

Technology Transfer Symposium

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A Database for Computer-Assisted Diagnosis of Bovine Diseases

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Abstract

Several computer diagnostic programs have recently been developed for use in both human and veterinary medicine. Computer diagnostic programs are particularly useful for the diagnosis of uncommon diseases and "atypical" outbreaks of common diseases. The primary purpose of these programs is to generate a set of likely differential diagnoses based on information collected about the case. The input information is usually restricted to clinical history and clinical signs. A list of possible diagnoses is generated, generally with no indication of which of the possibilities are most likely. We have developed a computer aided bovine diagnostics program which is unique in many respects. The emphasis is on the diagnosis of herd problems as opposed to the diagnosis of isolated diseases affecting a single animal. Thus, gross and histologic necropsy findings are included as input fields, along with clinical history and clinical signs. Multiple observations are entered into the program to obtain a list of differential disease diagnoses. The program graphically displays 1) the probability of disease occurrence in the users locale (hazard rating), 2) the probability that an input observation will be seen with each disease listed, and 3) the severity of lesions/signs observed with each disease listed. With this information the user is able to determine which of the diseases listed in the differential diagnosis are most likely in the given situation. The program is versatile in that the user can change the hazard ratings for diseases, add new diseases, and put in additional signs/lesions for any given disease in the program. The program is designed for use by clinicians and laboratory diagnosticians.

Summary

A database for bovine diseases was compiled to aid and improve practical diagnosis of field cases. The database is powered by a commercially available analytical database in the IBM PC format. A differential diagnosis of a disease may be made by entering clinical findings and/or necropsy or histopathological findings. The graphical presentation of the knowledge stored in the database facilitates speedy browsing through the data and an effortless heuristic evaluation of data relating to field cases.

Introduction

Veterinary medicine is the science and art of treating sick animals and ensuring their continuing health. A prerequisite for effectively treating sick animals is that an exact diagnosis be made. Considering the prime importance of diagnosis, it is somewhat lamentable that even sophisticated diagnostic laboratories have relatively low rates of diagnosis of field cases, especially in some key syndromes such as bovine abortion. Reasons for the lack of success in diagnosis include insufficient or inappropriate specimens, inadequate laboratory testing capabilities, incomplete details of the circumstances of the field case, poor access to a veterinary library and journals, and even diagnosticians insufficiently trained in the art of diagnosis. Ancillary aids to diagnosis which might improve rates of diagnosis should be utilized wherever possible. One such aid is a veterinary disease database, designed for use by diagnosticians. To the authors knowledge, only 2 such databases, CONSULTANT⁷ and BOVID¹, have been utilized in bovines. Each of the 2 programs has a separate software program and each has a different method of approach to supplying possible diagnoses. The present authors, whilst recognizing the worth of these programs, have attempted to build a bovine diagnosis program that answers some of the shortcomings of other programs, and adds new criteria to input, particularly necropsy findings and histopathological data.

System Requirements

1. *Software.* a. The bovine disease database (to be marketed in late 1993). b. Reflex 2 (Borland International, Scotts Valley, California); this analytical program powers the bovine database. A thorough knowledge of Reflex is highly desirable to fully utilize the potential of the bovine disease database.

2. *Computer.* An IBM compatible PC with a minimum configuration of an 80386SX processor is needed. Reflex is memory hungry and therefore 4 MB of RAM with a memory manager is needed. A color monitor with SVGA and a mouse are highly desirable.

Viewing of Data

The color graphical presentation of findings in the bovine disease database is such an integral part of the diagnostic process that to print black and white figures in this article would only detract from one of the highlights of the program. The full program will be demonstrated in the Conference. Therefore, only a partial representation of the use of bovine database is given here. As with any data file in Reflex, the bovine database can be red in three "views".

1. Form view - the data for each etiologic diagnosis was entered in this format. This view is best used when a differential diagnosis has been made and more details are required to reach a final diagnosis. The form shows fields in various categories:
 - a. A description of the cause - its alternate names, classification, and hazard rating.
 - b. References are given
 - c. Input fields detail type and age of animal, and husbandry (where kept, types of feedstuff given).
 - d. Clinical data are detailed. There is a quantitative expression of time of onset and recovery from the exposure, body weight change, morbidity and mortality. Clinical signs are detailed in 107 fields, which range from specific (e.g. tenesmus) to generalized (e.g. urine color). A whole number value from "0" (not recorded) to "3" (consistent involvement) expresses the probability of that sign to be associated with each cause. A value of "4" indicates signs of pathognomonic significance. A decimal after the whole number express the severity of these manifestations, where ".1" = mild, ".3" = moderate, ".6" = severe, and ".9" = very severe.
 - e. Notation of necropsy and histopathological findings. Changes are detailed in 85 fields, which range from specific (e.g. liver megalocytosis) to generalized (e.g. abomasum). Whole number and decimal suffixes express the changes as detailed above for clinical signs.
 - f. Remarks - a brief description of the cause, its effect on bovines and additional details not

expressed or not evident from the numerical evaluation in the database.

