Is All that Glitters Gold?

The case for artificial intelligence for infection prevention and control

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Disclosures

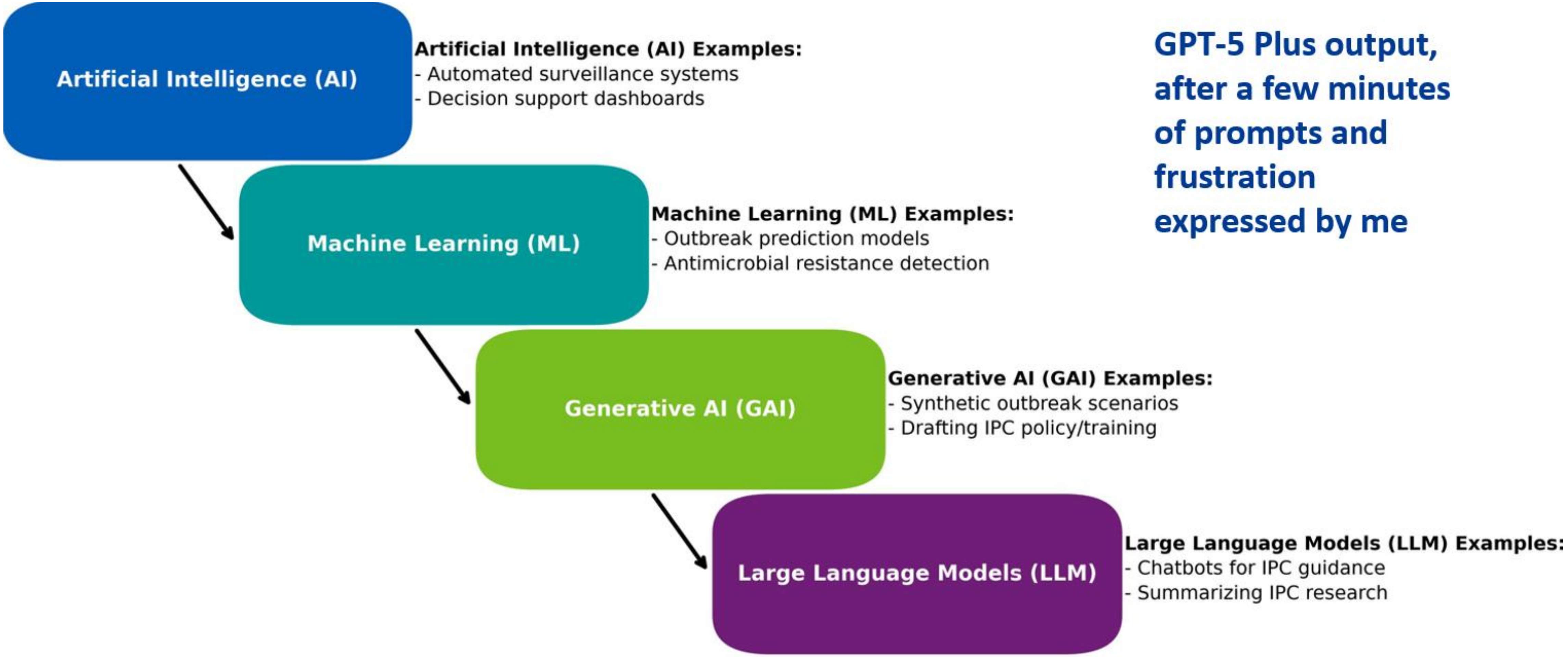
- I'm not a computer scientist
- Funding
  - Centers for Disease Control and Prevention (Strengthening Healthcare Infection Prevention and Control (IPC) and Improving Patient Safety in the United States; CDC-RFA-CK22-2203)
  - Assistant Secretary for Preparedness and Response (ASPR)
- Other
  - Author, Up to Date
  - Consultant, Combating Antibiotic-Resistant Bacteria Biopharmaceutical Accelerator (CARB-X)
  - Former Member, CDC Healthcare Infection Control Practices Advisory Committee (HICPAC)
  - Member, Board of Trustees, Society for Healthcare Epidemiology of America (SHEA)

Objectives

- What and Why
- Some use cases
- Are we there yet?

