

EPIDEMIOLOGY: INFORMATICS

Informatics (information science) includes the structure and properties of information, the computing technology and processing methods used to collect, classify, store, retrieve, analyze and disseminate it, and the methods for supporting decision-making tasks using it. The ASIS&T definition includes the investigation of the properties and behavior of information, the forces governing information flow, the methods for optimizing information accessibility and usability, the codes used for efficient message transmission and the study of processing devices and techniques.

Related terms are **medical (health, biomedical) informatics**, **bioinformatics** and **information technology**. AMIA defines **biomedical informatics** as “the science that develops methods, techniques, and theories regarding how to use data, information and knowledge to support and improve biomedical research, human health, and the delivery of healthcare services.” Scot Silverstein defines **medical informatics** as “the science and art of modeling and recording real-world clinical concepts and events into computable data used to derive actionable information, based on expertise in medicine, information science, information technology, and the scholarly study of issues that impact upon the productive use of information systems by clinical personnel.” **Bioinformatics** is the study of computationally-intensive methods for analyzing and interpreting biological data, particularly genomics data, pharmacogenomics being the core of **personalized (individualized, precision, stratified) medicine**.

Because agricultural animal practice includes analyzing individual animal health information from members of groups, whether the reproduction status of cows in a dairy herd, litter performance on a farrowing operation, or treatment responses in feedlots, specialized record systems and the associated processing technology have long been a component of services. As herds expanded and personal computer capability increased, these systems evolved from specialized paper records to central mainframe processing to on-farm computer systems. Dairy practices upload herd data from commercial on-farm systems to produce special reports. Feedlot consulting practices use internet-connected proprietary systems to analyze the health performance of millions of cattle in their client feedlots on almost a real-time basis, including uploading digital images from feedlot employee-performed necropsies.

Faced with a data tsunami from a myriad of sources and formats, methods for producing valid, unbiased information for use in new ways are evolving. Data historically recorded on paper, such as individual patient records, laboratory diagnostic reports, and individual livestock records, is now digital. Coming are small, inexpensive sensors capable of continually measuring physiological and other parameters from individuals, the data often uploaded via smart phone, that will result in a massive amount of data. Another massive data stream is originating from the “**internet of things**” in which sensors and microcontrollers embedded in diverse machines and structures communicate via the internet. The result is “**big data**”, data characterized by the 5 v’s: large volume, wide variety, high velocity, much variability and questionable veracity, generated in such large amounts and complexity that timely processing by conventional methods is not feasible.

Although the benefits of compiling information from diverse data streams and formats are easily envisaged, doing so is difficult. The primary bottleneck is the absence of standards and protocols for data generation, vocabulary definitions, report formats, data transmission and storage and analysis across the collection systems. Without **semantic interoperability**, different users are unlikely to derive the same meaning from even identical digital information. Santamaria and Zimmerman report that the AVMA and government agencies have adopted HL7 as the informatics standard for veterinary medicine, LOINC as the laboratory testing terminology standard, and SNOMED-CT for clinical medical terms.

Because the value of most on-farm livestock data is supporting day-to-day decision making on that operation and is short-lived, system designers have incentive to incorporate sufficient flexibility to meet managers' needs but little to make the data consistent between farms or other systems. An exception is generating data for evaluating genetic merit for which organizations such as BIF develop standards for consistency. Consistent data tracking is also limited by the lack of consistent national animal identification systems in most countries. Some countries, such as New Zealand and Uruguay, have successfully instituted national animal identification systems for livestock, thus increasing traceability and availability of resultant data.

The occurrence of economically devastating disease outbreaks, such as foot-and-mouth disease and avian influenza, the emergence of diseases in new locations, such as bluetongue, and the risk of more due to bioterrorism has prompted the development of new surveillance practices designed to detect such problems more rapidly than do conventional means. For example, syndromic surveillance involves aggregation of information from ingenious data sources, such as the monitoring for unusual spikes in over-the-counter antibiotic sales to farms or in the numbers of farm-origin pickups by rendering companies and so on.

