City Research Online

City, University of London Institutional Repository

This is the published version of the paper.

This version of the publication may differ from the final published version.

Permanent repository link: https://openaccess.city.ac.uk/id/eprint/30055/

Link to published version:

WHO PUBLIC HEALTH RESEARCH AGENDA FOR MANAGING INFODEMICS

WHO PUBLIC HEALTH RESEARCH AGENDA FOR MANAGING INFODEMICS

World Health Organization

infodemic MANAGEMENT

Contents

Acknowledgements

List of acronyms and abbreviations

Africa CDC   Africa Centres for Disease Control and Prevention

China CDC   China Centre for Disease Control

COVID-19   coronavirus disease 2019

ECDC   European Centre for Disease Prevention and Control

EPI-WIN   WHO Information Network for Epidemics

GAVI   The Vaccines Alliance

HIV   human immunodeficiency virus

ICFJ   International Centre for Foreign Journalists

MAFINDO   Masyarakat Anti Fitnah Indonesia (Indonesian Anti-Defamation Society)

UN   United Nations

UNICEF   UN International Children's Emergency Fund

US CDC   US Centers for Disease Control and Prevention

USAID   US Agency for International Development

WHO   World Health Organization

Note to the reader

This report condenses discussions according to the subjects addressed, rather than attempting to provide a chronological summary. The summaries of the discussions and group work address the themes emerging from wide-ranging discussions among all speakers, and do not necessarily imply consensus unless otherwise stated.

Summaries of the presentations and of points made in discussion are presented as the opinions expressed; no judgement is implied as to their veracity or otherwise.

Foreword by Sylvie Briand

Director of the WHO Department of Global Infectious Hazard Preparedness

The COVID-19 pandemic has affected all of us both professionally and personally, causing anxiety and stress to many. This conference was a constructive opportunity to respond and shape the science of managing the infodemic in an extremely practical way. We all connected, listened, and collaborated in new ways that we couldn't have imagined seven months ago. Holding an entirely "virtual" WHO scientific conference over three weeks with more than 100 participants was a first for many of us.

It was a necessary response, though; never before has there been a more urgent need for a coordinated, evidence-based approach to mitigating the harm caused by an infodemic and the spread of health misinformation. COVID-19 misinformation is harming communities and individuals.

Thanks to the diversity of perspectives, disciplines and geography we were able to draw upon through this innovative sprint format, we have begun to build a global research agenda in this area, and to promote further opportunities for collaboration. Experiencing this conference has highlighted for me that we all have a stake in infodemic management; this isn't just a responsibility for WHO or health authorities, but also for academics, researchers, the media and civil society and others.

Help us colour in the elephant...
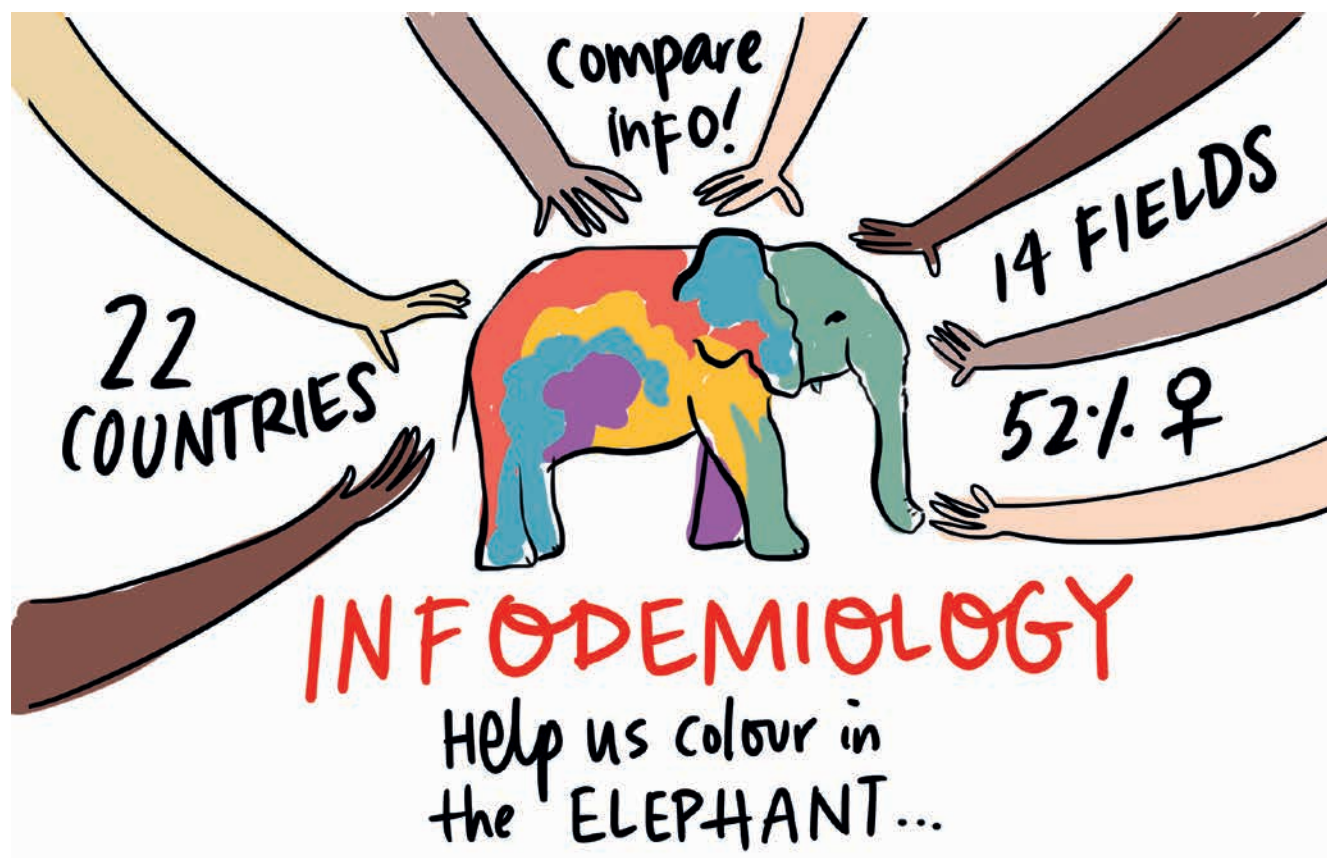
We ask for everyone's help to operationalize the research framework produced by this meeting, and to help find more opportunities to continue these interdisciplinary conversations and start rolling out research. We invite everyone to join us on this journey, as we build and fuel a vibrant community of research and practice.

This is only the beginning; the field is maturing fast. In April, we started with an infodemic management framework to lay the groundwork, and over the summer we developed the research discipline. Two more things must be done in the coming months: firstly, the development of the competency framework to underpin the new profession of "infodemic manager;" and secondly, work to build capacity in countries to prepare and respond to infodemics in health emergencies.

There is an old Indian proverb about several blind men who are touching different parts of an elephant. One holds the tail and thinks the elephant must resemble a pole. Another touches the ear and thinks it must be like a palm leaf. Another holds a leg and imagines a beast like a tree trunk. If they don't speak with one another, none of these men can perceive the whole picture.

The participants in this conference and of the research agenda development helped us draw the elephant, fill it in and colour it, and the world will reap the rewards of advancing the field of infodemiology to generate insights that will help us see the end of COVID-19.

Executive summary

> "We're not just fighting an epidemic; we're fighting an infodemic."
> *WHO Director-General Tedros Adhanom Ghebreyesus, 15 February 2020*

An "infodemic" is an overabundance of information – some accurate and some not – that occurs during an epidemic. It spreads between humans in a similar manner to an epidemic, via digital and physical information systems. It makes it hard for people to find trustworthy sources and reliable guidance when they need it.

An infodemic is propagated by the fundamentally interconnected ways in which information is disseminated and consumed: through social media platforms, online and through other channels. In the context of the COVID-19 pandemic, it is exacerbated by the global scale of the emergency.

During epidemics, more so than in normal times, people need accurate information so that they can adapt their behaviour and protect themselves, their families and their communities against infection. Infodemics affect citizens in every country and addressing them is a new and centrally important challenge in responding to disease outbreaks.

The current COVID-19 infodemic, given its scale and profile, is an important opportunity to find and adapt new preparedness and response tools.

Infodemiology: an emerging transdisciplinary scientific field

In April 2020, the WHO Information Network for Epidemics (EPI-WIN) held an online global consultation that produced a WHO framework for managing the COVID-19 infodemic along with 50 action points, one of which was to hold the first WHO infodemiology conference. This conference subsequently took place in June and July 2020. It was a transdisciplinary scientific consultation that gathered infodemic insights and approaches from as wide a range of relevant fields as possible.

Along with strengthening the foundations of the infodemiology discipline, the broader aims of this conference were to link this scientific discipline to infodemic management interventions and to improve understanding of the multidisciplinary nature of infodemic management; identify current examples and tools to understand, measure and control infodemics; build a public health research agenda to direct focus and investment in this emerging field; and establish a community of practice and research to prepare the ground for sustainable, long-term practices for responding to infodemics.

Responding to COVID-19: a new way of working

Held in the context of the pandemic of COVID-19, the conference was necessarily a digital affair and required a considerable degree of creativity to execute. The methodology of the meeting, which was spread over June and July 2020, was an innovation in itself. As COVID-19 accelerates changes in ways of working across borders, WHO and its partners sought to make a virtue of necessity and experiment with the possibilities of remote meetings. Discussions took place over eight meeting days spanning the course of four weeks. An invitation-only scientific conference was bookended by public opening and closing plenaries that drew

astonishing viewing figures for a scientific meeting: there were over 11 000 connections to the first public plenary and significantly more to the closing session. A livestream on the Reuters YouTube channel had over 17 000 views alone.

Participants in the scientific conference were split into four teams. Each team met four times for two-hour "sprint sessions" of intense discussion on one of four topics, led by dedicated topic masters. By the end of the process, each team had covered each topic – a total of 32 hours of expert discussion. The topics were:

1. How to measure and monitor digital and physical information environments
2. How information originates and spreads
3. How information affects and impacts individuals and populations
4. What interventions work to protect and mitigate the impact of mis- and disinformation.

A public health research agenda for infodemic management

By the meeting on 16 July, a draft research and practice agenda had emerged from these discussions, designed to strengthen work in five areas (Annex 1):

1. Measuring and monitoring the impact of infodemics during health emergencies
2. Detecting and understanding the spread and impact of infodemics
3. Responding and deploying interventions that protect against the infodemic and mitigate its harmful effects
4. Evaluating infodemic interventions and strengthening resilience of individuals and communities to infodemics
5. Promoting the development, adaptation and application of tools for managing infodemics.

Following the plenary of 16 July, the conference participants and additional reviewers proceeded through a research question prioritization exercise through October 2020.

The agenda, containing concrete, prioritized research questions, was the principal outcome of this conference. A further output of this meeting, an infodemiology glossary, has been established and will be handed over to the community of research and practice to develop and maintain to standardize the language and create the basis for this new field.

STREAM 01	STREAM 02	STREAM 03	STREAM 04	STREAM 05
Measure and monitor the impact of infodemics during health emergencies	Detect and understand the spread and impact of infodemics	Respond and deploy interventions that mitigate and protect against the infodemic and its harmful effects	Evaluate infodemic interventions and strengthen the resilience of individuals and communities to infodemics	Promote the development, adaptation and application of tools for managing infodemics

Framework of the public health research agenda for infodemic management

Stream 1: Measure and monitor the impact of infodemics during health emergencies

1.1. Standardize taxonomies and classifications

1.2. Develop new metrics to measure and quantify infodemics

1.3. Analyse and triangulate data from multiple sources

1.4. Improve evaluation approaches for infodemic interventions.

Stream 2: Detect and understand the spread and impact of infodemics

2.1. Understand how information originates, evolves and spreads on different platforms and channels

2.2. Assess the role of actors, influencers, platforms and channels

2.3. Understand how misinformation affects behaviour in different populations

2.4. Develop regulatory and ethical principles to mitigate the spread and propagation of harmful health information.

Stream 3: Respond and deploy interventions that protect against the infodemic and mitigate its harmful effects

3.1 Design a behavioural change model applicable to infodemic management

3.2. Intervention design for different levels of action to mitigate the infodemics.

Stream 4: Evaluate infodemic interventions and strengthen the resilience of individuals and communities to infodemics

4.1. Develop interventions that address individual, community, cultural and societal factors affecting trust and resilience to misinformation

4.2. Understand and learn from the way misinformation has affected behaviour among different populations and in different contexts for specific infodemics

4.3. Identify factors associated with successful infodemic management by health authorities, the media, civil society, the private sector and other stakeholders.

Stream 5: Promote the development, adaptation and application of tools for managing infodemics

5.1. Use implementation research evidence in programme improvement and policy development

5.2. Promote evidence-based interventions and approaches between countries

5.3. Improve effectiveness and response times to the infodemic during acute health events.

Introduction

Background

An "infodemic" is an overabundance of information – some accurate and some not – that occurs during an epidemic. Early use of the term was in 2003, blending the words information and epidemic[1], following previous information epidemic discussions[2]. An infodemic spreads between humans in a similar manner to an epidemic, via digital and physical information systems. It makes it hard for people to find trustworthy sources and reliable guidance when they need it.

It is propagated by the fundamentally interconnected ways that information is disseminated and consumed; through social media platforms, online and through other channels. In the context of the COVID-19 pandemic, it is exacerbated by the global scale of the emergency.

During epidemics, more so than in normal times, people need accurate information so that they can adapt their behaviour and protect themselves, their families and their communities against infection. Infodemics affect citizens in every country, and addressing them is a new and centrally important challenge in responding to disease outbreaks.

The current COVID-19 infodemic, given its scale and profile, is an important opportunity to find and adapt new preparedness and response tools.

In response to the pressing demand for timely, trustworthy information about COVID-19 and subsequent epi- and pandemics, the World Health Organization (WHO) established the Information Network for Epidemics (EPI-WIN) to serve as a network uniting technical and social media teams within WHO. EPI-WIN disseminates and amplifies evidence-based information about COVID-19, and tracks and responds to misinformation, myths and rumours.

On 7 and 8 April 2020, EPI-WIN held an online global consultation on managing the COVID-19 infodemic, with the aim of gathering information, evidence, ideas and comments from a wide range of technical experts and other stakeholders. The objective of this exercise was to gather input for a draft infodemic response framework, with the secondary aim of catalysing a new community of practice on infodemic management and beginning to define its work. This meeting produced a WHO framework for managing the COVID-19 infodemic and 50 action points[3]. One of those action points was to hold the first WHO infodemiology conference.

