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PERSPECTIVE

Using after-action reviews of outbreaks to enhance public health responses: lessons for COVID-19

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Learnings from outbreak after-action reviews can enhance response to COVID-19 and future public health threats

Summary

- After-action reviews (AARs) of Australian outbreaks have led to recommendations for enhancing readiness to respond.
- Recommendations for improvement from 14 Australian public health outbreak reviews facilitated between 2006 and 2020 were analysed for common themes and implications for the ongoing COVID-19 response.
- The challenges repeatedly identified in the AARs related to: information management and interagency access; incident command systems (ICS); surge response; clarification of outbreak leadership; communication; rapid risk assessment and decision support
- A national framework for enhancing outbreak response should embed AARs as standard practice supported by a national register of ARRs' findings and recommendations.
- Learnings from past outbreaks and intra-action reviews could further enhance pandemic responses.

Introduction

Every outbreak is a lesson in prevention. After-action reviews (AARs) and Intra-action reviews (IARs) of outbreaks play a similar role to clinical audit and review but in public health contexts.[1] They promote, blame-free, system learning to enhance responses. Australian health authorities have increasingly conducted outbreak AARs using a structured audit methodology since a Communicable Disease Network of Australia (CDNA) pilot in 1997.[2] In 2009, we published a structured methodology that was incorporated into Australian guidelines for multi-jurisdictional foodborne outbreak investigations.[3]

The WHO recommends outbreak AARs and joint external evaluations are collated systematically to allow analysis and assessment of preparedness for future events and is urging countries to conduct intra-action reviews during the current pandemic.[4,5]

We extracted learnings from Australian outbreak reviews to identify lessons for our future response to the pandemic, and routine and emerging infectious diseases.

We reviewed 14 outbreak reviews' findings facilitated from 2006-2020 (Box 1) using previously published methods.[3] Briefly, a pre-meeting survey identified participant concerns and defined the review's scope. Potentially contentious issues were constructively reframed and discussions about critical response issues were facilitated by an experienced public health physician.[3] The reviews took 3-4 hours with typically 10 to 30 attendees. Each review concluded with a report containing a summary of findings and list of recommendations for enhancing future practice.

It is difficult to access and collate outbreak reviews because of variations in methods and documentation, therefore this analysis includes reviews conducted by a single outbreak review facilitator (CD). We

extracted all of the recommendations from the 14 review reports then collated recommendations common to two or more outbreaks. We organised them under the major themes used in the review reports.

The 14 outbreak reviews included 13 AARs and one IAR from 2005-2020 across scenarios including six respiratory and eight foodborne disease outbreaks conducted at local, state and multi-jurisdictional/national level (Box 1).

Seven themes were commonly identified during these outbreak responses and are explored below (Table 1). The review recommendations that addressed these themes are listed in Table 2.

Communication

"Poor communication" was the most commonly cited concern; reported in all 14 outbreak reviews (Table 1). Outbreaks often require new, enhanced or more rapid communication pathways. The most common communication issues were: inability to rapidly communicate new or changing surveillance cases definitions and response protocols to clinicians across multiple settings; lack of agreement on the agency responsible for providing public comments and media releases on sensitive issues such as the case, hospitalisation, or death counts; limited interactions between public health agencies and important partners until a crisis occurred; clinical network fax streams (e.g. for ED directors) replaced with less reliable and changing email addresses

Agencies sometimes limited distribution of sensitive outbreak situation reports (SITREPS) leading to dissatisfaction among outbreak response teams and collaborating agencies. Many agencies had limited internal portals for sharing sensitive information undermining internal communication. It was recognised that social media was becoming an essential communication component during responses. Real time social media use was inhibited in some outbreaks by multiple approval levels required to release information and then respond interactively.

Communication across government agencies, health providers, and private entities was often challenging and there was a need for a stakeholder communication role in complex outbreaks. Messaging to stakeholders should be a standard agenda item for outbreak control meetings. Communicating effectively with staff, residents, and relatives in aged care facility outbreaks was identified as a priority.

