

# AUGMENTED INTELLIGENCE IN INFECTIOUS DISEASES (AI<sup>2</sup>D)

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## INTRODUCTION

Lower respiratory tract infection (LRTI) is among the most common infections globally and is one of the leading causes for hospitalisation locally. A 2024 survey at Singapore General Hospital (SGH) reported that 21% antibiotics used for treatment of infection was for LRTI. However, not all LRTI are caused by bacterial infection that requires antibiotic treatment, and some may be non-infectious conditions that have similar symptoms. According to published literature and local report, at least 30-40% of antibiotics used for suspected LRTI are unnecessary. Currently, due to manpower constraints, SGH Antimicrobial Stewardship Unit (ASU) conducts prospective audit feedback (PAF) on only 30% of all antibiotics to ensure appropriate prescribing. The remaining 70% are left to the sole discretion of primary physicians and with 30% of antibiotic use expected to be inappropriate. Hence, there is urgent need to expand oversight.

## METHODOLOGY

To address antibiotic over-prescribing in LRTI, a computerised yet individualised tool that effectively determines when antibiotics are indicated for suspected bacterial LRTI at the point of prescribing is needed. Artificial intelligence/machine learning (AI/ML) can ingest multiple data streams and identify meaningful patterns to generate highly accurate conclusions that surpass performance of conventional means. We explored its feasibility with clinical (infectious diseases physicians) and technical experts (data scientists & Synapxe), culminating in a proof-of-concept project. Following in-house development of AI<sup>2</sup>D in 2022, it underwent rigorous technical and prospective clinical validation studies.

## RESULTS

AI<sup>2</sup>D was implemented by ASU in April 2024 to significantly expand prospective audit feedback (PAF) of selected antibiotics by increasing operation efficacy to identify inappropriate antibiotics for discontinuation without compromising patient outcome.

From April to September 2024, 658 antibiotic courses for LRTI treatment was subjected to AI<sup>2</sup>D. AI<sup>2</sup>D immediately assessed 453 as appropriate and flagged only 205 (31.1%) cases for ASU review for potential antibiotic discontinuation. Cases that AI<sup>2</sup>D predicted to not require antibiotics were randomised 1:1 to receive AMS PAF or standard of care (SOC, no AMS review/intervention).

