

The Contribution of Disciplines from the Arts and Humanities to addressing Antimicrobial Resistance

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Executive Summary

The increasingly rapid evolution of microbial resistance to antibiotics and other antimicrobial drugs (antimicrobial resistance; AMR) poses a profound threat to human health. Global and national policies to address this crisis are increasingly recognising the need to engage research knowledge and action from disciplines outwith medical sciences. However, to date, the actual and potential contribution that disciplines from the arts and humanities (A&H) can make has not been substantively articulated or illustrated.

This report addresses this need firstly by analysing 11 recent research projects funded by the UKRI Arts and Humanities Research Council (UKRI AHRC) that focused on AMR primarily in relation to Indoor and Built Environments. Consideration of the various contexts, aims, methodologies and outcomes of these studies is informed by findings from a questionnaire survey of the research teams (40 respondents), with particular focus on A&H contributions and interdisciplinary working. An emergent set of themes is then used as a basis for broader consideration of the value that A&H can bring. This is informed by relevant literature and by questionnaire responses from a group of 10 other researchers involved in related UK and/or international research.

The focal set of projects spanned a range of settings: homes, a veterinary surgery, primary schools,

community pharmacies; community and hospital nursing contexts; out-patient clinics, and hospital operating theatres. All aimed to better understand a particular phenomenon in context and to co-develop practices/interventions that would help address AMR, whether directly or more broadly through infection prevention and control. The disciplines of design and architecture were particularly prominent, especially in productive collaborations with microbiology. Inputs from history were also often influential. Significantly, co-design approaches involving extensive participation from collaborating end-user groups were a key feature of the majority of the projects.

The report identifies a distinctive set of attributes that A&H approaches can contribute to research and developments addressing AMR. These comprise: imagination and creativity in framing new research questions from different angles, including questioning assumptions/orthodoxies; expertise in using visual communications to evince the abstract issue of AMR; expertise in the principles and practices of co-design for co-development; leveraging the explanatory power of history; offering various valuable ways of thinking, seeing, understanding, creating and presenting; commitment to collaborative interdisciplinary working that explores new ways of integrating knowledge; curiosity and creative response to emergent issues; and delivering a range of meaningful impacts and outputs.

Importantly, the report shows that these attributes can drive forward AMR-focused work that is highly interdisciplinary in nature. As such, it is contended that arts and humanities should not be seen as an appendage that brings added value to primarily medical endeavours in this field. Rather A&H approaches should be seen as contributing inherent, fundamental value.

The need for more national and international infrastructure funding and support for interdisciplinary work to address AMR is highlighted. Within this context, the contributions of the arts and humanities (and social sciences) provide particular potential. This has been emphatically underlined by the present global public health emergency of COVID-19, where the limitations of seeking solely medical solutions to a complex global problem are only too apparent. The report concludes by highlighting the relevance of A&H approaches to the COVID-19 situation, while emphasising the ongoing imperative for more interdisciplinary research and development work to address AMR.

Imagination and creativity in framing new research questions from different angles, including questioning assumptions/orthodoxies

Expertise in the principles and practices of co-design for co-development

Offering various valuable ways of thinking, seeing, understanding, creating and presenting

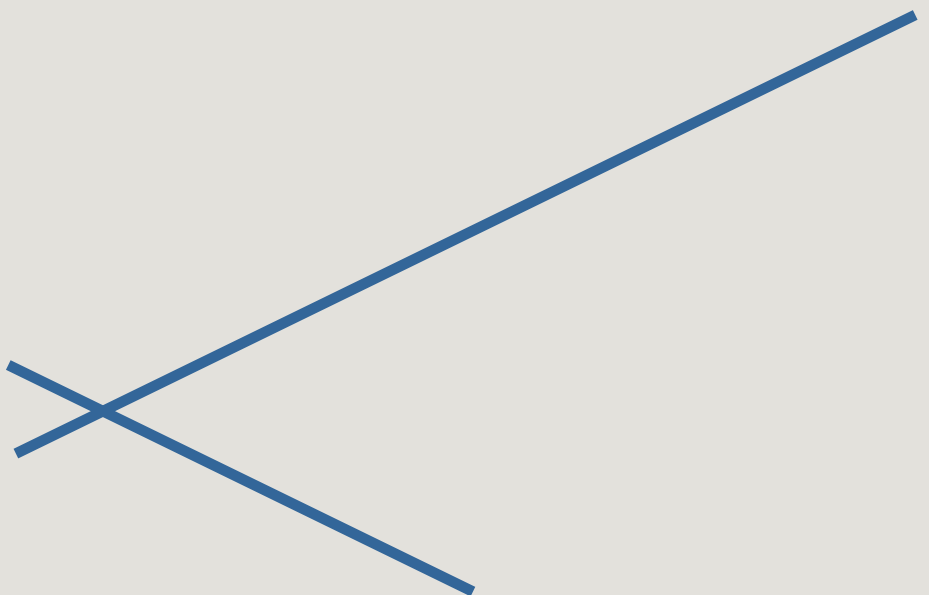
Leveraging the explanatory power of history

Commitment to collaborative interdisciplinary working that explores new ways of integrating knowledge

Curiosity and creative response to emergent issues

Expertise in using visual communications to evince the abstract issue of AMR

Delivering a range of meaningful impacts and outputs



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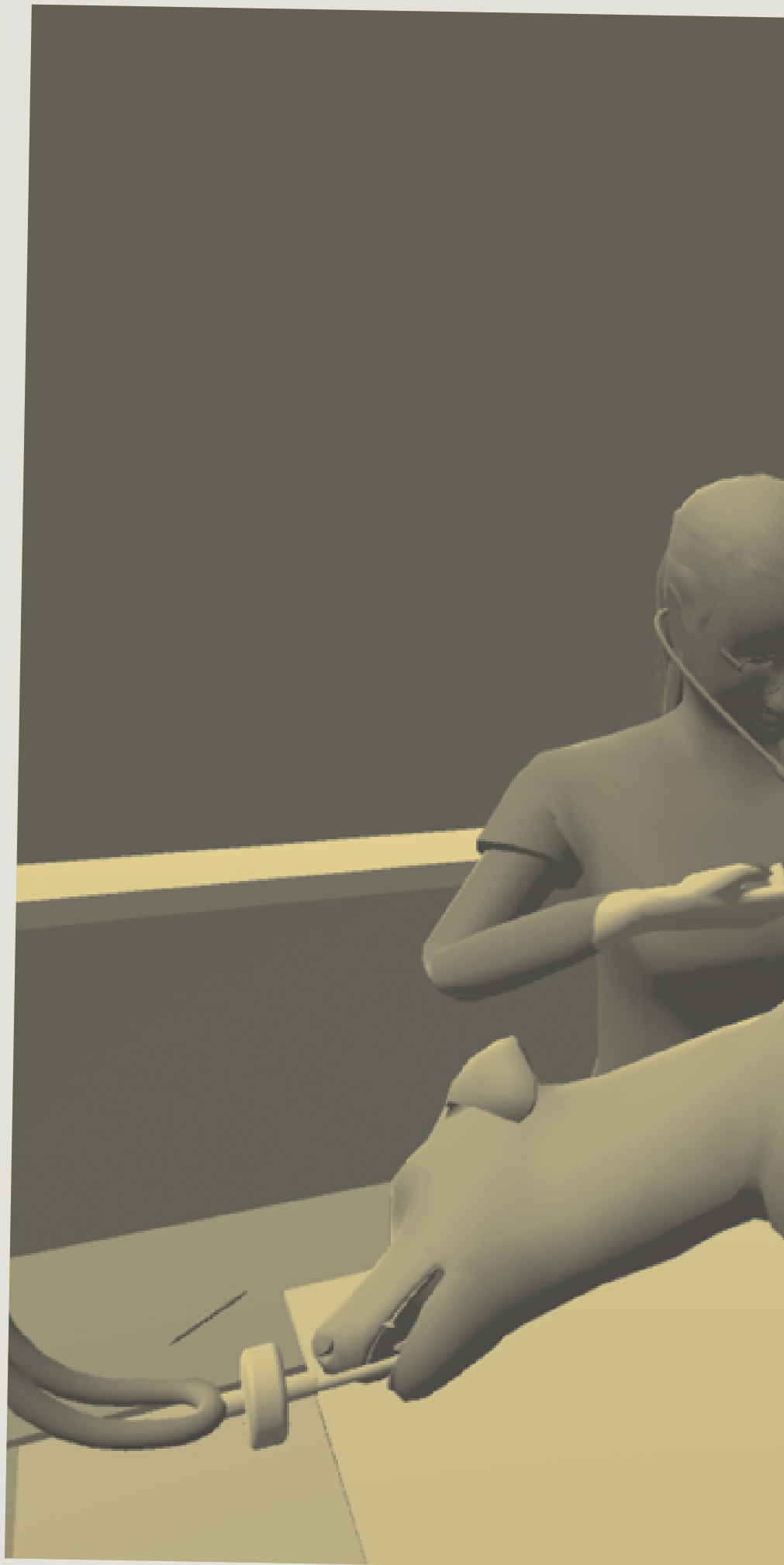
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Appendix 1





PART 1

AMR, A&H, and the
UKRI AHRC Theme 3b
projects

Introduction

The increasingly rapid evolution of microbial resistance to antibiotics and other antimicrobial drugs (antimicrobial resistance; AMR) is recognised as a global problem posing a profound threat to human health. Overuse and inappropriate use of antibiotics are at the heart of the problem. However, a multitude of factors underlie, frame and drive such usage (Chandler, Hutchinson and Hutchison 2016), meaning that AMR is a complex global health issue with intertwined political, social, ecological and economic dimensions.

During the past decade global efforts to combat AMR have gained some traction, as reflected in the World Health Organisation's Global Action Plan (WHO 2015). Concurrent policy activity in the UK gained momentum in 2013 with the first five year strategy (Department of Health 2013). As part of this plan the UK's various research funding councils embarked on a joint initiative to fund programmes of AMR research that encouraged a range of different disciplines to collaborate.

Reporting on the new initiative in the Lancet, Watts (2014) noted:

“Even the Arts and Humanities Research Council (AHRC) has found a place in this new Forum. By way of illustrating what may seem like an unlikely involvement.....”.

The article continued by citing a project that I had led (Visualising

the Invisible; Macduff et al 2014) as an example to explain why arts and humanities (A&H) could have relevance in the field of AMR. While the reference was welcome, the felt need for explanation highlights how A&H approaches may not be seen as relevant to efforts to combat this pressing issue.

One possible reason for this is that the arts and humanities comprise a broad constellation of disciplines (e.g. history, art, design, architecture, law, philosophy, health humanities, literature and many more: – see ahrc.ukri.org/funding/research/subjectcoverage/ahrc-disciplines/ for an indicative listing). Initial literature review suggests that a body of relevant A&H work is emerging in this field but it is manifest through varied contributions to individual studies and reported in very diverse journals (and reports, books, and project websites). As such, the individual and collective contributions of these A&H disciplines can be difficult to grasp.

Accordingly, there is a need to draw together, articulate and illustrate the contribution of A&H disciplines. In the apparent absence of a critical synthesis of work in the field, the present report starts into this challenge by exploring the question:

how can arts and humanities approaches contribute to addressing the problem of antimicrobial resistance?

To this end, the CODA AMR project capitalises on a dynamic opportunity to examine the collective learning that is accruing from a suite of recent, relevant research studies, then to consider this in the light of broader issues and the emergent body of literature. The report is structured in three parts to reflect this progression. It is hoped that the report is of value to a range of academic, professional and lay audiences. Critical engagement and feedback is welcomed.

CODA AMR

The 2014 UK cross-council initiative offered opportunities for A&H to contribute various disciplinary expertise. Specifically, the AHRC-led “AMR in the Indoor and Built Environment” theme (Programme Theme 3b) funded a suite of 11 projects with particularly extensive inputs from A&H researchers. These pump-priming projects ran from 2017/18 – 2019/20, with all completed by April 2020. As such, they offered a timely opportunity to generate collective learning to inform future developments in the field.

These projects formed the main focus of the CODA AMR study (April to August 2020). CODA AMR was led by myself and was kindly supported by the other Principal Investigators (PIs) involved in the projects (see acknowledgements). It was also informed by two “critical companions” (see acknowledgements), who provided expert advice and feedback at initiation and conclusion of the study.

CODA AMR was conducted in the spirit of a networking project where research teams were invited to share ideas and critical reflections. The main vehicle for this was a structured questionnaire which was e-mailed to the list of research team members provided by PIs. This sought reflections on the arts and humanities contribution to the project, any strengths and difficulties, the way disciplines worked together, and future directions. Participants shared their response

with their PI and myself to enable intra-team learning and cross project learning respectively.

The sources of data that the study drew on to address its central question were:

- A general search and reading of relevant literature in the field, drawing particularly on the Google Scholar and Medline databases
- Details of the 11 Theme 3b projects available on the web (e.g. UKRI Gateway to Research and individual project websites) and reports, papers and presentation materials shared by the project PIs
- Responses to the study questionnaire (10 from PIs and 30 from other research team members; in all 40 of the 48 approached took part – 83%)
- Responses to the study questionnaire from “key colleagues” (other prominent academic colleagues based in the UK or abroad who are active in the field as nominated by CODA AMR’s critical companions; 10 of the 15 approached took part- 67%)
- Two videoconference meetings involving PIs and critical companions where emergent findings and ideas were discussed

The approach to analysis and synthesis of this data is detailed in Appendix 1.

The report firstly presents an overview of the projects accompanied by key commentary points. Readers are invited to use the project web links to learn more about particular projects of interest. Part 2 then presents an analytic narrative incorporating the cross-project themes that emerged. Text extracts from questionnaires are used to exemplify themes through the voices of participants, and visual materials provide related perspectives from particular projects. The final part of the report addresses “so what” questions by discussing findings in the light of perspectives from key colleagues and wider literature.

Overview of the projects: settings, goals and disciplines

Figure 1 below provides visual overview of the 11 projects (abbreviated names in centre) in terms of the main disciplines involved, primary goal orientations, and settings. More details of the projects are then presented overleaf in Table 1.

