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Surveillance and disease control of a newly-emerging disease from the perspective of a State Health Institute using the example of the SARS-CoV-2 pandemic

Meldewesen und Kontrolle einer neu auftretenden Erkrankung aus der Sicht eines Landesgesundheitsamtes am Beispiel der SARS-CoV-2-Pandemie

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Summary

This paper gives an overview of the experience on state and local health authority level that the German human surveillance system had so far in integrating the newly emerging disease SARS-CoV-2 into the existing surveillance framework. The magnitude of cases within a short time frame stretched the surveillance system at federal, state and local level. The electronic infectious disease notification system SurvNet@RKI has been flexible enough to adapt to the situation, but has limitations for large-scale contact tracing. Despite it being a zoonotic disease, a One Health approach has not been implemented yet. A formal evaluation of the German disease surveillance across administrative levels and technical capabilities as well as implementation of resulting recommendations would improve the response to similar situations in the future.

Keywords: Covid-19, infectious disease surveillance, Germany

Zusammenfassung

Diese Veröffentlichung soll einen Überblick aus Sicht einer Landesmeldestelle und des Gesundheitsamtes darüber verschaffen, wie das deutsche Meldewesen den neuen Erreger SARS-CoV-2 integrierte. Das hohe Fallaufkommen innerhalb kurzer Zeit war eine starke Belastung auf Bundesebene, in den Ländern und Kreisen. Die elektronische Melde- und Übermittlungssoftware SurvNet@RKI war flexibel genug, sich an die Situation anzupassen, aber es gibt Schwächen in der Kontaktnachverfolgung. Obwohl es sich um eine Zoonose handelt, wurde der One-Health-Ansatz bisher nicht umgesetzt. Sowohl eine formale Evaluation des deutschen Meldewesens auf allen Verwaltungsebenen und der technischen Möglichkeiten als auch eine Umsetzung der daraus resultierenden Empfehlungen würde eine Reaktion auf ähnliche Situationen in der Zukunft verbessern.

Schlüsselwörter: Covid-19, Infektionssurveillance, Deutschland

Introduction

The federal republic of Germany consists of 16 states and is served by about 400 local health authorities (LHAs) (Faensen et al. 2006).

This article intends to describe the experience with the SARS-CoV-2 pandemic from the perspective of the state surveillance unit in Rhineland-Palatinate, a State with four million inhabitants. The organisation of state departments responsible for epidemiology and surveillance are inconsistent in the different states of Germany, e.g. sometimes being part of the ministry and sometimes separate institutes as in Rhineland-Palatinate. In order to simplify, we will use the term state surveillance unit for the responsible department in all states.

Notifiable diseases are reported by physicians, hospitals and laboratories amongst others (Bierbach 2018) to the local health department which then creates a digital record that is transmitted to the state surveillance unit and the RKI. Constitutionally, health is the responsibility of the states and not the federal government. While the infectious diseases protection act (IfSG) from 2001 applies to the whole of Germany, its implementation is largely the responsibility of the states. Lessons from

the large EHEC outbreak (Krause et al. 2012) helped formulate a federal regulation (German Government 2013) to streamline coordination between Federal and State institutions in future epidemics. However, systematic and regular interdisciplinary coordination using a One Health approach for zoonotic or sapronotic disease outbreaks and surveillance is not institutionalized. The surveillance system is based on different legal, economic, technical and political structures and working together depends on personal networks and inofficial information flow.

The IfSG mandated the implementation of an electronic surveillance system. One of several surveillance software products is SurvNet@RKI. The software is provided free of charge from the Robert Koch Institute (RKI) to the LHAs and state health surveillance units (Faensen et al. 2006, Krause et al. 2003a). The LHAs receive fax or phone notifications on 67 pathogens and 24 diseases defined by the IfSG and then enter that data into the surveillance software, plus any additional information collected from investigation like interviewed cases and environmental investigations. In the near future, transfer of laboratory data from the laboratory system will also be integrated electronically into a new German electronic reporting and information system for infectious diseases (DEMIS) (Robert Koch Institute 2020e). This reduces the amount of time from laboratory diagnosis to reception of the notification at national level. Part of the original plan was to incorporate the veterinary public health system in DEMIS, but the system will be limited to COVID first.

