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Transitioning to people centred Antimicrobial Resistance Surveillance

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Abstract:	In response to the emergence of antimicrobial resistance as a public health problem of global concern, several AMR surveillance programmes have been initiated, which are often dependent on establishing blood culture capacity. Blood is typically sampled from patients with suspected bloodstream infection or sepsis, a diagnostic sample of high clinical consequence for these conditions associated with high morbidity and mortality. In contrast, the purpose of global AMR surveillance is to improve understanding of AMR, which may lead to uni-directional flow of AMR data away from healthcare facilities. This can create the perception that blood culture is only undertaken for global AMR surveillance and risks failure to provide feedback on individual samples to sick patients and treating physicians or local aggregation and analysis of surveillance data for facility leadership to act upon. Lack of clinical or epidemiological returns at the local/hospital level places surveillance investments at risk of being invisible and unsustainable. Here, we propose re-focussing AMR surveillance, particularly that based on blood cultures, as primarily being a diagnostic tool for the benefit of patients. We believe that in doing so and by creating capacity to enable local data to be used for local action, we will both improve patient care and optimise the value of healthcare and diagnostic facilities, which will re-enforce and help sustain global efforts to surveil AMR and inform global policy.

Transitioning to people centred Antimicrobial Resistance Surveillance

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Synopsis

In response to the emergence of antimicrobial resistance (AMR) as a public health problem of global concern, several large, aid funded AMR surveillance programmes have been initiated, which are often dependent on establishing blood culture capacity. Blood is typically sampled from patients with suspected bloodstream infection or sepsis, a diagnostic sample of high clinical consequence for these conditions associated with high morbidity and mortality. In contrast, the purpose of global AMR surveillance is to improve understanding of AMR, which may lead to uni-directional flow of AMR data away from healthcare facilities. This can create the perception that blood culture is only undertaken for global AMR surveillance and risks failure to provide feedback on individual samples to sick patients and treating physicians or local aggregation and analysis of surveillance data for facility leadership to act upon. Lack of clinical or epidemiological returns at the local/hospital level places surveillance investments at risk of being invisible and unsustainable. Here, we propose re-focussing AMR surveillance, particularly that based on blood cultures, as primarily being a diagnostic tool for the benefit of patients. We believe that in doing so and by creating capacity to enable local data to be used for local action, we will both improve patient care and optimise the value of healthcare and diagnostic facilities, which will re-enforce and help sustain global efforts to surveil AMR and inform global policy.

Summary

Antimicrobial resistance (AMR) is a growing global health threat, and many public health surveillance programs rely on blood cultures as a means to track this phenomenon. Blood cultures, however, are diagnostic tests taken from patients with suspected sepsis or bloodstream infections, where timely results can be lifesaving. When blood culture-based AMR surveillance is instituted for global AMR monitoring, these investments may not realise their full potential in supporting patient care. This creates the risk that local hospitals see little benefit from surveillance activities, making such programs less sustainable. We argue that blood cultures should be viewed first and foremost as a vital diagnostic tool to guide patient care. By ensuring that local hospitals can use and act on their own data, we can both improve outcomes for patients and strengthen global AMR surveillance efforts.

Introduction

In 2015, at the 68th World Health Assembly the World Health Organization (WHO) Member States unanimously adopted a Global Action Plan to tackle antimicrobial resistance (AMR).¹ One of the five objectives of the plan is “to strengthen the knowledge and evidence base through surveillance and research.”¹ WHO defines surveillance as the ongoing systematic collection, analysis, and interpretation of outcome specific data for use in planning, implementing and evaluating public health policies and practices; a distinct and different objective from research. Since 2015, several large, multi-country AMR surveillance initiatives have been launched in low- and middle-income countries (LMICs). These include the WHO Global Antimicrobial Resistance and Use Surveillance System (GLASS) for reporting country level data, and the UK-Aid Fleming Fund for strengthening surveillance capacity in laboratories, and use of pre- and post-marketing surveillance from pharmacological companies.^{2,3,4} These and other initiatives have contributed to progress in establishing capacity to generate and report AMR data from LMICs.^{5,6} As the Global Action Plan undergoes revisions for 2026,⁷ we reflect on the achievements and unintended consequences of the efforts.

Global action on AMR is gaining political traction, as evidenced by the Political Declaration of the High-level Meeting on AMR resulting from United Nations General Assembly in 2024 which emphasized the importance of surveillance. Political declarations have not, however, translated to substantial increases in surveillance funding, particularly directed to LMICs.⁸ As a result, many surveillance challenges remain in LMIC settings including in conflict areas and war zones.⁹ As an example, a recent survey by the Mapping AMR and Antimicrobial Use Partnership (MAAP) in 14 African countries from 2016-2019, found that only 1.3% of over 50,000 medical laboratories could undertake bacterial isolation, identification and susceptibility testing, that in 8/14 countries greater than half of the population was out of reach of a bacteriology laboratory, and that data generated by healthcare facilities are rarely linked to clinical or treatment data.¹⁰ Where laboratory data are generated, progress has been variable in linking them to clinical syndrome, clinical outcome or treatment data, and are thus not always being optimally used for local actions (i.e. antimicrobial stewardship (AMS)). Although GLASS and similar initiatives exist AMR surveillance has not been adequately prioritized or received sustainable funding, and community engagement on AMR is neglected.^{11,12}

More recently, WHO has published guidance on taking a people-centred approach to AMR, focused on prevention of infections; access to essential health services; timely, accurate diagnosis; and appropriate,

quality-assured treatment.¹³ Here, we suggest five priority areas for implementation of patient-centred AMR surveillance that collectively aim both to support sustainable generation and mobilization of AMR data to inform effective policy and action and prioritize patient care. We focus on blood culture as the most frequent microbiological diagnostic test to be implemented for AMR surveillance.^{2,3,4}

The necessity of a patient-centred approach

AMR surveillance initiatives in LMICs have tended to focus on generating AMR data for delivery to global organisations. Yet AMR surveillance data are typically the byproduct of a diagnostic test performed on a sick person and often from a blood culture – one of the most consequential clinical specimens. This undue focus on aggregation of data to generate global estimates of AMR rather than consistently returning accurate diagnostic test results to inform patient treatment in a timely fashion can lead to a perception that newly established blood culture services are not primarily for diagnosis and treatment of patients in LMIC settings but to address health security concerns of high-income countries regarding AMR.

