zoonotic diseases

Article

Basis for a One Health Approach—Inventory of Routine Data Collections on Zoonotic Diseases in Lower Saxony, Germany

Anne Schnepf [1,*], Katja Hille [2], Gesine van Mark [3], Tristan Winkelmann [1], Karen Remm [3], Katrin Kunze [3], Reinhard Velleuer [3] and Lothar Kreienbrock [1]

1 Department of Biometry, Epidemiology and Information Processing, WHO Collaborating Centre for Research and Training for Health in the Human-Animal-Environment Interface, University for Veterinary Medicine, 30559 Hannover, Germany; lothar.kreienbrock@tiho-hannover.de (L.K.)
2 Department for Infectious Disease Epidemiology, Public Health Agency of Lower Saxony, 30449 Hannover, Germany
3 Lower Saxony State Office for Consumer Protection and Food Safety, 26133 Oldenburg, Germany
* Correspondence: anne.schnepf@tiho-hannover.de

Simple Summary: To the authors' knowledge, there is currently no standardised inventory on information on regularly collected routine data on zoonotic infections, meaning that they can spread from animals to humans and the other way around. We used a template with specific questions on the level of the data base and the different pathogens documented in each of these. To support further development in this sector, we gathered information on 37 different data bases, mainly from the human and veterinary sector, and showed opportunities and challenges in joint analysis of data from these data collections.

Abstract: Two-thirds of human infectious diseases are zoonotic diseases and routine data collections exist for each sector (human, veterinary, environmental). However, these operate separately and the collected data are not integrated across sectors. Publicly available information on these routine data collections in terms of metadata and the information collected is sparse. The aim was to create an inventory of routine data collections in the Federal State of Lower Saxony, Germany. A systematic screening of existing routine data collections from the human and veterinary sectors on zoonotic infectious diseases was carried out on the basis of expert interviews. A standardised template was used to collect relevant metadata on data collections and pathogens they contain. The template was transferred to Research Electronic Data Capture tools. We recorded metadata for 19 veterinary, 16 human and 2 other data collections, and for 69 different zoonotic pathogens. The frequencies of a selection of metadata were analysed descriptively. The data collections, which served different purposes, differed, e.g., in underlying population and sampling strategy, export format and access to the original data. We identified challenges for integrated analyses of data from different collections, which need to be addressed to develop a One Health monitoring and surveillance system.

Keywords: human health; animal health; metadatabase; secondary data use; foodborne infections

check for updates

Citation: Schnepf, A.; Hille, K.; van Mark, G.; Winkelmann, T.; Remm, K.; Kunze, K.; Velleuer, R.; Kreienbrock, L. Basis for a One Health Approach—Inventory of Routine Data Collections on Zoonotic Diseases in Lower Saxony, Germany. *Zoonotic Dis.* **2024**, *4*, 57–73. https://doi.org/10.3390/zoonoticdis4010007

Academic Editors: Francesco Vairo and Stephen K. Wikel

Received: 15 December 2023
Revised: 16 January 2024
Accepted: 25 January 2024
Published: 6 February 2024

1. Introduction

Although approximately two-thirds of all human infectious diseases are zoonotic infections [1], data from public health and veterinary authorities are usually not routinely linked and analysed together. Zoonotic pathogens can cause both acute (e.g., gastrointestinal) and chronic diseases (e.g., endocarditis following a Q fever infection [2]) and are therefore of high public health relevance. In Germany, of the about 60 notifiable pathogens (according to the German infection protection law) about 40 can be classified as zoonotic. One of the most frequent notifiable zoonotic, thus One Health-relevant, infection of which food is the main source of infection, is Campylobacter spp. with 60,000–70,000 cases per year (80–90 cases per 100,000 inhabitants) in Germany [3]. The control of zoonoses is a major One Health challenge. Globalisation, trade and climate change, among others, cause changes in living conditions and affect the transmission and occurrence of zoonoses [4–6]. This can be observed at global, national and local levels. Multisectoral monitoring, meaning primarily the simultaneous consideration of the human, animal and environmental sectors, is therefore of particular importance.

In Germany, existing routine data collections as well as monitoring and surveillance systems (MOSS) for the documentation of zoonotic agents in the human, animal and environmental sectors are currently operated separately [7–9]. Data on the national level are collected according to different regulations, e.g., the Act on the Prevention and Control of Infectious Diseases in Humans of 20 July 2000 (BGBl. I p.1045) as amended on 17 July 2023 (BGBl. 2023 I No. 190), the Directive 2003/99/EC of the European Parliament and of the Council of 17 November 2003 on the monitoring of zoonoses and zoonotic agents, amending Council Decision 90/424/EEC and repealing Council Directive 92/117/EEC [10] or the General administrative regulation on the collection, analyses and publication of data about the occurrence of zoonoses and zoonotic agents along the food chain from 10 February 2012, last changed on 13 September 2023 (BAnz AT 13 September 2023 B1). Additional data collections are applied only in specific federal states. For example, in Lower Saxony, the (human medicine) Surveillance for influenza and other acute respiratory illnesses (ARE) or particular pathogen-based laboratory projects in veterinary medicine.

The linkage of data from human and veterinary medicine in the sense of a One Health approach has been repeatedly discussed and recommended [8,11,12]. In Germany, the existing documentation systems serve different purposes and are operated under the legal responsibility of different authorities. So far, information exchange between human and veterinary health authorities in disease outbreak situations is only partially standardised and takes place in a rather informal way. However, a One Health MOSS, or framework, has only been established for basic data.

This study was carried out as part of the Connect One Health Data (Connect OHD) project. The overall aim of the Connect OHD project was to develop a concept, using underlying metadata structures of routine data collections, for a targeted integration and analysis of existing data collections to improve One Health surveillance. The aim of the present investigation is to provide an inventory of the existing routine data collections for zoonotic pathogens in Lower Saxony and corresponding metadata to set up the basis for secondary data use in the Connect OHD project.

2. Materials and Methods

2.1. Concept of the Study and Collaborating Partners

For this investigation, the Federal State of Lower Saxony, Germany, was chosen as a model region, because of the high livestock density and the existing cooperation between the sectors. The number of inhabitants in Lower Saxony is over 8,000,000 (31 December 2021 [13]). The number of food-producing animals is almost 100,000,000 (over 25,000 farms), including approx. 2,360,000 dairy and beef cattle (over 15,000 farms), 8,600,000 pigs (over 6000 farms), 55,500,000 broiler (over 900 farms) and 20,200,000 laying hens (over 4000 farms) and 5,000,000 turkeys (over 300 farms) (1 March 2020 [14–16]).

In Lower Saxony, data on zoonotic pathogens are mainly collected, compiled and managed by the Public Health Agency of Lower Saxony (NLGA) for human data and the Lower Saxony State Office for Consumer Protection and Food Safety (LAVES) for data from animal, food and feed origin. As the overall aim is to link data on zoonotic pathogens from routine data collections, these important stakeholders have been involved as project partners. The Department of Biometry, Epidemiology and Information Processing at the University of Veterinary Medicine Hannover (TiHo) was responsible for project coordination, data integration, management and analysis.

2.2. Identification and Selection of Data Collections and Pathogens

A systematic screening of existing human and veterinary data collections in Lower Saxony, focusing on routine data collections to which we have access at LAVES and NLGA, was performed. We also included data collections on zoonotic pathogens held by other institutions, e.g., the Friedrich-Loeffler-Institute, Federal Research Institute for Animal Health (FLI). Criteria for the inclusion of data collections was the regular recording of data on at least one zoonosis or zoonotic pathogen, independent of the population studied, the objective of surveillance and it had to refer to Lower Saxony and Germany. In addition, data collections on other One Health-relevant information, e.g., weather data, were included. In order to ensure that we have a complete collection of routine data in Lower Saxony, various experts were consulted during the enrolment process and missing data collections were included. The search for data collections, documentation of metadata, as well as continuous updating was carried out from April 2020 to February 2022.