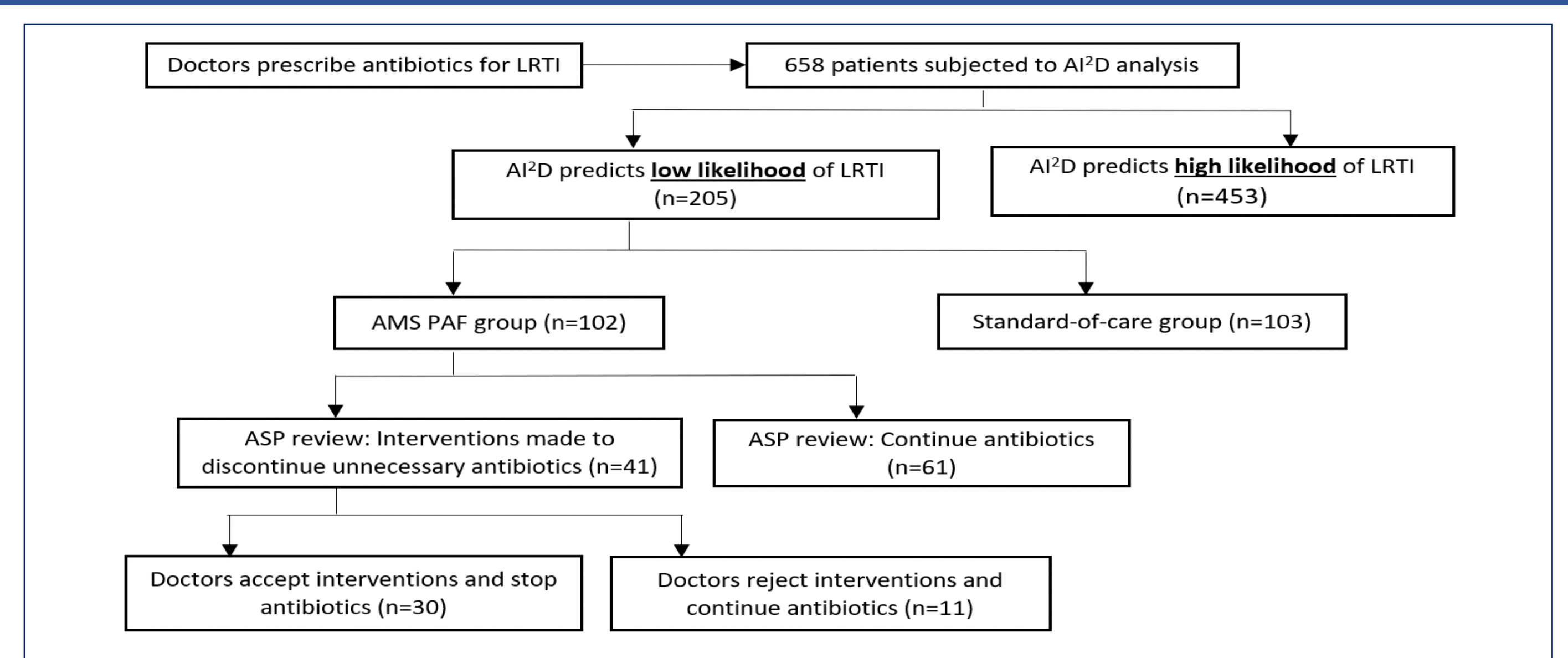
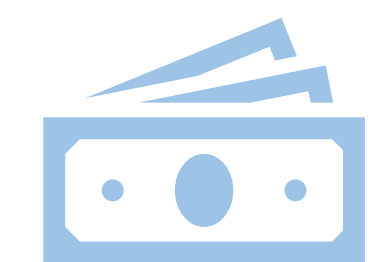


Figure 1: Flow of study population



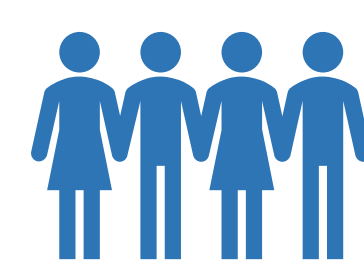
### REDUCTION IN ANTIBIOTIC USE IN THE AMS PAF

- ASU intervened to stop antibiotics in 40% of patients
- 73% of ASU interventions were accepted by primary physicians
- 30 (31%) of patients in the AMS group had antibiotics stopped within 2 days versus only 8 (7.8%) in the SOC group (i.e. 4x increment)



### COST-SAVINGS ARE EVIDENT IN THE AMS PAF

- Reduction in 120 antibiotic-days in the AMS PAF equates to the following savings:
  - \$11,560 of drug and administration cost
  - 180 hours of nursing time (~1.5 hour/day of medicine administration)
- Reduction in median length of hospitalisation by one day compared to SOC arm (5 vs 6 days) translates to 102 hospitalisation days saved (i.e. \$73,501\* of ward charge)

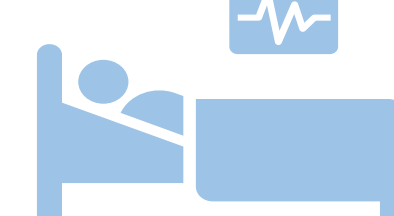


### PRODUCTIVITY GAIN

- 113 hours of ASU manpower saved from reviewing cases that had antibiotic appropriately prescribed

Month	% cases saved from unnecessary ASU review	% patients with ASU intervention for early discontinuation
Apr-24	72%	46%
May-24	66%	29%
Jun-24	66%	19%
Jul-24	71%	54%
Aug-24	66%	54%
Sep-24	85%	75%