We propose refocusing on communicating that the primary purpose of blood culture is as a vital tool for greater diagnostic accuracy to inform appropriate and effective use of antibiotics to improve patient management and outcomes and optimize AMS. The demand for quality AMR surveillance data, whilst legitimate and important, is secondary to what the primary focus should be - which is patient care. Using a facility level approach to the implementation of diagnostic clinical microbiology services that healthcare professionals can trust will improve care whilst strengthening AMR surveillance. The nature of this implementation will necessarily vary from setting to setting, for example in some settings medical microbiology does not exist as a distinct specialty, however this approach is entirely consistent with WHO recommendations that a patient-centred approach should be taken in addressing AMR.^{13,14,15}

It is difficult to argue against an initiative that puts patients first while ensuring data reuse for AMR surveillance, but re-focusing on the implementation of diagnostic microbiology services for patient care requires numerous steps and appropriate prioritisation.¹⁶ These start with engagement and communication with all levels of healthcare workers, policy makers, patients, and the public about the value of blood culture as a diagnostic test. Implementation of laboratory quality assurance programmes is also a requirement, as is effective and timely communication between microbiology laboratories and clinicians.^{17,18,19} Framing AMR as a process of implementing diagnostic stewardship, as proposed for example by the clinically-oriented resistance network (ACORN, a pragmatic approach to linking laboratory

to clinical data to improve patient care and burden of AMR estimates), will drive demand for diagnostic microbiology, increase patient benefit and thus generate meaningful AMR surveillance data linked to patient treatment and outcomes.²⁰ The kind of clinical and laboratory data linkage that ACORN facilitates might form the basis of evidence of patient centered AMR surveillance.

Creating mechanisms to enable use of local AMR surveillance data for local action

Aggregated AMR surveillance data often flows away (and ‘up’) from the sites that generate it, missing the chance to use such data to support facility level decision-making on prescribing policies. However, it is vital that hospitals generating surveillance data can then access and analyze it to inform local diagnostic and AMS guidelines and clinical practice without delay.^{21,22} This requires a combination of the right tools for data capture, sharing and analysis, and training of a skilled workforce to analyze these data. It is critical that data entry tools and requirements do not over burden resource constrained laboratories – many approaches to laboratory data management require two rounds of data entry, one for clinical diagnostic purposes and a second for surveillance purposes.²⁰ Despite this clinical need, laboratory information systems that are affordable and easy to use are in very short supply across much of the LMICs. A recent mapping study in Africa showed that only 26% of laboratories use electronic laboratory information management systems (LIMS).²³ In addition, when electronic laboratory data are available, the data are often not linked with clinical and treatment data, further most facilities lacked the time, resources and capacity to analyze data (particularly to deduplicate and validate summary data), write reports, and release summary data or reports.²⁴ While national authorities may collate and submit aggregated data to GLASS, these data may never be analyzed within a facility or compared between facilities nor used to inform national guidelines. For smaller laboratories, paper-based information management systems remain a necessary, low-cost and durable option, although a short-coming for AMR surveillance is that data will need to be re-entered into a system which enables aggregation and sharing.

Timely generation of high-quality and representative aggregate AMR data is not only crucial to support local quality improvement activities, but is also expected to be beneficial for large scale surveillance. For example, in some LMIC settings, blood culture testing is often performed only after failure of empirical antibiotic treatment; implementing a diagnostic stewardship programme emphasizing blood culture testing prior to commencement of might also reduce selection bias in AMR surveillance data.²⁰ Facility level data can be aggregated, stratified by exposure to antibiotics and used to monitor regional and temporal trends, spread and burden of AMR, compare the AMR situations between facilities, and inform

guidelines development.²⁵ Data can also be used to advocate for antimicrobial access and diagnostic stewardship. This requires steps to respond to the clear need for the development and implementation of open access microbiology-focused LIMS and analytical tools to manage, mobilize and analyze laboratory and clinical data.^{21,23,24,26} A fit-for-purpose open-source LIMS might replace paper in small scale laboratories and standardize analytical methods (for example, de-duplication and stratification by origin of infection based on the WHO GLASS recommendations) and generate reports with minimal cost implications or technical expertise in large laboratories, such that data can both be shared nationally and be useful locally and for individual patients.^{24,26} In addition to tools, workforce capacity at healthcare facility or district needs to be established and staff trained to use these data for local action such as developing, monitoring and improving local diagnostic stewardship, AMS and infection prevention and control (IPC) guidelines.^{27,28,29} The creation and usage of aggregate AMR data at healthcare facility or regional level might also evidence that a patient centred approach to AMR surveillance has been taken.

Sustainability of diagnostic microbiology laboratory capabilities for AMR surveillance

In many LMICs, AMR surveillance capacity has been established using automated blood culture platforms designed for high-income countries (HICs). Blood culture, however, has intrinsic shortcomings both as a diagnostic test, with imperfect sensitivity for diagnosis of bacterial bloodstream infection (BSI), specificity which can be impaired by contamination and because many AMR-relevant infections are not commonly associated with BSI. Whilst blood culture platforms have obvious value in supporting a high-quality diagnostic service, they are expensive to purchase (with only two companies providing systems) and challenging to maintain and service in the longer term. Consumables for automated systems are often more expensive in LMICs due to economies of scale, import cost, tax, and other factors. We and others have observed that facilities often discontinue blood culture services when funding from international initiatives stop due to the cost and shortage of effectively functioning supply chains for these systems. Discontinuation can lead to machine malfunction, making it difficult to re-start the service, pressure to reallocate trained laboratory staff and loss of trust among stakeholders. One example of this is discontinuation of use of blood culture instruments procured for use in research, but this problem is not unique to research facilities. Sustainability is a particularly acute and major problem, given the United States President's Executive Orders in January 2025, which has halted US funding to WHO and initiated the process for the US to leave WHO, while stopping funding for many international programmes, technical support and information sharing supported by the US Centers for Disease Control, and the United States Agency for International Development.

One approach to address sustainability is to scale up resilience in supply chains, increase global and local diagnostic manufacturing capacity, and negotiate for cost reduction, the urgency of which was brought into sharp relief by the COVID-19 pandemic.³⁰ An alternative approach would be to implement, improve, and validate manual blood culture methods. This could use locally or regionally produced blood culture broth and agars (either at facilities or country reference centers) to enable blood culture, bacterial identification and antimicrobial susceptibility testing at low cost.^{31,32,33} This approach, however, requires far more skilled human resources to support the primary diagnostic pathways and to implement robust in-country quality assurance programmes to address potentially high error rates.³⁴ The tension between these options must be resolved at the facility, national, regional and international levels, ideally before funding from international initiatives discontinues.