2.3. Collection of Metadata on Data Collections and Pathogens

In order to record information (metadata) of data collections, we developed a standardised template based on Wendt [17]. The template was optimised after consultation with respective thematic experts and tested in a pilot phase, where it was applied to two data collections in each sector. It was used to collect standardised metadata for the hierarchical levels of data collections, pathogens and variables. The same template was used for each sector (human, veterinary and environmental).

The template included 71 items on the data collection levels. The information recorded included the responsible institution, the purpose of the data collection, the populations covered (e.g., animals, humans, environment), the lowest level of aggregation of the original data, type of data collection (e.g., sampling), as well as possibilities to access the data.

For each data collection, we collected information at the pathogen level on the sample material examined, the depth of differentiation of the pathogens, the legal basis of the sample collection and on the availability of geographical or temporal information. At the pathogen level, the metadata included 50 items.

For each variable recorded in the data collection, 13 items, e.g., on variable content, data type and format, were collected (the original version of the template used can be found in Supplement S1, the translated version in Supplement S4).

The translation of the original template used was done with the help of deepl.com (accessed on 31 January 2023) and additional screening and correction by the authors. Metadata were gathered by the study team based on publicly available information and with the help of the experts for the respective data collection. For the management of metadata, the template itself was transferred to the Research Electronic Data Capture (REDCap) tools [18,19] hosted at TiHo. Access to the REDCap database can be requested from the authors after formal approval.

3. Results

3.1. Metadata of Data Collections

The metadata of 37 data collections were recorded. Nineteen data collections were assigned to the veterinary sector, sixteen to the human sector and two could not be assigned to either sector (see Supplement S2). For five of the human data collections, the NLGA is the competent authority, and for five of the veterinary data collections the LAVES. The other data collections are under the responsibility of different institutions.

Of the examined data collections, fourteen refer to the "human" population, four to the "animal" population, four to "food or feed", two to "environment or water", four to "other" targets, like demographics and nine data collections refer to a combination of different populations like "animal" and "food or feed" (Figure 1).

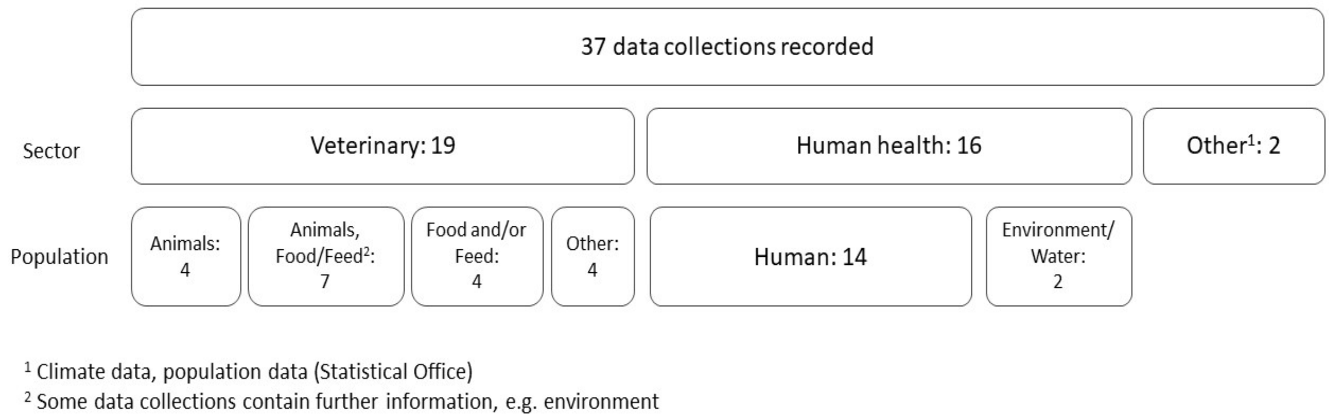

Figure 1. Overview of the number of recorded data collections as well as the corresponding sector and population of interest in Lower Saxony.

Of the 37 data collections, 13 are not pathogen-based, i.e., do not contain specific pathogen information (but some health-related information, e.g., climate data and trade). For further six data collections, pathogen-related metadata were not collected because zoonotic pathogens are in practice rarely documented in these data collections (e.g., haemovigilance report, diagnoses in hospitals) or there was an overlap between data collections and pathogen metadata were already collected for another data collection, e.g., the laboratory information management system (LIMS), which data are used for different purposes (Table 1). The LIMS of the LAVES collects information on all processed samples, associated tests and results. Therefore, it contains information on samples from different investigation programs, e.g., the federal surveillance plan, the MOSS according §§ 50-52 German Food and Feed Code, the National Residue Control Plan, the Monitoring of zoonoses and zoonotic agents, the Zoonoses Trend Reports and the Salmonella control programme. Thus, metadata of the data collections of the LAVES and the contained data collections were collected for each one, but, in order to avoid overlapping and double information, the pathogen part of the template was not used for these data collections. Furthermore, connections between data collections were documented.

Table 1. Overview of One Health data collections on zoonotic pathogens examined for Lower Saxony.

Data Collection	Population of Interest	Competent Authority	Number of Zoonotic Pathogens Recorded
	Human		
Causes of death	Human	Federal Statistical Office of Germany	36
Causes of death, Lower Saxony	Human	State Office for Statistics of Lower Saxony	4
Haemovigilance blood donations (Hämovigilanz Blutspenden)	Human	Paul-Ehrlich-Institut (PEI)	0
Hospital diagnoses—Full inpatients discharged from hospital (Krankenhausdiagnosen—Aus dem Krankenhaus entlassene vollstationäre Patientinnen und Patienten)	Human	Federal Statistical Office of Germany	31
Hospital diagnoses—Quality reports of the hospitals (Krankenhausdiagnosen—Qualitätsberichte der Krankenhäuser)	Human	Federal Joint Committee	0

Table 1. *Cont.*

Data Collection	Population of Interest	Competent Authority	Number of Zoonotic Pathogens Recorded
Krankenhaus-Infektions-Surveillance-System—Surveillance of nosocomial infections in intensive care units (Krankenhaus-Infektions-Surveillance-System (KISS)—Surveillance nosokomialer Infektionen auf Intensivstationen (ITS-KISS Infektionen)	Human	National Reference Center for Surveillance of Nosocomial Infections (NRZ)	3
Meningitis and Encephalitis Register in Lower Saxony (Meningitis- u. Enzephalitis Register in Niedersachsen (MERIN))	Human	Public Health Agency of Lower Saxony (NLGA)	2
Surveillance for influenza and other acute respiratory illnesses in Lower Saxony—Module virological surveillance (Surveillance für Influenza und andere akute respiratorische Erkrankungen (ARE) in Niedersachsen—Modul virologische Surveillance (ARE-Labor))	Human	Public Health Agency of Lower Saxony (NLGA)	3
Surveillance for influenza and other acute respiratory illnesses in Lower Saxony—Module sickness rate (Surveillance für Influenza und andere akute respiratorische Erkrankungen (ARE) in Niedersachsen—Modul Krankenstand (ARE-Krankenstand))	Human	Public Health Agency of Lower Saxony (NLGA)	Not pathogen-based
Surveillance of Clostridium difficile-associated diarrhoea in hospitals (Surveillance von Clostridium difficile assoziierter Diarrhoe in Krankenhäusern (CDAD-KISS)	Human	National Reference Center for Surveillance of Nosocomial Infections (NRZ)	1
Surveillance of device-associated nosocomial infections in normal care units/non-intensive care units (Surveillance Device-assoziierter nosokomialer Infektionen auf Normalpflegestationen/Nicht-Intensivstationen (Stations-KISS Infektionen))	Human	National Reference Center for Surveillance of Nosocomial Infections (NRZ)	1
Surveillance of Methicillin-Resistant Staphylococcus aureus in Hospitals (Surveillance von Methicillin-Resistentem Staphylococcus aureus in Krankenhäusern (MRSA-KISS))	Human	National Reference Center for Surveillance of Nosocomial Infections (NRZ)	1
Surveillance of patients with multidrug-resistant pathogens and/or Clostridium difficile-associated diarrhoea in intensive care units and normal care units (Surveillance von Patienten mit multiresistenten Erregern (MRE) und/oder Clostridium difficile assoziierter Diarrhö (CDAD) auf Intensivstationen und Normalpflegestationen (KISS Erreger ITS u.a. Stationen))	Human	National Reference Center for Surveillance of Nosocomial Infections (NRZ)	2
SurvNet@RKI	Human	Robert Koch Institute (RKI)	65

