Health Innovation East

Evaluation of a gamified learning tool for Antimicrobial Stewardship (AMS)

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Part of the Health Innovation Network
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Executive Summary

Background

The use of gamified learning approaches to antimicrobial resistance have been shown impact positively on knowledge retention, use of antibiotics and increased awareness among medical student populations. Health Innovation East was commissioned by NHS England (NHSE) East of England Regional team to explore gamified learning for Antimicrobial Stewardship (AMS) for prescribers and healthcare professionals, as part of working towards the goals within antimicrobial prescribing and stewardship (APS) competency framework.

The project was delivered in partnership with staff from East and North Hertfordshire Teaching NHS Trust, Royal Papworth Hospital NHS Foundation Trust and Cambridgeshire and Peterborough Integrated Care System (ICS) (herein referred to as the 'AMS Project team').

Methods

The AMS Project team developed a gamified learning tool conceptualised as a virtual escape room to promote AMS awareness and education. A survey was used to evaluate the impact and effectiveness of the gamified learning tool. Data were collected during the month of November 2025 using a snowball approach. The target population was prescribers and healthcare professionals in the East of England.

Findings

A total of 749 participants completed the game. 56.2% of all participants reported being based outside of the East of England. Participants reported greater knowledge or understanding of AMS principles and feeling more confident in their ability to apply the AMS knowledge in practice after participating in the AMS game. These findings were statistically significant. Most participants found the AMS game highly engaging and qualitative feedback was mostly positive. Ideas for improvement suggested by participants included onward links and more detailed explanations after submitting their answers, to support further learning and development.

Conclusions and recommendations

Findings from this brief pilot study suggest that using gamified learning provides an acceptable and effective approach to learning and raising awareness of AMS amongst a variety of health professionals. Participants also reported greater confidence in applying this knowledge in practice. Further development of the AMS game could focus on adapting the tool to suit a wider range of settings, topics and roles. Further recommendations include providing further reading and visual representation of correct and incorrect answers, providing clear definitions and justifications for all concepts and categories, and further evaluation of actual behaviour change and longer-term knowledge retention. Adaptations for use in non-secondary care settings (for example, community settings or primary care) covering a broader spectrum of AMS topics would support wider application and sustainability of the AMS game.

List of Abbreviations

ACP	Advanced Care Practitioner
AI	Artificial Intelligence
AMR	Antimicrobial Resistance
AMS	Antimicrobial Stewardship
APS	Antimicrobial Prescribing and Stewardship
AWaRe	Access, Watch and Reserve antibiotics
C.diff	Clostridioides difficile
EofE	East of England
GP	General Practice
HCP	Health Care Professional
ICB	Integrated Care Board
ICS	Integrated Care System
IV	Intravenous
NHSE	National Health Service England
NHS	National Health Service
SCR	Summary Care Record
WAAW	World Antimicrobial Awareness Week
WHO	World Health Organisation
WAR	Watch, Access, Reserve

Background

Gamified learning has been explored at length and there is substantial literature on the impact of gamified learning (1). Much of the literature demonstrates a high level of acceptability of this as an acceptable method of learning and improving retention of knowledge. Gamification has been shown to improve patient care and medical education, as well as learning, motivation and engagement (2, 3).

Antimicrobial resistance (AMR) occurs when bacteria, viruses, fungi and parasites develop and use resistance strategies by changing over time in response to the use of antibacterial drugs used against them, so that they no longer respond to antibacterial medicines such as antibiotics (drug resistance)(4). As a result, antibiotics and other antimicrobial medicines do not work as well, or at all, and infections become increasingly difficult or impossible to treat. AMR is already harming our health, food systems, environment and economies. Drug-resistant infections are increasing, but our current level of awareness, investment and action are insufficient (5).

Published literature has demonstrated promising findings from the use of gamified educational approaches to tackling antimicrobial resistance but concluded that most studies have been limited to use with medical students (6). Other studies have indicated positive effects on knowledge retention, promotion of optimal antibiotic use and increased awareness (7, 8). However there are a number of ethical considerations and a lack of standardisation of gamified approaches at present (9).

The UK-AWaRe (10) classifies antibiotics into three key areas, based on the World Health Organisation classification (11). These are 1) Access, 2) Watch and 3) Reserve. Any antibiotics that do not fit into one of these three categories, are classed as 'Other.' Access antibiotics have a narrow spectrum, fewer side effects, lower costs and lower potential for resistance. Watch antibiotics are broader spectrum and have a higher resistance potential. Reserve antibiotics are closely monitored and include new antibiotics and those used as a last resort (10).

Based on the Department of Health and Social Care five year action plan for antimicrobial resistance (12), the following priorities and regional opportunities were identified:

1. Improving patient safety by reducing broad spectrum (Watch and Reserve category)(10) antibiotic prescribing- all sectors
2. Improving patient flow by improving intravenous antibiotics (IV) to oral switching- acute sector
3. Reducing overprescribing by prescribing evidence-based antibiotic durations- all sectors
4. Reducing unnecessary antibiotic prescribing in children –primary care
5. Improving the regional AMS workforce capacity and capability- all sectors

Clinicians and health care professionals involved in prescribing, play a critical role in the fight to reduce AMR by following best clinical and prescribing practices. As part of working towards the goals within antimicrobial prescribing and stewardship (APS) competency framework (13) that aims to improve the safety and quality of patient care and make a significant contribution to the reduction in the emergence and spread of AMR, NHSE East of England Regional team commissioned Health Innovation East to explore opportunities for gamified learning for AMS and whether gamification of AMS learning could raise awareness and knowledge of AMS.

Aims

The aim of this project is to explore opportunities for gamified learning for AMS and whether gamification of AMS learning could raise awareness and knowledge of AMS.

Objectives

The objectives of this project were three-fold:

1. Design and develop an AMS Gamified Learning Tool for clinicians
2. Evaluate the impact of a gamified approach to clinician training on AMS through participant surveys, to determine:
   a) the effectiveness of the AMS game on knowledge improvement of AMR amongst healthcare professionals.
   b) the acceptability of the training approach for healthcare professionals.
   c) the impact of the AMS game on self-reported prescribing behaviour change (as measured by behaviour change intention[1]).
3. Understand the effectiveness of a gamified learning tool as an approach to clinician training on AMS

By testing the effectiveness and user experience of gamification as a learning method *(and the development of an AMS Gamified Learning Tool, herein referred to as the 'AMS game')*, the project sought to promote active engagement, improve understanding of AMR in line with the Department of Health and Social Care and UK Health Security Agency Competency Framework, and support more appropriate antibiotic prescribing to help prevent AMR (13).

Method

This project used a mixed-methods approach, using a quantitative survey combined with qualitative open-text comments, to determine the impact and effectiveness of a gamified learning tool.

Participants & stakeholder engagement

The primary target audience for the training was healthcare professionals in the East of England. To raise awareness of this project and to promote the AMS game, the project team attended AMS engagement events and other staff training events.

[1] The team acknowledge that intention to change behaviour is not necessarily equal to actual behaviour change as this was discussed at length. However, measuring actual behaviour change was beyond the scope of this project.

The game

Concept

The AMS Project team developed the concept of a gamified training tool in the form of an escape room, to educate healthcare professionals on the importance of AMR in practice. As part of their NHS core contract, Health Innovation East supported the development and implementation of the innovation.

The process of gamifying the content areas included establishing a game environment, challenge proposition, progress narrative and reward.

Game play took place in a (virtual) hospital. Players were presented with the concept of being trapped following a power-cut and were required to apply their AMS knowledge in a series of challenges in order to escape.

Development

The team agreed it would not be appropriate to share individual results or use this as a tool for monitoring or measuring performance, including the use of benchmarks or pass/fail thresholds. As such, the game was developed as a learning tool rather than an assessment, and therefore progression through the game was not conditional on answering questions correctly.

The AMS Project team designed the content for the escape room between July 2025-August 2025. The design and evaluative element were developed iteratively through discussions with the multi-disciplinary project team, identifying key areas for knowledge development. The final design was based on five different rooms, with each room representing one of five specific learning areas for AMR (outlined below). The objectives laid out in the APS competency framework informed the areas of focus (13) and were developed discursively in collaboration with the AMS specialists, who are experts in the field. There had also been some work drafted in this area by other members of the project team which were utilised and built on as part of this project. The full list of questions can be found in Appendix 4. After each stage was completed, players were presented with a summary of questions, the answers they had given, and the correct answers.

- Room 1: Microbes (5 questions)
- Room 2: Case studies - Urinary Tract Infection/C diff case (4 questions)
- Room 3: Antibiotic adverse drug effects (ADR's) (10 questions)
- Room 4: Case studies - Allergies (4 questions)
- Room 5: Antibiotics (11 questions)

Audiovisual media files introduced each stage within the game, including a map to demonstrate progress (see Figure 1), and narrative text enhanced through sound effects and graphics. To ensure the game was accessible, all audio-visual files were accompanied with plain text.

The AMS game was uploaded to *Zoho Survey (14)* for digital distribution. *Zoho Survey* was chosen as the host system as Health Innovation East had access and licences on this system and therefore there was no additional cost associated with the hosting or the build of the AMS game. A pilot of the AMS game was launched amongst Foundation Year 2 (FY2) medical students from NHS Cambridgeshire and Peterborough ICS to identify any further amendments to the AMS game prior to launch, to ensure smooth running and data collection.

FIGURE 1. A SCREENSHOT OF THE MAP USED IN AMS GAME PLAY

A brief video of the AMS game can be found here:

AMS Game screen recording

Following the pilot launch with the FY2 students and feedback, the following minor changes to the AMS game were implemented:

1) Clarifying acronyms: changing "SCR" to "Summary Care Record".
2) The addition of a question to enable students to identify their area of study.
3) The addition of a free text box for participants to indicate where they were from outside the East of England.

Evaluation measures were included at the beginning and end of the AMS game (see data measures).

Data collection

Data were collected between 01 November and 30 November 2025 using a snowball approach. Data were collected digitally using *Zoho Survey* (14) software.

Recruitment

A communication flow diagram was developed to guide distribution of the AMS game and ensure relevant professionals in the East of England region were reached (Appendix 1: Comms flowchart).

Health Innovation East supported dissemination of the AMS game through the development of a communications brief, and pre-release and launch posters (Appendices). Pre-release posters were developed to raise awareness of the forthcoming launch amongst healthcare professionals. These were displayed and disseminated for the month of October ahead of the launch of the game on 01 November 2025 and throughout the month it was live, until 30 November 2025.

The project was also presented during the World Antimicrobial Awareness Week Launch event hosted by NHSE East of England Regional team on 13 November 2025, held at The Cambridge Building, Babraham Research Campus, Cambridge. Launch posters with QR codes were displayed and distributed throughout the day.

Data Measures

Participants provided their answers through a number of multiple-choice options for each question. Questions were designed collaboratively with the AMS team, and the style of question was discussed at length. Participants were asked to rate 1) their understanding of AMS principles and 2) confidence in ability to apply AMS principles in practice on a Likert scale from one to 10. They were also asked whether they had previously received any other formal training before undertaking the AMS game.

At the end of the AMS game, participants were asked to re-rate their understanding and confidence having completed the AMS game, rated on a Likert scale of one to 10 (with one representing not at all confident and 10 representing very confident). Lastly, participants were asked to self-report how engaging they found the training, rated on a Likert scale of one to 10, with one representing not at all engaging and 10 representing very engaging. A free-text question was available at the end of the AMS game to capture any other feedback which was not captured in the earlier questions and for participants to comment on which elements of the training they found useful or not useful. Table 1 outlines the metrics and measures used to address each objective.