Wider engagement

Beyond the technical aspects of the implementation of blood culture in local facilities, it is also important to appreciate that patients, their families and communities want to understand why AMR surveillance is important. An extreme example of inadequate community engagement can occur in communities where there is no experience of blood sampling for diagnosis beyond that required for full blood count or a malaria rapid diagnostic test and little understanding about infection. In these settings, rumours surrounding “blood stealing” or “blood selling” can develop and have potentially dire effects on the success of surveillance.^{35,36} While messages such as “10 million people will die each year due to AMR by 2050” may be useful soundbites for global policy makers, they are less effective for the public and the electorate at country level than a message based on local data and on personal relevance.^{37,38} Further work is required to determine optimal ways to communicate the value of blood cultures through a process of community engagement and involvement, a process which will vary by geographical location.³⁹ There are some helpful examples of community engagement through established methods including the ‘Responsive Dialogues’ approach implemented in Thailand, Malawi and Laos.^{40,41} This provides a framework for co-development which can be extended to further understanding of surveillance for individual patient and community level benefit. Additionally, an ongoing application of the deliberative polling method involving panels in Brazil, Colombia; Nigeria and Tanzania; India and Indonesia is aimed at capturing shifts in understanding and behaviours on AMR preventative measures, diagnostics and antibiotic use at scale.⁴²

Engagement with healthcare professionals is equally important; AMR data presented in global dashboards may be difficult to interpret in a local context and may not correctly inform appropriate local action.⁴³ Learning from use of dashboards in the COVID-19 pandemic suggest that AMR dashboards presenting total cases and deaths attributable to/associated with AMR-infections for each country could help in-country planning.^{44,45} National authorities should also generate national dashboards (i.e. <https://laoamr.net/>), which explicitly present those parameters in each area or hospital and over time, similar to those for AMR infections in HICs to allow benchmarking of AMR burden between areas or hospitals within a country.^{46,47} Presentation of these data is a major challenge as AMR results are considerably more complicated to represent and interpret than the qualitative result associated with a COVID-19 test. If the quality, quantity and linkage to clinical data of AMR surveillance data are not improved then AMR can be both under and overestimated, which might result in either underuse (and excess mortality) or overuse (further driving AMR) of the WHO assigned Watch and Reserve antimicrobials.

Top-down aid-funded surveillance initiatives have unquestionably expanded laboratory networks and produced valuable aggregate datasets. However, this model risks treating LMIC health systems as being uniform rather than as complex, heterogeneous systems. The realities of laboratory access, patient pathways and laboratory medicine vary enormously within and between Asia and Africa. For example, for a large, extremely populous country such as India sustainable surveillance must recognise considerable subnational variation in public and private laboratory capacity, supply chains, prescribing patterns and governance. Surveillance strategy might be designed to re-balance AMR surveillance away from a minority of advanced urban sites. For a low-income African setting such as Malawi, however, sustainability looks different because baseline microbiology laboratory capacity is less developed even at urban hospitals. Here surveillance strategy might prioritise strengthening of routine, quality assured diagnostic availability and result-return in urban sentinel hospitals, where the earliest, clearest gains would accrue. In both settings, concentration of effort on centralized data gathering without investing in context appropriate strategy misses opportunities to improve individual patient care, infection prevention and control and antimicrobial stewardship. Equally important to laboratory capacity strengthening is empowering locally led surveillance and community engagement to co-design diagnostic services tailored to the structural realities of each health-system and that work for the frontline clinicians, laboratories and communities that surveillance investments are intended to benefit. Such a shift would reduce extractive data flows,

strengthen clinical decision-making where it matters most, and produce more ethically grounded and operationally useful intelligence about AMR.

Extending the benefit of AMR surveillance to address wider infectious disease challenges

AMR should not become another global vertical programme or a public health silo. Ongoing efforts being expended to create laboratory capacity to collect, curate and analyse AMR surveillance data should be leveraged to establish broader, One Health infection surveillance frameworks. This includes notifiable bacterial diseases, fungal infections, sepsis, food safety, environmental hygiene and emerging infectious diseases. The first and simplest step to maximize the value of data from microbiology laboratories would be to generate additional reports on other bacterial and fungal infections not required to be reported per the WHO priority pathogens list, which would support pandemic preparedness and align with International Health Regulations.⁴⁸ It should also support critical surveillance activities necessary for vaccination campaigns i.e. pneumococcal or typhoid conjugate vaccines. A combination of clinically oriented AMR surveillance and sequencing approaches could also be used to detect emerging or re-emerging infectious diseases that would also support pandemic preparedness.²⁰

Conclusion

Reported AMR prevalence in many LMICs may be over- or underestimated because blood culture sampling is under-used, delayed or biased.²⁵ This is because in many LMIC settings, patients are frequently treated empirically and blood culture is used only after failure of empirical treatment. Furthermore, patients infected with self-limiting and/or antibiotic-responsive bacterial infections are less likely to be sampled for blood culture. Whilst the recent UNGA high level meeting on AMR made diverse references both to surveillance and to people-centered approaches to AMR, it did not explicitly link the two. By promoting a people-centred approach to AMR and mobilizing data for local action we have the potential to save lives and expand demand for microbiology services thus generating more epidemiologically meaningful AMR surveillance data.

Whilst global initiatives for AMR surveillance in LMICs have made progress in building capacity, there remain challenges in realizing the full potential benefit from these investments, especially with recent constraints in aid funding, for example the recent announcement of the termination of the Fleming Fund. And whilst investing in AMR surveillance, it is prudent to ask: for what purpose and for whose benefit are we doing this? It is critical to put the patient at the centre of this effort and appreciate that the primary

purpose of blood culture is as a diagnostic tool to guide therapy. To do other than establish people-centred surveillance is unethical and will fundamentally undermine the demand for nascent blood culture services.

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Author contributions

This opinion piece was conceived at a SEDRIC board meeting. DL and NAF led the subsequent drafting and all authors contributed.

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Transitioning to people centred Antimicrobial Resistance Surveillance

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Synopsis

In response to the emergence of antimicrobial resistance (AMR) as a public health problem of global concern, several AMR surveillance programmes have been initiated, which are often dependent on establishing blood culture capacity. Blood is typically sampled from patients with suspected bloodstream infection or sepsis, a diagnostic sample of high clinical consequence for these conditions associated with high morbidity and mortality. In contrast, the purpose of global AMR surveillance is to improve understanding of AMR, which may lead to uni-directional flow of AMR data away from healthcare facilities. This can create the perception that blood culture is only undertaken for global AMR surveillance and risks failure to provide feedback on individual samples to sick patients and treating physicians or local aggregation and analysis of surveillance data for facility leadership to act upon. Lack of clinical or epidemiological returns at the local/hospital level places surveillance investments at risk of being invisible and unsustainable. Here, we propose re-focussing AMR surveillance, particularly that based on blood cultures, as primarily being a diagnostic tool for the benefit of patients. We believe that in doing so and by creating capacity to enable local data to be used for local action, we will both improve patient care and optimise the value of healthcare and diagnostic facilities, which will re-enforce and help sustain global efforts to surveil AMR and inform global policy.

