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Public health microbiology in Germany: 20 years of national reference centers and consultant laboratories



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ABSTRACT

In 1995, in agreement with the German Federal Ministry of Health, the Robert Koch Institute established a public health microbiology system consisting of national reference centers (NRCs) and consultant laboratories (CLs). The goal was to improve the efficiency of infection protection by advising the authorities on possible measures and to supplement infectious disease surveillance by monitoring selected pathogens that have high public health relevance. Currently, there are 19 NRCs and 40 CLs, each appointed for three years. In 2009, an additional system of national networks of NRCs and CLs was set up in order to enhance effectiveness and cooperation within the national reference laboratory system. The aim of these networks was to advance exchange in diagnostic methods and prevention concepts among reference laboratories and to develop geographic coverage of services. In the last two decades, the German public health laboratory reference system coped with all major infectious disease challenges. The European Union and the European Centre for Disease Prevention and Control (ECDC) are considering implementing a European public health microbiology reference laboratory system. The German reference laboratory system should be well prepared to participate actively in this upcoming endeavor.

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Introduction

Public health microbiology laboratories play a central role in detecting infectious disease, monitoring outbreak response and providing scientific evidence to prevent and control disease. They have important roles and responsibilities associated with accurate diagnosis, resistance testing and prevention of the spread of infectious disease. For example, outbreak investigations often depend on confirming cases by methods that are not commonly available in a routine laboratory setting. The scientific community, policy makers and pharmaceutical companies rely on advice and information from reference laboratories in order to adjust vaccine and antibiotic production (Witze et al., 2014). According to the European Centre for Disease Prevention and Control (ECDC), the five key activities of public health microbiology reference laboratories are reference diagnostics; reference material resources;

scientific advice; collaboration and research; and monitoring, alerting and responding (European Centre for Disease Prevention and Control, 2010). In the various European countries, microbiology reference laboratories are defined, organized, maintained and operated differently. We present an overview of Germany's public health reference laboratory system.

Organizational structures in Germany

Germany is a highly industrialized country with 82 million inhabitants, and is made up of 16 federal states ("Länder"). The principal responsibility for public health lies with the 16 states, or with their ministries of health, and with the almost 400 local public health departments. Since the 1980s, the federal government ("Bundesregierung"), federal assembly ("Bundestag") and federal council ("Bundesrat") have increasingly taken responsibility for healthcare reform and legislation. Specific health issues, such as infectious diseases that threaten public safety and life cycle management of pharmaceuticals, are within the jurisdiction of the federal government. For example, the German Protection against

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Infection Act (“Infektionsschutzgesetz,” IfSG) as a Federal law regulates the prevention and management of infectious diseases in humans. Federated states are responsible for all primary aspects of public health, but there are also responsible for the implementation of federal laws, including federal social and labour laws.

The Robert Koch Institute (RKI) is a federal institute within the portfolio of the Federal Ministry of Health (Bundesministerium für Gesundheit, BMG). As such the RKI is the central federal reference institution in the public health sector responsible for disease monitoring, control and prevention and conducting applied and response-oriented research in the field of disease control and prevention at the federal level. The research activities of the RKI are partly directly related to the activity fields of a ministry.

Mission of national reference centers and consultant laboratories in Germany

Although Robert Koch and his contemporaries built a strong tradition for infectious disease epidemiology in Germany in the late 19th and early 20th centuries, this tradition had all but disappeared in the 1930s and 1940s (Allerberger, 2013). In former West Germany, the work of the RKI as part of the then Federal Health Office (Bundesgesundheitsamt, BGA) mainly focused on basic science research. The AIDS epidemic demanded a national public health response which resulted in the creation of the National AIDS Centre in 1988. In 1994, when the BGA was dissolved and the RKI was assigned additional spheres of competence a combined AIDS center and infectious disease epidemiology division was created at the RKI. In 1995, representatives of the RKI, the Federal Ministry of Health and the Federal Ministry for Education and Research developed the concept of a network of collaborators whose goal was to intensify epidemiological research and improve infectious disease surveillance (Fock et al., 1995). As part of this concept, the RKI implemented a weekly epidemiological bulletin, formed the Committee for Infectious Disease Epidemiology, trained epidemiologists for surveillance and outbreak investigation and set up a system of national reference laboratories: national reference centers (NRCs) and consultant laboratories (CLs) (Petersen et al., 2000). They were responsible for laboratory surveillance of important pathogens and syndromes. These laboratories are considered national centers of excellence in the field of laboratory science for a particular pathogen or group of pathogens.