TABLE 1. KEY OBJECTIVES AND MEASURES

Objective	Metric	Measure	Method
User engagement	Total number (%) of clinicians registered and completed the gamified AMS training (stratified by staff role)	Self-reported staff role, years in practice, main area of practice, ICB	Multiple choice responses
Learning improvement - Behaviour change intention	Number of staff (%) who have adopted a new way of working Number (%) of staff reporting intention to change clinical behaviour/practice after completing AMS training	Self-reported confidence in ability to apply AMS principles in practice (before and after)	1-10 Likert scale
Learning improvement	Number / % of staff reporting improved understanding of AMS after completing AMS training)	Self-reported understanding of AMS (before and after)	1-10 Likert scale

Staff acceptability	Number (%) of staff reporting finding the gamified learning engaging. Qualitative feedback	Self-reported rating of engagement Free-text feedback	1-10 Likert scale Qualitative free text feedback

Data Analysis

Qualitative data collected as part of the pilot launch were used to inform the next iteration of the AMS game. The AMS game responses were not analysed or included in the final sample.

Data were analysed using a combination of *Microsoft Excel*, *Zoho survey* (14) software and using *R statistical analysis* software (15). Basic descriptive and frequency analysis were conducted. Wilcoxon signed rank tests for non-parametric data, were conducted to test for significant differences before and after training. Analyses were not conducted to support assessment or pass/fail rates of the training.

Lucid Software (16) was used to provide a summary of the free text content from participants using *Lucid AI (*artificial intelligence).

Findings

The survey received a total of 1424 responses out of 4774 visits, equating to a response rate of 29.8%. Of the total responses, 749 (52.6%) were complete. The following analyses are based on complete responses (herein referred to as 'participants'), unless otherwise stated.

Respondent demographics

The majority of participants, 46.5% (n=348) were pharmacists, 13.5% (n=101) were nurses, 13.2% (n=99) were doctor/medics, 9.75% (n=73) were pharmacy technicians,4.1% (n=31) were categorised as 'others', 2.9% (n=22) were advanced clinical practitioners, 2.8% (n=21) were students, 2.4% (n=18) were admin/managerial, 2.2% (n=17) were microbiologists, and 1.1% (n=8) were allied health professionals. 1.5% (n=11) participants did not select a role. Professions of those who selected 'Other' included trainee pharmacist, midwife and pharmacy assistant. The students' specialisms included pharmacy, medicine and doctor.

Figure 1 provides an illustration of participants' current occupations.

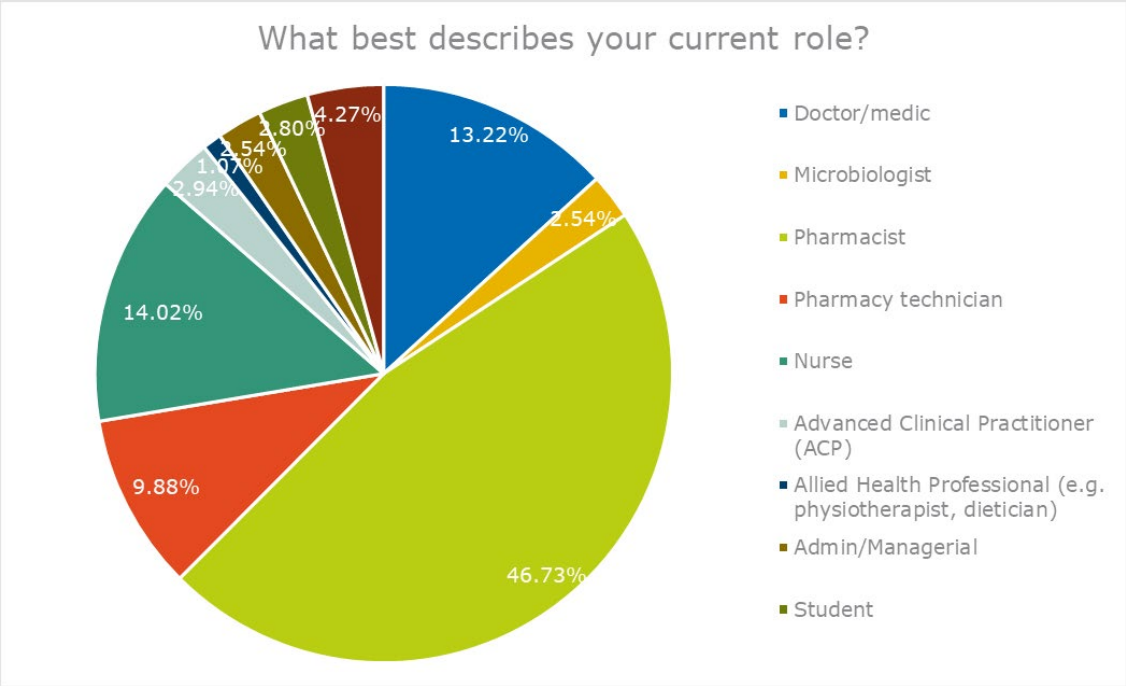

FIGURE 1. REPORTED CURRENT OCCUPATION (N=749)

Most, 57.5% (n=431), participants reported being in their profession for ten years or more (see Figure 2).

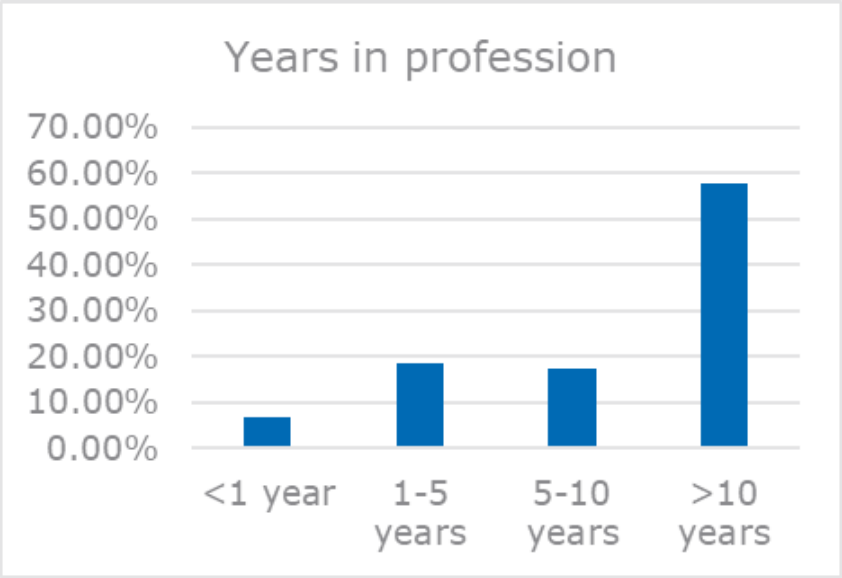

FIGURE 2. YEARS IN PROFESSION

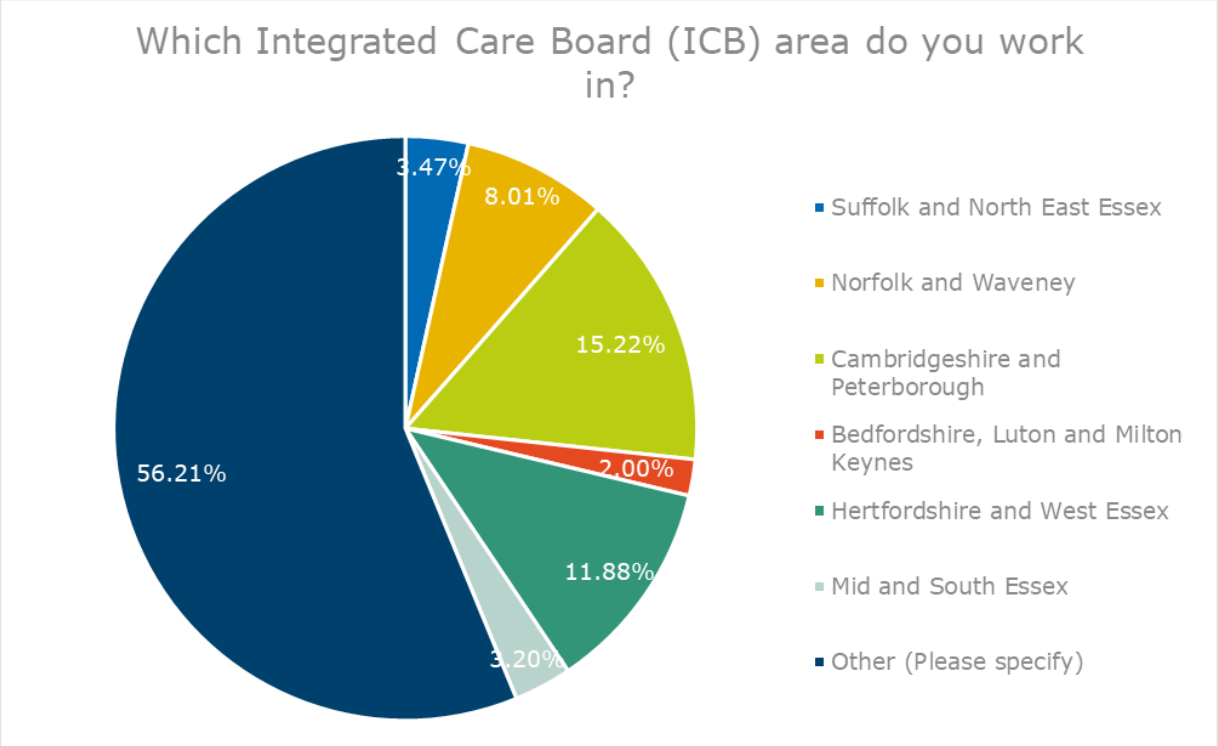

FIGURE 3. REPORTED LOCATION BASED ON ICB (N=749)

Out of the 749, 43.8% (n=328) participants were from an ICB in the East of England (see Figure 3). Participants worked across the following settings: 498 in secondary/tertiary care, 108 in primary care, 70 in 'other', 51 in community care, 21 in mental health services and <5 in social care settings. Of those who selected 'other' (9.35%, n=70), responses included ICB, academia and education. The AMS game was successfully completed by a number of participants outside of the East of England region (56.2%), with a small number of these being international participants citing locations including Ireland, Nigeria, Kenya and Tanzania.

63.4% (n=475) reported not having received any formal AMS training previously. Of the 36.6% (n=274) that had received formal training, participants reported receiving this via; formal online training or e-learning 65.3% (n=179), face-to-face teaching 59.9% (n=164), ad-hoc discussions 43.1% (n=118), or another type of delivery (not specified) 9.12% (n=25).

Table 2 shows the participant reported demographics.

TABLE 2. PARTICIPANT DEMOGRAPHICS (N=749)

		N (%)
Occupation	Pharmacist	348 (46.5)
	Nurse	101 (13.5)
	Doctor/medic	99 (13.2)
	Pharmacy technician	73 (9.7)
	Other	31 (4.1)
	Advanced Clinical Practitioner (ACP)	22 (2.9)
	Student	21 (2.8)
	Admin/Managerial	18 (2.5)
	Microbiologist	17 (2.5)
	Allied Health Professional (e.g. physiotherapist, dietician)	8 (1.1)
	No role selected	11 (1.5)
Years in profession	<1 year	50 (6.7)
	1-5 years	139 (18.6)
	5-10 years	129 (17.2)
	>10 years	431 (57.5)
Main area of practice	Primary Care (e.g. GP practice)	108 (14.4)
	Community Care	51 (6.8)
	Secondary/Tertiary Care (e.g. hospital)	498 (66.5)
	Mental Health Services	21 (2.8)
	Social Care	<5
	Other	70 (9.4)
Integrated Care Board (ICB)	Suffolk and North East Essex	26 (3.5)
	Norfolk and Waveney	60 (8.0)
	Cambridgeshire and Peterborough	114 (15.2)
	Bedfordshire, Luton and Milton Keynes	15 (2.0)
	Hertfordshire and West Essex	89 (11.9)
	Mid and South Essex	24 (3.2)
	Other (Please specify)	421 (56.2)
Previous training in AMS	Yes	274 (36.6)
	No	475 (63.4)
Delivery method of previous training	Face to face teaching	164 (59.9)
	Ad-hoc discussions	118 (43.1)
	Formal online training/ e-learning	179 (65.3)
	Other	25 (9.1)

Training outcomes

TABLE 3. BEFORE AND AFTER TRAINING STATISTICS (N=749)

	Before		After	
	Median	*Range*	*Median*	*Range*
Understanding (Knowledge)	7	1-10	8	1-10
Confidence in application	7	1-10	8	1-10
Acceptability[2]	n/a	n/a	9	1-10

Understanding (Knowledge)

Self-reported scores for understanding and knowledge of AMS principles before participation in the AMS game had a mean of 6.9 and a median of 7, compared with the after scores which had a mean of 7.62 and a median of 8. This difference was significant (Wilcoxon signed rank test, n = 749, V = 23,783.5 p-value < 0.00001). This suggests that participants' after Understanding scores were generally greater than their before scores, indicating they felt they had a greater understanding after the training than before the training (see Figure 4).

