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Antimicrobial resistance challenging professional learning in three LMICs

Introduction: AMR challenges professionals' learning and working

In 2019 the World Health Organization (WHO) listed ten serious threats to public health, including antimicrobial resistance (AMR), the ability of a micro-organism to stop an antimicrobial from working against it (WHO, 2019). The World Bank has highlighted the magnitude of the threat of antimicrobial resistance, estimating a potential for up to 1 million additional deaths worldwide every year by 2050 if the rate of antimicrobial resistance is not reduced (IACG, 2019).

Recognising the seriousness of antimicrobial resistance, in 2015 the World Health Assembly endorsed a Global Action Plan to reduce the rate of antimicrobial resistance (WHO, 2015). In assembling this Global Action Plan, the World Health Organization recognised the significant challenges faced by Low to Middle Income Countries (LMICs) in setting up the health infrastructures necessary to reduce antimicrobial resistance (ibid.).

In 2017 the World Health Organization (2017) introduced 'One Health' which addresses the need for a holistic and multisectoral approach to reduce AMR. Resistant bacteria can originate in humans, animals or in the environment and can spread across these domains. Therefore, collaboration across these sectors, professionals and countries is critical to achieve better public health outcomes.

Recognising the potentially devastating global effects of antimicrobial resistance, the UK Government launched a major UK Aid initiative, the Fleming Fund[1], to support LMICs to improve the surveillance of AMR, the process of tracking changes in microbial populations, supporting early detection of resistant strains of bacteria of public health importance, and enabling prompt notification and investigation of outbreaks (WHO, 2020).

[1] The Fleming Fund is a £265 million UK aid investment to tackle antimicrobial resistance in low- and middle-income countries around the world. The programme is managed by the UK Department of Health and Social Care, in partnership with Mott MacDonald, the Fleming Fund Grants Management Agent

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An increasing number of studies are examining the global threat of AMR. Recent work by Singh and Manchada (2017) identified following challenges: limited diagnostic capability of laboratories; low numbers of trained professionals trained; poor collaboration across different parts of the health system; and insufficient policy legislation to ensure high quality surveillance data. Other studies have identified challenges around actions of raising the awareness of AMR, and emphasising the importance of improved infrastructure, information and regulation (Pearson and Chandler, 2019); limited levels of communication between local clinics and central or national laboratories (Sayed et al., 2018); rigid structures and rules in workplace settings that hinder new AMR surveillance practice (REFERENCE 5 REMOVED FOR BLIND REVIEW); issues associated with hierarchies in healthcare (Gebretekele et al., 2018) leading to issues of trust among clinicians and lab workers (REFERENCE 5 REMOVED FOR BLIND REVIEW); and problems caused by the practices of clinicians who do not draw on the expertise of other specialists, such as nurses or pharmacists (Charani et al., 2019).

Arguments that understanding of AMR have been extensively biomedically driven, focusing on restrictions and individual behaviour suggest that there is need for more critical social science research to reveal problems associated with disconnected practices and organisational, cultural, and political influences (Broom and al., 2020; Broom and Doron, 2020; Frid Nielsen et al., 2019). Being rapidly changing and difficult to manage, AMR can be conceptualised as runaway object (Engeström, 2009); understanding and managing it calls for systemic analysis as well as above mentioned social science research.

This paper, as part of a larger study funded by the Fleming Fund, contributes to this gap by taking a systemic view in analysing AMR activities. It highlights the voices of local practitioners in three LMICs in Africa and South East Asia and builds on a previous study of tensions that inhibit the development of AMR surveillance within one country (REFERENCE 1 REMOVED FOR BLIND REVIEW).

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The objective of this paper is to identify the tensions experienced by professionals involved in AMR activities that may affect processes of knowing and learning around AMR within the context of a workplace culture and the actions required to resolve these. The paper aims to help practitioners to reconceptualise their work and solve problems around AMR practice. To identify tensions, the CHAT framework was applied in ways that fit the objective of the study, with the tensions being understood as manifestations of contradictions in the form of problems, challenges and disturbances associated with interviewees' work within an activity system (Engeström, 2015; Ilyenkov, 1982). Analysis of tensions has the potential to reveal issues that prevent the development of new activity and suggest potential new openings. Some studies have analysed tensions across different contexts by using interview data (REFERENCE 4 REMOVED FOR BLIND REVIEW; Martínez-Roldán, 2015; Vainio, 2011; REFERENCE 1 REMOVED FOR BLIND REVIEW), others have focused on contradictions as sources of identifiable tensions in interventionist settings (Engeström and Sannino, 2011; Lopes et al, 2018; Mudokwani and Mukute, 2019).