This conference was subsequently held in June and July 2020, with a research question prioritization exercise through October 2020. It was a transdisciplinary scientific consultation that gathered infodemic insights and approaches from as wide a range of relevant fields as

---

1   Rothkopf DJ. When the Buzz Bites Back. The Washington Post. 11 May 2003 (https://www.washingtonpost.com/archive/opinions/2003/05/11/when-the-buzz-bites-back/bc8cd84f-cab6-4648-bf58-0277261af6cd//, accessed 20 January 2021).
2   Coiera E. Information epidemics, economics, and immunity on the internet: We still know so little about the effect of information on public health. BMJ 1998;317:1469.
3   WHO ad-hoc online consultation on managing the COVID-19 infodemic [web page]. Geneva: World Health Organization; 2020 (https://www.who.int/teams/risk-communication/infodemic-management/who-ad-hoc-online-consultation-on-managing-the-covid-19-infodemic, accessed 20 January 2021).

possible. Along with strengthening the foundations of an evolving infodemiology[4] discipline, the broader aims of this conference were to improve understanding of the multidisciplinary nature of infodemic management; identify current examples and tools to understand, measure and control infodemics; build a public health research agenda to direct focus and investment in this emerging field; and establish a community of practice and research, preparing the ground for sustainable, long-term practices. From the working groups and plenary discussions, a framework for a public health research agenda was produced, followed by a research question prioritization exercise over the following eight weeks.
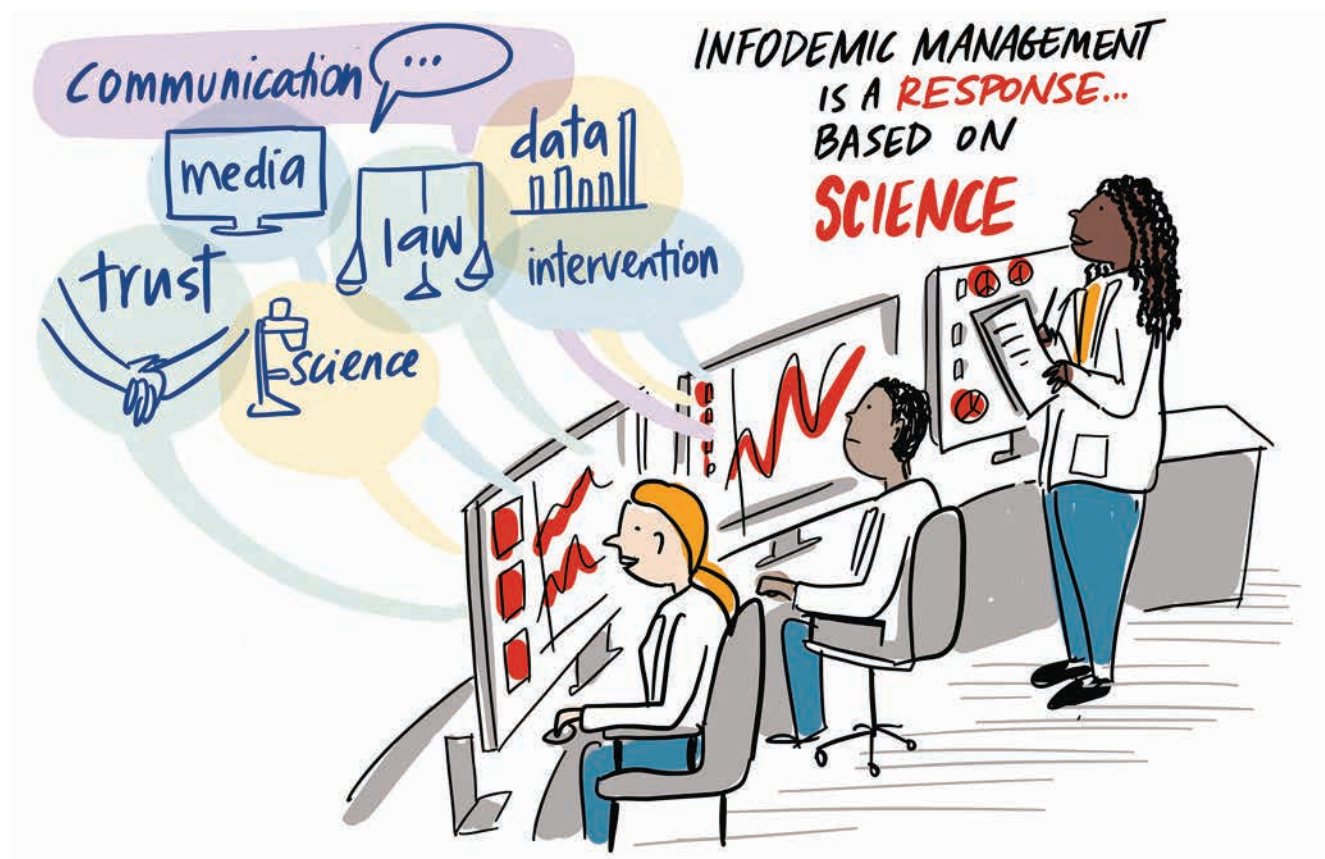
Problem statement

In public health terms, too much information is a far better situation than a lack of information and scientific evidence. Systematic tools exist for capturing, assessing and synthesizing large amounts of scientific evidence but are applied within the scientific community. However, most parts of the population are confronted with too much information – beyond scientific evidence – which does not necessarily have positive aspects. For example, too much information makes it difficult for people to filter through it for what would be useful and relevant to them. Too much information can also engender a feeling of disorientation, which may induce people to lose heart, lose the perception that they have any control over what happens to them, or paralyse them from action. This then becomes not an only an issue of

---

4   Eysenbach G. Infodemiology and Infoveillance: Framework for an Emerging Set of Public Health Informatics Methods to Analyze Search, Communication and Publication Behavior on the Internet. J Med Internet Res 2009;11(1):e11.

(poor) information management and communication but rather an inherent problem of too much good information that needs more research attention on the way it affects behaviour.

Information, misinformation and public health are intertwined by nature, and WHO has dealt with issues around the intersection of misinformation, trust, and demand for health services since its founding.

As the world changes, so too do emergency response strategies; WHO has evolved its risk communication and community engagement approach during every major global outbreak, from smallpox to HIV/AIDS to H1N1 to Ebola to Zika.

Misinformation nowadays is highly sophisticated and deliberately designed to prey on the vulnerable. Just as the tactics for health education, social mobilization and public communication that helped eradicate smallpox over 40 years ago have evolved, so have the tactics used by purveyors of misinformation. Misinformation is increasingly sophisticated, hard to track and emotive, and can imperil public trust in health authorities and service delivery[5]. It can be used as a wedge to encourage polarization, stigmatize groups of people, and encourage "treatments" and behaviours that harm health.

Misinformation and distrust can be a particularly toxic mix that causes people to reject health interventions such as vaccines – as in the case of polio[6]; disregard health guidance, as has been seen with Ebola[7]; or try out unproven and dangerous therapies like ingesting methanol to prevent COVID-19[8]. They can also spur stigma and violence.

Individuals and communities that have been historically marginalized have weaker access to health services and weaker social linkages, which can make it difficult to reach them with services during health emergencies. In addition, these communities may have different trust profiles in health workers and the health system, and low trust and confidence can affect uptake and adherence to public health advice and interventions[9].

This conference and other such recent meetings may have been among the first opportunities for many people working towards the goal to hear about the expertise and activities of others, and to frame the entirety of this activity within the problems of epidemic response and public health.

There is a need for standards in the science of managing an infodemic, even – perhaps particularly – around such basic issues as the consistent use of terminology. Coordinated and

5   Islam S, Sarkar T, Khan SH, Kamal A-HM Hasan SMM, Kabir A, et al. COVID-19-Related Infodemic and Its Impact on Public Health: A Global Social Media Analysis. Am J Trop Med Hyg 103(4) 2020 1621–1629; and Wang Y, McKee M, Torbica A, Stuckler D. Systematic Literature Review on the Spread of Health-related Misinformation on Social Media, Social Science and Medicine 2019; 240:112552.

6   Toole MJ. So close: remaining challenges to eradicating polio. BMC Med 14, 43 (2016). doi:10.1186/s12916-016-0594-6

7   Chandler C, Fairhead J, Kelly A, Leach M, Martineau F, Mokuwa E, et al. Ebola: limitations of correcting misinformation. Lancet. 2014;385:1275–1277; and Vinck P, Pham PN, Bindu KK, Bedford J, Nilles EJ. Institutional trust and misinformation in the response to the 2018–19 Ebola outbreak in North Kivu, DR Congo: a population-based survey. Lancet Infectious Diseases. 2019;19: 529–536.

8   Hassanian-Moghaddam H, Zamani N, Kolahi AA, McDonald R, Hovda KE. Double trouble: methanol outbreak in the wake of the COVID-19 pandemic in Iran—a cross-sectional assessment. Crit Care 2020;24: 402. doi:10.1186/s13054-020-03140-w 2020

9   Jaiswal J, LoSchiavo C, Perlman DC. Disinformation, misinformation and inequality-driven mistrust in the time of covid-19: lessons unlearned from AIDS denialism. AIDS and Behavior. 2020;24:2776–2780

integrated methods are required to manage the flow of information, and common taxonomies are needed to classify and compare the way infodemics manifest in specific places and to implement strategies to maximize public health impact. To fill these gaps, it will be necessary to build on existing scientific frameworks to define the new cross-disciplinary fields needed for the science of managing infodemics.
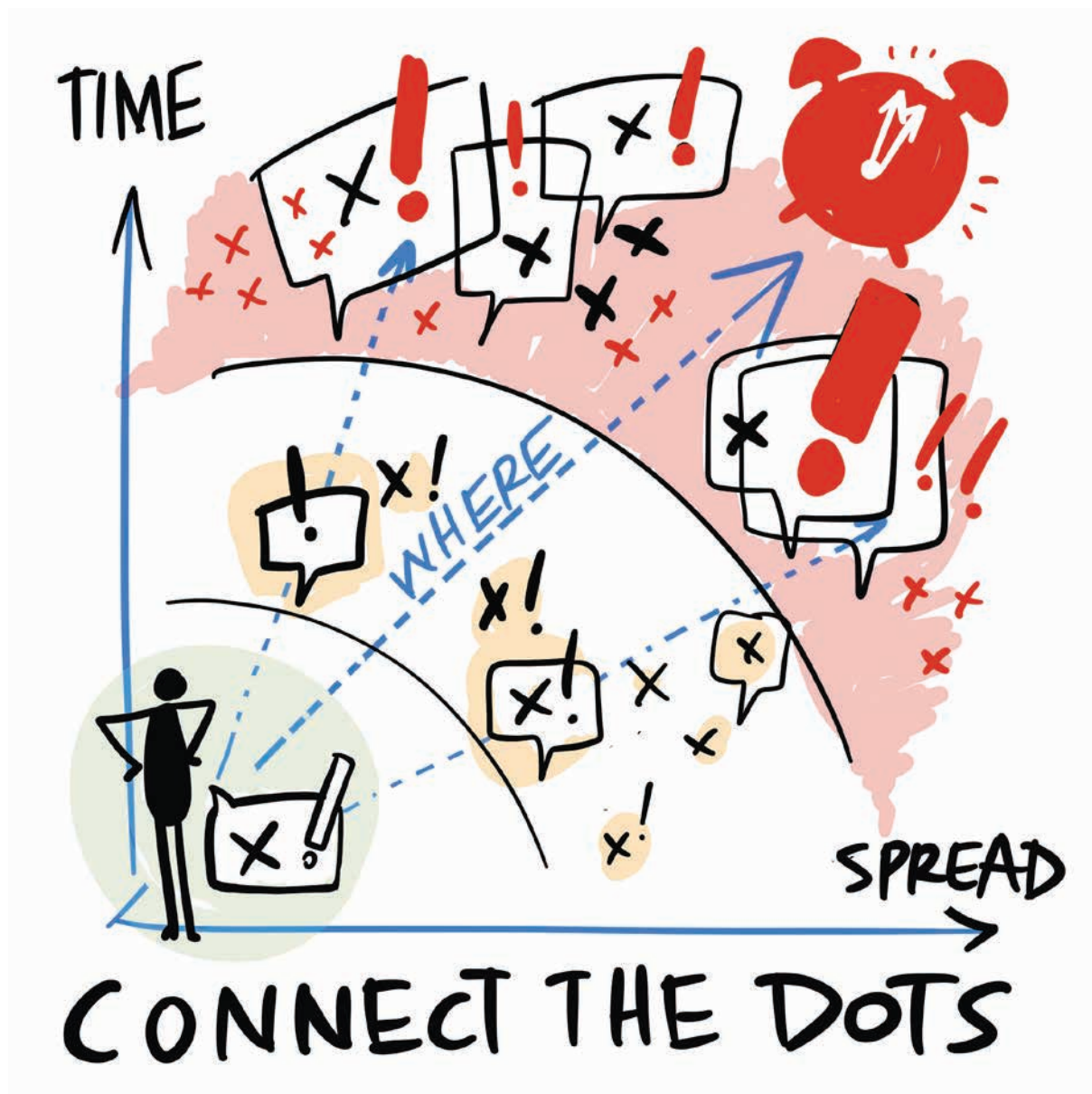
This field will work to measure and understand the flow of health-related information around the world, clarifying where it comes from, how it propagates, who it harms and how to prevent this harm, what interventions are successful, and what makes them successful in context.

The desired outcome is to reorient existing knowledge and expertise towards strategies that result in positive health-seeking or self-protective behaviours in individuals and communities, empowering them to stand resilient to misinformation. Infodemiology can provide the crucially necessary multidisciplinary expertise and coordination to achieve this goal.

A public health research agenda for managing infodemics will provide input into research and decision-making by global health partners, research policy-makers and academia, to best prioritize efforts to generate the evidence to support an effective infodemic response.

Approach to research agenda development

The research agenda was developed during a virtual meeting, followed by an asynchronous research question prioritization exercise. The virtual meeting consisted of eight working days spread out over four weeks[10]. These were made up of:

- a public preconference meeting;
- a scientific conference, consisting of opening and closing plenary meetings either side of four separate "topic sprint" days; and
- a final public meeting to present the meeting outcomes[11].

After the meeting, a process took place to gather and rank research questions based on the research agenda created during the meeting.

Preconference

The public preconference was held on 29 June. Reflecting the urgent interest in this topic, over 11 000 members of the public tuned in to live streams on Zoom and on YouTube – record-breaking attendance for a WHO meeting. While the meeting was happening, a series of polls and questions were held in real time, with 738 participants.

Seven speakers from different backgrounds spoke at the preconference, painting a picture of how the COVID-19 infodemic is entangled with many different disciplines and areas of expertise. It was an unusual insight into a range of expert experiences, and an eye-opening overview of potential interventions and approaches for managing infodemics.

Scientific conference and topic sprints

The scientific conference that followed ran from 30 June to 16 July and comprised the opening plenary session, four days of "topic sprints," and a closing plenary session. It was open to invited participants, who attended from all around the world, representing 20 professional disciplines, 19 time zones, over 35 countries, all WHO regions, and several different professional sectors. The 110 participants were supported by 49 organizers and speakers from all WHO regions. Throughout these working sessions, there was a total of 32 hours of discussion time, with 18 hours of plenary and meetings per participant, representing a combined work time of 3062 workhours.

---

10   More detail on the conference proceedings is available in the annexes to this report.
11   Recordings, illustrations and related resources for these meetings are available through the following links.
Preconference: https://www.who.int/teams/risk-communication/infodemic-management/pre-conference-1st-who-infodemiology-conference
Conference: https://www.who.int/teams/risk-communication/infodemic-management/1st-who-infodemiology-conference
Post-conference: https://www.who.int/teams/risk-communication/infodemic-management/post-conference-1st-who-infodemiology-conference

Opening plenary

The opening plenary took place on 30 June. It consisted of four scientific keynote talks from experts in the disciplines of physics, media studies, digital media and behavioural science, followed by a roundtable talk that used the science of epidemiology as a framing device to kickstart the infodemiology discussions.