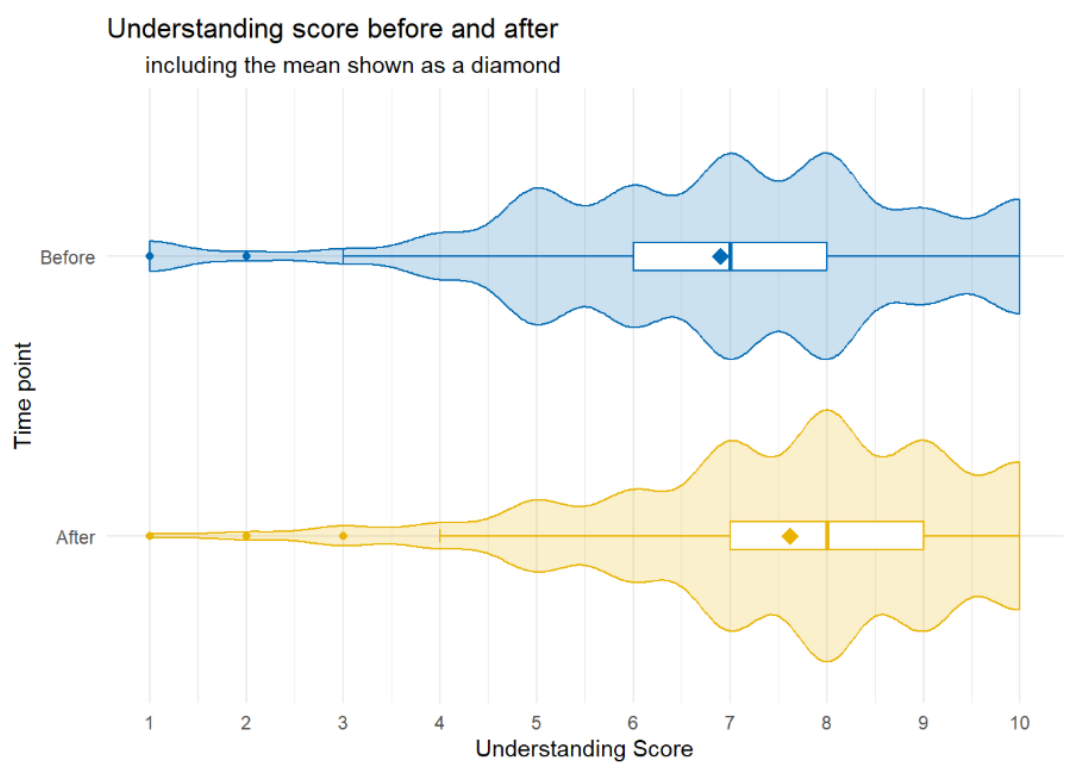

FIGURE 4 SELF-REPORTED SCORES FOR UNDERSTANDING AND KNOWLEDGE OF AMS PRINCIPLES BEFORE PARTICIPATION IN THE AMS GAME BY PROFESSION (N=749)

[2] As measured by participant self-reported measure: "To what extent did you find this training engaging?"

When considering the self-reported scores for understanding by profession, four professional groups had a significant difference between before and after confidence scores (Wilcoxon signed rank tests, $p < 0.05$ Bonferroni-corrected). These professions were: pharmacist, nurse, doctor/medic, and pharmacy technician. These were also the professions with the greatest number of participants. All four professions had a greater mean understanding score after the AMS game than before (see Figure 5). Other professional groups also showed differences in scores before and after training, however, because of the small sample size of these groups, we were unable to test for statistical significance. Details of all sub-group analyses can be found in Appendix 6.

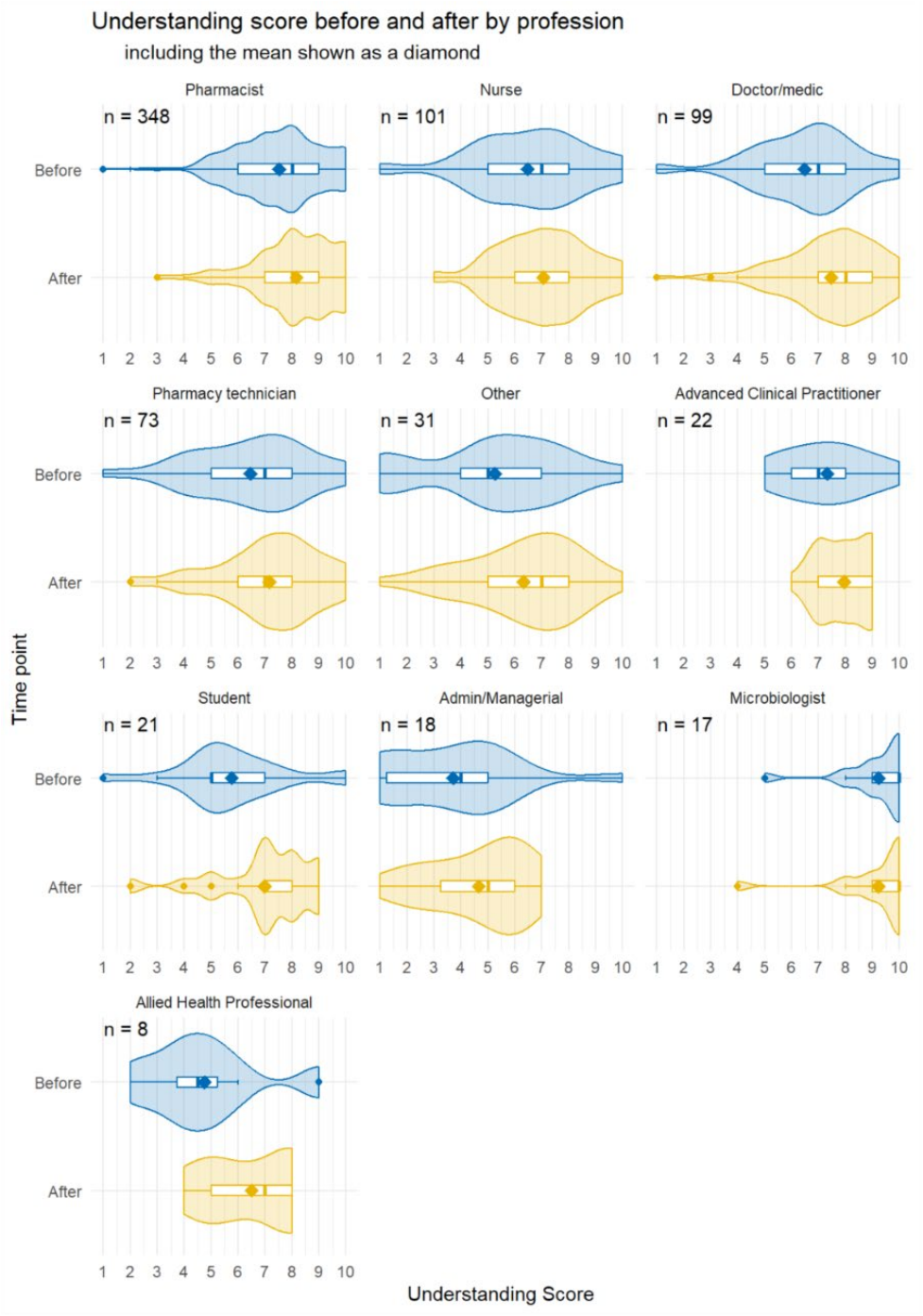

FIGURE 5. UNDERSTANDING OF AMS PRINICIPLES FOLLOWING PARTICIPATION IN THE AMS GAME, BY REPORTED PROFESSION (N=749)

Acceptability

When considering the acceptability of the training as measured by a proxy of how engaging the game was, participants gave a median score of nine. 79.6% (n=596) of participants gave the game a score of eight or higher. Of these, 40.6% (n=304) gave the maximum score of 10 (very engaging) (see Figure 6).

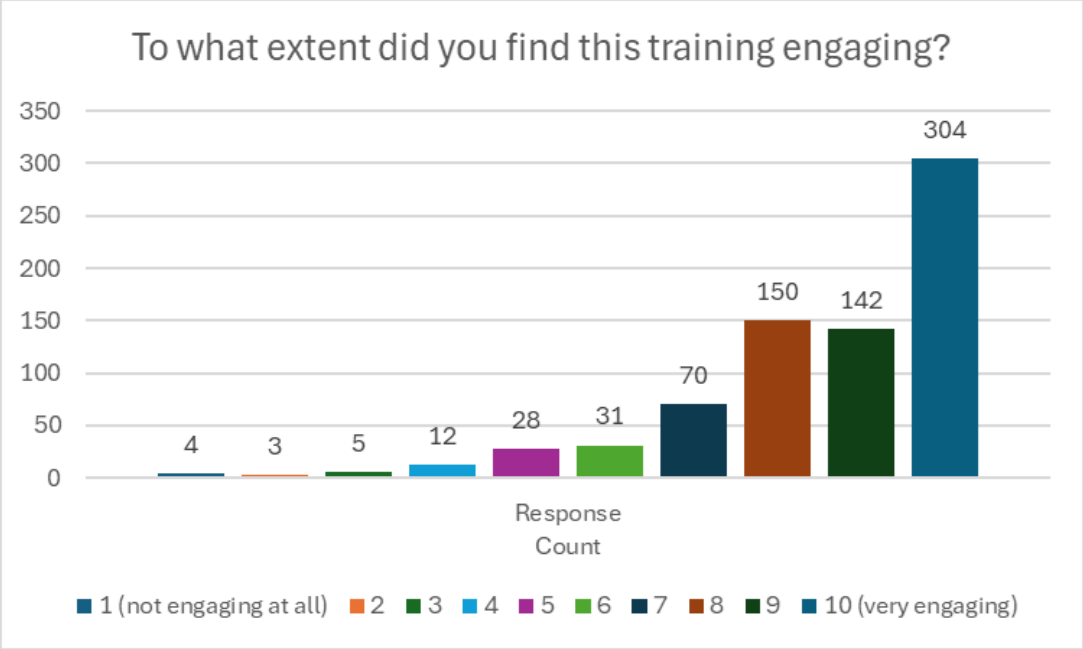

FIGURE 6. ACCEPTABILITY OF THE AMS GAME (N=749)

Confidence in applying AMS knowledge

Self-reported scores for confidence in applying AMS principles before participating in the AMS game had a mean of 6.7 and a median of 7, compared with the after scores which had a mean of 7.45 and a median of 8. This difference was significant (Wilcoxon signed rank test, n = 749, V = 25, 320 p-value < 0.00001) indicating that participants' Confidence scores after the training were generally greater than before the training (see Figure 7), indicating they felt they had more confidence after the training than before.

