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Jokelainen, Pikka; Sandberg, Marianne; Hald, Tine

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7. Outcome and future perspectives of One Health collaborations

By Pikka Jokelainen (PIJO@ssi.dk), Marianne Sandberg and Tine Hald

The health of humans, animals and our shared environment are interconnected. Protection of animal health and public health from zoonotic threats requires a One Health approach and collaborations across sectors and country borders. Cross-sectoral One Health collaboration is increasingly emphasised and applied in Denmark, in Europe and globally and societal, political and environmental changes call for continuous evolution of the One Health approach.

7.1 Impactful outcomes, science-to-policy experiences and perspectives for future from One Health EJP

One Health European Joint Programme (One Health EJP, 2018-2023) is a European flagship initiative for One Health collaborations. Gathering 44 partners across Europe to address foodborne zoonoses, Antimicrobial Resistance (AMR) and emerging threats, the programme has delivered impactful outputs. Danish participation has been active, and supported collaborations also at national level in particular between Statens Serum Institut (SSI) and the National Food Institute at the Technical University of Denmark (DTU-FOOD). For example, the two institutes hosted together the Annual Scientific Meeting of One Health EJP in 2021 and a Continuing Professional Development Module in 2022. In 7.1.1-7.1.3, examples of activities of the One Health EJP are briefly described.

A key part of the legacy of One Health EJP is its recently published Strategic Research and Innovation Agenda (SRIA). The SRIA summarises the main outcomes and impacts of the One Health EJP, and discusses future perspectives for One Health in Europe. It highlights the importance of international, cross-sectoral, multidisciplinary collaborations and the trust built in such collaborations. Dialogue with stakeholders has proven useful to ensure impact at national, European and global levels. Harmonisation of methods and approaches across sectors is needed for comparable data.

Environmental aspects were not in the core of the scope of One Health EJP, but they were identified as important. Future One Health initiatives should have more collaboration with environmental and ecosystem health sectors and could more strongly contribute to a green, sustainable future.

After September 2023, the end of the implementation period of One Health EJP, no direct continuation for

similar collaboration is foreseen. However, several other large projects have focus on One Health, and many One Health EJP partners continue collaborations also outside formal projects.

7.1.1 Discovering the sources of *Salmonella*, *Campylobacter*, STEC and antimicrobial resistance

The DiSCoVeR project was one of the Joint Research Projects under One Health EJP. It brought together researchers and experts from different disciplines (microbiology, bioinformatics and epidemiology) and sectors (veterinary science, food safety, public health, and environmental health) from 19 institutions in 13 European countries to address the challenges of source attribution in an interdisciplinary manner. As there exists no gold standard for conducting source attribution, DiSCoVeR took a comprehensive approach applying several different methodologies and models in a comparative fashion.

Comprehensive datasets covering a broad range of reservoirs and sources, including those not traditionally part of the existing monitoring and surveillance activities (e.g., pets, wildlife, and environmental sources), were collected. A substantial number of the pathogen isolates was also sequenced and formed the basis of the whole genome sequencing (WGS)-based source attribution approaches. The final databases included: *Salmonella* (n = 145,000 isolates; s = 4,185 sequences), *Campylobacter* (n = 5,361 isolates/sequences), STEC (n = 7,552 isolates; s = 3,418), and ESBL (n = 10,674 isolates). Metadata including phenotypic information are made open accessible through Zenodo, where the WGS data is currently stored at a secure sharing platform available for all partners and with ongoing work to further expand. The WGS data will eventually be uploaded to the European Nucleotide Archive (ENA).