From 2001 until 2019, the LHAs generated an average of 418,000 notifications per year for the whole of Germany, mainly driven by Norovirus and Influenza numbers (Robert Koch Institute 2020g). For Covid-19 alone, close to 195,000 positive cases were transmitted to the RKI until 1 July 2020 (Robert Koch Institute 2020a) which demonstrates the burden on the system. The notification to The European Surveillance System "Tessy" is also done electronically through the RKI (Ammon and Faensen 2009). Personal information of the cases (name, place of residence, day of birth) is stored at the local level only. At state and national level, only county of residence, year and month of birth, and sex are available.

We present the integration of SARS-CoV-2 into the existing surveillance system describing the tasks and responsibilities at the different levels; federal government, state government and county level.

Surveillance activities at federal level during SARS-CoV-2 pandemic

The RKI manages an emergency operating centre to coordinate all activities and information exchange. It provides disease expertise, publishes guidelines and recommendations based on current knowledge regarding management of Covid-19 in hospitals, senior homes, schools, kindergartens, private practices and other institutions. It publishes daily situation reports in German and English, runs a "dashboard" with extensive data-extraction capabilities for third party data analyses (Robert Koch Institute 2020d) and provides a selection of useful links for the public and professional sector (Robert Koch Institute 2020c). The RKI also exchanges information with the international community with the help of established knowledge platforms (EWRS) regarding international cases and contacts. During the first wave in Germany, the RKI held daily press briefings, sometimes together with the national Ministry of Health. This was a major channel of risk communication during this pandemic in Germany and other stakeholders relied on this information.

In addition, and independent of the pandemic, weekly telephone conferences are being held with state surveillance units since 2009 (Zeitlmann et al. 2019) and with state ministries responsible for health for several years. During the first wave, the frequency was increased to twice a week telephone conferences between the RKI and the state ministries responsible for health or the RKI and the state surveillance units.

As a novel pathogen, SARS-CoV-2 did not have a pre-existing notification category on its own but was grouped instead into the generic category "Weitere bedrohliche Krankheiten" (WBK, "other highly contagious diseases"). Compounding this problem was the mandatory paper based notification from the LHA to the state surveillance unit and the RKI via fax using an International Health Regulations (IHR) form that scaled up very badly once the case numbers took off: IHR-fax was additional to electronic submission "WBK".

Whereas the notifying person still uses a fax to inform the LHA, the remaining part of the surveillance system is electronic and based on single case notifications up to the national level.

The RKI formulates the case definition. It describes whom the LHA should consider a suspected case, a confirmed case, an excluded case or a death due to SARS-CoV-2 infection. For SARS-CoV-2, every PCR or virus culture positive case is defined as a confirmed case until publication of this article. Cases are classified within the surveillance system according to the reference definition that takes clinical diagnosis, epidemiological links, laboratory diagnosis or a combination of them into account. The use of a reference definition standardises nationwide infectious disease notifications in order to create comparable statistical outputs. Only cases fulfilling the reference definition are reported to the public.

Furthermore, guidance was given on who should be tested. This guidance evolved over time, enabling a broader section of the population (e.g. asymptomatic cases) to be tested at a later stage. Similarly, the different categories for contact persons have been adapted to reflect the epidemiological situation over time.