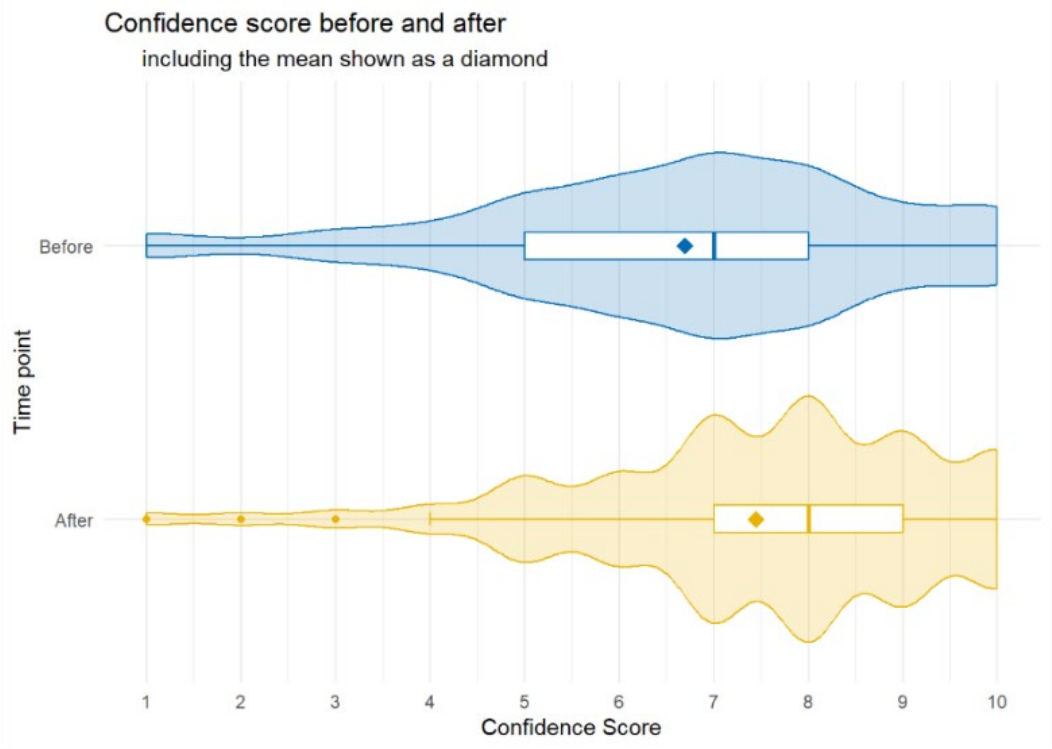

FIGURE 7. SELF-REPORTED SCORES FOR CONFIDENCE IN APPLYING AMS PRINCIPLES BEFORE PARTICIPATING IN THE AMS GAME (N=749)

By profession

When considering the Confidence scores by profession, four professions had a significant difference between before and after confidence scores (Wilcoxon signed rank tests, $p < 0.05$ Bonferroni-corrected). These were Pharmacist, Nurse, Doctor/medic, Pharmacy technician. These were also the four professions with the greatest number of participants. All four professions had a greater mean confidence score after than before (see Figure 8). Other professional groups also showed differences in scores before and after training, however, because of the small sample size of these groups, we were unable to test for statistical significance. Details of all sub-group analyses can be found in Appendix 5.

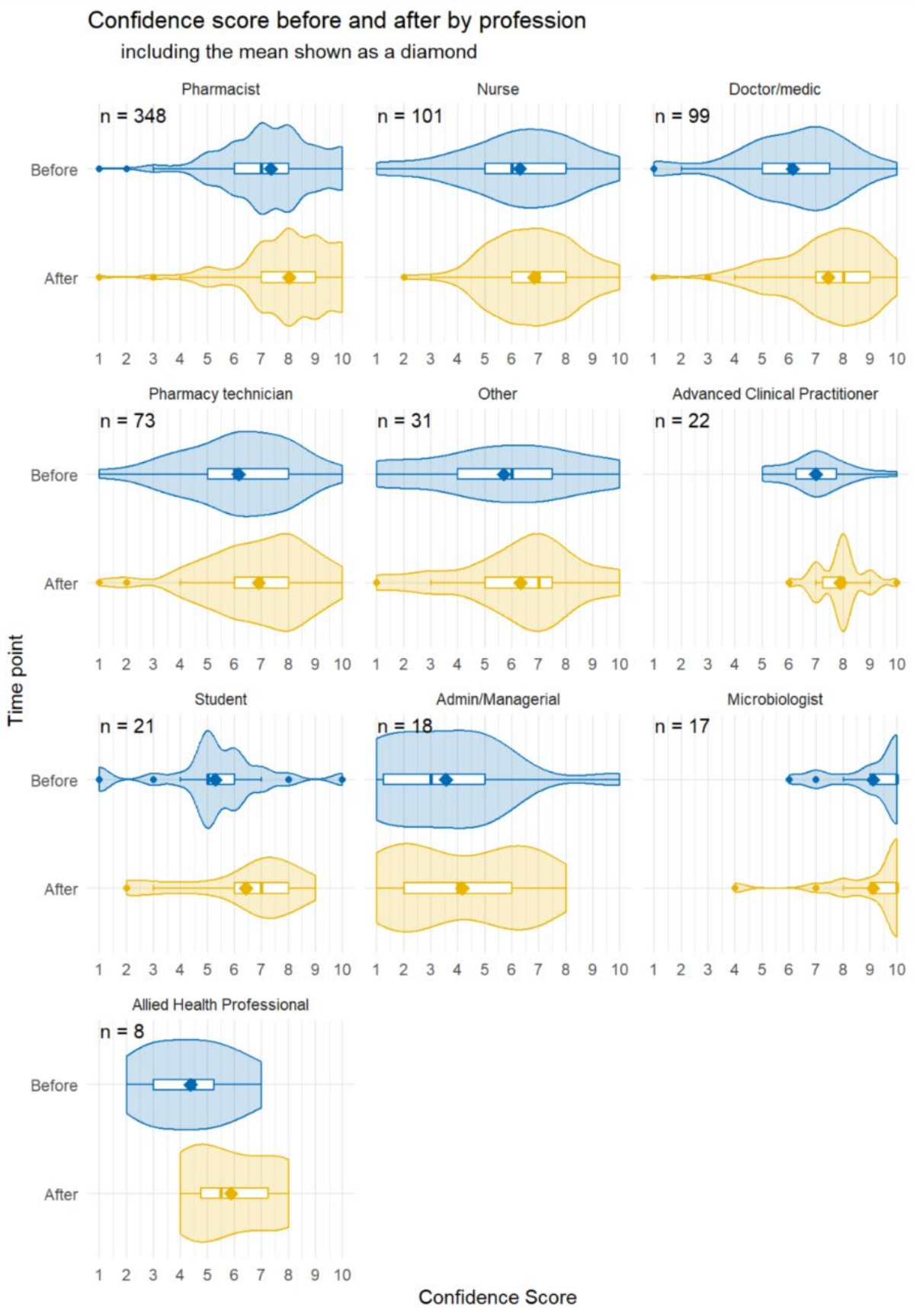

FIGURE 8. SELF-REPORTED SCORES FOR CONFIDENCE IN APPLYING AMS PRINCIPLES BEFORE PARTICIPATING IN THE AMS GAME, BY PROFESSION (N=749)

Qualitative Feedback

749 participants provided textual feedback in response to the usefulness of the training. Of these, 634 comments were considered related to the project's aims and objectives and included in the analysis. Thematic analysis of these free-text comments resulted in four key themes: game content, game format, wording and audience, and requests for additional information. Each theme is presented below:

Game Content

Feedback relating to the clinical accuracy, relevance and applicability of the questions and scenarios presented in the game were organised into an overarching theme of 'game content.'

Many participants provided positive feedback and the majority of participants found the game content to be clinically relevant and useful:

> *"Scenarios relevant to practice" [ID045]*
>
> *"Very good range of questions testing knowledge" [ID003]*
>
> *"It was very useful in making me consider and refresh Knowledge on AWaRe classification of antibiotics rather than rely on clinical experience[sic]" [ID084]*

However, there was some feedback related to clinical accuracy. Some participants also perceived the content as heavily secondary-care, hospital and adult-focused, and expanding content breadth to include additional case study scenarios, such as paediatric or primary care, were welcomed.

> *"More useful for prescribers[. W]ould like an escape room more about challenging inappropriate prescribing." [ID004]*
>
> *"Not that helpful to a paediatrician." [ID028]*
>
> *"IV questions not useful for primary care" [ID506]*
>
> *"Very adult specific. I had to guess a lot as a lot of the meds I don't come across in everyday use." [ID090]*

Intravenous (IV) antimicrobials were reportedly unfamiliar to many participants. Some participants saw the questions as too drug-specific, rather than principle-based AMS decision-making, whilst other questions were perceived as ambiguous, (particularly around Clostridioides difficile (C.diff) infection testing and Type 4 stools), long-winded, or lacking sufficient clinical context, leading to guessing the answers.

> *"Type 4 stool would not be tested for c diff- this confused us" [ID736]*
>
> *"I think some of the choices would require more explanation- formulary choices will vary so may cause some confusion. Ciprofloxacin use ahead of co-amoxiclav could be explained better- after mhra alert it shouldn't be used now unless no other option?" [ID323]*
>
> Game format

Participants found the game to be fun, innovative and engaging:

> *"I found it entertaining" [ID010]*
>
> *"Fun to try a game rather than usual q&s" [ID029]*
>
> *"Excellent and super quick" [ID033]*
>
> *"Really engaging" [ID081]*
>
> *"Loved it all, so clever" [ID106]*

A small number of participants provided feedback on issues relating to the structure, pacing, feedback mechanisms, usability, and technical performance of the game, including how results are displayed and how participants interact with the platform. In particular, some participants noted a desire for clearer, more pictorial feedback to indicate right or wrong answers, and a large minority of participants requested overall scores, and to be broken down by section.

> *"Would have been good to get the scores after each questions e.g. 8/10"* [ID034]
>
> *"Quite long if asking HCPs to complete on the wards."* [ID039]
>
> *"If possible to have more visual tick or cross marks especially when there are combination answers (risk is you could gloss over a wrong answer here) - otherwise great well done!"* [ID161]

<u>Wording and audience</u>

Participants found the interactive quiz format engaging and fun, especially the escape room style, which provided a refreshing way to test and reinforce knowledge on antibiotic use and antimicrobial stewardship (AMS).

> *"Written in a nice format. Very relatable scenarios"* [ID730]
>
> *"I found the training really useful, particularly the case-based scenarios and the Q&A format, as it helped me think through real clinical situations. The sections on antibiotic selection, side effects, and allergy management were especially helpful for reinforcing safe prescribing practices."* [ID710]
>
> *"Unique idea for keeping the reader engaged - well done. I enjoyed completing this!"* [ID704]

Some participants felt there was misalignment between how the game was described (i.e., as a training tool) versus how the how the content is presented and experienced psychologically (as a quiz or assessment).

> *"The training was engaging. However, it did not actually contain any training or teaching, only knowledge tests." [ID565]*
>
> *"…it is not probably a training but rather a quiz"* [ID065]

Additionally, some participants expressed uncertainty about the intended clinical audience and difficulty level.

> *"Questions long winded. Who is this aimed at? Could be quite difficult for some staff."* [ID093]

Requests for additional information

While the questions were considered useful for identifying knowledge gaps and refreshing understanding, many users expressed a desire for more explanations and resources to enhance learning, particularly regarding specific antibiotic categories and clinical scenarios.

> *"Liked the range-scenarios/tests/medicines knowledge. Confirmed what I knew that I am distant from general medical clinical situations. I am a specialist and manager and am very rusty in my knowledge."* [ID645]
>
> *"All was useful and interesting to test knowledge. Gave me confidence that I do know lots about AMS."* [ID692]

Issues relating to the supporting information, explanations, definitions, and signposting provided alongside questions and answers, including whether participants are helped to understand why an answer is correct and where to go for further learning.

