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Prospective and Clinical Evaluation of an AI-Driven Decision Support System

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ICID

4th December 2024

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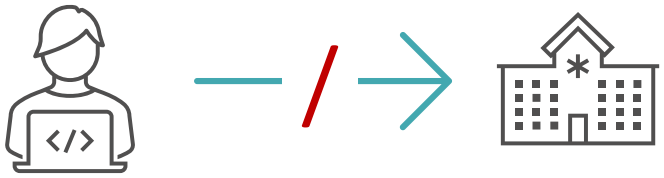
The data and findings presented here are part of ongoing, unpublished work.

Please refrain from sharing or distributing this information publicly. Thank you.

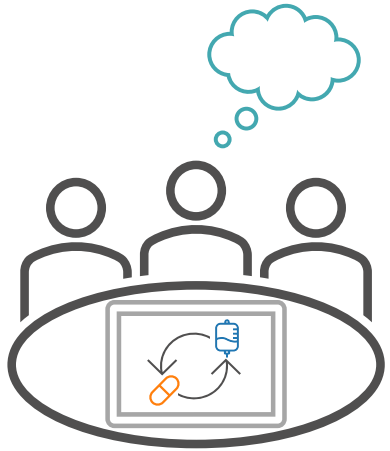
I have no conflicts of interest to declare.

Translating AI technology for infectious disease from research into healthcare settings is difficult.



Few AI decision support systems have been truly **translated, integrated and adopted** in healthcare

Infectious disease is especially **complex** due to **behavioral**, and cultural factors as well as **uncertainty** and frequent lack of a ground truth



We conducted **clinical evaluation** of an AI system for IV-to-oral switching to understand **user perceptions** and its **impact** on decision making

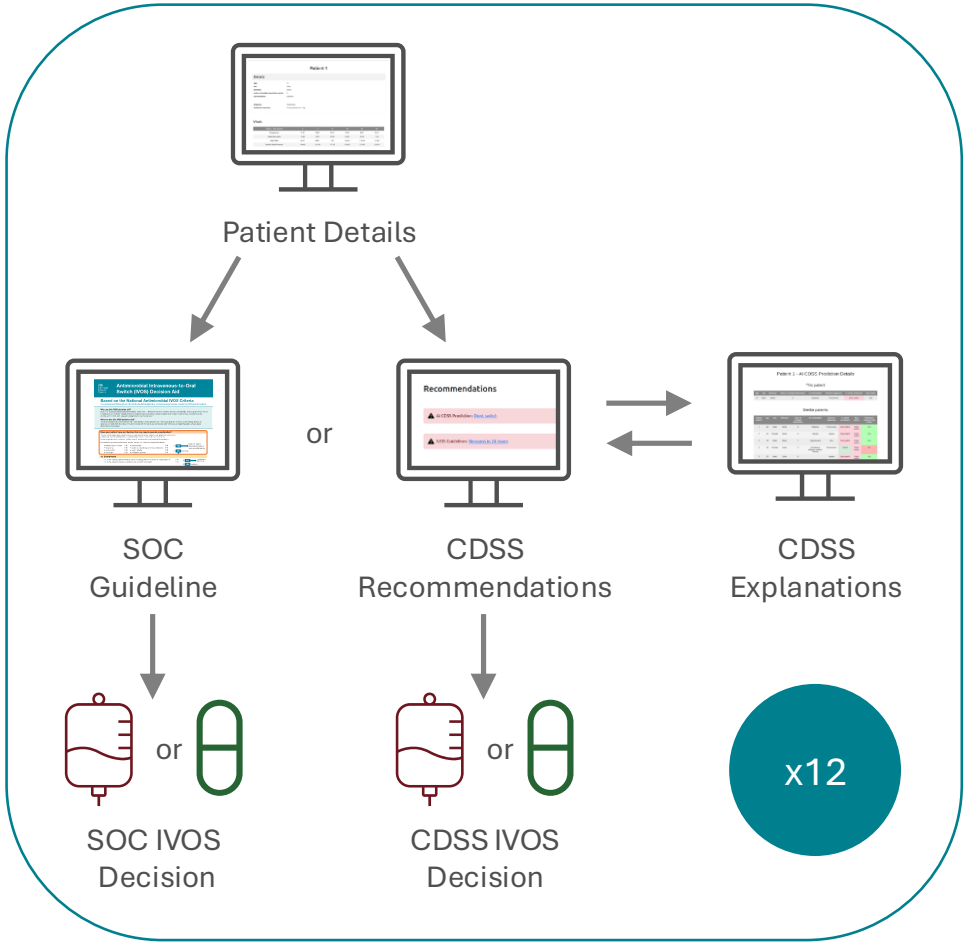
A randomized clinical vignette methodology with semi-structured interviews and questionnaires was used.