2. List view - best used for moving from place to place in the database.
3. Graph view - most of the data analysis is carried out in this mode, with color graphic representation of data, forming a "fingerprint" for each substance.

Analysis of Data

Reflex is very flexible and analysis of data can be obtained in various ways. One best starts the program in the "graph view". All of the potential causes (covering 13 screens) are displayed on the vertical scale of the graph and on the horizontal scale are places in which to enter the data ("fields"). The "hazard" field is always present. This is an essential diagnostic criterion which relates to the likelihood of diagnosing that particular cause in the diagnosticians own region of the country. The hazard rating is a combination of intrinsic virulence/toxicity of the agent and the likelihood of bovines being exposed to it at deleterious levels, all with regard to occurrence in that particular geographical location. A hazard of "-0.5" = exotic cause (not in diagnosticians country), "-0.25" = very local occurrence in country, "0" = has not been recorded in that area/laboratory; "1" relates to rare expected incidence, "2" = uncommon, "3" = common. Any of the fields can now be chosen from a menu, one at a time, to describe the suspect etiology. Chosen fields appear above the hazard field, and are expressed graphically as bar values, opposite the list of causes on the vertical axis, where "0" = not associated with this substance, "1" = rarely associated, "2" = commonly associated, "3" = very commonly associated, "4" = of pathognomonic significance. The "page up", "page down" keys are used to rapidly "browse" through the screens, noting the connections between entered fields and the values appearing for each cause. The "filter" facility is used to exclude inappropriate causes and also to maximize usage of computer memory. Filtering is an essential part of the analysis and must be carried out only for constant findings of prime diagnostic significance - if filtering is made on an incidental finding, the real diagnosis may be excluded and missed. Causes may be added or deleted until a "fingerprint" is obtained, whereby the data for each cause can be compared with the case findings. The more matching fields and the higher their numerical values, the more likely is the cause - effect link.

Discussion

In human medicine, computer-assisted medical decision making programs have largely evolved into

expert systems which not only strive to bring the operator to a diagnosis, but also give advice with regard to treatment. Although this philosophy of approach may also be used in pet animal medicine, it is largely inappropriate in farm animal medicine. In addition, the tools of artificial intelligence⁴ and Bayesian analysis^{5,6}, so often used in human medicine, are not appropriate, as reliable epidemiological data based on the detailed workups of disease with regard to incidence of clinical signs are non-existent in animals.

In the present database, some of the parameters used in human systems⁶ are applicable and have been incorporated. These are a four-point scale with mapping onto the probability scale, expressed as "hazard". In addition, there is a five valued logic, in which variables are absent (value = 0), or present at variable likelihood's (values of 1 to 4). The operator can easily change values of the hazard rating according to a specific disease incidence in his area. The inclusion of rarely encountered causes focuses on one of the main *raison d'être* of the database, and indeed a main vocation for all veterinary diagnosticians, that is to detect potentially dangerous outbreaks of exotic disease or contamination of milk or meat and so to avoid the specter of pandemic spread of disease or subclinical or clinical secondary toxicosis in man. Likewise, the operator can change the values for any of the fields according to his own experience or as new findings are made available.

Although computer assisted diagnosis in veterinary science has been a topic much discussed for many years^{2,3}, few groups have progressed very far practically. This is in part no doubt due to the extremely long input time careful planning how to approach diagnosis, assembling data and putting the data into the program; the fact that this input is best measured in man-years shows the dedication necessary to attain success. The largest and oldest program is CONSULTANT⁷, which comprehensively details clinical signs of domestic animals, with an emphasis on pet animals. However, this program gives only lists of causes in which the signs are seen. Another program, with a very comprehensive list of clinical signs seen in all the diseases of cattle is BOVID¹. A prevalence of each disease is given, and

although it is based mainly on the incidence of diseases in southern Australia, it can be changed by the user. Another addition is the numerical probability of each clinical sign occurring in each disease.

Our bovine diagnostic database incorporates both a disease prevalence (hazard), and the probability of a particular sign being associated with a particular cause. It also includes an expression of the severity of a particular finding, something not present in either of the other programs. Other useful features not found elsewhere are necropsy and histopathological findings. It is a fact of life that in a large proportion of cases submitted to a diagnostic laboratory for diagnosis, mortality has been recorded, and therefore pathology can be an important aid to final diagnosis.

The bovine disease database was planned to give a heuristic approach to diagnosis in which the computer only presents data in an easily assimilated form; the operator still has to use his skills in the interpretation of data and their application to the case at hand. Whilst not readily comparable to the computers' efforts to mathematically defeat man at chess, a good diagnostician has powers of intuition and clinical experience that no computer has, and given the differentials, can do a better job of diagnosis in biological systems when presented with the facts in a well presented form.

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