Another important output of DiSCoVeR is a critical and systematic assessment of existing source attribution models and development of new phenotypic and genomic-based attribution models for foodborne pathogens and antimicrobial resistance. For *Salmonella*, *Campylobacter*, and STEC, several types of national and multi-country WGS-based attribution models were developed. Overall, the results were in agreement and in line with those

found with the 'conventional' subtyping approaches (phenotypic and MLST based), which gives credibility to both the results and the different models. Findings were further supported by a systematic literature review and meta-analysis of case-control studies of sporadic *Salmonella* and *Campylobacter* infections and an aggregated analysis of EU *Salmonella* outbreak data. Although the nuances and the level of attribution of these types of studies are different from the subtyping approaches, the results are comparable and dissimilarities can to a large extent be explained. In conclusion, WGS-based models have some clear advantages (e.g. higher predicting accuracy due to the increased discriminatory power), but they are also more resource demanding, and in some situations, phenotypic and/or epidemiological models may give results that are just as useful.

From a One Health perspective, the work in DiSCoVeR gave rise to some reflections and recommendations. First of all, surveillance activities are still very much focused on livestock and food, whereas the environment, including e.g. wildlife, is only sporadically monitored resulting in data scarcity. The role of the environment and pets as sources for human infections, therefore, remains unclear and is complicated by bi-/multi-directional transmission, specifically addressed by one of the models. Still, a research synthesis of all the findings confirm that livestock populations are the main reservoirs for the target pathogens except for ESBL, where human-to-human transmission are more important. From a risk assessment point of view, particularly, *Salmonella* in pigs and pork and *Campylobacter* in broilers and chicken meat stand out as areas, where targeted future control and intervention could be implemented/intensified to reduce the burden of human infections significantly.

Other recommendations based on the work in DiSCoVeR include, but are not limited to, harmonizing sampling and reporting further, including an expansion of the existing minimum requirement for accompanying metadata and subtyping results, and promote capacity building on integrated surveillance, burden of disease, source attribution, risk assessment, and system thinking at country level.

7.1.2 ORION

The ORION project was an EU initiative aimed to support the inter-sectorial harmonization and use of data, to inform the decision-making in One Health surveillance. Moreover, the project focused on data FAIRness (Findability, Accessibility, Interoperability and Reusability).

Within the ORION, three scientific studies were carried out at DTU-Food. Those studies were based on the integration of national datasets collected for surveillance of

Campylobacter along the Danish poultry meat chain (from two national surveillance components), which provided information on the flock's infection status (positive or negative) and carcass contamination levels (cfu/g). In one study it was assessed the impact of flocks produced from high-risk farms on the risk of human campylobacteriosis posed by a meal contaminated from fresh poultry meat. Whereas in the next study the occurrence of flocks cross-contamination (CC) at slaughterhouses was assessed. Finally, the relative contribution of the CC flocks on the risk of human campylobacteriosis was assessed. These studies gives a practical example of how inter-sectorial data integration can be routinely used for data-driven risk assessment modelling, to inform risk-based control of *Campylobacter* (and of similar foodborne pathogens) along the food chain, within OH systems. In this way, surveillance actors and stakeholders can decide the prioritization of risk mitigation measures and control actions "from farm to patient", according to resources available and feasibility. For example, especially in countries with low *Campylobacter* flock prevalence and high relative contribution of CC flocks to the human risk; the control measures could be prioritized to high-risk farms (to reduce flock prevalence at the pre-harvest), and could be combined with other actions aimed to remove/minimize cross-contamination at slaughter (e.g. logistic slaughtering).

Currently (mid-2023) the outcomes from the three studies, are under consideration within the technical working group of the Danish National *Campylobacter* Action Plan. Moreover, the mused data-driven approach, has been presented to EFSA, as a future project-idea for standardizing (at EU level) the inter-sectorial data integrations and analysis, which are aimed to inform risk assessment models for foodborne pathogens across EU Member States. Therefore, outputs of the ORION project, have the potential to mitigate the risk of human campylobacteriosis not only in Denmark, but also in the rest of Europe.