The paper begins with consideration of the theoretical background, followed by description of research methodology and analytical approach. It then represents quantitative and qualitative findings, discussion, and conclusions.

Theoretical background

This paper draws on theoretical framework of cultural-historical activity theory (CHAT) (Leontyev, 1978; Vygotsky, 1978). It conceptualises human activity as object-oriented, collective and social providing framework to analyse individual actions and learning within a social context. Being a dialectical theory, CHAT views human relationships as interwoven with a range of contradictions which are a driving force for change (Ilyenkov, 1982).

By using the CHAT framework, this study utilises an activity system, presented in Figure 1, (Engeström, 2015) to analyse data.

[Figure 1]

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Figure 1. Activity system

The elements of an activity system (Figure 1) are interdependent and constantly being constructed and transformed during situations of change. Using an activity system as a unit of analysis allows explaining the origin of tensions from the systemic whole instead of trying to trace them to behaviour of individuals. The next section outlines the research methodology.

Methodology

Countries and participants

The study took place within three LMICs, each at different levels of readiness in the development of their AMR National Action Plans. Country 1 was an Asian country at mid-stage of development of the Action Plan, while Country 2 and Country 3 were African countries. Each had mature and embryonic Action Plans respectively. Data was gathered during July to October 2018 through a series of face-to-face and online interviews supplemented by in-country observations in laboratory settings. Figure 2 illustrates the different laboratory sites, distributed across sectors, that participated in the study.

[Figure 2 here]

Figure 2. Sites selected for fieldwork

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Purposive site sampling was performed, and a list of interviewees was compiled through recommendations from the Management Agency's staff and availability of staff to meet. The criteria for selection included having cross-sectoral representation from both sentinel and regional sites which were part of Fleming Fund AMR surveillance network. Those interviewed represented a wide range of job roles at different ranks and were selected by senior staff. The data collection and analysis process were granted ethical approval by the (name hidden for blind review) ethics committee. A consent form was offered to everyone prior to interview with information about the process for data gathering, analysis, and data storage along with the interviewee's rights to choose whether to participate, to withdraw data at any stage and to remain anonymous.

Interviews were conducted in English, lasting 30–60 minutes. The interview instruments are available here: (links hidden for blind review). Each interview was audio-recorded and transcribed verbatim and personal details were removed. In total 60 people were interviewed, 21 women and 39 men. Table 1 illustrates the professional roles of those interviewed.

[Table 1 here]

Table 1. Interviews and roles of the interviewees

Analytic approach

First, 'tensions' identified in the interview data were coded using NVivo 11. The term 'tension' purposively was used in a broad way (see REFERENCE 4 REMOVED FOR BLIND REVIEW; REFERENCE 1 REMOVED FOR BLIND REVIEW) to refer to observed challenges associated with AMR activity. Examples of tensions include descriptions of learning needs, but limited opportunities to meet these needs; the need to conduct specific lab tests, but not having materials; and gaps in boundary-crossing communication.

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In the Finnish school of CHAT, problems within an activity system are typically analysed in interventionist settings in one organisation and by focusing on four layers of contradictions (Engeström, 2015; Virkkunen and Newnham, 2013). This study took a broader approach by analysing country level activity (typically used in object-historical analysis) within three countries meaning that the use of 'tension' and the analysis is more abstract than in the interventionist settings (see REFERENCE 4 REMOVED FOR BLIND REVIEW). Nonetheless, this method provides important clues about the systemic challenges needing to be resolved to reduce AMR in LMICs.

