



BRIEF REPORT

Innovative strategies to fight antimicrobial resistance: crowdsourcing to expand medical training [version 1; peer review: awaiting peer review]

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Abstract

Background: Antimicrobial resistance is a serious public health concern across the world, but public awareness is low, few educational resources on diagnostics exist and professional interest in infectious diseases is waning. To spur interest in infectious disease, emphasize the role of diagnostics in management of resistant infections and develop educational resources to support antimicrobial stewardship.

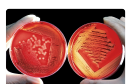
Methods: We employed crowdsourcing methods, using an open challenge contest to solicit clinical cases on antimicrobial resistance and clinical diagnostics.

Results: We received 25 clinical cases from nine countries. After screening, 23 cases were eligible for judging. Three cases emerged as the top finalists and were further developed into an open access learning module on diagnostics and antimicrobial resistance.

Conclusions: Crowdsourcing methods are beneficial for generating interest in infectious disease and developing educational resources to support antibiotic stewardship.

Keywords

Antimicrobial resistance, clinical diagnostics, crowdsourcing, infectious diseases



This article is included in the **Antimicrobial Resistance** collection.

Open Peer Review

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Any reports and responses or comments on the article can be found at the end of the article.

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Introduction

Antimicrobial resistance (AMR) is a major public health threat. Reports from the World Health Organisation (WHO) global surveillance and Global Point Prevalence Survey show high rates of inappropriate antibiotic use¹, suggesting the need for enhanced antimicrobial stewardship. Yet public awareness of AMR remains low² and the pipeline from medical school into careers relating to infectious diseases is weak. The numbers of US trainees entering infectious diseases decreased 41% between 2009 and 2017³.

There is a need to respond to the lack of interest in infectious disease training through various methods, including expanding medical training on infectious diseases³. Most medical schools give limited teaching on AMR and even less on the use of diagnostics to reduce inappropriate use of antibiotics⁴. A European study reported that in all but one of seven medical schools studied, the majority of students wanted further education on antibiotic prescribing, which is an essential aspect of AMR management⁵. A US study also suggested that physicians receive inadequate training on the interpretation of antibiograms⁶. Other studies from the UK⁷, China⁸ and Ethiopia⁹, suggest the need for more AMR and diagnostics content in medical curricula. The WHO recently highlighted the importance of undergraduate training in prudent prescribing and research highlights the need for more AMR and diagnostics training for healthcare workers around the world¹⁰.

In response to this need, we organised a crowdsourcing project, soliciting clinical cases on diagnostics/AMR from medical

students and physicians. Crowdsourcing is a bottom-up approach that allows many individuals to attempt to solve a problem and then shares solutions with the public¹¹. Crowdsourcing contests typically convene a steering committee, engage citizens or a particular group to participate, evaluate entries, recognize finalists and share solutions with the public (Table 1). It has been used in medical research and piloted as a tool to develop medical education materials¹².






Our crowdsourcing approach focused on developing an educational resource for medical students and trainees on infectious disease diagnostics/AMR. The overall goal of the challenge contest was to spur enthusiasm for infectious diseases and increase infectious disease diagnostics/AMR knowledge to support antibiotic stewardship. The aim of the call was to encourage medical students, trainees, physicians, and others to collect or write clinical cases to develop educational materials for AMR.

Methods

Crowdsourcing for clinical AMR cases

We set up a global steering committee comprised of 19 individuals from six WHO regions (seven women and 12 men). The steering committee included experts in laboratory science, medicine, public health, health communications, and medical education. Members were selected based on sex, geographic region, and expertise. We accepted clinical cases focused on used of diagnostics in AMR from mid-March until May 1, 2018. This call was disseminated through social media channels (including Facebook, Twitter and YouTube), partner organizations, professional association mailing lists, and in-person events. The call for

Table 1. Steps in a crowdsourcing challenge contest.