7.1.3 Science-to-policy translation or OHEJP SimEx

The One Health EJP Simulation Exercise (OHEJP SimEx) aimed at practicing One Health capacity and interoperability across public health, animal health and food safety sectors in a outbreak scenario. The OHEJP SimEx was delivered through a sequence of scripts covering the different stages of an outbreak investigation at a national level, involving both the human food chain and the raw pet feed industry. Altogether 255 participants from 11 European countries took part in national level two-day exercises during 2022. Recommendations for future One Health simulation exercises were also summarized; such exercises are essential to practice, challenge and improve national One Health strategies.

In Denmark, OHEJP SimEx conduction took place on May 30-31, 2022. SSI, DTU-FOOD and the Danish Veterinary and Food Administration (DVFA) - the three organisations that constitute in the Central Outbreak Management Group (COMG) - participated in the exercise. The Training Audience included representatives of communication teams from each of the three organisations. The national aims were i) to improve the existing collaboration in COMG and increase understanding about roles and responsibilities among the involved organisations, and ii) to strengthen the national communication of foodborne outbreaks to different target groups and stakeholders.

OHEJP SimEx conduction in Denmark highlighted the unique strengths of the well-functioning COMG. The exercise was excellent for networking, which supported the first national aim. The focus on communication was considered useful, and key outcomes from One Health EJP SimEx in Denmark include more explicit integration of communication aspects to the structure and workflow of COMG.

7.1.4 Science-to-policy translation in One Health EJP

Evidence-based decision making and policy making in relation to complex challenges, such as those requiring a One Health approach, are not easy. The experiences from Science-to-Policy approaches of One Health EJP provide useful experiences for this.

A dedicated Science to Policy Translation work package, co-lead by SSI, established collaborations with both national and international stakeholders (public institutes, ministries, ECDC, EFSA, EEA, EMA, FAO, WOA, WHO-Europe). The work was based on dialogue and started with surveying the needs related to foodborne zoonoses, antimicrobial resistance and emerging infectious threats of key stakeholders to inform the Strategic Research and Innovation Agenda. Later, focus was moved to match the needs with consortium outputs by targeted dissemination. The different stakeholders were invited to become involved at strategically relevant timepoints. The dissemination activities included reports, meetings and workshops, and ensuring that the consortium outputs were made easily findable and available.

The structures and the dialogue allowed timely identification of synergies. A key achievement was bringing stakeholders to discuss together around the same table, which supported e.g. the establishment of the European cross-agency One Health Task Force. Success of One Health Science-to-Policy approaches requires understanding of the mandates and needs of different stakeholders, funding and structural support, building trust across networks, and applying suitable dissemination processes.

7.2 Scaling up One Health surveillance activities in Europe - OH4Surveillance and UNITED4Surveillance

Two new initiatives funded under EU4Health programme strengthen surveillance using One Health approach. UNITED4Surveillance is an ongoing Joint Action, and its sister-initiative OH4Surveillance will start soon. The OH4Surveillance consortium is coordinated by SSI and gathers countries to work together to set up and scale up One Health surveillance to priority pathogens, in close collaboration with EFSA. Focus in Denmark will be on West Nile Virus and zoonotic influenza viruses, in collaboration between SSI and University of Copenhagen.

7.3 New European Partnerships on research for improved animal health and welfare, contingency and sustainable food systems

A number of Danish institutions have been active in the preparation of a large European partnership focusing on animal health and welfare (EUP AH&W). EUP AH&W aims to progress Europe towards healthy and sustainable livestock production systems (for both terrestrial and aquatic animals), including the reduction of anti-microbial usage, and to improve production animal welfare, in line with the European Green Deal and farm-to-fork strategy. Moreover, the EUP AH&W will strengthen public health and well-being by facilitating cross-sector collaboration in a One Health - One Welfare perspective. The objective is also to facilitate the collaboration between sectors within countries and between institutions in different countries.

Yet another One Health related Partnership is the PSFS FutureFoodS. According to FAO a sustainable food system is "a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised". The ambition of the PSFS FutureFoodS is to collectively develop and implement an EU-wide committed research and innovation (R&I) partnership which accelerates the transition towards diets that are healthy, safe and sustainably produced and consumed in resilient EU and global food systems. DTU National Food Institute will especially contribute to the partnership with regard to sustainable nutrition, risk-benefit assessments and science to policy activities.