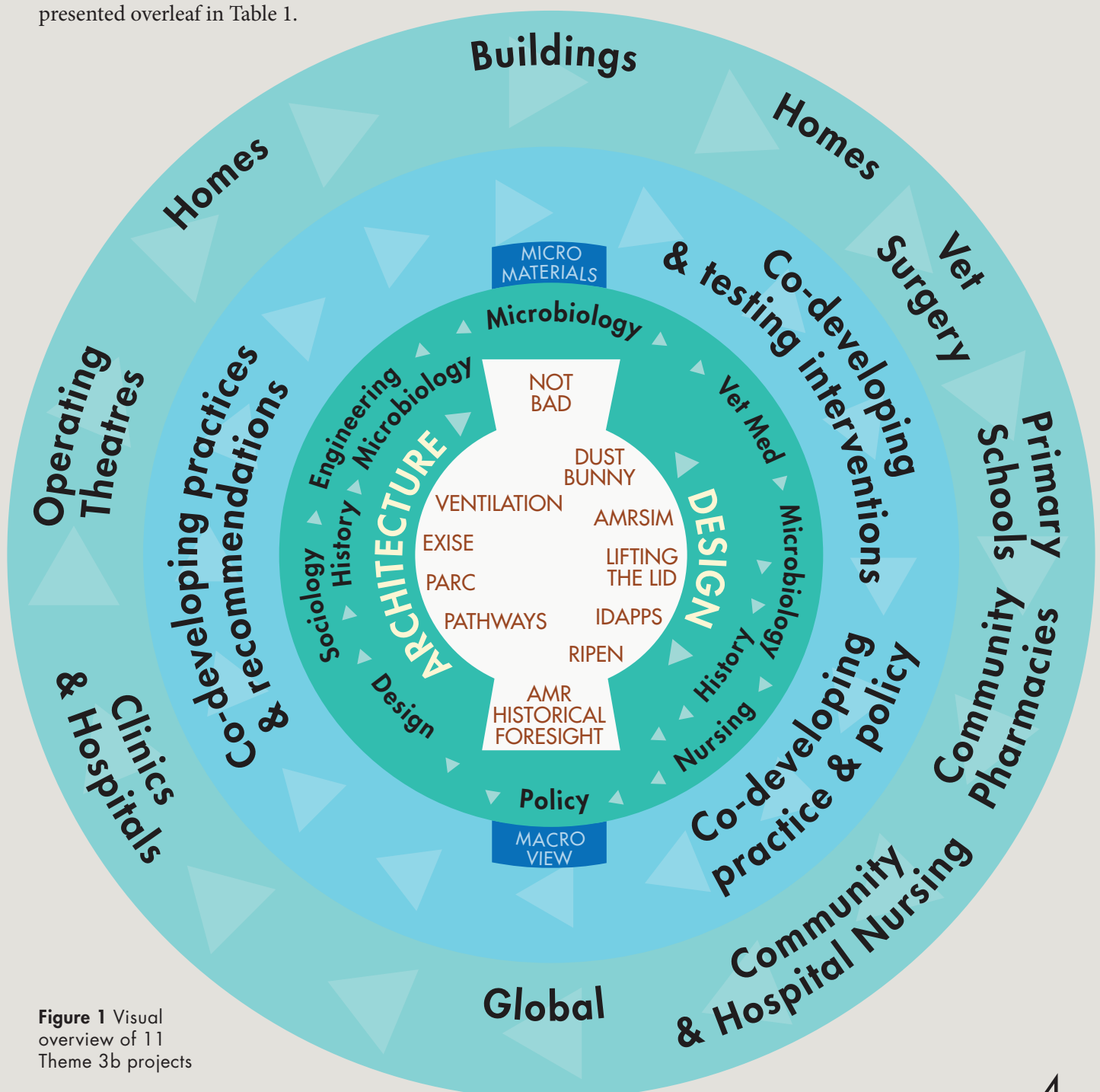


Figure 1 Visual overview of 11 Theme 3b projects

Table 1 Summary details of 11 Theme 3b projects

Project	Main disciplines	Other key disciplines	Summary of nature of project	Primary goal orientation
Dust Bunny: understanding the home as a source of infection of AMR bacteria carried by dust by exploring hygiene practices in different home environments in Ghana dustbunny.global	Design and Microbiology	Epidemiology Social science	Through a design-led approach, ethnography and cultural probing directed microbiological sampling in order to explore diversity of bacteria in a sample of homes, then examine changes related to interventions implemented through co-design with community members	Understanding Co-developing and testing interventions
AMRSim: A Microbial Reality Simulator amrsim.org	Design and Veterinary Medicine	Microbiology Veterinary Practice Psychology Medical Visualization	A design-led, veterinary microbiology informed approach, led to user-centred development and testing of an educational intervention to change perception of infection risk within veterinary surgical practice	Understanding Co-developing and testing an intervention
Lifting the Lid on Bacteria: designing ambient communications to improve hygiene in primary school toilets 123germfree.co.uk	Design and History	Information Science Microbiology Health Services Research	Through a design-led, historically informed, approach involving extensive engagement with children in primary schools, a set of persuasive space graphics for children's toilets were created and tested to gauge impact on hand hygiene	Understanding Co-developing and testing an intervention
IDAPPS: Information Design and Architecture in Persuasive Pharmacy Space: combating AMR amrpharmacy.org amrpharmacy.org/exhibition	Design and Architecture	Pharmacy	This design and architecture-led, historically informed, approach involved a competition to generate ideas for persuasive community pharmacy spaces to combat AMR, in-situ installation and testing of a prototype, good practice recommendations and an exhibition	Understanding Co-developing and testing interventions
RIPEN: Re-envisaging Infection Practice Ecologies in Nursing through Arts and Humanities approaches ripen.org.uk	Design and Nursing	History Health Services Research	Through a design and nursing-led approach involving extensive engagement with hospital and community based nurses, this project explored how arts and humanities methods could be used to understand and develop nursing's practice and policy engagement with AMR	Understanding Co-developing practices and policy recommendations
AMR Historical Foresight: looking forward through history sites.exeter.ac.uk/amrhistoricalforesight	Policy Analysis and History	Public Health Economics	Policy analysis and history of medicine/science were combined to explore what can be learnt from history and from other complex issues (such as climate policy and tobacco control) to inform future AMR policy development	Understanding Co-developing policy recommendations

Project	Main disciplines	Other key disciplines	Summary of nature of project	Primary goal orientation
Paths of resistant pathogens in hospitals: architecture, design interventions, transmission risks ucl.ac.uk/bartlett/architecture/paths-resistant-pathogens	Architecture and Design	Public Health Infection Control	This architecture and design-led approach involved observations and mapping of staff movements in hospital wards and related co-development of creative design ideas to raise awareness of factors affecting the potential spread of pathogens	Understanding Co-developing practices and recommendations
PARC: Pathways, Practices and Architectures: Containing AMR in the Cystic Fibrosis Clinic parcproject.org.uk	Sociology and Architecture	Microbiology Art History	This sociology/social anthropology and architecture-led approach involved extensive engagement with cystic fibrosis clinic settings and stakeholders to map journeys, explore experiences, and enable ideas for re-design of practices and spaces to limit AMR and cross-infection	Understanding Co-developing practices and recommendations
ExISE: excising infection in the surgical environment infectiousdisease.cam.ac.uk/news/excising-infection-in-the-surgical-environment-exise	Architecture and History	Policy Analysis Infection Control	This architecture and history of medicine/art-led approach involved historical and contemporary analyses/modelling of operating theatre design, leading to a short film presenting ideas for re-design with focus on eliminating risk of airborne infection	Understanding Co-developing practices and recommendations
Influence of Ventilation Design on the prevalence of anti-microbial bacteria in homes hemacnetwork.com/amr-project	Architecture and Engineering	Microbiology	This architecture and engineering-led, microbiologically informed, approach engaged with the occupants and environments of contemporary homes to gather data and explore how housing design affects the indoor microbiome, especially relating to ventilation and AMR	Understanding Co-developing practices and recommendations
NOTBAD: Niches for Organic Territories in Bio-Augmented Design richard-beckett.com/projects	Architecture and Microbiology		Working from a biologically integrated design perspective, this architecture-led project developed and tested the integration of beneficial microbes within buildings material via prototype lab-based constructions	Understanding Co-developing and testing materials

As Figure 1 indicates, 9 of the 11 projects focused their work on specific types of settings relevant to AMR in the indoor and built environment. The two remaining projects approached the challenge from different angles. NOTBAD focused on the micro perspective through its lab development and testing of the integration of beneficial microbes within building materials. By contrast, the AMR Historical Foresight project explored AMR policy development from a macro perspective, incorporating learning from other complex global issues.

In terms of contributions from arts and humanities (A&H) disciplines, two predominated. Four of the 11 projects were led by PIs from design and four projects were led by PIs from architecture. These projects were typically driven (or at least extensively informed) by questions and methods arising from these disciplines and their various engagements with others around the topic of AMR. This is significant because the initial literature search and questionnaire responses from key colleagues strongly suggest that A&H has tended to be at the margins of AMR research and development to date and has rarely been a driving force.

Commentary: This suite of projects offers particular opportunity to learn from design-led and architecture-led studies focusing on AMR

Figure 1 also indicates the other main disciplines involved in the 11 projects. In terms of A&H, history is the next most prominent contributor. This manifested in a variety of ways. The conception of some projects was strongly underpinned

by historical perspectives (e.g. the seminal work of the Neuraths in information design was central to IDAPPS), while others (e.g. Lifting the Lid; ExISE) were designed so that medical historians would play a key role in developing new understandings. Within the Parc project the contribution from historical perspectives evolved dynamically through the collaborative learning. These observations are important as the initial literature search and questionnaire responses from key colleagues strongly suggest that, to date, history has been the most prominent A&H contributor to AMR research (but has often been seen as providing background context rather than driving fundamental questions).

Commentary: History is a key contributor to these projects and this field

Perhaps unsurprisingly, microbiology was the main discipline from outwith A&H that was involved in many projects. In some of these (e.g. Dust Bunny; AMR Sim) microbiologists were involved centrally as Co-Is, in others (e.g. Lifting the Lid; Parc) as key collaborators/advisers. The conjunction of A&H disciplines and microbiology in these projects is potentially insightful, and this theme will be returned to later in the report.

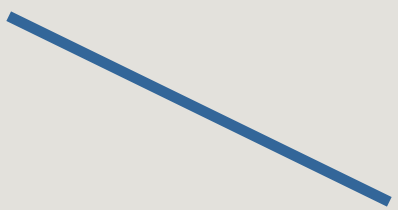
Commentary: Collaborations between A&H disciplines and microbiology are a frequent feature, meriting further analysis

Figure 1 indicates the other lead disciplinary contributions. The Parc and RIPEN projects were led by a sociologist and a nurse respectively,

while engineering was core to the Ventilation project and policy to AMR Historical Foresight. Indeed, the main disciplines and other key disciplines listed in Table 1 show the breadth of disciplinary involvement in these projects.

Commentary: These projects typically combined contributions from a wide range of disciplines, meriting analysis of collaborative working and outcomes

Finally Figure 1 has attempted, where possible, to group the various projects in terms of shared orientations. This pertains not only to common disciplinary involvements, but also to the nature of primary goals and common foci for enquiry (e.g. Parc, ExISE and Ventilation all have a central focus on the environment and air quality in particular). The report turns now to consider what these projects were trying to do and how they took them forward, focusing primarily on cross-cutting themes.



Interview

I was diagnosed

Now who the other
patients are - we have
the same sort of cough

I felt safe there

The old clinic was here -
we were more in
together

times just
sputum
sent

When
waiting
and all

view.

sed late on



When I a
- there didn't
I have to p

You can always
microbiolo
won't sh

It's good to get in
early - I have an
early appt, so I am in + o
If I'm late, we are
everywhere!



I am in this
room. I get tults
sorts if I cough.

catch
don't
that

PART 2

Emergent themes
across the projects

Primary goals and rationales

Projects typically incorporated two primary goals as follows:

Theme 1

Common primary goals

- 1) Seeking better understanding of a phenomenon within a relevant context
- 2) Working collaboratively to co-develop an intervention or practice(s) that would help address AMR

Within some projects the main emphasis was on eliciting primary understandings in the absence of a relevant existing knowledge base.

Thus, the overall research question in the Parc project asked:

how are attempts to limit AMR through containment and segregation differently designed, performed and redesigned within outpatient lung infection clinics? (Parc Final Report)

Figure 2 gives a glimpse of how this question was subsequently approached.

Similarly, the main aim of the Ventilation project was:

undertaking an assessment of contemporary housing to determine the ventilation characteristics and relate this to the presence and nature of microorganisms in the home, with the specific aim of identifying factors that would impact on the presence and proliferation of anti-microbial resistant micro-organisms. (Ventilation Project Abstract)

Figure 3 shows some of the subsequent assessment contexts and processes.



Figure 2 Sketch of waiting area incorporating interview feedback from patients with cystic fibrosis (Parc: artist Lynne Chapman)

Importantly, the fundamental “what’s going on?” questioning in these projects coalesces with “how can things be improved?” explorations, reflected in goals and activities.

Within other projects, the emphasis was set more explicitly on the enactment and evaluation of a practice intervention. Emanating from a preceding body of work on visualisation and infection prevention and control with health service staff, and from a need identified by veterinarians, the AMRSim project had a specific hypothesis:

From a design perspective it was to use an approach to conceive of, develop, build and test an intervention to be used to demonstrate proof of concept by testing our hypothesis – that by making the invisible (pathogen contamination), visible – we could change perception of risk of infection in veterinary practice (Design; AMRSim)

Figure 4 overleaf shows the original design concept for a visual tool.

This was predicated on building initial understandings of risk through working with veterinary academics, veterinary surgeons and staff from a small animal veterinary practice. This included consideration of microbiological data prior to co-designing the intervention through a series of iterative evaluations and refinements.