Summary

Antimicrobial resistance (AMR) is a growing global health threat, and many public health surveillance programs rely on blood cultures as a means to track this phenomenon. Blood cultures, however, are diagnostic tests taken from patients with suspected sepsis or bloodstream infections, where timely results can be lifesaving. When blood culture-based AMR surveillance is instituted for global AMR monitoring, these investments may not realise their full potential in supporting patient care. This creates the risk that local hospitals see little benefit from surveillance activities, making such programs less sustainable. We argue that blood cultures should be viewed first and foremost as a vital diagnostic tool to guide patient care. By ensuring that local hospitals can use and act on their own data, we can both improve outcomes for patients and strengthen global AMR surveillance efforts.

Introduction

In 2015, at the 68th World Health Assembly the World Health Organization (WHO) Member States unanimously adopted a Global Action Plan to tackle antimicrobial resistance (AMR).¹ One of the five objectives of the plan is “to strengthen the knowledge and evidence base through surveillance and research.”¹ WHO defines surveillance as the ongoing systematic collection, analysis, and interpretation of outcome specific data for use in planning, implementing and evaluating public health policies and practices; a distinct and different objective from research. Since 2015, several large AMR surveillance initiatives have been launched in low- and middle-income countries (LMICs). These include the WHO Global Antimicrobial Resistance and Use Surveillance System (GLASS) for reporting country level data, and the UK-Aid Fleming Fund for strengthening surveillance capacity in laboratories, and use of pre- and post-marketing surveillance from pharmacological companies.^{2,3,4} These and other initiatives have contributed to progress in establishing capacity to generate and report AMR data from LMICs.^{5,6} As the Global Action Plan undergoes revisions for 2026,⁷ we reflect on the achievements and unintended consequences of the efforts.

Global action on AMR is gaining political traction, as evidenced by the Political Declaration of the High-level Meeting on AMR resulting from United Nations General Assembly in 2024 which emphasized the importance of surveillance. Political declarations have not, however, translated to substantial increases in surveillance funding, particularly directed to LMICs.⁸ As a result, many surveillance challenges remain in LMIC settings including in conflict areas and war zones.⁹ As an example, a recent survey by the Mapping AMR and Antimicrobial Use Partnership (MAAP) in 14 African countries from 2016-2019, found that only 1.3% of over 50,000 medical laboratories could undertake bacterial isolation, identification and susceptibility testing, that in 8/14 countries greater than half of the population was out of reach of a bacteriology laboratory, and that data generated by healthcare facilities are rarely linked to clinical or treatment data.¹⁰ Where laboratory data are generated, progress has been variable in linking them to clinical syndrome, clinical outcome or treatment data, and are thus not always being optimally used for local actions (i.e. antimicrobial stewardship (AMS)). Although GLASS and similar initiatives exist AMR surveillance has not been adequately prioritized or received sustainable funding, and community engagement on AMR is neglected.^{11,12}

More recently, WHO has published guidance on taking a people-centred approach to AMR, focused on prevention of infections; access to essential health services; timely, accurate diagnosis; and appropriate,

quality-assured treatment.¹³ Here, we suggest five priority areas for implementation of patient-centred AMR surveillance that collectively aim both to support sustainable generation and mobilization of AMR data to inform effective policy and action and prioritize patient care. We focus on blood culture as the most frequent microbiological diagnostic test to be implemented for AMR surveillance.^{2,3,4}

The necessity of a patient-centred approach

AMR surveillance initiatives in LMICs have tended to focus on generating AMR data for delivery to global organisations. Yet AMR surveillance data are typically the byproduct of a diagnostic test performed on a sick person and often from a blood culture – one of the most consequential clinical specimens. This undue focus on aggregation of data to generate global estimates of AMR rather than consistently returning accurate diagnostic test results to inform patient treatment in a timely fashion can lead to a perception that newly established blood culture services are not primarily for diagnosis and treatment of patients in LMIC settings but to address health security concerns of high-income countries regarding AMR.

We propose refocusing on communicating that the primary purpose of blood culture is as a vital tool for greater diagnostic accuracy to inform appropriate and effective use of antibiotics to improve patient management and outcomes and optimize AMS. The demand for quality AMR surveillance data, whilst legitimate and important, is secondary to what the primary focus should be - which is patient care. Using a facility level approach to the implementation of diagnostic clinical microbiology services that healthcare professionals can trust will improve care whilst strengthening AMR surveillance. The nature of this implementation will necessarily vary from setting to setting, for example in some settings medical microbiology does not exist as a distinct specialty, however this approach is entirely consistent with WHO recommendations that a patient-centred approach should be taken in addressing AMR.^{13,14,15}

It is difficult to argue against an initiative that puts patients first while ensuring data reuse for AMR surveillance, but re-focusing on the implementation of diagnostic microbiology services for patient care requires numerous steps and appropriate prioritisation.¹⁶ These start with engagement and communication with all levels of healthcare workers, policy makers, patients, and the public about the value of blood culture as a diagnostic test. Implementation of laboratory quality assurance programmes is also a requirement, as is effective and timely communication between microbiology laboratories and clinicians.^{17,18,19} Framing AMR as a process of implementing diagnostic stewardship, as proposed for example by the clinically-oriented resistance network (ACORN) will drive demand for diagnostic

microbiology, increase patient benefit and thus generate meaningful AMR surveillance data linked to patient treatment and outcomes.²⁰

Creating mechanisms to enable use of local AMR surveillance data for local action

Aggregated AMR surveillance data often flows away (and ‘up’) from the sites that generate it, missing the chance to use such data to support facility level decision-making on prescribing policies. However, it is vital that hospitals generating surveillance data can then access and analyze it to inform local diagnostic and AMS guidelines and clinical practice without delay.^{21,22} This requires a combination of the right tools for data capture, sharing and analysis, and training of a skilled workforce to analyze these data. Despite this clinical need, laboratory information systems that are affordable and easy to use are in very short supply across much of the LMICs. A recent mapping study in Africa showed that only 26% of laboratories use electronic laboratory information management systems (LIMS).²³ In addition, when electronic laboratory data are available, the data are often not linked with clinical and treatment data, further most facilities lacked the time, resources and capacity to analyze data (particularly to deduplicate and validate summary data), write reports, and release summary data or reports.²⁴ While national authorities may collate and submit aggregated data to GLASS, these data may never be analyzed within a facility or compared between facilities nor used to inform national guidelines. For smaller laboratories, paper-based information management systems remain a necessary, low-cost and durable option, although a short-coming for AMR surveillance is that data will need to be re-entered into a system which enables aggregation and sharing.