NRCs establish and use reference methods, and can validate and verify test results from other laboratories (confirmatory testing). NRCs also produce and distribute reference materials for external quality control and assurance. Owing to the high level of expertise, resources and infrastructure, NRCs and CLs are involved in training and in providing expert advice to national health authorities and other laboratories. Moreover, these laboratory scientists work closely together with their epidemiologist counterparts at the RKI as well as those at the federal, state and local levels. The NRCs focus on outbreak detection and response and advice the RKI in the preparation of case definitions according to the Protection against Infection Act (IfSG). Furthermore, the reference laboratories conduct or are involved in laboratory surveillance systems which provide additional information complementing statutory notifications. NRCs and CLs are also involved in developing RKI guidelines for physicians (“Ratgeber für Ärzte”) as well as investigating outbreaks and conducting epidemiological studies.

The following are the basic tasks of NRCs and CLs, which include detailed requirements referring to specific pathogens or syndromes as listed in the respective calls for tenders:

General catalogue of NRC tasks

- (1) Developing or improving diagnostic procedures; coordinating standardization and distribution of generally accepted test procedures; initiating investigations for quality assurance.
- (2) Diagnosing and subtyping pathogens beyond routine measures, including molecular biological studies to elucidate the epidemiological context.
- (3) Maintaining a strain collection and distributing reference strains or diagnoses of specific reference strains, with the exception of commercially available isolates, such as from the American Type Culture Collection (ATCC) and the German Collection of Microorganisms and Cell Cultures (DSMZ).
- (4) Organizing and coordinating the upkeep of a network of diagnostic facilities.
- (5) Providing a consulting service for public health services laboratories, practicing physicians, hospitals and research institutes; implementing continuing education and handling public relations.
- (6) Collaborating with reference laboratories of other countries as well as collaborating centers of the WHO, including participating in international ring trials.
- (7) Evaluating and interpreting data in coordination with the RKI with the aim of best describing the epidemiological situation relevant for Germany; initiating and participating in surveillance projects.
- (8) Monitoring incoming data with the goal of timely detection of outbreaks or outbreak hazards as well as immediate communication with the RKI; support of public health services and the RKI with complementary studies during outbreak investigations.
- (9) Epidemiological analysis and evaluating the development of resistance and virulence.
- (10) Reporting routinely to and consulting with the RKI on relevant issues; participating in developing RKI recommendations for diagnostics, therapies and prevention as well as for applied epidemiology of infectious diseases in general.

General catalogue of CL tasks

1. Consulting (especially with the public health services as well as laboratories, practicing physicians, hospitals and research institutes).
2. Working within the framework of quality assurance (participating in studies and inter-laboratory tests, e.g., in cooperation with INSTAND (German EQAS), WHO, EU, and professional associations and participating in further education).
3. Improving or developing diagnostic procedures.
4. Participating in epidemiological evaluations of the current situation by the RKI.
5. Carrying out studies within the network of diagnostic facilities.
6. Consulting with the RKI in developing scientific materials concerned with pathogens or symptoms (e.g., case definitions, RKI guidelines for physicians).

The number of NRCs increased from 12 in 1995 to 15 in 2009. Presently, 19 NRCs have been appointed (Table 1). Five laboratories are situated at the RKI; the others are located at various universities and research facilities in Germany. Since 1996, 46 CLs have decreased to 40 designated CLs, mainly devoted to providing scientific advice (Table 2). Currently a total of 59 NRCs and CLs located at universities, federal or state institutes and private laboratories are supported for this function by the RKI.

The high relevance of NRC and CL work for the surveillance of infectious diseases is evident by the wide range of national and international publications. For example, the NRC for mycobacteria and the RKI performed analyses of routine laboratory diagnosis data of pediatric tuberculosis in the European Union/European

Table 1

List of the 19 national reference centers in Germany (June 2015).