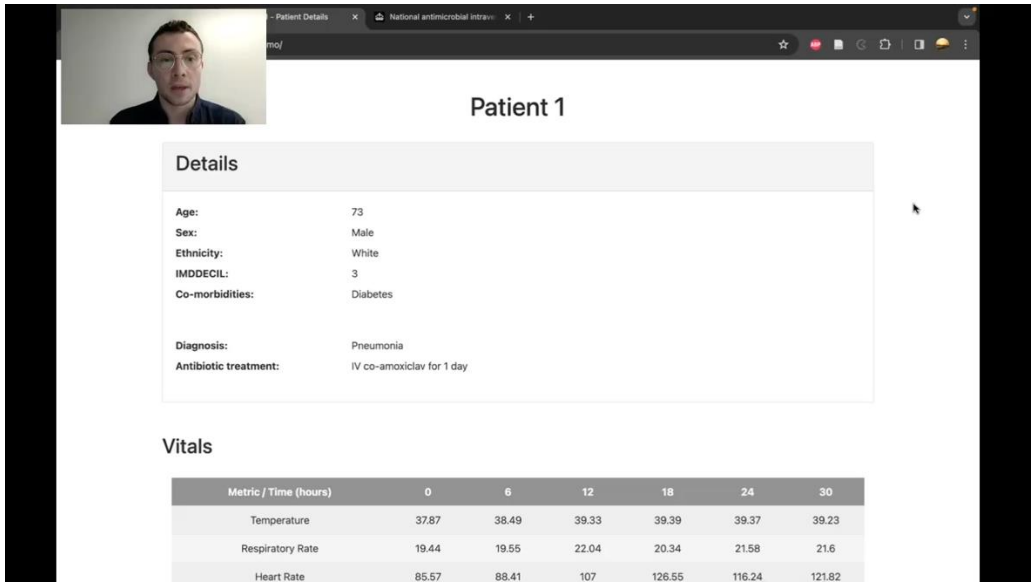
Clinicians

- Information sheet
- Informed consent
- Video demonstration

Semi-structured Interview

SUS & TAM Questionnaires



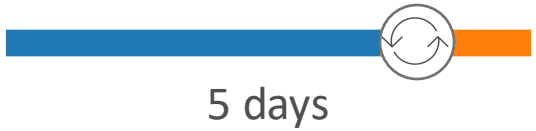


AI algorithms have been developed that use routinely collected data to support IV-to-oral antibiotic switching.

make the switch
FROM IV TO ORAL ANTIBIOTICS

One key challenge of stewardship is **determining when to switch** antibiotics from **IV-to-oral administration**

Numerous studies have shown that **oral therapy can be non-inferior to IV**



There is a **poor understanding** of the factors that facilitate or inhibit an individual from receiving oral therapy

FEATURES

UK Health Security Agency
Antimicrobial Intravenous-to-Oral Switch (IVOS) Decision Aid
Based on the National Antimicrobial IVOS Criteria
Co-produced through a UK-wide multidisciplinary consensus process involving 279 participants

RESULTS

Dataset	AUROC Result
MIMIC	0.78 (SD 0.02)
eICU	0.72 (SD 0.02)
ICHT	0.78 (SD 0.01)