What and Why

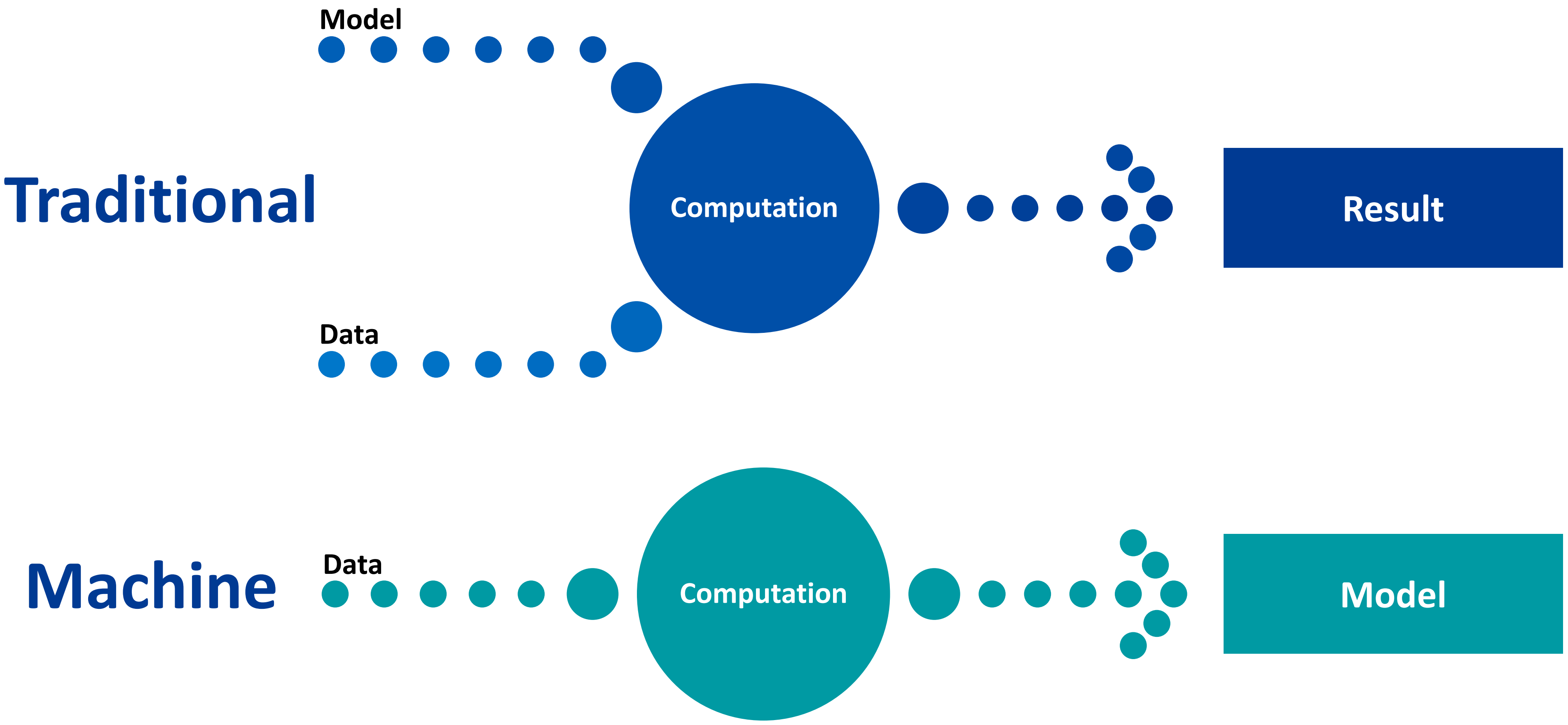
Common Parlance



GPT-5 Plus output, after a few minutes of prompts and frustration expressed by me

10.1056/NEJMsb2503956. Epub 2025 Apr 10. PMID: 40208922; Wiens J, Shenoy ES. Machine Learning for Healthcare: On the Verge of a Major Shift in Healthcare Epidemiology. Clin Infect Dis. 2018 Jan 6;66(1):149-153. doi: 10.1093/cid/cix731. PMID: 29020316; PMCID: PMC5850539; Bajwa J, Munir U, Nori A, Williams B. Artificial intelligence in healthcare: transforming the practice of medicine. Future Healthc J. 2021 Jul;8(2):e188-e194. doi: 10.7861/fhj.2021-0095. PMID: 34286183; PMCID: PMC8285156; GPT-5 Plus, Accessed 8/30/2025.

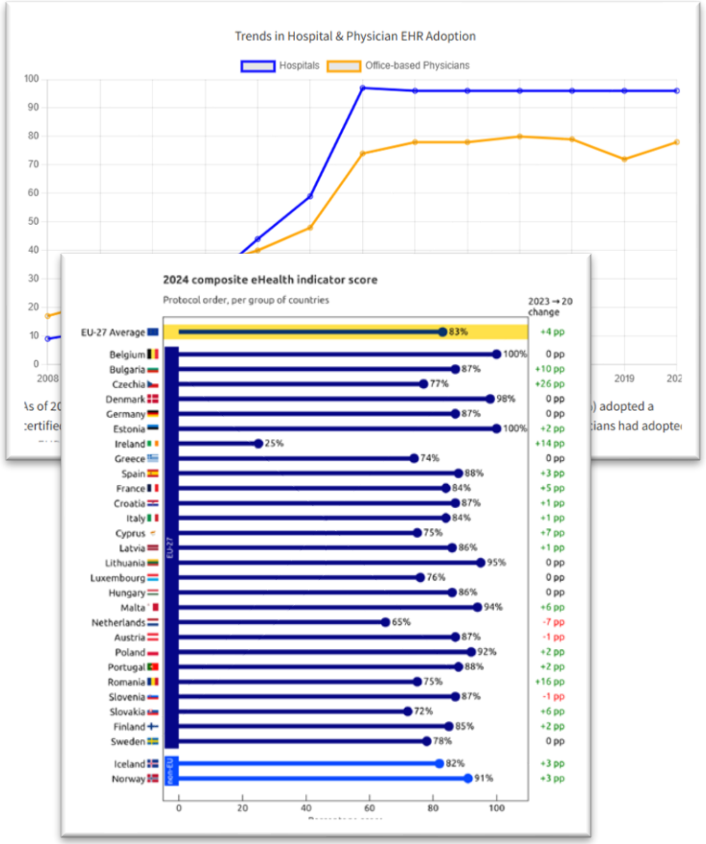
Traditional vs Machine Learning



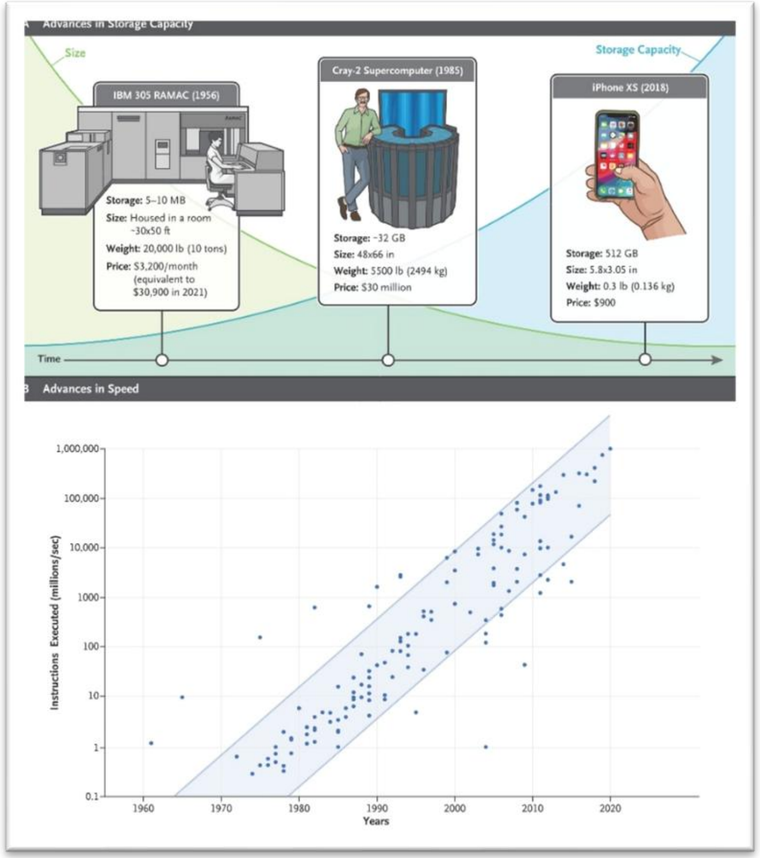
Wiens J, Shenoy ES. Machine Learning for Healthcare: On the Verge of a Major Shift in Healthcare Epidemiology. Clin Infect Dis. 2018 Jan 6;66(1):149-153. doi: 10.1093/cid/cix731. PMID: 29020316; PMCID: PMC5850539.