Topic sprints

The topic sprints happened on 1, 7, 9 and 14 July. Participants were divided into four teams (red, yellow, green and blue) that stayed together throughout this part of the conference. On each sprint day, each team met for an intensive two-hour discussion on one of four topics, rotating on subsequent days so that each team had covered each topic by the end of 14 July. Each topic discussion was led by fixed "topic masters," who were able, as time went on, to inform their moderation approaches with insights from previous sessions, ensuring that participants' contributions could be gathered and cross-referenced in as organic a fashion as possible.

There were four working topics:

1. How to measure and monitor digital and physical information environments
2. How information originates and spreads
3. How information affects and impacts individuals and populations
4. What interventions work to mitigate the impact of mis- and disinformation.

Throughout all of this, the organizing team was monitoring the discussions and using them to supplement an initial core draft of the infodemiology glossary. This was either edited directly by participants (with confirmation of those edits by the organizing team) or by the organizing team based on participants' discussions, reports of those discussions, and – when suitable and possible – additional literature reviews. The glossary will be handed over to take forward for maintenance by the community of research and practice, which is a recommendation from the conference.

Closing session and conclusions

On 16 July, the scientific participants reconvened, and the topic masters presented their conclusions and a series of next steps.

This way of working – imposed by COVID-19 but embraced as an opportunity to innovate in the way that international technical meetings are held – resulted in a draft public health research agenda for managing infodemics, a working draft of an infodemiology glossary, and the beginnings of a community of research and practice for this new field.

Conference outcomes were discussed by five technical partners: the US Centers for Disease Control and Prevention (US CDC), the US Agency for International Development (USAID), the Sabin Vaccine Institute, GAVI, the Vaccine Alliance and the Bill & Melinda Gates Foundation.

To end the conference, organizers presented a list of possible actions that participants – and others – could take in the short term to further work on infodemiology in the context of COVID-19, and to remain engaged in this new field. These included co-authoring publications following the meeting, small grants and fellowship opportunities, and participation in a range of related events and conferences including regular EPI-WIN webinars[12].

---

12   See EPI-WIN webinars [web page]. Geneva: World Health Organization; 2020 (https://www.who.int/teams/risk-communication/epi-win-webinars, accessed 20 January 2021).

Beyond these, several major action points emerged for the longer term.

Joint call for papers on infodemic management

Five scientific journals – *Big Data & Society; Health Security;* the *International Journal of Intelligence, Security and Public Affairs;* the *Pan American Journal of Public Health*; and the *Eastern Mediterranean Health Journal* – have come together in a call for papers on infodemiology and the topics of the research agenda[13].

Establishing a community of research and practice
A community of research and practice will be built to foster connections, build repositories of tools and resources, and track implementation of the agenda. Please see Annex 1 for more detail.

Developing the infodemic management profession and related training and education programmes
The work of the infodemiology research and practice community will allow the development of a competencies framework for an infodemic management skillset, which will be followed by the development of related online training tools[14].

Post-conference public webinar to report the outcomes

The conference closed with another public meeting at which these outcomes were presented to the wider world, with over 20 000 views on the web stream. Another huge audience was told about the conclusions of the scientific conference and the next steps in infodemiology and linked with a range of opportunities for those with a more proactive interest to follow up.

Gathering and prioritizing research questions

Expert discussion during the conference resulted in the creation of five streams for the research agenda. To focus research and prioritize investment, experts who participated in the conference and additional subject matter experts took part in a follow-up exercise after the conference to indicate specific research questions that would further current understanding of, and response to, infodemics.

Each research question was expected to be relevant to the topic, to be answerable in the short or medium term, ideally to be applicable in the short or medium term, and to be focused in scope (i.e. an answer to the question could be provided in a single academic paper).

Over 160 such questions were gathered. These were submitted back to the whole expert group

---

13   See Joint call for papers – Special issues on Infodemiology [web page]. Geneva: World Health Organization; 2020 (https://www.who.int/news-room/articles-detail/joint-call-for-papers-special-issues-on-infodemiology, accessed 20 January 2021).
14   See Call for applicants for 1st WHO training in infodemic management [web page]. Geneva: World Health Organization; 2020 (https://www.who.int/news-room/articles-detail/call-for-applicants-for-1st-who-training-in-infodemic-management, accessed 20 January 2021).

in order to rank and select a number of the most relevant research questions, as chosen for feasibility and expected impact.

The resulting public health research agenda for infodemic management (see Annex 1) will be maintained on the WHO website as a living document and its implementation and priorities will be reviewed and adjusted on a regular basis.

In addition to the prioritized public health research agenda, other research questions that were not identified as a high priority in the short term will also be published on the WHO website alongside the agenda. These can be used to map gaps in the topic.

A new approach to virtual meetings

Beyond the outcomes presented in the closing sessions, this intense process generated a real team spirit. When surveyed on how they hope to continue engaging in the area of infodemiology, 84% of participants intended to collaborate with other conference participants on future work; 89% said they would take part in related training or conference opportunities; 78% planned to take part in an infodemiology community of research; and 70% said they would conduct infodemic-related research themselves.

As an evaluation exercise, and looking forward to follow-ups in the future, the organizing team gathered suggestions on how this approach to meetings could be improved. These included the use of visual prompts and human-centred design techniques to focus the discussion and/or changes to facilitation approaches to help prioritize the focus and structure of discussions. One issue, both a benefit and a complication of such diverse groupings of professionals, was the temptation to explore a wide range of avenues of thought, but time was necessarily limited.

Consensus by the end of the conference was that this approach was refreshing: it gave all the participants an opportunity to understand different views and sensitivities and around a very complex problem. Fundamentally, it established a forum for collective intelligence that brought together people from different walks of professional life to create a new layer of reason, initially establishing and building a transdisciplinary space to manage infodemiology, then building greater capacity to interact and reflect as the conference progressed and mutual understanding grew between participants. The work of the glossary project was – and will be – key to this; a multidisciplinary space requires the establishment of a common language.

Achieving synthesis of all this input will be a difficult and probably ongoing task, but the meeting showed that it can be done. Over the course of this conference, a common framework for progress emerged, as did a clear understanding of the value of working in this way. This novel approach to international technical discussion, while imposed by circumstance, has ended up a milestone of sorts: it is possible, with a lead time of less than a month, to create an environment for a truly global, interdisciplinary, cross-sectoral, collaborative emergency response to a scientific problem.

Discussion themes feeding into the research agenda formation

Over the course of the conference, the discussions built up progressively, sharing a wealth of experience, benefits and challenges, clarifying the initially amorphous topics at hand, and ultimately achieving a high degree of consensus. The mission is clear: take the research framework and other conclusions of the meeting, along with the framework for action from the April 2020 infodemic management meeting, and implement the actions and commitments they contain.

We care about addressing the harms of infodemics because they impact health behaviours, and the reasons why mis- and disinformation are spread are complex. We must take good care not to reduce the complexity of why misinformation is perpetuated by framing infodemiology as just a battle against misinformation. Mis- and disinformation are major and growing challenges, certainly, but a holistic view also includes an understanding of how we can manage and address these while also reinforcing and accelerating health-enhancing behaviours and generating information to help people make informed decisions and access essential health services in the long term – way beyond the current crisis.

First WHO Infodemiology conference, scientific conference, 30 June 2020
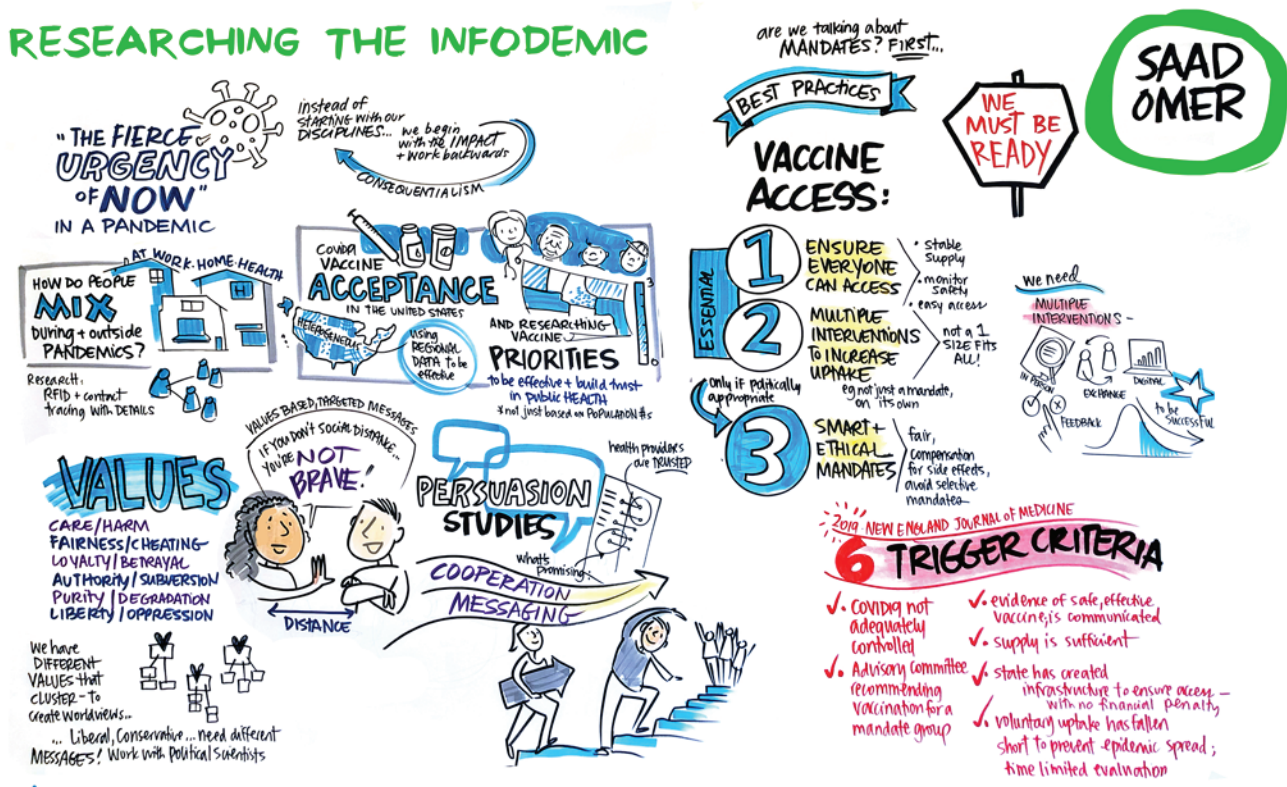
The challenge of a novel pandemic pathogen twinned with an infodemic has not been seen on this scale before, and it demands action-oriented research to inform health programming. The infodemic is a complex issue, in which much more is unknown and evolving than is known. The new research agenda should strengthen scientific understanding of how infodemics impact populations and their health, but also serve as a basis for action and

learning for future action, strengthened through cross-sectoral pilot projects and continuous after-action reviews to build capacity. In addition, a taxonomy of language and ideas is needed to underpin the research effort. Post-COVID-19, our focus will need to shift to strengthening longer-term capacities and advocating for the inclusion of new tools and indicators.

Coordination, connection and integration across disciplines and sectors were persistent themes, and a collegial approach will be essential in order to mitigate the effects of COVID-19 and ensure preparation for future crises. **Developing the field of infodemic management will necessitate a huge level of transdisciplinary synthesis: an interdisciplinary approach on one hand, but at the same time also the creation of a brand new discipline, with different contributions from different fields**. Research will also need to be cross-cultural: infodemics are not globally uniform, and different sociocultural contexts give information completely different implications. For example, satire and humour vary across cultures, and misinformation can be created through cultural misunderstandings.

First WHO Infodemiology conference, scientific conference, 30 June 2020
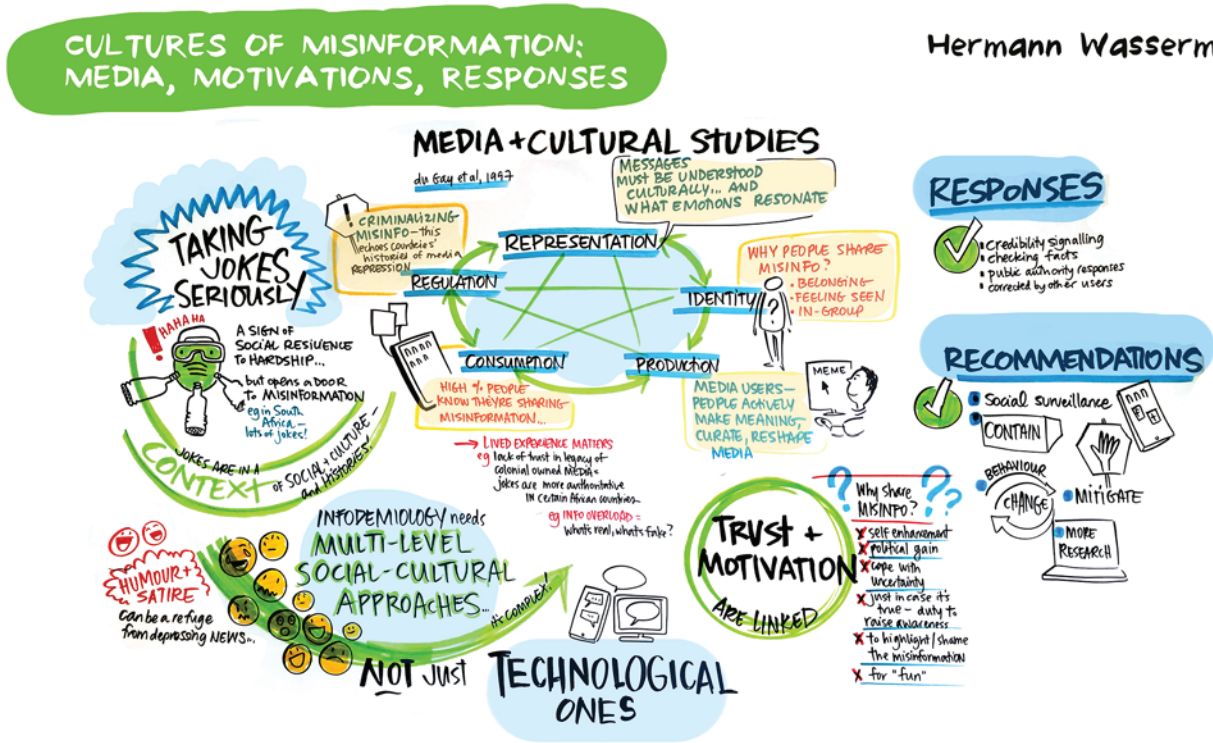
As the new field develops, we will need "to build the plane while we fly it," applying insights from implementation to the evidence base. The issue of connecting practice and research is not trivial. The community built on the back of this meeting must be, and must remain, a community of practice and research that prioritizes questions that inform operations and improve practice today. This means that practice must lead, foregrounding the needs of people in the field and on the ground. The major partners involved in this effort should approach the effort with humility, understanding that sometimes they will lead but at other times should follow, playing always to strengths and comparative advantages.

Maintaining high standards of ethics and transparency helps build credibility and public trust in health programme responses. Measuring the digital and physical information

environments requires ethical strategies for managing user-generated data. Handling social media data, for example, requires a number of stewardship processes related to all aspects of data management including collection, storage, analysis, publishing and reuse. Unlike laboratory data, social media data are generated by users and curated by platforms, and researchers must negotiate the expectations of both to meet high ethical standards for data management. Stewardship is not – and cannot be – a one-size-fits-all framework; the need for (and definition of) privacy varies between users, uses and data types.