PAPER

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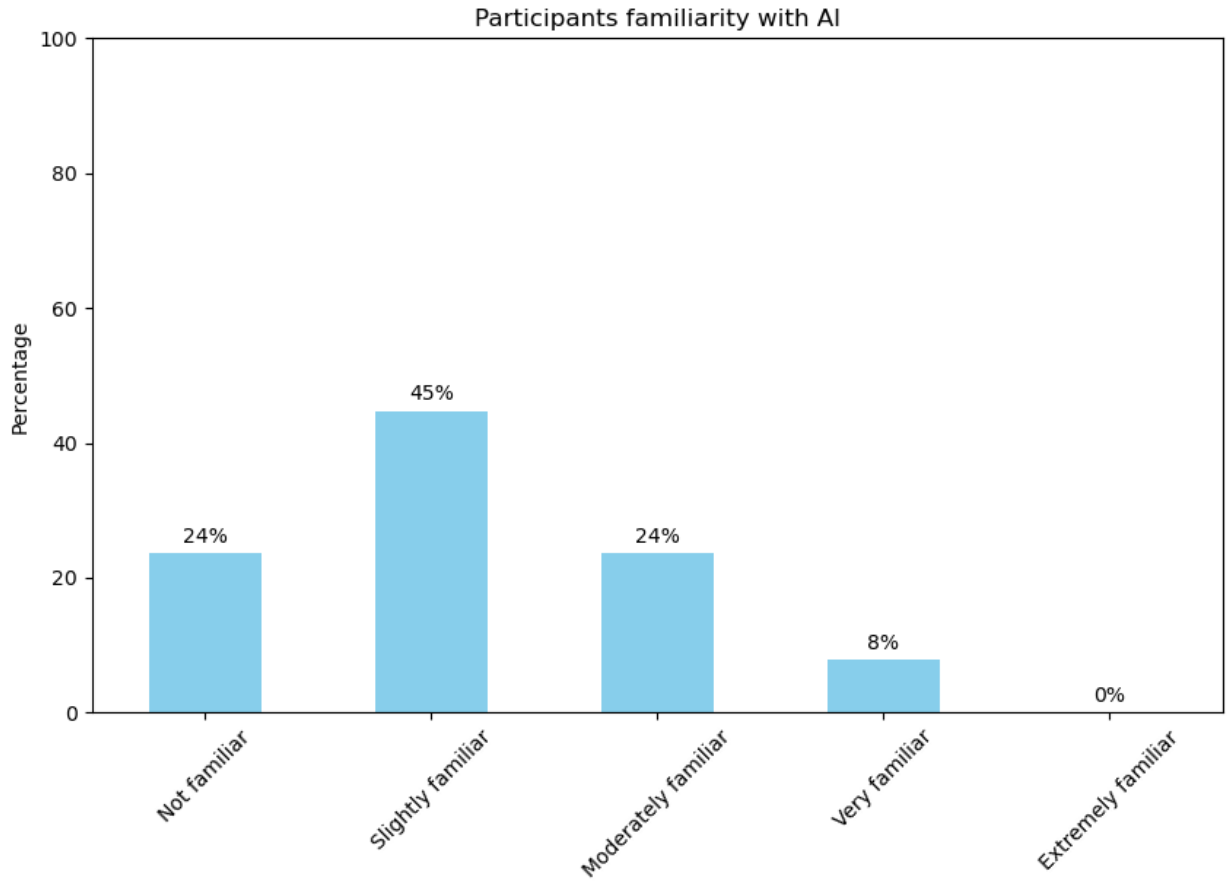
Forty-two clinicians completed the study with most UK consultant level and specializing in infectious disease.

42 PARTICIPANTS

Demographic	No. (%) of participants
Grade	
Consultant	26 (61.90%)
Other	16 (38.10%)
Medical Speciality	
Infectious Diseases	14 (33.33%)
Microbiology	12 (28.57%)
Pharmacist	6 (14.29%)
Other	10 (23.81%)
Sex	
Male	23 (54.76%)
Female	19 (45.24%)
Age	
20s	4 (9.52%)
30s	17 (40.48%)
40s	12 (28.57%)
50s	6 (14.29%)
60s	2 (4.76%)
Prefer not to say	1 (2.38%)
Age Statistics	
Mean	42
Median	37
Standard Deviation	8.84



The AI-IVOS CDSS has a greater impact on clinician's decision making when it recommends don't switch.

NO DIFFERENCES

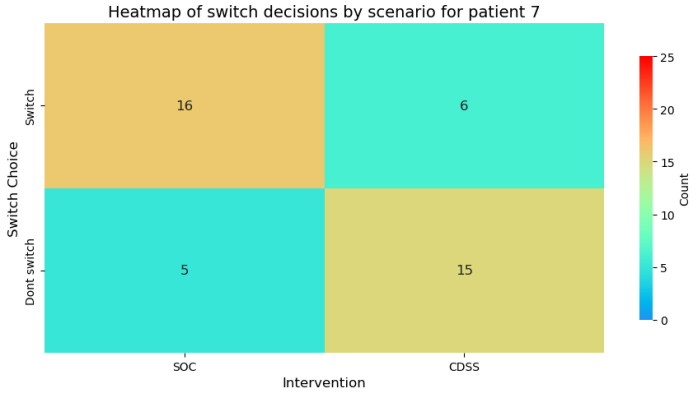
11/12 cases

TAKAWAYS

- Prescribing decisions are **nuanced** and **complex**
- Clinicians could correctly identify incorrect AI recommendations and **ignore the support**

STATISTICALLY SIGNIFICANT DIFFERENCES

Patient 7 and subgroup analysis for 3 patients



- The system has a **greater influence** on clinicians when it recommends **don't switch**
- Participants were **persuaded to take the option perceived as safer** which matches the culture of cautiousness (40%) and hesitancy to change (24%) reported in interviews.