Table 1. *Cont.*

Data Collection	Population of Interest	Competent Authority	Number of Zoonotic Pathogens Recorded
	Animal		
"Import Screening for the Anticipating of Food Risks"-Tool (ISAR-Tool)	Animal, food or feed	Bavarian Health and Food Safety Authority (LGL)	Not pathogen-based
Animal Disease Reporting System—Public part of the Animal Disease Information System (Tierseuchennachrichtensystem (TSN)-TierSeuchenInformationsSystem (TSIS))	Animal	Friedrich-Loeffler-Institut (FLI)	0 (see TSN-online)
Animal Disease Reporting System—Crisis module (Tierseuchennachrichtensystem (TSN)–Krisenfallverwaltungsprogramm)	Animal	Friedrich-Loeffler-Institut (FLI)	0 (see TSN-online)
Animal Disease Reporting System—Central animal disease database (Tierseuchennachrichtensystem (TSN)-Zentrale Tierseuchendatenbank (TSN-Online))	Animal	Friedrich-Loeffler-Institut (FLI)	26
Approval control data for food establishments (Zulassungskontrolldaten für Lebensmittelbetriebe)	Food or feed	Lower Saxony State Office for Consumer Protection and Food Safety (LAVES)	Not pathogen-based
BALVI iP	Animal, food or feed, environment or water	BALVI GmbH various authorities	Not pathogen-based
BALVI iP—Animal feed safety	Feed	Lower Saxony State Office for Consumer Protection and Food Safety (LAVES)	Not pathogen-based
Federal surveillance plan (Bundesweiter Überwachungsplan (BÜP))	Food	Federal Office of Consumer Protection and Food Safety (BVL)	Not pathogen-based
Laboratory information management system (LIMS) of the Lower Saxony State Office for Consumer Protection and Food Safety (LAVES)	Animal, food or feed, environment or water	Lower Saxony State Office for Consumer Protection and Food Safety (LAVES)	31
Monitoring according §§ 50–52 German Food and Feed Code	Food	National: Federal Office of Consumer Protection and Food Safety Lower Saxony: Lower Saxony State Office for Consumer Protection and Food Safety (LAVES)	Not pathogen-based
Monitoring of zoonoses and zoonotic agents (Zoonosen-Monitoring (ZooMo))	Animal, food or feed	National: Federal Office of Consumer Protection and Food Safety Lower Saxony: Lower Saxony State Office for Consumer Protection and Food Safety (LAVES)	0 (see LIMS LAVES)
National Residue Control Plan (Nationaler Rückstandskontrollplan, NRKP)	Animal, food or feed	Federal Office of Consumer Protection and Food Safety Lower Saxony: Lower Saxony State Office for Consumer Protection and Food Safety (LAVES)	Not pathogen-based

Table 1. *Cont.*

Data Collection	Population of Interest	Competent Authority	Number of Zoonotic Pathogens Recorded
Nationwide system for collecting data on food involved in foodborne outbreaks (Bundesweites System zur Erfassung von Daten zu Lebensmitteln, die an lebensmittelbedingten Krankheitsausbrüchen beteiligt sind (BELA))	Other	Federal Office of Consumer Protection and Food Safety (BVL)	7
Rapid Alert System for Food and Feed (RASFF)	Food or feed, other	European commission, Directorate-General for Health and Food Safety (GD SANTE)	15
Salmonella control programme (Salmonellen-Bekämpfungsprogramm)	Animal	German Federal Institute for Risk Assessment (BfR)	1
Organizational tool for sampling (Probenbörse)	Other	Lower Saxony State Office for Consumer Protection and Food Safety (LAVES)	Not pathogen-based
Trade Control and Expert System New Technology (TRACES NT)	Animal, food or feed	European Commission-DG Health and Food Safety	Not pathogen-based
Whistleblower system/Anonymous reporting system (Anonyme Meldestelle)	Overarching	Lower Saxony State Office for Consumer Protection and Food Safety (LAVES)	Not pathogen-based
Zoonoses Trend Reports (Zoonosen-Trendbericht)	Overarching	National: Federal Office of Consumer Protection and Food Safety (BVL)	0 (see LIMS LAVES)
Environment			
Bathing Water Report of Lower Saxony for the European Union (EU-Badegewässer-Berichterstattung für Niedersachsen (BBE))	Environment or water	Public Health Agency of Lower Saxony (NLGA)	2
Climate Data Center (CDC)	Environment	Deutscher Wetterdienst	Not pathogen-centred
Drinking Water Database of Lower Saxony (Niedersächsische Trinkwasserdatenbank (NiWaDaB))	Environment, other	Public Health Agency of Lower Saxony (NLGA)	5
Others			
LSN-Online-Database	Humans, Animal, environment	Statistical Office of Lower Saxony	Not pathogen-centred

A more detailed version of Table 1 can be found in Supplement S2. Selected variables have been made available to the public as an R-Shiny app. The Shiny app can be accessed at https://shiny.tiho-hannover.de/connectohd/ (accessed on 14 December 2023).

The level (statistical unit) at which data is recorded in the various data collections varies. Thirty-one data collections contain individual data with an individual human case, an animal, a farm or a sample being the statistical unit. Six data collections contain aggregated data.

The purposes of the data collections recorded were diverse (Figure 2). For human data collections, the most common purposes are identification of events, monitoring and prediction (n = 14; 38.9%), evaluation of activities (n = 10; 27.8%) and tracing or tracking (n = 4; 11.1%). The most common purposes for data collection in the veterinary sector are food safety (n = 11; 23.4%), prediction, identification, monitoring (n = 10; 21.3%) and identification of risk factors (n = 8; 17.0%).

