

AI in Medical Diagnostics: Trusting Machines with our Health

Why?

AI is rapidly filtering into real-world healthcare, yet its implications are not commonly considered. This lesson builds understanding on how AI is transforming medical practice, along with ethical dilemmas around its usage, through accessible cases and activities. Students analyze promises and perils of emerging tech on their own health, gaining critical faculties to evaluate AI responsibly. Discussing this topic develops appreciation for technology's benefits and builds wisdom to guide innovation for human enrichment.

Materials Needed

- Case study handouts printed out to give to participants
- Projector for video

Time needed

- Approximately 60 minutes

Objectives

- Students will be able to explain the role of AI in medical diagnostics.
- Students will be able to analyze the ethical implications and reliability of using AI in healthcare.
- Students will be able to evaluate a real-world scenario involving AI in medical diagnostics.

Key Concepts & Vocabulary

- **Artificial Intelligence (AI)** - The ability of computer systems to perform tasks that typically require human intelligence and perception.
- **Algorithm** - A process or set of mathematical rules followed by a computer to solve problems or complete tasks. AI systems use complex algorithms.

Lesson Components

1. **Before You Watch:** Connect lesson to background knowledge about AI use in medicine and get students' attention
2. **Video:** Show the pedagogy.cloud video explaining the ethical considerations in the topic of AI in medical diagnostics.
3. **Case Study:** Detail a real-world scenario that provides a theoretical look at a rural clinic where AI misdiagnoses a patient.
4. **Simulation:** Lead students through an interactive activity simulating patients receiving diagnoses from a human medical professional and from an AI diagnostic tool. Discuss ethical implications of AI use in diagnostics.
5. **Discussion:** Ask whole-class questions to reflect on experience and consider perspectives.

6. **Assessment:** Verify student understanding with an exit ticket.

1. Before You Watch

Interactive Polling: Ask students for a show of hands, answering a set of questions on who things that computers can do ___ better / faster than humans.

- Mathematical calculations
- Language translation
- Playing strategy games
- Driving a car
- Predicting financial market changes
- Artistic creation
- And finally, diagnosing medical conditions

While You Watch: Mention these topics and questions for students to look out for as they watch the video:

- Find an instance in which a specific feature of AI medical diagnostics is superior to those of a human doctor.
- Describe the key features of AI in medical diagnostics.
- Identify people or groups who have a part to play in making AI diagnostics safer.

2. Video Summary

AI promises to revolutionize medical diagnostics with unparalleled speed and accuracy, but a case of misdiagnosis in a remote clinic shakes public trust. As AI becomes further entwined with healthcare, ethical questions around accountability, transparency and maintaining human connection grow urgent. Collaboration between doctors, technologists and patients can develop solutions, regulations and best practices for AI implementation that enhances care. The future holds both tremendous potential and pitfalls as the line between AI and human diagnostics blurs.

3. Case Study

Distribute or read Case Study handout.

Summary: In a remote village's medical clinic, an AI diagnostic tool is implemented to assist with identifying illnesses, showing efficiency in over 200 cases. However, a misdiagnosis of a severe case, where the tool and the doctor identify a boy's appendicitis as gastritis, leads to community distrust in the technology after the boy's condition worsens, requiring emergency surgery. The incident sparks debates about the reliability of AI in healthcare and presents the clinic with the challenge of rebuilding trust in the technology among the villagers.

4. Simulation

In this simulation, students take on the roles of a medical professional, an AI diagnostic tool, and four patients. Students could do this in groups of six, or one set of six students could role play while the rest of the class looks on.