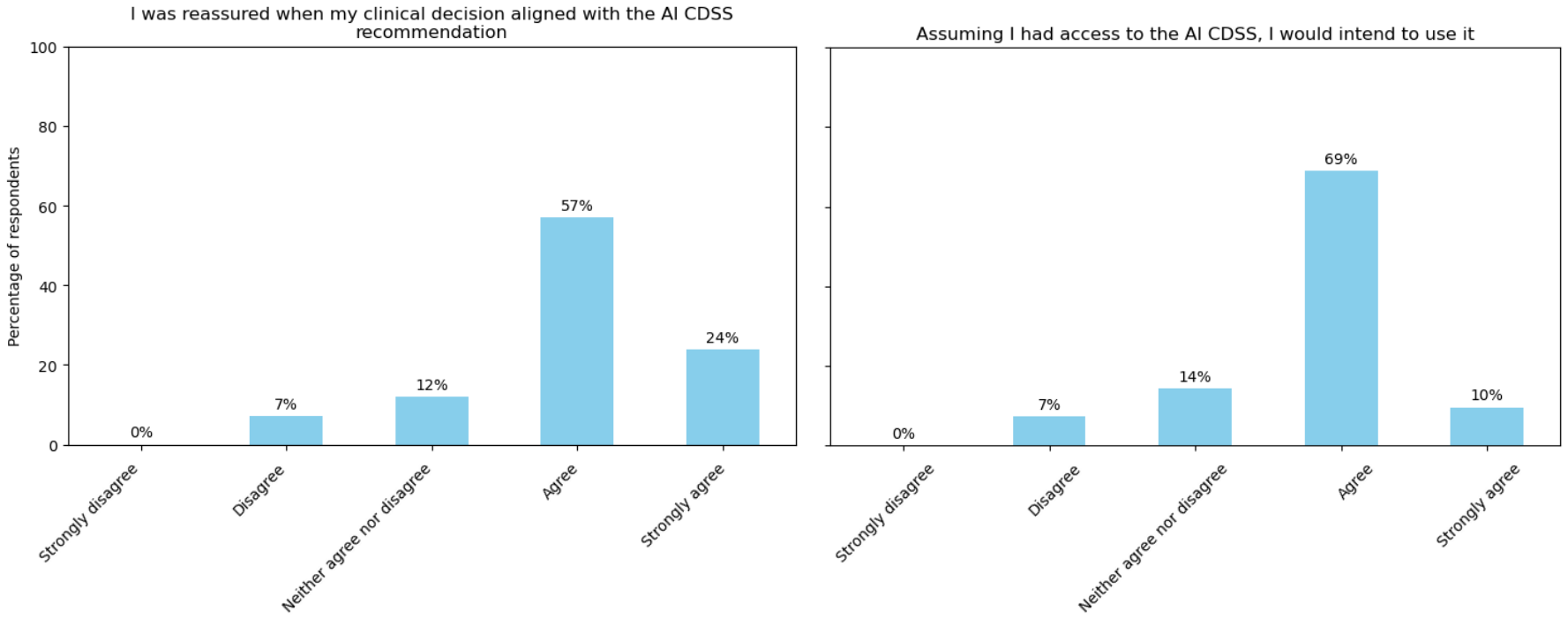
The technology was useful, usable and perceived well by participants.

System Usability score: 72.32 / 100

Perceived ease of use: 3.83 / 5

Perceived usefulness: 3.59 / 5

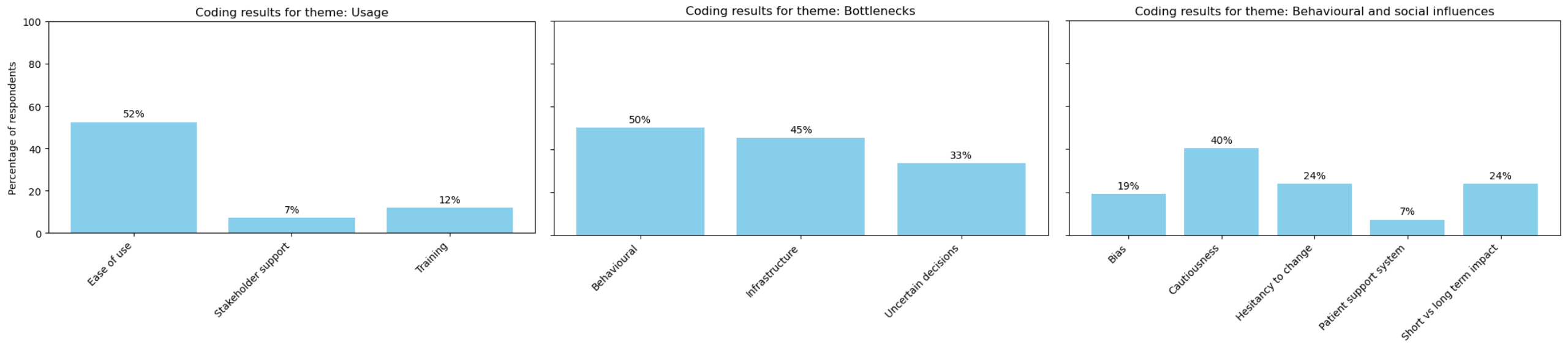
Self efficacy: 4.05 / 5



TAKAWAYS

- Clinicians are **reassured** and more confident when given AI recommendations
- The AI CDSS was well perceived being **useful, usable and appropriate**

Numerous barriers exist to implementing AI technology with evidence and the system being easy to use essential for adoption.