Biological data contains uncertainty of random origin (noise) that arises because of inherent biological differences (**biological variability**) and of non-random **bias (systematic deviation)**. The effects of both are minimized through proper data selection, collection and analysis. The discipline of **epidemiology**, the methods for understanding information from groups, provides the principles for evaluating surveillance and other big data results as well as those of more conventional analyses. The key problem associated with big data is **systematic bias**, which occurs as **sampling (selection) bias**, **measurement (information) bias** and **confounding bias**. These are minimized by incorporating where possible Fisher's principles of comparison, randomization, replication, blocking and orthogonality. **Biostatistics** are the mathematical procedures used to summarize biological data (**descriptive statistics**) and to provide an estimate of how likely random imprecision accounts for observed differences (**analytical statistics**).

Evidence-based veterinary medicine (EBVM) is the identification, critical appraisal and use of current best evidence for making decisions. Practicing EBVM requires integrating case history, clinical findings, and diagnostic test results with evidence from clinical research that has been critically appraised for strength. This requires going beyond reasoning based on the traditional "-ologies", beyond reliance on authority or expert opinion and beyond under-evaluated clinical experience. These critical appraisal methods are derived from epidemiological methods. Because much on-line information bypasses the traditional gatekeepers (e.g., journal editors, anonymous reviewers) that maintain information quality, EBVM skills are needed to use this resource wisely. Core concepts include dogma vs. empirical evidence, strength of evidence, systematic reviews, and meta-analysis.

Suggested Reading

[Journals]

Humphrey, H.M., Orloski, K.A., Olea-Popelka, F.J. Bovine tuberculosis slaughter surveillance in the United States 2001-2010: Assessment of its traceback investigation function. *BMC Veterinary Research* 2014;10:182. DOI: 10.1186/s12917-014-0182-y

Johnson, L. M.; Ames, T.R.; Jacko, J.A.; et al. The informatics imperative in veterinary medicine: Collaboration across disciplines. *Journal of Veterinary Medical Education* 2011;38(1):5-9. DOI: 10.3138/jvme.38.1.5

Santamaria, S.L.; Zimmerman, K.L. Uses of informatics to solve real world problems in veterinary medicine. *Journal of Veterinary Medical Education* 2011;38(2):103-109. DOI: 10.3138/jvme.38.2.103

Stark, K.D.C., Hasler, B. The value of information: Current challenges in surveillance implementation. Preventive Veterinary Medicine 2015;122:229-234.

Thompson, P.N., Etter, E. Epidemiological surveillance methods for vector-borne diseases. Revue Scientifique et Technique-Office International des Epizooties 2015;34(1):235-247.

Vial, F., Berezowski, J. A practical approach to designing syndromic surveillance systems for livestock and poultry. Preventive Veterinary Medicine 2015;120(S1):27-38. DOI: 10.1016/j.prevetmed.2014.11.015

[Books]

Porta, M. ed. A Dictionary of Epidemiology. 6th ed. New York: Oxford University Press, 2014.

Thrusfield, M.V. Veterinary Epidemiology. 3rd ed. Blackwell Publishing Co, 2007.

[Internet Resources]

Online Journal of Public Health Informatics <http://ojphi.org/index>

What is Medical Informatics, and why is it an important specialty? Silverstein, S.
<http://cci.drexel.edu/faculty/ssilverstein/informaticsmd/infordef1.htm>
<http://cci.drexel.edu/faculty/ssilverstein/cases/?loc=other>

professional associations:

AMIA - American Medical Informatics Association <https://www.amia.org/>

ASIS&T - Association for Information Science and Technology <https://www.asist.org/>

AVI - Association for Veterinary Informatics <https://avinformatics.wildapricot.org/>

EBVMA - Evidence-based Veterinary Medicine Association <http://ebvma.org/home/>

HIMISS - Healthcare Information and Management Systems Society <http://www.himss.org/>

example informatics standards:

BIF - Beef Improvement Federation Guidelines <http://beefimprovement.org/library-2/bif-guidelines>

CEN/ISO EN 13606 <http://www.en13606.org/the-ceniso-en13606-standard>

HL7 - Health Level Seven <http://www.hl7.org/>

LOINC - Logical Observation Identifiers Names and Codes <https://loinc.org>

OpenEHR <http://www.openehr.org/>

[Schema.org](http://www.schema.org)

SNOMED CT - Systematized Nomenclature of Medicine Clinical Terms
<http://www.ihtsdo.org/snomed-ct>

USDA NAHLN - National Animal Health Laboratory Network <https://www.nahln.org/>

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