PEER-REVIEWED

Considerations in making a diagnosis

Despite the sophisticated diagnostic technology available to today's practitioners, the most important part of making a diagnosis is still thinking.

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ARRIVING at a correct diagnosis is a continuing challenge for clinicians. Clinical epidemiology, biostatistics, and clinical decision-making are "new" tools that help practitioners make diagnoses.' Biostatistics and epidemiology allow large amounts of raw data to be analyzed into useful information. As an example, for years we have known that dogs have more mammary tumors than cats. horses. or cattle, and that mammary tumors were common in females, although males also have mammary tissue. We have learned that the rate of mammary tumors in dogs is more than twice that in people. and this tumor type accounts for about 40% of canine tumors. Analysis of a large number of cases has also revealed certain risk factors for mammary tumors. As a result of analyzing large numbers of canine mammary tumors, we now know female dogs spayed before one year of age are less likely to develop mammary tumors.

Epidemiology is often considered a new science, but many of the concepts are not new. More than 100 years ago, a physician named William Farr became the first Registrar-General in the General Register Office of England. where he worked for more than 40 years." In his Annual *Reports*. Far-r described death rates and noted healthy and unhealthy districts of England. His publication of Vital Statistics in 1885 described the concepts of incidence, prevalence, and the value of retrospective and prospective approaches to studying disease. which are fundamental to epidemiology today. Two-hundred years before Farr, English parish registers published annual breakdowns of death by cause, particularly during plague epidemics: these were the basis for the earliest vital statistics.

When making a diagnosis, it is not possible to obtain all clinical information on every patient, nor is it desirable. Practitioners must be selective when confronting a mass of data, which varies in value from the highly significant to the trivial. Understanding epidemiologic concepts helps in selecting probable causes for the presenting complaint and determining whether laboratory tests are indicated. In making clinical decisions. clinicians go through two processes at the same time. While examining the individual patient, they simultaneously generalize their previous training and experience. The generalizing of experience is part of epidemiology.

The most important part of making a diagnosis is thinking. In determining the cause of disease, diag-

nostic testing is secondary to thinking. Many cases do not require any laboratory tests to make a diagnosis. Clinicians use epidemiologic concepts in making diagnoses, though they may not use the jargon of epidemiologists. Jargon can place barriers in the communication process. In place of the term diagnosis, the epidemiologist might prefer such terms as medical decision-making, decision analysis, or decision tree appraisal.

The purpose of this article is to provide a perspective on methods used to make a diagnosis. Part of diagnosing is an art, and no specific approach works for everyone. Many diagnoses are based on information that is uncertain and, as a result, are our best educated guesses. We may be able to reduce uncertainty, but we cannot eliminate it. For a humbling experience, I suggest performing a necropsy if possible in every case in which you were certain of the diagnosis.

Searching for a diagnosis

When a patient is presented. the practitioner begins to search for a diagnosis, or an explanation, of an illness. The extent of the search is determined by the presenting complaint. The search ends when enough evidence has been collected to enable the practitioner to make a management decision.". The end of the search is often the diagnosis, but the search might also end before a diagnosis is made. If the fever subsides and the animal returns to normal, the search for the cause ends. And a particular practitioner's search for a diagnosis may end with the decision to consult with other animal-health professionals or refer the patient to another clinic.

Students may be taught in veterinary school that a specific diagnosis can be made for every illness. If this is taken too literally, a practitioner is bound to feel like a failure. A specific diagnosis may not be possible with the information available to the practitioner, or cost may be a limiting factor. In general practice, physicians are able to make a diagnosis in about 50% of their patients. This can be disquieting to the purist who feels that a thorough work-up and specific diagnosis should be obtained in all cases. Not understanding that uncertainty is inherent to medicine can be detrimental to a practitioner's sense of self-worth, as was illustrated by one physician's bewilderment: "I had not long been in the practice when I discovered how defective, was my knowledge. I left college under the impression that every patient's condition could be diagnosed.. . . For some years I thought that this inability to diagnose my patient's complaints was due to personal defects.. . . I came to recognize that the kind of information I wanted did not exist.""

Conditions that cannot be diagnosed can always be given labels that may provide some comfort to the animal owner, but the labels may have no relationship to the disease present. For example, an owner reports that her cat has been vomiting and has had diarrhea for the past four days. After the examination, the client asks what the problem is and is told the problem is gastroenteritis. Often the client is satisfied, but we have merely combined her words together. Be wary of tautologies. A tautology is a statement that merely repeats an idea in different words, without giving any new information.