Figure 3 Aspects of assessment on the Ventilation project



Within other projects, propositions were set up to generate a range of potential intervention ideas (e.g. in IDAPPS where a competition mechanism was used), or to explicitly contrast with current thinking and practices. In the NOTBAD project an architect and microbiologist co-developed building materials integrated with beneficial microbes:

to challenge existing and predominantly negative perceptions of built environment actors towards the presence of microbes in buildings (Architecture; NOTBAD)

Within this context, it is also important to note that some projects (e.g. AMR Historical Foresight) focused more specifically on AMR while the majority of others addressed the topic less directly, under the more general ambit of prevention and control of infection (e.g. Lifting the Lid’s focus on children’s hand hygiene).

Thus, although the two primary goals cited in Theme 1 were common across projects, the examples cited above show that these goals were framed and approached in a range of ways:

Theme 2 Diversity of frames and angles of enquiry

There was diversity in the framing of, and in the angles of, enquiry that these typically A&H-led projects applied to the various contexts where AMR manifests as a potential or established issue.

The above theme reflects a potential strength of arts and humanities-based approaches:

it (A&H) asks different types of (research) questions e.g. more exploratory and perhaps sometimes less rigid and definitive vs most STEM research. (Pharmacy; IDAPPS)

Despite this diversity, a common rationale was identified as underpinning the design and conduct of the majority of the projects:

Theme 3 Belief in the potency of visual communications in this field

There was widespread belief that the creation and/or deployment of meaningful, relevant visual communications could positively influence perceptions and behaviour in contexts where AMR is an invisible, abstract threat

Often this belief was explicit and explained as a key project design rationale:

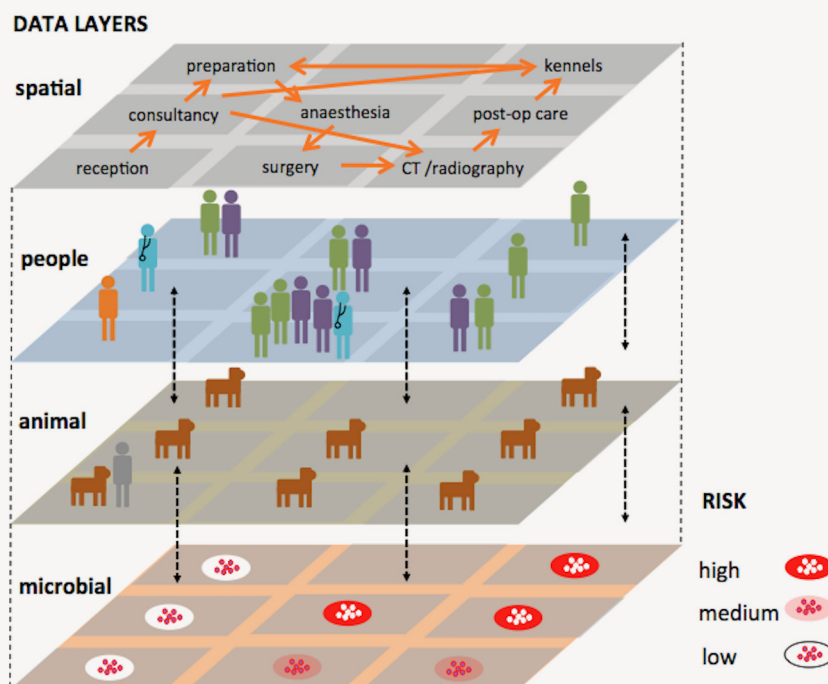


Figure 4 Original concept for the AMRSim tool

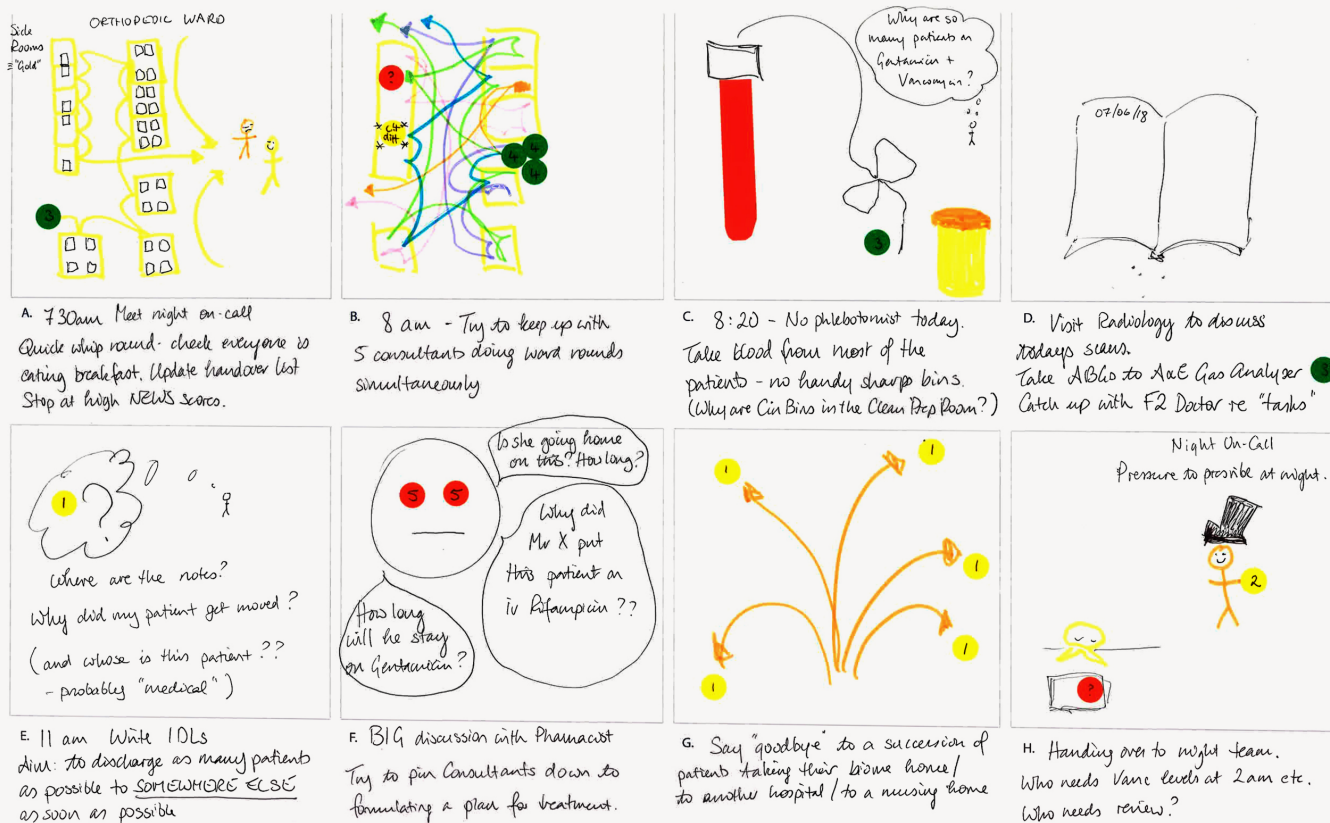
one key intention of our design interventions was to make hidden movement paths and embedded behaviours of different agent groups visible. Through storytelling, narrative and creative visualisation of our findings we wanted to inspire curiosity and appreciation of the hidden microbial life (good and bad) (Design; Pathways)

A&H was able to combine the architectural/design analysis and patient/health worker experiences to produce interactive and highly visual outputs enabling key stakeholders to view their working practices in the context of what others do. (Bacteriology; Parc)

The details of their experiences, prompted by the tools and activities, generated visual narratives and solutions to deal with the identification of AMR hotspots and practices – this reified their daily, routinised

practices and made tangible the problem of AMR. The workshop also generated new futures at an individual, system and policy level (Design; RIPEN)

Figures 5 and 6 on the following pages show examples of these visual narratives in the form of storyboards. The first shows scenes from a typical working day in 2018, featuring perceived AMR hotspots. The second envisages practice in 2030.



"Hotspots": green dot = Infection prevention and control (IPC) only; red dot = AMR only; yellow dot = both IPC and AMR concurrently

Figure 5 Junior doctor's storyboard of typical working day 2018 (RIPEN)

The extracts from questionnaires cited in this section give insights into the way that creative visual communications were central to the conception of many projects, and to their working processes and outcomes. Interest in the development of visualisation approaches for application within the various fields of infection prevention and control has gained momentum recently, and several of the project PIs were closely involved in the UKRI AHRC funded HAIVAIRN (Healthcare Associated Infection Visualisation and Ideation Research Network) project (Macdonald and Macduff 2018) which brought A&H disciplines together with others to map the field.

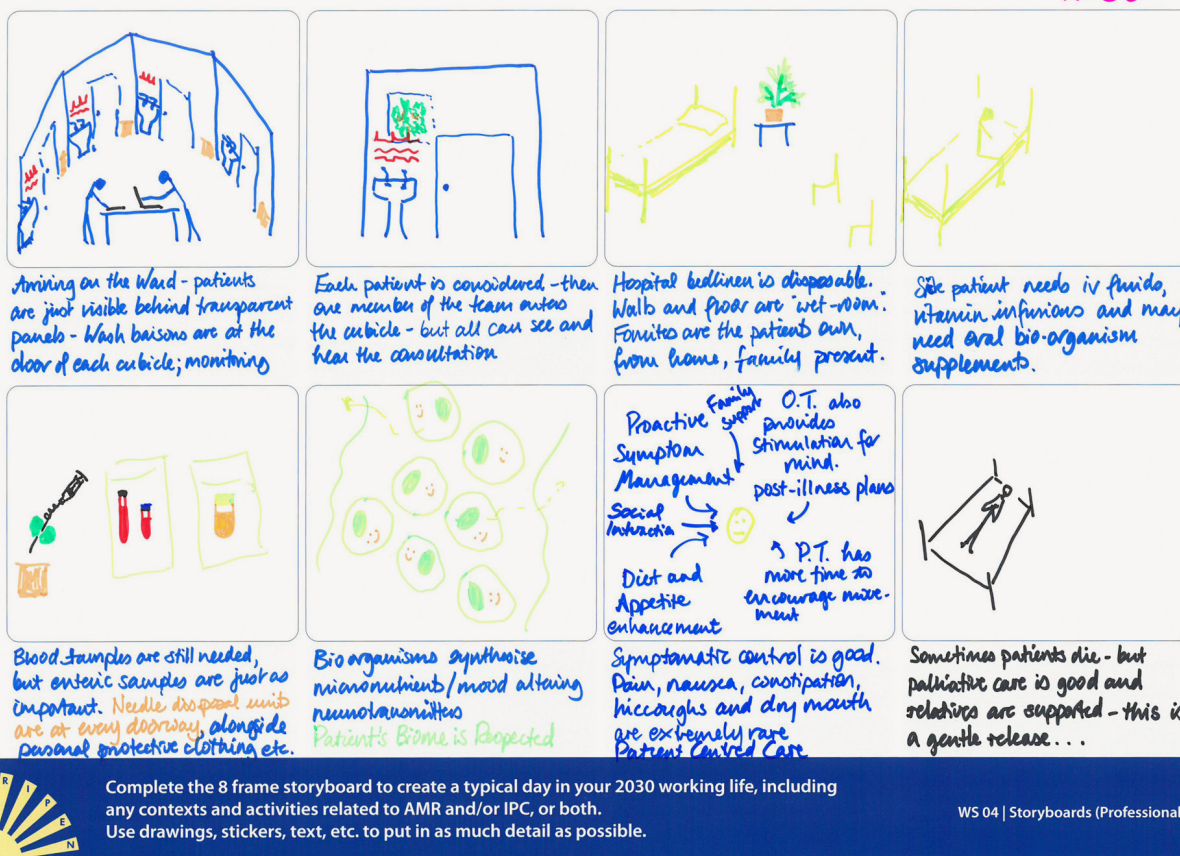


Figure 6 Junior doctor's projection of typical working day 2030 (RIPEN)

Methodology

Alongside the predominant focus on visual communications, there was a predominant methodology across the projects:

Theme 4

Use of co-design methodology for co-development

There was widespread use of co-design methodology involving substantive engagements with key stakeholders as co-developers of meaningful interventions/practices and outputs.

A typical example of such an application was:

The iterative and user centred approach to developing ambient designs with children to produce effective communication materials that were relevant and engaging to the intended audience.

(Design; Lifting the Lid)

Figure 7 shows enactment of this co-design methodology with children.