Information management and data exchange

Information management and data exchange was the next most frequently identified issue; noted in nine outbreak reviews. While most public health agencies have mature software platforms for processing routine notifiable conditions, outbreaks require new systems to track cases and contacts in community and workplace setting and across a range of novel and routine laboratory tests, referral pathways, and reporting. New systems were required to track cases and contacts through incubation periods; daily symptom, quarantine and isolation status; release from monitoring; administration of treatments; and prophylactic therapies. Lacking a central share database, multiple spreadsheets were often used to manage data with potential duplication and data integrity issues. System limitations sometimes led to data being entered into a local database and then re-entered into a separate spreadsheet to produce reports or for data exchange across jurisdictions. This presented challenges due to agency-specific password protection,

dissimilar IT platforms, and lack of legal precedent for data exchange across jurisdictions. Additionally, most current surveillance databases do not integrate with call centre contact tracing activity systems.

Important information was often disseminated via email which, in the absence of formal structured record management systems, became a repository of corporate knowledge and decision-making records. Email "overload" was a concern of staff in large outbreaks. Version control of widely circulated and updated documents was challenging. Scarce epidemiological resources were often consumed in generating duplicative reports for multiple stakeholders.

Access to outbreak information improved over time; however, it was variable and sometimes relied on interpersonal relationships rather than established data exchange permissions. In several foodborne outbreaks, epidemiological, laboratory and food safety investigations were conducted with minimal or delayed sharing of data between agencies. This prevented an understanding of the epidemiological, laboratory and environmental outbreak interdependencies which inhibited response and control.

Clarification of roles

There were multiple reviews for which, when the question was asked "who was in charge of this outbreak?", the response was, "that was unclear". There was often an absence of an identified lead agency or investigator in multi-agency investigations. This lack of clarity occurred both between public health agency hierarchies and between different agencies, i.e. food safety and public health. This was not due to competition between agencies, but rather an unrecognised need for a single lead investigator and team, despite each agency's unique responsibilities. Lacking formal recognition, lead investigators struggled to access information and resources.

Surge capacity

Outbreaks often required enhanced capacity across epidemiological, environmental health/food, laboratory, logistics and communication personnel. In many outbreaks, resources were overwhelmed before staffing was surged. There was limited awareness of the early signs of being overwhelmed or forecasting to pre-empt being overwhelmed. With routine staff under pressure they were unable to specify the surge needs, recruit or train surge staff.

Maintaining the engagement of surged staff seconded from external organisations during lulls in activity was often reported as challenging. Seconding organisations and seconded staff themselves were often intolerant of down-time with requests for return within days of activity declines. One challenge to surge response was the lack of systems to share workloads and track workflows across different agencies or jurisdictions.

Surge capacity was sometimes limited by budgetary constraints. There were rarely mechanisms for identifying or triggering emergency funding for emergent public health responses. Barriers to on-boarding staff or volunteer staff delayed surge responses. Inability to surge led to outbreak investigation and control timelines being determined by available resources rather than by public health control objectives. Laboratories were often challenged by the need to surge staff, introduce and validate new testing platforms and analytic platforms, specimen handling and processing prioritisation during large outbreaks.

Incident command system (ICS)

Military inspired incident command or control systems (ICS) align structures and communication across disparate organisations allowing rapid and controlled resource surging to meet outbreak control objectives.[6] Agencies had varied ICS training and application experience. ICS was often implemented later than optimal, incompletely, or with inadequate training. This resulted in obstacles to span of control (number of staff each manager supervised), clarity of leadership, surge capacity, and considerable stress upon personnel who went unrelieved for prolonged periods. In large and prolonged responses, team leaders were required to attend multiple committee meetings, which they indicated limited their effectiveness.

Rapid risk assessment and decision support

Outbreaks often involved uncertainty requiring rapid risk assessment. The virulence and transmissibility of pathogens may be unknown and exposure levels may be uncertain. Public health agencies have to make informed judgements regarding public health orders, venue closures, travel restrictions, product recalls, case isolation and quarantine of close contacts, or administration of prophylaxis. Identified delays in decision-making highlighted the importance of rapid risk assessment capacity. Assessments should explain the level of uncertainty underlying public health actions and recommendations.[7] Public health resources were often fully focused on response and operations with little time, or trained staff, available to conduct formal risk assessments.

At times in outbreak investigations junior epidemiologists were given significant responsibility with limited support, which resulted in delays and uncertainty in design, analysis, and interpretation of complex analytical studies.

Need for outbreak exercises

While only three outbreaks formally identified outbreak exercises as important, exercises have the potential to improve performance across all identified themes. Exercises, including local, state, and national agencies are required to address the array of issues identified. Very few outbreak responses benchmarked performance and standards are required to assess performance of both outbreak practice and exercises.