- Strong and repeated requests for explanations of correct and incorrect answers.
- Widespread confusion about Watch, Access, and Reserve (WAR)(10) terminology.
- Lack of links to guidance, references, or further reading.

> *"Link to the rationale/training for the correct answers would have been helpful."* [ID216]
>
> *"Highlighted lack of knowledge but no guidance as to where to now go to do some learning!!"* [ID059]

The game was praised for its innovative approach and potential to improve clinical practice, though it was noted that it might be less relevant for those outside hospital settings or in non-prescribing roles. A small number of participants, particularly senior clinicians, indicated they wouldn't have engaged with the AMS game if they knew this would be fed back to any staff teams, particularly if it identified gaps or limitations in their knowledge, highlighting the importance of psychological safety in relation to training and development needs.

Summary of Findings

The aims of this project were to:

1. Design and develop a AMS gamified learning tool for clinicians.
2. Evaluate the impact of a gamified approach to clinician training on AMS.
3. Understand the effectiveness of a gamified learning tool as an approach to clinician training on AMS.

Taking a collaborative approach, the AMS project team have successfully developed a gamified AMS learning tool for use with healthcare professionals.

The AMS game survey achieved a 29.8% response rate of those who opened the survey link, and of these more than half (52.6%, n=749) of the responses were complete in full. The participants reported feeling they had a greater knowledge or understanding of AMS principles after participating in the AMS game, suggesting that it was an effective learning tool immediately after participation.

Before and after evaluation measures demonstrate that the AMS game was effective in improving knowledge and understanding of AMR amongst clinicians and health professionals. Despite the original target population of the AMS game being the East of England, the tool was successfully completed by a number of participants outside of this region (56.2%), with a small number of these being international participants citing locations including Ireland, Nigeria, Kenya and Tanzania. This finding indicates significant positive reach and acceptability. Health Innovation East has also subsequently received a number of requests to use the AMS game since the pilot has closed.

Furthermore, the escape room concept and quiz content were received positively and described as engaging and fun. The positive feedback received through the collection of free-text responses, as well as self-reported data from participants as to how engaging the AMS game was, has demonstrated high levels of acceptability of this approach for the participants who took part, which included prescribing and non-prescribing healthcare professionals. However, it was reported that the AMS game was of less relevance to those who were in non-prescribing roles or those not based in hospital settings or worked in paediatric services.

The impact of the AMS game on prescribing behaviour change amongst participants, appears to be positive, as participants reported more confidence in applying their AMS knowledge in practice following completion of the AMS game. Whilst this does not guarantee behaviour change in prescribing and clinical practice, it suggests a positive intention to do so.

An unintended consequence of implementing the AMS game and gamified learning approach was identifying an unmet training need (63.4% identified they had not received any formal AMS training) and many participants reported that the game was helpful in identifying gaps in their existing knowledge, and useful refresher training. Participants also reported feeling more confident in their ability to apply the AMS knowledge in practice after participating in the AMS game, demonstrating that the AMS game had a positive impact on participants' confidence in applying their learning of AMS principles to their practice which may promote positive behaviour change and improve clinical practice related to AMS, after participation in the game. These findings were found to be statistically significant, meaning that differences in scores before and after participation are unlikely to be a result of chance.

Strengths and Limitations

Whilst there are demonstrable and statistically significant positive findings, there are a number of limitations to this project.

The development of the AMS game

The questions included in the AMS game were all multiple choice (questions pre and post game to support analysis included questions of different types). This means that it is possible for participants to have selected the correct answer by chance. However, given that the increase in knowledge and confidence after participation was statistically significant, this is unlikely. The AMS Project Team informed the quiz content and broad topic areas which were pertinent to AMS best practice. It is possible that this could have introduced bias to the quiz content. However, the content was ultimately informed by the Global antibiotic resistance surveillance report (5) and AMS National Action Plan (12) and therefore is likely to have minimised the impact of any bias.

The AMS game was hosted by Health Innovation East using *Zoho Survey* (14). This approach had both benefits and limitations. *Zoho Survey* (14) is a highly effective tool for developing surveys. As a result, it was less flexible for designing an interactive gamified quiz. However, it was not designed for highly technical gamification, and therefore there were more complex question structures and graphics which would have been desirable but were unfeasible to incorporate due to the software limitations of *Zoho Survey* (14).

A small number of participants, particularly senior clinicians, indicated they wouldn't have engaged with the AMS game if they knew this would be fed back to any staff teams, particularly if it identified gaps or limitations in their knowledge, thus introducing the risk of possible response bias. This finding confirms the team's decision to not share individual results or use this as a tool for monitoring or measuring performance. It also highlights the need for support and psychological safety from line managers around training and development.

Evaluation measures

This project was a small and brief pilot and as such, measuring actual behaviour change was beyond the scope of this study, which would have required a more complex, longitudinal approach and objective observation. As a result we are only able to report on clinicians' intention (as measured by self-reported confidence) to change practice. We recognise that intention to change behaviour does not necessarily ensure actual behaviour change and therefore this is a limitation of our findings. Additionally, while participants reported an increase in knowledge related to AMS following completion of the AMS gamified learning tool, we are unable to draw any conclusions about the length of effect of this finding – i.e. How long is knowledge retained for, following participation?

Participants who completed the AMS game, included specialist pharmacists and microbiologists, who were likely to have expertise in AMS before participating in the game and it is possible that responses from this subgroup of participants may have skewed the overall results. Conversely, non-prescribing clinicians, may have responded in ways that were also not representative of the target cohort and therefore could have also skewed the overall results. That said, proportionately, both sub-groups make up a small minority (5.2%, n=39) of the overall sample, which would reduce any impact of bias.

Conclusion and recommendations

The gamified AMS learning tool was found to be effective as a learning tool for AMS amongst clinicians. The escape room concept and quiz content was received positively and demonstrated high levels of acceptability for the participants who took part. Overall, the AMS game had a positive impact on AMS awareness and demonstrated clear potential for changes in prescribing practices by supporting prescribing clinicians to feel more confident in their application of AMS knowledge, particularly in hospital-based settings. Box 1 outlines the key recommendations following the evaluation.

Gamified learning for AMS training and raising awareness, is acceptable to a variety of health professionals. Recommendations for further developments of a gamified learning tool are as follows:

1. **Accompanying answers with an explanation or linked resource for further learning.** Participants indicated a need for an onward link or an explanatory narrative to accompany the correct responses and would allow the participant to review further information to understand further areas of learning.

2. **Providing visual representation of correct and incorrect answers, for example, ticks and crosses.**
   Participants suggested that using more visual representation would make the game more accessible.

3. **Provide clear definitions and justifications for all concepts and categories, such as AWaRe categories and stool sampling.**
   Some participants expressed that they did not fully understand all of the acronyms and concepts used in the game, or the rationale for the correct answers.

4. **Further evaluation to examine the impact on actual behaviour change and longer term knowledge retention for participants.**
   further evaluation should focus on conducting a longer study to capture objective data relating to behaviour change and prolonged knowledge retention across a variety of clinical areas and roles within health systems.

5. **Ensure planning for long/longer term development and sustainability of the game, including adaptations for non- secondary care and broader AMS topics.**
   adaptations to the AMS game should be made to support the training and development needs of prescribing and non-prescribing healthcare professionals. All clinical content should be informed by recognised clinical guidelines and regularly reviewed by a nominated and agreed clinical AMS expert, with appropriate governance in place.

6. **The tool should not be used for tracking / monitoring or measuring individual performance.**
   Doing so is likely to reduce participation rates

BOX 1. KEY RECOMMENDATIONS

Acknowledgments

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We are grateful to the participants who participated in this pilot study and we acknowledge the collaborative approach by the whole AMS Project Team, who provided crucial and insightful contributions. We also acknowledge Simi Odimayo (in her former role at Health Innovation East) for her project management skills which were integral to the successful and smooth running of this project.

The project was delivered in partnership with our colleagues in East and North Hertfordshire Teaching NHS Trust, Royal Papworth Hospital NHS Foundation Trust, Cambridge and Peterborough Integrated Care System (ICS), and NHS England EoE region.