Outbreaks of pathogens and misinformation are ultimately local. The relationships between global and local needs will need to be mapped carefully, thinking through the ways in which social trust and cohesion are built outside of crises, using sustained efforts to build that trust as inoculation against the infodemic elements of future crises. A central toolkit of resources is needed that can be delivered to local communities in relevant, meaningful ways. Communities must be identified by their levels of risk and their differing needs for information, working with different groups – young people, faith-based organizations, refugees and displaced people, the business sector, etc. – to understand how existing groups are affected by infodemics, what their information needs are, and how they can play a role in disseminating accurate information and amplifying correct messages. The science that WHO produces should be translated into products that are meaningful and actionable for different groups based on people's contexts and capacities.

Conference outcome: a public health research agenda for infodemic management

Health authorities need to identify and apply the necessary capacity to manage infodemics. This is a programmatic and process issue. Once that capacity is in place, authorities need to adapt, develop, validate and implement tools for infodemic management during acute public health events in ways that are appropriate for their countries and contexts.

For that to be possible, infodemiology must provide a scientific foundation.

As the draft research agenda that emerges from this meeting is refined and consolidated, a number of cross-cutting principles must be rigorously applied to all of its elements in order to reduce the possibility of unintended harm. These principles are:

- Ethical conduct
- Empowerment, through the framing of access to reliable health information as a right
- Prioritizing community-centred and context-appropriate action that promotes resilience to misinformation
- A focus on interventions that can be implemented rapidly in response to acute health events
- Ongoing efforts to strengthen health systems and build trust.

Across all of the different types of input and discussion throughout the conference, a range of distinct points emerged that will need to be factored into the new field.

- **The computational dimension** will be key. An ability to tap into huge amounts and flows of data will make a critical difference, enabling reactions in real time and closing feedback loops; but it will entail some bias, and this will have to be countered.

- **The behavioural dimension** of infodemiology, an exciting space and a current frontier for policy design in general, is central to this new field.

- **The cognitive and emotional dimensions** of infodemiology interact with behavioural concerns, and the points of view of cognitive and social neuroscience may be especially important.

- **The sociocultural dimension** of infodemiology is complicated and hard conclusions are sometimes difficult to find, but tools like social network analyses and anthropological studies are clearly helpful.

- **The communications dimension** is crucial. While we have a certain understanding of what is required, it must be acknowledged that we are yet to establish the necessary expertise and evidence of impact, and new approaches are needed.

Based on these needs and the discussions throughout the conference, a draft framework for a research agenda (see Annex 1) emerged based on five comparative workstreams geared to the different phases in the epi curve of an infodemic. They map onto phases of an epidemic curve, and address the evidence needed for an infodemic response, analogous to an epidemic response.

Research agenda streams supporting tools, methods and interventions during phases of epidemic response along the epidemic curve of an outbreak.
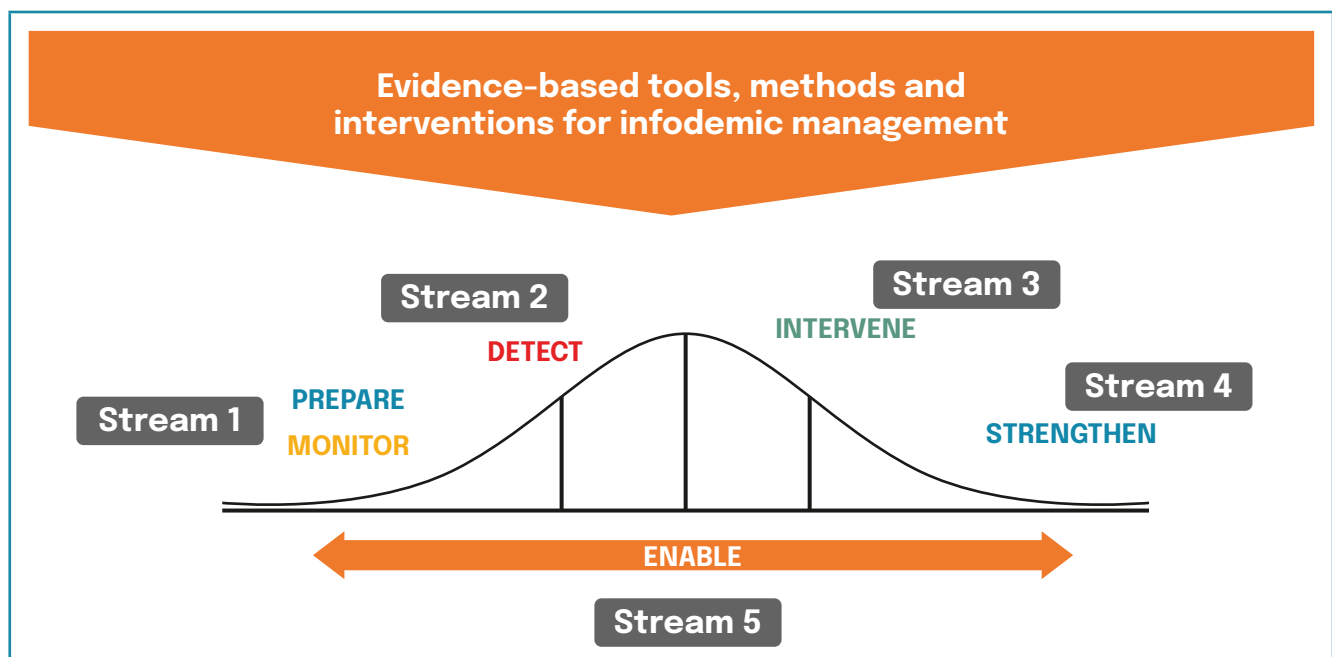
Stream 1: Measure and monitor the impact of infodemics during health emergencies
Standardized metrics and tools are needed to track the evolution of infodemics among individuals, communities, societies and health systems, in both the digital and the physical information environments. This requires multidisciplinary approaches, methods and tools, including those from the fields of artificial intelligence and natural language processing, and the use of structured and unstructured data (including but not limited to "big data" approaches and ethnographic data).

Infodemics do not only propagate in the digital world; they occur both online and offline and can be very harmful to vulnerable unnetworked populations as well. Information flows or behaves differently depending on what kind of network it is in. Standardized metrics and tools can help recognize tipping points for when detailed investigations need to take place.

It is also important to recognize situations where information is absent, because this is where misinformation can gain more traction. Damaging misinformation can manifest especially well in the absence of accurate, credible information from sources that individuals and communities trust. Promoting accurate, actionable information must therefore be seen as a process, not an end state.

Stream 2: Detect and understand the spread and impact of infodemics
A common approach is needed to understand how information and misinformation is spread and how it affects online and offline behaviour in different populations.

Averaging data at national or regional level is not helpful when trying to understand how an infodemic impacts communities and individuals. Communities need not be defined only by physical boundaries. They can also consist of geographically disparate people with shared values, goals or motivations. Information and misinformation are usually shared peer to peer, and every infodemic is in this sense local. A localized contextual understanding of the infodemic is critical for the development of interventions, whether those contexts are geographical or otherwise in nature.

We currently do not know how a person's digital behaviour reflects their offline behaviour. We also have a difficult time tracking misinformation through platforms, and figuring out what and how much of this channel-hopping is relevant to track and understand. Analysis is driven by the data that are available, which creates an abundance of information on some topics and blind spots on others.

Stream 3: Respond and deploy interventions that protect against the infodemic and mitigate its harmful effects
An evidence base is needed to identify interventions that are effective in different contexts and for different types of acute health events.

No epidemiologist uses hunches and anecdotes to drive decision-making that can affect population health. We need to start measuring what we are doing and understanding what works and what does not, and for which populations and types of misinformation. Implementation thinking must be factored into all of our infodemic management activities, otherwise we risk doing harm by detaching research from what health authorities need in order to respond.

Stream 4: Evaluate infodemic interventions and strengthen the resilience of individuals and communities to infodemics

Common evaluation frames are needed to improve the development of interventions and programmatic responses to infodemics.

The only way we can flatten the epi curve is for people to change their individual behaviour. This includes accepting the uptake of a COVID-19 vaccine. It is not sufficient simply to provide more and more information and hope that this changes behaviour. People will often interpret information based on their culture, past experiences and environment. Empathy is therefore needed to develop interventions based on the needs of individuals and communities – and ideally developed in collaboration with them. Top-down communication approaches will not be sufficient. We need individuals and influencers who are trusted and who represent values that communities accept and listen to. That takes time and consistent engagement. Building these relationships cannot happen in the midst of an outbreak, or at least not as effectively.

Stream 5: Promote the development, adaptation and application of tools for the management of infodemics

There is a need to enhance the transferability of lessons and evidence-based interventions between contexts, countries and infodemics.

Although every country has experienced some degree of the infodemic related to COVID-19, this conference made obvious the need for a multidisciplinary approach to address infodemics in specific contexts. Readiness assessment tools are needed to allow strategic oversight of local capacities and environments so that tools and interventions can be adapted accordingly. Different communities display variations in levels of literacy and education, relationships with technology and patterns in using it, levels of internet penetration and cost of access, and the ability to assess information critically. We cannot therefore copy the same intervention into different countries and hope that it will always work in the same way.

Framework of the public health research agenda for infodemic management

Stream 1: Measure and monitor the impact of infodemics during health emergencies

1.1. Standardize taxonomies and classifications
1.2. Develop new metrics to measure and quantify infodemics
1.3. Analyse and triangulate data from multiple sources
1.4. Improve evaluation approaches for infodemic interventions.

Stream 2: Detect and understand the spread and impact of infodemics

2.1. Understand how information originates, evolves and spreads on different platforms and channels
2.2. Assess the role of actors, influencers, platforms and channels
2.3. Understand how misinformation affects behaviour in different populations
2.4. Develop regulatory and ethical principles to mitigate the spread and propagation of harmful health information.

Stream 3: Respond and deploy interventions that protect against the infodemic and mitigate its harmful effects

> 3.1 Design a behavioural change model applicable to infodemic management
>
> 3.2. Intervention design for different levels of action to mitigate the infodemics.

Stream 4: Evaluate infodemic interventions and strengthen the resilience of individuals and communities to infodemics

> 4.1. Develop interventions that address individual, community, cultural and societal factors affecting trust and resilience to misinformation
>
> 4.2. Understand and learn from the way misinformation has affected behaviour among different populations and in different contexts for specific infodemics
>
> 4.3. Identify factors associated with successful infodemic management by health authorities, the media, civil society, the private sector and other stakeholders.

Stream 5: Promote the development, adaptation and application of tools for managing infodemics

> 5.1. Use implementation research evidence in programme improvement and policy development
>
> 5.2. Promote evidence-based interventions and approaches between countries
>
> 5.3. Improve effectiveness and response times to the infodemic during acute health events.

We can use workstream 2 as an example of how this research agenda might be applied in research and practice. Area 2.1 is work to "understand how information originates, evolves and spreads on different platforms and channels." Questions to consider in this regard might include how the sharing of misinformation is encouraged by factors in the information environment, information tools, and platform design; how misinformation evolves when it crosses borders or platforms; why some misinformation remains confined to particular platforms or communities, while other misinformation crosses platforms/channels/community boundaries; and when and how rumours become misinformation. Types of approaches and research questions might include synthesis, the development of an evidence base, and implementation and programmatic evaluation.

The next steps will be to develop reviews of evidence in each of the five workstreams; to develop a community of research and practice to foster connections, build repositories of tools and resources, and track implementation of the agenda; and – finally and crucially – to build a competencies framework for an infodemiology skillset and develop related online training tools.

Next steps

The public health research agenda for infodemic management can be used by WHO, partners, research agencies and academia as a reference in identifying key research and evidence gaps to underpin infodemic management interventions and their evaluation. As such, the agenda is a list of research priorities that can frame the work of the community of research and practice, evidence synthesis reviews in each of the five streams, tracking of the agenda's implementation, and development of repositories of tools, resources, and training curricula and frameworks.

WHO will work with collaborators to conduct reviews annually to identify which research questions are being addressed to further evidence synthesis in the five research streams and therefore to track the research agenda implementation. As the agenda is implemented, WHO will propose additional processes for further revision or the addition of research questions to continue working with the research and practitioner community to drive the research agenda.

Annex 1: Public health research agenda for infodemic management

The conference resulted in the creation of a research agenda with five streams. To focus research and prioritize investment, experts were further consulted in two phases after the conference so that they could submit and prioritize specific research questions to refine the agenda and further the understanding of infodemics and infodemic management[15]. The main target audience for these research questions is researchers and practitioners. They will also be of interest to public health experts, NGOs, the media and other stakeholders.

In the first phase, experts were contacted in a follow-up survey after the conference and asked to submit three to five research questions each. They were asked to devise questions that were relevant to the topic, answerable in the short or medium term, ideally capable of producing knowledge that could be put to use in the short or medium term, and focused in scope (i.e. an answer to the research question could be provided in a single academic paper). Experts were asked to focus on scientific feasibility and expected public health benefit.

To improve the reach beyond the pool of conference participants, each expert could invite up to two additional experts, based on their expertise and the value of their potential contribution. To maximize transparency in the categorization, experts could themselves choose under which subcategory to submit a research question. To identify potential gaps in the overall research agenda, the survey included open-ended questions.

At the end of the first phase, over 160 research questions had been submitted, distributed across all five research streams and all 19 subcategories. The output of this phase was a list of research questions on infodemic management.

In the second phase, the 160 submitted questions were reviewed and combined to identify repetition and suggestions that that were not formulated as research questions were eliminated. This resulted in a final list of 65 questions. Experts were asked in a separate survey to rank the 65 research questions based on two dimensions. The following methodology was used for the prioritization by asking about the public health impact of each proposed research question: could this research lead individuals or communities to take healthy actions or help to understand why and how they don't take healthy actions? Research questions that could lead to meaningful change or adaptation of behaviours would be considered more impactful. Experts were asked to rate this question on a 5-point Likert scale (1 = very low impact, 2 = minor impact, 3 = moderate impact, 4 = high impact, 5 = very high impact). Feasibility was assessed by answering the question: can you think of a research project that would answer this specific question in about # months? The faster the research project could be initiated and generate results was considered to be more feasible and useful for the COVID-19 pandemic response. Experts were asked to rate this question on a 5-point Likert scale (1 = 3 months, 2 = 6 months, 3 = 12 months, 4 = 18 months, 5 = 24+ months). A research question was considered to be high priority when scored above 3 on impact and under 3 on feasibility.

---

15 A systematic approach for undertaking a research priority-setting exercise: guidance for WHO staff. Geneva: World Health Organization; 2020. (https://apps.who.int/iris/handle/10665/334408, accessed 20 January 2021).

The questions to rank were more or less evenly distributed, with at least 10 questions included for ranking in each of the five research streams. Due to potential survey fatigue, and to avoid systematic absence in the rankings (i.e. due to respondents ranking only the first few questions within each stream), the order of the research questions to rank was randomized within each research stream.

The resulting public health research agenda for infodemic management will be maintained on the WHO website as a living document and its implementation and priorities will be reviewed and adjusted on a regular basis.

In addition to the prioritized public health research agenda, other research questions that were not identified as a high priority in the short term will also be published on the WHO website alongside the agenda. These can be used to map gaps on the topic.

The five research streams are listed below. For each stream, three top research questions were identified, resulting in a list of 15 top priority research questions for the public health research agenda for infodemic management. Further, we listed for each subcategory a second tier of important research questions, totalling 50 questions.