Meaningfulness and flexibility were seen as central to the methodology:

The main strength emerges from adopting the embedded knowledge and lived-experiences of participants as the starting

point for change, rather than being solely based on impersonal 'evidence'. The methodology is responsive, rather than prescriptive or formulaic. That facilitates a process of finding collective meaning and establishing common ground (and, sometimes, achieving consensus without obliterating different views)

(Design; RIPEN)

However, this capacity for responsiveness had to be designed-in with a structure to provide cohesion for collaboration:

*Provided a suite of approaches
that imposed a structured*

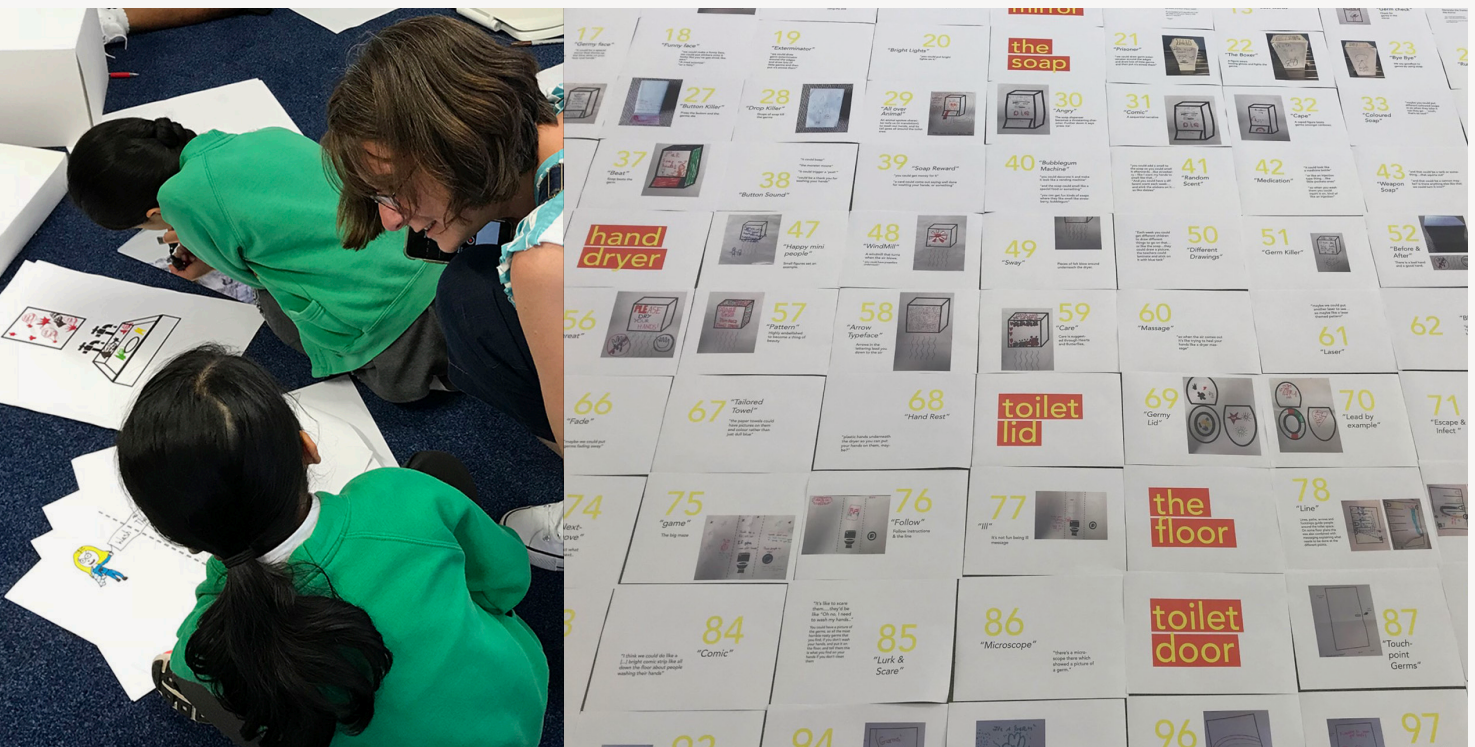


Figure 7 Co-designing with children: idea generation and analysis (Lifting the Lid)

and disciplined approach to co-design that translated and engaged across a diverse set of disciplines. This approach was unfamiliar or simply not used typically in the biological sciences.

(Veterinary Microbiology; AMR Sim)

A sense of comparative advantages over other methods was evident:

it differed significantly from traditional software development in which users are often not able to provide feedback until the product is being released
(Medical Visualisation; AMR Sim)

An A&H approach allowed us to exploit methods such as Co-Design and think beyond, say, systematic reviews, clinical trials or other more standard methods. Our approach was a 'human' one acknowledging that hand hygiene is a complex issue within schools and that children and teachers have diverse experiences of the space they are in.
(Design; Lifting the Lid)

Thus, the valuing of others' knowledge and experiences is fundamental to this methodology. This orientation is not necessarily exclusive to the arts and humanities, and a number of social science methods place central value on personal experience. However, perhaps what makes arts and humanities approaches distinctive in this context is their propensity to combine responsiveness to context, iterative engagement, visual orientation and commitment to co-development?:

In terms of understanding the problems, A&H approaches

tend to have a more open-ended, stakeholder-focused view whereby individual narratives, lived-experiences and contextualised realities are recognised and appreciated. As such, there's an effort to try and visualise, or provide rich descriptions (which often utilise visual/audiovisual methods) according to multiple perspectives. But A&H approaches – and perhaps Design in particular – are also propositional/solution-focused; they often aim at intervening in reality rather than just describing it. So, a big part of the contribution comes in the form of actions aiming at addressing the issues identified. At RIPEN these involved various types of co-design, participatory activities that were prepared in reaction or response to emerging knowledge that stemmed from the research process.

(Design; RIPEN)

As can be seen, design academics were particularly in the vanguard for this co-design and co-development work. This is not surprising given that creative thinking and ideation is deeply embedded in the teaching and research aspects of their discipline, enabling them to draw out similar modes of thinking in non-designers too. Moreover, they offer particular skills in visual analysis – sketches, prototypes and design annotations are already familiar tools.

Theme 5

The discipline of design offers distinctive expertise for envisaging and enacting co-design approaches

In a recent study of visualisation-based interventions to address

healthcare associated infections (Tsattalios 2019), co-design for co-development emerged clearly as the framework that would give both system-wide and focal interventions the best chance of succeeding in practice. Interestingly this came from an international Delphi process involving 23 experts, only one of whom came from a discipline traditionally classified as arts and humanities. As such, the potential of the approach for developing sustainable improvements is highlighted.

Not all of the 11 projects used co-design with situation-specific stakeholder groups such as house occupiers, schoolchildren, pharmacy users. For instance, the NOTBAD project was primarily lab-based. However, this also involved ongoing co-design of building materials and methods between the main research team members. Indeed, the aim of co-designing novel methods that would be a legacy output was a feature of several other projects, notably Visualisation and AMR Historical Foresight.

Part of the project was to develop an approach and methodology so in some senses a blank sheet. It needed us to bring together approaches to come up with a method.

(Health Services/Policy Research; AMR Historical Foresight)

Methods and roles enacted in arts and humanities contributions

Although co-design was the predominant overarching methodology, looking across the projects, a wide range of specific methods and processes were used towards achieving project goals. Rich insights into the nature and scope of these emerged in response to the questionnaire items on the contribution of arts and humanities:

The historical focus of the first part of the project situated the project well within the A&Hs. By identifying, say that the visualisation of germs, hadn't radically changed in the 20th Century we were able to consider more closely why various types of germs were pervasive and the semiotic potential in their form. (Design; Lifting the Lid)

Figure 8 shows an output from this historical focus.

The contribution from history was in terms of methods but also in terms of critical understanding and questioning throughout. Part of the project was to disrupt more traditional spaces and bring policymakers and historians together to discuss learning from climate change and tobacco control for AMR policy.

(Health Services/Policy Research; AMR Historical Foresight)

Methodologically – the study used in-situ sketching – an illustrator working along with research interviews

and observation techniques – yielding novel data.

Intellectually – cross currents between sociology and literature in terms of meanings of illness experiences and performance of health relating practices – e.g. choreography of clinic, of coughing, of hand washing etc and between sociology and history – the changing design of clinical settings and how these shift in conjunction with medical scientific discourses – miasma to germ theory etc etc. Co-design stage of the project involved working with architecture / an architect. (Sociology, Parc)

Figure 9 overleaf shows one of the specific methods used.

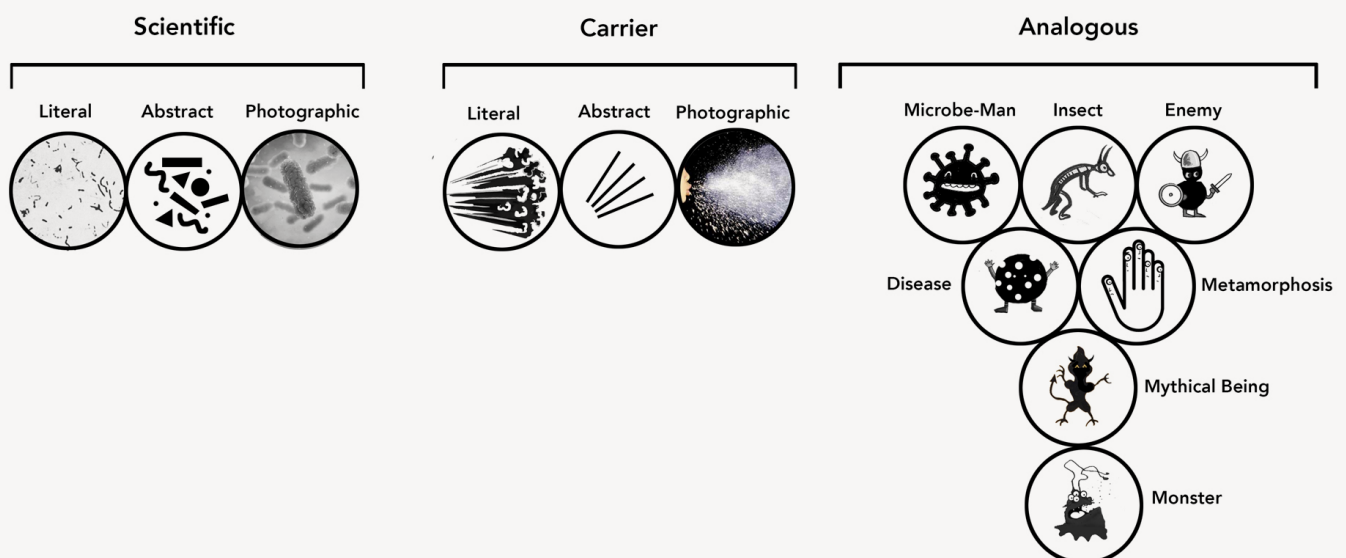


Figure 8 New typology of germ representations produced during Lifting the Lid



Figure 9 Sketch incorporating interview feedback about patient's experiences of accessing facilities (Parc: artist Lynne Chapman)

The project explored how design can become a tool to interrupt or break infection pathways. (Design; Pathways)

Understanding of design and architecture and its interaction with people. Brought strong survey and data collection methodologies (Engineering; Ventilation)

approaches included co-design, historical methods, and visualisation methods which allowed research participants to think about and conceptualise AMR and Antimicrobial Stewardship practices differently from how they are understood

and enacted through other research approaches e.g. medical, health services research etc (Public Health/Nursing; RIPEN)

Figure 10 overleaf shows material from a workshop activity using historical visualisations

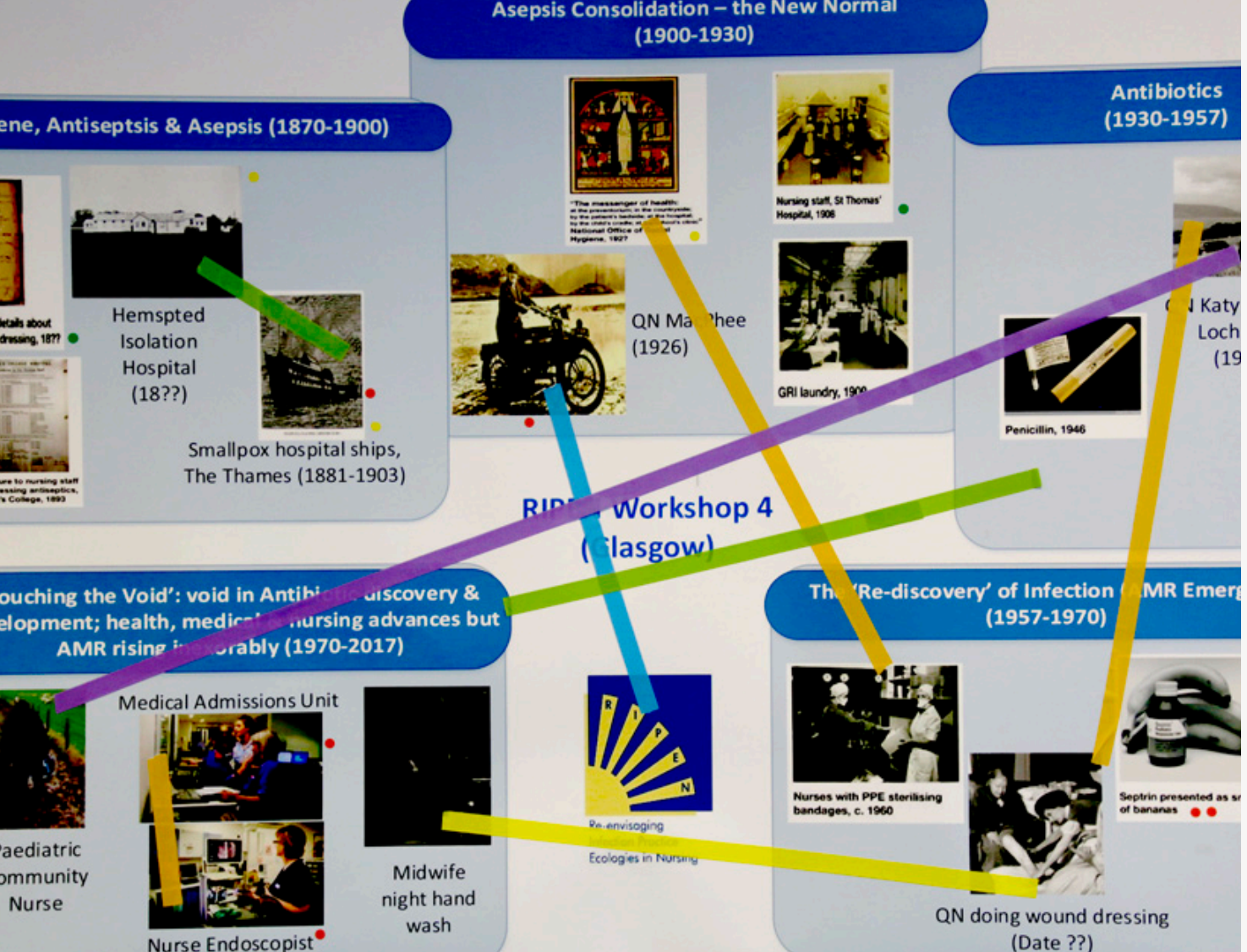


Figure 10 Workshop activity using visuals from eras of Infection Prevention and Control (RIPEN)

Ordinarily the sampling would choose houses at random and sample. However through 'design' one can target dwellings that are linked or offer different 'practices' thereby the data generated can reveal more about the people than the dwelling per se. In addition, coupling design and microbiology enables the strengths of one discipline, to counterbalance the weaknesses found in another; namely evidence-base/data in design and storytelling in microbiology. (Design; Dust Bunny)

Figure 11 shows an example of a compound house in Ghana

A large number of questionnaire extracts are presented above to indicate not only the range of activities, but also their inherent vitality and potential potency. All the above aspects coalesce to suggest the arts and humanities can contribute by:

Theme 6
Offering varied and valuable ways of thinking, seeing, understanding, creating and presenting
 Arts and humanities research approaches can offer participants and audiences for research a range of different and valuable perspectives and practices

The extracts above and those used in previous sections also indicate some of the range of actions that can characterise arts and humanities contributions. Conceiving ideas, structuring, facilitating, brokering competitions, questioning, challenging, disrupting, mapping, modelling, sketching, prototyping, analysing, producing: all these aspects and more were to the fore in feedback.