Why Now?

Availability of so *so* much data



Computing storage and speed

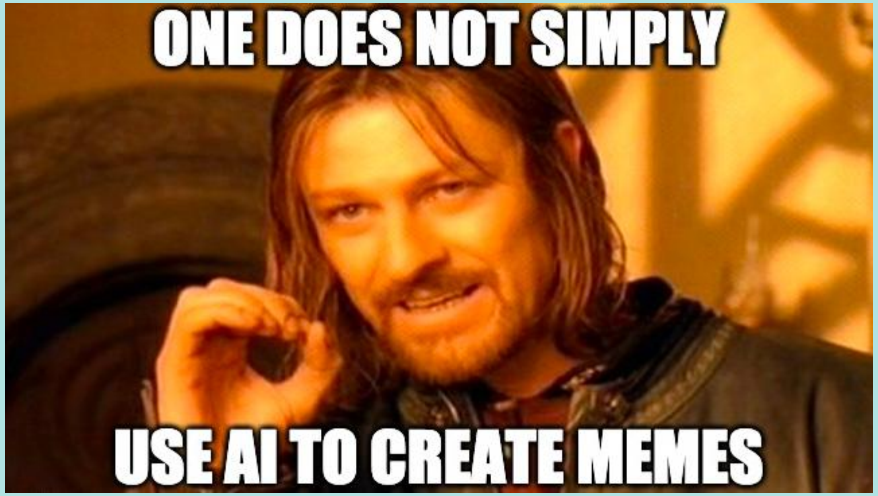


Bringing models to end users

Use Case	Example Tools
Clinical Decision Support & Diagnostics	Aidoc • Zebra Medical Vision • IDx-DR • Viz.ai • Ask Avo • PEACH
Documentation & Administrative Support	Nuance DAX • Heidi Health • Suki • Sully.ai
Remote Monitoring & Wearables	Eko Health • Empatica • Current Health • Apple Watch ECG/AFib detection
Patient Engagement & Chatbots	Babylon Health • Ada Health • ChatGPT (adapted) • Buoy Health
Research & Knowledge Support	OpenEvidence • PubMed/LitCovid NLP • Trial-matching AI • DeepMind AlphaFold
Administrative / Workflow Optimization	Olive AI • Notable Health • Qventus • Epic Cognitive Computing

Office of the National Coordinator for Health Information Technology. 'National Trends in Hospital and Physician Adoption of Electronic Health Records,' Health IT Quick-Stat #61; European Commission: Directorate-General for Communications Networks, Content and Technology, Capgemini Invent, Page, M. and de Waal, P., *2025 digital decade ehealth indicator study – Final report*, Publications Office of the European Union, 2025, https://data.europa.eu/doi/10.2759/2737039 ; Haug CJ, Drazen JM. Artificial Intelligence and Machine Learning in Clinical Medicine, 2023. N Engl J Med. 2023 Mar 30;388(13):1201-1208. doi: 10.1056/NEJMra2302038. PMID: 36988595; GPT-5 Plus, Accessed 8/30/2025.

Some Use Cases

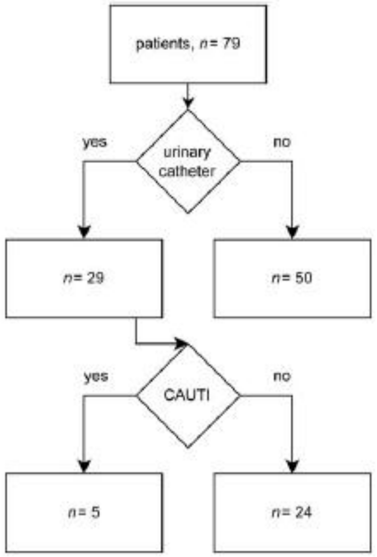


1. **Detection/Surveillance** of Healthcare Associated Infections: CAUTI

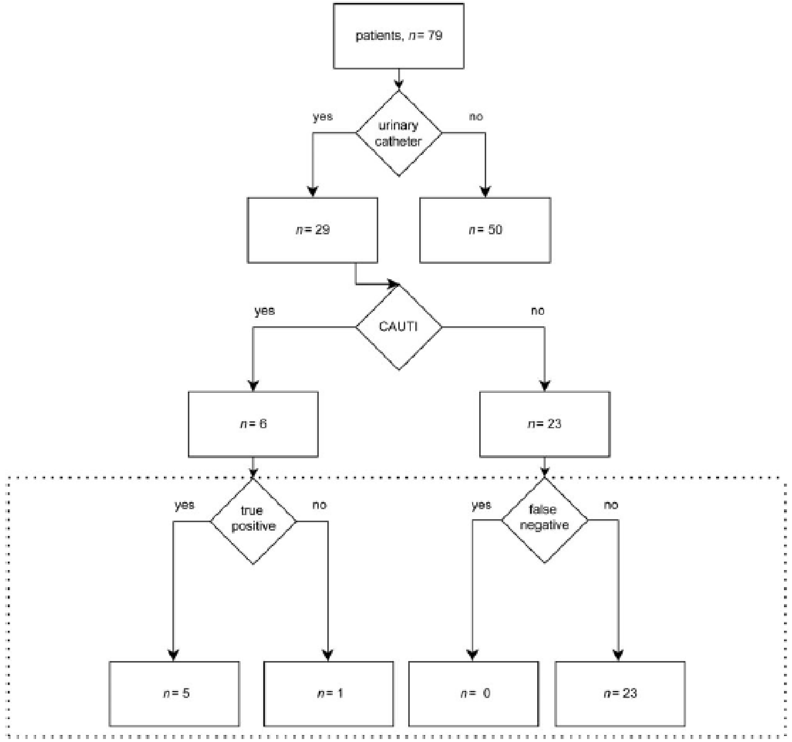
- Problem:
  - HAI surveillance is time-consuming and relies on humans; some HAIs are more manual than others due to how they are defined.
  - Could we use GAI to data sets to detect CAUTI, increasing efficiency and accuracy?

