Commentary

The contribution of biomedical informatics to one health

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One health is defined as a collaborative transdisciplinary effort to attain optimal sustainable health for humans, animals, and the environment. The underlying rationale is that extensive overlaps exist among these three domains and there are many external influences driven by other disciplines, such that changes—good or bad—in any one domain are inextricably linked to changes in the other two.

The one health concept has been endorsed as a worthy pursuit by numerous veterinary and human health entities. The ongoing challenge, however, is determining how to move forward from recognition and endorsement of the concept to measurable improvements in human, animal, and environmental health. In this regard, the authors suggest two things to determine how informative or useful the one health approach will prove to be. The first is understanding how profoundly one health efforts are dependent on transdisciplinary collaboration. The second is viewing the collective of human, animal, and environmental health as a health ecosystem, rather than as three separate domains.

Importantly, if the one health approach is to be useful, there must be effective processes to collect and share data, exchange derived information, and transfer and apply the knowledge that is acquired. The field of biomedical informatics involves the technology, techniques, and science of collecting, communicating, understanding, and managing biomedical information. As such, it has the potential to play a crucial role in advancing one health.

Using Biomedical Informatics to Address the Challenge of Multiple Disciplines

One health is a cultural and behavioral concept that requires both an awareness of and a willingness to work closely with other disciplines. It affects the approach to individual cases, community health and herd health, and epidemiological investigations and has implications for practice (eg, history taking, physical examination, and health status interpretation). Ultimately, it requires a shift in thinking so that policy, practice, and professional education are all viewed through a one health lens.

The recent Ebola pandemic provides a good illustration of the benefits of the one health approach, as containing this outbreak required addressing not just human health concerns but also wildlife epidemiology (eg, bats as reservoirs of the virus), environmental issues (eg, caves near villages), social norms (eg, local culture and international travel), and companion animal health (eg, potential capacity as reservoirs) as well as policy and economic issues. Without good data, sound analytics, and an effective transfer of knowledge to policy makers, the individuals and groups responding to the outbreak would have been left floundering among diverse independent, ill-founded opinions.

Overlapping domains of human, animal, and environmental health add layers of complication that compound the difficulties associated with obtaining reliable information and performing appropriate analyses. Further, it is imperative that findings be disseminated across all domains so that a comprehensive holistic approach can be developed to address these important societal issues. Thus, development of disambiguating data management processes, communication standards, knowledge transfers, and quality applications that span disciplines becomes critical. This includes, but is not limited to, developing standardized terminology, information models, and data-exchange formats (ie, messaging transport structures). The idea of one health requires interoperability between systems, and interoperability between systems requires agreed-upon standards, among other things. This is true

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whether we are dealing with two health care systems, a point of care and a data repository, a point of care and a public health surveillance program, or any two systems where a timely exchange of information is critical. Of course, rarely are only two systems involved.

No right standards have been established, at least not ones that are right for every area or every domain. Thus, standards must be selected with the domains and goals of all involved in mind. In the context of diverse domains and disciplines, selecting appropriate standards is both more complex and more critical. It can be done, but some tradeoffs will be needed. For example, a company developing systems for use in veterinary clinical practices can choose between standard terms incorporated into the Veterinary Extension of the Systematized Nomenclature of Medicine Clinical Terms or the terms developed by the VeNom Coding Group. The VeNom terms might be easier to use and may serve the developer's immediate purpose, but likely will not scale up to support human medical terms or interoperate with human medical systems.

Owing to the well-established limitations of free-text data storage, systems must share a common structural terminology and an explicit understanding of important data types. Despite these limitations, when and where free-text systems cannot be avoided and the overhead expense is warranted, rigorous natural language processing and other analytics can minimize the loss of information. Even with the best of standards, ambiguity persists, some of which can be addressed with other tools of the trade and applications of information theory. Ensuring that information crosses legacy boundaries between domains requires further consideration. Ultimately knowing when the information is relevant—and when an exception is faced—mandates yet another level of expertise. This is compounded by the nature of one health diversity and interdependence. Data, information, knowledge, and application exchange formats must also be developed to allow movement between systems. All of the above are areas in which biomedical informatics can play an important role.

Using Biomedical Informatics to Maintain an Ecosystem Perspective

From the one health perspective, it makes little sense to focus specifically on, for example, improving the health of the environment because environmental health (good and bad) impacts human and animal health. Thus, one cannot focus on the internal functions of the environment without also considering how the environment interacts with people and animals. Changes to the environment, for example, may raise cultural, socioeconomic, and public policy concerns that, if not addressed, could doom the environmental intervention to failure. Rather than thinking of human health, animal health, and environmental health in isolation, it is therefore better to think in terms of a cohesive health ecosystem that incorporates all three along with the external forces that affect them. But, when scientific data or information is lacking, necessary evidence will be missing, weakening the initiative and robbing it of its justification. In this regard, biomedical informatics has the potential to provide what is missing, as it provides the key to guide everything from data collection to knowledge application.

Recommendations for Incorporating Biomedical Informatics into the One Health Concept

Joint efforts are needed to implement informatics standards across disciplines, especially in those areas where limited resources may hinder development efforts. These efforts could be aided through collaboration among human medical schools, veterinary medical schools, and schools of public health and the environment, along with schools of agriculture, social science, economics, and engineering. Biomedical informatics could also be used to improve communication among allied health networks and enhance efforts to assess, treat, and prevent diseases that cross species boundaries, including cross-species disease surveillance and control and comparative research on cross-species disease transmission. It could also play a role in the validation of new diagnostic methods and the development of new medicines and new vaccines for the treatment and prevention of diseases across species.

Conclusion

Just as there are many components of one health, there are many components of biomedical informatics. Those who work in the field of biomedical informatics would do well to examine their efforts through a one health lens. At the same time, biomedical informatics has the potential to provide what is needed for one health to be informative. It can be employed recursively to evaluate the effectiveness of every aspect of one health from data collection to knowledge application and to assess the impacts of cultural change and incentives.

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