STAGES	PURPOSE	RESULTS
 Organize a steering committee	To support a strong community, buy-in from the start which resonates with local language/culture/preferences	The contest had a steering committee of nineteen experts from seven WHO regions
 Engage the community	To clarify the rules/guidelines of the contest for community members and encourage participation	The call for entries was promoted through a website, social media and in-person events. We received 25 entries received from 9 countries
 Evaluate Entries	To determine a group of judges from the crowd, steering committee, or others to evaluate entries based on a pre-specified criterion	All entries were evaluated in 3 stages and 23 entries were eligible for judging. Fourteen judges evaluated the eligible entries after screening and three cases emerged as the finalists
 Recognize Finalists/ prizes	Announcement of finalists and through social media, other online platforms and in-person events	Three finalists were invited and supported to attend an AMR symposium to present their cases where they were presented with commendation certificate
 Share solutions	To share finalists with national or local agencies, and to implement the final outcomes in the relevant context	Finalist cases published online in Partners ID Images and further developed into an open access learning module

WHO- World Health Organisation, AMR- Antimicrobial Resistance, ID-Infectious Disease

participation was translated into the six official languages of the WHO, but only entries in English were accepted. Links to a one-minute video and a website developed for the contest were shared as part of the call. The website received an average of 117 page views each week. Banners and posters (see *Extended data*)¹³ were also printed and displayed in some hospitals and medical schools in London to create awareness about the contest. All cases were screened for eligibility by two steering committee members and then sent to four physician judges for evaluation using pre-specified criteria. Judges included infectious disease fellows and residents identified by the steering committee. Eligibility criteria published alongside details of the open contest included a focus on AMR clinical case, written in English, using less than 2000 words, and included at least one image. Participants were also required to obtain consent from patients to share cases. The selected judges were neither part of the steering committee nor involved in the design of the call. At this stage, each case was scored between 0 and 10 by the judges. Criteria set for judging the cases include focus on diagnostics and AMR, relevance to medical teaching and capacity to enhance appropriate antibiotic use. The judging rubric is available as *Extended data*¹³.

Individual scores were collated, and the mean score for each case was calculated. At the end of the judging process, the finalists (cases that achieved a mean score of 7/10 or greater) were announced. These clinical cases had a second level of review from three independent judges with detailed feedback on specific areas to improve overall quality and understanding of the cases presented.

All case authors were provided commendation certificates for participation. The finalists were provided with individualized feedback and supported to attend a multidisciplinary diagnostics/AMR focused symposium in London. Finalist cases were disseminated through Partners ID Images. Partners ID Images is an open access online library focused on infectious diseases.

Delphi approach

We used a modified Delphi method as part of a one-day symposium to identify and prioritize key learning objectives for the AMR learning module that was developed using finalist cases¹⁴. The Delphi survey was included as part of activities in a one-day AMR symposium held in London on November 1, 2018, which had experts in AMR research and practice in attendance. The symposium had a line up different AMR research presentations and a panel discussion on diagnostics and AMR. A total of 30 participants, including physicians, medical microbiologists, clinical researchers and medical post graduate students, who attended the one-day AMR symposium and were asked to participate in a survey. Participants were briefed about the survey contents and were also informed that participation was voluntary. The initial round in the morning session consisted of 30 participants and the second round in the afternoon had 21 participants, as some participants attended only the morning session. After two rounds, there was consensus to include 12 objectives (see *Extended data*, supplementary file 3) in the AMR learning module.

Crowd voting

A crowd voting platform was set up on Partners ID images for the general public to select a crowd favourite from the three finalists. The voting page was open for two weeks and received 334 votes, mostly from the US, Peru, Australia and the UK. A random number generator was used to select 17 voters (5% of total votes) to receive a free digital Sanford Guide app.

Results

We received 25 clinical case entries from nine countries. Peru had the highest number of entries – seven (28%), followed by the US with six entries (17%). Other submissions were received from Nigeria (n=4), China (n=3), Australia (n=1), Canada (n=1), Ethiopia (n=1), Paraguay (n=1), and Zambia (n=1). After screening, 23 cases were eligible for the next stage of judging (see *Underlying data*)¹³; two entries were excluded for not being relevant to the subject of the call. In total, 19 were original cases written by participants, and four were adapted from already published literature. All cases were submitted alongside a signed declaration of patients' consent from the authors. The cases described clinical presentations of drug resistant organisms and the role of diagnostics in their management. An overview is given on the [SESH Global website](#).