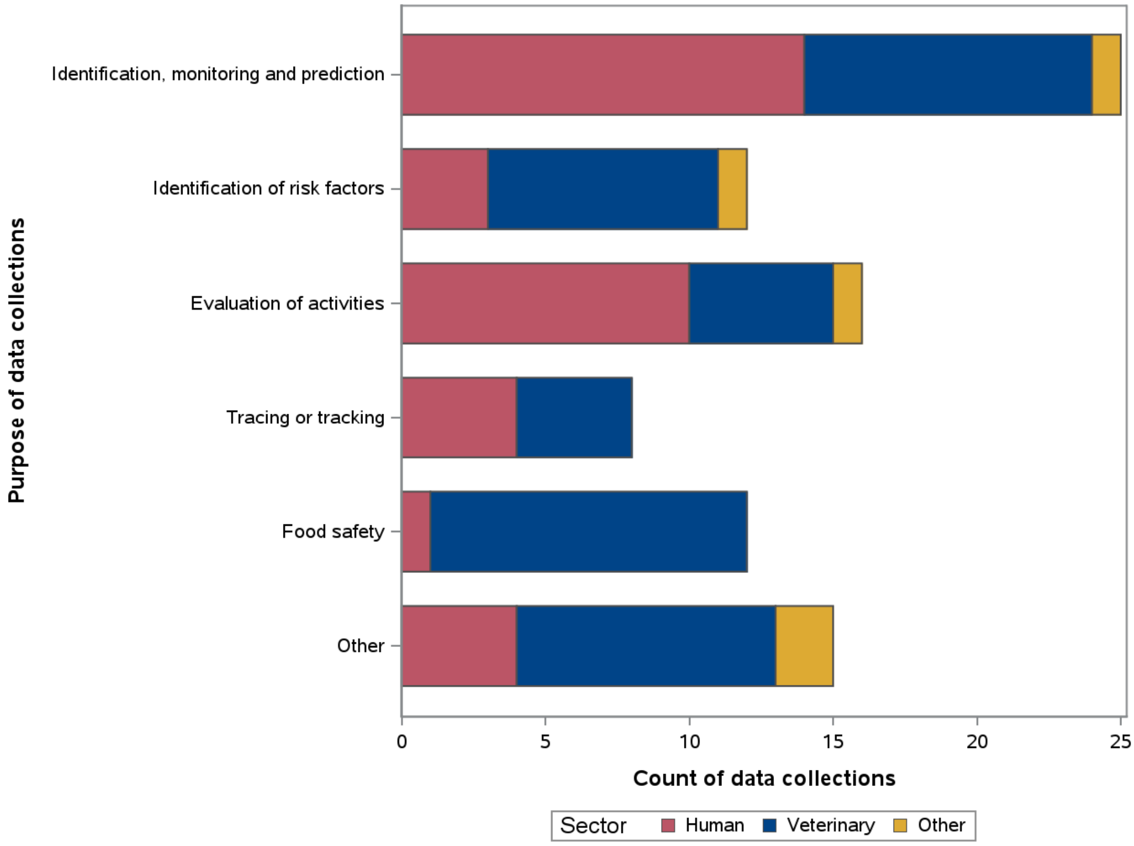

Figure 2. Purposes of data collection in the respective data collections of the different sectors in Lower Saxony (multiple selections were possible).

Concerning the sampling strategy, 5 out of 37 data collections (13.5%) are based on passive surveillance, 20 (54.1%) are based on active surveillance and 12 (32.4%) are surveys. Most of the veterinary data collections (52.6%, *n* = 10) gather their data via active surveillance, five (26.3%) via a survey and four (21.1%) via passive surveillance. For the human sector, eight (50%) out of sixteen data collections collect the data via active surveillance, seven (43.8%) via a survey and only one (6.2%) collects data via passive surveillance. All data collections that belong to other sectors collect their data in active surveillance.

The number of records in the data collections per year varied from low numbers, e.g., the nationwide system for collecting data on food involved in foodborne outbreaks with less than 50 records per year, to data sources with more than 1,000,000 records per year (LIMS LAVES, Trade Control and Expert System New Technology–TRACES NT and the diagnoses in hospitals).

Data can be extracted from the documented original data collections in a variety of export formats, including, Excel (*n* = 22), CSV (*n* = 19) and other formats (*n* = 12, often XML). However, six data collections only offer an export in PDF-format. Exporting data in two or more different data formats is possible for 25 data collections. For two data collections, information on the export format was not available.

Access to and export of original data is regulated in very different ways. Data directly available through open access are sparse. At the State Office for Statistics in Lower Saxony, access to data is generally possible online but sometimes with restrictions due to confidentiality. Data from the Climate Data Center from the Germany's National Meteorological Service are publicly available.

Results (aggregated data) from data collections in the human sector are usually publicly available (*n* = 14, 87.5%), while anonymised original data are available on request (*n* = 2; 12.5%). In the veterinary sector, access to data is more limited. Only three out of nineteen

(15.8%) data collections provide publicly accessible data. For the remaining data collections (*n* = 16, 84.2%) access is denied. Here, data use is possible only after written request and its formal approval by the competent authorities. In addition, data export is restricted due to technical reasons. Overall, the results show that access to data in the veterinary sector, both for researchers and the public, is much more limited than in the human sector.

The results of 86.5% (32/37) of the data collections from all sectors are published in regular reports.

Concerning timeliness of data, data collections are updated daily (*n* = 17; 46.0%), weekly (*n* = 3; 8.1%), monthly (*n* = 4; 10.8%), quarterly (*n* = 1; 2.7%) or annually (*n* = 12; 32.4%). Data from 79.0% (*n* = 15) of the veterinary data collections are updated daily. The majority of human data collections are updated annually (*n* = 7; 43.8%).

3.2. Metadata of Pathogens

Metadata were collected for about 69 different zoonotic agents. The number of pathogens per data collection varied considerably and depended, e.g., on the sector, the reference population and the legal basis or purpose of the data collection. However, *Escherichia coli* was covered by most data collections from both sectors compared to other pathogens (see Figure 3).