Top three prioritized research questions overall across all five streams:

1. What are the ways to score health-related misinformation in regards to its potential for harm (to people's health, unhealthy behaviours, social cohesion, mistrust in health service delivery, mistrust in government, mistrust in communities, mistrust in the media, etc.)?

2. How do different types of health misinformation affect online and offline behaviour and what are some of the measures that can help to forecast the impact of health misinformation types on behaviour?

3. What would a readiness assessment look like for infodemic preparedness for a new COVID-19 health intervention?

Research stream 1: Measure and monitor the impact of infodemics during health emergencies

> *Standardized metrics and tools are needed to track the evolution of infodemics in the digital-physical information environment, between individuals, communities, society and the health system, using multidisciplinary approaches, including methods and approaches from artificial intelligence, natural language processing, and using structured and unstructured data (big data, ethnographic data, and similar).*

Top three questions within this stream:

• What are the ways to score health-related misinformation in regards to its potential for harm (to people's health, unhealthy behaviours, social cohesion, mistrust in health service delivery, mistrust in government, mistrust in communities, mistrust in the media, etc.)?

- How do the infodemic curve and measures of spread and impact change over time during the phases of a disease outbreak?
- What are the potential indicators or their proxies for measuring trust, resilience, behaviour change, exposure to misinformation, susceptibility to misinformation, social cohesion, depth of community engagement, and similar?

1.1 Standardize taxonomies and classifications

- What are the classes of health-related misinformation and disinformation that can be used for standardized research analysis?
- What reference datasets and algorithms are needed to establish standardized measures of an infodemic?
- How can we compare infodemics and the way they manifest in different countries to detect and understand patterns?

1.2 Develop new metrics to measure and quantify infodemics

- What are the ways to score health-related misinformation in regards to its potential for harm (to people's health, unhealthy behaviours, social cohesion, mistrust in health service delivery, mistrust in government, mistrust in communities, mistrust in the media, etc.)?
- What social network analysis principles are most relevant to generating rapid insights for use in routine and acute emergencies to inform the public health response?
- What attributes contribute to high self-efficacy in individuals to identify and address misinformation effectively?
- What methods from computational science, digital analytics and other fields are applicable to infodemic monitoring?

1.3 Analyse and triangulate data from multiple sources

- How are the epidemic curve and infodemic impacts related?
- How do the infodemic curve and measures of spread and impact change over time during the phases of a disease outbreak?
- What standards, methods and approaches can be used to co-analyse different data types from disparate data sources related to use in infodemic management?

1.4 Improve evaluation approaches for infodemic interventions

- What are the potential indicators or their proxies for measuring trust, resilience, behaviour change, exposure to misinformation, susceptibility to misinformation, social cohesion, depth of community engagement, and similar?
- What role does participatory evaluation play in infodemic intervention implementation?

Research stream 2: Detect and understand the spread and impact of infodemics

> *A common approach is needed to understand how an overabundance of information and misinformation is spread and how it affects online and offline behaviour in different populations.*

Top three questions within this stream:

- How does misinformation mutate, adapt or get remixed between infodemics and within infodemics?
- What are the strategies used to reduce misinformation's potential harmfulness in closed networks (online and offline)?
- How do different types of health misinformation affect online and offline behaviour and what are some of the measures that could help to forecast the impact of health misinformation types on behaviour?

2.1 Understand how information originates, evolves and spreads on different platforms and channels

- What are the attributes and drivers within the information environment, communication tools, and platform design that encourage the sharing of misinformation?
- How does misinformation mutate, adapt or get remixed between infodemics and within infodemics?
- What are the elements for classifying content for its potential for amplification and organic spread online?
- What are the attributes that promote faster spread of misinformation across platforms/ channels/community boundaries?

2.2 Assess the role of actors (influencers), platforms and channels

- What are strategies that could be used on online communication platforms to reduce the spread of misinformation online?
- What are the best practices for engaging with influencers to address misinformation with unique and tailored content that has high potential to be amplified further?
- What are the strategies used to reduce misinformation's potential harmfulness in closed networks (online and offline)?
- What role do advocates, fence-sitters, lurkers/observers and opponents of accurate information play in the spread of misinformation?
- How do analysis and intervention options differ between health disinformation and health misinformation?

2.3 Understand how misinformation affects behaviour in different populations

- How does misinformation spread and affect marginalized, vulnerable and at-risk populations?

- How can health-related concerns be used or weaponized to target specific groups of people with disinformation and threaten health security and social cohesion?
- How do different types of health misinformation affect online and offline behaviour and what are some of the measures that can help to forecast the impact of health misinformation types on behaviour?

2.4 Develop regulatory and ethical principles to mitigate the spread and propagation of harmful health information

- What policies or policy tools are available to health authorities that balance the need between propagating accurate information, curbing misinformation, and ensuring human rights of access to information?

Research stream 3: Respond and deploy interventions that protect against the infodemic and mitigate its harmful effects

An evidence base is needed to identify interventions that are effective in different contexts, populations, cultures, and for different types of acute health events.

Top three questions within this stream:

- What behavioural or process models can inform the development of an infodemic strategy and measure its impact at individual, community, platform or society levels?
- What are promising interventions at the societal/community/individual/health systems level to address and mitigate health misinformation?
- What types of participatory or human-centred design approaches can be used to produce more tailored and more effective infodemic management interventions?

3.1 Design a behavioural change model applicable to infodemic management

- What behavioural or process models can inform the development of an infodemic strategy and measure its impact at individual, community, platform or society level?

3.2 Intervention design for different levels of action to mitigate the infodemics

- What are promising interventions at the societal/community/individual/health systems level to address and mitigate health misinformation?
- What types of participatory or human-centred design approaches can be used to produce more tailored and more effective infodemic management interventions?
- What types of infodemic management interventions are most appropriate to deploy rapidly in acute health events or emergencies?
- What are the attributes of interventions that are effective across different contexts, populations, cultures, and for different types of acute health events?

- What are the considerations for designing infodemic management interventions when balancing promoting access to accurate health information and protecting freedom of expression?

Research stream 4: Evaluate infodemic interventions and strengthen the resilience of individuals and communities to infodemics

Common evaluation frames are needed to improve intervention development and a programmatic response to infodemics.

Top three questions within this stream:

- How might we define and measure the gradient of community engagement, trust and empowerment at individual and community level as they relate to infodemic management and reduction of harm from health misinformation?
- What are the socio-behavioural and mental heuristics that need to be considered when developing an intervention at individual and community level?
- What are the "best-buy interventions" to be used by different types of actors in society, to maximize the impact on the infodemic at lower marginal cost?

4.1 Development of interventions that address individual, community, cultural and societal factors affecting trust and resilience to misinformation

- How might we define and measure resilience to misinformation at individual and community level?
- How might we define and measure the gradient of community engagement, trust and empowerment at individual and community level as they relate to infodemic management and reduction of harm from health misinformation?
- What are the socio-behavioural and mental heuristics that need to be considered when developing an intervention at individual and community level?
- What role does social inoculation play in developing resilience to misinformation in the context of an infodemic?
- What principles from social marketing can be leveraged to build demand for accurate health information at individual and community level?

4.2 Understand and learn from how misinformation has affected behaviour in different populations and contexts for specific infodemics

- What are the lessons learned from infectious diseases such as Ebola, Zika, and polio on how to effectively combat misinformation at community level that also apply to COVID-19?
- What are the lessons learned on information environments and misinformation spread related to noncommunicable diseases and risk factors such as cancer and smoking?

4.3 Identify factors associated with successful infodemic management by health authorities, the media, civil society, the private sector and other stakeholders

- What are the roles, responsibilities, and possible spheres of influence on the infodemic by different types of actors in society?

- What are the "best-buy interventions" to be used by different types of actors in society, to maximize the impact on the infodemic at lower marginal cost?

- What are the factors of success for collaboration between health authorities and fact-checking organizations/media, civil society, and the private sector?

Research stream 5: Promote the development, adaptation and application of tools for managing infodemics

> *There is a need to enhance transferability of lessons learned and evidence-based interventions between contexts, countries and infodemics.*

Top three questions within this stream:

- What considerations should be included in the assessment of risk, harms and opportunities during the design and implementation of research and infodemic management interventions?

- What would a readiness assessment look like for infodemic preparedness for a new COVID-19 health intervention?

- What recommendations can be made to update the International Health Regulations to incorporate infodemic management more strongly as a core capacity in Member States?

5.1 Using implementation research evidence in programme improvement and policy development

- What considerations should be included in the assessment of risk, harms and opportunities during the design and implementation of research and infodemic management interventions?

- How can we ensure that infodemic management research and interventions are not misused for non-public health purposes?

- How can we ensure that infodemic management research and interventions do not cause unintended harm or are misused to purposefully cause harm?

5.2 Promote evidence-based interventions and approaches between countries

- What would a readiness assessment look like for infodemic preparedness for a new COVID-19 health intervention?

- What types of infodemic management interventions are more transferrable across countries, populations and health events.

5.3 Improve response times and the effectiveness of responses to infodemics during acute health events

- What standardized capacities should health authorities have to address an infodemic concurrent with a disease outbreak?

- What would a severity grading look like for rating infodemic threats and potential appropriate response options?

- What recommendations can be made to update the International Health Regulations to incorporate infodemic management more strongly as a core capacity in Member States?

Other questions that were considered in the prioritization exercise

- How can artificial intelligence and machine learning help in exploiting multi-source or other data?

- How can metrics provide evidence of impact at multiple levels (institutional, societal and community, individual attitudes, individual behaviour)?

- How can measurement and evaluation frameworks employed by communicators be applied for measuring and monitoring the spread of misinformation in epidemics?

- What would a taxonomy for mis-/disinformation and rumours look like for different public health emergencies and based on previous experience?

- What are the distinctive and objective indicators that characterize an infodemic? What datasets can be used?

- What are the lessons learned from past infodemics that can be applied to this one?

- Which are the predominant themes around which information/misinformation spread the fastest during outbreaks?

- How is the concept of infodemic understood by epistemic communities – local authorities and policy-makers, researchers, clinicians, media? Especially in low- and middle-income countries.

- What is the measurable threshold after which an outbreak of dis-/misinformation becomes an infodemic at the policy level? How can it be measured?

- How can what constitutes harmful health information be characterized clearly and systematically, i.e. information with harmful consequences?

- How can the impact of COVID-19-related misinformation be monitored in low- and middle-income countries? Which media should be looked at, using what tools?

- Which populations are more susceptible and exposed to infodemics?

- What are the pathways and influences through which rumours and misinformation reach those who are not digitally connected?

- How do national and regional contexts related to the determinants of health impact the uptake of health information or disinformation?

- How to measure the link between the spread of online health misinformation and negative behavioural outcomes (from a health perspective)?

- How should the available data be used for infodemic surveillance and early alert?

- What measurement and evaluation tools can be developed for offline information flows? What would a holistic whole-of-communication evaluation system (online and offline) for infodemic management look like? How can different interventions be evaluated?

- How can automated methods involving machine learning and artificial intelligence be used for pattern recognition and alerting?

- How do rumours spread across countries in a region?

- To what extent does misinformation relating to specific therapeutics result in adverse health impacts?

- How to assess which misinformation is most important to address, i.e. which misinformation is more likely to adversely impact individual health behaviour?

- What type of information contributes to an infodemic? Are there any differences between human-generated and machine-generated content?

- What are possible sources from which to gather evidence in a timely manner?

- What are the most feasible applications of artificial intelligence (and machine/reinforcement learning techniques) to detect the origins and transmission vectors of mis/disinformation on selected social media platforms?

- What are the relationships between individual characteristics (e.g. socioeconomic, trust in institutions, etc.), information consumption patterns and health-related behaviour?

- What measurable factors should be used to determine the threshold for deciding if an intervention's benefits and cost-effectiveness outweigh any potential harm and unintended amplification?

- What post-event analysis methodology/framework can be applied to understand and track how the infodemic originated and spread?

- To what extent do people change their behaviour based on misinformation?

- How does misinformation from different platforms, media, or channels foster behaviour change?

- What are the linkages of misinformation with drivers for behaviour and social change?

- What existing vulnerabilities (international, national, local) and narratives can be exploited by malicious actors in disinformation campaigns in the context of epidemics?

- How does media literacy mediate the adverse health impacts of misinformation? What are the policy implications?

- How can automated, anonymized methodologies (e.g. machine learning) help to overcome the privacy risks associated with infodemic surveillance?

- What kind of change in online information sharing can limit the spread of harmful health information? What is the most effective way to prevent the spread of harmful health information when regulating in different contexts?

- How can media literacy campaigns be designed to be more responsive to specific social settings?

- How should health systems prepare for prevention, monitoring, early warning and risk assessment of an infodemic?

- To what extent are migrant populations (immigrants, refugees, asylum seekers, labour migrants, international students), in particular those irregular migrants within a country, affected by infodemics? To what extent do infodemics permeate within the ecosystems of how migrant communities access information on public health measures?

- How can health system assets be used to counter the impact of dissemination of misinformation/disinformation on different public health programmes?

- How can community expertise and community organizations be harnessed to develop contextually relevant interventions?

- Which models, theories or methodologies can infodemic management research borrow from health literacy research?

- How can techniques such as "nudge" messaging or random mixing of narratives from opposing camps help to overcome the escalation or entrenchment of harmful belief systems, as seen in existing social media "filter bubbles"?

- How are infodemics associated with the mode of information accessed, understood and spread among different age groups?

- What are the best forms of public engagement for alerting citizens to the psychological influence of harmful online messaging and supporting critical evaluation?

- How can a set of common requirements for public health agencies, health care providers and related institutions be built to support a more effective response to misinformation during pandemics?

- Does access to universal health coverage act as a lever for greater trust in public health institutions? Does it act as a means of infodemic resilience?

- How do pandemic conspiracy theories spread in different cultures and geopolitical settings?

- What are the long-term effects of interventions against misinformation on the behaviour of individuals and communities?

- How can health organizations and communicators (e.g. chief medical officers) strengthen their credibility?

- What policy interventions are relevant to infodemic management? Why?

- What are the effects of interventions to identify, prioritize, reduce the spread, and mitigate the misinformation consequences?

- What knowledge, skills and tools contribute to strengthen the resilience of individuals and 'inoculate' them against misinformation and disinformation? How can public health organizations, the media and the education sector contribute to strengthen that resilience?

- How is individual behaviour affected by changing information content or transmission mode?

- What would be examples of diffusion of health information of various gradients of quality and harmful impacts that can be used to build a knowledge base for infodemic management training of health and communication professionals?

- How can infodemic management be better coordinated between different levels of government, and what is the comparative advantage at each level?

- To what extent have Member States included strategies on addressing/managing the impact of misinformation during a pandemic within their national pandemic preparedness and response plans?

- How can a real-time data collection tool be developed to improve the effectiveness and timeliness of response to infodemics?

- Which actors should be considered as the "initiator" for building infodemiology capacity in a country (i.e. academia, Ministry of Health)? Why?

- What rapid alert/indications and warning system on infodemics should be in place? What organizations should take part in it?
- How can interventions be designed to be more responsive to specific geographical factors (including sociocultural, political and historical)?
- How and with which tools can the extent and the threat of infodemics be measured within and across borders, with reliable and validated instruments?
- Which Member States are comparable regarding their information structure and information behaviour?
- How can innovative techniques such as crowdsourcing and artificial intelligence pattern-detection methods be harnessed to identify the early warning signs of infodemics?
- How can schools and higher education institutions be further empowered in addressing critical thinking and knowledge of scientific thinking?
- What can be learned from a comprehensive meta-analysis of research focused on aspects relevant to infodemic management?
- What is the estimated impact of misinformation on policy, with examples?