Table 1: Percentage of cases saved from unnecessary ASU review and percentage of patients with ASU intervention for early discontinuation recorded during ASU pilot study



### PATIENT SAFETY WAS NOT COMPROMISED IN AMS PAF

- 30-day all-cause mortality among patients whom ASU intervened to stop antibiotics early was 6.9% vs. 10.7% in SOC
- No difference between 30-day readmission or care escalation between AMS PAF and SOC arm

## When scaled up hospital-wide for all antibiotics use in LRTI, AI<sup>2</sup>D is projected to be financially sustainable & cost-effective

	No. of antibiotic courses & man-hours saved
No. of patients admitted for LRTI (in 2024)	8,454 (100% screened by AI <sup>2</sup> D)
No. of cases saved from ASU review (i.e. cases identified by AI <sup>2</sup> D with bacterial LRTI)	5,816 (68.8% of 8,454 cases)
Manpower hours saved from ASU review	1,454 hours (5,816 x 15min/case)
Nursing hours saved (due to shorter antibiotic courses)	13,853 hours (9,235 x 1.5 hours)

Table 2: Productivity gain due to reduction in antibiotic use as reflected by number of antibiotic courses saved from ASU review and reduction in nursing hours due to shorter courses of antibiotic therapy

	No. of courses of antibiotics and related cost saved
No. of cases that can be potentially stopped at day 2	1,847 courses (70% of 2,638)
No. of antibiotic days saved	9,235 days (1,847 x 5 days)
Cost savings from drug and nursing administration*	\$719,499 (9,235 x \$77.91/day)
No. of administration sets saved**	138,795 (9,235 x 3 doses x 5 days)
Hospitalisation days saved	3,694 days (1,847 x 2 days <sup>Δ</sup> )
Cost of hospitalisation saved	\$2,661,896 (3,694 x \$720.60/day)
Cost-savings from patient perspective (drug, nursing administration cost & hospitalisation cost)	\$3,381,395 (\$2,661,896 + \$719,499)

Table 3: Cost-savings due to shorter antibiotic courses

\*Daily cost based on \$9.21/day of IV co-amoxiclav and \$68.70/day for nursing administration cost

\*\*Includes consumables such as antibiotic drug vials, syringes, diluents for reconstitution and dilution, infusion tubing, and burettes for administration

<sup>Δ</sup> 2 days of hospitalisation saved for AMS intervention cases with <2 days of antibiotics (likely still a gross underestimate if there is higher ASU intervention rate of 70%)

## SCALING UP

- AI<sup>2</sup>D was successfully deployed in SGH and integrated with SGH electronic medical records in Sep 2024.
- Progressive extension of AI<sup>2</sup>D to include all patients with LRTI under ASU PAF since Jan 2025.
- AI<sup>2</sup>D used by primary prescribers explored with SGH Internal Medicine physicians in a pilot implementation study from Dec-2024 to Sep-2025. If successful, it will be rolled out to all departments by Dec 2026
- Beyond SGH, other institutions CGH, TTSH, and KTPH have also shown interest. Validation and adjustments are ongoing to ensure interoperability, generalisability, and sustained performance. AI<sup>2</sup>D will be piloted in CGH ASU in Jul 2025.

## CONCLUSION

AI<sup>2</sup>D represents a significant leap forward in combating antibiotic resistance and improving infectious disease management. We showed that AI<sup>2</sup>D reduced unnecessary antibiotic use, man-hours for healthcare staff, streamlined clinical workflows, and increased cost-savings for the hospital and patients.

As we continue to refine and expand AI<sup>2</sup>D's capabilities, we anticipate further improvements in care delivery, patient outcomes, resource allocation, and our fight against antibiotic resistance. The success of AI<sup>2</sup>D paves the way for wider adoption of AI in infectious disease management, promising a future of a more efficient, effective, and personalised healthcare delivery.