With SARS-CoV-2, the RKI adapted the case definition from a classical outbreak definition of confirmed, probable and excluded cases to a definition that is used in a mandatory electronic surveillance system (Robert Koch Institute 2020b). Initially, SARS-CoV-2 cases (confirmed, suspect, excluded) were held in a generic "other highly contagious diseases" category. The XML-based architecture of SurvNet@RKI allowed a quick adaptation of data entry fields to account for the new disease characteristics. However, using the generic "other highly contagious diseases" (WBK) category came at significant database performance costs and user interface barriers at all levels. The generic WBK category accommodates pathogens from Acanthamoeba to Wuchereria and does not provide for SARS-Cov-2 specific properties. Pathogen-specific notification categories on the other hand allow far more

focussed and faster search options, e.g. filtering certain serotypes in the Salmonella category. Consequently, a new notification category "COVID" was introduced in mid-April. This required a coordinated software update (Robert Koch Institute 2020f) across all German state surveillance units and all LHAs that use SurvNet@RKI or other software products in the midst of the pandemic. The new notification category greatly improved speed and usability and opened flexibility for future changes to the case definition.

The electronic infectious disease notification system has the possibility to incorporate deaths due to or with any notifiable disease. However, Germany does not have a nationwide mortality surveillance system and official mortality statistics are compiled from a different dataset from DESTATIS (Schneider et al. 2020). The Covid-19 pandemic highlights the shortcomings of the mortality system in Germany and Schneider et al. give recommendations for improvement such as the digitization and connection of all systems, not just for infectious diseases. Furthermore, classification of cause of death, access to data from different sources and transparency of results need to be improved (Schneider et al. 2020).

Surveillance activities at state level during SARS-CoV-2 pandemic

We describe the experience of the Rhineland-Palatinate State. The Federal State Agency for Consumer and Health Protection Rhineland-Palatinate (LUA) accommodates the formal state surveillance unit of Rhineland-Palatinate. The department's main tasks are to detect outbreaks, analyse trends and report vaccination rates. It advises the LHAs on anything related to surveillance and outbreak management. This teamwork between the LUA and the LHAs and the division of labour are a very important part of quality control of the surveillance system and highlight the fact that surveillance systems and software for surveillance are not equivalent (Bean and Martin 2001). An electronic surveillance system is only useful, when the data entered are meaningful, correct and complete. A relationship based on mutual support and trust between state and local level improves data quality significantly. Furthermore, local knowledge is substantial in state surveillance units since they are responsible only for a defined number of the LHAs.

The state surveillance unit analyses surveillance data on a regular basis for the whole state and disseminates the results to politicians, press and the public. Information that is more technical is given to stakeholders within the health and surveillance system. During the peak of case counts, one major task was the clarification and explanation of numbers and estimates drawn from the surveillance system to stakeholders in media and politics that were usually less involved with infectious disease surveillance.

One of the big advantages in Rhineland-Palatinate is the close collaboration between state laboratory and surveillance department. It was possible to connect variations in case numbers with the amount of samples tested in the laboratory that gave an indication of the general disease situation across the State. However, the influence of laboratory supply shortages on case counts is uncertain and should be part of a post-pandemic evaluation (Bean and Martin 2001).

Surveillance activities at local level during SARS-CoV-2 pandemic

Only about 10% of all personnel in an LHA are generally involved in the surveillance of infectious diseases (Brodhun et al. 2004). The majority of personnel in an LHA are not physicians (Brodhun et al. 2004). Furthermore, the LHAs have only limited epidemiological knowledge which could also influence management and response mechanisms (Brodhun et al. 2004). This was even more profound during the peak of SARS-CoV-2 cases, since personnel from other non-health administrative departments were recruited to support the LHAs. Their training through health staff may have been hampered by the amount of more urgent tasks to be performed. This may have reduced the quality of the investigations and data entry into the electronic infectious disease notification system due to lack of expertise and experience.