Borrelia
Head: Dr. Volker Fingerle, Bavarian Health and Food Safety Authority, Oberschleissheim
Helicobacter pylori
Head: Dr. Erik Glocker, University Freiburg
Meningococcal diseases and H. influenzae
Head: Prof. Dr. Ulrich Vogel, Prof. Dr. Matthias Frosch, University Wuerzburg
Mycobacteria
Head: Dr. Katharina Kranzer, Research Centre Borstel
Salmonella and other bacterial enteritis pathogens
Head: Prof. Dr. Antje Flieger, Robert Koch Institute, Wernigerode
Staphylococci and Enterococci
Head: Dr. Guido Werner, Robert Koch Institute, Wernigerode
Streptococci
Head: Dr. Mark van der Linden, University Aachen
Invasive mycotic infections
Head: Dr. Oliver Kurzai, Friedrich-Schiller-University Jena
Hepatitis B and D viruses
Head: PD Dr. Dieter Glebe, University Giessen
Hepatitis C viruses
Head: Prof. Dr. Stefan Ross, University Essen
Influenza
Head: Dr. Brunhilde Schweiger, Robert Koch Institute, Berlin
Measles, Mumps, Rubella
Head: PD Dr. Annette Mankertz, Robert Koch Institute, Berlin
Papilloma and polyoma viruses
Head: Prof. Dr. Herbert Pfister, University Koeln
Poliomyelitis and enteroviruses
Head: Dr. Sabine Diedrich, Robert Koch Institute, Berlin
Retroviruses
Head: Prof. Dr. Oliver Keppler, University Frankfurt/Main
Tropical infection agents
Head: Prof. Dr. Bernhard Fleischer, Bernhard-Nocht-Institute for Tropical Medicine Hamburg
Gram-negative hospital-acquired infections
Head: Prof. Dr. Soeren Gatermann, University Bochum
Surveillance of nosocomial infections
Head: Prof. Dr. Petra Gastmeier, Charite—Universitätsmedizin Berlin
Surveillance of transmissible spongiform encephalopathies
Head: Prof. Dr. Inga Zerr, University Goettingen

Economic Area (Sanchini et al., 2014). The NRC for *Helicobacter pylori* and the RKI examined *H. pylori* resistance to antibiotics in Europe and its relationship to antibiotic consumption (Megraud et al., 2013). Another example is the work of the streptococci NRC, which studied the epidemiology of *Streptococcus pneumoniae* Serogroup 6 isolates from invasive pneumococcal disease in children and adults in Germany (van der Linden et al., 2013). NRCs and CLs are also involved in outbreak investigations and epidemiological studies. For instance, the CL for coronaviruses performed contact investigation for an imported case of Middle East respiratory syndrome (Reuss et al., 2014), and the influenza NRC was involved in detecting local influenza outbreaks (Schweiger and Buda, 2013). The RKI and the NRC for surveillance of nosocomial infections examined the question, “How many outbreaks of nosocomial infections occur in German neonatal intensive care units annually?” (Schwab et al., 2014). Additionally, the CL for legionella was involved in examining a Legionnaires’ disease outbreak associated with a cruise liner in August 2003 (Beyrer et al., 2007). Dengue virus infections in a traveler returning from Croatia to Germany were analyzed by the NRC for tropical infection agents (Schmidt-Chanasit et al., 2010). The NRC and the RKI for meningococcal diseases and *H. influenzae* examined a cluster of invasive meningococcal disease in young men who have sex with men in Berlin (Marcus et al., 2013). NRCs and CLs are also involved in evaluating implemented vaccination recommendations and analyzing the effectiveness of the vaccines (Kalies et al., 2009; Ruckinger et al., 2009).

Management of national reference centers and consultant laboratories in Germany

For which pathogen a reference laboratory is to be established is decided based on the public health relevance of the pathogen as appraised by the RKI and on the needs expressed by the national public health services (“Öffentlicher Gesundheitsdienst,” ÖGD) (Gilsdorf and Krause, 2011). In addition, medical professional societies, the Federal Ministry of Health and other third parties can approach the RKI with perceived needs for additional reference laboratories. In the next step, the Advisory Board for Public Health Microbiology (formerly called the Committee for Infectious Disease Epidemiology) assesses the proposal and provides the RKI with a recommendation on whether to set up a new laboratory. In addition to the epidemiological relevance, and a declared need from national public health services, the availability of financial resources is another essential criterion. The decision to establish or continue an NRC or a CL is made by the RKI, which considers recommendations given by the Advisory Board for Public Health Microbiology, and must be confirmed by the Federal Ministry of Health. Appointments are restricted to three-year periods. The advisory board consists of up to 14 experts, appointed by the RKI for periods of three years. The members of this advisory forum are renowned experts in the fields of microbiology, virology, hygiene, epidemiology and public health. Occasionally, other national and international professional societies and experts are consulted to achieve a solid appraisal of the candidate laboratories.

