dangerous
- Retrofitting safety into future more generally capable AI systems may be difficult
- Researchers and developers will confront a progressively more complex set of ethical and technical safety issues in the development and deployment of increasingly autonomous and capable AI systems
What should the self-driving car do?

1. In this case, the self-driving car will decide what to do based on the information available.

2. The self-driving car will have to make a decision based on the information available.

Options: 1. Block 2. Let it go 3. Stop

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Options: 1. Block 2. Let it go 3. Stop
• AI must learn to diagnose disease on large data sets, and if that data doesn’t include enough patients from a particular background, it won’t be as reliable for them.

• Some facial recognition programs incorrectly classify less than 1 percent of light-skinned men but more than one-third of dark-skinned women.

• What happens when we rely on such algorithms to diagnose melanoma on light versus dark skin?

• Most widely used cardiovascular risk score, developed using data from mostly white male patients, can be less precise for women and minorities.

AI Could Worsen Health Disparities

AI is trained on real-world data, it risks incorporating, entrenching and perpetuating the economic and social biases that contribute to health disparities in the first place.

• AI programs used to help judges predict which criminals are most likely to reoffend have shown troubling racial biases, as have those designed to help child protective services decide which calls require further investigation.

In medicine, unchecked AI could create self-fulfilling prophecies that confirm our pre-existing biases, especially when used for conditions with complex trade-offs and high degrees of uncertainty.

• Poorer patients do worse after organ transplantation or after receiving chemotherapy for end-stage cancer; machine learning algorithms may conclude such patients are less likely to benefit from further treatment — and recommend against it.

• Neutral AI has the potential to worsen disparities if its implementation has disproportionate effects for certain groups.

• Consider a program that helps doctors decide whether a patient should go home or to a rehabilitation facility after knee surgery; a decision imbued with uncertainty but has real consequences: Evidence suggests discharge to an institution is associated with higher costs and higher risk of readmission.

• If an algorithm incorporates residence in a low-income neighborhood as a marker for poor social support, it might result in less treatment for dark-skinned patients moving to nursing facilities instead of receive home-based physical therapy.

• Worse yet, a program designed to maximize efficiency or lower medical costs might discourage operating on those patients altogether.
Safety and Beneficence of Artificial Intelligence

Future AI systems may have the capacity to impact the world on a scale of the agricultural or industrial revolutions.

Personal Data and Individual Access Control

- **Autonomous and Intelligent systems (A/IS)** are developing faster than the supporting standards and regulation required for transparency and societal protections can keep pace.

- Impact of these systems on society is **direct** and considerable.

- A/IS require data to fuel learning and inform automatic decision-making.

- Personal data, or personally identifiable information, known as PII is defined as any data that can be reasonably linked to an individual based on their unique physical, digital, or virtual identity.

Privacy

- Ethical considerations regarding data are often focused largely on issues of privacy.

- What rights should a person have to keep certain information to themselves or have input into how it is shared?

- Individuals lack clarity around how to access, organize, and share their data to ensure unintended consequences are not encountered.
Privacy

Fundamental need for people to have the right to define access and provide informed consent with respect to the use of their personal data (as they do in the physical world).

Individuals require mechanisms to help curate their unique identity and personal data in conjunction with policies and practices that make them explicitly aware of consequences resulting from the bundling or resale of their personal information and life experiences.

What could go wrong?

Cambridge Analytica

JACR

Protecting Your Patients’ Interests in the Era of Big Data, Artificial Intelligence, and Predictive Analytics

Patricia Belfiore, MD,*, Peer Nuss, MD,*, John Powers, MD, MPH,†, Noble H. Safier, MD, MPH*
Privacy and Confidentiality

How do we keep data-driven insights about sensitive health issues confidential?

How do institutions prevent the reidentification of individuals from joining of data sets?

What is your obligation to notify a patient or subject of a health risk or propensity identified using big data or machine learning techniques?

Ownership of Data and Subsequently Developed Products

• Can patient data be reused for developing and validating advanced analytic methods?

• Can they be shared or sold for this purpose?

• If an app is developed and validated using patient data, should the app be sold for profit?

Informed Consent

What mechanisms are in place to exclude the data of individuals who do opt out?

What mechanisms are in place to allow patients to donate all their medical data for research?
AI Data Challenges

- Heterogeneity of data
- Heterogeneity of workflow
- Determination of ground truth
- Validation of AI models at different institutions
- FDA approval of AI models for clinical use
34 states aren’t represented in any medical AI training sets

- Many academic research centers that do artificial intelligence and machine learning research are in health care hubs like Massachusetts, California, and New York.
- Data from California, home to Silicon Valley, was included in about 40% of the algorithms.
In science, computing, and engineering, a black box is a device, system or object which can be viewed in terms of its inputs and outputs (or transfer characteristics), without any knowledge of its internal workings.

- Its implementation is "opaque".
How do we know that the results of artificial intelligence algorithms are valid?

Were the data sets with which they were developed representative?

How can we defend the results of an algorithm affecting a patient’s health care, if no anybody could completely comprehend how the algorithm reached its conclusion?