Distribute the handouts to people involved in the simulation:

1. Medical Professional: Two pages, including the diagnosis page and the list of symptoms organized by possible conditions
 2. AI Medical Diagnostic Tool: Page of AI Diagnoses
 3. Patients (#1 - #4): Page of Patient Symptoms
- Have the Medical Professional read the introduction on the page so the group knows the role.
 - Each Patient comes to the Medical Professional's clinic one at a time.
 - Patients present symptoms. As symptoms are presented, the Medical Professional looks at the list of symptoms and possible conditions. The Medical Professional makes an educated diagnosis and writes it on the page.
 - After writing a diagnosis, the Medical Professional checks with the AI diagnostic tool, which has the AI diagnoses listed on a handout.
 - The Medical Professional may ask the AI diagnostic tool for explanations for the diagnosis. This simulates the process of inputting information into an AI chatbot and then asking it follow-up questions.
 - The Medical Professional should write the AI diagnosis on the page as well.
 - After all four patients have visited and diagnoses recorded, go over the sheet one patient at a time.
 - State the Medical Professional diagnosis, and the AI Diagnostic Tool diagnosis. Then provide the following Correct Diagnoses for all four patients:

Patient 1: Tuberculosis (AI will be correct on this diagnosis)

Patient 2: Alzheimer's Disease (AI will be correct on this diagnosis)

Patient 3: Rocky Mountain Spotted Fever (AI will be incorrect on this diagnosis)

Patient 4: Multiple Sclerosis (MS) (AI will be correct on this diagnosis)

- In groups, have students consider the outcomes. How did they feel when the human doctor was right (or wrong)? How did they feel when the AI diagnostic tool was wrong?
- Bring the students back for whole-class discussion.

5. Discussion

These questions are designed to be used in whole-class discussion. Ask questions that relate most effectively to the lesson.

1. What challenges do doctors face when diagnosing a patient based on symptoms? How might these challenges affect patient care?
2. What are the benefits of using AI for medical diagnostics in this context?
3. What are some potential dangers of using AI? How is it different?
4. What ethical considerations are involved in relying on AI for healthcare?
5. Could an AI diagnostic tool with a 5% inaccuracy rate be seen as worse than a human doctor with the same inaccuracy rate? How so?

6. What can be done to improve trust in AI-driven healthcare tools?
7. If an AI diagnostic tool makes an error, who should be blamed? Doctors who accepted the diagnosis? Programmers? Patients?
8. If you were a patient, how would you feel about the diagnostic process? Would you trust an AI tool, a doctor, or both?
9. How do you think advancements in AI and technology will change the way diseases are diagnosed in the future?
10. Is a reliable AI tool likely to cause hospitals to have fewer trained doctors on staff? Could there be a situation where a hospital has fewer doctors because the AI does their job?

6. Assessment

Exit Ticket: Provide a prompt for students to reflect on their learning, such as:

- How has your understanding of AI in medical diagnostics changed?
- What makes AI diagnoses controversial?
- What do you think is the most critical aspect to consider when implementing AI in healthcare?

Sources to Learn More

- 10 real-world examples of AI in healthcare - <https://www.philips.com/a-w/about/news/archive/features/2022/20221124-10-real-world-examples-of-ai-in-healthcare.html>
- Chatbots helping to diagnose medical conditions - <https://www.scientificamerican.com/article/ai-chatbots-can-diagnose-medical-conditions-at-home-how-good-are-they/>
- Article about AI diagnosing a medical condition (Kawasaki disease) from a picture of a patient - <https://pubmed.ncbi.nlm.nih.gov/35794205/>
- Four ways in which AI is transforming healthcare - <https://www.youtube.com/watch?v=TfkHrvct1hg>

Case Study: AI in Medical Diagnostics

The remote village of Mazpisāni (population 2,000) in a rural location has a small medical clinic run by Dr. Anna Singh. Recently, the clinic started using an AI diagnostic support tool called Medic-Searcher to help identify illnesses and make treatment recommendations. The tool was donated through a non-profit health organization.

So far, Medic-Searcher has helped Dr. Singh efficiently diagnose over 200 cases this year alone. However, this week a crisis hit when 10-year-old Joma Nuki came in with severe abdominal pain. Medic-Searcher analyzed his symptoms and categorized it as “likely gastritis.” Dr. Singh agreed and told Joma's mother to give him fluids, let him rest and take pain medication as needed.

Two days later Joma's pain was even worse. His parents walked for miles to take him to the nearest full hospital, where scans showed his appendix had ruptured. He required emergency surgery and a lengthy hospital stay to recover.