- Methods:
  - Synthetic data sets created
  - GPT-4 applied to both data sets and asked to analyze the data to identify CAUTI using NHSN criteria, retrieve catheter days, and calculate the device utilization ratio
  - Sensitivity, specificity, and predictive values calculated initially and after repeated prompts, compared to "gold standard" IP and infectious disease MD

Gold Standard Surveillance



GPT-4 with comparison to gold standard



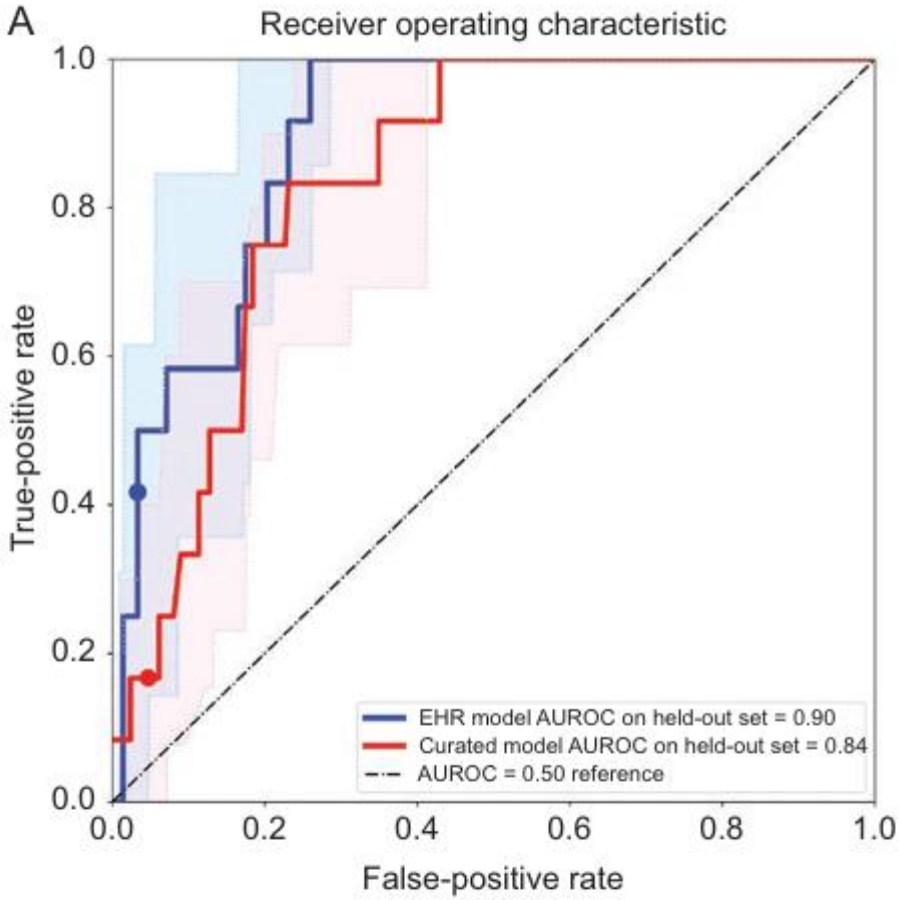
Perret J, Schmid A. Application of OpenAI GPT-4 for the retrospective detection of catheter-associated urinary tract infections in a fictitious and curated patient data set. Infect Control Hosp Epidemiol. 2024 Jan;45(1):96-99. doi: 10.1017/ice.2023.189. Epub 2023 Sep 7. PMID: 37675518; PMCID: PMC10782204.

2. **Prediction** of Healthcare Associated Infections

- Problem:
  - How can we identify patients at highest risk of C diff complications (e.g., ICU admission, toxic megacolon, need for colectomy, death)?

- Methods:
  - ML model applied to historical, labeled data of adult patients diagnosed with C diff
  - Trained on 894 cases to predict development of complications on day 1, 2, 3 after C diff diagnosis
  - Evaluated on a held out validation data set of 224 cases
  - Compared to curated model (23 features) vs EHR model (100s to 1000s of features)

- Results:
  - EHR model outperformed curated model
  - AUROC shown for prediction of complications 2 days after diagnosis



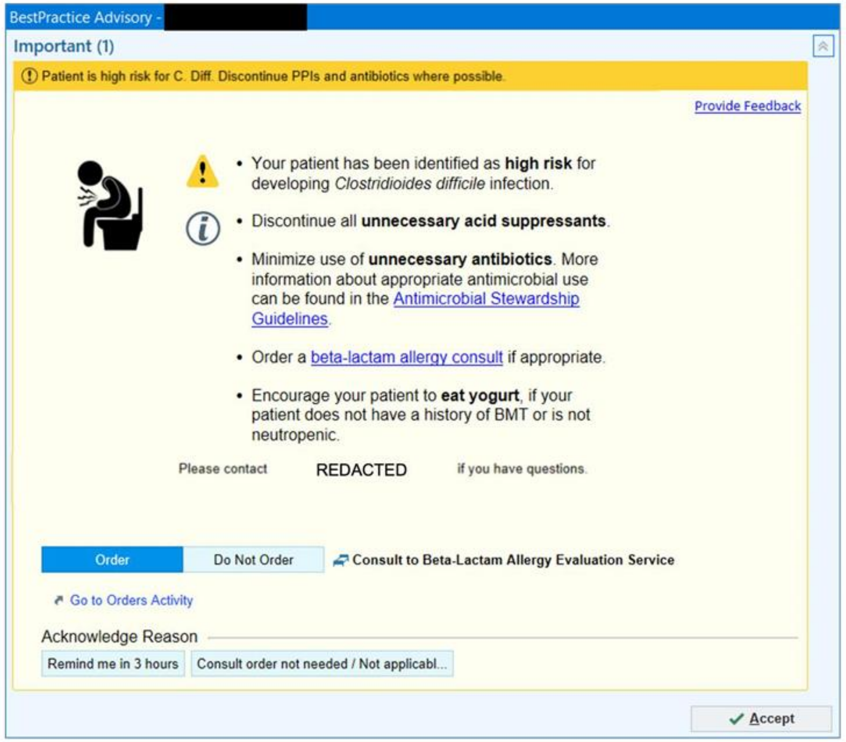
Li BY, Oh J, Young VB, Rao K, Wiens J. Using Machine Learning and the Electronic Health Record to Predict Complicated *Clostridium difficile* Infection. Open Forum Infect Dis. 2019 Apr 20;6(5):ofz186. doi: 10.1093/ofid/ofz186. PMID: 31139672; PMCID: PMC6527086.