Out of the 23 eligible cases, three cases emerged as finalists with mean scores of seven or above. Most cases achieved scores greater than five; only six entries (26%) had mean scores less than five. *Underlying data* shows scores for each case¹³.

The crowd favourite was a clinical case on pyelonephritis caused by metallo-beta-lactamases producing *Pseudomonas aeruginosa*. All three finalist cases (see *Extended data*, Supplementary file 1)¹³ were further reviewed with medical education experts from partner organizations and integrated into an online diagnostics/AMR interactive learning module (see *Extended data*, Supplementary file 2)¹³. This was done with the help of the results of the Delphi approach (see *Underlying data* for results)¹³.

Discussion

Crowdsourcing provides several advantages in the development of medical training materials compared to conventional approaches, including duration of time needed, cost, and global coverage. Our challenge was able to solicit over 20 cases in less than two months, faster than most medical education development. The total cost of the challenge was less than having experts develop clinical cases. Finally, the global composition of our steering committee and case contributors allowed us to develop a resource that may be relevant in diverse global settings.

However, our crowdsourcing contest had several limitations that warrant consideration. This contest received fewer clinical cases than other crowdsourcing contests. The low number of cases may have been related to the lack of official partnerships with a larger conference or professional associations, the relatively high requirements – including need to obtain patient's consent – in the guidelines for submissions, and the timing of the call. Our call for cases coincided with a similar call for clinical

cases on infectious diseases from the Infectious Diseases Society of America. Despite the overall low number of submissions, we had sufficiently strong cases to create the learning module and develop new case content for the database.

One gap identified during the challenge was the limited strategic priorities within AMR medical education. The purpose of the learning module is to increase awareness and understanding of diagnostics and AMR in adult and paediatric medicine. This could be used as Continuing Medical Education (CME) or integrated into undergraduate medical curricula.

While we have created an open access learning resource on diagnostics and AMR (supplementary file 2), there is still a need for more educational resources related to AMR. Crowdsourcing may be a useful adjunct in the development of medical education materials. Crowdsourcing could be used in a variety of settings to encourage interest in infectious diseases, decrease unnecessary antibiotic use and promote antibiotic stewardship.

Data availability

Underlying data

Open Science Framework: Innovative strategies to fight antimicrobial resistance: crowdsourcing to expand medical training. <https://doi.org/10.17605/OSF.IO/WVP9G>¹³.

This project contains the following underlying data:

- AMR_Delphi_ResultsTable. (Results of the two-part Delphi study).
- Clinical cases (The 23 clinical cases submitted).
- Scores for AMR Clinical cases. (Judges scores for each submitted case).
- AMR_Delphi[1]. (Raw results from Delphi study round 1).
- AMR_Round2[1]. (Raw results from Delphi study round 2).

Extended data

Open Science Framework: Innovative strategies to fight antimicrobial resistance: crowdsourcing to expand medical training. <https://doi.org/10.17605/OSF.IO/WVP9G>¹³.

This project contains the following extended data:

- Supplemental_digital_appendix_1FINALIST_Clinical_cases[1]. (Supplementary file 1: Summaries of the case finalists).
- Supplemental_digital_appendix__2_The_learning_module[1] (Supplementary file 2: How to access the diagnostic/AMR learning module)
- Supplemental digital appendix 3 The learning Objectives. (Supplementary file 3: Learning objectives).
- AMR contest flyer (flyer used to advertise AMR case competition)
- AMR Contest roll up banner (banner used to advertise AMR case competition)
- CrowdvotingAnnouncement14Oct2018 (announcement made to encourage crowdvoting)
- AMRsurvey_ToPrint[1] (blank survey used for Delphi study round 1)
- AMRsurvey_round2[1] (blank survey used for Delphi study round 2)

Data are available under the terms of the [Creative Commons Attribution 4.0 International license \(CC-BY 4.0\)](https://creativecommons.org/licenses/by/4.0/).