Practitioners often see illness in the early stages before the complete clinical picture has developed. Many illnesses are transient, and it may be more important to know what the patient does *not* have than to know precisely what the patient does have. One clinical sign may raise a higher index of suspicion than another because of the greater probability that it is associated with a potentially serious illness. Many veterinarians attempt to fit a problem into one of a series of syndromes related to an anatomic, physiologic, or biochemical peculiarity and develop a hypothesis concerning the deranged function. The clinician begins the reasoning process with the history and continues depending on his or her tidings and formulated hypotheses.

The clinician develops a working hypothesis of what the medical problem is from the information collected. When presented with a problem, clinicians respond to cues and form one or more hypotheses about the nature of the problem and embark on a search to test their suspicions. Gaining feedback, clinicians revise, test, and further revise the hypotheses. Hypothesis formation involves creativity, with experience being an asset.

It is prudent to first think in terms of types of illness or undifferentiated medical problems rather than disease. We can think of illness as the patient's experiences with the disorder: clinical signs are cues of the patient's experiences. Disease is the theoretical framework used to explain the patient's illness. The col-

lection and analysis of facts are intermingled and often not separate sequential steps. It is not possible, nor is it practical, to gather every conceivable piece of information before formulating a differential diagnosis. However, this doesn't argue against the need for a systematic, thorough, complete history in particular cases.

For example, a dog is presented with vomiting and diarrhea. The first thing that comes to mind is the gastrointestinal system, and then such causes as dietary indiscretion, infection, a foreign body, or a biochemical disorder. As the client is questioned more closely, we learn more about the situation and our focus narrows. The owner reports the dog chewed up a plastic toy, and the results of the physical examination are normal. In our minds, certain causes become more likely, while others become less likely.

The clinician is looking for cues to make it possible to develop a hypothesis regarding the illness. For example, a six-month-old, unvaccinated dog with a cough, purulent nasal discharge, and a fever of 105 F is examined. With these cues, we develop hypotheses about the probable cause of illness. The fever suggests an infectious disease, while the cough and purulent nasal discharge point to the respiratory tract. The age and lack of vaccination remind us to consider the common infectious diseases against which the dog was not immunized.

Practitioners often intuitively estimate the probability of a particular disease in a patient. without consciously being aware that they are making such calculations. This probability is based on the clinician's experience and the type and extent of the patient's clinical signs. Some knowledge is objective and easy to document and some is subjective and difficult to express, although no less valuable in generating a probable cause of disease in an individual.

TABLE 1

Diagnostic Aids for the Clinician*

1. History
2. Physical examination
3. Environment
4. Epidemiology
5. Time
6. Diagnostic procedures

*To use these diagnostic tools effectively, one must first have experience (previous knowledge of disease) and think.

Diagnostic aids used by clinicians

There are several tools that clinicians use to arrive at a diagnosis (Table 1). Each of the tools is used in the search for cues to understand the patient's condition.

The history and physical examination

In diagnosing a patient's condition. all tools do not have the same weight. The two most important ones are the history and physical examination. and together they have been referred to as the routine search."

The history is the beginning and, in some instances, is all that is required to make the diagnosis. For example, in May, an owner calls reporting his nine-month-old female Siamese cat is acting strange. The cat calls and purrs, is affectionate, rubs its head on the furniture, rolls on the carpet, crouches and elevates its rear quarters, and treads with its back legs — the classic signs of estrus.

When esamining a patient, the clinician is comparing the information gained from the examination with his or her experiences and forma1 education. Students may be taught that the initial diagnosis is limited to an orderly, formal consideration of all the diagnostic possibilities. But the practitioner should focus on the probable, not the possible.

The history and physical examination may be glossed over in a rush to get to high-technology medicine, particularly by inexperienced practitioners. This has caused embarrassment for many of us at one time or another. Laboratory tests cannot be a substitute for a complete history and thorough physical examination.

In veterinary medicine, the expression "clinical examination" refers to an examination of the patient history, the animal's environment, and the animal. Inadequate examination of any of these can render valueless a great deal of work on the other aspects and lead to error in diagnosis.7

The history is often the vanguard of the diagnosis. The history allows diagnostic hypotheses and probabilities to be generated. The description of a patient is more than a collection of isolated facts: it can be viewed as a list of risk factors. Which patient with a firm cutaneous mass in the ventral, posterior, subcutaneous tissue would most likely have a mammary tumor — a 10-year-old mare or a lo-year-old bitch?

The medical record may be referred to as a data base by the epidemiologist. For example, a 12-year-old cryptorchid dog is presented with the complaint of enlarged nipples. By evaluating the risk factors on the medical record (age, sex, cryptorchidism, species).

the clinician begins thinking of diagnostic possibilities even before physically examining the patient. Change any of the risk factors, and the diagnostic probabilities change.