TAKAWAYS

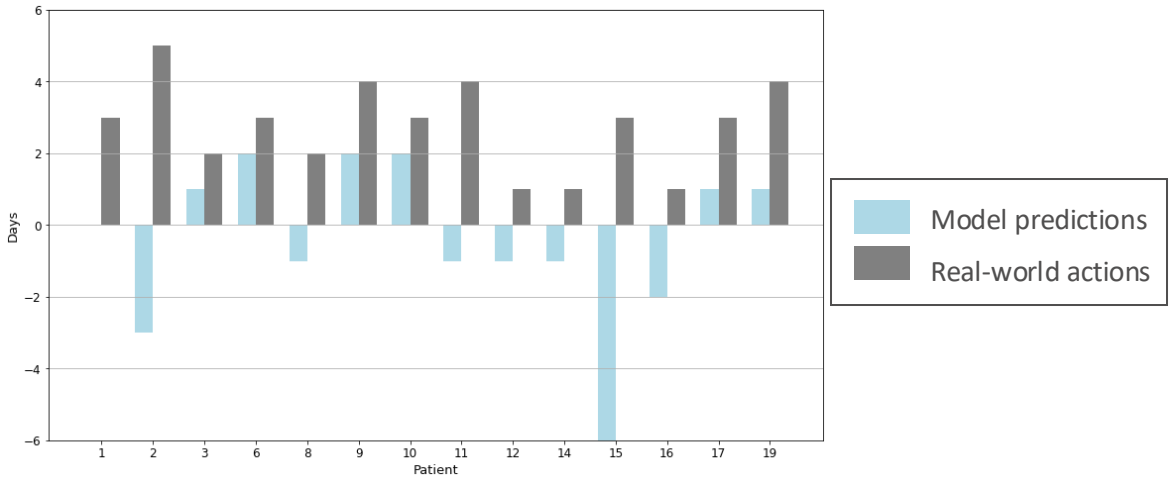
- There was disagreement on whether healthcare institutions have the necessary **infrastructure to support AI technology**
- **Behavioural factors** such as cautiousness play an important role in antimicrobial prescribing and can act as a **barrier** to technology adoption
- Trust in AI-CDSSs is built through **clinical evidence**, with **ease of use** being essential for adoption

Preliminary prospective evaluation was conducted on 40 patients at Imperial NHS Trust against pharmacists' recommendations.

Metric	Result
AUROC	0.68
Accuracy	0.70
FPR	0.28

Temporal difference	Percentage
Early	37.50
Same day	32.50
Late	30

Overall absolute temporal difference of 1.23 days (SD 1.42)



TAKAWAYS

- **Reasonable performance** on small patient sample with a slight preference for **early predictions**
- Such prospective evaluation is essential for highlighting the AI systems **successes and pitfalls**

This AI CDSS was perceived well and has a greater influence on clinicians when it recommends don't switch.

Future Work

Prospective validation

Clinical translation and adoption

Conclusion

- Clinical decision support system can often have **unexpected impacts on decision making**, such as this system having a greater influence when it recommends don't switch.
- This artificial intelligence system has **potential** to support antibiotic stewardship through **optimising antibiotic switch decision making**
- **Numerous barriers exist** to implementing AI technology including **behaviour change** with further prospective validation required to gather **evidence on the safety and clinical benefit** of the system
- **Studies such as this are essential** for **engaging with end users** and understanding the potential impact and performance of AI technology

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I would like to acknowledge the contribution of the following individuals.

Dr Tim Rawson

Professor Pantelis Georgiou

Professor Alison Holmes

Dr Mark Gilchrist

Mr Richard Wilson

Health
camo
centre for antimicrobial optimisation

Thank you!