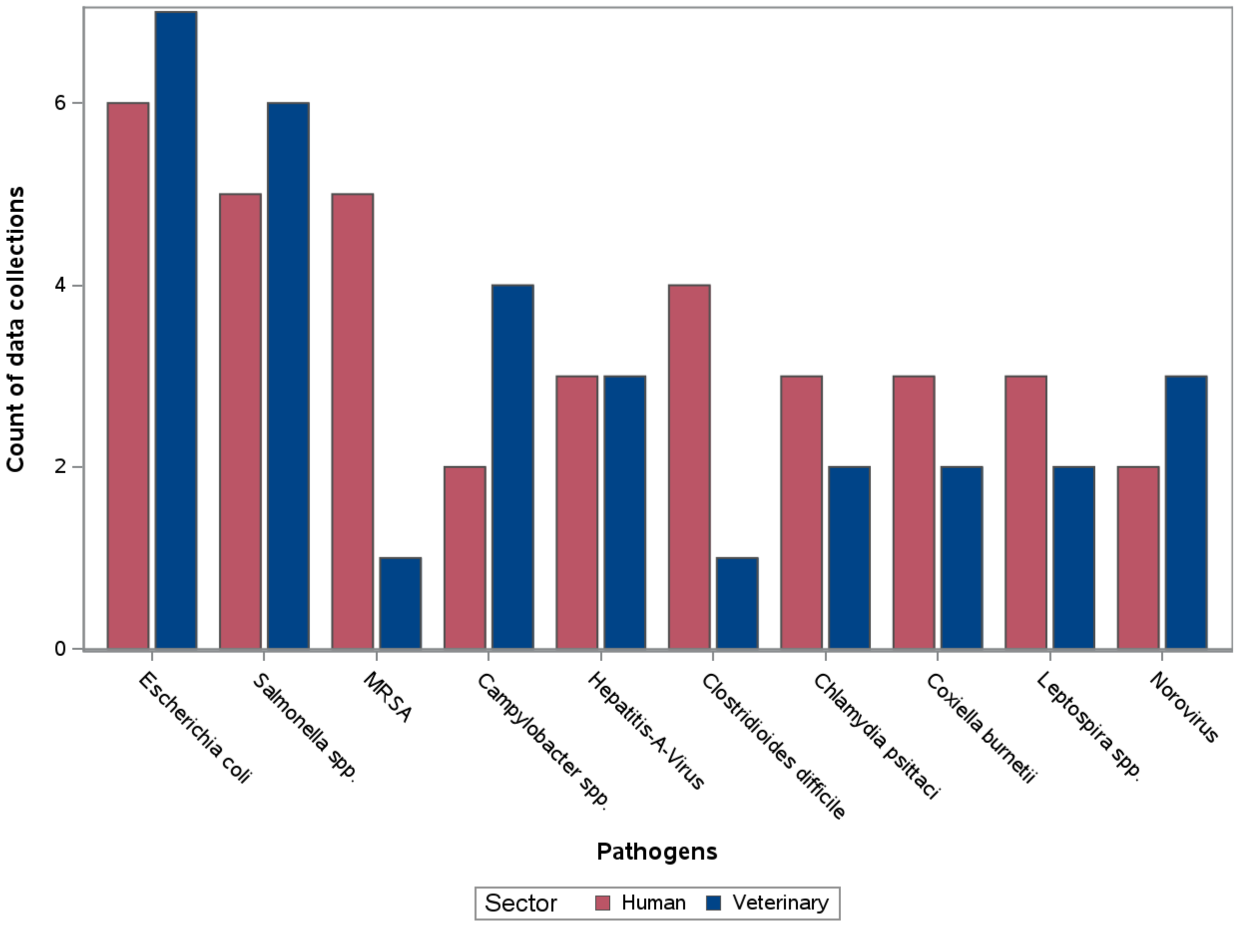

Figure 3. The top ten pathogens recorded in the gathered data collections.

The metadata collected on the level of pathogens for each data collection can be used to identify overlaps in the available information in order to plan an integrated analysis. A subset of the metadata collected is shown in Table 2 for *Campylobacter* spp., *Listera* spp. and *Francisella tularensis* as an example. Some information is consistently recorded in different data collections per pathogen while other information differs.

Table 2. Selected information for *Campylobacter* spp., *Listeria* spp. and *Francisella tularensis*. Veterinary information is based on data provided for Connect OHD.

Data Collection	Population and, if Applicable, Matrix of Interest	Average Findings per Year *	Publication of Data	Access to Original Data	Source Data Type	Export Data Type	Editing of the Original Data	Updating
				Campylobacter spp.				
Rapid Alert System for Food and Feed (RASFF)	Food	2	Yes	Reading and/or export publicly	Database	Excel, CSV	Re-selection and reduction	Daily
Nationwide system for collecting data on food involved in foodborne outbreaks (BELA)	Food	20	Yes	Access denied	PDF	PDF	No	Annually
Animal Disease Reporting System (TSN)	Animal	30	Yes	Access denied	Database	Excel, CSV, KMZ/KML	Re-selection and reduction	Daily
Laboratory information management system LAVES	Animal, food or feed, environment or water: divers matrices	460	No	Access denied	Database	Excel, CSV, XML	Anonymisation, re-selection and reduction	Daily
SurvNet@RKI	Human: blood/serum, tissue sample, other	6000	Yes	Reading and/or export on request	Database	CSV	Anonymisation	Daily
Causes of death	Human	5	Yes	Reading and/or export publicly	Database	Excel, PDF	Anonymisation, aggregation of detailed data into larger units	Annually
				Listeria spp.				
Hospital diagnoses—full inpatients discharged from hospital	Human	30	Yes	Reading and/or export publicly	Database	Excel, CSV, XML, FLAT	Anonymisation, aggregation of detailed data into larger units, re-selection and reduction	Annually
Rapid Alert System for Food and Feed	Food	30	Yes	Reading and/or export publicly	Database	Excel, CSV,	Re-selection and reduction	Daily
Animal Disease Reporting System (TSN)	Animals	5	Yes	Access denied	Database	Excel, CSV, KMZ/KML	Re-selection and reduction	Daily
Laboratory information management system LAVES	Population and matrix both divers	250	No	Access denied	Database	Excel, CSV, XML	Anonymisation, re-selection and reduction	Daily
SurvNet@RKI	Human: blood/serum, tissue sample, Other	60	Yes	Reading and/or export on request	Database	CSV	No	Daily
Causes of death	Human	20	Yes	Reading and/or export publicly	Database	Excel, PFD	Anonymisation, aggregation of detailed data into larger units	Annually
				Francisella tularensis				
Laboratory information management system LAVES	Population and matrix both divers	50	No	Access denied	Database	Excel, CSV, XML	Anonymisation, re-selection and reduction	Daily
SurvNet@RKI	Human: blood/serum, tissue sample, other	2	Yes	Reading and/or export on request	Database	CSV	No	Daily

* Average number from 2017 to 2019.

Overall, the average number of records per pathogen and year varied between the different data collections (Table 2). The number of records depends on the sector and the sampling strategy.

An overview of the documented pathogens can be found in Supplement S3.

4. Discussion

The huge impact of zoonotic diseases requires an integrated One Health MOSS to map the entire infection process [20]. Within Germany, the federal states are often responsible for the implementation and maintaining of human or animal health monitoring programmes. In more or less every monitoring program in Germany, the data are collected for a specific purpose, whereby an actual One Health integration of the data is currently not taken into account. However, the integrated use of data from different data sources, beyond the intended purpose, can add significant value to the prevention and management of zoonotic diseases [12]. The added value is multiple and aims to identify associations between pathogen records in different sources, improve awareness of health problems, detect events early and ultimately save resources.

4.1. Strategies for a One Health MOSS and Inventory of the Existing Routine Data Collections

In general, two strategies to set up a One Health MOSS can be discussed: A newly constructed monitoring system based on a representative sampling frame (active surveillance), or a passive and secondary system that uses information from different existing collections. To our knowledge, an MOSS, whose primary task is the monitoring and surveillance in the One Health context does not currently exist. Existing One Health surveillance activities are not based on sharing original or secondary data but rely on more or less standardised, regular information exchange (e.g., meetings) between sectors [21].

Secondary data use is the use of data that were originally collected for another purpose, usually based on a specific (legal) foundation, and are used secondarily for another analysis. As a result, depending on the purpose of secondary data use, not all information that would be useful for the particular secondary analysis is usually available, and the quality of the data may be limited. On the other hand, the use of secondary data has the great advantage of reducing the additional effort for data collection. Other advantages are moderate costs, the usually large reference population and the often long time series of data available [22]. But it has to be taken into account that using secondary data can cause additional effort due to data protection and during data management, and the advantages and disadvantages must be considered.

Until now, an operating and integrated One Health system is far from being realised in Germany and the use of secondary data from existing data collections therefore currently seems to be the only option. However, in order to develop a One Health surveillance approach and strategies for integrated analyses, the existing data sources and their contents must first be known, comprehensively described, and finally be assessed for their applicability to a specific One Health use case.

In order to investigate the possibilities of a continuous integrated analysis strategy of data from human and veterinary authorities in Germany, the data collections available in Lower Saxony, as a pilot region within Germany, were described comprehensively for the first time, and the corresponding metadata were systematically documented. This metadata inventory can be recognized as a "One Health Data Hub", i.e., a systematic documentation of the available data (Tables 1 and 2, Supplement S2 and S3). Our metadata inventory generally is in line with recent "data-sharing activities" in Germany, like the National Research Data Infrastructure for Personal Health Data (NFDI4Health) for the documentation of general human health data [23,24], the "Datenintegrationszentren (DIZ)" of the "Medizininformatik-Initiative" for the usage of data from different systems and different sites or the "Forschungsdatenportal (FDPG)" of the "Medizininformatik-Initiative", which describes available research data from the sector of German health care [25].