Qualitative content analysis type of categorisation (Tuomi & Sarajärvi, 2009) was used to thematically categorise identified tensions to better understand the main themes the professionals talked about. These five themes were:

- Capacity building and professional learning
- Collaboration and communication
- Resources (facilities, equipment, materials, and HR)
- Guidelines, protocols, and policies
- Organisational structures and management

Second, the tensions identified were associated with each of the five themes and within an activity system (Engeström, 2015). The interviewees were subjects in the analysis. Training, education, and materials were, for example, tools; and curriculum, budgets and guidelines were considered as 'rules'. 'Division of labour' referred to, for example, clinicians working in wards and lab technicians in labs and community to clients in the activity. Each country was viewed as one activity system. Third, data was further analysed to identify whether the tensions required local (organisational) or national level actions for them to be resolved. The next section outlines the results of this analysis.

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Results

Quantitative findings

Due to the large size of the data set, in this paper we chose to restrict the analytic attention to report only on the elements of each activity system that occurred most frequently and that were observed across all three countries.

The analysis revealed a range of tensions, shown in Table 2. Most tensions were linked to the themes of 'capacity building' and 'resources'.

[Table 2 here]

Table 2. The number of themes and the main elements of the activity system

Table 3 (below) shows whether the resolution of tensions called for local or national actions.

[Table 3 here]

Table 3. Tensions at local/organisational and societal level

We examined how often each professional described challenges associated with local or national level activities. The interview questions focused on challenges and needs at local level, therefore the number of national level tensions they articulated seems high. In Country

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3 the number of national tensions is higher than the number of local tensions. This reflects the roles of the interviewees who were mainly senior level professionals. Note that the figures in Table 3 include all coded data, whereas Table 2 only includes selected tensions, as explained previously.

Qualitative findings

In this section we present examples of the analysis that we interpreted being the most important and interesting from the point of view of the research objective: to identify tensions and actions required to resolve them.

Capacity building and learning

The analysis revealed that many professionals have limited opportunities to acquire new skills and knowledge about AMR, suggesting tensions between the subject and the tools. The reasons for this included poor financial resources and a low number of staff available to carry out work while individuals (colleagues) were engaging in training (tools and rules).

Learning needs were articulated around a range of topics from foundations of microbiology, bacteriology and AMR to learning about animal sample collection; from safety and risk management in the laboratories to understanding health care processes and systems behind laboratory data processing (subject and tools).

Young professionals appeared to have low level knowledge of AMR (subject and tools). In some cases, training needed to be organised for new staff to introduce them to the concept of AMR, revealing deficiencies in the current college and university curriculum (subject and rules).

Data from Human Health Sector in Country 2 showed how the entrenched practices of established professionals' may dissuade young professionals to apply new knowledge they have learnt while

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studying their degree. The concern was senior practitioners influencing young professionals' work based on their own outdated practice (subject and rules):

> C2 Site 2 P8 Senior Lab Professional: When people go to actual practice, sometimes they don't practise what they are taught, but rather how they see their seniors doing. In the medical school, [teachers] try to teach them the correct thing. But when they go to practise, they're kind of being observed by the seniors. So I cannot really go against my senior. Even if I know he's doing something wrong.

The problem of entrenched practice was also a concern in Gebretekele's et al. (2018) study on AMR in Ethiopia. They argued that junior clinicians' antibiotic prescription behaviour can be driven by fear of a judgement of incompetence from senior practitioners rather than by evidence for infection.

An important finding was that across all three countries professionals tended to self-learn by searching for information on the Internet, drawing on 'unofficial' and potentially inaccurate online learning environment. This emphasised how the responsibility around developing knowledge and skills was on the individual (tools and rules).

The salience of learning within an environment of trust was evident. In the Human Health Sector, the issue of trust was discussed from the perspective of how capacity building could enhance and create trust between Lab Professionals and clinicians. Trust was not evident because the resources within the laboratories and the skills and knowledge of laboratory staff did not meet clinicians' expectations (inside rules; rules and tools).

In all three countries it was mandatory for professionals to participate in Continued Professional Development (CPD) to gain accreditation to maintain their professional licence to practice. However, the analysis identified obstacles preventing participation in CPD or other professional learning. Some

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of these obstructions were associated with formal procedures, legislation and resources (subject and rules).

Even when CPD was available, often staff needed to cover the cost of professional learning on their own, rather than being funded by their organisation, therefore only a few were able to participate as illustrated in the following examples:

> C2 S5 P19 Policymaker: But it's very difficult because they have to pay themselves. One of the requirements is that every animal officer have to go after every four years to CPD. But we are not doing it. If you ask them, they don't have money for that.