Timely generation of high-quality and representative aggregate AMR data is not only crucial to support local quality improvement activities, but is also expected to be beneficial for large scale surveillance. For example, in some LMIC settings, blood culture testing is often performed only after failure of empirical antibiotic treatment; implementing a diagnostic stewardship programme emphasizing blood culture testing prior to commencement of might also reduce selection bias in AMR surveillance data.²⁰ Facility level data can be aggregated, stratified by exposure to antibiotics and used to monitor regional and temporal trends, spread and burden of AMR, compare the AMR situations between facilities, and inform guidelines development.²⁵ Data can also be used to advocate for antimicrobial access and diagnostic stewardship. This requires steps to respond to the clear need for the development and implementation of open access microbiology-focused LIMS and analytical tools to manage, mobilize and analyze laboratory and clinical data.^{21,23,24,26} A fit-for-purpose open-source LIMS might replace paper in small scale

laboratories and standardize analytical methods (for example, de-duplication and stratification by origin of infection based on the WHO GLASS recommendations) and generate reports with minimal cost implications or technical expertise in large laboratories, such that data can both be shared nationally and be useful locally and for individual patients.^{24,26} In addition to tools, workforce capacity at healthcare facility or district needs to be established and staff trained to use these data for local action such as developing, monitoring and improving local diagnostic stewardship, AMS and infection prevention and control (IPC) guidelines.^{27,28,29}

Sustainability of diagnostic microbiology laboratory capabilities for AMR surveillance

In many LMICs, AMR surveillance capacity has been established using automated blood culture platforms designed for high-income countries (HICs). Blood culture, however, has intrinsic shortcomings both as a diagnostic test, with imperfect sensitivity for diagnosis of bacterial bloodstream infection (BSI), specificity which can be impaired by contamination and because many AMR-relevant infections are not commonly associated with BSI. Whilst blood culture platforms have obvious value in supporting a high-quality diagnostic service, they are expensive to purchase (with only two companies providing systems) and challenging to maintain and service in the longer term. Consumables for automated systems are often more expensive in LMICs due to economies of scale, import cost, tax, and other factors. We and others have observed that facilities often discontinue blood culture services when funding from international initiatives stop due to the cost and shortage of effectively functioning supply chains for these systems. Discontinuation can lead to machine malfunction, making it difficult to re-start the service, pressure to reallocate trained laboratory staff and loss of trust among stakeholders. One example of this is discontinuation of use of blood culture instruments procured for use in research, but this problem is not unique to research facilities. Sustainability is a particularly acute and major problem, given the United States President's Executive Orders in January 2025, which has halted US funding to WHO and initiated the process for the US to leave WHO, while stopping funding for many international programmes, technical support and information sharing supported by the US Centers for Disease Control, and the United States Agency for International Development.

One approach to address sustainability is to scale up resilience in supply chains, increase global and local diagnostic manufacturing capacity, and negotiate for cost reduction, the urgency of which was brought into sharp relief by the COVID-19 pandemic.³⁰ An alternative approach would be to implement, improve, and validate manual blood culture methods. This could use locally or regionally produced blood culture

broth and agars (either at facilities or country reference centers) to enable blood culture, bacterial identification and antimicrobial susceptibility testing at low cost.^{31,32,33} This approach, however, requires far more skilled human resources to support the primary diagnostic pathways and to implement robust in-country quality assurance programmes to address potentially high error rates.³⁴ The tension between these options must be resolved at the facility, national, regional and international levels, ideally before funding from international initiatives discontinues.

Wider engagement

Beyond the technical aspects of the implementation of blood culture in local facilities, it is also important to appreciate that patients, their families and communities want to understand why AMR surveillance is important. An extreme example of inadequate community engagement can occur in communities where there is no experience of blood sampling for diagnosis beyond that required for full blood count or a malaria rapid diagnostic test and little understanding about infection. In these settings, rumours surrounding “blood stealing” or “blood selling” can develop and have potentially dire effects on the success of surveillance.^{35,36} While messages such as “10 million people will die each year due to AMR by 2050” may be useful soundbites for global policy makers, they are less effective for the public and the electorate at country level than a message based on local data and on personal relevance.^{37,38} Further work is required to determine optimal ways to communicate the value of blood cultures through a process of community engagement and involvement, a process which will vary by geographical location.³⁹ There are some helpful examples of community engagement through established methods including the ‘Responsive Dialogues’ approach implemented in Thailand, Malawi and Laos.^{40,41} This provides a framework for co-development which can be extended to further understanding of surveillance for individual patient and community level benefit. Additionally, an ongoing application of the deliberative polling method involving panels in Brazil, Colombia; Nigeria and Tanzania; India and Indonesia is aimed at capturing shifts in understanding and behaviours on AMR preventative measures, diagnostics and antibiotic use at scale.⁴²

Engagement with healthcare professionals is equally important; AMR data presented in global dashboards may be difficult to interpret in a local context and may not correctly inform appropriate local action.⁴³ Learning from use of dashboards in the COVID-19 pandemic suggest that AMR dashboards presenting total cases and deaths attributable to/associated with AMR-infections for each country could help in-country planning.^{44,45} National authorities should also generate national dashboards (i.e.

<https://laoamr.net/>), which explicitly present those parameters in each area or hospital and over time, similar to those for AMR infections in HICs to allow benchmarking of AMR burden between areas or hospitals within a country.^{46,47} Presentation of these data is a major challenge as AMR results are considerably more complicated to represent and interpret than the qualitative result associated with a COVID-19 test. If the quality, quantity and linkage to clinical data of AMR surveillance data are not improved then AMR can be both under and overestimated, which might result in either underuse (and excess mortality) or overuse (further driving AMR) of the WHO assigned Watch and Reserve antimicrobials.

