Incorporating the Bovine Syndromic Surveillance System (BOSSS) within an animal health surveillance network

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Traditional disease surveillance systems rely upon the strategic use of diagnostic testing within a population. Individuals may be sent for testing if detected as being unusual by the general surveillance system or if selected for testing by targeted surveillance programs. The testing program data is analysed to detect the presence of disease, changes to the prevalence and distribution of disease, or to demonstrate that disease is not present within a population (Green and Kaufman, 2002).

An outbreak may also be detected by observing a change to the pattern of clinical signs within a population. A syndrome is defined as the association of several clinically recognised features, signs, symptoms, phenomena or characteristics (Anonymous, 2006). The surveillance of syndromes may allow detection of outbreaks within a population, and the analytical methods required for syndrome data have general applicability to all surveillance system data.

A recent review of veterinary capability concluded that there was a significant and ongoing loss of veterinary expertise from rural regions of Australia (Frawley, 2003). This loss depletes the capacity of the general surveillance system (the ‘alert clinician’ network) within the extensive production animal sector.

Many people who work with livestock have attuned observational skills and this network of ‘alert livestock observers’ can assist in the detection of disease when provided with a vocabulary and a system for reporting their observations. Estimates indicate that there are approximately 42 full-time livestock workers for every production animal veterinarian in Australia.

Lay observers can provide detailed information on disease events when their data collection and reporting process is guided to follow the approach of a veterinarian. The natural tendency for a lay observer is to report only obvious signs that are present (positive signs). Veterinarians combine clinical examination skills with an extensive knowledge of cattle disease to investigate cases. The veterinarian uses various techniques to gather extra information to rule in or rule out individual diseases. Most lay observers do not have sufficient knowledge of diseases and their causes to use the presenting signs to guide an investigation. This is the key skill of the clinician. However, most lay observers are able to describe what they have seen; especially when asked questions on their observations.

The Bovine Syndromic Surveillance System (BOSSS) was developed to provide a framework for capture of this information from lay observers. BOSSS employs the cattle diagnostic program BOVID© (Larcombe, 1994). BOVID© is a naïve Bayes classifier and contains data on around 1,000 diseases of cattle (endemic and exotic) and around 1,500 individual signs. The Bayes classifier updates the probability of individual diseases when information on clinical signs is provided. The interrogation module of BOSSS enhances the capture of information through selective questioning. Questions on individual signs are selected based upon entered data, current probabilities for disease and conditional sign probabilities.

The artificial intelligence systems interprets the observations of the user and provides the user with meaningful information on potential causative diseases, further investigation and access to expertise as a reward.

Algorithms that detect change to syndrome report distributions are the most common detection systems deployed for analysis of low specificity data. Two detection algorithms have been evaluated using simulated syndrome reporting data from the BOSSS systems. BOSSS will deploy CuSum detector(s) to identify change in the reporting incidence of nominated syndromes, and WSARE (What's Strange About Recent Events) as a general pattern recognition algorithm (Wong et al., 2003). Both algorithm systems require training data to set parameters, control sensitivity, false alarm rate and timeliness of detection. This work will be undertaken when sufficient baseline data is obtained. The artificial intelligence system deployed within BOSSS also provides an immediately functional monitoring system for disease. This case-based analytical system provides the surveillance managers with reasoned interpretation of individual events. The differential list of diseases can be used to guide further surveillance activity as required. This may be as simple as telephone contact with the observer. Then surveillance worth of BOSSS will be dependent upon the quality and extent of data captured and the systems used to process the data.

BOSSS was developed as an online system using the server-side scripting language php. Data is processed and stored on a central server within a mySQL database. A user hierarchy was developed to preserve confidentiality whilst encouraging information flow along approved reporting pathways. Each user is assigned to a physical position with predetermined data access rights and reporting requirements. All users can access aggregated data summaries, but only users from approved positions may access the individual data reports from another position. Logical reporting pathways include from individual farms within a corporate farming business to head office managers, and from local property to regional stock inspector, then to divisional veterinary officer, then to surveillance manager, and finally to chief veterinary officer.

To ensure that data is available for surveillance, each non-government reporter is linked to report to their nearest government officer. Within the government system, access to producer reports allows local officers to maintain surveillance activities within their domain. For example, a stock inspector can examine the reports lodged by farmers within their region. The local veterinary officer can also view the data from this and other stock inspectors within their jurisdiction. This system allows a user within a reporting hierarchy to assess the quality and coverage of syndromic surveillance activity occurring within their sphere of control. This allows users to identify and address surveillance gaps within components of the reporting pathway below their position. The establishment and maintenance of the user hierarchy is time consuming because surveillance personnel will be able to describe both the distribution of disease signs within the cattle population and the level of syndromic surveillance activity within their region.

The reporting pathway is also essential within the Australian state based disease control and surveillance system. State level information is not automatically aggregated at federal level. The Chief Veterinary Officer in each state is currently the final user in the chain. Information obtained from BOSSS is available for contribution to national surveillance at the discretion of the Chief Veterinary Officer. This ensures that state-level information remains within the state. The system requires one extra layer of reporting to allow automatic centralisation of data at Commonwealth level. This extra layer can be simply and seamlessly implemented if required.

The BOSSS system was launched for state-level assessment and refinement in Australia in February 2006. Data contributions by departments of agriculture personnel (veterinary and non-veterinary) and by private cattle owners and observers is supported by the system. The level of use of the system, the value of data captured and analysed and the internal data reporting network will be assessed to determine if BOSSS can make a meaningful contribution to the existing surveillance system operating in the remote pastoral region of Australia.

References

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