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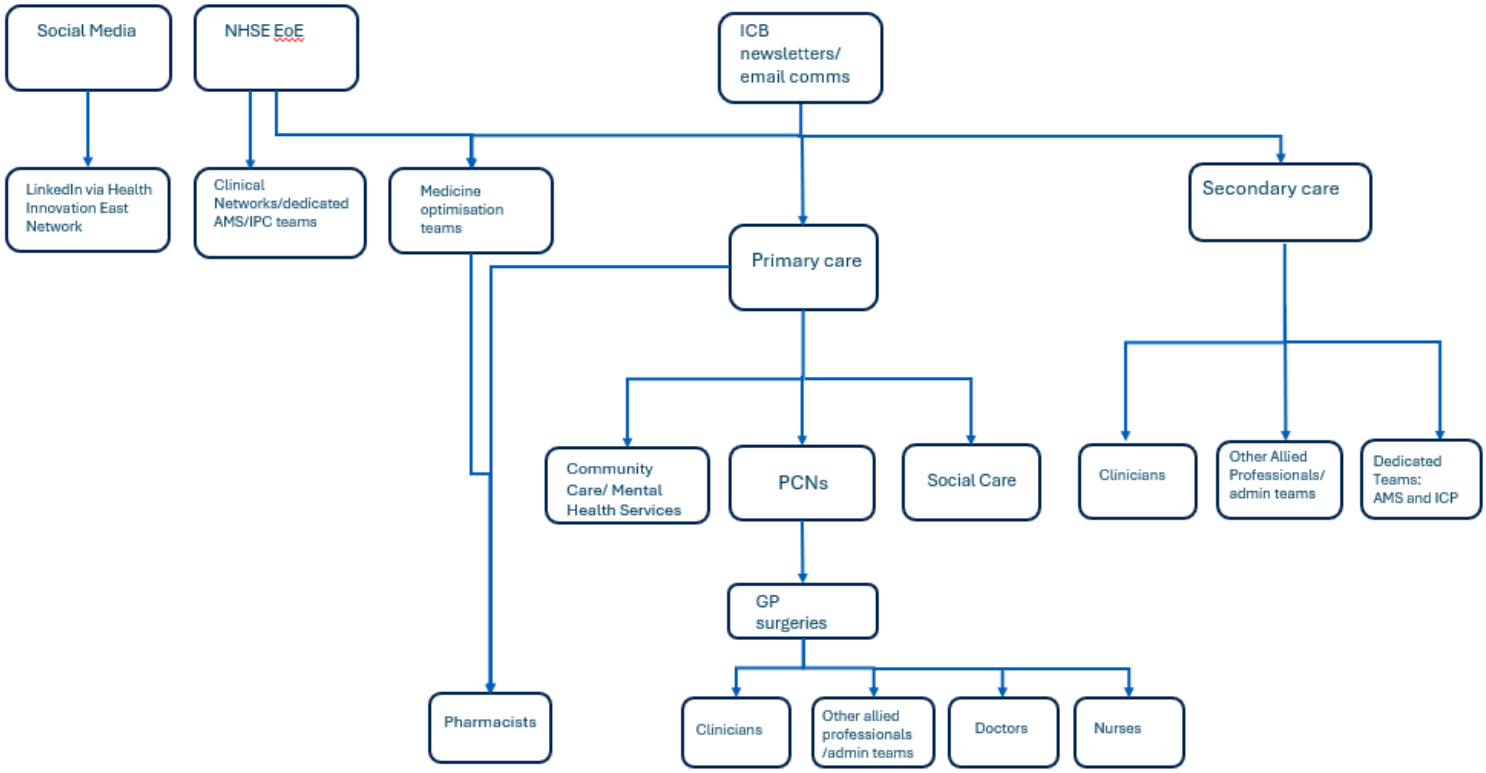
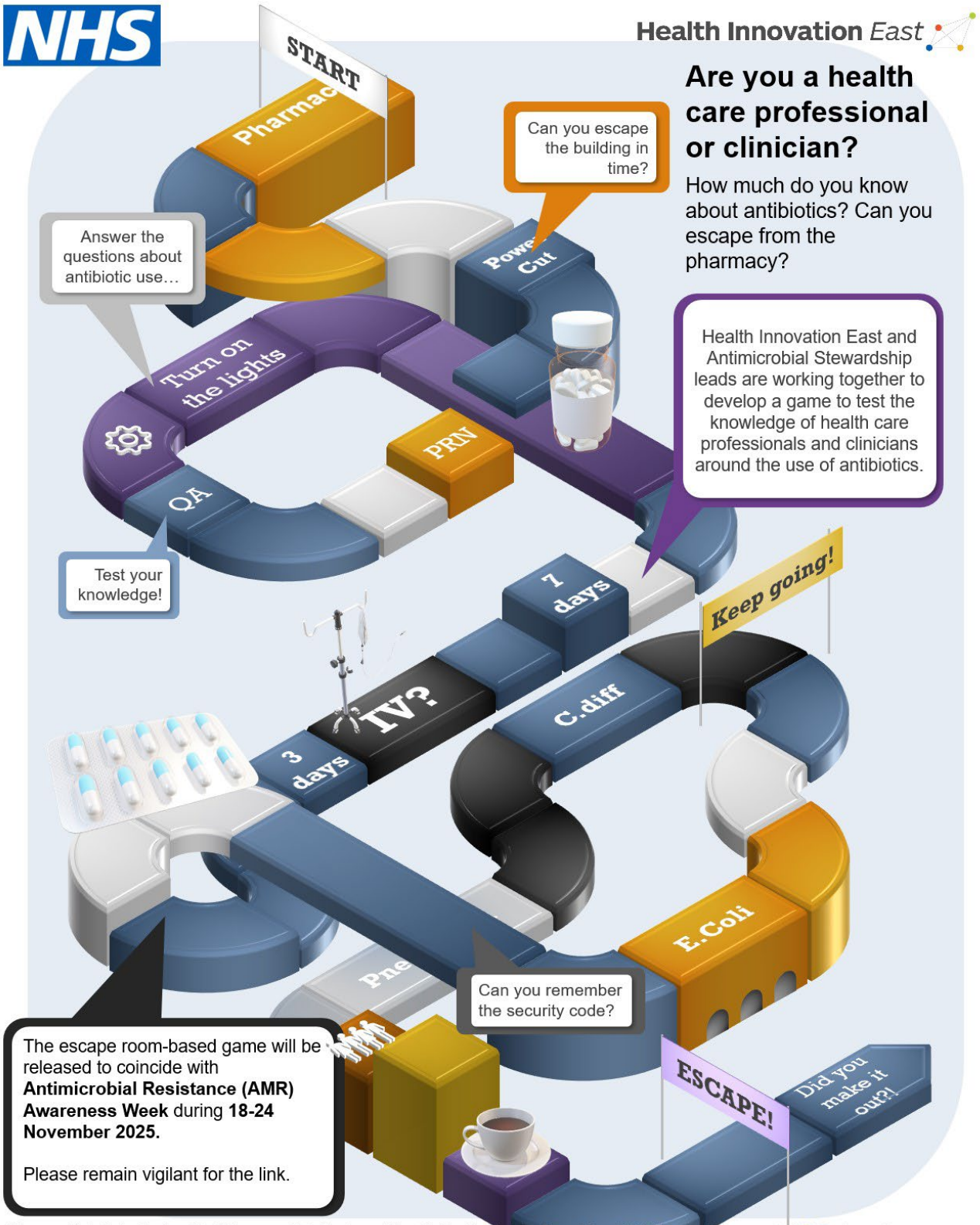
Appendices

Appendix 1: Comms Flowchart



Appendix 2: Promotional pre-release Posters



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NHS

Health Innovation East

Are you a health care professional or clinician?

How much do you know about antibiotics? Do you know enough to escape the hospital during a power cut?

Health Innovation East and Antimicrobial Steward leads are working together to develop a game to test the knowledge of health care professionals and clinicians around the use of antibiotics.

Interested?

The escape room-based game will be released to coincide with **Antimicrobial Resistance (AMR) Awareness Week** during **18-24 November 2025.**

Please remain vigilant for the link.

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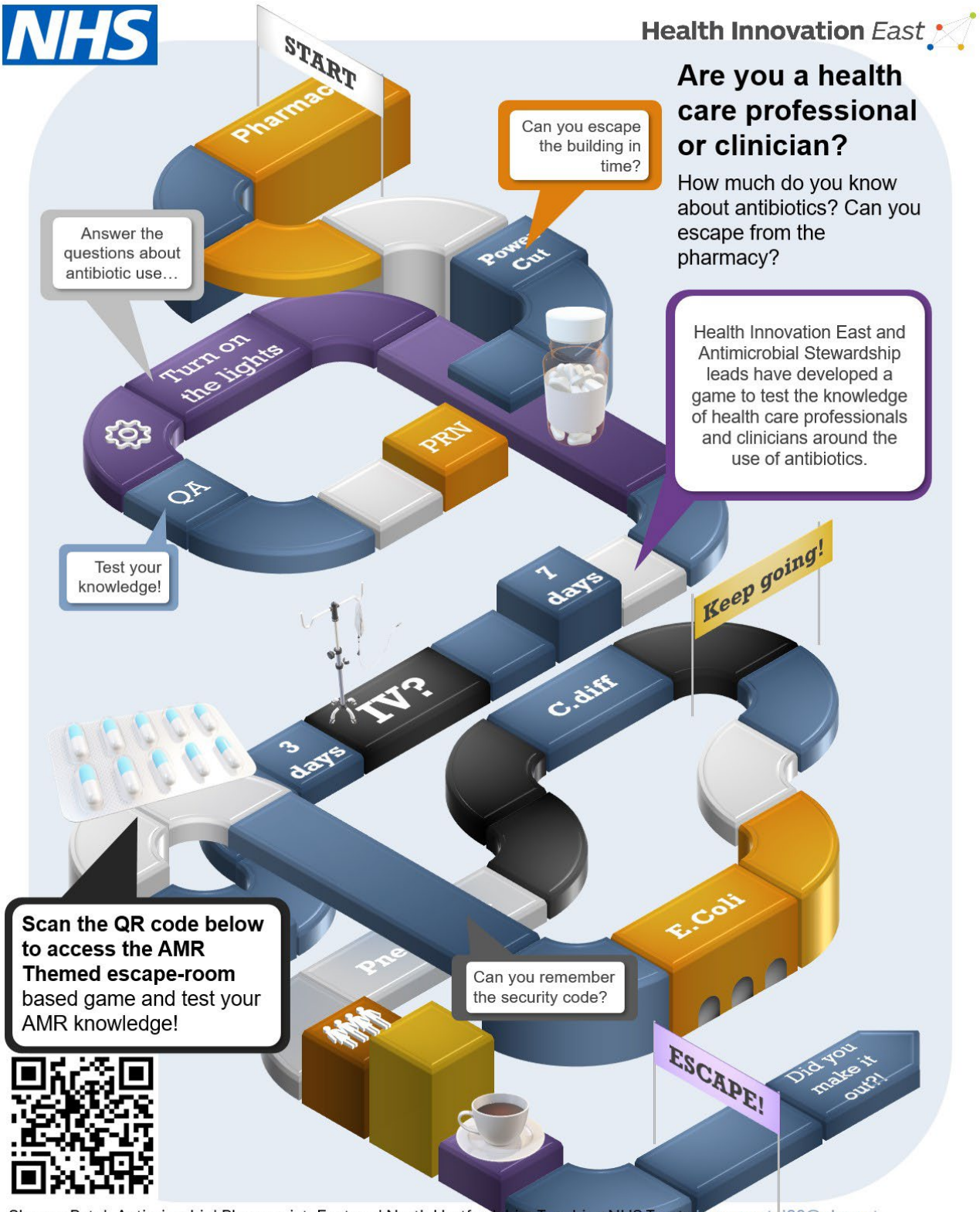
Appendix 3: Promotional Launch Posters



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Health Innovation East and Antimicrobial Steward leads have developed a game to test the knowledge of health care professionals and clinicians around the use of antibiotics.

Interested?

Scan the QR code to access the AMR Themed escape-room based game and test your AMR knowledge!

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Appendix 4: AMS game Questions

Antimicrobial Stewardship Gamification

Antimicrobial Stewardship Escape Room Training

Antimicrobial resistance (AMR) occurs when bacteria, viruses, fungi and parasites change over time and no longer respond to medicines (drug resistance). As a result, antibiotics and other antimicrobial medicines do not work as well, or at all, and infections become increasingly difficult or impossible to treat.

AMR is already harming our health, food systems, environment and economies. Drug-resistant infections are increasing, but our current level of awareness, investment and action are insufficient.

Clinicians play a critical role in the fight to reduce AMR by following best clinical and prescribing practices.

In line with this year's theme for the annual World AMR Awareness Week (WAAW) (18 to 24 November) the East of England regional Antimicrobial resistance Stewardship (AMS) team, in partnership with Health Innovation East, are addressing AMR with an interactive AMS and Infection Control Escape Room-style training.

This training consists of five educational, case-based scenarios and aims to deliver the following learning objectives:

- Increased awareness of AMR
- Knowledge of AMS best practice
- Confidence in applying AMS principles in practice

The training also supports regional and national AMS efforts to highlight the importance of the clinician's role in reducing AMR.

The need to know stuff

- The training consists of interactive questions to test your knowledge and apply it to case studies, alongside feedback questions before and after.
- You can find out which questions you got right or wrong at the end of the training.
- You should be able to "escape" within 15 minutes and would love to hear your thoughts on how you got on, so please complete the feedback questions at the end.
- We do not ask for your name or any identifiable information during the training, and responses are anonymous. Any data collected will be used to evaluate and further develop the training.

So, if you think you can make it out in time, click start to begin!

Pre-game questions

* What best describes your current role?

◯ Doctor/medic	◯ Microbiologist	◯ Pharmacist
◯ Pharmacy technician	◯ Nurse	◯ Advanced Clinical Practitioner (ACP)

- ( ) Allied Health Professional (e.g. physiotherapist, dietician)
- ( ) Admin/Managerial
- ( ) Student
- ( ) Other (Please specify)

*Please specify which profession you are a student in

*How many years have you been in your profession?

- ( ) <1 year
- ( ) 1-5 years
- ( ) 5-10 years
- ( ) >10 years

*What is your main area of practice?

- ( ) Primary Care (e.g. GP practice)
- ( ) Community Care
- ( ) Secondary/Tertiary Care (e.g. hospital)
- ( ) Mental Health Services
- ( ) Social Care
- ( ) Other (Please specify)

*Which ICB (Integrated Care Board) area do you work in?

- ( ) Suffolk and North East Essex
- ( ) Norfolk and Waveney
- ( ) Cambridgeshire and Peterborough
- ( ) Bedfordshire, Luton and Milton Keynes
- ( ) Hertfordshire and West Essex
- ( ) Mid and South Essex
- ( ) Other (Please specify)

* What is your current understanding of Antimicrobial Stewardship (AMS)?

- ○ 1 (no understanding)
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10 (great understanding)

* How confident are you in your ability to apply AMS principles in practice?

(Prior to completing the training)

- ○ 1 (not at all confident)
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10 (very confident)

* Have you received any formal AMS training?

- ○ Yes
- ○ No

* What format has your previous AMS training taken?

- ☐ Face to face teaching
- ☐ Ad-hoc discussions
- ☐ Formal online training/ e learning
- ☐ Other

Game Introduction

Welcome to the antimicrobial stewardship escape room

You have just started working in a new hospital pharmacy. Your colleagues are nice, and you're excited to settle in – right now it's all very new and the building still feels like a bit of a maze.