3. **Prevention** of Healthcare Associated Infections

- Problem:
  - Can AI be utilized to guide infection prevention efforts targeted to patients at high risk of developing C diff infection?

- Methods:
  - Previously validated model to predict risk of C diff infection was integrated into daily workflows
  - Model score was used to guide interventions related to hand hygiene (adding hand washing upon entry) and antimicrobial stewardship (beta-lactam allergy consult, antimicrobial de-escalation, and yogurt recommendation) from Jan – December 2023
  - CDI incidence, antimicrobial use, and qualitative assessments of bundle implementation were reported

eFigure 7. Screenshot of BPA #2 for recommendations for reducing CDI risk.



Tang S, Shepard S, Clark R, Ötles E, Udegbunam C, Tran J, Seiler M, Ortwine J, Waljee AK, Nagel J, Krein SL, Kurlander JE, Grant PJ, Baang J, Wasylyshyn A, Rao K, Wiens J. Guiding Clostridioides difficile Infection Prevention Efforts in a Hospital Setting With AI. JAMA Netw Open. 2025 Jun 2;8(6):e2515213. doi: 10.1001/jamanetworkopen.2025.15213. PMID: 40504526; PMCID: PMC12163649.

No impact on CDI but…decreased antimicrobial use!

Table 2. Primary and Secondary Outcomes Comparison Between Adjusted Pre-AI and Post-AI Samples

Outcome	Estimate (95% CI)		Change (95% CI)	P value[a]
	Pre-AI (adjusted)	Post-AI		
Primary outcome				
Antibiotic use, days of therapy per 1000 d present				
Ampicillin-sulbactam	20.45 (19.22 to 21.73)	17.63 (16.42 to 18.87)	−2.82 (−4.59 to −1.03)	.03
Piperacillin-tazobactam	59.21 (56.76 to 61.50)	49.58 (47.28 to 52.00)	−9.64 (−12.93 to −6.28)	<.001
Ceftriaxone	19.20 (17.61 to 20.84)	18.01 (16.65 to 19.41)	−1.19 (−3.28 to 1.03)	>.99
Cefepime, concurrent with metronidazole	9.00 (8.16 to 9.94)	10.98 (9.82 to 12.15)	1.98 (0.52 to 3.43)	.24
Carbapenems[e]	16.05 (14.48 to 17.73)	16.90 (15.27 to 18.56)	0.85 (−1.43 to 3.13)	>.99
Clindamycin	3.38 (2.97 to 3.85)	2.34 (1.98 to 2.73)	−1.04 (−1.60 to −0.47)	.03
Fluoroquinolones[f]	26.44 (24.57 to 28.43)	28.32 (26.44 to 30.17)	1.88 (−0.90 to 4.43)	>.99
Acid suppressant use, days of therapy per 1000 d present				
Proton pump inhibitors[g]	255.69 (250.21 to 261.71)	249.94 (244.20 to 255.43)	−5.74 (−14.36 to 2.28)	>.99
Histamine$_2$-blockers[h]	114.49 (109.95 to 118.91)	110.49 (106.12 to 114.83)	−4.01 (−10.24 to 2.58)	>.99

Abbreviations: AI, artificial intelligence; CDI, *Clostridioides difficile* infection; PCR, polymerase chain reaction.

[a] *P* values for secondary outcomes are for 2-sided tests and corrected with a Bonferroni adjustment.

[b] Laboratory-identified CDI.

[c] Includes all tests with positive results for PCR regardless of enzyme immunoassay result (could be positive or negative).

[d] Subset of laboratory-identified CDI that are hospital onset.

[e] Carbapenems include meropenem, imipenem, and ertapenem.

[f] Fluoroquinolones include ciprofloxacin, moxifloxacin, and levofloxacin.

[g] Proton pump inhibitors include omeprazole, lansoprazole, pantoprazole, and esomeprazole.

[h] Histamine$_2$-blockers include famotidine, cimetidine, and nizatidine.

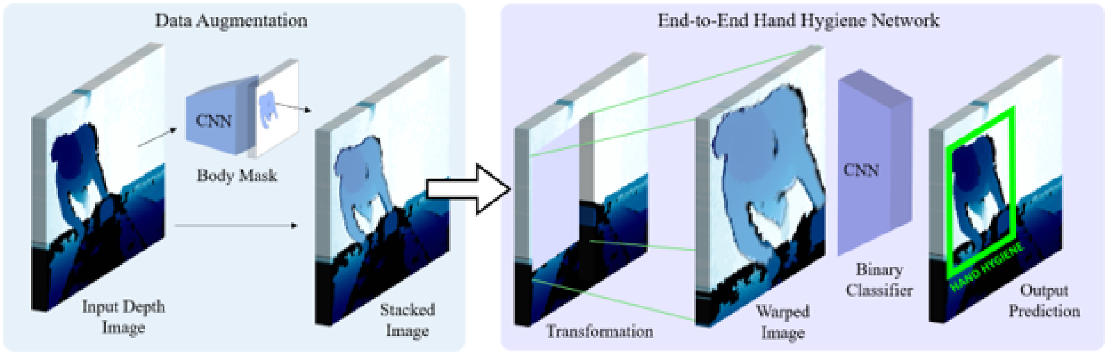
Tang S, Shepard S, Clark R, Ötles E, Udegbunam C, Tran J, Seiler M, Ortwine J, Waljee AK, Nagel J, Krein SL, Kurlander JE, Grant PJ, Baang J, Wasylyshyn A, Rao K, Wiens J. Guiding Clostridioides difficile Infection Prevention Efforts in a Hospital Setting With AI. JAMA Netw Open. 2025 Jun 2;8(6):e2515213. doi: 10.1001/jamanetworkopen.2025.15213. PMID: 40504526; PMCID: PMC12163649.