> C3 S3 P10 Laboratory Professional: Sometimes we organise internal ones for free. But they're not enough to meet your credit point. So you have to obtain some training outside. And you have to pay for those ones yourself. If you look at a fee you cannot afford, you skip.

Another problem was that training tended to be targeted towards people at senior levels rather than being prioritised for professionals who needed it. This created a hierarchy of opportunity to engage in training (subject and rules). Furthermore, there were questions around the competence of HR Departments to identify and purchase adequate training (subject and tools).

Resources (HR, facilities, equipment, materials, funding)

A systemic problem in LMICs is scarcity of resources, which presents challenges on a daily basis. These challenges range from poorly designed physical workspaces, making it difficult to maintain clean environments and eliminate contamination; challenges in transporting isolates; an imbalance in

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the allocation of resources; poor access to digital resources, including computers; low quality lab materials; and limited access to professional literature (tools and rules).

Even when staff had good knowledge about AMR, insufficient access to the right materials forced professionals to improvise and carry out their work in a limited way (subject and tools):

> C3 S4 P12 Clinical Services Professional: So it is not like they don't know what is right, what is wrong. But because of limited resources, lack of some reagent, you must improvise. But it's a little becoming frustrating, when you know what is there. But you know you cannot apply. And you must every time improvise.

Books were considered an important source of information, but there were challenges associated with the information in these resources not being contextualised towards LMIC settings (subject and rules):

> C1 S2 Group interview Lab Professional: This is the problem with them, some textbooks when they come here, they [authors of books] don't understand our settings. So it's little bit difficult to learn from those experts.

Training and learning materials targeted to LMICs should be contextualised to specific needs (Cox et al., 2018). This, however, is not always reality which may reflect historically developed division of labour that allows resource rich countries to dominate discussions about AMR.

Cross-sectoral collaboration and communication

The main issues associated with collaboration and communication focused on national level cross-sectoral collaboration; patchy surveillance systems; and poor sharing of information and data within and across organisations (rules and division of labour).

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An interviewee in Country 1, while discussing the One Health (WHO, 2017), described difficulties associated with collaboration of Animal and Human Health Sector colleagues at the national level:

> C1 P22 Policymaker: It's very difficult to coordinated with animal sector with the One Health activities that are coming in, because these two ministries are two different separate ministries. And then the time management, the planning, everything is so different from one another. There was never a time where there is a need to know that human health and animal health need to work together and then need to work towards one objective. Unless there is something which needs to be discussed, we never come together.

A Policymaker from Country 2 emphasised the salience of developing a collaborative working culture and working towards a shared object in prevention of AMR (subject and rules).

At the organisational level cross-sectoral collaboration and information sharing across Lab Professionals and clinicians/nurses was a major challenge identified across all three countries (rules and division of labour).

> C3 S3 P8 Senior Lab Professional: The patient was put on another drug and we don't know.

> C1 S2 P8 Senior Lab Professional: Also, the lab and the clinical data are not being really related. Like when we sent some cultures to the lab, we do not send any history.

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Guidelines, legislation and policies

The main themes identified in the analysis were associated with guidelines for carrying out laboratory tests; lab quality control; submitting information to international databases; antibiotic prescription; and issues around AMR surveillance system. Although the surveillance system was at different level of readiness, none of the three countries had a fully developed system and data were not collected systematically. This created a challenge associated with the norms within the national decision-making system: without empirical data there was no progress in AMR activities.

In the Animal Health Sector, not having guidelines for carrying out laboratory tests led to professionals working in unsystematic ways (subject and rules):

> C1 S3 P2 Senior Management Staff in Veterinary Services: There's no hard and fast rules or guidelines that you should start this way. So whichever you feel like doing, we say, OK, we'll do this.

In Country 2 there was a perception that some guidelines were written in too much detail and not updated regularly preventing gaining knowledge (tension inside rules). Having regular training or workshops to support applying new guidelines was proposed as a solution.

Staff in one laboratory found it difficult to implement quality control, even though it is fundamental to the operation of a microbiology lab. The following quote illustrates the perception of staff that when a solution (quality control) is transferred from one context (haematology, biochemistry) to another (microbiology), the process is not effective (inside rules):

> C1 Site 2 Group interview Lab Professional: We don't know what the quality system's supposed to be like. We have a quality system in a place but the one which they [in the other

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> field] started, he was a biochemist. So we felt it was a little bit in line towards haematology and biochemistry. We tried to mimic their things but it didn't work.