Secondary usage of routine data is advisable and reasonable [26,27].The added value of our metadata inventory is that it can be used as basis for further One Health activities. Based on the metadata description, overlaps as well as limitations (see below) can be identified and characterised. The extensive collection of metadata down to variable levels facilitates the generation of ideas and the planning of integrated data analyses. With this transparent description of the metadata of existing data collections, it is possible to support One Health initiatives or developments [7]. As it is often difficult to identify existing data collections, and detailed descriptions of metadata are lacking [17], the inventory presented here can be a basis for further work. As the knowledge of data collections in other sectors is sparse [17], the inventory can also help to identify relevant data collections in other sectors.

As our One Health inventory covers a variety of populations, the potential for linking data is quite diverse. Depending on the population or sector of "human", "animal/food/feed" and "environment", the most detailed statistical units are a "human", an "animal", a "farm", a "food sample" or an "environmental sample site". These different statistical units alone complicate a joint data analysis. In addition, for reasons of data privacy, the data are often processed for use as secondary data, e.g., through aggregation and pseudonymization. Therefore, linking the data is often only possible on an aggregated spatial level such as municipalities, counties or similar.

To decide which data collections are useful in a One Health approach, the application in specific use cases is essential. A use case can be defined as "a specific scenario that sets requirements for a concept and thus serves as the basis for its development" [28]. Therefore, the pathogen of interest is an essential aspect to choose relevant data collections. For this reason, our inventory provides the possibility to search for pathogens and to find out in which data collections entries on these pathogens exist. Overlaps and differences between data collections can be assessed and a general framework for integrated data analysis based on a specific use case can be developed. Restrictions for conducting a use case can be the (low) number of detections or technical and data privacy restrictions. For example, *Campylobacter* spp. is the most frequently reported bacterium causing gastroenteritis in humans and is therefore an important pathogen to investigate. However, it does not cause infection in animals, like broilers. Thus, the number of diagnostic samples taken in the veterinary monitoring programs is low compared to the number of reported human cases. This is one of the reasons for the different number of records. Other reasons are the different underlying legal bases and sampling strategies. Also due to the processing and distribution of animals and food, pathogen findings in food production that are spatially correlated to human cases must be interpreted with caution.

The metadata inventory generated also documents information, e.g., on access to the original data, export format and processing of the original data. Thus, it provides necessary information for the development of secondary data analyses. Moreover, this framework may initiate further developments on existing data structures like frequency of data updates, harmonising of data fields and catalogues and others (Table 2). Based on the metadata collected in the inventory, use cases can be developed but also requirements for changes to the data collections can be identified in order to improve the usability for cross-sector analyses.

The many different legal bases of data collections as well as the different responsible data holders (see Table 1, Supplement S2 for a more detailed insight into the metadata), can hinder joint analyses across data collections, even when a specific use case has been developed. To carry out a legal data assessment for secondary data use, considering the data protection law, the exact purpose of data use must be defined each time original data are requested. This procedure is at odds with a rapid response to an outbreak, as it requires time and human resources. To develop a One Health MOSS in the future, solutions need to be created by the legislative body [29].

Diverse institutions and persons, such as competent authorities and administrators are involved in the cross-sectoral One Health concept. So far, the exchange of information between the sectors in Lower Saxony mainly takes place in the event of an outbreak in accordance with certain guidelines and administrative directives, but to some extent informally. The intersectoral exchange of information in general and of data can increase data quality and trust, improve communication and build collaborations [7,21,28]. The "post-hoc-standardisation" of different data sources is not a technical problem. However, interfaces must be defined and inter-operability needs expertise, on both the good knowledge of the data and their origin and the technical implementation [30]. These issues, and especially the personal capacities, need to be addressed in the development of a One Health MOSS as well. Nevertheless, to take advantage of the added value of integrated analysis (One Health), more standardised information exchange is needed.

4.2. International One Health MOSS

In general, developments in the area of One Health MOSS are difficult to track as they are rarely published or shared in detail. However, the challenges described are not only a German problem. Comparing the documented data collections with available data collections from other countries shows similar limitations [21,31,32]. In addition, information on officially established One Health surveillance systems is rarely published [33]. Furthermore, the uniqueness of the systems makes it difficult to compare them, even if they were developed for a similar purpose [7,20].

Ellis-Iversen et al. [21] present a selection of smaller One Health surveillance initiatives from different countries such as France, Finland, Switzerland, Denmark, the Netherlands and Sweden. The authors collected the information through questionnaires and interviews. They also describe that the responsible data holders often have separate databases on separate servers. This can lead to an increased effort to implement One Health surveillance. In addition, One Health surveillance initiatives face the problem that new developments in data privacy have to be adopted, which can have negative consequences for existing standard operating and information exchange procedures.

In the Dutch Signalling Forum Zoonoses, only signals of zoonotic events that pose a potential threat to the public are communicated, either at its monthly meeting or in urgent case at an ad hoc meeting. This initiative brings together stakeholders from the relevant sectors (human, veterinary, food and wildlife) [34].

International One Health initiatives deal with specific issues but do not have a comparable method. Nevertheless, they contain important information, for example on carriers of diseases like food or parasites.

4.3. Considerations for Cross-Sector One Health Data Curation

To enable data from different collections to be used more easily in the future for integrated data use beyond their original purpose, this data integration should already be taken into account when collecting the data. Based on our metadata inventory, we identified a list of issues that need to be considered for cross-sector One Health data curation and to achieve an integrated MOSS in the future, namely:

1. Data-related
    a. Data structure and level of aggregation: i.e., the level of spatial and temporal aggregation has to be harmonised;
    b. Nomenclature and formats: i.e., catalogues and definitions have to be harmonised with easy to follow rules;
    c. Completeness and data quality: i.e., according to the use cases addressed, variables under study have to be selected, the number of missing values has to be calculated and data quality rules have to be addressed;
    d. Level of differentiation of pathogens: i.e., the available/needed level, e.g., genus, species, subspecies, genes, needs to be considered/harmonised.
2. Content-related
    a. Purpose of data collection: e.g., to improve knowledge and monitoring purposes, food safety;

   b. Type of data collection sampling: e.g., monitoring, surveillance, active or passive systems.
3. Data privacy-related
   a. Re-Identification: i.e., individual plants or people must not be identifiable. Therefore, access to the highest possible spatial resolution may be denied.
   b. Purpose of data use: i.e., for legal data protection assessments, the purpose of data use must be precisely defined.
4. Technical-related
   a. Implementation of data exchange: e.g., via individual exports, data-interfaces or a data warehouse. Most data collections are stand-alone solutions, which were developed for a specific purpose and have grown historically. This makes it difficult to use these systems for other purposes.
   b. Development of analysis procedures: e.g., control charts/Shewart charts, time series analysis and expected values derived therefrom.
5. Personal-related
   a. Experts for the original data: i.e., due to the variety of data and types of documentation, experts in each data collection are needed to explain and interpret the data.
   b. Statistical-, data management-, and IT-experts: i.e., to develop analysis procedures and to implement data transfer and management.
   c. Personal contacts between the sectors and other stakeholders: i.e., intersectoral exchange is essential to build a One Heath MOSS, e.g., via regular meetings or joint workshops.

5. Conclusions and Outlook

Common zoonoses pose a risk to human and animal health and are therefore the focus of monitoring and surveillance of public authorities. However, as zoonoses occur with different frequencies in human and animal populations, and also with different severity (from ubiquitous and asymptomatic to fatal), the actions of the competent authority will differ depending on the reference population. Original data from different sectors cannot be linked at the individual level because they relate to different populations and levels of production. In addition, legal and data privacy issues hinder immediate linkage between data. As a result, data from the various sectors have not yet been combined directly. Such data combination is made even more difficult by the lack of harmonisation between MOSS [21,35]. A general solution is hard to create, as the different purposes of the data collections, the different underlying legal acts and the different competent authorities hinder a common approach. In addition, the primary purpose of data collection must remain assured. Therefore, connecting different data sources and joint analyses based on defined use cases is currently the only way to answer specific One Health questions.