From 2009 to 2012, numerous important modifications were made to improve the transparency of the tendering and selection processes for the NRCs and the CLs. A strict prioritization process, based upon necessity and not upon offer, was implemented. The evaluation process became more rigorous. Essential evaluation criteria are public health needs and public health relevance, successful network activities, attestable quality assurance, publications as well as a positive appraisal of the advancement of diagnostic procedures. At the end of each appointment period, an evaluation of the laboratories is performed by the RKI in cooperation with the Advisory Board for Public Health Microbiology, which again consults national and international professional societies and experts. Based on the evaluation results, the president of the RKI, in cooperation with the Federal Ministry of Health, appoints and reappoints the NRCs and CLs. The 2013 evaluation of the CLs resulted in the reappointment of 40 CLs and the shutdown of nine CLs. Reasons for closing were, for example, the retirement of the laboratory head (appointments are based on the combination of personal and institutional expertise), decreased public health relevance of the pathogen or an overlapping of the functional areas of responsibility with other CLs or NRCs. In the 2013 evaluation of the NRCs, all 19 NRCs were reappointed.

In 2007, the 16 NRCs were supported with €1540,000 in total. In 2008, the available funding increased to €2173,000. The NRCs received between €57,000 and €241,000 per year. The decision on the level of funding of individual NRCs is made by the RKI, based on criteria such as high consultation effort, high sample appearance and extraordinary public health relevance of the pathogen. In contrast to the NRCs, which have always been financially supported, the CLs initially performed their work (mainly consultation) without any financial support. From April to December 2009, the CLs received basic funding of €5000 per year (total amount in 2009: €2173,000). In 2010, the available funding increased to €2612,000. The increase in funding was used to upgrade the CLs’ basic funding to around €10,000 per year. Beyond that, the funds had to cover new national networks. In 2014, the 19 NRCs received between €60,000 and €253,000 per year. Thirty-three of the CLs get €10,200, and seven CLs with a high number of samples and extraordinary public health relevance of the pathogen received €16,000 per year.

Table 2
List of the 40 consultant laboratories in Germany (February 2015).

Bacteria (n = 21)
Anaerobic bacteria
Head: Prof. Dr. Arne Rodloff, University Leipzig
Bacillus anthracis
Head: PD Dr. Roland Grunow, Robert Koch Institute, Berlin
Bartonellosis
Head: Prof. Dr. Volkhard Kempf, University Frankfurt/Main
Bordetella pertussis
Head: Prof. Dr. Carl-Heinz Wirsing von Koenig, Labor:Medizin Krefeld
Brucella
Head: Prof. Dr. Lothar Zoeller, Institute for Microbiology of the German Armed Forces, Munich
Chlamydia
Head: Prof. Dr. Eberhard Straube, University Jena
Clostridium botulinum
Head: Dr. Brigitte Dorner, Robert Koch Institute, Berlin
Clostridium difficile
Head: PD Dr. Lutz von Müller, University of Saarland, Homburg/Saar
Coxiella burnetii
Head: PD Dr. Silke Fischer, Public Health Authorities of Baden-Wuerttemberg, Stuttgart
Diphtheria
Head: PD Dr. Dr. Andreas Sing, Bavarian Health and Food Safety Authority, Oberschleissheim
Gonococcus
Head: Prof. Dr. Peter Kohl, Vivantes Clinical Centre Berlin-Neukoelln
Hemolytic-uremic syndrome (HUS)
Head: Prof. Dr. Dr. Helge Karch, University Muenster
Legionella
Head: Dr. Christian Lück, Technical University, Dresden
Leptospirosis
Head: Dr. Karsten Noeckler, German Federal Institute for Risk Assessment, Berlin
Listeria (binational consultant laboratory)
Head: Dr. Steliana Huhulescu, Austrian Agency for Health and Food Safety, Wien, Austria
Head: Prof. Dr. Antje Flieger, Robert Koch Institute, Wernigerode
Mycoplasmas
Head: Prof. Dr. Enno Jacobs, Technical University, Dresden
Pseudomonas-bacteriology
Head: Prof. Dr. Sebastian Suerbaum, University Hannover
Treponema (diagnostics/therapy)
Head: Prof. Dr. Hans-Jochen Hagedorn, Labor Krone, Bad Salzufflen
Tularemia
Head: PD Dr. Roland Grunow, Robert Koch Institute, Berlin
Tropheryma whipplei
Head: PD Dr. Annette Moter, Centre for Biofilms and Infection at the German Heart Institute Berlin
Yersinia pestis
Head: PD Dr. Holger Scholz, Institute for Microbiology of the German Armed Forces, Munich
Parasites and Fungus (n = 4)
Cryptococcosis, scedosporiosis and imported systemic mycosis
Head: Dr. Kathrin Tintelnot, Robert Koch Institute, Berlin
Dermatophytes
Head: PD Dr. Yvonne Gräser, Charite—Universitaetsmedizin Berlin
Echinococcus
Head: Prof. Dr. Mathias Frosch, University Wuerzburg
Toxoplasma
Head: Prof. Dr. Uwe Gross, University Goettingen
Viruses (n = 14)
Adenoviruses
Head: PD Dr. Albert Heim, Hannover Medical School
Coronaviruses
Head: Prof. Dr. Christian Drosten, University Bonn
Cytomegalovirus
Head: Prof. Dr. Thomas Mertens, University Ulm
Filoviruses
Head: Prof. Dr. Stephan Becker, University Marburg
Hantaviruses
Head: Prof. Dr. Detlev Krueger, Charite - Universitaetsmedizin Berlin
Hepatitis A virus, hepatitis E virus
Head: Dr. Juergen Wenzel, University Regensburg
Herpes-simplex virus and varicella zoster virus
Head: Prof. Dr. Andreas Sauerbrei, University Jena