In 2004, all state surveillance units and a third of German LHAs used SurvNet@RKI as their surveillance software (Brodhun et al. 2004). Currently, two thirds of German LHAs use this software with an increasing trend (Hermann Claus, personal communication). In Rhineland-Palatinate, all LHAs use SurvNet@RKI. In other states, the multitude of different software platforms poses substantial problems to the surveillance output. The prospect of the implementation of the German electronic reporting and information system for infectious diseases (DEMIS) (Robert Koch Institute 2020e), a software that integrates the electronic notification of laboratory results, will likely increase adoption of SurvNet@RKI as main notification software. However, SurvNet@RKI is not designed nor suited for mass contact tracing. In the beginning of the pandemic, the majority of LHAs used MS Excel® spreadsheets to manage their contacts but soon the magnitude of cases and contacts overwhelmed these self-designed systems and both, open and commercial software designers started offering specific contact-tracing solutions (Helmholtz Centre for Infection Research 2020, Mikroprojekt GmbH 2020, MUNICH INQUIRE MEDIA GmbH 2020, Neuhann et al. 2020). Unfortunately, these software packages do not yet share an interface with SurvNet and therefore confirmed cases held in these contact-tracing systems require a second entry into SurvNet@RKI for mandatory notification procedures.

In a recent unpublished LUA survey, a convenience sample of 14 out of 24 LHAs exemplified the workload of the SARS-CoV-2 pandemic caused at the local level. The maximum amount of people contacted in relation to one index case ranged from 28 to 250 in the rural LHAs and 135-600 in an urban LHA. The LHAs were also asked for the total number of administrative procedures (phone calls, letters and mails) between 1 March-1 July 2020 needed in order to verify and investigate a possible or confirmed SARS-CoV-2 infection. One administrative procedure can entail multiple contacts between the LHA and a single person. The maximum number of administrative procedures was more than 18,000 in one single LHA. Divided by the number of laboratory confirmed cases, this corresponds to 20-60 procedures in the urban and 8-44 in the more remote areas per lab-confirmed case.

The management of cases adds to the strain of the LHAs because of the sudden increase of high case numbers and the more work-intensive management of

Covid-19 cases. Cases were asked to fill in diaries and local authorities called cases or visited them at home to ensure quarantine conditions were kept. The procedures used at local level differed depending on local capacities.

Also, the supervision of measures through community engagement and hygiene concepts falls under the jurisdiction of the LHAs. The investigation of international transmission chains and contacts is assigned to the local level with support from the state or national level. However, contact tracing of airplane passengers can be tremendously time consuming due to lack of support from carriers. International flight passenger data is often woefully incomplete as not all carriers fulfil their obligations mandated by IHR (World Health Organization 2008). Consequently, the timely coordination of Covid-19 activities is an immense burden on the local level.

Before the Coronavirus pandemic, the LHAs and the state surveillance unit in Rhineland-Palatinate did not have weekend shifts. The requirement to transfer case counts daily within the surveillance system and to react in a timely manner to the epidemic situation in the county made it inevitable to establish weekend shifts. The perpetuation of an epidemic state of emergency is greatly wearing down staff and prevents their recuperation.

Selected strengths and weaknesses of the surveillance system

One major advantage that Germany had in tackling the pandemic was the very early availability and capacity of PCR tests in different laboratories, probably triggered through an early cluster in Bavaria (Böhmer et al. 2020), the first mass quarantine of repatriates from Wuhan in Germersheim, and the timely dissemination of the PCR protocol through the Charité (Corman et al. 2020). Also, the technical flexibility of the notification architecture SurvNet@RKI allowed a quick adaptation of novel pathogen surveillance categories.

The fact that notification for SARS-CoV-2 infection is based on a positive laboratory result can be considered an advantage. Notifications coming from the laboratory are usually more frequent than the ones from physicians (Krause et al. 2003a, Krause et al. 2005). As of July 2020, clinical cases with a strong epidemiological link to a confirmed case, e.g. household member, do not fulfil the reference definition. However, the underlying notification framework could easily reclassify past and future notifications with a software update. The notification of clinical-epidemiological cases is advantageous during times of limited laboratory capacity and high burden of the public health system. At the same time, Covid-19 cases can be asymptomatic and people with Covid-19 related symptoms can be infected with a different pathogen, not SARS-CoV-2. This may blur the true case counts.