As such, researchers would typically have a number of roles related to these actions, requiring a range of skills. Some of those not explicitly cited so far include advocacy and leadership:

The PI (A&H) was the protagonist for living architecture
(Bacteriology; NOTBAD)

the PI, who was critical in pulling everything together and helping the team keep focus – I wondered how feasible it would be to replicate this in a different setting with a different group of people. (Pharmacy; IDAPPS)

The latter extracts and others in this section speak strongly of the amount of mixing of disciplinary knowledge and activities occurring within these projects. The report now examines this in more detail.

Theme 7

Clear, inclusive leadership and project management from PIs is critical, especially where a diverse group of disciplines are involved



Figure 11 Compound house in Ghana (Dust Bunny)

Arts and humanities disciplines working together and with others

As Table 1 shows, these projects typically involved several academic disciplines working together, often with a range of public and/or professional stakeholder groups. The CODA AMR questionnaire invited PIs and research team members to consider which of four commonly used terms best characterised the workings of their project, namely: multidisciplinary; interdisciplinary; crossdisciplinary; or transdisciplinary (providing definitions drawn from Stember's 1990 work).

Jensenius (see arj.no/2012/03/12/disciplinarity-2) provides useful reflections on these terms, along with a visual representation (see fig. 12).

Almost a half of respondents saw their project as interdisciplinary (i.e. integrating knowledge and methods from different disciplines, using a real synthesis of approaches). Almost a quarter saw

their project as multidisciplinary (i.e. where people from different disciplines work together, each drawing on their disciplinary knowledge). The remainder tended to see their project as a mixture of these ways of working. Often these perspectives varied amongst a project's team members, perhaps relating to different degrees and types of personal involvement.

Responses yielded insights into these different perspectives. Reflections on interdisciplinary working tended to highlight how this was characterised by integration of several disciplines in most (or all) aspects of the work and by this synthesis going beyond the sum of each disciplinary part:

The interdisciplinarity in IDAPPS was evident in the way that we combined methods from architecture, information design and pharmacy practice to create a new way of generating ideas

for using community pharmacies to get across messages about drug resistant infection.
(Design; IDAPPS)

The iterative, collaborative approach taken to developing the tool and the intervention was led from the A&H side, but all disciplines contributed to a similar degree and what emerged was a genuine synthesis in which most elements benefitted from contributions from more than one discipline, and boundaries between disciplines were generally not evident.
(Veterinary Medicine; AMRSim)

This approach relies on the integration of interdisciplinary work methods that combines scientific methodology (microbiology and material science) alongside design research methods which use iterative design as the

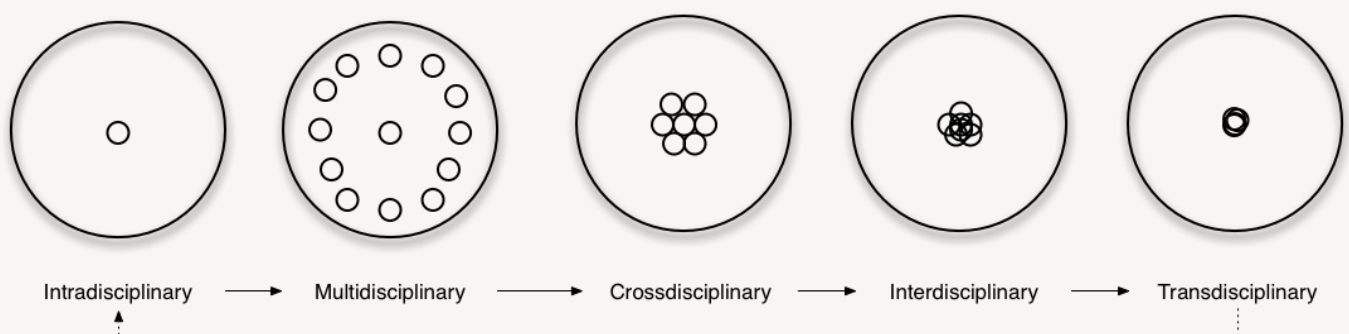


Figure 12 Jensenius's depiction of types of disciplinary collaboration

overriding principle for a hybrid methodology between disciplines (Bacteriology; NOTBAD)

This is a rare case of interdisciplinary working – with the sociologists, artists, architects and microbiologists working together on the same research questions and interpreting of data. (Sociology; Parc)

We brought together architecture, engineering and microbiology in a way which interacted together rather than each working on their own aspects. Good knowledge sharing between the team (Engineering; Ventilation)

In this process, the participants were equally collaborating with various decision-making aspects of the process and their (mostly nursing) expertise was of central importance to the directions taken and the results achieved. With this project it became even clearer to me that the collaborative, interdisciplinary work that permitted the insights and understandings achieved by the group could hardly be matched by any of the individual disciplines or professional groups alone (Design; RIPEN)

The latter extract makes the important point that in these projects



Figure 13 Community representatives, experts (e.g. public health) and research team working together (Dust Bunny)

interdisciplinary working was not restricted to the academic members of research teams. Figure 13 shows a similar interdisciplinary process on the Dust Bunny project.

Theme 8

Interdisciplinary work as an embedded and developed process

This was characterised by integration of several different disciplines within most (or all) aspects of the work, and this synthesis went beyond the sum of each disciplinary contribution.

Those who described multidisciplinary working often made the point that it was common, and indeed necessary, at certain points in a project:

I would mostly characterise this project as multidisciplinary, with certain aspects of interdisciplinary working, because of the shared reference points at times (e.g., the

illustrator had worked with sociologists in previous research, and so I felt there were affinities in our working practices in particular here). (Sociology; Parc)

I think it's sometimes difficult to distinguish, in practice from Multidisciplinary and Interdisciplinary and I'm torn between the two with our project. Given the 'lead' author approach to all our publications I would say that the authors leant mostly on their disciplinary expertise – and I think that's fine and efficient. (Design; Lifting the Lid)

Only one respondent opted for crossdisciplinary (i.e. viewing one discipline from the perspective of another) as their main descriptor. A useful example was shared of how this can manifest within a project:

Team meetings and workshop planning applied cross disciplinary perspectives – considering participatory

and co-design practices to be used in the two labs. At the advisory board meetings, a cross disciplinary view also prevailed examining the work from the perspective of different disciplines but particularly how the findings translated into nursing and health care community practices.
(Design; RIPEN)

The concept of transdisciplinarity (i.e. creating a unity of intellectual frameworks beyond the disciplinary perspectives) was only referred to by a few respondents. Jensenius (see above web link) cites difficulty in distinguishing this clearly from interdisciplinary working (as reflected in the limitations of his diagram).

At one level it is easy to dismiss definitions of joint disciplinary working as irrelevant or tedious semantics. Moreover, as one of the key colleague respondents disarmingly pointed out in responding:

We label our research and use these concepts strategically, depending on the specific context and aim.
(Sociology and Philosophy)

However, this respondent goes on to explain:

We actually experiment with transdisciplinary, as we find it challenging to actually integrate diverse types of knowledge: but this takes lots of time, to discuss, learn etc.
(Sociology and Philosophy)

The latter point is important because it suggests that the goal of taking interdisciplinary working further to create new integrated frameworks that may be

transferable is something worthwhile. Moreover, it may be a goal to which arts and humanities approaches are particularly well suited.

Theme 9 **Transdisciplinary working as an opportunity and challenge for arts and humanities disciplines**

Developing interdisciplinary work to the point where useful original syntheses of knowledge are produced is a challenging goal, but one that may be well suited to A&H

For one respondent the evidence was in the outcome:

The AMRSim project was more than the coming together of expertise. The project required the integration of several academic areas to achieve its end goal. While the project itself was interdisciplinary I believe the end product (the AMRSim intervention inc. educational workshop) is transdisciplinary as the 'real-world' application of the intervention transcends a single discipline
(Health Services Research/ Psychology; AMRSim)

For another who characterised their project as primarily transdisciplinary the process was seen to start from the initial terms of the enquiry:

Incorporating design research in microbiology and in public health, in Dust Bunny, has enabled interdisciplinary and transdisciplinary research questions to be addressed through collective research approaches. The approach

adopted has the opportunity to provide a platform for understanding complex issues regarding microbiology (microbial resistance) and public health through engaging the community of practice.
(Design; Dust Bunny)

Within this project one outcome is seen as a possible new integrated methodology. Notably, design leads and directs the microbiological testing but as part of an integrated process involving equal partners. Figure 14 shows an example of one of the co-designed tools arising from this partnership. Within the AMRSim project, design principles and practices drive the overall hypothesis and approach, working in an integrated way with veterinary medicine and microbiology. Within the NOTBAD project, as noted in an extract above, an iterative design approach provides the principle for developing a new methodology jointly with microbiology. All these projects demonstrate how arts and humanities can lead studies that meaningfully embed microbiology as a core partner from inception.

Furthermore, several other projects showed how knowledge and practice from collaborating microbiologists can substantively inform A&H-led projects in the AMR field. Expertise from microbiology was crucial on the architecture-led Ventilation project for assessing the home biome and in the process developing methodology for future applications. On the Parc and Pathways projects, which both involved architectural mappings and analyses of healthcare premises, microbiological advice on risk was an important element. The design-led Lifting the Lid project's incorporation of microbiology evolved as part of its pilot of evaluation methods

and helped yield evidence of the effectiveness of the persuasive space graphics.

Thus, many of the Theme 3b projects show the strong potential for arts and humanities driven work involving microbiology.

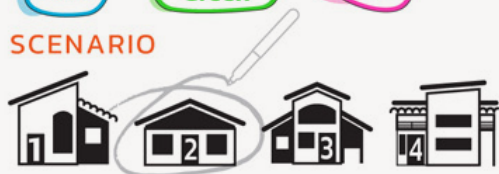
Theme 10
**Design-led and/
 or architecture-led
 interdisciplinary work
 with microbiology to
 address AMR is growing
 critical mass**

The portfolio of these projects provides evidence of the potential for innovative collaborations to impact in this field

YOUR GROUP



SCENARIO



PATHOGEN

HOTSPOT/AREA

DRAW IT

TASK
No.

STEP
No.



DESCRIBE IT



Figure 14 "Storyboard Cells" tool – house occupants can link cleaning plans to particular pathogens and contexts (Dust Bunny)

Challenges of joint working

As can be seen from the foregoing sections, these primarily interdisciplinary projects developed a range of productive processes. The related challenges varied but there were some common themes, some of which are already well recognised in the literature.

The need to engage with, and ideally have working understanding of, other disciplines was highlighted:

Although it can be enriching to work with other disciplines it can also be “lonely” – not speaking the same language, not familiar with the same literature etc (Information Science; Lifting the Lid)

It was also significant that one of the main reasons that we decided to work together is that I have some awareness of sociological approaches to research (it was suggested that I know how to “speak the language”) (Architecture; Parc)

Theme 11

Willingness to engage with other disciplines’ thinking and language is necessary to progress collaborations between disciplines

Within this ambit, it is important to note that arts and humanities disciplines such as design can have a bridging or translating function.

The following extracts from four different members of the same team speak of a recurrent challenging issue in A&H and microbiology collaborations: how best to visually communicate complex data.

an early decision, was whether to go for a mathematical model visualising quantitative microbial data or to go for a different approach where the key principles of contact and contamination could be clearly visualised in way that would hopefully change perception of risk. (Design; AMRSim)

Having A&H team members approach a technical challenge within a specialised, clinical area using a layperson’s understanding of the procedures allowed the more specialist members of the team to ‘see’ the problems and learning opportunities from a different perspective. (Veterinary Medicine; AMRSim)

A&H could provide a completely different and complimentary set of skills to approach the AMR problem from a new perspective. A&H had knowledge of the design and skills needed to develop a program like the one we imagined. (Veterinary Nursing; AMRSim)

the visualisation was visually simplified such that it was accessible, memorable and the learning was applicable to their

day to day work..... there was a trade-off between detail and eliminating visual clutter so that the focus remains towards interactions and subsequent spread of bacteria. (Digital Visualisation; AMRSim)

Taken together, they suggest that design simultaneously contributes knowledge of principles (of infection, education and research design/management), a valuable layperson-type perspective on the detailed microbiology data, and the technical expertise to produce a solution.

Similar visual communication challenges relating to conveying nuanced infection control/AMR information were addressed in the Lifting the Lid, IDAPPs, Dust Bunny, Pathways and Parc projects.

Theme 12

Visualisation of complex data is a key challenge in this field

One of the evident challenges for different disciplines working together on the same questions relates to the rigour of joint processes and the criteria to be used for evaluating outcomes:

The input of our microbiologists was very much as a source of biological expertise in making sure we were getting the clinical science right and establishing strong credibility with senior

clinicians involved in the study.
(Sociology; Parc)

What was less obvious, was how knowledge and methods from different disciplines worked together in the prototype implementation and evaluation stage. For example, evaluation methods can differ greatly in different disciplines and I wondered whether there could be more integration there that was made more obvious.
(Pharmacy; IDAPPS)

It could also be said that this project couldn't draw on the A&Hs for every component of the project – it was limited, say, in what it could contribute to the more quantitative elements of the evaluation and most of the papers we learned from regarding previous co-production projects with children about hand hygiene or evaluation methods were not written from an A&H perspective.
(Design; Lifting the Lid)

As such, evaluation seems one of the more problematic areas for A&H, with tension between what is seen as valid within one discipline and perceived need to demonstrate effectiveness in terms that medical science would recognise.