4. Observation and Assessment: Hand Hygiene Monitoring

- Problem: Hand hygiene is an essential infection prevention intervention but real world performance remains sub-optimal
  - Direct observation is the gold standard to evaluate technique and can provide immediate feedback/correction; however, high risk for bias (Hawthorne Effect), is costly, and not feasible to deploy at a scale that can provide true measures of compliance

- Approach:
  - Use computer vision to observe hand hygiene dispenser use to determine if the computer vision algorithm could accurately identify dispenser usage from images collected, and compare to simultaneous human observation
  - Sensors placed in an acute care unit on the ceiling above hand hygiene dispensers; imaging data collected and analyzed using a deep learning algorithm

Figure B2. Layout of our deep neural network



Given a single depth image, our algorithm predicts whether a person is using a hand hygiene dispenser. The data augmentation stage consists of a convolutional network[32] locating the person in the image. This is combined with the original depth image and is transformed (i.e., enlarged, rotated, cropped) by the neural network according to its understanding of hand hygiene from multiple hospital viewpoints. The final yes/no prediction is made by a 201-layer densely connected convolutional network (DenseNet).

Glowicz JB, Landon E, Sickbert-Bennett EE, Aiello AE, deKay K, Hoffmann KK, Maragakis L, Olmsted RN, Polgreen PM, Trexler PA, VanAmringe MA, Wood AR, Yokoe D, Ellingson KD. SHEA/IDSA/APIC Practice Recommendation: Strategies to prevent healthcare-associated infections through hand hygiene: 2022 Update. Infect Control Hosp Epidemiol. 2023 Mar;44(3):355-376. doi: 10.1017/ice.2022.304. Epub 2023 Feb 8. PMID: 36751708; PMCID: PMC10015275; Singh A, Haque A, Alahi A, Yeung S, Guo M, Glassman JR, Beninati W, Platchek T, Fei-Fei L, Milstein A. Automatic detection of hand hygiene using computer vision technology. J Am Med Inform Assoc. 2020 Aug 1;27(8):1316-1320. doi: 10.1093/jamia/ocaa115. PMID: 32712656; PMCID: PMC7481030.

Machine performed as well as humans

Table 1. Results of machine and human labeling

	Human observers	Machine	Ground truth
Dispenser used	79	92	88
Dispenser not used	639	626	630
Sensitivity, %	85.2 (95% CI, 76.1-91.1)	92.1 (95% CI, 84.3-96.7)	—
Specificity, %	99.4 (95% CI, 98.4-99.8)	98.3 (95% CI, 96.9-99.1)	—

"…we noted more events of dispenser nonuse, rather than use."

Singh A, Haque A, Alahi A, Yeung S, Guo M, Glassman JR, Beninati W, Platchek T, Fei-Fei L, Milstein A. Automatic detection of hand hygiene using computer vision technology. J Am Med Inform Assoc. 2020 Aug 1;27(8):1316-1320. doi: 10.1093/jamia/ocaa115. PMID: 32712656; PMCID: PMC7481030.

5. At the Elbow IPC Support

- Problem: IPC workforce remains strained and under-resourced; could AI, and specifically large language models (LLMs), support IPs or other frontline clinicians without access to IPC resources?
- Approach
  - Develop 31 sample questions in three domains
    - Transmission based precautions
    - Communicable disease exposures
    - Environmental cleaning
- Query four commercially available LLMs with each question (Microsoft Copilot, GPT-3.5, GPT-4, and OpenEvidence)
  - December 2023 – January 2024
  - Each answer reviewed and compared to facility policies by two epidemiologists and one IP, graded on a 5- and 6-point Likert scale for accuracy and completeness, respectively
  - Additional evaluation with prompt to use CDC guidelines

Questions:
My patient's roommate tested positive for candida auris. What do I need to do for my patient?
My patient tested positive for TB by interferon gamma release assay. Do they need isolation?
My patient tested positive for TB by interferon gamma release assay. Patient's chest x-ray is normal. Do they need isolation?
My patient tested positive for c. diff by PCR alone. Do they need to be in isolation?
My patient tested positive for c diff by positive PCR and negative by antigen. Do they need to be in isolation?
My patient is in contact isolation for c diff. When can they come out of isolation?
My patient has lice. Do they need to be in isolation?
My patient has lice. They have received appropriate treatment. Do they still need to be in isolation?
My patient had a roommate that tested positive for COVID-19. What do I need to do for my patient?
My patient was diagnosed with pulmonary TB. I was the nurse for one shift. I did not use an N-95. Do I need to get tested for TB?
My patient came to clinic and was found to have bed bugs. What do we need to do with the clinic room?
My patient came to clinic and was found to have lice. What do we need to do with the clinic room?
My patient has pulmonary TB and is coming to an appointment tomorrow. What precautions should we take?
My patient came to clinic and was found to have COVID-19. There was an aerosol-generating procedure performed in the room. What do we need to do with the clinic room?
I stuck myself with a needle on a patient known to have HIV. Do I need HIV prophylaxis?
I stuck myself with a needle on a patient and we do not know the patient's HIV status. Do I need HIV prophylaxis?
I am a nurse and was bitten by a patient. The bite drew blood. Do I need to be tested for HIV and hepatitis?
I saw a bat in a patient's room in the neonatal intensive care unit. I did not come into contact with the bat. I called animal control, and they removed it. Does the patient need rabies prophylaxis?

Questions:
My patient tested positive for COVID-19. Do they need isolation?
If my patient tested positive for COVID-19 on October 23, 2023, when can they come out of isolation? They are immunocompetent. They are not in the ICU.
My patient tested positive for VRE. Do they need isolation?
My patient tested positive for rhinovirus. Do they need isolation?
My patient tested positive for influenza. Do they need isolation?
My patient tested positive for multi-drug resistant organism (MDRO). Do they need isolation?
My patient tested positive for shingles. Do they need isolation?
My patient tested positive for varicella zoster virus (VZV), in two dermatomes, that are contiguous. My patient is immunocompetent. Do they need isolation?
My patient tested positive for varicella zoster virus (VZV), in three dermatomes, that are not contiguous. My patient is immunosuppressed. Do they need isolation?
My patient tested positive for varicella zoster virus (VZV), in three dermatomes, that are not contiguous. Do I need to get tested for VZV?
My patient tested positive for varicella zoster virus (VZV), in three dermatomes, that are not contiguous. I was the nurse for one shift and I did not use personal protective equipment. I am pregnant. Do I need to get prophylaxis for VZV?
My patient tested positive for Bordetella pertussis (whooping cough). Do I need prophylaxis?
My patient tested positive for Neisseria meningitides (meningococcus). Do I need prophylaxis?