Discussion

The outbreak reviews identified seven common themes for improvement and presaged challenges for Australian pandemic response. The major theme centred on communication between and within teams, across agencies, between agencies and important stakeholders such as general practitioners, the public and laboratories. Both this review and the Finkel review highlight the importance of surging epidemiological, laboratory and communications responses, cross jurisdictional information management and access, performance metrics and conducting exercises.[8] The recommendations hold lessons for our

ongoing pandemic response and to future emerging infectious diseases.

AARs are designed to celebrate good performance as well as identify opportunities for improvement. Australia has made substantial improvements in outbreak performance over the last two decades, including development of national guidelines for response.[9] The sharing of information and coordination between jurisdictions has improved significantly through the CDNA which was formed in 1989 with jurisdictional and institutional representatives to provide public health co-ordination and leadership, and support prevention and control of communicable diseases.[10] Laboratory capacity to perform timely whole genome sequencing and other subtyping has also increased. Electronic laboratory reporting has reduced reporting delays and sequencing has improved responses. The unfiltered use of social media by agencies has enhanced community engagement.[11] It is unclear whether recommendations from past AARs contributed to these improvements.

These AARs provided recommendations that, if enacted, could have enhanced our pandemic response. Failure to enact lessons from bushfire AARs led to the development of a database of AAR recommendations to inform practice and the United States has a public health lessons-learned database.[12,13]

In addition to AARs of real public health emergencies to support IHR implementation, the WHO recommends AARs of simulation exercises.[14] Poorly executed table top exercises can often produce a false sense of security.[15] A four-day pandemic influenza exercise in a public health unit conducted in 2008 permitted a rapidly surged response during the 2009 influenza pandemic and participants noted that the pandemic was less stressful than the exercise.[16] Exercise frequency determines performance outcomes and should include local public health units, the frontline of outbreak responses, which are infrequently included in national exercises.

Performance standards are essential for enhancing outbreak response and provide indicators for evaluation in reviews and exercises. Indicators can include meta-level domains of governance, ethics, and strategy, down to practical operational response indicators. Many countries have developed performance indicators and metrics for public health response and capacity.[17,18,19,20] Examples of important operational response indicators for coronavirus disease 2019 (COVID-19) are included in Box 2.

These reviews were a snapshot of outbreaks since 2005 and facilitated by a single facilitator. While this raises the possibility of bias, similar themes were identified in overseas contexts in a literature review and expert consultation on recommendations for outbreak response[19] and on indicators for outbreak preparedness.[18] Many agencies conduct reviews, however practice and reporting is inconsistent. The included reviews were consistently conducted and reported, with findings and recommendations those made by the participants. Recommendations for a national framework and community of practice for AARs should reduce practice and reporting variability. There is a growing body of guidance in the conduct of AARs in public health to assist countries to build a community of practice.[4,21,22,23]

Future reviews should consider higher-level decision making, cognitive biases, variations in situational awareness, group decision making, staff well-being, gender, CALD and First Nations equity issues, ethics and privacy. Given the impact of political interference with disease control in other countries, particularly the United States, this should be considered.[24]

In many outbreaks, the response was determined by routinely available resources rather than achievement of specific public health objectives. The COVID-19 pandemic demonstrates that public health response should be reconceived as a combat agency response. Similar to fire and defence services, public health requires significant reserve capacity in peacetime to allow rapid expansion when called upon in an emergency. A pandemic of the scale of COVID-19 takes years, perhaps decades, to prepare optimally for. The timing of herd immunity is uncertain and the pandemic may be extended by variant strains. Australia and other countries should review the recommendations from past reviews and urgently begin WHO recommended pandemic intra-action reviews.[5,25] Looking to the future, it is clear that rapid public health responses can prevent weeks or months of lockdown, with savings variably estimated at between $450 million to four billion dollars per week.[26] Emergency public health response capacity is clearly both a health and economic investment.

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Boxes and tables

Box 1: Outbreaks subject to after-action review or intra-action review	
1.	Local response to COVID-19, 2020*
2.	Meningococcal meningitis outbreak, 2016
3.	Legionella outbreak, 2016
4.	Multi-jurisdictional outbreak of hepatitis A, 2015
5.	Hospital listeriosis outbreak, 2013
6.	Multi-jurisdictional outbreak of listeriosis, 2012
7.	Measles outbreak, 2012
8.	Pandemic influenza response (Public Health Lab Network), 2009
9 .	Multi-jurisdictional outbreak of listeriosis, 2009
10.	Outbreaks of salmonellosis in a region, 2009
11.	Salmonella outbreak in a restaurant, 2008
12.	Salmonella outbreak in an aged-care facility, 2008
13.	Prophylaxis of contacts of food handler with hepatitis A to prevent an outbreak, 2006
14.	Multiple influenza outbreaks in aged-care facilities, 2005

* The only intra-action review.