Your last colleague leaves for the day, but you stay a little longer as your bus isn't for another half hour. You relax into your chair, when suddenly -

HELP! There has been a power cut!

The lights have gone out and the door is locked. Answer the questions to start your escape...

Part 1: shot in the dark...

Alone in the pharmacy, the lights have gone out!

Your phone battery is running low – you won't be able to use its torch for long - **answer the quick fire questions to find the light switch and illuminate the situation...**

---

* What is the major causative organism for urinary tract infections ?

- ○ Pseudomonas
- ○ E. coli or Escherichia coli
- ○ Staphylococcus aureus or S. aureus
- ○ Clostridioides difficile or C. difficile
- ○ Oral streptococci or Viridans group streptococci

---

* What is the bacteria where the only oral option to treat it is a quinolone?

- ○ Pseudomonas
- ○ E. coli or Escherichia coli
- ○ Staphylococcus aureus or S. aureus
- ○ Clostridioides difficile or C. difficile
- ○ Oral streptococci or Viridans group streptococci

---

* What is the bacteria most commonly associated with skin and soft tissue infection?

- ○ Pseudomonas
- ○ E. coli or Escherichia coli
- ○ Staphylococcus aureus or S. aureus
- ○ Clostridioides difficile or C. difficile
- ○ Oral streptococci or Viridans group streptococci

---

* What is the organism most commonly associated with endocarditis?

- ○ Pseudomonas
- ○ E. coli or Escherichia coli
- ○ Staphylococcus aureus or S. aureus
- ○ Clostridioides difficile or C. difficile
- ○ Oral streptococci or Viridans group streptococci

---

* What organism causes antibiotic associated diarrhoea?

- ◯ Pseudomonas
- ◯ E. coli or Escherichia coli
- ◯ Staphylococcus aureus or S. aureus
- ◯ Clostridioides difficile or C. difficile
- ◯ Oral streptococci or Viridans group streptococci

Part 1 answers

Part 1: answers

1. What is the major causative organism for urinary tract infections?

- **You selected:** ${Q-CL}
- **Correct answer:** E. coli or Escherichia coli

2. What is the bacteria where the only oral option to treat it is a quinolone?

- **You selected:** ${Q-CM}
- **Correct answer:** Pseudomonas

3. What is the bacteria most commonly associated with skin and soft tissue infection?

- **You selected:** ${Q-CN}
- **Correct answer:** Staphylococcus aureus or S. aureus

4. What is the organism most commonly associated with endocarditis?

- **You selected:** ${Q-CO}
- **Correct answer:** Oral streptococci or Virdans group streptococci

5. What organism causes antibiotic associated diarrhoea?

- **You selected:** ${Q-CP}
- **Correct answer:** Clostridioides difficile or C. Difficile

Part 2: crack the case!

The lights are on, but you're still no closer to getting out and going home… You look to the desk to see if there's a key for the door – what a mess!

On top of a pile you see a patient case study – **answer the questions to sort out the papers and hunt for a key.**

Mr. Davies (72years old)

He has come to see you as he has noticed in the last week:

- Stings when he passes urine and he says its smells
- He has felt tired and generally achy
- He has some pain in his stomach
- Background: benign prostatic hypertrophy and Type 2 diabetes.
- Penicillin allergic – rash
- O/E: apyrexial, Heart rate 76bpm, Blood Pressure 125/72
- Discomfort noted at subrapubic area

---

* **Which investigation would you pick?**

- ◯ Urine dipstick
- ◯ Urine microscopy and culture
- ◯ Blood tests – FBC, CRP and U&Es
- ◯ Stool culture

Part 2: crack the case!

Mr. Davies (72years old)

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- He has felt tired and generally achy
- He has some pain in his stomach
- Background: benign prostatic hypertrophy and Type 2 diabetes.
- Penicillin allergic – rash
- O/E: apyrexial, HR 76bpm, BP 125/72
- Discomfort noted at subrapubic area

The GP sends a urine sample off and commences Nitrofurantoin. After 2 days the GP receives the below results:

- Urine: pus cells >100
- Culture >15cfu– Proteus mirabilis
- Resistant to Amoxicillin, Nitrofurantoin and Trimethoprim.
- Sensitive to Ciprofloxacin, Co-amoxiclav and Gentamicin

---

* **Which antibiotic will you start the patient on?**

- ○ Gentamicin
- ○ Co-amoxiclav
- ○ Nitrofurantoin
- ○ Ciprofloxacin
- ○ Trimethoprim

Part 2: crack the case!

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- Sensitive to Ciprofloxacin, Co-amoxiclav and Gentamicin

The GP contacts the patient and asks him to stop the Nitrofurantoin. The patient complains he is still symptomatic with dysuria and feels generally very tired. The GP starts the patient on oral Ciprofloxacin 500mgs BD for 7 days. On day 5 after starting the antibiotics the patient contacts the GP complaining of loss of appetite, loose stools (type 4) and low abdominal cramps.

---

* **What will be your next step?**

- ○ Tell the patient to complete the course of Ciprofloxacin and take some loperamide for the loose stools
- ○ Tell the patient to complete the course of Ciprofloxacin and drink plenty of water – it's important to keep hydrated
- ○ Tell the patient to STOP Ciprofloxacin and send the stool sample to the lab (test for Clostridiodes difficile)
- ○ Tell the patient to complete the course of Ciprofloxacin and eat more fibre to harden his stools.

Part 2: crack the case!

Mr. Davies (72years old)

He has come to see you as he has noticed in the last week:

- Stings when he passes urine and he says its smells
- He has felt tired and generally achy
- He has some pain in his stomach
- Background: benign prostatic hypertrophy and Type 2 diabetes.
- Penicillin allergic – rash
- On Examination: apyrexial, HR 76bpm, BP 125/72
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- Resistant to Amoxicillin, Nitrofurantoin and Trimethoprim.
- Sensitive to Ciprofloxacin, Co-amoxiclav and Gentamicin

The GP contacts the patient and asks him to stop the Nitrofurantoin. The patient complains he is still symptomatic with dysuria and feels generally very tired. The GP starts the patient on oral Ciprofloxacin 500mgs twice a day for 7 days. On day 5 after starting the antibiotics the patient contacts the GP complaining of loss of appetite, loose stools (type 4) and low abdominal cramps.

The GP gets a test result back from the lab:

C. difficile or Clostridiodes difficile in stool GDH (glutamate dehydrogenase) positive, Toxin positive

---

* **How would you progress with patient care? (select 2 answers)**

- [ ] Offer a course of oral Metronidazole for 10 days and advice patient on staying hydrated
- [ ] Suggest the patient to take probiotics
- [ ] Offer a course of oral Vancomycin for 10 days and advise oral hydration
- [ ] Check the patient for symptoms of severe C.difficile infection and ask him to monitor bowel frequency
- [ ] Ask patient to continue 3 days more of Ciprofloxacin to finish UTI course when on C.difficile treatment

Part 2 answers

Part 2: answers

1. Which investigation would you pick (pick only one test):

- **You selected:** ${Q-AB}
- **Correct answer:** Urine microscopy and culture

2. Which antibiotic will you start the patient on?

- **You selected:** ${Q-AD}
- **Correct answer:** Ciprofloxacin

3. What will be your next step?

- **You selected:** ${Q-AF}
- **Correct answer:** Tell the patient to STOP Ciprofloxacin and send the stool sample to the lab (test for Clostridiodes difficile).

4. How would you progress with patient care? (select two options)

- **You selected:** ${Q-AI}
- **Correct answer:** Offer a course of oral Vancomycin for 10 days and advise oral hydration; Check the patient for symptoms of severe C.difficile infection and ask him to monitor bowel frequency

Part 3: corridor dash!

You have waded through the notes to discover a key – well done!

You unlock the pharmacy door to find… a maze of corridors, side rooms and locked doors. Sprint through the questions to find a way through.

---

* Which antibiotic can cause QT prolongation, tendon rupture, increase in suicidal ideation, aortic aneurysm rupture?

- ◯ Trimethoprim
- ◯ Doxycycline
- ◯ Nitrofurantoin
- ◯ Ciprofloxacin

---

* Which drug is a cytochrome P450 enzyme inducer and colours bodily fluids orange?

- ◯ Rifampicin
- ◯ Ciprofloxacin
- ◯ Co-trimoxazole
- ◯ Meropenem

---

* Which drug treats PCP pneumonia and can cause high potassium and Steven-Johnsons?

- ◯ Clarithromycin
- ◯ Co-trimoxazole
- ◯ Linezolid
- ◯ Daptomycin

---

* Which drug can cause optic neuropathy and myelosuppression and should only be used for maximum 28 days?

- ◯ Linezolid
- ◯ Voriconazole
- ◯ Rifampicin
- ◯ Ciprofloxacin

---

* Which drug is a cytochrome P450 enzyme inhibitor and is used to treat atypical pneumonia?

- ◯ Trimethoprim
- ◯ Daptomycin
- ◯ Clarithromycin
- ◯ Doxycycline

---

* Which drug reduces sodium valproate levels increasing the risk of seizures?

- ◯ Ciprofloxacin
- ◯ Voriconazole
- ◯ Meropenem
- ◯ Linezolid

* Which drug should be avoided in patients with eGFR <45ml/min due to risk of treatment failure?

- ◯ Doxycycline
- ◯ Co-trimoxazole
- ◯ Daptomycin
- ◯ Nitrofurantoin

* Which drug is no longer recommended as first line for UTI due to widespread resistance?

- ◯ Ciprofloxacin
- ◯ Trimethoprim
- ◯ Linezolid
- ◯ Meropenem

* Which drug cannot be used in children due to dental staining, side effects include oesophagitis and photosensitivity?

- ◯ Meropenem
- ◯ Rifampicin
- ◯ Doxycycline
- ◯ Trimethoprim

* Which drug can cause Phototoxicity, Squamous cell carcinoma of the skin, visual disturbances, QT prolongation, Hepatotoxicity?

- ◯ Trimethoprim
- ◯ Co-trimoxazole
- ◯ Voriconazole
- ◯ Nitrofurantoin

Part 3 answers

Part 3: answers

1. Which antibiotic can cause QT prolongation, tendon rupture, increase in suicidal ideation, aortic aneurysm rupture?

- **You selected:** ${Q-BR}
- **Correct answer:** Ciprofloxacin

2. Which drug is a cytochrome P450 enzyme inducer and colours bodily fluids orange?

- **You selected:** ${Q-BS}
- **Correct answer:** Rifampicin

3. Which drug treats PCP pneumonia and can cause high potassium and Steven-Johnsons?

- **You selected:** ${Q-BT}
- **Correct answer:** Co-trimoxazole

4. Which drug can cause optic neuropathy and myelosuppression and should only be used for maximum 28 days?

- **You selected:** ${Q-BV}
- **Correct answer:** Linezolid

5. Which drug is a cytochrome P450 enzyme inhibitor and is used to treat atypical pneumonia?

- **You selected:** ${Q-BW}
- **Correct answer:** Clarithromycin

6. Which drug reduces sodium valproate levels increasing the risk of seizures?

- **You selected:** ${Q-BX}
- **Correct answer**: Meropenem

7. Which drug should be avoided in patients with eGFR <45ml/min due to risk of treatment failure?

- **You selected:** ${Q-BY}
- **Correct answer:** Nitrofurantoin

8. Which drug is no longer recommended as first line for UTI due to widespread resistance?

- **You selected:** ${Q-BZ}
- **Correct answer:** Trimethoprim

9. Which drug cannot be used in children due to dental staining, side effects include oesophagitis and photosensitivity?

- **You selected:** ${Q-CA}
- **Correct answer:** Doxycycline

10. Which drug can cause Phototoxicity, Squamous cell carcinoma of the skin, visual disturbances, QT prolongation, Hepatotoxicity?