Consent

Written informed consent for publication of their clinical details and/or clinical images was obtained from each of the patients.

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References

1. Versporten A, Zarb P, Caniaux I, *et al.*: **Antimicrobial consumption and resistance in adult hospital inpatients in 53 countries: results of an internet-based global point prevalence survey.** *Lancet Glob Health.* 2018; 6(6): e619–e29. [PubMed Abstract](#) | [Publisher Full Text](#)
2. Mason T, Trochez C, Thomas R, *et al.*: **Knowledge and awareness of the general public and perception of pharmacists about antibiotic resistance.** *BMC Public Health.* 2018; 18(1): 711. [PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
3. Bonura EM, Armstrong WS: **Increasing Subspecialization in the Field of Infectious Diseases: Evaluating Challenges and Strategies to Move Forward.** *J Infect Dis.* 2017; 216(suppl_5): S594–S9. [PubMed Abstract](#) | [Publisher Full Text](#)
4. Abbo LM, Cosgrove SE, Pottinger PS, *et al.*: **Medical students' perceptions and knowledge about antimicrobial stewardship: how are we educating our future prescribers?** *Clin Infect Dis.* 2013; 57(5): 631–8. [PubMed Abstract](#) | [Publisher Full Text](#)
5. Dyar OJ, Pulcini C, Howard P, *et al.*: **European medical students: a first multicentre study of knowledge, attitudes and perceptions of antibiotic prescribing and antibiotic resistance.** *J Antimicrob Chemother.* 2014; 69(3): 842–6. [PubMed Abstract](#) | [Publisher Full Text](#)
6. Nand P, Wilson MD, Cohen SH, *et al.*: **Curbing antimicrobial resistance: Do physicians receive adequate education about antibiograms?** *J Infect.* 2016; 72(1): 127–9. [PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
7. Castro-Sanchez E, Farrell S, Drumright L, *et al.*: **Do we need to review and escalate the antimicrobial stewardship education in health and veterinary**

- undergraduate courses in the United Kingdom? Results of a national survey.** *Int J Infect Dis.* 2014; **21**: 203.
[Publisher Full Text](#)
8. Hu YH, Wang XM, Tucker JD, *et al.*: **Knowledge, Attitude, and Practice with Respect to Antibiotic Use among Chinese Medical Students: A Multicentre Cross-Sectional Study.** *Int J Environ Res Public Health.* 2018; **15**(6): pii: E1165.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
 9. Seid MA, Hussen MS: **Knowledge and attitude towards antimicrobial resistance among final year undergraduate paramedical students at University of Gondar, Ethiopia.** *BMC Infect Dis.* 2018; **18**(1): 312.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
 10. Rogers Van Katwyk S, Jones SL, Hoffman SJ: **Mapping educational opportunities for healthcare workers on antimicrobial resistance and stewardship around the world.** *Hum Resour Health.* 2018; **16**(1): 9.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
 11. Lendvay TS, White L, Kowalewski T: **Crowdsourcing to Assess Surgical Skill.** *JAMA Surg.* 2015; **150**(11): 1086–7.
[PubMed Abstract](#) | [Publisher Full Text](#)
 12. Tucker JD, Meyers K, Best J, *et al.*: **The HepTestContest: a global innovation contest to identify approaches to hepatitis B and C testing.** *BMC Infect Dis.* 2017; **17**(Suppl 1): 701.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
 13. Kpokiri EE: **Innovative strategies to fight antimicrobial resistance: crowdsourcing to expand medical training.** 2020.
<http://www.doi.org/10.17605/OSF.IO/WVP9G>
 14. Budak J, Kpokiri EE, Abdoler E, *et al.*: **2547. Prioritizing Antimicrobial Resistance Learning Objectives Through a Modified, Two-Round, One-Day Delphi at a Multidisciplinary Conference.** *Open Forum Infectious Disease.* 2019; **6**(Supplement_2): S885.
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