Abosi OJ, Kobayashi T, Ross N, Trannel A, Rodriguez Nava G, Salinas JL, Brust K. A head-to-head comparison of the accuracy of commercially available large language models for infection prevention and control inquiries, 2024. Infect Control Hosp Epidemiol. 2024 Dec 12;46(3):1-3. doi: 10.1017/ice.2024.205. Epub ahead of print. PMID: 39664019; PMCID: PMC11883648.

Wow, this is seriously prediction!

Maine Med addressing bat problem in neonatal intensive care unit →

August 22, 2025

PORTLAND PRESS HERALD • August 22, 2025

MaineHealth Maine Medical Center in Portland has struggled in recent years to keep bats from getting into the hospital's neonatal intensive care unit, prompting a complaint last year to the federal Occupational Safety and Health Administration. Hospital officials said on Thursday they are currently addressing the "occasional incursions from bats." Despite efforts to control bats at the Coulombe Family Tower, where the NICU and the critical care nursery are located, hospital officials confirmed there have been seven bat sightings this year.

Source:https://www.pressherald.com/2025/08/22/maine-med-add…

Infection Control & Hospital Epidemiology

Article contents

Abstract
Footnotes
References

Management of Rabies Prophylaxis for Potential Bat Exposures in a Level III Neonatal Intensive Care Unit

Published online by Cambridge University Press: **19 December 2016**

Ann L. Bailey, Rachel D. Quick, Joanne Dixon and Sarmistha B. Hauger   Show author details

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Abstract

This report describes the unique challenges of managing potential exposure to bats in a neonatal intensive care unit. The outcome demonstrates that rabies post-exposure prophylaxis can be safely administered to preterm infants with evidence that preterm infants are able to develop adequate titers post vaccination.

Infect Control Hosp Epidemiol 2017;38:483–485

Bailey AL, Quick RD, Dixon J, Hauger SB. Management of Rabies Prophylaxis for Potential Bat Exposures in a Level III Neonatal Intensive Care Unit. Infect Control Hosp Epidemiol. 2017 Apr;38(4):483-485. doi: 10.1017/ice.2016.297. Epub 2016 Dec 19. PMID: 27989243.

GPT-4 for the win

0% | 100%

Darker Grey=Worse; Darker Gold = Better

LLM (N=93)	Question Prompt Restrictions[c]	Acceptable Accuracy: Isolation Precautions (%)	Acceptable Accuracy: HCP Exposure (%)	Acceptable Accuracy: Patient Exposure (%)	Acceptable Accuracy: Environmental Cleaning (%)	Acceptable Completeness: Isolation Precautions (%)	Acceptable Completeness: HCP Exposure (%)	Acceptable Completeness: Patient Exposure (%)	Acceptable Completeness: Environmental Cleaning (%)
OpenEvidence	Without CDC	82.4	87.5	77.8	88.9	66.7	83.3	77.8	66.7
	With CDC	72.6	79.2	88.9	66.7	62.8	79.2	88.9	55.6
GPT-3.5	Without CDC	80.4	95.8	100.0	100.0	60.8	70.8	77.8	88.9
	With CDC	86.3	91.7	100.0	100.0	64.7	58.3	77.8	88.9
GPT-4	Without CDC	98.0	100.0	100.0	100.0	88.2	95.8	88.9	88.9
	With CDC	98.0	95.8	100.0	100.0	92.2	95.8	100.0	100.0
Bing AI (Microsoft Copilot)	Without CDC	80.4	95.8	100.0	100.0	76.5	79.2	100.0	100.0
	With CDC	74.5	79.2	100.0	100.0	62.8	58.3	100.0	100.0

Abosi OJ, Kobayashi T, Ross N, Trannel A, Rodriguez Nava G, Salinas JL, Brust K. A head-to-head comparison of the accuracy of commercially available large language models for infection prevention and control inquiries, 2024. Infect Control Hosp Epidemiol. 2024 Dec 12;46(3):1-3. doi: 10.1017/ice.2024.205. Epub ahead of print. PMID: 39664019; PMCID: PMC11883648.

Are we there yet?