Table 2 (Continued)

Noroviruses
Head: Dr. Marina Hoehne, Robert Koch Institute, Berlin
Parvoviruses
Head: Prof. Dr. Susanne Modrow, University Regensburg
Poxviruses
Head: PD Dr. Andreas Nitsche, Robert Koch Institute, Berlin
Rotaviruses
Head: Dr. Marina Hoehne, Robert Koch-Institute, Berlin
Respiratory syncytial virus, para-influenza virus, metapneumoviruses
Head: Dr. Janine Reiche, Robert Koch Institute, Berlin
Rabies
Head: Prof. Dr. Stefan Ross, University Essen
Tick-borne encephalitis
Head: PD Dr. Gerhard Dobler, Institute for Microbiology of the German Armed Forces, Munich
Electron-microscopic pathogen differentiation (n = 1)
Electron-microscopic pathogen differentiation
Head: Dr. Norbert Bannert, Robert Koch Institute, Berlin

The network projects were funded with approximately €380,000 in 2014. The NRCs have a more comprehensive work package than the CLs and therefore the NRC receive a higher funding. Public funding does not and cannot cover the total costs of the reference laboratories. Since 2010, the sphere of action and the workload of the laboratories have increased due to advancement of methods. At the same time costs in general have increased, but the grant total has remained unchanged. Currently, funding increases for individual laboratories can occur only through money shifting from one laboratory to another or through giving up funding for existing NRCs or CLs. In order to maintain the current quality and scope an increase in funding for NRCs and CLs is urgently needed.

National networks

Since 2005, the RKI, in close cooperation with the Advisory Board for Public Health Microbiology, has worked to foster collaboration between and among the NRCs and the CLs. This concept was amended in a workshop with representatives of public health microbiology laboratories of other EU member states in 2008. Ten NRC networks were launched at a work conference of the standing working group of NRCs and CLs (“Ständige Arbeitsgruppe NRZ/KL”) in Stuttgart in 2009. These networks covered the following topics: respiratory tract infections; enteral infections; infections in patients with immune deficiency or pregnancy; invasive bacterial infections; zoonoses; mycoses; sexual and blood transmitted infections; infections of the nervous system; antimicrobial resistance; and parasitoses, tropical and vector-borne infections. The aim of these networks was to facilitate the exchange of diagnostic methods among the NRCs and CLs, to improve collaboration in planning and performing studies and to enlarge the geographic coverage of these services. Furthermore, these networks should provide opportunities to work on issues beyond single pathogens.

Scientific coordination and administration are supervised by the RKI. The Advisory Board for Public Health Microbiology and external experts play a pivotal role in selecting the proposed network projects. Essential selection criteria are public health relevance and the scientific quality of the proposal, the prospect of success and the cost efficiency of the planned network project. Moreover, it is important that these projects contribute to expanding the network's characteristics. An exclusion criterion is if the project addresses established NRC or CL tasks.