Another step in the search for a diagnosis is performing a physical examination. A dog is presented because of anorexia and vomiting. The results of a cursory physical examination are negative, The results of the CBC, serum chemistry analysis, urinalysis, and radiography are inconclusive. Because a cause for the clinical signs cannot be determined, the patient is re-examined and the abdomen palpated again, revealing a firm sausage-shaped mass. "When all else fails, examine the patient" is an adage that holds true in both veterinary and human medicine.

The patient's environment

An understanding of the animal's environment can be the keystone to the diagnosis. This concept is stressed in diagnosing livestock diseases, and it is equally important with small animals. It is standard procedure for epidemiologists to describe disease in terms of the animal (species, age, sex. breed, vaccination history, medical history), environment, and time.

The impact of environment on disease has been known for more than 2.000 years. Hippocrates stated, "Whoever would study medicine aright must learn of the following subjects. First he must consider the effect of each of the seasons of the year.. .." The role of the environment may seem so obvious that it is neglected. For esample a dog is examined with sudden profuse salivation. diarrhea. tachpcardia. and a body temperature of 104 F. Blood panels, stool cultures, urinalysis; and radiology provide a large amount of data, but the key to the diagnosis is in the history. Knowing that the dog spent the last 45 minutes locked in the car on a hot summer day would provide you with more useful information than all the diagnostic tests available.

Epidemiology

The clinician uses information on animal populations as a reference for comparing his or her patient. For example, a body temperature of 106 F generally indicates fever in patients seen by small-animal practitioners. However, if the patient is a bird, this body temperature is normal.

Epidemiology is the study of the relationships of various factors that determine the frequency and distribution of disease in a community. Epidemiologic statements may be expressed as rates. Rates require the specification of a numerator (patients in our example) and denominator (the population to which the patients belong) within a specified time period. Our clinical training focuses on understanding disease in individuals because we are responsible for treating individuals or small groups of individuals. The epidemiologist, on the other hand, is focused on the distribution and determinants of disease in populations.

While examining a patient, the clinician uses knowledge of the experiences reported from populations and correlates this to the problem encountered in practice. For example, a review of a medical record indicates that your next patient is a three-year-old, mixed-

breed male dog with bloody discharge from its prepuce. The owner obtained the dog six months ago as a stray while in Puerto Rico. The time of ownership and origin of the dog provide cues about a possible diagnosis. Knowing that there is a high prevalence of canine transmissible venereal tumors in stray dogs in the tropics is helpful when analyzing the patient's history. Realizing the disease is enzootic in Puerto Rico and is the most common tumor of dogs in Puerto Rico 9 leads to one likely diagnosis. If the dog was from Wisconsin, then you would consider canine transmissible venereal tumor a remote possibility. Physical examination allows the clinician to rule in or rule out initial hypotheses and may provide information for additional hypotheses.

Probability

In medicine, absolute certainty is not usually attainable. Many clinical decisions are based on information that is uncertain, and the diagnosis is our best educated guess. Even the final diagnosis is a statement of probability. The probability is determined by experience with similar patients and an understanding of the distribution of diseases in the practice area. To reach a diagnosis, the focus is upon the probable. not the possible. All things might be considered possible. If additional evidence is obtained, it may provide a clearer understanding of the situation and the diagnosis can be changed.

In general practice. disease is often seen in the early stages before the full clinical picture has developed. Decisions have to be made with fewer cues than will be available in the later stages of disease. The early stages present different cues than the late stages. A disease may remain undifferentiated for months before its true nature unfolds. Feedback from the animal owner can be very important in assisting with a diagnosis, so it is necessary to develop a good relationship with him or her.

How probable a clinician believes a diagnosis is depends on the number of his or her encounters with particular diseases and the clinical signs. A recent graduate entering a practice may wonder how an older clinician knew what the problem was. To the inexperienced, two clinical pictures may appear identical, but to the astute practitioner differences are apparent. The more experienced clinician understands what is typically seen m that particular practice area.

Populations

To enhance their diagnostic abilities, clinicians need a basic understanding of the morbidity and mortality associated with particular diseases for the various animal species in their practice area. Unfortunately, such information may not be available for your practice area and you will need to rely on your experiences and those of your colleagues. The same clinical signs may suggest different diseases depending on the population. Clinical signs have to be related to the populations in your practice area. When a practitioner moves to another area. the distribution of diseases he or she will see changes. For example. a four-year-old dog is presented with chronic fatigue. coughing, and radiopaque lesions in the lungs. The practitioner in Georgia would suspect heartworm disease, whereas the practitioner in an arid region of Arizona would think coccidioidomycosis was more likely.