Up until recently, only positive tests were notifiable which makes sense in the context of a passive surveillance system for infectious diseases. However, the total number of tests performed in a population adds the powerful epidemiological metric of test-positivity (number of positive tests per total tests) within the population, broken down by time, place and person. Therefore, a recent amendment to the IfSG has been applied to make notification of negative SARS-CoV-2 tests mandatory as well. Until its technical implementation, the RKI relies on voluntary laboratory sentinels that provide these data and publishes State level positivity once per week in their situation reports (Robert Koch Institute 2020a, Seifried and Hamouda 2020).

When evaluating if the German surveillance system based on the IfSG was capable to detect outbreaks by unknown or emerging infectious diseases and if the system was simple, acceptable, stable, sensitive and well-timed, the answer was clearly positive (Krause et al. 2007).

Krause et al. evaluated the response to SARS in an article in 2003 and published recommendations how to prepare the system better for the next pandemic (Krause et al. 2003b). Problems identified in the response were the lack of notification of suspect cases and absent registration of contact persons and control measures. These problems are still valid today, but the LHAs have more or less individually tried to fill these gaps. Other identified limitations were the lack of a uniform software across all counties and the dependence on a fax notification instead of electronic entry (Krause et al. 2003b). The multitude of different software platforms used at local level still cause problems in the surveillance system. In the context of double entries of information into two software systems, this has an effect on timeliness and completeness. Moreover it poses an additional strain on the deficient personnel situation in the local and state public health authorities (Krause et al. 2003a).

At the beginning of the pandemic, the need for qualified and well-trained staff at the LHAs far outnumbered availability. The federal government followed a suggestion by the RKI to address this staff shortage of the LHAs by recruiting and providing so-called "containment scouts". They are mostly medical students or people of related background to support the health departments for six months during the SARS-CoV-2 pandemic. This was an immediate alleviation to benefitting the LHAs, but also meant training someone who will not be available in the long run.

A general and systemic issue of infectious disease surveillance in Germany is the lack of a formal One-Health approach (Wendt et al. 2016). SARS-CoV-2 is per definition a zoonotic pathogen but the role of inter-species transmission in this pandemic seems to be negligible (World Organisation for Animal Health 2020). Efforts in using a One Health approach have been limited so far despite the fact that the start of this pandemic was of animal origin. Testing and isolation of pet animals that have shown susceptibility to SARS-CoV-2 such as cats and dogs is not monitored in the general surveillance system to be able to generate transmission chains. A fruitful use of the One Health approach would need substantial structural, political, technical, economic and legal changes in both health systems that are not planned for the near future. However, a good start for a systemic implementation would be to foster networks and create designated teams between all disciplines. Epidemiological methods for example are similar if not the same between animal and human health, thus teams including veterinarians, physicians, environmental experts, food production specialists, communication experts amongst others could constantly work together at local, regional and national

level in outbreak situations and surveillance activities independent of the disease.

The current division of responsibilities and tasks at national, regional and local level as well as between the levels had advantages in coping with the pandemic, however, it needs to be evaluated. The decentralised system in Germany can slow down the response and leave people insecure about what the current regulations are in a given State considering the fast changing situation of the SARS-CoV-2 pandemic. On the other hand, local knowledge and networks are irreplaceable in complex settings where decisions have to be taken within a short time frame. Also, what impact did the current lack of technical resources, personnel and training have on the response to the pandemic? Were the containment scouts a useful measure to adopt? Last but not least, electronic surveillance using a different software platform in particular needs to be evaluated for data exchange, ease-of-use, flexibility, sensitivity, scalability and timeliness. An integrated system of chronic and infectious diseases and mortality should be addressed in the future.

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Ethical approval

The authors hereby declare that they have followed the universally accepted guidelines of good scientific practice while preparing the present paper.

Conflict of interest

The authors hereby declare that they have no proprietary, professional or other personal interests in any product, service and/or company that could have influenced the contents or opinions expressed in this publication.

Authors contribution

KS: conception and drafting of the manuscript; data collection, analysis and interpretation.
FB: critical revision of the article.

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