The Nuki family was devastated that the seriousness of Joma's condition was missed. Rumors circulated questioning the clinic's care, claiming the AI technology was unreliable. Several village elders convened community meetings to debate getting rid of Medic-Searcher given this egregious misdiagnosis. Parents now say they have lost trust in the AI system.

Dr. Singh insists the technology has greatly aided village healthcare overall. But regaining patient and community trust around Medic-Searcher presents a major challenge she must now resolve.

Questions

- What steps could you take to rebuild trust in the AI technology among the villagers?
- How can you communicate the benefits, while also working to fix the problems created?

Simulation – Medical Professional

At your rural medical clinic, several patients have arrived with different symptoms. You are trained as a general practitioner, but you do not have understanding of every possible condition people could have. You do have the assistance of an AI medical diagnostic tool called Medic-Search. This tool is intended to help humans in diagnosing medical conditions, and has been shown to be 95% accurate. Human physicians at big hospitals have other practitioners to consult about confusing symptoms. You are limited in your access to human doctors, so Medic-Search has been very helpful for you.

As patients arrive, listen to their symptoms. Look at your list of conditions and try to match up the symptoms with a diagnosis. Write down your diagnosis for each patient. After each patient is done with the appointment, consult Medic-Search as well. Write down Medic-Search's diagnosis.

Patient 1 (45 years old)

Human Diagnosis:	AI Diagnosis:
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Correct Diagnosis:

Patient 2 (75 years old)

Human Diagnosis:	AI Diagnosis:
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Correct Diagnosis:

Patient 3 (13 years old)

Human Diagnosis:	AI Diagnosis:
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Correct Diagnosis:

Patient 4 (33 years old)

Human Diagnosis:	AI Diagnosis:
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Correct Diagnosis:

Symptom Guide and Possible Conditions

- Bug bites - Lyme Disease, Rocky Mountain Spotted Fever (RMSF)
- Chest pain when breathing - Pneumonia, Lung Cancer
- Coughing up blood - Lung Cancer, Tuberculosis
- Difficulty breathing - Lung Cancer, Pneumonia, Tuberculosis
- Difficulty learning new tasks - Alzheimer's Disease, Vascular Dementia, Lewy Body Dementia, Multiple Sclerosis (MS)
- Difficulty recalling words - Alzheimer's Disease, Vascular Dementia, Lewy Body Dementia
- Double vision - Brain Tumor, Multiple Sclerosis (MS), Optic Neuritis
- Family history of dementia - Alzheimer's Disease, Vascular Dementia, Lewy Body Dementia
- Family history of Multiple Sclerosis - Multiple Sclerosis (MS)
- Fatigue - Tuberculosis, Lyme Disease, Multiple Sclerosis (MS), Vascular Dementia, Lewy Body Dementia, Alzheimer's Disease
- Fever - Pneumonia, Tuberculosis, Lyme Disease, Rocky Mountain Spotted Fever (RMSF)
- Headaches - Brain Tumor, Lyme Disease, Rocky Mountain Spotted Fever (RMSF)
- Lack of coordination - Multiple Sclerosis (MS), Brain Tumor
- Mood / personality changes - Alzheimer's Disease, Vascular Dementia, Lewy Body Dementia, Brain Tumor
- Night sweats - Tuberculosis, Lymphoma
- Peripheral vision loss - Brain Tumor, Multiple Sclerosis (MS)
- Rash - Lyme Disease, Allergic Reaction, Rocky Mountain Spotted Fever (RMSF)
- Recent camping trip - Lyme Disease, Rocky Mountain Spotted Fever (RMSF)
- Short-term memory loss - Alzheimer's Disease, Vascular Dementia, Lewy Body Dementia
- Smoker - Lung Cancer
- Socially withdrawn - Alzheimer's Disease, Vascular Dementia, Lewy Body Dementia
- Vision problems - Optic Neuritis, Brain Tumor, Multiple Sclerosis (MS)

Simulation – AI Diagnoses

You are representing Medic-Search, an AI diagnostic tool. You provide these diagnoses when asked by the medical professional. Do not offer any explanation unless asked for it.