At the moment, spatial and temporal analyses of aggregated data can be realised. Another way to use the existing routine data is to develop analysis procedures that generate signals to detect unexpected events (higher number of findings than usual). These signals could then be shared and discussed across sectors. Routine data have to be available in sufficient detail for authorised institutions. For One Health analyses additional information like food production, consumption or supply chains could be considered [36].

Overall, communication, trust and exchange between sectors need to be improved in the future to enable collaboration and joint analyses in the One Health context [17,33]. These goals can be achieved through further and advanced training as well as collaborative projects [21,35].

We found that, several aspects have to be considered for cross-sectoral data analyses: First, harmonisation of existing data and integration of additional information seems to be crucial. Here, especially data from the environment sector should be complemented by data which are non-routine data, such as from temporary projects or off-schedule investigations.

These data sources have been underrepresented in our inventory to date, but these aspects should be considered in future One Health approaches. To establish a comprehensive One Health approach, more information, e.g., on the number of animals per species (underlying animal population), generally environmental data, and data on social behaviour, diet, or hygiene habits have to be collected and made accessible.

Ideally, integrated analysis should already be considered when collecting One Health-relevant data. However, this was not taken into account in the past and will require fundamental adjustments to routine data collection in the future. Therefore, good coordination between the sectors, both on the scientific and technical as well as on the legal level will be necessary.

Recent data privacy regulations hinder the secondary data use substantially. For a sustainable One Health MOSS, legal acts and regulations have to be adjusted.

The project showed that the evaluation and the interpretation of the data requires considerable background and expert knowledge in order to be able to analyse and interpret the data correctly. Therefore, a structured data curation process will be key to conducting a One Health MOSS.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/zoonoticdis4010007/s1, Supplement S1: Original version of the template used for the collection of standardised metadata of data collections; Supplement S2: More detailed overview of One Health data collections on zoonotic pathogens examined for Lower Saxony; Supplement S3: Overview of the documented zoonotic pathogens in Lower Saxony, Supplement S4: Translated version of the template used for the collection of standardised metadata of data collections.

Author Contributions: Conceptualization: A.S. and L.K.; Data curation: K.H., G.v.M. and A.S.; Methodology: A.S., K.H., G.v.M. and L.K.; Project administration: L.K.; Software: T.W., and A.S.; Supervision: L.K.; Writing—original draft: A.S. and L.K.; Writing—review and editing: A.S., K.H., G.v.M., T.W., K.R., K.K., R.V. and L.K. All authors have read and agreed to the published version of the manuscript.

Funding: This study was supported by the Ministry for Science and Culture of Lower Saxony (NMWK) (Reference No. 11-76251-21-1/19 (ZN3433)) as part of "Niedersachsen Vorab: Big Data in den Lebenswissenschaften der Zukunft–Chancen datenintensiver Forschung und personalisierter Medizin", which is funded by the Volkswagen Foundation. This Open Access publication was funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation)-491094227 "Open Access Publication Funding" and the University of Veterinary Medicine Hannover, Foundation. The funders had no role in the study design, decision to publish or preparation of the manuscript. The authors hereby agree to provide the details of such funding upon a reasonable request.

Institutional Review Board Statement: Not applicable. Our research does not include any direct procedures performed in humans or animals of any kind. For this reason, formal approval by an ethical committee was not necessary under the provisions of the German regulations. Data privacy was not applicable, as the data is not considered personal data.

Informed Consent Statement: Not applicable.

Data Availability Statement: Any access to the complete metadata information base for interested institutions or qualified researchers is not allowed without an additional formal contract with the University of Veterinary Medicine Hannover. This contract will include guarantees to the obligation to maintain data confidentiality in accordance with the provisions of the German data protection law. Read-only access can be granted after validation and approval through all research partners (TiHo, NLGA, LAVES) upon reasonable request. Interested institutions may contact: Department of Biometry, Epidemiology and Information Processing, University of Veterinary Medicine Hannover, Bünteweg 2, 30559 Hannover, email: lothar.kreienbrock@tiho-hannover.de.

Acknowledgments: We would like to thank all employees from the various authorities who were both directly or indirectly involved and providing analysed data or contributed to the preparation of this template and this publication. The translation of Supplement S1 was done with the help of deepl.com (accessed on 31 January 2023).

Conflicts of Interest: The authors declare that no competing interests exist. There are no patents, products in development or marketed products to declare.

Abbreviations

Connect OHD:	Connect One Health Data
LAVES:	Lower Saxony State Office for Consumer Protection and Food Safety, Germany (Niedersächsisches Landesamt für Verbraucherschutz und Lebensmittelsicherheit)
LIMS:	Laboratory information management system
MOSS:	Monitoring and surveillance system
NLGA:	Public Health Agency of Lower Saxony, Germany (Niedersächsisches Landesgesundheitsamt)
REDCap:	Research Electronic Data Capture
TiHo:	University for Veterinary Medicine Hannover, Foundation (Stiftung Tierärztliche Hochschule Hannover)