The training of students at veterinary schools takes place in a setting where the later stages of disease are encountered and referrals are common. Referral patients seen at universities tend to be atypical examples of diseases occurring in a normal community. Based on the university caseload, students may develop an unrealistic concept of the kinds of medical problems prevalent in the community in which they will practice. Internships in private practices with a cross section of cases provide a more realistic understanding of disease prevalence. As a clinician develops a better understanding of disease patterns. his or her instincts in making a likely diagnosis will improve.

Time

Time is repeatedly used as an efficient diagnostic aid. Observation over time can be used as a method for testing hypotheses, assessing probabilities, and better understanding the problem. If the initial evaluation does not reveal a serious problem. you might decide the clinical signs are minor and transient and then wait for this hypothesis to be verified. Using time to validate a hypothesis is a common medical practice.

_Also, it is possible for patients to get well in spite of what we do, not because of what we do. For example, a five-year-old. castrated Beagle is presented because it has had diarrhea for the past 24 hours. Physical examination findings and the body temperature are normal.

TABLE 2

How Disease Prevalence Affects the Predictive Value of a Laboratory Test*

	Predictive Value of a Ptxitlve Test (%)	Predictive Value of a Negative Test (%)
New York	95	95
Caliiomia	2	99.9"

'In this example. the test is assumed to have both a sensitivity and a specifcity of 95 percent. The dii prevalence is assurnad to be 50% in New York and 0.1% in Califomla.

' The predictive value of a negative test appears to be good in California. However. with a disease prevalence of 0.1%. if you just said the patient does not have the disease you would be correct 99.9% of me time.

All types of diseases are possible, but in all probability the condition is temporary and will resolve itself, providing we don't make it worse.

An observation period of 24 hours can be very useful. "Tincture of time," the expeiienued practitioner may say. A decision to wait might be viewed as.doing nothing, 10 but "the well trained doctor knows what to do for his patient: the especially well trained doctor knows what not to do." 11 Besides, encounters with modern medicine are not always beneficial to the patient. Iatrogenic disease, a result of an individual's experience with the medical profession, is seen in both human and veterinary medicine. 12-13 One situation many of us have faced is the healthy dog that comes in to be spayed and leaves the clinic the next day with kennel cough. Such nosocomial infections, infections acquired within the hospital setting, are not uncommon. 14-19 When people enter a hospital. 3.5 to 5% of them develop a nosocomial infection. 20

Test selection

A myth has developed that modern medical technology makes clinical diagnosis nearly infallible. In fact, postmortem examination may alter the major clinical diagnosis in as many as 20 to 25% of people examined. And this percentage has not changed during the past 30 years despite all the new diagnostic technology. 21-23

When the practitioner considers laboratory tests, he or she may be considering ultrasonography, radiography, blood tests, and urinalysis. When the epidemiologist considers laboratory tests, the following concepts come to mind: accuracy, sensitivity, specificity, and predictive value. More tests do not necessarily produce more certainty. More tests may actually produce extraneous data and be harmful to the patient. 24 If you run enough tests, it is certain you will obtain results that are above or below the normal range. One hazard is the finding of a spurious abnormality and then prescribing inappropriate treatment. Reliance on the laboratory for a diagnosis when clinical observation would be a better strategy can create problems. It is well recognized that the competence of a physician is inversely related to the use of laboratory tests. 3

The clinician wants to know how well a test predicts disease. A test result can be highly reliable. or repeatable, but the probability of predicting disease from the test may be low. To determine the test's accuracy, the test characteristics (sensitivity and specificity) and the disease prevalence must be known. 25,26 The predictive value of a test or the ability to accurately diagnose the presence or absence of disease based on a test result is the bottom line. If my patient tests positive or

negative, how much confidence can I place in the result? Tests with known sensitivity and specificity are a beginning. A test with a sensitivity of 95% and a specificity of 95% is considered a good test. However, the predictive value of the result varies with the prevalence of the disease in the practice area. An identical test result may be interpreted differently in different geographic regions (Table 2).

All tests have associated costs and risks. It is always prudent to rationally and methodically determine whether the benefits outweigh the risk and cost. Myelograms supply information, but they can also be risky. A test should not be done just for the sake of thoroughness. Overinvestigation, redundant testing, and iatrogenic disease do occur. Irrelevant or redundant data do not improve the quality of care, but contribute to the cost of care.

Conclusion

Despite the array of diagnostic laboratory testing and procedures available to veterinarians. the patient history and physical examination are still the most effective tools for increasing the probability of a correct diagnosis.

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