In 2010, the network projects were funded with €400,000 per year, allocated to ten projects (duration 1.5 years). As of 2011, network projects ran for three years. In the funding period 2011–2013, the RKI supported eight projects. Within the scope of the projects, common database infrastructures were set up, such as tissue material and serums. Other projects performed cross-sectional studies

to ascertain data on the prevalence and incidence of different pathogens. In 2014, the RKI evaluated the present composition and structure of the networks. The evaluations revealed that difficulties with ethical approval and with compliance with data protection and juridical aspects were the most commonly experienced hurdles during the study planning process. Recruiting participating laboratories was also a challenge for some projects. It became clear that early involvement of epidemiological and statistical experts is necessary to further optimize study design and case number planning for the specific research questions and to raise the prospects of success for the projects.

In addition to this evaluation, the RKI organized a network meeting in 2014, in which all NRCs and CLs were represented. Members of the Advisory Board for Public Health Microbiology and representatives of the Federal Ministry of Health participated. At this meeting, the networks shared their experiences. Potential for improvement from the perspective of the members of the NRCs and CLs as well as from the RKI and the Advisory Board for Public Health Microbiology was identified and discussed. As a consequence of this meeting, the RKI initiated the following changes:

- (1) Regular network meetings with all NRCs and CLs
To address the stated need for regular face-to-face meetings, the RKI will organize network meetings every three years. The meetings will take place one year before the start of the upcoming funding period for network projects, so that the NRCs, the CLs and the RKI can elaborate on the content and structure of project submissions.
- (2) Basic funding for the networks
The RKI will provide annual basic funding to allow for separate meetings of the respective networks, to facilitate exchange among network participants regardless of successful project applications. These meetings can be used for more intensive preparation of new project proposals and should strengthen network cohesion.
- (3) Stronger presence of the networks on the Internet
To satisfy network demand for the presentation of network projects to a larger professional audience, accepted projects will be presented on the RKI's Internet site.
- (4) Decrease in the number of funded projects
In the past, the RKI funded up to eight projects; in 2014, the institute decided to decrease the number of projects funded per period in the future. In the current funding period four projects were selected for funding. In the following period only two projects will be financed. That implies higher financial support for single projects, which could be used to employ a study coordinator.
- (5) Two-stage application procedure for network projects
The RKI installed a two-stage application procedure for network projects. As the first step, the networks formulate short pre-applications. The RKI screens these short concepts for network projects with the help of the Advisory Board for Public Health Microbiology and external experts. In the case of positive assessment, the networks are asked to submit a detailed project proposal for final evaluation.

Conclusion and perspectives

During the last 20 years, the field of public health microbiology has seen many changes. The everyday work of local public health agencies depends on the professional expertise of national reference centers (NRCs) and consultant laboratories (CLs). Meanwhile, the public often sees the relevance of public health microbiology only within the context of serious health events. During periods of restricted financial resources, the need for public health

infrastructures is consistently questioned. The large EHEC O104 outbreak in Hamburg during 2011 provides an example of the importance of public health laboratory infrastructures (Frank et al., 2011). During the Hamburg outbreak caused by fenugreek sprouts, the German public health system successfully investigated and controlled the outbreak, which would not have been possible without support from the NRC for enteral infections and the CL for hemolytic uremic syndrome (HUS). This support would not have been possible without these highly specialized laboratory structures. The work of all other NRCs and CLs is also highly relevant, since their work and expertise help in the efforts to contain and prevent higher levels of infectious disease. Nevertheless, there is also room for improvement in Germany. For example, the anticipating of new outbreak situations that might require cooperation with the responsible veterinarian and food authorities or with other national authorities should be the focus of optimization plans. The creation of a prospective network of EU-wide public health microbiology reference laboratories is currently being discussed within the European Union, which will have consequences for the public health laboratory systems of each member state. From this perspective, considerable future challenges to the German public health laboratory system can already be foreseen. Thus, the structures established during the past 20 years should be adaptable so that the responding public health infrastructures can react adequately to the upcoming challenges.

Conflict of interest statement

Sandra Beermann, Franz Allerberger, Angela Wirtz, Osamah Hamouda and Reinhard Burger have no financial disclosures to declare.

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