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4th December 2024

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Website

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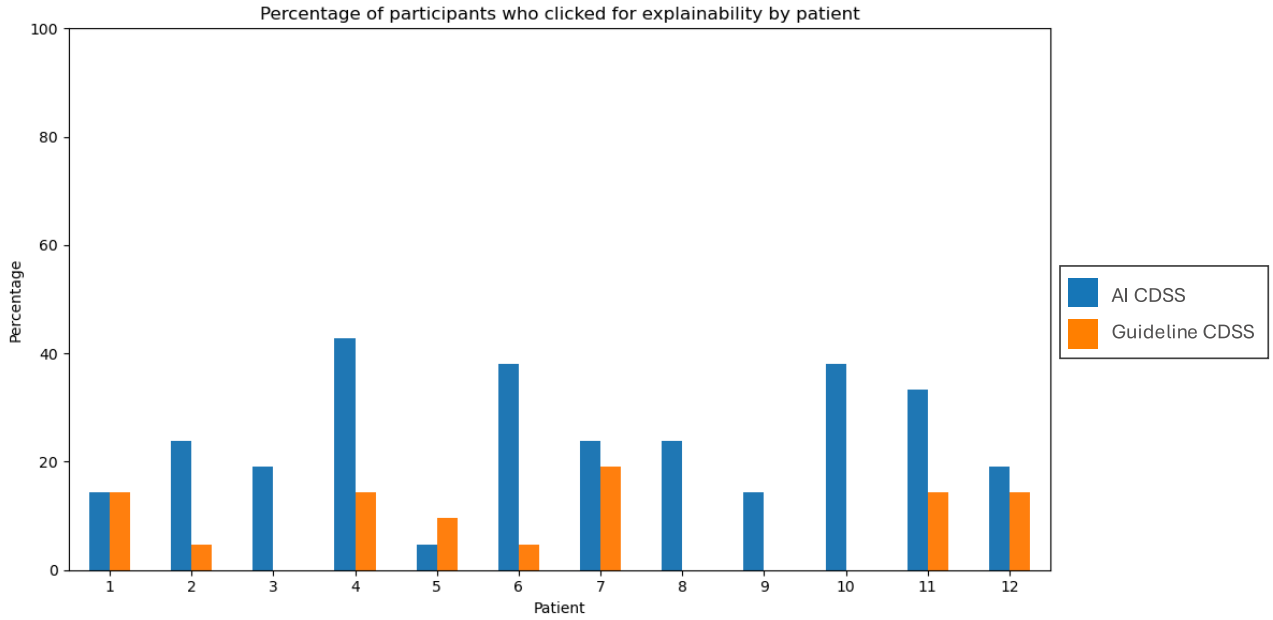
GitHub

Explanations are likely to be underutilized in real clinical practice due to time constraints on decision making .

	Percentage of participants that clicked	
	At any time	When available
AI CDSS explanations	55%	**9%**
Guideline CDSS explanations	29%	5%



TAKAWAYS

- CDSS explanations were **not frequently used when available**
- Implying that it was the **presence of an AI recommendation** itself driving changes in decision making
- Explainability methods including displaying **similar** patients (including their outcomes) and summarizing information in **free text** warrants further research

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Case vignette details.

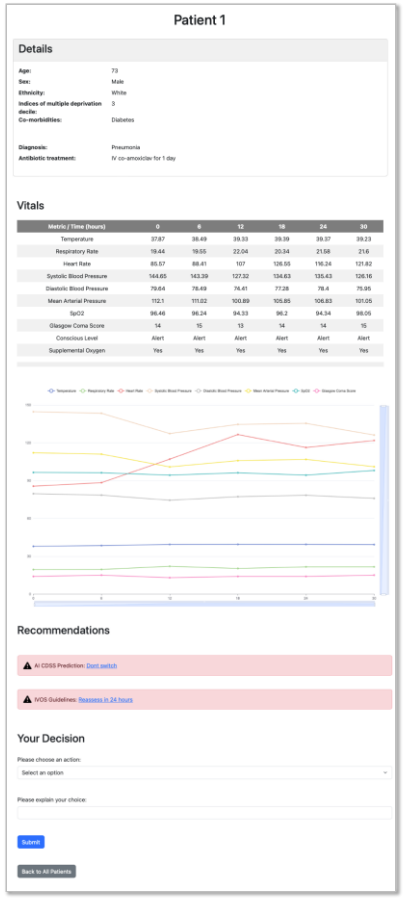
Patient	Intervention		AI CDSS recommendation	Guideline CDSS recommendation	Ground Truth	Data	Group
	Arm A	Arm B					
1	CDSS	SOC	Don't switch	Don't switch	Don't switch	ICHT	AI correct
2	SOC	CDSS	Switch	Switch	Switch	ICHT	AI correct
3	SOC	CDSS	Switch	Don't switch	Don't switch	ICHT	AI incorrect
4	CDSS	SOC	Don't switch	Switch	Switch	ICHT	AI incorrect
5	SOC	CDSS	Switch	Don't switch	-	ICHT	Uncertain
6	CDSS	SOC	Don't switch	Switch	-	ICHT	Uncertain
7	CDSS	SOC	Don't switch	Don't switch	Didn't switch	MIMIC	AI correct
8	SOC	CDSS	Switch	Switch	Switched	MIMIC	AI correct
9	SOC	CDSS	Potentially switch	Switch	Didn't switch	MIMIC	Uncertain
10	CDSS	SOC	Don't switch	Switch	Switched	MIMIC	AI incorrect
11	CDSS	SOC	Switch	Don't switch	Didn't switch	MIMIC	AI incorrect
12	SOC	CDSS	Potentially switch	Don't switch	Switched	MIMIC	Uncertain

Table 1: Details of the experimental setup and case vignettes.