Top-down aid-funded surveillance initiatives have unquestionably expanded laboratory networks and produced valuable aggregate datasets. However, this model risks treating LMIC health systems as being uniform rather than as complex, heterogeneous systems. The realities of laboratory access, patient pathways and laboratory medicine vary enormously within and between Asia and Africa. For example, for a large, extremely populous country such as India sustainable surveillance must recognise considerable subnational variation in public and private laboratory capacity, supply chains, prescribing patterns and governance. Surveillance strategy might be designed to re-balance AMR surveillance away from a minority of advanced urban sites. For a low-income African setting such as Malawi, however, sustainability looks different because baseline microbiology laboratory capacity is less developed even at urban hospitals. Here surveillance strategy might prioritise strengthening of routine, quality assured diagnostic availability and result-return in urban sentinel hospitals, where the earliest, clearest gains would accrue. In both settings, concentration of effort on centralized data gathering without investing in context appropriate strategy misses opportunities to improve individual patient care, infection prevention and control and antimicrobial stewardship. Equally important to laboratory capacity strengthening is empowering locally led surveillance and community engagement to co-design diagnostic services tailored to the structural realities of each health-system and that work for the frontline clinicians, laboratories and communities that surveillance investments are intended to benefit. Such a shift would reduce extractive data flows, strengthen clinical decision-making where it matters most, and produce more ethically grounded and operationally useful intelligence about AMR.

Extending the benefit of AMR surveillance to address wider infectious disease challenges

AMR should not become another global vertical programme or a public health silo. Ongoing efforts being expended to create laboratory capacity to collect, curate and analyse AMR surveillance data should be

leveraged to establish broader, One Health infection surveillance frameworks. This includes notifiable bacterial diseases, fungal infections, sepsis, food safety, environmental hygiene and emerging infectious diseases. The first and simplest step to maximize the value of data from microbiology laboratories would be to generate additional reports on other bacterial and fungal infections not required to be reported per the WHO priority pathogens list, which would support pandemic preparedness and align with International Health Regulations.⁴⁸ It should also support critical surveillance activities necessary for vaccination campaigns i.e. pneumococcal or typhoid conjugate vaccines. A combination of clinically oriented AMR surveillance and sequencing approaches could also be used to detect emerging or re-emerging infectious diseases that would also support pandemic preparedness.²⁰

Conclusion

Reported AMR prevalence in many LMICs may be over- or underestimated because blood culture sampling is under-used, delayed or biased.²⁵ This is because in many LMIC settings, patients are frequently treated empirically and blood culture is used only after failure of empirical treatment. Furthermore, patients infected with self-limiting and/or antibiotic-responsive bacterial infections are less likely to be sampled for blood culture. Whilst the recent UNGA high level meeting on AMR made diverse references both to surveillance and to people-centered approaches to AMR, it did not explicitly link the two. By promoting a people-centred approach to AMR and mobilizing data for local action we have the potential to save lives and expand demand for microbiology services thus generating more epidemiologically meaningful AMR surveillance data.

Whilst global initiatives for AMR surveillance in LMICs have made progress in building capacity, there remain challenges in realizing the full potential benefit from these investments, especially with recent constraints in aid funding. And whilst investing in AMR surveillance, it is prudent to ask: for what purpose and for whose benefit are we doing this? It is critical to put the patient at the centre of this effort and appreciate that the primary purpose of blood culture is as a diagnostic tool to guide therapy. To do other than establish people-centred surveillance is unethical and will fundamentally undermine the demand for nascent blood culture services.

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Author contributions

This opinion piece was conceived at a SEDRIC board meeting. DL and NAF led the subsequent drafting and all authors contributed.

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Dear Dr De Ambrogi

Thank you for sending our manuscript *Transitioning to people centred Antimicrobial Resistance Surveillance* for review and for inviting revision. We have made point by point responses below. I can confirm that the paper has not been submitted to another journal, and has not been published in whole or in part elsewhere previously

Yours sincerely,

Nick Feasey

Reviewers' comments:

Reviewer #1: The authors appear to be arguing that ethical clinical practice is commonly absent in some African LIC settings, where resource-poor hospitals are unable to support microbiological data analysis and therefore subject to exploitative studies that do not return local epidemiological data. They argue for increased resources to address this.

Authors' Response: The focus of this opinion piece is not research activity but public health surveillance and this distinction is important. The surveillance activities we are critiquing are thus outside the remit of a REC as they are typically funded by aid agencies in partnership with ministries of health framed around improving surveillance of a major global health issue, but which are neglecting the patient from whom the surveillance data point derives from.

This has been clarified from the third line of the introduction, which now reads:

"WHO defines surveillance as the ongoing systematic collection, analysis, and interpretation of outcome specific data for use in planning, implementing and evaluating public health policies and practices; a distinct and different objective from research. Since 2015, several large AMR surveillance initiatives have been launched in low- and middle-income countries (LMICs). These include the WHO Global Antimicrobial Resistance and Use Surveillance System (GLASS)² for reporting country level data, and the UK-Aid Fleming Fund."

The opening states that invasive sampling (blood culture) is made available primarily to inform surveillance in some LIC settings, or even that data (such as a positive blood culture result) which might provide benefit to the patient, is not provided in a timely manner because it is somehow deprioritised.

"...undue focus on aggregation of data to generate global estimates of AMR rather than consistently returning accurate diagnostic test results to inform patient treatment in a timely fashion can lead to a perception that newly established blood culture services are not primarily for diagnosis and treatment of patients in LMIC settings"

This is a statement of principle that no one would dispute. Where blood culture infrastructure is funded for use in aggregate as a surveillance tool or within a clinical trial context, these should be subject to GCP principles. Withholding timely positive results would not pass scrutiny by a properly constituted research ethics committee.

The later understatement that "It is difficult to argue against an initiative that puts patients first while ensuring data reuse for AMR surveillance " appears to assert that this is the norm in some centres. Perhaps I am misstating the authors intended message and perhaps an opening clarification of issues would be useful.

Authors' Response: Whilst GCP governs research activities, the focus of this piece is public health surveillance activities of AMR that have not primarily been established for research, but by international aid programmes. Their focus has been on generating aggregate AMR data, neglecting the individual level benefit that might accrue from the diagnostic tests from which aggregate AMR surveillance data derive. Addressing the reviewer's second point, this dual use of data, both at an individual level diagnostic and aggregation of data is the norm in well-resourced healthcare settings, but is typically reliant on a clinical microbiology service to support the interpretation of test results at the individual patient level. This has been clarified in the introduction.

It appears later in the essay that the concern is rather that the local data should be returned as focused local information. This is generally accepted as good practice but it is not certain that such data are reliably predictive of community-acquired infection as blood cultures tend to be drawn only in the most ill. Indeed, the authors point out toward the end of the essay that blood culture data are misleading in LMICs because of the way blood cultures are used. The assertion that small numbers of local blood culture results will successfully inform locally specific antibiotic stewardship needs support.

Authors' response: Whilst a comprehensive diagnostic microbiology service would be optimal for the generation of antimicrobial stewardship guidelines, the synthesis of some data are certainly better when drafting antimicrobial stewardship guidelines (as required by WHO) than doing so with no data at all. We have addressed this concern by revising the section named "Creating mechanisms to enable use of local AMR surveillance data for local action".