Theme 13

Evaluation can be a problematic area for collaborative work in this field, with tensions around different principles and practices

In turn, several respondents highlighted a recurring issue for these types of interdisciplinary projects:

difficulties in finding or choosing apt dissemination formats and outlets:

Publishing interdisciplinary work – different requirements for journals from different fields. Different potential audiences for the work who will also be reading different types of journals.
(Information Science; Lifting the Lid)

Moreover, a considerable amount of environmental and microbiological data was collected over the duration of the project (qualitative and quantitative data of various size, complexity and quality), which raised challenges regarding the management, analysis and presentation of data for diverse audiences.
(Architecture; Ventilation)

the fact that only one person with Cystic Fibrosis can be present in a room, which is why we also developed the virtual version. It was challenging with the virtual exhibition to fully capture the activity and multisensory experience of these spaces. (Sociology; Parc)

Furthermore, dissemination of academic findings can be challenging as it can be difficult to identify the 'core audience' for interdisciplinary research i.e. journals or conferences which often have a 'pure' focus
(Health Services Research/ Psychology; AMRSim)

Theme 14
Finding suitable dissemination formats and publication outlets for collaborative work in this field can be difficult

Project outcomes: findings; outputs; impacts

Given the range of project questions and contexts, it is impossible here to do justice to all the various outcomes in terms of what was found, what material outputs resulted, and the immediate impact of each project. Readers are referred to the project websites in Table 1 for more detailed information. It is also important to say that, at time of writing, most projects have only recently finished (i.e. within the last six months).

However, it is possible to highlight indicative examples and give overview of some themes which are emerging.

At a fundamental level, many of the projects generated useful, and

often novel, primary understandings of how AMR manifests and is understood (or not) in particular indoor and built environment contexts. The Parc project generated such insights in relation to clinics for Cystic Fibrosis patients, as did the Pathways project for staff in hospital wards. The Dust Bunny project generated understandings of how household beliefs impact on hygiene practices in different Ghanaian homes. The RIPEN project illuminated how nurses understand AMR in the context of their daily practices and differentiate it (or don't) from other infection prevention and control work.

In terms of findings, several projects (e.g. Pathways, IDAPPS,

AMRSim, RIPEN) showed how the participation process had raised awareness, changed perceptions and/or generated new ideas relating to behaviours in context:

we moved our workshops directly into the ward and their working environment. Here, we shared our findings and used costume design to engage professional practitioners on the ward in conversations around the spread of pathogens. This raised awareness of how behaviours, but also architectural decisions result in the potential spread of bugs. Audience reported change in views, opinions or behaviours. (Design; Pathways)



Figure 15 Hands on engagement through costume design (Pathways)

Figure 15 shows this costume design in action.

Through a multi-faceted evaluation process, including microbiological sampling, the Lifting the Lid project was able to demonstrate that persuasive space graphics were effective in increasing hand hygiene amongst primary school children:

the most obvious contribution is that the designs have led to a behaviour change – that the project is led by someone with a design communication background (rather than just public health) is likely significant (Information Science; Lifting the Lid)

Theme 15

These projects achieved outcomes involving new understandings, changed perceptions and behaviours

Several projects (e.g. IDAPPS; AMRSim; NOTBAD) produced and evaluated tangible prototypes which can act as a basis for practice implementation and/or further developments:

We have successfully developed building material incorporating benign bacteria that prevent AMR bacteria colonisation and which can be used in "living architecture". None of this could have been achieved without the A&H contribution and further development could impact significantly on AMR. (Bacteriology; NOTBAD)



Figure 16 Overview and detailed views of new probiotic tiles (NOTBAD)

Figure 16 shows examples of these new materials.

Figure 17 on the following page shows examples of visualisations from the prototype training tool developed by the AMRSim project.

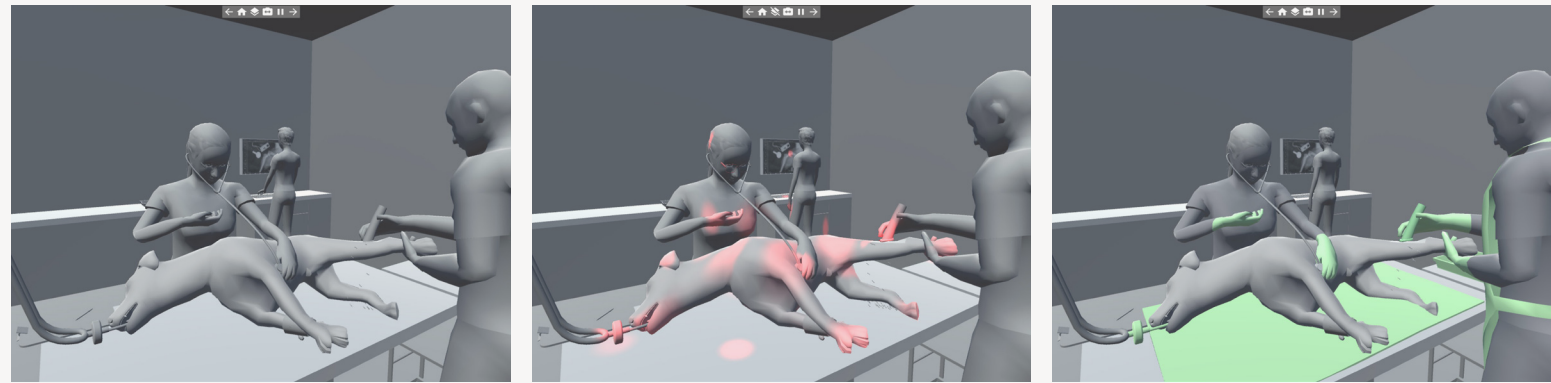


Figure 17 AMRSim: 3D interactive 3-layer digital animation tool, used to support the AMRSim infection prevention and control (IPC) training intervention, showing pre-surgical veterinary procedures: layer 1 (left) with in-built risky behaviours; layer 2 (centre) 'switched on' to show transfer of 'invisible' contamination between animal, veterinary staff, surfaces and equipment if proper IPC measures are not being observed; and layer 3 (right) showing IPC measures in place.

This tool – with an accompanying educational script – has the flexibility to be adapted for use with a range of individuals.

(Health Services Research/ Psychology; AMRSim)

Lifting the Lid's integrated set of persuasive space graphics for primary school toilets (see examples in Figure 18) have proved effective and successful application has been made for funding for further development and roll out.

economic framework on top of microbiology that may define microbial distribution and exposure in domestic dwellings. This means that the ethnography and cultural probe activities can be used to direct and focus the sampling required for the microbiology. Therefore, the microbiology can be targeted at answering questions that arise from the 'design'

(Design; Dust Bunny)

Moreover, methodology evolved within the community pharmacy context could have transferable applications:

The IDAPPS approach – summarised perhaps as 'interdisciplinary competition format to generate ideas quickly' – is certainly something that could be applied to other situations. (Design; IDAPPS)

Theme 16 Prototype materials and tools were successfully developed and tested

A very strong theme to emerge from these pump priming projects is the development and initial testing of new methodologies and methods, often with the potential for transferable applications. As alluded to previously, the Dust Bunny project has evolved a potential new integrated methodology combining disciplinary frameworks:

Coupling microbiology with design has allowed a complementary design approach to include the needs of a socio-



Figure 18 Effective persuasive space graphics (Lifting the Lid)

Within a different context, the AMR Historical Foresight project has worked towards applying and articulating a new integrated methodology synthesising historical and policy research methods.

There was innovation too at the more specific level of particular methods:

The study developed a sampling strategy and protocols that could be applied to larger studies and, given access to facilities for culturing the samples, may be included as a process in other building performance related studies that gather data in homes
(Architecture; Ventilation)

There are lessons from the project's modelling aspects that are transferable to other fields – to make visible the invisible – for example, to the field of air quality.
(Architecture; AMRSim)

Looking across the extracts cited above, it can be seen that these outcomes also start to suggest possible synergies for further work combining what has been learned from individual projects, notably around air quality and infection prevention and control.

Theme 17 **Collaborating disciplines developed methodologies and/or methods with potential for transferable applications**



Figure 19 Public engagement in a community pharmacy (IDAPPS)

Various impacts were manifest for public, professional and academic stakeholders.

Despite the fact that most projects have only recently finished, evidence of diverse useful impacts is rapidly accruing. In the case of the ExISE project it is contributing to a wider body of knowledge informing the design of emergency hospitals built to treat patients with COVID-19 [youtube.com/watch?v=dVuPKgSJjP8&feature=youtu.be](https://www.youtube.com/watch?v=dVuPKgSJjP8&feature=youtu.be). Learning from the Ventilation project is also being applied to the current infectious disease emergency:

We are taking methodologies developed through this project into approaches to assess environments where there are outbreaks (of COVID-19). Project expertise is actively involved in supporting the science for government
(Engineering; Ventilation)

Through a national policy workshop involving a range of policy and

practice stakeholders, the RIPEN project has specifically informed the Royal College of Nursing's further development of its AMR policy:

The impacts are to enable policy makers and health service managers and clinicians to appreciate the clinical, practical and experiential dimensions of AMR reduction
(Medical Sociology; RIPEN)

Impacts for the public, professions and other stakeholder groups have been notable and diverse. Speaking of the project which elicited public responses to new visual communications in community pharmacies (see Figure 19), one respondent said:

I am always amazed by the interest people take in the IDAPPS project – for me its lasting impact is in showing the positive results that can happen when health professionals and scientists work with designers.

Another important impact has been in raising the profile of practice-led research within design companies, including architecture
(Architecture; IDAPPS)

Moreover, new dialogue can be facilitated within professional practice:

this enables discussion and further development of this emerging area outside of the current and predominantly scientific literature in to architectural practice and related built environment actors. This includes architects, building designers, owners and users which would have been likely unfeasible without an interdisciplinary yet design-led approach
(Architecture; NOTBAD)

Theme 18

Projects are impacting by informing government and professional organisations' policies and practices, and by engaging with the general public

Importantly, A&H approaches can impact by challenging established perspectives and practices:

the study's findings present an alternative to the perspective that mitigating AMR is simply about the application of robust scientific knowledge. Rather, the findings show how AMR-mitigation strategies are negotiated and contested.
(Architecture; Parc)

This kind of impact, arising from the collaborative work undertaken,

was reported by a number of research team members:

This project has made me realise that A&H have a lot to contribute, not just for changing behaviours such as increasing handwashing in this case through design but also the way these interventions are assessed, as a purely quantitative methodology, again what I am used to, is not going to give the full picture. (Microbiology; Lifting the Lid)

This was a new way of working for all so some of the challenges/ naturally different approaches that we would bring were a deliberate part of the project and part of the fun of the project. More fully appreciating primary vs secondary historical research. I think the historians in team also enjoyed the challenge of being asked to look forward as they would not normally do so. (Health Services/Policy Research; AMR Historical Foresight)

Theme 19

Projects are impacting by challenging established perspectives and practices

Given the range of project framing, questions and audiences it is not surprising that related outputs vary in terms of content, formats and timings. Project websites often shared details of processes and progress via interim and final reports. Projects such as Parc and IDAPPS have held public exhibitions (e.g. see: amrpharmacy.org/exhibition/). ExISE is making a short film about operating theatres. RIPEN has created a short film featuring workshop participants,

processes and poetry: vimeo.com/368059130

Many of the projects have published related journal papers or are in the process of doing so. The Lifting the Lid project has been particularly successful in having peer-reviewed journal papers published to date, and these comprise: (i) an historically informed new typology of the visual representation of germs (ii) a paper synthesising emergent lessons for education and design arising from children's own perceptions of communication around handwashing (iii) a state-of-the-art integrative review of methods for evaluating children's handwashing in schools, and (iv) a keynote paper reporting the effectiveness and efficiency of the co-designed persuasive space graphics. Published in various public health and health/visual communication journals, these outputs (see Figure 20) show the range and potential reach an A&H-led project can bring to the AMR field.



Communicating Handwashing to Children, as Told by Children

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ABSTRACT

Posters encouraging handwashing would seem to offer a low-cost solution addressing barriers to handwashing in schools. However, what barriers can be successfully addressed and, how effective posters targeted at children may be is not known. In this study, using a co-design methodology, seventy-nine children (aged 6 to 11) from three English schools evaluated and generated handwashing messages in two workshops.

The results were then compared with an evaluation (by the authors) of handwashing posters targeted at children. Messages that children considered most effective addressed barriers relating to reminders and encouragement, and education and information (particularly germ transmission, consequence, location and avoidance).

Messages that addressed time and social norms were not considered as effective.

Posters targeted at children also used reminders and encouragement, and education and information messages. However, the focus of these education and information messages was on instruction (how and when to wash hands), not on germs. Unlike the posters targeted at children, the majority of children's messages were persuasive in that they did more than simply instruct. This has implications for the design of posters and educational material in handwashing interventions.



Article

Effectiveness and Efficiency of Persuasive Space Graphics (PSG) in Motivating UK Primary School Children's Hand Hygiene

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Abstract: Good hand hygiene is necessary to control and prevent infections, but many children do not adequately wash their hands. While there are classroom communications targeted at children, the toilet space, the location of many hand hygiene activities, is neglected. This paper describes an initial evaluation of "123" persuasive space graphics (images and messages integrated within an architectural environment that encourage specific actions). The effectiveness (whether hand hygiene improves) and efficiency (the ease with which a setting can adopt and implement an intervention) is evaluated in three UK schools and one museum. Five evaluations (participant demographic, handwashing frequency, handwashing quality, design persuasiveness, stakeholder views) were conducted. In the school settings, persuasive space graphics increased the quality and frequency of handwashing. In the museum setting, frequency of handwashing slightly increased. In all settings children found the graphics persuasive, and stakeholders also believed them to be effective. Stakeholders considered persuasive space graphics a low-cost and time-efficient way to communicate. It can be concluded that persuasive space graphics are effective in increasing hand hygiene, particularly in school settings where children have a longer exposure to the graphics. Persuasive space graphics are also an efficient low-cost means of communicating hand hygiene.