Annex 2: Summary of discussions in working groups

Topic 1: How to measure and monitor digital and physical information environments

Topic leaders: **Neil Johnson**, *George Washington University, USA;* **Anatoliy Gruzd**, *Ryerson University, Canada*
Supported by: **Elisabeth Wilhelm**, *US CDC;* **Tina Purnat**, *WHO;* **Dylan Johnson Restrepo**, *Volunteer*

First WHO Infodemiology conference, scientific conference, 30 June 2020
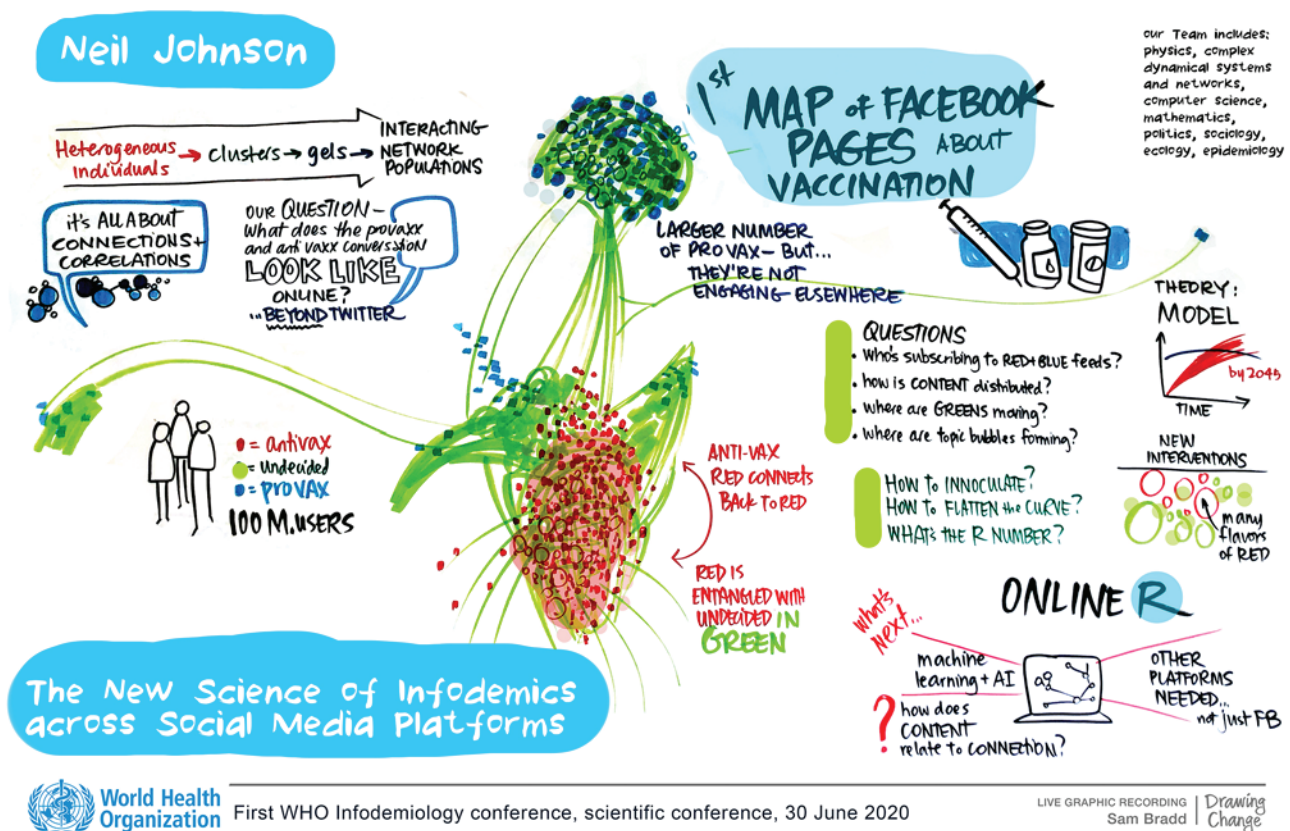
Four major themes emerged in discussion of this topic.

The possibility of reproducible patterns and cross-disciplinary metrics for a science of infodemiology. It is difficult to produce generalizable or comparable results from social media data because: (a) access to full datasets from social media is rare; (b) these datasets do not represent the engagement of all populations anyway; and (c) metrics vary from platform to platform.

Mathematical modelling, like epidemiological modelling, does not necessarily take human behaviour into account, which can limit its efficacy for predicting future human behaviour and impact on an outbreak. But modelling can help develop hypotheses for how information/ infection flows and how networks might respond; and interventions can be designed to test them.

There are limits to applying epidemiological techniques as a way to monitor and measure spread, especially if we assume that the units we are working with are pieces of information and not pathogens: in biology, pathogens infect opportunistically; they do not have an agenda. Disentangling the differences between rumours, misinformation and disinformation requires a common taxonomy to classify information and label it as more or less harmful. Such an approach could inform identification of "tipping points," or points at which action needs to be taken to address more harmful misinformation and offer more tailored and effective responses.

The need for a balance between a system-level understanding which washes over details, and a case-study understanding which captures details but may miss the bigger picture. There is an ocean of social and behavioural and health data available to us, but it is necessary to determine more clearly which data sources and types of analyses would improve an infodemic response. It remains difficult to determine what degree of detail is needed to understand the infodemic while still balancing the privacy and ethical concerns of users whose data are being collected and analysed. In the midst of a pandemic, speed is of the essence, and balancing rapid data collection and analysis methods with a desire for rigour may mean prioritizing specific kinds of data for short-term operational use versus longer-term use and longitudinal trend analysis. Understanding diffusion of information through certain networks – for example, encrypted networks and fully offline communities – will require other data collection approaches.

The issue of COVID-19 vaccines and upcoming vaccine candidates, and what is and will be said on social media. Long before the first COVID-19 vaccine was available to the public, related anti-vaccine misinformation had begun to circulate. In order for the pandemic to end, a vaccine or some other treatment will be needed, in addition to individual behaviour change, to stop the spread. People should seek out vaccination and demand for it needs to be high. Misinformation, online and elsewhere, that seeks to undermine trust in governments, health authorities, health staff and vaccines, endangers vaccine acceptance and will prolong or worsen the pandemic. Identifying promising approaches to address this aspect of the infodemic is an urgent task, but a one-size-fits-all solution is unlikely to work. There are multiple vaccine candidates and more are in the pipeline with varying safety and efficacy profiles. Some populations will initially be prioritized to receive the vaccine, and it will become a politicized issue – indeed, in some countries it already is. Social listening can be used to understand public sentiment towards the vaccine; to analyse how online groups that may have been previously spreading anti-vaccine views around routine immunization are repurposed to focus on the COVID-19 vaccine; to identify influencers; and to identify behavioural or social interventions that can promote the spread of accurate information about the COVID-19 vaccine development and implementation process.

The extent to which offline behaviour is influenced by online behaviour and vice versa. There is limited research on how exposure to information or misinformation affects behaviour, because behavioural processes can be complex. In the midst of a crisis, people may use cognitive shortcuts: that is to say, when under pressure, people may rely on the first or loudest information they hear and may become less adept at processing more complex information. When misinformation is easy to spread, this can create a harmful mixture. Anecdotal evidence suggests that people can exhibit negative health behaviours because of misinformation they heard during the COVID-19 outbreak, but responding properly will require better measures of the way knowledge connects to intent and behaviour, both online and offline. For example, does increased exposure to misinformation make it more likely that someone will exhibit

behaviours detrimental to their health? Further research is needed, as are consolidated and validated indicators that predict behaviours, or which serve as proxies for specific behaviours.

Research recommendations:
1. There is a need to categorize the spread of information and misinformation through an information taxonomy organized by content, audience, etc.
2. There is an urgent need to establish how best to prepare for the online infodemic concerning future COVID-19 vaccines
3. We all need to engage immediately across disciplines, and not return to work as usual in our own fields and silos.

Topic 2: How information originates and spreads

Topic leaders: **Anis Azlan**, *Universiti Kebangsaan Malaysia, Malaysia;* **Masato Kajimoto**, *University of Hong Kong, China*
Supported by: **Atsu Ishizumi**, *US CDC;* **Saad Uakkas**, *Volunteer*

Diagnostics. "Diagnostics" in this context refers to the processes through which we characterize mis- and disinformation. This includes the identification of its features and dimensionality, and how these can be categorized with reference to the agents involved and the harmful effects that result from exposure to mis- and disinformation. It is also important to acknowledge that the characteristics of this information can mutate and merge rapidly, and thus may be difficult to classify.

Tracking. Discussions emphasized the importance of tracking the trajectories of infodemics through surveillance and other interdisciplinary methods. Mapping exposure and consumption patterns may allow us to predict how different types of mis- and disinformation can spread. Tracking of online (and other) information does raise concerns about data availability, the ethics of data collection, and privacy. Policy, control and governance in an infodemic response will have implications for freedom of expression, and these issues need to be considered from the start.

Human factors. There is a need to deepen our understanding of different human factors that make individuals and communities more susceptible to mis- and disinformation – for example, individual motivations, emotions, trust, social norms, values and beliefs. Better understanding of these factors may allow us to identify the individuals and communities that are not only more vulnerable in terms of acting harmfully on the basis of the information they receive, but which may also be more likely to spread bad information to others. Identifying these groups can help us to understand the underlying factors influencing the creation and spread of mis- and disinformation, and plan better interventions.

Measurement. It will be necessary to design measuring methods and instruments to assess the velocity and volume of infodemic spread; detect exposure; predict the type and scale of impact; and evaluate other identifiable characteristics of each outbreak of harmful information. This will facilitate triage and the allocation of resources for response.

Concerns. Responses and countermeasures must be grounded in methodologically solid findings – although, given the time pressure of the current infodemic, the feasibility of devising effective measuring systems in a short period of time has been questioned. Participants also raised a range of concerns around the practicality of several of the approaches discussed given the complexity of infodemics, the timescale of the response, and the diversity of contexts in which research must be conducted – for example, the complexity of building simulation models of infodemics supplemented by ethnographic fieldwork.

Research recommendations:
1. Infodemiology researchers should consider prioritizing a number of small-scale action research projects that would have pragmatic implications in the field. Such research could involve trials in at-risk communities designed to find effective ways to track spread and analyse human factors. Collaboration between academic researchers and practitioners on the ground will be essential in order to design and conduct practical, useful, action-based research.

2. Drawing on the insights gained from this action research, experimental intervention strategies can be designed, with controls. The goals of this phase would include measuring factors that contribute to behavioural and environmental changes. This type of research is experimental in nature, because infodemics are so highly contextual on so many levels – for example, capacity-building training among frontline health care workers as a form of intervention strategy could be effective in one community but not in another.

3. Finally, echoing the recommendations that emerged from Topic 1, participants suggested establishing an international interdisciplinary taskforce to create a taxonomy of infodemiology beyond the glossary work. This project would set out to catalogue every aspect of different strains of information, agents, actors, impacts and any other infodemic-relevant criteria as completely as possible, potentially with case studies of real events.

Topic 3: How information affects and impacts individuals and populations

Topic masters: **Julienne Anoko**, *WHO;* **Judit Bayer**, *Budapest Business School, Hungary*
Supported by: **Margaux Mathis**, *WHO;* **Vicky Houssiere**, *WHO*

Communication. The reception of information content and subsequent behaviours affected by that information are the product of social constructs influenced by social structures (friends, family, formal and informal influencers, etc.), age, gender, history, education, personality, political polarization and other factors.

- Science journalists have important roles to play in bridging the gaps between scientists, science and the general public, and thereby building resilience against bad information.

- Counter-communication interventions should be designed and implemented in the form of easily accessible information, along with other cultural products such as fiction and drama, which can model conflict situations and bring about values and positive behaviour patterns.

- The ambiguous role of social media companies was discussed extensively. Without strong incentives, social media platforms tend to be uninterested in self-regulation, because sensational content generates income. Incentives should be designed, and implemented through regulatory policy, to make companies interested in taking social responsibility and fighting infodemics within their means, and particularly by prioritizing corrective action, ensuring transparency, and implementing other best practices.

- Education is also crucial in fighting infodemics. Curricula should be bolstered to foster slow thinking, the development of scepticism and critical thinking, and the ability to recognize trustworthy sources (i.e. information literacy). Beyond these skills, basic knowledge of scientific rules should be taught to everyone, to prepare them to recognize true and false scientific arguments.

- Governments can use legislation to shape the information environment and to protect the population from misleading and deceptive communications. This research agenda is needed to better understand the information ecosystem and how information (good and bad) spreads and how it affects people's behaviour, and how the impact of any policy action (legislation) can be measured. The implementation of the research agenda will provide a basis for development of evidence to inform such policies and to evaluate their impacts.

Community. Trust is a key element in building resilient communities: there is a need to establish and maintain trustworthy information sources. Research is required to identify the best such sources and ensure easy and equal access to them, and to increase understanding of how people navigate through information and recognize their own trusted sources.

- Discussions also highlighted the urgent need to empower communities to build their own resilience to bad information. Interventions should be constructed in partnership with those communities, which would be possible through greater efforts to understand the contexts in which infodemics occur and spread. Community engagement goes along with building self-efficacy and self-capability within those communities, which can be achieved through practice. Community engagement should focus on the middle ground – not the shrill voices at the extremes of the big arguments, but the majority of "silent lurkers" who may not yet have formed strong opinions.

- Along with individuals, communities and states, market actors should be regarded as factors in infodemics; they can be active vectors or targets of campaigns and are influential members of communities.

Research. To facilitate collaborative, effective research in this area, some concepts and terms need to be more clearly defined and/or better and more commonly understood. These include "social networks," "social media platforms," "social listening," "group identities/ context," "community engagement," "empowerment," "self-efficacy," "self-capability," "preparedness," "trusted sources and channels of information," "inclusiveness," "dynamics," "behavioural change" and "language issues." Whatever the methods used, important principles for infodemic management should include the use of bottom-up approaches grounded in people's lived realities; the use of innovative and creative approaches; precautionary principles; ethics; and investment to fund and build capabilities and expertise.

- To boost scientific cooperation, a shared database should be built from the references of existing research, connecting relevant disciplines including communication sciences, social science, behavioural and cognitive psychology, data science and others. This should include a repository of relevant surveys conducted in different countries.

- Measuring people's vulnerability and resilience to infodemics could be done in a number of ways. We already know that susceptibility and levels of resistance to debunking are influenced by cognitive factors and worldview. Possible approaches and tools to add detail to that basic understanding include: surveys; social listening; after-action reviews; compiling lessons and benchmarks; the use of the integrated evaluation framework devised by AMEC (the international association for the measurement and value of communication) to quantify the real-world effects of communications work; observational studies; focus groups; interviews; diary-keeping; and deliberative workshops. Quantitative and qualitative information surveillance methods should be used over time to deepen understanding of macro, micro and local nuances.

Research recommendations:
1. Develop an inclusive and sustainable model of science communication
2. Explore and test the capabilities and levels of understanding of individuals using a comparative approach based on social groups, in order to help design appropriate communication methods
3. Design research to understand the contexts in which infodemics originate and spread.