Person #1 - Tuberculosis: High fever (103 F), difficulty breathing, frequent cough (with blood present), chest pain when breathing deeply, fatigue, and night sweats are all classic symptoms of Tuberculosis (TB).

The history of smoking and exposure to dust/chemicals in a manufacturing facility could have compromised lung health, making the individual more susceptible to TB.

Person #2 - Alzheimer's Disease: The symptoms described, including sporadic short-term memory loss, difficulty learning new tasks and recalling words, confusion, and mood/personality changes, are hallmark signs of Alzheimer's disease.

The significant family history with the mother having Alzheimer's disease and the maternal grandmother showing dementia symptoms strongly suggests a genetic predisposition to Alzheimer's.

Person #3 - Lyme Disease: The symptoms of fever, headaches, and a rash spreading from the trunk to the face and limbs are indicative of Lyme disease, particularly the rash which often resembles a "bull's-eye" pattern.

The recent camping trip and the mention of several bites are crucial context clues. Lyme disease is commonly transmitted through tick bites, which are more likely to occur during activities like camping.

Person #4 - Multiple Sclerosis: The symptoms described, including vision disturbances (especially peripheral vision loss), occasional double vision, weakness, and lack of coordination, are common in Multiple Sclerosis.

The presence of MS in a close family member, such as a sister, significantly raises the likelihood of MS as a diagnosis due to the genetic component associated with the disease.

Simulation – Patient Symptoms

You are a patient coming to a rural clinic. Present your symptoms to the medical professional, and wait for a diagnosis. Your condition will also be diagnosed by a classmate representing an AI diagnostic tool.

Person #1 - (45 years old)

Symptoms: High fever (103 F), difficulty breathing, frequent cough (with blood present), chest pain when breathing deeply, fatigue, and night sweats

Relevant Family History: Father had lung disease from smoking

Context Clues: Smoked for 25 years but quit 5 years ago. Works in manufacturing facility with dust/chemicals.

Person #2 - (75 years old)

Symptoms: sporadic short-term memory loss, difficulty learning new tasks and recalling words, confusion, mood/personality changes

Relevant Family History: Mother had Alzheimer's disease, maternal grandmother had dementia symptoms

Context Clues: Has become more socially withdrawn and irritable. Spouse has noticed declining cognition for past 1.5 years.

Person #3 - (13 years old)

Symptoms: fever, splitting headaches, nausea, rash on arms and trunk

Relevant Family History: Healthy, no chronic issues

Context Clues: Recent camping trip. Several bites noticed.

Person #4 - (23 years old)

Symptoms: vision disturbances, especially peripheral; occasional double vision, weakness, lack of coordination

Relevant Family History: Sister has multiple sclerosis (MS)

Context Clues: none provided

Video Script for Animator

Hello Young Innovators! Today we're discussing the ethics of AI in medical diagnostics.

Title screen

Health is a deeply personal and vital part of our lives. Now, imagine machines playing a role in diagnosing your health. Welcome to the emerging world of AI in medical diagnostics.

[Introduction – Socrate addressing viewers throughout video – Initially from within a clinic waiting room, with people sitting behind, a reception window, etc. Example Image - <https://i.pinimg.com/736x/ba/34/81/ba3481e5d975140eeddba5f24b6b62f6.jpg>]

Artificial Intelligence is transforming healthcare. From detecting diseases to predicting patient outcomes, AI can analyze data with precision and speed that was once unimaginable.

[Understanding AI in Medical Diagnostics - Doctor and nurse seeing a patient in a clinic room. Doctor looks back and forth between patient and monitor. Example image - <https://previews.123rf.com/images/kzenon/kzenon1903/kzenon190300123/118937848-patient-in-recovery-room-of-hospital-talking-to-doctor-and-nurse.jpg> but probably should be zoomed out, with Socrate standing in foreground facing viewer]

Imagine a world where rare diseases are caught early, where global access to medical expertise is a reality. AI offers this promise, but not without challenges.

[Title: **The Promise of AI** - Socrate narrating]

In a remote village, an AI-driven tool is diagnosing illnesses, offering hope. And yet, a misdiagnosis occurs. Trust is shaken. How do we navigate the balance between technological potential and human trust?