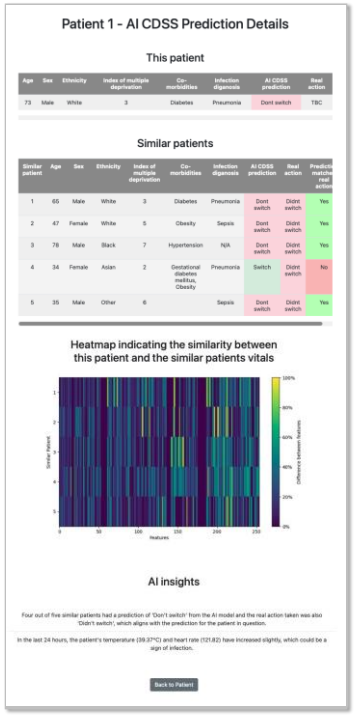
Screenshots of the web app used for the case vignette experiment.

A

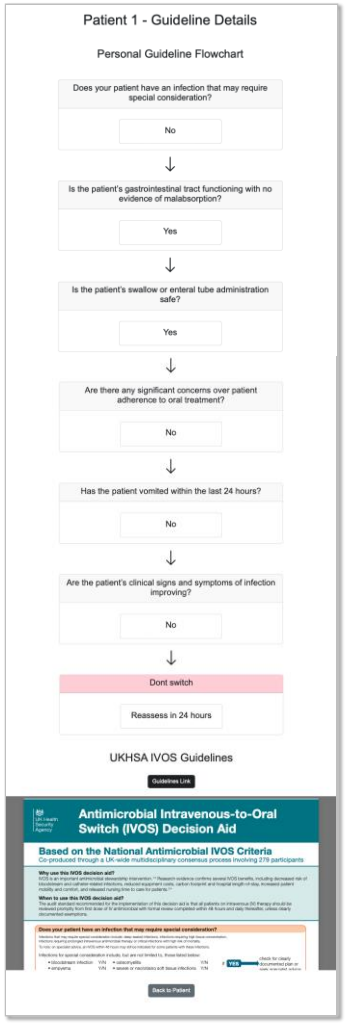
Case Vignette



AI CDSS Explanations

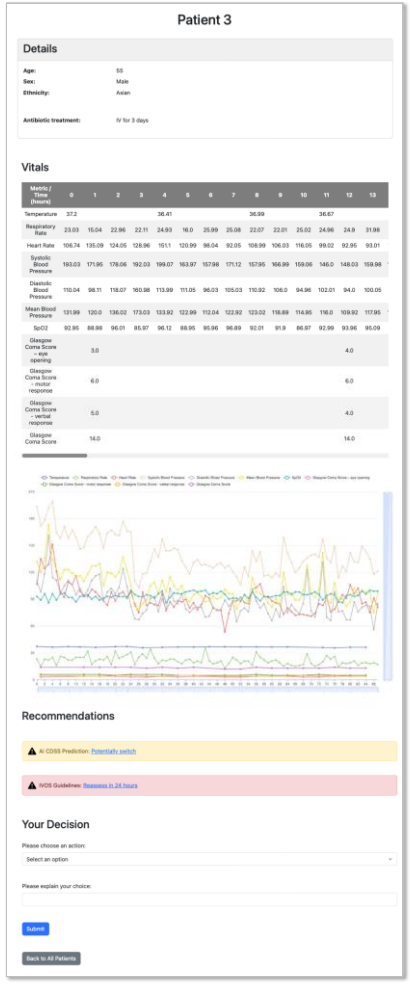


Guideline CDSS Explanations

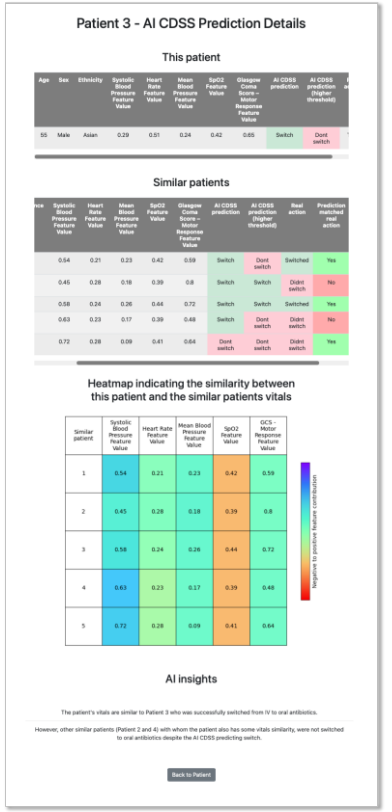


B

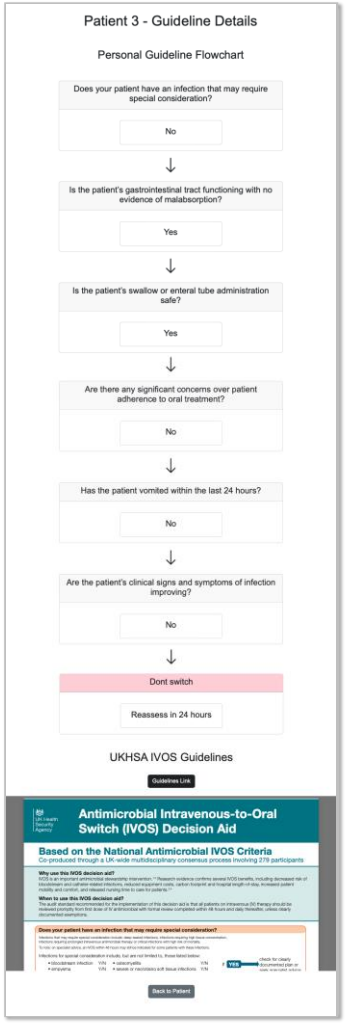
Case Vignette



AI CDSS Explanations



Guideline CDSS Explanations



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Shannon entropy results from the case vignette experiment.

Patient	Shannon entropy
1	0.00
2	0.28
3	0.78
4	0.28
5	0.28
6	0.45
7	1.00
8	0.97
9	0.53
10	1.00
11	1.00
12	0.94

Table 9: Shannon entropy values for the switch decisions made by participants for each patient. Note due to two options (i.e., switch or dont switch) the minimum and maximum possible Shannon entropy values are 0 and 1 respectively.

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Our work on artificial intelligence for optimised antibiotic decision making.

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STAGES OF ANTIBIOTIC DECISION MAKING

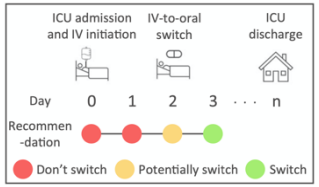
Hospital admission

Antimicrobial stewardship

Hospital discharge

0 — 1 — 2 — 3

IV-to-oral switch



Antibiotic readmission

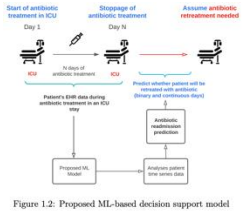


Figure 1.2: Proposed ML-based decision support model

Side effects

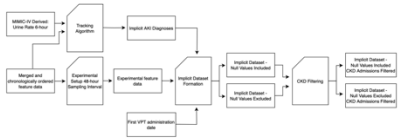
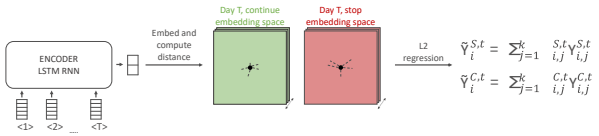


Figure 13: Implicit dataset formation workflow.

Antibiotic cessation



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frontiers in Digital Health

Using AI to optimize antimicrobial prescribing raises important ethical questions.

ETHICAL VIEWPOINT

Comment

https://doi.org/10.1038/s42256-022-00558-5

Developing moral AI to support decision-making about antimicrobial use

William J. Bolton, Cosmin Badea, Pantelis Georgiou, Alison Holmes and Timothy M. Rawson

Check for updates