Moreover, an ongoing Coordination and Support Action BE READY is building a consolidated European Research and Innovation Area that provides the foundation of the candidate European partnership for pandemic preparedness. From Denmark, SSI participates in BE READY.

7.4 Preparedness for emerging threats - DURABLE, EU-HIP and EU-WISH

SSI has collaborated with the Health Emergency Preparedness and Response Authority (HERA) since its early days, and now the collaborations are strengthened by several large projects under EU4Health programme, all notably applying One Health approaches: DURABLE is HERA's Laboratory Network that provides scientific advice based on research conducted in a network of top laboratories, EU-HIP works towards interoperability of national IT systems with HERA's upcoming IT-platform for intelligence gathering, and upcoming EU-WISH will enhance and extend wastewater surveillance for priority targets across Europe.

7.5 Building on the collaborations created to address COVID-19

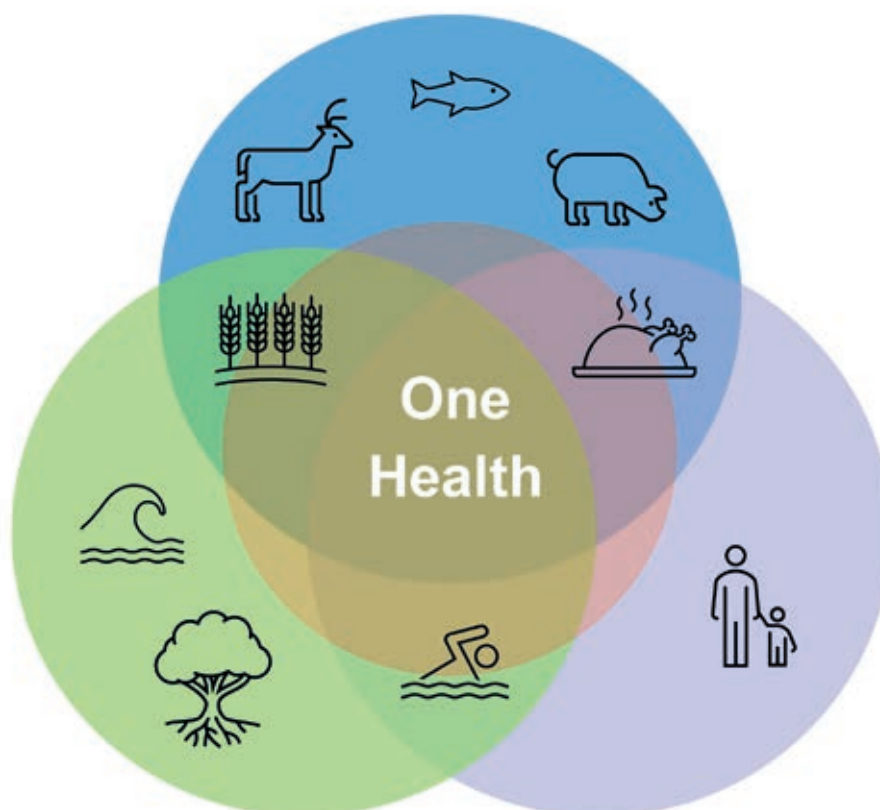
COVID-19 pandemic showed that multidisciplinary, cross-sectoral collaborations are needed to address complex challenges. Such collaborations were established quickly in Denmark, making the country a trailblazer for generating and using data, including One Health data, for COVID-19 response. Now that WHO has declared that COVID-19 is no longer a public health emergency of international concern, it is time to build on and extend

these collaborations, to be better prepared to address other current and future challenges. A multidisciplinary One Health approach is crucial in this.

7.6 Further reading

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Figure 7.1. Conceptual diagram of One Health. Original by Abbey Olsen [15], adapted by Brian Lassen



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