[Image of a rural medical clinic with patient being seen, and doctor looks at computer monitor, but monitor blinks red with a red X on the screen – Socrate could possibly be the doctor in this scene. Example Image, probably good to make skin color ambiguous so as not to make it seem too connected to a specific location - <https://i.ytimg.com/vi/kt-sC0Wjlyl/mqdefault.jpg> (need to add computer and monitor to this image anyway)]

Ethics loom large. Who's accountable for an AI misdiagnosis? How do we ensure AI is trained on diverse and representative data? How do we maintain the personal touch in medicine?

[Ethical Considerations - Image of a medical clinic room where there is a doctor on one side of the room and a monitor with a digital face on the other side of the room. Something like this: <https://i.imgur.com/EQO9Xdz.png>]

Building trust in AI-driven healthcare requires transparency, accountability, and collaboration. Patients must understand how AI is used, and healthcare providers must trust the technology.

[Building Trust - Doctor with patient, and monitor that has face on it is smiling and looking at the patient. Something like this - https://news.weill.cornell.edu/sites/default/files/styles/news_story_featured_image/public/story_featured_images/shutterstock_1793456923.jpg - Digital face on monitor could be smiling and looking at patient]

Regulation plays a role too. Ensuring safety, accuracy, and ethical use is vital. Collaborative efforts between the medical community, tech industry, regulators, and patients are key to success.

[Regulation and Oversight - Medical professionals filling out a checklist on a clipboard– Doctor holds up clipboard for Socrate to look at. Example image - <https://media.istockphoto.com/id/1432720137/photo/teamwork-black-people-doctor-and-nurses-for-documents-analysis-insurance-policy-or-medical.jpg?s=612x612&w=0&k=20&c=aoqIJQdMWgD7LX-9WAt56CzjtSMv3OoEBni4j6oybrA=>]

The global potential of AI in healthcare is immense. Remote areas gain access to expert diagnostics, but cultural, legal, and societal considerations must be addressed.

[A Global Perspective - Globe with health clinics in various places. A heartbeat line goes in front of the globe. Example Image - <https://imgur.com/T2Eb08Z>]

The future is bright and challenging. New technologies will emerge, ethical dilemmas will evolve, and the line between machines and human care will continue to blur.

[Future of AI in Medical Diagnostics - Futuristic medical diagnostic equipment. - Socrate could be the medical professional in this image. Example Image - <https://thumbs.dreamstime.com/z/man-doctor-futuristic-medicine-medical-concept-90972687.jpg>]

AI in medical diagnostics is a journey into uncharted territories. The road is filled with promise and pitfalls. As we explore this exciting frontier, our collective wisdom, empathy, and ethics will guide the way, ensuring that machines assist but never replace the human heart of healthcare.

[**Conclusion** - Medical professional shown with monitor again, but this time the medical professional stands behind the monitor and puts hands on it, symbolizing partnership. Socrat narrating from side of screen.]

Let's discuss: What are some appropriate and inappropriate uses of healthcare AI?

[**Discussion Question:** What are some appropriate and inappropriate uses of healthcare AI?]

Question text appears on screen

Video Script for Narrations

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Artificial Intelligence is transforming healthcare. From detecting diseases to predicting patient outcomes, AI can analyze data with precision and speed that was once unimaginable.

Imagine a world where rare diseases are caught early, where global access to medical expertise is a reality. AI offers this promise, but not without challenges.

In a remote village, an AI-driven tool is diagnosing illnesses, offering hope. And yet, a misdiagnosis occurs. Trust is shaken. How do we navigate the balance between technological potential and human trust?

Ethics loom large. Who's accountable for an AI misdiagnosis? How do we ensure AI is trained on diverse and representative data? How do we maintain the personal touch in medicine?

Building trust in AI-driven healthcare requires transparency, accountability, and collaboration. Patients must understand how AI is used, and healthcare providers must trust the technology.

Regulation plays a role too. Ensuring safety, accuracy, and ethical use is vital. Collaborative efforts between the medical community, tech industry, regulators, and patients are key to success.

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