A common approach to transformation projects is to change part of the system, rather than taking a systemic change approach. However, such cost-effective actions do not necessarily support moving to new activity.

Another professional from the same laboratory site explained how working in isolation and with little support from senior staff made it difficult to expand quality control (rules and division of labour):

> C1 S2 Group interview Lab Professional: we don't have a clear picture of what quality activities we should have. The division or Ministry, they don't have a defined structure of what these quality activities in microbiology are. And they even don't know about quality activities that we are doing.

Organisational structures and management

The main themes associated with organisational structures and management were concerned with a hierarchy in procurement systems; an imbalance in the division of labour in government organisations; changes in policies; project-based development; and public and private service provision.

In Country 1 participants expressed concerns around difficulties in securing funding when their organisation become an autonomous corporation that was no longer part of the public sector. Government funding had decreased substantially, restricting the recruitment of new staff. Participants perceived an imbalance in the division of labour in Government organisations because there was not a sufficient number of technical staff. As a consequence, these organisations had to rely solely on

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externally (often internationally) sourced project funding to recruit new staff (rules and division of labour).

Sustainability of development actions and external project funding was a concern across all three countries. This meant that people had to contemplate the division of labour and their responsibilities and allegiances when developing, for example, the National Action to address AMR (rules and division of labour):

> C2 S1 P1 Senior Management Staff in Clinical Services: So my concern is that if people think the Fleming Fund is a project. So we are going to ensure that people take it as their own activity instead of thinking that this is a project.

The division of labour across the private and public sectors was discussed in Country 2 and Country 3. In the Animal Health Sector in Country 2, a policy that had been established since 1980s had transferred the responsibility for disease surveillance from the public sector to the private sector. This change had distorted previously well-functioning practices, such as the prescription of medicines. An urgent need was expressed to review and reflect on the effects of private-public sector collaboration (rules and division of labour).

> C2 S5 P18 Policymaker: That one was very easy at that particular time. But whatever technician or a vet was prescribing, it was a physical examination of the animal, plus lab results. So that one allowed what kind of stuff should be used. Now, that policy change that came in place, really paralysed the sound system.

Another problem associated with outsourcing practices was that private sector laboratories were less accessible than the public sector labs had been in the old system. Lab Professionals no longer visited farmers to collect samples placing more responsibility on the farmer to learn about sample collection, packaging and transportation for analysis.

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Discussion

The threat of AMR is increasing as bacteria become ever more resistant to medicines at a faster pace. It can be conceptualised as a runaway object (Engeström, 2009) which has the potential to influence at a global scale by changing rapidly and being out of control. The management of runaway objects requires a systemic analysis and identification of the challenges that support learning and lead to new activities.

This research explored AMR in LMICs where its impact is particularly acute. The findings verified some of those challenges that have been previously identified in other AMR studies, in particular the need to learn specific skills and scarce resources (Singh and Manchada, 2017; Cox et al., 2017). This analysis extends beyond these findings by taking a systemic approach (Engeström, 2015) and identifying the organisational, political and cultural dynamics that are critical to reduce AMR (Broom et al., 2020; Frid-Nielsen at el, 2019).

The main tensions analysed suggesting the transformational potential for new activity (Engeström, 2015) were between the following elements of the activity system:

(1) subject and tools, (2) rules and tools, (3) subject and rules, (4) rules and division of labour, and (5) inside rules. Tensions 2-5 particularly show the transformational potential and are outlined here in more detail.

The main tensions between subject and rules were associated with *capacity building and learning*, and *guidelines, protocols and policies*. The study revealed how culturally developed organisational norms support hierarchies that influence how professionals can apply what they have learnt. Young professionals do not use their expertise and stick to entrenched practices out of fear of being 'judged' by seniors (Gebretekele et al., 2018). This points to a need to train senior professionals to help them appreciate the need to change practice.

Second, the workplace 'norms' tend to influence which groups have opportunity to participate in training. The norms favouring particular groups of professionals having access to training, based on roles and hierarchies, have to change. It was also evident that some individuals do not attend training

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because of not having the required funding, a rule that is often set by the authorities and needs to be reviewed. These observations cannot be ignored because it is crucial that everyone has opportunity to learn to create a holistic view of AMR in ways that reduce the global threat.