Topic 4. What interventions work to protect against mis- and disinformation?

*Topic masters: **Emily Vraga**, University of Minnesota; **Sara Rubinelli**, University of Lucerne
Supported by: **Aybuke Koyuncu**, US CDC; **Jamie Guth**, WHO*

The vast amount of uncertainty around a new phenomenon such as COVID-19 results in information voids that provide opportunities for mis- and disinformation to spread and seed distrust in public institutions. Proactive sharing of high-quality information can help to build public trust and encourage sustained partnerships with information platforms.

Infodemic management is needed as part of an operating structure that is in place and tested before crisis situations develop. Having established teams in many relevant organizations will facilitate a coordinated – rather than piecemeal – response to misinformation.

While participants highlighted many relevant theories from different fields including brand, risk, and health communication, a more practical understanding is needed of how these theories apply to infodemiology given the unique demands and constraints of the field.

Any intervention in a democratic society has to consider issues and sensitivities around freedom of speech and should avoid censorship. Recognition of the possible unanticipated consequences of interventions, including the potential for them to be co-opted, is essential.

Research recommendations:

1. **Test critical thinking and literacy theory (e.g. around health literacy, information literacy, digital literacy and news literacy) as interventions to address infodemics**
   Health literacy is a major topic in health communication research and practice. It includes critical literacy as the ability to evaluate and apply health information and is considered a major asset in managing an infodemic. Likewise, information, news, digital, and media literacy all speak to the necessary ability to distinguish high- from low-quality information, especially online. Although research into each type of literacy has developed in isolation, questions remain on how to empower populations to think critically, what normative models of thinking are most appropriate for an infodemic, who is responsible for building literacy, and how literacy efforts can be integrated into existing societal systems (e.g. school education) and adapted to reach populations outside of traditional education settings.

2. **Identify priority populations based on key vulnerabilities**
   Population studies should be carried out to identify the specific individuals and groups at the greatest risk of accepting misinformation and then spreading it. This should include studying people's perceptions, beliefs and knowledge, and the barriers and facilitators for access to and evaluation of credible health information. Research should consider how information vulnerabilities align with disease vulnerabilities.

3. **Develop a shared public rubric for characterizing misinformation (including examples), in order to identify appropriate interventions and when and how to deploy them**
   This rubric could include different types of misinformation (e.g. the seven types of misinformation presented by Claire Wardle in the 29 June preconference); the sources of misinformation; the intent of those creating or sharing misinformation; the degree of inaccuracy (based on the level of expert consensus and scientific evidence that exists); the impact of the misinformation on attitudes and/or behaviours; the likely audiences; the virality of the misinformation; and/or the alignment of mis- and disinformation with politics. This rubric would be populated with specific examples of misinformation in each domain and aligned with interventions based on best practices shown to be effective for that type of misinformation.

4. **Develop a shared "living systematic review" for interventions measured in terms of their effectiveness on a set range of criteria, strength of evidence, generalizability, and likely contexts for application**
   Interventions across disciplines should be collected, with a rubric describing the outcomes against which the intervention has been tested, its generalizability or application to specific populations, the contexts in which it has been tested, its feasibility and costs, and the level of confidence in the findings. Special attention should be paid to determining the consistent metrics appropriate to evaluate the success of an intervention, to aid the prioritization of efforts, but there is broad consensus that no one intervention will be successful and a toolkit of different approaches is likely to be needed. This living systematic review should be aligned with the misinformation rubric to identify gaps where good evidence-based research does not exist, in order to address particular types of misinformation.

Annex 3: Conference programme[16]

Programme - preconference (public)
Day 0 – Monday, 29 June 2020, 13:00–17:30 Geneva time

- Introduction – *Sylvie Briand, WHO*

- Headline keynote talk – *David Nabarro, WHO COVID-19 Special Envoy & Imperial College Institute of Global Health Innovation, UK*

- Battling a pandemic in a fact-resistant world: epidemiology, public health, and the COVID-19 infodemic – *Saad Omer, Yale University, USA*

- A new digital reality: how fake news and misinformation are derailing the largest vaccination effort in history – a case study of polio programme – *Rustam Haydarov, UNICEF*

- "Gotong Royong": Blunting the impact of multiple infodemics via a whole-of-society approach – *Harry Sufehmi, MAFINDO, Indonesia*

- Conspiracies, rumours and falsehoods: the truth about why the infodemic is so dangerous – *Claire Wardle, FirstDraft News, UK*

- When fact-checking, media and misinformation collide in Africa – *Catherine Gicheru, ICFJ Knight Fellow, Kenya*

- Viral (p)articles: a network mapping approach to infodemiology – Camille Francois, Berkman-Klein Center for Internet & Society, Harvard University, USA

- Working together to manage infodemics – *Tim Nguyen, WHO*

Programme - scientific conference (closed session)
Day 1 – Tuesday, 30 June 2020, 12:00 – 17:40 Geneva time
Closed session – plenary

- Welcome – *Sylvie Briand, WHO*

- Introduction and moderation by conference co-chairs – *Neville Calleja, Ministry for Health, Malta, and Viroj Tangcharoensathien, Ministry of Health, Thailand*

- Discussion: epidemiology and its linkages to the new scientific discipline of infodemiology – *Rosamund Lewis, WHO; Dimitri Prybylski, US CDC, USA; Akhona Tshangela, Africa CDC; Lei Zhou, Chinese CDC, China; Laura Espinosa, ECDC*

- Researching the COVID-19 infodemic in the digital era – *Saad Omer, Yale University, USA*

- Social media & collective behaviour: a media science perspective – *Anja Bechmann, Aarhus University, Denmark*

- The new science of infodemics across social media platforms – *Neil Johnson, George Washington University, USA*

- Cultures of misinformation: media, motivations, responses – *Herman Wasserman, University of Cape Town, South Africa*

---

16   Full programme available in a conference brochure at: https://www.who.int/teams/risk-communication/infodemic-management/1st-who-infodemiology-conference, accessed 20 January 2021.

- **Break-out discussion: discussion in teams expanded with keynote speakers and observers** - *Break-out group moderators*: Elisabeth Wilhelm, US CCDC, USA; Tina Purnat, WHO; Margaux Mathis, WHO; Stefano Burzo, WHO

Days 2,3,4,5 – 1, 7, 9, 14 July 2020
Closed working sessions

Participants work in their assigned team.
Rotating discussion of each team through four set topics.

Topic 1: How can the digital-physical information environment be measured and monitored?
Using data triangulation, real-time surveillance and monitoring and metrics development

Topic masters:
- Neil Johnson, George Washington University, USA
- Anatoliy Gruzd, Ryerson University, Canada

Support to topic masters:
- Marcelo D'Agostino, Pan American Health Organization/WHO Regional Office for the Americas
- Dylan Johnson Restrepo, Volunteer

Topic 2: How does information originate and spread?
Information environment, how low-quality information develops into harmful narratives, and how misinformation propagates

Topic masters:
- Anis Azlan, Universiti Kebangsaan Malaysia, Malaysia
- Masato Kajimoto, University of Hong Kong, China

Support to topic masters:
- Atsu Ishizumi, US CDC, USA
- Saad Uakkas, Volunteer

Topic 3: How does information affect and impact individuals and populations?
Understanding the risk factors, impact on population & societies' behaviour and action, building and maintaining trust, and resilience to misinformation

Topic masters:
- Julienne Anoko, WHO
- Judit Bayer, Budapest Business School, Hungary

Support to topic masters:
- Margaux Mathis, WHO
- Vicky Houssiere, WHO

Topic 4: What interventions work to protect and mitigate?
Improving intervention design and building the evidence-based response toolkit

Topic masters:
- Emily Vraga, University of Minnesota
- Sara Rubinelli, University of Lucerne

Support to topic masters:
- Aybuke Koyuncu, US CDC, USA
- Jamie Guth, WHO

Team coordination
- Coach – red team: Tom Trewinnard, WHO
- Coach – blue team: Daniel Hougendobler, WHO
- Coach – green team: Brian Yau, WHO
- Coach – yellow team: Neetu Abad, US CDC, USA

Glossary curation
- Stefano Burzo, WHO
- Patricia Ndumbi Ngamala, WHO

Day 6 – Thursday, 16 July 2020
Closed session – plenary

- Introduction and moderation by conference co-chairs – *Neville Calleja, Ministry for Health, Malta, and Viroj Tangcharoensathien, Ministry of Health, Thailand*
- Report back from Topic 2 – *Anis Azlan, Universiti Kebangsaan Malaysia, Malaysia; Masato Kajimoto, University of Hong Kong, China*
- Report back from Topic 3 – *Julienne Ngoundoung Anoko, WHO; Judit Bayer, Budapest Business School, Hungary*
- Report back from Topic 1 – *Neil Johnson, George Washington University, USA; Anatoliy Gruzd, Ryerson University, Canada*
- Report back from Topic 4 – *Emily Vraga, University of Minnesota; Sara Rubinelli, University of Lucerne*
- Presentation of the public health research agenda for managing infodemics – *Tina Purnat, WHO*
- Report back on infodemiology glossary – *Stefano Burzo, WHO; Patricia Ndumbi Ngamala, WHO*
- Reflections from coaches – *Tom Trewinnard, WHO; Daniel Hougendobler, WHO; Brian Yau, WHO; Neetu Abad, US CDC, USA*
- Reflections by technical partners, moderator: *Tim Nguyen, WHO – Dimitri Prybylski, US CDC, USA; Anton Schneider, USAID; Meaghan Charlton, Sabin Institute; Susan Mackay, GAVI; Danielle Pedi, Bill & Melinda Gates Foundation*
- Next steps – *Tim Nguyen, WHO*
- Remarks by chairs – *Neville Calleja, Ministry for Health, Malta; Viroj Tangcharoensathien, Ministry of Health, Thailand*
- Closing remarks – *Sylvie Briand, WHO*

Day 7 – Public webinar, Tuesday, 21 July 2020, 15:00–16:30 Geneva time
Round-table on the outcomes of the conference

Host: Sarah Hess, WHO

Speakers: Stefano Burzo, WHO; Margaux Mathis, WHO; Brian Yau, WHO; Elisabeth Wilhelm, US CDC; Emily Vraga, University of Minnesota, US; Pier Luigi Sacco, IULM University, Italy; Lisa Talia Moretti, University of London, UK; Meaghan E. Charlton, Sabin Vaccine Institute, USA.

Annex 4: list of participants in the scientific conference

*Denotes a member of the core organizing team

1st Global WHO Infodemiology Conference, 29 June - 21 July 2020, Geneva and virtual

World Health Organization

Participants

Neetu Abad*
Behavioural Scientist
Global Immunization Division
Centers for Disease Control
and Prevention
USA

Naglaa Ahmed
Public health consultant
Epidemiologist, STOP
programme graduate
Egypt

Kwame Amponsa-Achiano
Programme Manager
Ministry of Health
Ghana

Arina Anis Azlan*
Lecturer
Centre for Communication
and Digital Society, Faculty of
Social Sciences & Humanities
Universiti Kebangsaan
Malaysia
Malaysia

Ruben Arcos
Professor
Department of
Communication Sciences
and Sociology
Rey Juan Carlos University
Spain

James Ayodele
Principal Communication
Officer
Africa Centres for Disease
Control and Prevention
Ethiopia

Judith Bayer*
Associate Professor
Department for
Communication Studies
Budapest Business School of
Applied Sciences
Hungary

Anja Bechmann
Professor
School of Communication
and Culture – Media Studies
Aarhus University
Denmark

David Broniatowski
Associate Professor
School of Engineering and
Applied Science
George Washington
University
USA

Ian Brooks
Research Scientist
School of Information
Sciences
University of Illinois
USA

Lucie Bucci
Senior manager, Immunize
Canada
University of Montreal
Canada

Neville Calleja*
Director
Directorate for Health
Information and Research
Ministry for Health
Malta

Elinor Carmi
Postdoctorate Research
Associate in Digital Culture &
Society
Department of
Communication and Media
University of Liverpool
United Kingdom

Damon Centola
Professor of
Communication, Sociology
and Engineering
Annenberg School for
Communication, the School
of Arts and Sciences, and
the School of Engineering
and Applied Sciences
University of Pennsylvania
USA

Orana Chandrasiri
Researcher
International Health Policy
ProgrammeProgramme
Ministry of Public Health
Thailand

Ying Cui
Chinese Center for Disease
Control and Prevention
China

Katharine Dommett
Senior Lecturer in the Public
Understanding of Politics
Department of Politics and
International Relations
University of Sheffield
United Kingdom

Joan Donovan
Research Director
Shorenstein Center on Media,
Politics and Public Policy
Harvard Kennedy School –
John F. Kennedy School of
Government
USA

Eve Dube
Researcher
Social Sciences and
Humanities Network
Québec National Institute of
Public Health
Canada

Adam Dunn
Head of Discipline and
Associate Professor in the
Discipline of Biomedical
Informatics and Digital
Health
School of Medical Sciences
University of Sydney
Australia

Ullrich Ecker
Professor of Psychological
Science
Faculty of Science, School of
Psychological Science
University of Western
Australia
Australia

Laura Espinosa
Scientific Officer Epidemic
Intelligence
European Centre for Disease
Prevention and Control
Sweden

Camille Francois
Berkman-Klein Center for
Internet & Society, Harvard
University
USA

Fu Gao
Director-General
Chinese Center for Disease
Control and Prevention
China

Anat Gesser-Edelsburg
Professor and Head of Health
Promotion Programme
School of Public Health
University of Haifa
Israel

Nina Gobat
Senior Researcher
Nuffield Department
of Primary Care Health
Sciences
University of Oxford
United Kingdom

Alfred Gomez
Public health consultant
Epidemiologist, STOP
programme graduate

Kacper Gradon
University of Warsaw
Poland

Anatoliy Gruzd*
Associate Professor,
Director, Social Media Lab
Ted Rogers School of
Management
Ryerson University
Canada

Aliaksandr Herasimenka
Political communication
scholar and a postdoctoral
researcher
Oxford Internet Institute –
Computational Propaganda
Project
University of Oxford
United Kingdom

Beverly Ho
OIC-Director IV
Health Promotion and
Communication Service
Department of Health
– Government of the
Philippines
Philippines

Edda Humprecht
Senior Research and
Teaching Associate
Department of
Communication and Media
Research
University of Zurich
Switzerland

Cherstyn Hurley
Immunisation publications
manager
Public Health England
United Kingdom

Santi Indra Astuti
Communication Studies
Faculty
Bandung Islamic University
(Universitas Islam Bandung)
Indonesia

Atsu Ishizumi*
CDC/ORISE Fellow
Demand for Immunization
Team
Centers for Disease Control
and Prevention
USA

Yaling Jin
Assistant Researcher
Chinese Center for Disease
Control and Prevention
China

Neil Johnson*
Professor
Department of Physics,
Columbian College of Arta
and Sciences
George Washington
University
USA

Masato Kajimoto
Associate Professor of
Practice
Journalism and Media
Studies Centre
University of Hong Kong
China

Aybuke Koyuncu*
PHI/CDC Global
Health Fellowship
ProgrammeProgramme
Centers for Disease Control
and Prevention
USA

Shibani Kulkarni*
CDC/ORISE Evaluation Fellow
Global Immunization Division
Centers for Disease Control
and Prevention
USA

Hao Li
Chinese Center for Disease
Control and Prevention
China

Mark MacCarthy
Senior Fellow and Adjunct
Professor
Communication,
Culture and Technology
ProgrammeProgramme
Georgetown University
USA