- **You selected:** ${Q-CB}
- **Correct answer:** Voriconazole

Part 4: patient preparation

Phew! You burst through the nearest door and find yourself in the hospital waiting room. The exit is in sight, but in front of you is a group of patients who have been trapped in the building as well!

Solve the case study questions to get the group ready to leave.

Case study 1: Mrs Bloom

Mrs Bloom (65 years old) has been admitted to hospital for the 5th time this year with a flare up of COPD. She has tendonitis in the knee:

Allergy history:

- Penicillin allergy = Sickness
- She cannot remember which particular penicillin it was
- Strongly denies any rashes or symptoms of anaphylaxis.

---

* **What would be the best course of action for Mrs Bloom?**

- ◯ Obtain microbiology approval to use meropenem
- ◯ Prescribe ciprofloxacin
- ◯ Explain that sickness is a common side effect with many antibiotics. Recommend a trial of IV piperacillin/tazobactam and doctors can prescribe anti-sickness medicine on a PRN basis

---

Case study 2: Mr Bean

Mr Bean (50 years old) has been diagnosed with sepsis of unknown source. He is currently prescribed IV vancomycin, gentamicin and metronidazole. He has had missed/delayed doses due to difficult IV access.

Allergy history:

- Penicillin allergy (unknown reaction) on electronic prescribing system
- Summary Care Record = NKDA
- Acute section of Summary Care Record: Multiple courses of amoxicillin 500mg TDS in the last year which he has confirmed he has taken for chest infections with no issues.

---

* **Pick the most suitable option for Mr Bean**

- ◯ Obtain patient consent to remove allergy from the electronic prescribing system and ask team to change to co-amoxiclav (first line option)
- ◯ Do nothing
- ◯ Document allergy discrepancy in notes hoping the consultant will review

---

Case study 3: Mr Grant

Mr Grant (65 years old) is being treated for a urosepsis. He is currently on IV gentamicin for 3 days.

Plan:

- Switch to oral treatment as clinically improving and discharge planning.
- Urine culture grown E.coli.
- Sensitive to co-amoxiclav & gentamicin
- Resistant to nitrofurantoin, trimethoprim, pivmecillinam

Allergy history:

- Summary Care Record: co-amoxiclav - rash
- Mr Grant mentions having a childhood rash with amoxicillin when he was a teenager but does not have further details.
- Patient reports no breathing difficulties with any antibiotics or needing to go to hospital.

---

* **Pick the most suitable option for Mr Grant**

- ◯ Discharge with oral co-amoxiclav
- ◯ Discharge with co-amoxiclav and PRN chlorphenamine
- ◯ Suggest oral co-amoxiclav trial with patient consent

Case study 3: Mr Hart

Mr Hart (46 years old) needing cardiac surgery, went to dental practice for a review prior to surgery, due to persistent tooth pain. The dentist noted a possible tooth abscess and prescribed the patient oral amoxicillin.

Mr Hart attends their GP practice 30 minutes after taking the oral amoxicillin, distressed with swollen lips and tongue and widespread body rash which is itchy. He has no viral symptoms.

On examination they are apyrexial, blood pressure was 100/60mmHg , pulse 94bpm, respiratory rate 34 breaths per minute, oxygen saturation. 97% They appear to be increasingly short of breath.

---

* **What should the next actions be for Mr Hart? (pick 5 options)**

- [ ] Lie the patient down with feet raised
- [ ] Organise for an ambulance to take the patient to A&E
- [ ] Immediate administration of adrenaline in the upper thigh muscle in the leg
- [ ] Establish airway and give high flow oxygen
- [ ] Apply calamine lotion to help the itchiness
- [ ] Label patient as penicillin allergic in the notes with description of reaction as anaphylaxis

Part 4 answers

Part 4: answers

1. What would be the best course of action for Mrs Bloom?

- **You selected**: ${Q-AX}
- **Correct answer:** Explain that sickness is a common side effect with many antibiotics. Recommend a trial of IV piperacillin/tazobactam and doctors can prescribe anti-sickness medicine on a PRN basis

2. Pick the most suitable option for Mr Bean:

- **You selected:** ${Q-AZ}
- **Correct answer:** Obtain patient consent to remove allergy from the electronic prescribing system and ask team to change to co-amoxiclav (first line option)

3. Pick the most suitable option for Mr Grant:

- **You selected**: ${Q-BB}
- **Correct answer:** Suggest oral co-amoxiclav trial with patient consent

4. What should the next actions be for Mr Hart? (pick 5 options)

- **You selected:** ${Q-BE}
- **Correct answer:** Lie the patient down with feet raised; Organise for an ambulance to take the patient to A&E; Immediate administration of adrenaline in the upper thigh muscle in the leg; Establish airway and give high flow oxygen; Label patient as penicillin allergic in the notes with description of reaction as anaphylaxis

Part 5: code crunch!

You're so close to escaping – all you need to do is enter the code into the keypad for the doors to slide open. There's just one problem… in the frenzy of breaking out you have forgotten the code!

Answer the following security questions to reveal the code and finally get out!

---

* **When should IV antibiotics be reviewed for an oral switch?**

- ◯ By 48 hours and every 24 hours thereafter
- ◯ After 3 days
- ◯ When the patient needs to be discharged

---

* **What course length of antibiotics is required to treat community acquired pneumonia in an adult?**

- ◯ 7 days
- ◯ 3 days
- ◯ 5 days

---

* **Which of the following are antibiotics from the watch category?**

- ◯ Penicillin
- ◯ Clarithromycin
- ◯ Meropenem

---

* **Which of the following are antibiotics from the access category?**

- ◯ Nitrofurantoin
- ◯ Co-amoxiclav
- ◯ Lymecycline

---

* **Which of the following cover pseudomonas?**

- ◯ Co-amoxiclav
- ◯ Piperacillin-tazobactam
- ◯ Azithromycin

---

* **Which of the following cover anaerobes?**

- ◯ Co-amoxiclav
- ◯ Co-trimoxazole
- ◯ Amoxicillin

---

* **Which of the following is high risk for C difficile?**

- ○ Doxycycline
- ○ Flucloxacillin
- ○ Co-amoxiclav

* **Which samples would you send for a patient with CAP (Community-Acquired Pneumonia)? (select as many as relevant)**

- ☐ Sputum
- ☐ Nose and throat swab for viral screen
- ☐ Urine for legionella antigen
- ☐ Urine MCS
- ☐ Stool sample

Part 5 answers

Part 5: answers

1. When should IV antibiotics be reviewed for an oral switch?

- **You selected:** ${Q-BG}
- **Correct answer:** By 48 hours and every 24 hours thereafter

2. What course length of antibiotics is required to treat community acquired pneumonia in an adult?

- **You selected:** ${Q-BH}
- **Correct answer:** 5 days

3. Which of the following are antibiotics from the watch category?

- **You selected:** ${Q-BI}
- **Correct answer:** Clarithromycin

4. Which of the following are antibiotics from the access category?

- **You selected:** ${Q-BJ}
- **Correct answer:** Nitrofurantoin

5. Which of the following cover pseudomonas?

- **You selected:** ${Q-BK}
- **Correct answer:** Piperacillin-tazobactam

6. Which of the following cover anaerobes?

- **You selected:** ${Q-BL}
- **Correct answer:** Co-amoxiclav

7. Which of the following is high risk for C difficile?

- **You selected:** ${Q-BM}
- **Correct answer:** Co-amoxiclav

8. Which samples would you send for a patient with CAP?

- **You selected:** ${Q-CF}
- **Correct answer:** Sputum; Nose and throat swab for viral screen; Urine for legionella antigen

Post-game questions

Congratulations! You have made it through the training. Answer the following feedback questions and then find out if you escaped…

---

* To what extent would you rate your understanding of AMS now?

- ○ 1 (no understanding)
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10 (great understanding)

---

* To what extent do you feel confident in your ability to apply AMS principles in practice now? (after the training)

- ○ 1 (not at all confident)
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10 (very confident)

---

* To what extent did you find this training engaging?

- ○ 1 (not engaging at all)
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10 (very engaging)

---

* What elements of this training did you find useful or not useful?

Appendix 5. Wilcoxon signed rank tests, p < 0.05 Bonferroni-corrected Understanding scores, by profession

		Before				After				Difference				Wilcoxon			
Profession	N	Min	Max	Mean	Median	Min	Max	Mean	Median	Min	Max	Mean	Median	Significant?	After greater?	V	p
All	749	1	10	6.90	7	1	10	7.62	8	-9	9	0.72	1.0	True	True	23783.5	< 0.0001
Pharmacist	348	1	10	7.54	8	3	10	8.18	8	-5	6	0.64	1.0	True	True	3895.0	< 0.0001
Nurse	101	1	10	6.48	7	3	10	7.06	7	-5	5	0.58	1.0	True	True	623.5	0.0004
Doctor/medic	99	1	10	6.49	7	1	10	7.48	8	-9	9	0.99	1.0	True	True	310.0	< 0.0001
Pharmacy technician	73	1	10	6.45	7	2	10	7.18	7	-5	3	0.73	1.0	True	True	219.0	< 0.0001
Other	31	1	10	5.26	5	1	10	6.32	7	-6	9	1.06	1.0	Sample size too small	NA	NA	NA
Advanced Clinical Practitioner	22	5	10	7.32	7	6	9	7.95	8	-3	2	0.64	1.0	Sample size too small	NA	NA	NA
Student	21	1	10	5.76	5	2	9	7.00	7	-5	4	1.24	2.0	Sample size too small	NA	NA	NA
Admin/Managerial	18	1	10	3.72	4	1	7	4.67	5	-3	5	0.94	1.0	Sample size too small	NA	NA	NA
Microbiologist	17	5	10	9.24	10	4	10	9.24	10	-1	2	0.00	0.0	Sample size too small	NA	NA	NA
Allied Health Professional	8	2	9	4.75	4	4	8	6.50	7	-5	6	1.75	1.5	Sample size too small	NA	NA	NA

Appendix 6. Wilcoxon signed rank tests, p < 0.05 Bonferroni-corrected Confidence scores, by profession

		Before				After				Difference				Wilcoxon			
Profession	N	Min	Max	Mean	Median	Min	Max	Mean	Median	Min	Max	Mean	Median	Significant?	After greater?	V	p
All	749	1	10	6.70	7	1	10	7.45	8	-9	9	0.75	1	True	True	25320.0	< 0.0001
Pharmacist	348	1	10	7.36	7	1	10	8.03	8	-5	6	0.67	1	True	True	3968.0	< 0.0001
Nurse	101	1	10	6.30	6	2	10	6.84	7	-4	5	0.54	1	True	True	932.0	0.0032
Doctor/medic	99	1	10	6.14	6	1	10	7.44	8	-5	9	1.30	1	True	True	256.5	< 0.0001
Pharmacy technician	73	1	10	6.15	6	1	10	6.90	7	-6	5	0.75	1	True	True	215.5	< 0.0001
Other	31	1	10	5.71	6	1	10	6.32	7	-9	5	0.61	1	Sample size too small	NA	NA	NA
Advanced Clinical Practitioner	22	5	10	7.00	7	6	10	7.91	8	-3	3	0.91	1	Sample size too small	NA	NA	NA
Student	21	1	10	5.29	5	2	9	6.43	7	-3	4	1.14	1	Sample size too small	NA	NA	NA
Admin/Managerial	18	1	10	3.56	3	1	8	4.17	4	-3	5	0.61	0	Sample size too small	NA	NA	NA
Microbiologist	17	6	10	9.12	10	4	10	9.12	10	-2	2	0.00	0	Sample size too small	NA	NA	NA
Allied Health Professional	8	2	7	4.38	4	4	8	5.88	6	-3	6	1.50	1	Sample size too small	NA	NA	NA