Inadequate education about AMR in college and university programmes is a national level challenge that pushes learning into workplaces that are already under pressure. Consequently, the responsibility for learning had been placed on individuals or individual units. Without adequate education and learning, professional work has evolved in ways not supporting the reduction of AMR.

Tensions between rules and division of labour were linked to *cross-sectoral collaboration and communication, guidelines, protocols and policies,* and *organisational structures and management*. At the local level there are insufficient protocols to enable cross-sectoral collaboration and information sharing across different professions. This was raised as a significant challenge, fundamental to the reduction of AMR (Sayed et al., 2018; REFERENCE 5 REMOVED FOR BLIND REVIEW). Similar concerns were raised in connection with national level collaboration. There is an urgent call to action to make sure cross-professional work is improved, not allowing the historical development of divisions of labour hinder new forms of activity that has potential to reduce AMR.

Tensions around division of labour tended to be shaped by political and economic milieu and required national level resolution. In one country, the government had not taken ownership of the development of quality control, which was vital for the effective operation of a major microbiology lab. At the national level, there appeared to be no systematic approach to the reduction of AMR despite introduced National Action Plan. Responsibilities had been transferred to individuals at the local level. This finding agrees with Sayed et al. (2018) who argued that improvement of local laboratories in LMICs to enable them to carry out AMR surveillance has been local, fragmented and unsustainable.

One fundamental factor was the reliance on external project funding (e.g. from donors, Aid funding) to maintain basic activities that contribute to AMR prevention. Concerns over the sustainability of these, externally funded, project-based initiatives were raised. Another change was the transfer of core

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activities from the public to the private sector, following neoliberal regime changes experienced around the world (Hood, 1991). This outsourcing of services had negative effects on well-functioning public systems that are essential for the prevention of AMR. In the spirit of neoliberal ideology, this change had placed more responsibility on individuals within the system.

The main tensions associated with rules included *guidelines, protocols and policies.* There was evidence to suggest that staff were aware of procedures and regulations, but access to a limited range of resources forced them to rely on their own initiative when performing daily tasks rather than following guidelines. The production and distribution of new information was a concern and there were anxieties around how these could be integrated within current and emerging activities. One challenge was insufficient time allocated for learning. This finding is significant, considering that AMR professionals are required to closely adhere to regulations and protocols forming part of their professionalism. Lack of guidelines to develop fundamental systems placed responsibility firmly on the individuals.

Conclusions

This research reveals a range of tensions at the local and national levels associated with antimicrobial resistance in LMICs. These tensions are within the systemic activity highlighting potential for transformational change and suggesting critical points when developing AMR activities. Tensions extended beyond identification of barriers in individual behaviours focusing on wider influences critical for AMR prevention (Broom et al., 2020; Broom and Doron, 2020).

The research shows that division of labour and responsibilities both at local and national level need attention in prevention of AMR. The role of cultural and organisational norms and rules need to be considered when arranging learning opportunities and developing work around AMR. Sharing guidelines to improve practice, increasing funding for training or training provision for individuals will not be enough though essential at the right time.

Previous research has shown that when analysing organisations' learning needs, a three-level conceptualisation is helpful: (1) individuals learning new skills (2) collaborative team-level learning

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to develop current practices and (3) collaborative and boundary-crossing learning to change the whole activity (Virkkunen and Ahonen, 2007). Our work suggests that there is an urgent need to implement professional learning about AMR at all three levels. Participatory interventions are suggested to develop practice in LMIC contexts by engaging employees horizontally and vertically. This would enhance sustainability and provide a systematic approach to the AMR activity development (Virkkunen and Newnham, 2013).

Using the CHAT framework, tensions are observed as indications of the contradictions causing these tensions (Engeström, 2015; Ilyenkov, 1982). Although the analysis of contradictions was not the main objective of this paper, the analysis provided a solid grounding and understanding of the direction of further analysis by laying out, what we call, four opposing forces:

- cost efficiency and good public health objectives;
- historically and culturally developed hierarchies and good public health objectives;
- individual responsibility and institutional responsibility;
- fragmented set ups and holistic view of activity.