Box 2: Performance indicators relevant to COVID-19

1. Number of cases (and their contacts) able to be interviewed/contact traced per day/million population
2. Proportion of unlinked (mystery) cases (24 hrs, weekly, monthly)
3. The number of hours from specimen collection to notifying all people of their results, with the target being fewer than 24 hours at the 90th percentile.*
4. The number of hours from the patient's specimen collection to notifying their close contacts that they must quarantine, with the target being fewer than 48 hours at the 90th percentile.*
5. Positivity of laboratory tests by age group, gender, ethnicity, SES of postcode (weekly time series)
6. Testing rates by distance from testing sites stratified by SES
7. Number of contact tracers per million population (to address heterogeneity in resources).

* From the Finkel Report.[8]

Table 1: Category and number of themes identified across 14 outbreak reviews

Issues requiring improvement	Number of outbreaks in which this issue was identified*
Communication	14
Information management and sharing	9
Clarification of roles	8
Surge capacity	5
Incident Command System	4
Decision support/rapid risk assessment	3
Need for exercises	3

*Many themes were identified across multiple reviews.

Table 2. Key recommendations for outbreak response from past reviews with potential relevance to the ongoing COVID-19 pandemic response

Recommendation from past reviews
Communication
Health alert networks including primary care, emergency departments, intensive care, hospital infection control and hospital epidemiology (where it exists) should be developed. Approved self-subscription could ensure email addresses are current.
Social media should be activated to allow a rapid and proactive sharing of information and correction of misunderstandings.
Situation reports that update all stakeholders on the evolving epidemiological narrative should be broadly disseminated.
Stakeholder communication (internal and external) should be a standing agenda item on outbreak management meetings. Particularly important for Aged Care Facility outbreaks.
Information management and interagency access
Information management and sharing could be enhanced through investment in a common national (interoperable) digital platform that is specifically built for outbreak investigation integrating outbreak cohort data, case data, contact data, and laboratory data.
Legal and policy instruments should enable sharing of information across jurisdictions and between agencies within the same jurisdiction. Legal barriers to sharing information across jurisdictions and agencies should be resolved. In particular, agreements for sharing of information between epidemiological, environmental inspection, and laboratory arms of investigations should be developed
Alternatives to distributing information via email need to be explored.
Clarification of roles
National protocols for leadership in outbreak investigations, both vertically, and horizontally should be developed. This is particularly important in foodborne and zoonotic outbreaks where multiple agencies may be involved.
Surge capacity
Agencies should develop a culture that encourages surged responses based on forward prediction of overwhelm, not evidence of current overwhelm.

Legal and human resource impediments to rapid on boarding of staff need to be adapted for emergencies.
Stockpiles of laboratory and PPE are required for pandemics and other large outbreaks
Scalable call centres and "help desk" applications to respond to massive community information needs are required.
Incident control systems and surge
Adoption of an incident control system (ICS) in outbreak responses may better clarify leadership and coordination responsibilities.ICS needs to be adapted and exercised across multiple sectors (e.g. health, agriculture, food safety, hospitals) with regard to operational, planning, logistics and communications functions.
ICS needs to be activated early in outbreaks.
There needs to be a tolerance for "down time" in outbreaks that wax and wane. Commitment to longer deployments needs to be institutionalised.
Training in ICS needs to be developed for a wide range of agencies with clear roles (job descriptions) for all ICS roles.
ICS needs to be adapted and exercised across multiple sectors (e.g. health, agriculture, food safety, hospitals) with regard to operational, planning, logistics and communications functions
Mechanisms and triggers for emergency funding for public health response should be identified.
Decision support /Rapid risk assessment
Capacity for rapid risk assessment and rapid literature review should be developed as part of outbreak response.
Appropriate depth of epidemiological support is required for outbreak investigations.
Need for exercises
Exercises conducted at appropriate frequency that engages vertically through local, state and national public health agencies and horizontally across collaborating external agencies should be conducted and assessed.