Overall, I think this essay makes several unarguable statements:

- that local information regarding infections and antibiotic susceptibilities should be available to best inform local stewardship

- that immediate assessment of the antibiotic susceptibility of a pathogen in the bloodstream is a primary clinical goal that should be resourced

- that programs drawing data away to central locations without observing the duty of care they share with the health authority that provides these data are unhelpful

Is the authors central position that we must address the growth of self-serving external funding programs that do not support local infrastructure but rather harvest the data - and are thus in

conflict with established 'fair benefits principles' (e.g. doi: 10.1111/bcp.12879) , articulated in the Helsinki Declaration \ and its most recent updates (doi:10.1001/jama.2024.22530), and the United Nations Copenhagen Declaration on Social Development (https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_CONF.166_9_Declaration.pdf)?

The underlying theme that LMICs are at risk of being exploited to inform HICs of coming threats is worth highlighting - and whether existing principles and frameworks are serving LMICs adequately is a key question.

Is it the authors position that these frameworks are inadequate and that new or revised position statements are needed?

Authors' response: we thank the reviewer for summarising the piece, but as we are discussing the public health implementation of AMR surveillance, we do not think changing the frameworks governing research activities would help.

Summary

1. The essay argues that universally accepted principles are not being observed - this should ideally be illustrated by concrete examples

2. The assertion around local data has some technical caveats relating to sample sizes, observer bias, power etc - these would be good to at least acknowledge, even if the primary argument is to better empower local microbiology and infection management, which is something that all readers would accept - do the authors think the solution is more national or even regional than local? How does this affect how big surveillance programs should operate?

Authors' response: We thank the reviewer for their thoughtful analysis of our manuscript. We have addressed both summary points above. Regarding point 2, sample size calculations, bias and power are not normally considerations when reflecting on the antibiogram generated by microbiology data to draft antimicrobial stewardship guidelines (AMS). There are diverse approaches to developing AMS and we believe a critique of how much diagnostic microbiology data is enough to inform this process is out with the remit of this opinion piece, but have revised the relevant section to highlight that institutions should strive to ensure that local AMR data are sufficiently representative (i.e. large enough and free from as much bias as possible) to inform AMS. We have revised the second half of the section entitled "Creating mechanisms to enable use of local AMR surveillance data for local action".

Reviewer #2: Thank you for asking me to review this timely viewpoint by authors, who have experience in structuring surveillance programmes across HICs and LMICs and have also played a role in designing the current global surveillance system. The viewpoint makes the important point that the post-2015 expansion of global AMR surveillance has not necessarily served local communities and has been hampered by lacklustre funding. The authors make a series of useful suggestions to ameliorate described fallouts including investing in local buy-in, ensuring timely communication of data to local patients, and diversifying current reliance on blood culture. All of this makes sense and is commendable.

Authors' response: we thank the reviewer for their support

However, given the generational turmoil the Global Health system is currently facing (including the recent closure of the Fleming Fund), calling for more funds, better communication, and more resilient supply chains seems rather tame and vague. It is also notable that even though communities are supposed to be engaged with, the viewpoint does not engage with social sciences research on surveillance and community acceptance. As such, the viewpoint criticises the top-down approach to surveillance while remaining quite top-down in its own analytical approach.

Authors' response: The authorship includes several clinical microbiologists from diverse settings with extensive experience of facility level capacity strengthening activities in diagnostic and clinical microbiology and health systems expertise, it is precisely this “ground-up” experience we have drawn on. The current version has at its core the ground-up perspective with the *patient-centred and facility level considerations*. We have nonetheless given further space to a ground up approach in the revised version by extensively revising the “Wider Engagement” section drawing on a wider literature to enhance the discussions.

The authors could remedy this issue by drawing on the now extensive social sciences literature on AMR. Social scientists have long highlighted similarities between global AMR surveillance and other security- and audit-based global surveillance programmes that were designed to satisfy international demands for data but failed to strengthen local health systems (e.g. Overton et al. Waves of Attention, 2022; Leach et al., Governing Epidemics, 2010; Kenny et al. The (Anti)Microbial Gaze, 2024). Recent research has also highlighted the fact that international AMR surveillance has followed a unidirectional implementation pattern that sees best practice protocols from HICs reverse-engineered to fit into lower resource contexts - rather than building local programmes in a bottom-up fashion (Chandler et al., (Un)intended Consequences, 2025). Lack of community engagement and perceived local usefulness is thus not entirely surprising.

Authors' response: We acknowledge the value and contributions of the papers cited by the reviewer, particularly in analysing the global politics of surveillance. However, their emphasis is largely on the macro-political dynamics of global health governance and security framings, whereas our paper is focused on the operational and diagnostic utility of blood culture in LMIC health systems and sustainability. We agree that the social science literature offers valuable complementary perspectives, but we believe our article already addresses the spirit of these critiques by calling for patient-centred, locally embedded, and clinically useful surveillance systems. We do elaborate on successful community engagement as follows:

There are some helpful examples of community engagement through established methods including the ‘Responsive Dialogues’ approach implemented in Thailand and Malawi. This provides a framework for co-development which can be extended to further understanding of surveillance for individual patient and community level benefit. Additionally, an ongoing application of the deliberative polling method involving panels in Brazil, Colombia; Nigeria and Tanzania; India and Indonesia is aimed at capturing shifts in understanding and behaviours on AMR preventative measures, diagnostics and antibiotic use at scale.

The authors could also be more reflective regarding the vast differences between the local settings they want to engage with in part three of their viewpoint. The article currently treats LMICs as a uniform block of countries. As the author team themselves know due to their work across the UK, Malawi, India, etc., there are major differences between surveillance requirements in middle-income and low-income settings. It would be good to see a more detailed analysis of what 'sustainable' surveillance means for a country such as India as opposed to Malawi. Spelling out what exactly and how large the local benefits of AMR surveillance (as opposed to baseline diagnostic provision) are is especially important when it comes to low-income settings with stressed healthcare systems, inadequate drug supplies, and patchy governance infrastructures. It also means being explicit about the fact that initial surveillance benefits will likely accrue in urban tertiary care settings rather than in rural primary health care.

Authors' response: We thank the reviewer for reminding us of the within LMIC variation and have added the following text in the engagement section.