These opposing forces evidence a contradiction between use-value and exchange value, as explained in Marx's theory of capitalism (Ilyenkov, 1982) as well as neoliberal ideology emphasising individual responsibility (Hood, 1991) and the One Health aims (Chandler, 2019). These point to less tangible issues that should be considered when developing activities around AMR. However, more research is needed using a historical and contextual approach to further analyse contradictions. It is important to remind that, because of the country level unit of analysis the study is somehow abstract and decontextualised. The findings presented here should also be considered accordingly.

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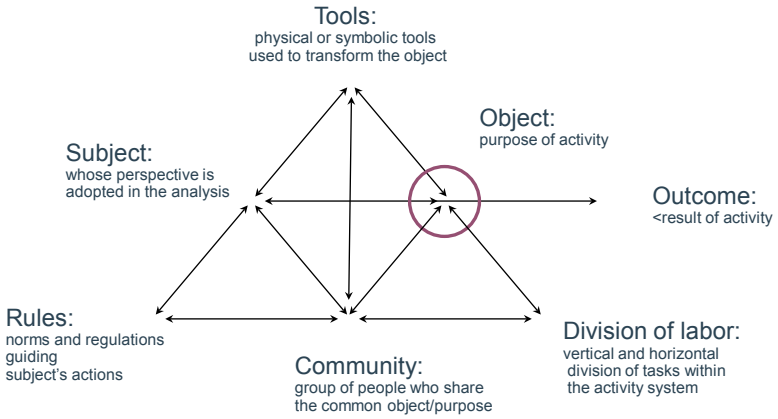

(modified from Engeström, 2015)

1

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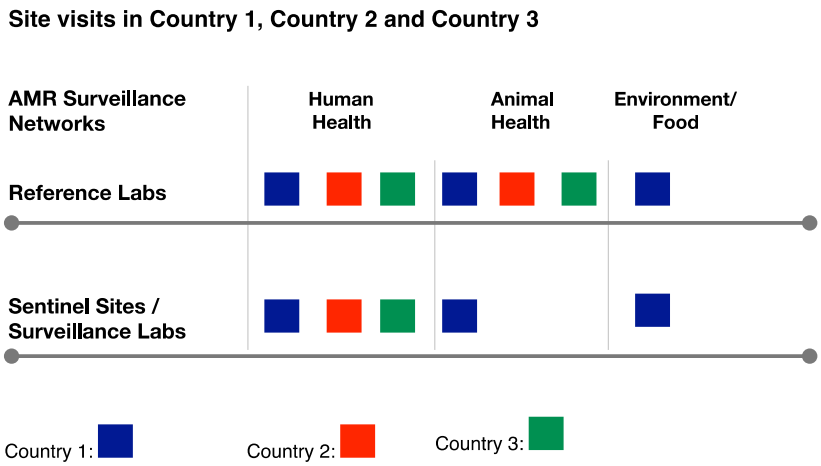

Figure 2. Sites selected for fieldwork

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Professional Roles	Country 1	Country 2	Country 3
Laboratory Professionals	9	10	5
Senior Laboratory Professionals	10	4	2
Clinical Services Professionals	1	-	-
Senior Management Staff in Clinical Services	1	-	1
Policymaker	3	6	4
AMR Community / Expert	1	1	2
Total	**25**	**21**	**14**

Table 1. Interviews and roles of the interviewees

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Tension themes	The main element of an activity system	Country 1	Country 2	Country 3
Capacity building and learning	Subject, tools, rules	128	163	111
Resources (HR, facilities, equipment, materials, funding)	Subject, tools, rules	95	60	47
Cross-sectoral collaboration and communication	Subject, rules and division of labour	23	12	21
Guidelines, protocols, policies	Subject, rules, division of labour, community	38	23	36
Organisational structures and management	Rules, division of labour	4	18	19
Total		**288**	**276**	**239**

Table 2. The number of themes and the main elements of the activity system

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	Country 1 (N=25)	Country 2 (N=21)	Country 3 (N=14)
Number of local action tensions	210 by 22 interviewees	209 by 18 interviewees	125 by 14 interviewees
Number of national level tensions	61 by 16 interviewees	91 by 13 interviewees	127 by 15 interviewees

Table 3. Tensions at local/organisational and societal level

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