References

1. Palmer, S.R.; Soulsby, L.; Torgerson, P.; Brown, D.W.G. The global challenge of zoonoses control. In *Oxford Textbook of Zoonoses: Biology, Clinical Practice, and Public Health Control*; Oxford University Press: Oxford, UK, 2011.
2. Tissot-Dupont, H.; Raoult, D. *Clinical Aspects, Diagnosis and Treatment of Q Fever: Rickettsial Diseases*; CRC Press: Boca Raton, FL, USA, 2007.
3. Robert Koch-Institut. Campylobacter-Enteritis; RKI-Ratgeber. Available online: https://www.rki.de/DE/Content/Infekt/EpidBull/Merkblaetter/Ratgeber_Campylobacter.html;jsessionid=72441A0798DDA71F0BE17C306AB559F3.internet092#doc2374558bodyText2 (accessed on 21 November 2022).
4. Leal Filho, W.; Ternova, L.; Parasnis, S.A.; Kovaleva, M.; Nagy, G.J. Climate Change and Zoonoses: A Review of Concepts, Definitions, and Bibliometrics. *Int. J. Environ. Res. Public Health* **2022**, *19*, 893. [CrossRef] [PubMed]
5. Slingenbergh, J.; Gilbert, M.; de Balogh, K.I.; Wint, W. Ecological sources of zoonotic diseases. *Rev. Sci. Tech. Off. Int. Épizooties* **2004**, *23*, 467–484. [CrossRef] [PubMed]
6. Mishra, J.; Mishra, P.; Arora, N.K. Linkages between environmental issues and zoonotic diseases: With reference to COVID-19 pandemic. *Environ. Sustain.* **2021**, *4*, 455–467. [CrossRef]
7. Wendt, A.; Kreienbrock, L.; Campe, A. Zoonotic Disease Surveillance—Inventory of Systems Integrating Human and Animal Disease Information. *Zoonoses Public Health* **2015**, *62*, 61–74. [CrossRef]
8. Wendt, A.; Kreienbrock, L.; Campe, A. Joint use of Disparate Data for the Surveillance of Zoonoses: A Feasibility Study for a One Health Approach in Germany. *Zoonoses Public Health* **2016**, *63*, 503–514. [CrossRef] [PubMed]
9. Friedrich-Loeffler-Institut. OHEJP Knowledge Base: Inventory on Surveillance Systems. Available online: https://shiny.fli.de/ife-apps/EJPOrion_WP2Epi/ (accessed on 13 July 2022).
10. European Union EU. *Directive 2003/99/EC of the European Parliament and of the Council of 17 November 2003 on the Monitoring of Zoonoses and Zoonotic Agents, Amending Council Decision 90/424/EEC and Repealing Council Directive 92/117/EEC*; European Union: Brussels, Belgium, 2003.
11. Narrod, C.; Zinsstag, J.; Tiongco, M. A one health framework for estimating the economic costs of zoonotic diseases on society. *Ecohealth* **2012**, *9*, 150–162. [CrossRef]
12. Zinsstag, J.; Schelling, E.; Crump, L.; Whittaker, M.; Tanner, M.; Stephen, C. *One Health: The Theory and Practice of Integrated Health Approaches*, 2nd ed.; CAB International: Wallingford, UK, 2021.
13. Landesamt für Statistik Niedersachsen. *Bevölkerung und Katasterfläche in Niedersachsen (Gebietsstand: 1.11.2021)*; Tabelle A100001G; Landesamt für Statistik Niedersachsen: Hannover, Germany, 2022. (In German)
14. Landesamt für Statistik Niedersachsen. *Landwirtschaftliche Betriebe mit Viehhaltung und Viehbestand am 1. März in Niedersachsen*; Tabelle Z6080020; Landesamt für Statistik Niedersachsen: Hannover, Germany, 2021. (In German)
15. Landesamt für Statistik Niedersachsen. *Landwirtschaftliche Betriebe mit Haltung von Sonstigem Geflügel und Bestand an Sonstigem Geflügel am 1. März in Niedersachsen*; Tabelle Z6080026; Landesamt für Statistik Niedersachsen: Hannover, Germany, 2021. (In German)
16. Landesamt für Statistik Niedersachsen. *Landwirtschaftliche Betriebe mit Hühnerhaltung und Hühnerbestand am 1. März in Niedersachsen*; Tabelle Z6080025; Landesamt für Statistik Niedersachsen: Hannover, Germany, 2021. (In German)
17. Wendt, A. *One Health Surveillance*; Tierärztliche Hochschule: Hannover, Germany, 2016. (In German)
18. Harris, P.A.; Taylor, R.; Minor, B.L.; Elliott, V.; Fernandez, M.; O'Neal, L.; McLeod, L.; Delacqua, G.; Delacqua, F.; Kirby, J.; et al. The REDCap consortium: Building an international community of software platform partners. *J. Biomed. Inform.* **2019**, *95*, 103208. [CrossRef] [PubMed]
19. Harris, P.A.; Taylor, R.; Thielke, R.; Payne, J.; Gonzalez, N.; Conde, J.G. Research electronic data capture (REDCap)—A metadata-driven methodology and workflow process for providing translational research informatics support. *J. Biomed. Inform.* **2009**, *42*, 377–381. [CrossRef] [PubMed]

20. Buchanan, R.L.; Anderson, W.; Anelich, L.; Cordier, J.L.; Dewanti-Hariyadi, R.; Ross, T.; Zwietering, M.H. *Microorganisms in Foods 7: Microbiological Testing in Food Safety Management*; Springer: Cham, Switzerland, 2018; p. 5.
21. Ellis-Iversen, J.; Petersen, C.; Helwigh, B. *One Health Integration in Surveillance—Inspiration and Ideas*; Technical University of Denmark: Kongens Lyngby, Denmark, 2019; p. 17.
22. Kreienbrock, L.; Pigeot, I.; Ahrens, W. *Epidemiologische Methoden*, 5th ed.; Springer: Berlin/Heidelberg, Germany, 2012.
23. Intemann, T.; Kaulke, K.; Kipker, D.-K.; Lettieri, V.; Stallmann, C.; Schmidt, C.O.; Geidel, L.; Bialke, M.; Hampf, C.; Stahl, D.; et al. White Paper—Verbesserung des Record Linkage für die Gesundheitsforschung in Deutschland. *Fachrepositorium Leb.* **2023**, *1*, 125. (In German) [CrossRef]
24. Fluck, J.; Golebiewski, M.; Darms, J. Data Publication for Personalised Health Data: A New Publication Standard Introduced by NFDI4Health. In Proceedings of the Conference on Research Data Infrastructure, Karlsruhe, Germany, 12–14 September 2023.
25. TMF. Technologie- und Methodenplattform für die Vernetzte Medizinische Forschung e.V. Deutsches Forschungsdatenportal für Gesundheit (FDPG). Available online: https://forschen-fuer-gesundheit.de/ (accessed on 1 December 2023).
26. Wieler, L.; Antao, E.-M.; Semmler, T. Research on zoonoses: Central element of the "One Health" initiative. *BMTW* **2009**, *122*, 412–416.
27. Rudolph, B.; Davis, R. *Administrative Data and Disease Surveillance: An Integration Toolkit*; National Association of Health Data Organizations: Provo, UT, USA, 2011.
28. Förster, C.; Nordhoff, K.; Fritzemeier, J.; Breuer, J.; Kreienbrock, L. A Framework for Study Planning in Food Safety Investigations. *Berl. Münchener Tierärztliche Wochenschr.* **2022**, *135*, 1–10.
29. El Idrissi, A.H.; Larfaoui, F.; Dhingra, M.; Johnson, A.; Pinto, J.; Sumption, K. Digital technologies and implications for Veterinary Services. *Rev. Sci. Tech.* **2021**, *40*, 455–468. [CrossRef] [PubMed]
30. Ganslandt, T. Perspektive Interoperabilität. In Proceedings of the TMF Jahreskongress 2023 Köln—Session 4: Panel Standardisierung & Datenqualität, Köln, Germany, 18–19 April 2023. (In German).
31. Häsler, B.; Gilbert, W.; Jones, B.A.; Pfeiffer, D.U.; Rushton, J.; Otte, M.J. *The Economic Value of One Health in Relation to the Mitigation of Zoonotic Disease Risks*; Springer: Berlin/Heidelberg, Germany, 2013; Volume 365, pp. 127–151.
32. Häsler, B.; Cornelsen, L.; Bennani, H.; Rushton, J. A review of the metrics for One Health benefits. *Rev. Sci. Tech.* **2014**, *33*, 453–464. [CrossRef] [PubMed]
33. Bordier, M.; Uea-Anuwong, T.; Binot, A.; Hendrikx, P.; Goutard, F.L. Characteristics of One Health surveillance systems: A systematic literature review. *Prev. Vet. Med.* **2020**, *181*, 104560. [CrossRef] [PubMed]
34. National Institute for Public Health and the Environment (RIVM). Dutch Signalling Forum Zoonoses. Available online: https://www.rivm.nl/en/one-health/dutch-signalling-forum-zoonoses (accessed on 12 May 2023).
35. Alves, F.; Artursson, K.; Bloch, J.; Brisabois, A.; Imberechts, H.; Jokelainen, P.; La Ragione, R.; Lindblad, M.; Forss, R.L.; Marston, D.A.; et al. A multi-country One Health foodborne outbreak simulation exercise: Cross-sectoral cooperation, data sharing and communication. *Front. Public Health* **2023**, *11*, 1121522. [CrossRef] [PubMed]
36. National Research Council (US) Committee on Achieving Sustainable Global Capacity for Surveillance and Response to Emerging Diseases of Zoonotic Origin. *Sustaining Global Surveillance and Response to Emerging Zoonotic Diseases*; Keusch, G.T., Pappaioanou, M., Gonzalez, M.C., Scott, K.A., Tsai, P., Eds.; Making the Case for Zoonotic Disease Surveillance; National Academies Press: Washington, DC, USA, 2009; Volume 2.