“Top-down aid funded surveillance initiatives have unquestionably expanded laboratory networks and produced valuable aggregate datasets. However, this model risks treating LMIC health systems as being uniform rather than as complex, heterogeneous systems. The realities of laboratory access, patient pathways and laboratory medicine vary enormously within and between Asia and Africa. For example, for a large, extremely populous country such as India sustainable surveillance must recognise extreme subnational variation in laboratory capacity, supply chains, prescribing patterns and governance; some tertiary hospitals already generate large amounts of AMR surveillance data. Surveillance strategy might be designed to re-balance AMR surveillance away from a minority of urban sites. For a low-income African setting such as Malawi, however, sustainability looks different because baseline laboratory capacity is more fragile. Here surveillance strategy might prioritise strengthening of routine, quality assured diagnostic availability and result-return in urban sentinel hospitals, where the earliest, clearest gains would accrue. In both settings, concentration of effort on centralized data gathering without investing in context appropriate strategy misses opportunities to improve individual care, infection prevention and control and antimicrobial stewardship. Equally important to laboratory capacity strengthening is empowering locally led surveillance and community engagement to co-design diagnostic services tailored to the structural realities of each health-system and that work for the frontline clinicians, laboratories and communities that surveillance investments are intended to benefit. Such a shift would reduce extractive data flows, strengthen clinical decision-making where it matters most, and produce more ethically grounded and operationally useful intelligence about AMR.”

Would environmental surveillance be able to decentre some of this bias?

Authors' response: whilst environmental surveillance (ES) was undoubtedly of benefit in identifying SARS-CoV-2 during the COVID pandemic, many of the bacteria of greatest concern in the AMR pandemic are near ubiquitous in the environment and currently environmental surveillance would likely vastly inflate our estimates of the scale of drug resistant infection, so not we do not believe current approaches to environmental surveillance would be helpful and that a discussion of ES is not in the remit of this paper.

I would also encourage the authors to reflect more on the proposed technological solutions. Global and national AMR surveillance relies on digitised data collection. However, digital systems are often expensive/ challenging to maintain/keep up-to-date: although WHO has invested in Open Source software to capture AMR data since the 1980s (e.g. WHONet), other laboratory software is often proprietary, requires regular updates (and training), and a wider underlying infrastructure of reliable electricity grids, internet connections, and digital storage. Replacing cumbersome paper-based systems with real-time digital systems has long been a mantra of HIC surveillance (e.g. Kirchhelle, *Giants on Clay Feet*, 2022) and can also work very well in MIC settings and large-scale laboratories. However, digital systems have yet to function at scale in LICs with a wide range of different laboratory settings. The ACORN project is a promising initial step in this direction. However, anthropologists and microbiologists such as Iruka Okeke (Okeke, *Divining without Seeds*, 2011; Vernooji, 'Infrastructural Instability', 2021) have also published numerous articles and books describing low-income setting laboratories cluttered with abandoned (mostly donated) technical systems that could not be serviced or updated because of cost once donor programs terminated (just like the Fleming Fund has now). Paper can be a remarkably durable and cheap data storage and management system in these settings. Would replacing it with new digital infrastructure, which will also require continuous servicing, really be a sustainable solution in a situation where donor funding is becoming less not more reliable? How would sustainable local ownership, integration, and maintenance of digital systems and data be secured? Which other tangible benefits - beyond satisfying NAP requirements - would accrue to local actors adopting platforms? And how would national digital AMR dashboards realistically translate into local buy-in? All of this is not to deny the advantages of the authors' proposed solutions, which may work. However, if AMR is primarily an equity and not a security centred challenge, more detail is required on how the proposed people-centred solutions would work in and impact local communities.

Authors' response: We thank the reviewer for this point and agree with the robust nature of paper as the backbone of a laboratory information management tool for individual level reporting. The obvious short-coming of paper from an AMR-surveillance perspective is that information written on paper needs to then be entered into some form of system that enables aggregation and sharing, and double entry of data takes time and is a barrier to AMR surveillance. Indeed, it was Iruka Okeke who highlighted the shortcomings of current approaches to laboratory data management for the purposes of AMR surveillance and the need for context appropriate LIMS tools at a SEDRIC AMR surveillance workshop (October 2019).

We also disagree that the establishment of an open-access piece of software is quite the same as an entirely new digital infrastructure. It is anticipated that the continuous servicing of a LIMS, rather like Microsoft Excel, would be the responsibility of the software developer. As with other software, there is no reason that AMR surveillance data once generated would be transferred to the company or organisation that maintained the software. Regarding the use of dashboards, we believe we have been clear that their role would be at national- or facility-level planning.

Reviewer #3: The authors described the personal point against the WHO's released patient-centered AMR strategy and concentrated on the blood culture as a tool which will helpful on both patient management and AMR surveillance. some comments:

1. The WHO's people centered approach to AMR is based on four pillars: first, preventing infections. second, ensuring access to essential health services. Third, enabling timely and accurate diagnosis. Fourth, providing appropriate , quality-assured treatment. So, I think the authors should discuss the approach from the 4 items:

- (1) prevention: How to identify and protect the patients with the risk to be infected by drug-resistant pathogens? how to prevent the contact between them?
- (2) access to health services: including hospitals, physicians and nurses to manage the patients
- (3) timely and accurate diagnosis: not only on the bacteria pathogens, but also fungi and virus.
- (4) appropriate treatment: including surgical treatment and right antibiotics.

Authors' response: Thanks for noting that the viewpoint already aligns with the patient centred approach advocated for by the WHO. This piece focuses on problems with the current implementation of AMR surveillance systems – the suggested format is rather tangential to the focus of our opinion piece.

2. Blood culture is only one of the diagnostic tools. It can only identify 10-15% sepsis. Moreover, it will miss more patients infected with fungi, viruses and the moderate infections in which the pathogens may not enter the blood. The authors should clarify why they just recommend BC as a useful tool for AMR. Actually, different infection site may require different specimens to be tested.

Authors' response: We agree with this critique of blood cultures and have already made similar comments in the manuscript, however we have not recommended blood culture as a surveillance tool anywhere in this piece. Rather we have reflected that it is the tool most commonly implemented by global AMR surveillance programmes, and on the consequences of this.

3. One of the key factors which hinder the enough diagnosis and treatment in low-middle income countries is the price of the diagnostic tools and effective antibiotics. So, calling for the lower price of these items is more important.

Author's response: we agree and have stated this in the manuscript.

4. In recent years, molecular testing , including some POCT devices, were used widely. I suggest authors to discuss the use of these tools in the field of AMR surveillance.

Authors' response: We are unaware of any POCT that would be relevant to this piece on AMR surveillance, indeed this has very recently been the focus of an American Society for Microbiology's systematic review and meta-analysis of the evidence-base for diagnosis of bloodstream infections using rapid tests and we respectfully refer the reviewer to this comprehensive review (<https://pubmed.ncbi.nlm.nih.gov/40522178/>).

Editor's points

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Authors' response: We have addressed all these points and requirements.