What happens if the algorithm makes a mistake or leads to an adverse patient event or irreversible damage?

Attacking the Black Box
Adversarial attacks

- Manipulations that can change the behavior of AI systems using tiny pieces of digital data.
  - By changing a few pixels on a lung scan, for instance, someone could fool an AI system into seeing an illness that is not really there, or not seeing one that is.
- Doctors, hospitals and other organizations could manipulate the AI in billing or insurance software in an effort to maximize the money coming their way.
- "The inherent ambiguity in medical information, coupled with often competing financial incentives, allows for high-stakes decisions to swing on very subtle bits of information."

Manipulation

- Researchers demonstrated that, by changing a small number of pixels in an image of a benign skin lesion, a diagnostic AI system could be tricked into identifying the lesion as malignant.
  - Simply rotating the image could also have the same effect.
- Small changes to written descriptions of a patient’s condition also could alter an AI diagnosis: “Alcohol abuse” could produce a different diagnosis than “alcohol dependence,” and “lumbago” could produce a different diagnosis than “back pain.”
Hospital viruses: Fake cancerous nodes in CT scans, created by malware, trick radiologists

Malware they created would let attackers automatically add realistic, malignant-seeming growths to CT or MRI scans before radiologists and doctors examine them.

Or it could remove real cancerous nodules and lesions without detection, leading to misdiagnosis and possibly a failure to treat patients who need critical and timely care.

Deepfake

AI and the Physician

- How does the AI algorithm influence the performance of the physician?
- Does Physician + AI outperform just the Physician?
- What is considered the "ground truth"?
- How will the AI model be displayed?
- Will the AI model learn over time?
AI and the Physician (automation bias)

- Physicians received chest X-rays and diagnostic advice, some of which was inaccurate, and were asked to evaluate advice quality and make diagnoses.
- All advice was generated by human experts, but some was labeled as coming from an AI system.
- As a group, radiologists rated advice as lower quality when it appeared to come from an AI system; physicians with less task expertise did not.
- Diagnostic accuracy was significantly worse when participants received inaccurate advice, regardless of the purported source.
- Important considerations for how advice, AI and non-AI, should be deployed in clinical environments.

Liability

Current law shields physicians from liability as long as they follow the standard of care, the “safest” way to use medical AI from a liability perspective is as a confirmatory tool to support existing decision-making processes, rather than as a source of ways to improve care.

- In the future, some medical AIs will perform better than even the best physicians.
- Because threat of liability encourages physicians to meet and follow the standard of care, they may reject such recommendations and thus fail to realize the full value of AI, in some cases to patients’ detriment.
Regulating AI

- Which medical AI/ML-based products should be reviewed by regulators?
- What evidence should be required to permit marketing for AI/ML-based software as a medical device (SaMD)?
- How can we ensure the safety and effectiveness of AI/ML-based SaMD that may change over time as they are applied to new data?
- Regulators like the FDA need to widen their scope from evaluating medical AI/ML-based products to assessing systems.
Responsibilities of Medical Societies and Organizations

- Encourage balanced regulation of AI technology
- Establish standards for AI data and algorithms
- Advocate for and provide research funding for AI
- Assemble publicly available training data sets
- Convene collaborations: physicians, scientists, industry
- Support development of AI cases
- Develop a robust technical workforce
- Review by the FDA will provide some quality assurance, but societies will be well placed to provide additional guidelines to evaluate AI products at implementation and to evaluate AI recommendations for individual patients.

- Guide physicians in the selection of cases for specific interventions through shared guidelines, they can guide practices for adopting and using medical AI reliably, safely, and effectively.

Physicians’ Role

- Deeply involved in the development, validation, and implementation of big data analytics, artificial intelligence, and personalized medicine in medicine.
- Learn how to better use and interpret AI algorithms, including in what situations medical AI should be applied and how much confidence should be placed in an algorithmic recommendation.
- Fiduciary responsibility for the well-being of their patients, as affirmed in the Hippocratic oath, rendering them professionally responsible for securing the interest of their patients.
Ensure that administrative efforts to develop and deploy algorithms reflect what is truly needed in clinical care.

When external AI products are procured, physicians should advocate for safeguards to ensure that such products are rigorously vetted before procurement, just as with other novel medical devices.

Check carefully with their malpractice insurer to determine how the insurer covers the use of medical AI in practice.

- Is care that relies on AI recommendations covered the same as care without such recommendations, or does the insurer treat such practices differently?
- Are practices different for more opaque algorithms that provide little or no reasoning?

Problem becomes far more complex with the recognition that physician liability is only one piece of a larger ecosystem of liability.

- Hospital systems that purchase and implement medical AI, makers of medical AI, and potentially even payers could all face liability.

Parting Advice and Summary

- AI is a powerful tool with many applications that can help physicians in many diagnostic tasks.
- Integrating AI models holds promise for improving healthcare delivery and patient outcomes.
- More research needs to be done regarding the evaluation of AI in a clinical setting, including its impact on workflow and value of services.
- No matter how AI is implemented in the workflow, physicians will have an important role in ensuring accuracy, safety, and quality of the algorithms.
Thank you