Dominic Maddumba
Executive Assistant
Office of the Secretary
Department of Health
– Government of the
Philippines
Philippines

Philip Mai
Director of Business and
Communications and
Researcher, Social Media
Lab
Ted Rogers School of
Management
Ryerson University
Canada

David Nabarro
Chair of Global Health and
co-Director of the Institute
of Global Health Innovation
(IGHI)
Imperial College London
United Kingdom

Mariam Nouh
Research Associate
Center of Complex
Engineering Systems (CCES)
King Abdulaziz City for
Science & Technology
Kindgdom of Saudi Arabia

Orkan Okan
Research Associate
Faculty of Educational
Science
University of Bielefeld
Germany

Saad Omer
Director
Yale Institute for Global
Health
Yale University
USA

Claudia Pagliari
Senior Lecturer in Primary
Care and Informatics /
Programme Co-Director (MSc
Global eHealth)
Usher Institute – Global
Health Academy
University of Edinburgh
United Kingdom

Kisoo Park
Professor
Institute for Occupational &
Environmental Health
Korea University College of
Medicine
South Korea

Palak Patel*
Centers for Disease Control
and Prevention
USA

Dimitri Prybylski*
Team Lead
Demand for Immunization
Team
Centers for Disease Control
and Prevention
USA

Junaid Qadir
Professor
Electrical Engineering
Department
Information Technology
University of the Punjab
Pakistan

Atonu Rabbani
Associate Professor
James P Grant School of
Public Health
BRAC University
Bangladesh

Emily Rempel
Knowledge Translation Lead
British Columbia Centre for
Disease Control
Canada

Hana Rohan
Assistant Professor in
Social Sciences
UK Public Health Rapid
Support Team
London School of Hygiene
and Tropical Medicine
United Kingdom

Sara Rubinelli*
Professor in Health Sciences
with a focus in health
communication
Department of Health
Sciences and Medicine
University of Lucerne
Switzerland

Pier Luigi Sacco
Professor
Department of Humanities
Studies
IULM University
Italy

Marietje Schaake
International Policy Director
Cyber Policy Center,
Freeman Spogli Institute for
International Studies
Stanford university
USA

Tara Kirk Sell
Senior Scholar, Assistant
Professor
Center for Health Security,
Bloomberg School of Public
Health
Johns Hopkins University
USA

Kenji Shibuya
Director
Institute for Population
Health
King's College London
United Kingdom

Kai Shu
Assistant Professor
Department of Computer
Science
Illinois Institute of
Technology
USA

Briony Swire-Thompson
Associate Research Scientist
Harvard Institute for
Quantitative Social Sciences
Northeastern University
USA

Lisa Talia Moretti
Digital Sociologist and Head
of user research
Institute of Management
Studies
Goldsmiths University of
London
United Kingdom

Mike Tamir
Lecturer
School of Information
University of California
Berkeley
USA

Viroj Tangcharoensathien*
Senior Adviser
International Health Policy
ProgrammeProgramme
Ministry of Public Health
Thailand

Naveen Thacker
Director
Deep Children Hospital and
Research Center Kutch,
Gurajat, and International
Pediatric Association
India

Akhona Tshangela
Programme manager
Mortality Surveillance
Africa Centres for Disease
Control and Prevention
Ethiopia

Shannon Turner
Executive Director
Public Health Association of
British Columbia
Canada

Heidi Tworek
Assistant Professor
Department of History
University of British Columbia
Canada

Emily Vraga*
Associate Professor
Hubbard School of
Journalism And Mass
Communication
University of Minnesota
USA

Herman Wasserman*
Professor of Media Studies
and Director of the Centre
for Film and Media Studies
University of Cape Town
South Africa

Robyn Whittaker
Honorary Associate
Professor and Programme
Co-Lead, eHealth/mHealth
National Institute for Health
Innovation
University of Auckland
New Zealand

Elisabeth Wilhelm*
Health Communications
Specialist
Demand for Immunizaiton
team, Global Immunization
Division
Centers for Disease Control
and Prevention
USA

Andrea Würz
Expert Behaviour Change and
Risk Communication
European Centre for Disease
Prevention and Control
Sweden

Lei Zhou
Senior Researcher, Chief
of Branch for Emerging
Infectious Disease
Public Health Emergency
Center
Chinese Center for Disease
Control and Prevention
China

Ying Zhou
Chinese Center for Disease
Control and Prevention
China

Observers

Juliet Bedford
Anthrologica
United Kingdom

Manlio De Domenico
Head of the Complex
Multilayer Networks
(CoMuNe) Research Unit
Center for Information
Technology
Fondazione Bruno Kessler
Italy

Stéphane Duguin
Chief Executive Officer
CyberPeace Institute
Switzerland

Bruce Gellin
President
Global Immunization
Sabin Institute
USA

Catherine Gicheru
ICFJ Knight Fellow
Kenya

Aino Huxley
Publications Editor
Hybrid CoE – The European
Centre of Excellence for
Countering Hybrid Threats
Finland

Rachel Lonsdale
Senior Programme Officer
Communications and
Advocacy for the Polio
Programme
Bill & Melinda Gates
Foundation
USA

Susan Mackay
Head, Demand,
Communities and Gender
GAVI

Erin Mcaweeney
Graphika Inc.
USA

Danielle Pedi
Senior Programme Officer
Water, Sanitation and Hygiene
Bill & Melinda Gates
Foundation
USA

Anton Schneider
Senior SBC Advisor
Bureau for Global Health,
Office of Infectious Disease
United States Agency for
International Development
(USAID)
USA

Melanie Smith
Cyber Intelligence Analyst
Graphika Inc.
USA

Harry Sufehmi
Founder
Mafindo
Indonesia

Olivia Tulloch
Anthrologica
United Kingdom

Claire Wardle
Co-Founder and Director
Firstdraft
United Kingdom

Sonia Whitehead
Head of Research
BBC Media Action
United Kingdom

Harry Wilson
Chief Product Officer
CitiBeats
Spain

Tim Zecchin
Managing Director
Media Measurement
United Kingdom

United Nations organizations

Guy Berger
Director for Freedom of
Expression and Media
Development
United Nations Educational,
Scientific and Cultural
Organisation (UNESCO)

Carla Daher
Global Emergency Specialist
Community Engagement
and Accountability to
Affected Populations
United Nations Children's
Fund (UNICEF)

Stewart Davies
Humanitarian Affairs Officer
United Nations Office for the
Coordination of Humanitarian
Affairs (OCHA)

Katie Drew
Innovation Officer
(Communicating with
Communities)
The UN Refugee Agency
(UNHCR)

Niamh Hanafin
Senior Advisor Information
Integrity
United Nations Development
Fund (UNDP)

Rustam Haydarov
Global Polio Eradication
Programme
United Nations Children's
Fund (UNICEF)

Miguel Luengo-Oroz
Chief Data Scientist
UN Global Pulse

Carlos Navarro Colorado
Principal Advisor
Public Health in Emergency
UNICEF

Angus Thompson
Senior Social Scientist:
Demand for Immunization
United Nations Children's
Fund (UNICEF)

Kolitha Prabash Wickramage
Global Health Research and
Epidemiology Coordinator
Migration Health Division
International Organization for
Migration

Fatou Wurie
Emergency Specialist
U-Report
United Nations Children's
Fund (UNICEF)

Other International organizations

Vitalba Crivello
Policy Analyst
European Science Media Hub
(STOA)
European Parliament
Belgium

Sabrina Spieleder
Information and
Communication Officer
Strategic Communications
Division
European Union External
Action
Belgium

World Health Organization

Regional Office for Africa

Halim Abdallah
Deputy Communications
Focal Point
COVID-19 Response, WHO
Health Emergencies
Programme

Julienne Anoko*
Risk communication &
community engagement/
Social Sciences Officer
Emergency Preparedness

Tom Trewinnard*
Consultant
COVID-19 Response, WHO
Health Emergencies
Programme

Regional Office for the Americas / Pan American Health Organization

Marcelo D'Agostino*
Senior Advisor
Information Systems for
Health, Evidence and
Intelligence for Action in
Health

Regional Office for Eastern Mediterranean

Tamer El-Maghraby
Information Officer
Infectious Hazard Prevention
and Preparedness,
Emergency Preparedness

Beste Sultan Gülgün
Technical Officer
(Communications)
Country Health Emergency
Preparedness & IHR, Eastern
Mediterranean Regional
Office

Arash Rashidian
Director
Science, Information and
Dissemination Division

Regional Office for Europe

Olga Fradkina*
Administrative Officer
WHO European Centre for
Primary Health Care

Clayton Hamilton
Technical Officer
Country Health Policies and
Systems

Regional Office for South-East Asia

Supriya Bezbaruah
Technical Officer, Risk
Communications
WHO Health Emergencies
Programme

Regional Office for Western Pacific

Leilia Dore
Consultant, Community
Engagement (COVID-19)
WHO Health Emergencies
Programme

Headquarters

Philip Abdelmalik
Team Lead
Information Systems
and Innovation for Public
Health Intelligence, Health
Emergency Information and
Risk Assessment, WHO Health
Emergencies Programme

Zerthun Alemu Belay*
Assistant to Unit Head
High Impact Events
Preparedness, Global
Infectious Hazards
Preparedness, Emergency
Preparedness

Ian Askew
Director
Sexual and Reproductive
Health and Research,
Science Division

Yolanda Bayugo
Technical Officer
Learning Solutions and
Training

Sylvie Briand*
Director
Global Infectious Hazards
Preparedness, Emergency
Preparedness

André Buell*
Office Assistant
High Impact Events
Preparedness, Global
Infectious Hazards
Preparedness, Emergency
Preparedness

Stefano Burzo*
Consultant
High Impact Events
Preparedness, Global
Infectious Hazards
Preparedness, Emergency
Preparedness

Melinda Frost
Technical Officer
High Impact Events
Preparedness, Global
Infectious Hazards
Preparedness, Emergency
Preparedness

Ioana Ghiga
Technical Officer
High Impact Events
Preparedness, Global
Infectious Hazards
Preparedness, Emergency
Preparedness

Hermjona Gjyla*
Clerk
Staff Health Insurance

Jamie Guth*
Consultant
High Impact Events
Preparedness, Global
Infectious Hazards
Preparedness, Emergency
Preparedness

Lisa Hansen
Consultant
Health Emergency
Information and Risk
Assessment, WHO Health
Emergencies Programme

Daniel Hougendobler*
Project Officer
Pandemic Influenza
Preparedness, Emergency
Preparedness

Vicky Houssiere*
Consultant
High Impact Events
Preparedness, Global
Infectious Hazards
Preparedness, Emergency
Preparedness

Aleksandra Kuzmanovic
Social Media Officer
Department of
Communications

Rosamund Lewis*
Medical Officer
Emerging Diseases and
Zoonoses

Jianfang Liu*
Web Producer
High Impact Events
Preparedness, Global
Infectious Hazards
Preparedness, Emergency
Preparedness

Abdi Mahamud
Incident Manager
Strategic Health Operations

Jaouad Mahjour
Assistant Director-General
Emergency Preparedness

Margaux Mathis*
Technical Officer
Epidemic Forecasting and
Analysis, Global Infectious
Hazards Preparedness,
Emergency Preparedness

Lisa Menning
Technical Officer
Essential Programme on
Immunization

Thomas Moran
Consultant
High Impact Events
Preparedness, Global
Infectious Hazards
Preparedness, Emergency
Preparedness

Patricia Ndumbi Ngamala*
Technical Officer
Digital Health Technologies,
Digital Health and
Innovation, Science Division

Tim Nguyen*
Unit Head
High Impact Events
Preparedness, Global
Infectious Hazards
Preparedness, Emergency
Preparedness

Andrew Pattison
Technical Officer
Department of
Communications

Jonathan Polonsky
Epidemiologist
Health Emergency
Information and Risk
Assessment, WHO Health
Emergencies Programme

Tina Purnat*
Technical Officer
Digital Health Technologies,
Digital Health and Innovation,
Science Division

Romana Rauf*
Programme Management
Officer
Infectious Hazard Prevention
and Preparedness,
Emergency Preparedness

Isabelle Sahinovic
Technical Officer
Pharmacovigilance,
Regulation and Safety

Sameera Suri
GOARN Secretariat,
Emergency Response

Brian Yau*
Consultant (Vaccine Safety)
Pharmacovigilance,
Regulation and Safety

Volunteers

Dylan Johnson Restrepo*
USA

Saad Uakkas*
Morocco

Rapporteur

Mark Nunn

Illustrator

Sam Bradd

Interpreters

Cleila Antonel

Katryona Kryzhanovska

Marisa Martinez

Tazara Spafford

Annex 5: Summary of the review of declarations of interest by participants

Final number of participating experts: 106 (non-WHO) experts
Final number of experts with disclosed interests: 27

The Global Infectious Hazard Preparedness department, within the WHO Health Emergencies Programme, organized a closed scientific conference on infodemiology, the science behind managing epidemics, from 30 June to 16 July 2020. The overall aim of the conference was to take stock of relevant research and effective practices and define public health research needs in order to advance this field. Some 106 experts from various areas of expertise have been invited to attend and submit a declaration of interest (DOI) form.

Three experts did not submit a DOI: Kisoo Park, Alfred Gomez and Robyn Whittaker. The three participated in the opening and closing plenaries and did not attend the working sessions. It was determined that without declaring interests, Kisoo Park, Alfred Gomez and Robyn Whittaker would not be able to participate in the formulation of recommendations or advice. This was implemented accordingly during the research agenda prioritization exercise.

On review of the completed DOIs, 27 experts declared interests. Most of them were assessed as non-significant by the WHO Secretariat. The following five experts declared interests that required further consideration:

- Anja Bechmann: she received about 46 000 dollars from the Carlsberg Foundation for a research project about online hostility. Dr Bechmann is co-PI for the project.
  - It was determined that this interest did not present a conflict in respect of the meeting and Anja Bechmann could participate as an expert.

- Camille Francois and Melanie Smith: they both hold stock options for the company they work for (Graphika). Graphika receives funding from private entities.
  - It was determined that Camille Francois and Melanie Smith could participate as observers during the meeting but would not be able to participate in the formulation of recommendations or advice.

- Claire Wardle: she is the co-founder of a company (FirstDraft) which receives significant funding from Google and Facebook.
  - It was determined that Claire Wardle could participate as an observer during the meeting but would not be able to participate in the formulation of recommendations or advice.

- Tim Zecchin: he is the managing director and shareholder of a social media research business (Media measurement) supplying services to WHO. The consultation could benefit his business:
  - It was determined that Tim Zecchin could participate as an observer during the meeting but would not be able to participate in the formulation of recommendations or advice.

- Marietje Schaake: she is the President of the Cyberpeace Institute and international policy director at Stanford University's Cyber Policy Center and provides consulting services in the area of cyber policy and governance. The consultation could benefit her business.
  - Marithe Schaake submitted the DOI with delay. It was determined that Marietje Schaake could participate as an observer during the meeting but would not be able to participate in the formulation of recommendations or advice. This was implemented accordingly during the resarch agenda prioritization exercise.

In summary, these experts were only allowed to attend and participate on the opening and closing days of the conference where general presentations and the outcomes of the group discussions were presented. They did not take part in the group work nor the formulation of it outcomes, nor in the research question collection nor prioritization process.

Global Infectious Hazards Preparedness (GIH) Department