Keywords: handwashing; hand hygiene; children; schools; measures; data collection tools; research methods

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ARTICLE



Evaluating children's handwashing in schools: an integrative review of indicative measures and measurement tools

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ABSTRACT

Children are a key target of handwashing interventions as washing hands reduces the spread of disease and reliance on antibiotics. While there is guidance for evaluating handwashing with adults in other settings, this is lacking for children in schools. An integrative review of 65 studies where handwashing was measured in schools was conducted to establish which indicative measures (what is measured to evaluate the processes and/or impacts of, handwashing) and measurement tools (data collection instruments) have been applied to evaluate handwashing in schools, and under what circumstances. Further analysis highlighted different challenges when seeking to apply such measures and tools in schools, as opposed to other settings. It was concluded that indicative measures, and measurement tools need to be appropriate to the organizational setting, the study participants, and research objectives. A summative analysis of relevant considerations is presented.

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Age group; health; hygiene; hygiene standards

visual communication
ARTICLE

The visual representation of germs: a typology of popular germ depictions



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ABSTRACT

Germs have been visually represented in popular texts for over 100 years, yet little is understood about the dominant practices/concepts resident in such images. This article presents a new typology of popular germ representations from the UK consisting of three main types: Scientific, Carrier and Analogous. The first category pertains to the realm of the scientist, the second to domestic space and social norms, and the third primarily to the realm of the imagination. The study identifies a further 13 sub-types and discusses each in turn. The authors argue that a more varied range of germ images exist than the previous binary positioning of germ representations in the US would suggest. They account for the continued adoption of the Analogous Germ in relation to four key cultural forces and problematize the use of the Monster Germ and its alignment of ugliness and obesity with disease.

KEYWORDS

bacteria • germs • health • hygiene • typology

Theme 20

Projects are giving rise to a diverse range of public outputs

Naturally, the projects each had to address challenges during their planning and enactment, and good leadership and project management (as referred to earlier) seem particularly necessary when diverse disciplines are collaborating.

Research team members reported being aware of various limitations to their projects. Some of these were logistic in nature and related to processes (e.g. resource limitations in relation to the costs of microbiological testing). Perhaps one of the more fundamental limitations, however, relates to the relationship between processes and outcomes:

In healthcare it is sometimes difficult to move forward and propose changes without a solid 'evidence-base' (according to positivist scientific paradigms). So, this participatory process that usually generates very rich material may not translate into a proportional amount of action (and thus change), which may explain why it is hard to really innovate and do things genuinely different than what is already in course (Design; RIPEN)

In effect critics will say "it sounds like the A&H-led processes must have been nice for the participants, but what more lasting impacts has it had on their practices and those of their colleagues, and what learning can reliably be generalised from it?". This was a possible issue for a number of the projects that sought to influence ways of thinking and seeing (e.g. Pathways, RIPEN, Parc, AMRSim, Dust Bunny), and it is

a familiar issue for studies with limited longitudinal follow-up.

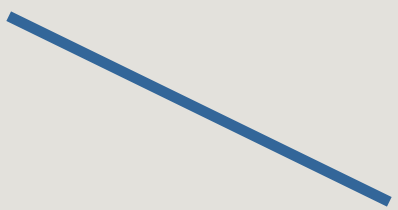
As reflected in some of the extracts cited earlier this issue tended to manifest particularly around evaluation strategies. Both AMRSim and Lifting the Lid incorporated before and after evaluation models, using descriptive statistics and exploring the use of inferential ones. Being able to make some inferences around cause and effect in this way was seen as helpful in terms of rigour and building credibility for the intervention, even while recognising that it was only one dimension of an iterative development narrative. Although RIPEN was not formally testing one intervention, the project elicited some evidence of impacts on participant's nursing practices six months after workshops completed. However, this type of self-report data is often viewed as of limited significance from a natural sciences perspective.

Thus, there were some inherent tensions within a number of the A&H-led projects about how best to evidence the worth of the endeavour:

The design and methodology were strong but the impact of the work was more difficult to determine. How can these interactions, personal developments be evidenced and accepted to deliver change when compared to more established health care methodologies? The depth of engagement by a dedicated group of participants can be questioned when situated against more common place research methods (Design; RIPEN)

Theme 21

Evidencing impact beyond the immediate effects for participants was recognised as a limitation/challenge for some projects







PART 3

So what?

So what is distinctive about A&H and the value of its contribution?

This section starts by returning to CODA AMR's central question: *how can arts and humanities approaches contribute to addressing the problem of Antimicrobial Resistance?* In the absence of other critical syntheses of studies in the field, it is hoped that the first two parts of this report have provided helpful analytic insights into key contexts, processes and outcomes from a suite of A&H-led projects relating to Indoor and Built Environment aspects of AMR.

If one accepts on this basis that A&H approaches can contribute to addressing AMR, the questions that might tend to follow are:

- “So what, if anything, is distinctive about A&H approaches in this field?”
- “And what value do they contribute?”

Addressing the first question immediately involves acknowledging the diversity of disciplines that constitute A&H. In some ways this diversity may be seen as a weakness when thinking of the distinctiveness of the A&H contribution as a whole i.e. it may be hard to grasp.

Moreover, some relevant disciplines (e.g. anthropology) may be variously categorised as arts or social science, and live in different university faculties, depending on historical, cultural or organisational factors. Often this reflects

fundamental tensions and debates within individual disciplines between arts and science aspects. The most prominent disciplines involved in the 11 Theme 3b projects (design and architecture) both have these tensions within them. Nursing lives with even more contested categorisations, variously being housed as an art/health humanity, a social science, or a sub-category of medicine.

Perhaps though the above aspects are particular strengths when considering A&H applications in the field of AMR. As the questionnaire extracts herein suggest, the ability to incorporate concepts and practices from arts and science flexibly seems important when engaging with a complex issue like AMR.

Looking over the main themes to emerge from these 11 projects, it can be argued that the distinctiveness of the arts and humanities contribution to the field is bound up in various combinations of the following attributes:

- imagination and creativity in framing new research questions from different angles, including questioning assumptions/orthodoxies
- expertise in using visual communications to evince the abstract issue of AMR
- expertise in the principles and practices of co-design for co-

development

- leveraging the explanatory power of history
- offering various valuable ways of thinking, seeing, understanding, creating and presenting
- commitment to collaborative interdisciplinary working that explores new ways of integrating knowledge
- curiosity and creative response to emergent issues
- delivering a range of meaningful impacts and outputs

Commentary: CODA AMR has identified a range of attributes that, in various combinations, can characterise the contribution of arts and humanities to addressing AMR

The value of A&H contributions lies in the deployment of these attributes to study contexts where AMR manifests and to do so in ways that may differ from the natural sciences. The value can also be gauged in terms of the range of outcomes highlighted in this paper, namely: (i) new understandings, changed perceptions and behaviours (ii) successful development and testing of prototypes (iii) development of new methodologies and methods with potential for transfer

(iv) manifest beneficial impacts for public, professional and academic stakeholders (v) challenges to established perspectives and practices, and (vi) related public outputs in a range of creative formats designed for different audiences.

On this basis it can be argued that A&H contributions to the field have inherent, fundamental value.

Commentary: The range of meaningful processes, impacts and outputs achieved by these projects shows A&H contributions as being of fundamental value to addressing AMR

These contributions clearly tend to focus less on *AMR in terms of prescription of pills* and more on *AMR in terms of conjunctions of place, people, pathogens and power*, addressing causes and consequences with creativity. Their value could be categorised as primarily cultural from the broad perspective of Crossick and Kaszynska (2014) where culture comprises aspects such as health, community, individuality, citizenship and economy. Alternatively, their value could be categorised as primarily (but not exclusively) social using the four leaf model of value (social, environmental, economic and cultural) developed for design research (Rodgers, Mazzanella and Conerney 2020). However, it seems more pertinent to highlight their value in contributing to public health in a way that integrates all the aforementioned aspects. Indeed, one of the most distinctive features of the A&H contributions featured here is their propensity for integrating valuable new work across disciplines and categories.

The wider picture: valuing A&H contributions

In order to further situate the work of the Theme 3b projects in a wider context, it is useful to draw on the thoughts of the key colleagues nominated by CODA AMR's critical companions. The majority of these 10 key colleagues were based out with the UK (Europe and USA) and their disciplines spanned A&H (predominantly history of medicine/science) and the social sciences (e.g. sociology).

Many of these respondents highlighted the contribution history has made to understandings of AMR:

Telling a meaningful and empirically based story about the past never felt more gratifying. AMR, after all, was a daunting reality that did not seem to have much of a history (except for tales about Fleming and penicillin). A slowly growing group of scholars has come a long way since then. Being at the frontlines of historical research is great fun! It becomes most meaningful when I experience that I can actually broaden perspectives of others working on AMR (History of Medicine)

Our group was able to integrate knowledge from different disciplines by focusing on major biosocial health challenges like AMR, which will only be solved by addressing both the biological and the social (cultural,

economic, and political) components of a problem. (History of Science/Medicine)

As can be seen, key points relate to group momentum and how this A&H approach can widen perspectives. Indeed, many also made the fundamental point that increasingly A&H contributions should frame/reframe questions around AMR and play a central role in enactment of studies:

I see the greatest benefit of A&H (in this case anthropology) where it can play a defining role for research, rather than a role as add-on to projects that have essentially been defined by the health or natural sciences. (Social Anthropology)

Our analyses of the science publications, the mainstream media, and popular fiction and film can offer insight into the assumptions that are circulating that are not sufficiently recognized that shape the way people understand antibiotics—hence, how they understand AMR. (Literary/Cultural Criticism)

Commentary: A small cadre of international scholars, particularly historians, are showing how arts and humanities

can frame/reframe questions around AMR and play a central role in enactment of studies

Almost all these respondents spoke of the struggles they had experienced in being accepted as a substantive contributor within the context of biomedical dominance:

the tendency is to see humanities perspectives as purely instrumental to bio- medical aims (Sociology and Philosophy)

The most significant problem facing historians in interdisciplinary settings is being taken seriously by colleagues from the biomedical sciences, whose previous training has not exposed them to perspectives from other disciplines. In the worst case, this leads to historians being asked to write a couple of sentences for the 'historical backdrop' of a study whose main parts are completely ahistorical. (History of Science/Medicine)

These sorts of struggles were also a familiar background for some of the research team members involved in the Theme 3b studies:

The project being led by social scientists rather than being led

by natural scientists was crucial. In projects led by the latter in my experience – results in diluted social science / humanities work that becomes an appendage (multidisciplinary) rather than interdisciplinary
(Sociology; Parc)

Commentary: Arts and humanities scholars have often struggled to achieve agency and recognition within collaborations that are predicated on biomedical models, especially if scientists view them as an add-on

However, experiences of integration on the 11 projects were generally very positive:

This was a relatively new experience for me. I certainly learned how valuable the A & H contribution can be in tackling problems like the spread of infections relating to patient movement and interaction, and how open people working in the medical field are to learning from these approaches
(Bacteriology; Parc)

An important point that emerges here from the Theme 3b and the key colleague respondents is that A&H disciplines can be central actors in setting agendas in AMR research, challenging assumptions and leading teams. Therefore, it is important not to frame the A&H contribution in terms of “added value”. Rather, in the context of moving collaborative interdisciplinary work forward, it is more productive to think in terms of “integral/inherent value”

Commentary: To move innovative interdisciplinary work forward in this field it is important that arts and humanities contributions be considered in terms of integral/inherent value, rather than “added value”

The above point is particularly pertinent at time of writing as the new SHAPE initiative (social sciences, humanities and the arts for people and the economy/environment; see theguardian.com/education/2020/jun/21/university-and-arts-council-in-drive-to-re-brand-soft-academic-subjects) seeks to complement the success of the longer established STEM grouping (science, technology, engineering and mathematics). The projects featured in this report show how researchers from both groupings can work together to address a complex and pressing global issue that transcends disciplinary boundaries. These examples not only provide insights for established researchers, but can also be used to help fire the imaginations of undergraduate and postgraduate students so that understandings of the potential for meaningful interdisciplinary work can become embedded early in careers.

So what next?: advancing A&H contributions

As extracts in the outcomes section above indicate, many respondents cited ways in which their research could be further developed and applied in the immediate future. These span disciplines and contexts:

Future research could involve microbiologists to assess the relationship between potential and actual spreading risks. We see this project as a starting point of a wider conversation between design research and medical science.

(Design; Pathways)

The methods and approaches used and developed in RIPEN could have applicability in other country contexts e.g. middle and low income countries; RIPEN approaches would allow for AMR responses in these contexts to be informed by local knowledge and capabilities of nurses, rather than solutions being imposed which have been developed in high income country contexts without due consideration of resource constraints and availability of materials etc.

(Public Health/Nursing; RIPEN)

It is important to note that while only one of the 11 Theme 3b projects focused on a country outside of the UK (Ghana; Dust Bunny), a number of recent UKRI

funded projects have involved arts and humanities researchers in AMR-focused interdisciplinary research (e.g. ESRC funded projects such as DARPI: <https://gtr.ukri.org/projects?ref=ES/S000216/1>).

Commentary: Many of these pump priming projects show rich potential for further development in contexts within the UK and in other countries

Several of the Theme 3b projects are known to have applied for follow-on funding from the AHRC to develop their ideas further for impact and engagement. However, several respondents indicated a need for further substantive, integrated and sustained research funding in the field:

Research funding bodies still largely 'silo' research (AHRC, MRC, BBSRC) which makes it challenging to form the more diverse research consortia such as the Design and Veterinary Medicine collaboration in AMRSim.

(Health Services Research/ Psychology; AMRSim)

one challenge for design may be in convincing humanities research funding bodies that the higher financial costs of

scientific processes, such as the microbiology methods used in the pilot, should be accounted for to allow (design-led transdisciplinary) projects to be more expansive and so they might become more than feasibility studies.

(Design; Dust Bunny)

This is highlighting the need for longer and larger studies – these would probably go to EPSRC for funding as AHRC normally can't fund to a level that allows this scale of project

(Engineering; Ventilation)

Within this context, one key colleague based in the UK highlighted factors for success:

Two key factors in the success of our project were: 1) the length of funding (5 years) and 2) the non-target oriented hands-off approach of our PIs. Working together with other disciplines requires time, trust, and mutual learning.