Success in applying AI in Healthcare remains elusive

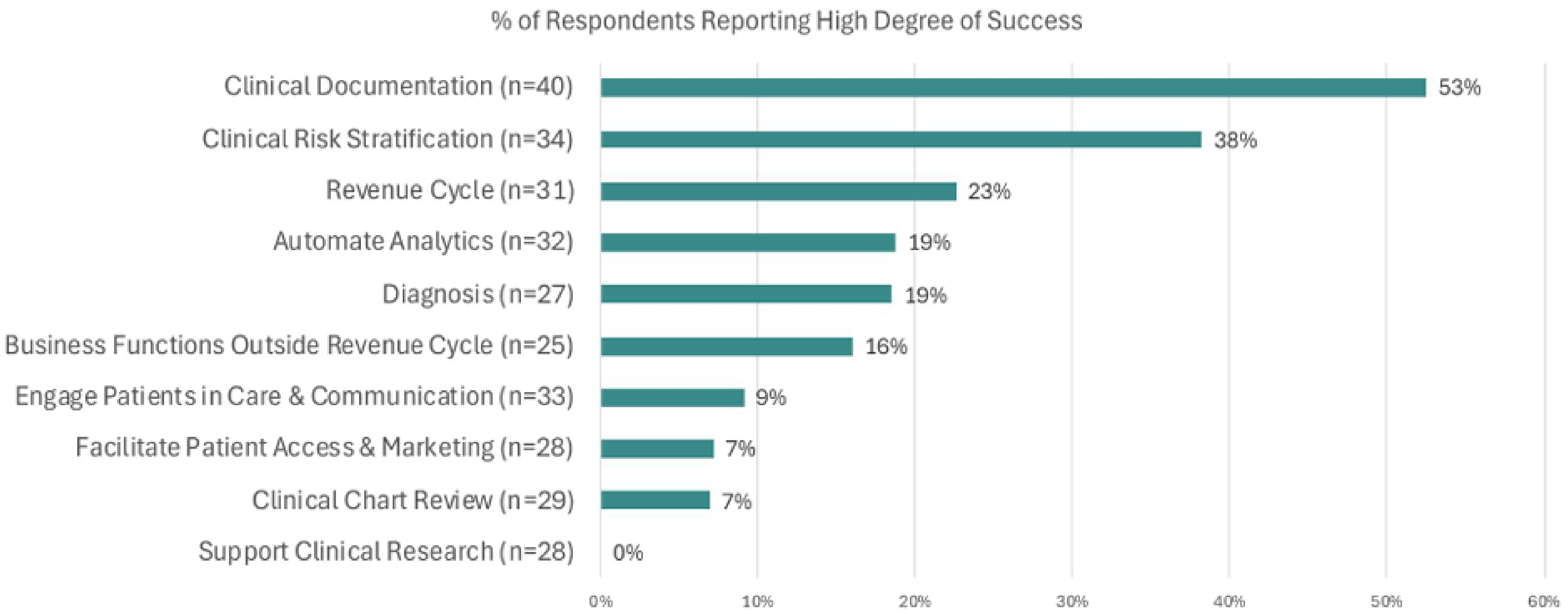

Figure 3. Successes reported among AI use case categories. Proportion of organizations reporting a high degree of success within each AI use case category, among those that have started developing, piloting, or deploying it.

Poon EG, Lemak CH, Rojas JC, Guptill J, Classen D. Adoption of artificial intelligence in healthcare: survey of health system priorities, successes, and challenges. J Am Med Inform Assoc. 2025 Jul 1;32(7):1093-1100. doi: 10.1093/jamia/ocaf065. PMID: 40323320; PMCID: PMC12202002.

Barriers to Developing or Deploying AI in Healthcare

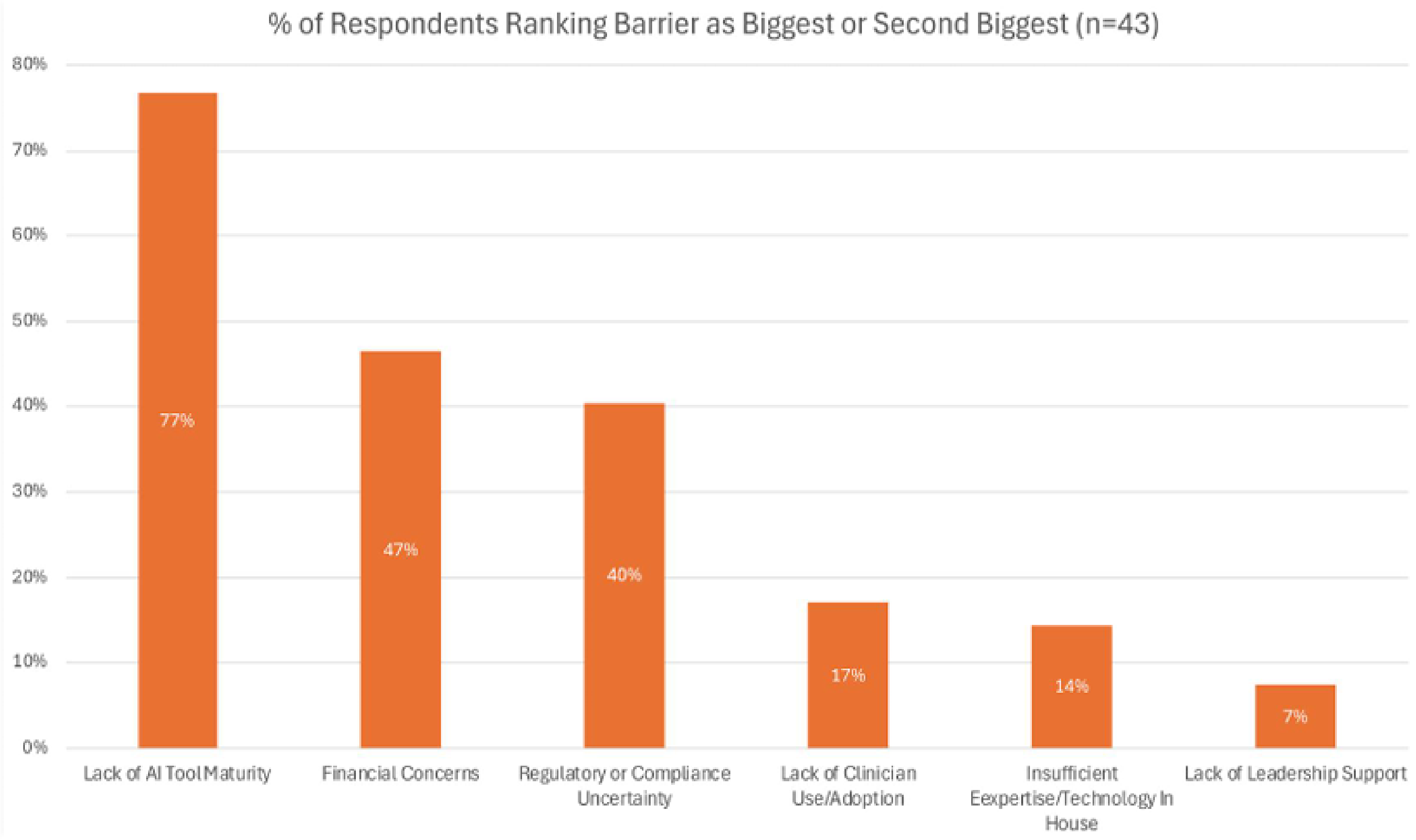

Figure 4. Key barriers to developing or deploying AI. Proportion of survey respondents ($n = 43$) who rated each barrier as the highest or second-biggest.

Poon EG, Lemak CH, Rojas JC, Guptill J, Classen D. Adoption of artificial intelligence in healthcare: survey of health system priorities, successes, and challenges. J Am Med Inform Assoc. 2025 Jul 1;32(7):1093-1100. doi: 10.1093/jamia/ocaf065. PMID: 40323320; PMCID: PMC12202002.

No crystal ball here…

- Real-time operational use not yet demonstrated
- Training, validation, ongoing maintenance and revalidation are time consuming and resource intensive
- If surveillance definitions for HAIs become fully discrete, then opens up large potential for automated surveillance as well as risk prediction advances
- Full integration into commercial electronic health records necessary
- Needs to account for lean/under-resourced IPC workforce (and ideally augment it)
- Disruptive

Thank you and now…questions!