The use of decision-support systems based on artificial intelligence approaches in antimicrobial prescribing raises important moral questions. Adopting ethical

decision is morally right is often unclear. Incorporating such concepts into AI systems is complex but may be supported by the development of a consensus on the optimal approach to decision-making in this context. In this article, we aim to explore potential ethical frameworks and nuances that may be applied to define what is ethical or not during the development of AI-based clinical decision-support systems (CDSSs)

nature machine intelligence

Variables	Description	Exemplar of starting antimicrobial treatment	Corresponding ad-hoc utility value
Intensity	How strong is the pleasure?	Treating a relevant infection with antimicrobials has the potential to save that person's life	Highly positive utility
Duration	How long will the pleasure last?	Any extension of life is immeasurable while it is reasonable AMR will continue in the near-term future	Positive utility
Certainty or uncertainty	How likely or unlikely is it that the pleasure will occur?	Limited information often means treatment may or may not be helpful and there is always an inherent risk of developing AMR	Neutral utility, without more information
Propinquity	How soon will the pleasure occur?	Treatment can be effective immediately however the same is true for the evolution of AMR	Neutral utility, without more information
Fecundity	The likelihood of further sensations of the same kind	-	Unable to assign
Purity	The likelihood of not being followed by opposite sensations	-	Unable to assign
Extent	How many people will be affected?	Prescribing antimicrobials effects the patient and those close to them, while the development of AMR is a certainty and may affect everyone, causing significant suffering and mortality	Immense negative utility

Patient and clinician views have been considered, with the public and stakeholder educated.

EDUCATION

PRIMARY RESEARCH