(History of Science/Medicine)

Respondents clearly saw continuing need for dedicated UK and international funding to encourage innovative A&H contributions as an integral part of addressing the ongoing global issue of AMR. Moreover, it was noted that there is scope for a number of other A&H disciplines (e.g. philosophy/ethics; law) to

join with those already referred to in this report. This could further advance the creative public health agenda highlighted in recent global health humanities work (Crawford, Brown and Charise 2020).

Finally, it is important to note concurrent (and complementary) advocacy for more support coming from social science researchers in the AMR field. Writing in a recent contribution to *Lancet Infectious Disease*, Kamenshchikova et al (2020) argue that it is not helpful to treat social sciences as only a support to effective antimicrobial stewardship programmes. Rather, they posit a more substantive and integral role:

“without a research infrastructure to build and sustain transdisciplinary collaborations, we are locked in disciplinary paradigms and will not understand AMR as a biosocial issue”.

Commentary: To sustainably develop more valuable interdisciplinary and transdisciplinary work to address AMR involving the arts and humanities, social sciences and biomedical sciences, there is need for dedicated national and international funding schemes

A COVID Coda: when medical science is not enough

This short project started in early April 2020 as the COVID-19 infectious disease emergency was unfolding more fully across the UK and many other parts of the world. Given some of the parallels between the COVID-19 situation where medical science as yet can offer only very limited help, and the AMR situation where medical science's antimicrobial arsenal has become ever more depleted, the opportunity was taken to ask the Theme 3b research teams if their projects had any relevance to the COVID situation.

The overwhelming majority cited relevance or high relevance:

There is some relevance. COVID-19 and treatment of related infections is relevant in relation to AMR, particularly ABR. The global nature of the pandemic will also provide learning for global governance arrangements. Our project starts to look at polycentricity etc. History I think will also have a critical perspective as to why some countries were more prepared for this type of pandemic and why some countries better emergency preparedness overall
(Health Services/Policy Research; AMR Historical Foresight)

It feels that many of the responses to COVID-19 are

drawing on local knowledge and the need to live differently now and in the future – this is exactly the kind of engagement which the RIPEN project engendered through its careful crafting of the approaches used and the nurturing of the engagement with participants. RIPEN also encouraged participants' creativity and innovation in health care and in our everyday lives, which has been a noticeable part of the COVID-19 response (Public Health/ Nursing; RIPEN)

Though less is known about the virome, is likely that approaches that look only towards separation of humans from the microbiome will potentially select for lower resilience towards future occurrences. Future directions might include research towards understanding the relationship of how we design, organise and use our built environment and how this shapes the types of microbes we are exposed to.
(Architecture; NOTBAD)

Home cleanliness and hygiene as well as understanding the contextual, cultural and behavioural aspects of communities across different socio-economic scales can help us target COVID-related interventions and promote

hygiene-related practices.
(Design; Dust Bunny)

COVID-19 has meant that the general public have required a lot more education with regards to cross-contamination and spread of pathogens to help stop the spread. For example, a supermarket or public transport version of the simulation that could be used by the public would be very useful and informative. (Veterinary Nursing; AMRSim)

Given our focus on hand hygiene, the study was and is incredibly relevant. As COVID-19 wanes, and no doubt, others may emerge over the next decades, it's vital that we all, and in particular the next generation, continue to practice HH systematically. Soap has become even more 'super'! COVID-19 also is relevant to the AMR debate more generally as it gives the public a taste of what happens when medical solutions don't exist. Unfortunately, it's not that difficult to draw parallels between the rapid spread of the COVID infection with no cure, and the potentially rapid mutation of bacteria that will lead to conditions with no cure.
(Design; Lifting the Lid)

The winning designs could possibly be adapted in the

community pharmacy (physically) or virtually (e.g. social media and key trusted health websites) for COVID-19. This would be a really good time to test and evaluate ideas. (Pharmacy; IDAPPS)

It has absolutely everything to do with COVID-19. People with cystic fibrosis (the focus of our study) have spent their lives wrestling with issues of social distancing and avoiding potentially risky and infectious situations (retail spaces, lifts, public spaces, public transport). Everyone in our study has a life-long familiarity with all the terms that are now become painfully familiar to the people of the world: Social distancing, self-isolation, shielding, cohorting and segregation, hand hygiene, mask-wearing, etc. Our project speculated on what post-antibiotic spaces, architectures, and practices might look like. The answer is that they might look a lot like post-COVID-19 spaces (Sociology; Parc)

Furthermore, as mentioned earlier, work from two of the Theme 3b projects focusing on ventilation in indoor environments (ExISE and Ventilation) is currently informing aspects of the national response to COVID-19.

Commentary: The majority of the projects outlined here are of much relevance to the emergent COVID-19 global public health crisis and some are already informing responses

Conclusion

This report began by highlighting that the contribution of disciplines from the arts and humanities to addressing AMR has not been substantively recognised to date. The UKRI AHRC funded suite of research projects outlined in the report now provide an array of examples of meaningful and useful contributions across a range of settings. CODA AMR has identified a set of emergent themes that draw together initial learning from these projects. Moreover, it has identified a set of distinctive attributes that A&H can contribute in order to help develop further work in this field. Not least of these is the spark and substance it can bring to drive forward interdisciplinary collaborations. This is particularly germane in a field where no one discipline or confederation has all the answers, and where the scope of enquiry and action needs to range well beyond antibiotics as pharmaceuticals.

As such, this report provides a start. Nevertheless, it is partial in scope and UK-centric. A full integrative review of relevant literature would be beneficial. There is also need for more recognition and encouragement of contributions from other A&H disciplines not featured in this report, such as philosophy, ethics, law, film, drama and literature. Sustained research funding with supportive infrastructure is clearly the key factor that will enable the future contribution of arts and humanities to addressing AMR.

At time of writing, research communities are innovating to address the global challenge of COVID-19. Focus on the creation of an effective vaccine is clearly very necessary but is not in itself sufficient. In many ways this echoes the situation with AMR, where focus on producing new antibiotics to replace failing ones cannot in itself adequately address the issue. The report has shown that A&H approaches have much relevance in both these related fields and it is hoped that this learning will inform ongoing research and actions in both.

Finishing on the musical analogy of a coda as a tail piece, CODA AMR has served to look back on a main body of work and reach conclusion. The conclusion is that initial momentum has been achieved and that a new movement can be developed, taking up the theme that A&H contributions can be of integral value in addressing antimicrobial resistance.

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Appendix 1: approach to analysis and synthesis of data

The approach to analysis and synthesis involved three main stages:

Stage 1 Analysis

Critical, comparative reading of individual project materials to learn more about the research and build up a picture of areas of convergence and contrast across the projects. This primarily descriptive analysis was structured around a template incorporating *key elements of research* (i.e. context; issue/rationale; aims/questions; methodology; methods/processes; outcomes).

Stage 2 Analysis

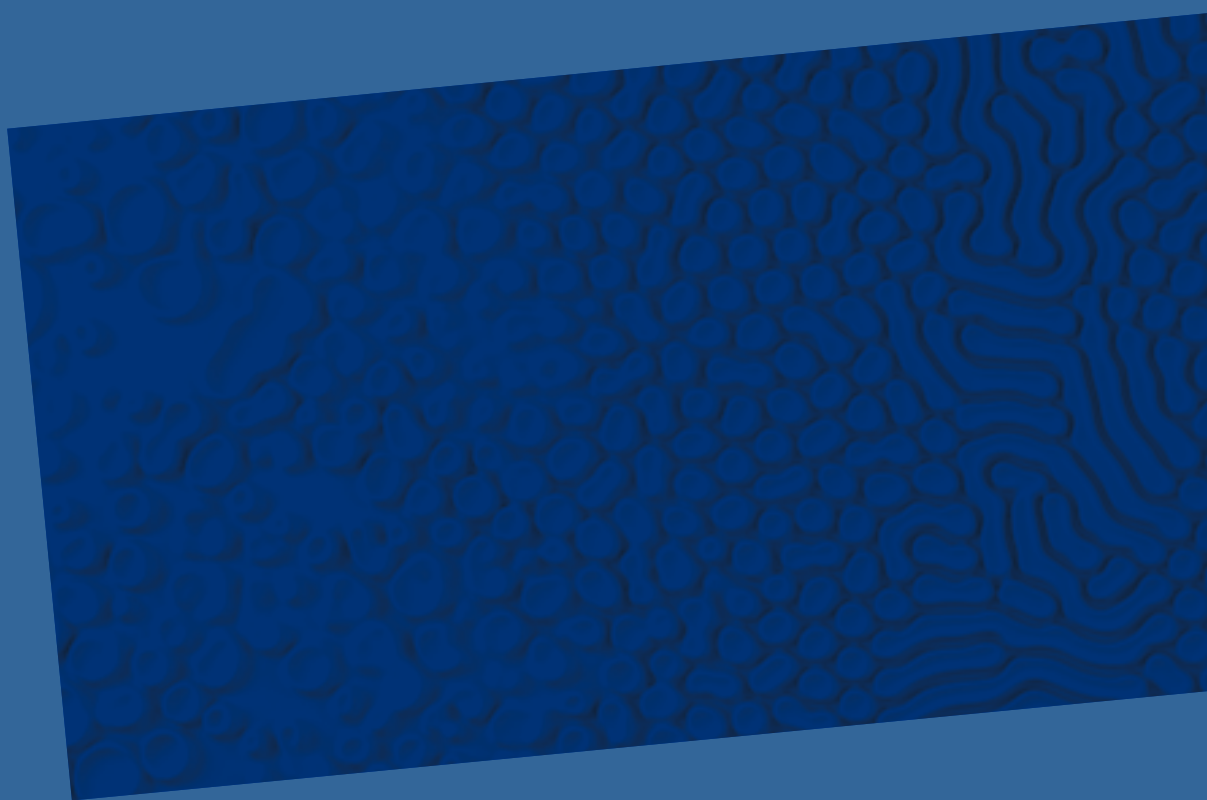
The collation and analysis of the questionnaire responses from the Theme 3b projects involved four steps:

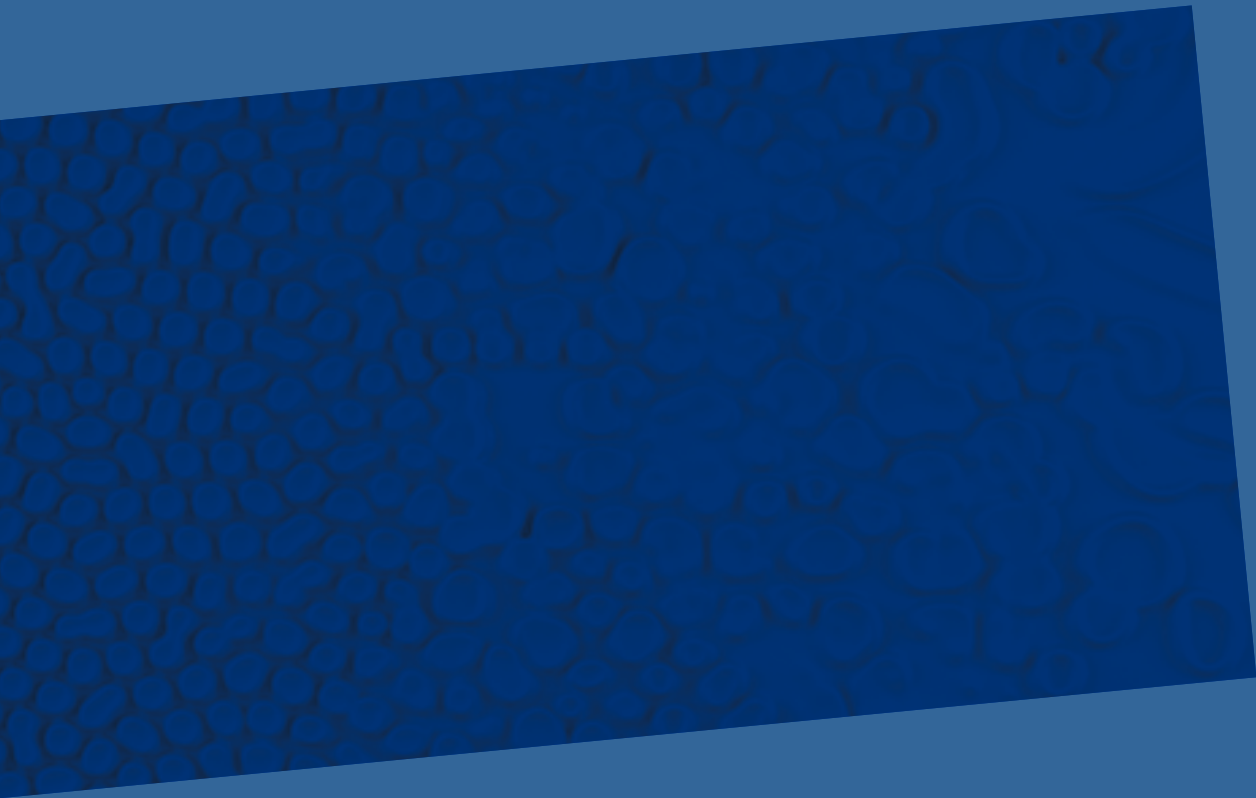
- i. Analysis of each individual response by summarising the manifest and latent content of key text, drawing on qualitative content analysis ideas from Graneheim and Lundman (2004)
- ii. Compiling and charting this material on a matrix for each project to give intra-project overview (drawing on matrix methods; see Miles et al 2014)
- iii. Creating a matrix of initial themes based on the responses, and charting these for each project using extracts of key text to exemplify
- iv. Creating a cross-case matrix showing the coverage and relative strength of each initial theme within and across the projects

Analysis of the “key colleague” responses involved steps (i) and (ii) only.

Stage 3 Synthesis

A final set of 21 overarching themes was synthesised by drawing on the findings of Stages 1 and 2 of analysis. This was broadly structured around the *key elements of research template* (see Stage 1) so as to enable presentation of an integrative analytic narrative in the final report. This narrative was also informed by understandings drawn from review of relevant literature.





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