Specific Challenges in Conducting and Reporting Studies on the Diagnostic Accuracy of Ultrasonography in Bovine Medicine

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KEYWORDS

• Imaging • Bias • Sensitivity • Specificity

KEY POINTS

- Studies reporting diagnostic accuracy of ultrasound for medical and surgical diseases of cattle need to be consistently reported in order to improve their applicability in private practice.
- Specific challenges need to be addressed when designing studies on ultrasound diagnostic accuracy to avoid any bias that could affect the reported accuracy (in terms of sensitivity and specificity).
- Improving the reporting of the studies and trying to avoid any bias would help with faster dissemination of ultrasonography as an effective diagnostic test in bovine medicine and surgery.

INTRODUCTION

Bovine ultrasonography has gained popularity since the early 1980s, first as a tool for assessing the reproductive tract. The medical and surgical indications of ultrasonography developed in parallel with its use as an interesting noninvasive tool in humans and in veterinary species. The portability of ultrasonography, as well as its relatively low cost, are factors associated with its more general use as a diagnostic test by bovine practitioners for reproductive management of cattle. The use of ultrasonography for nonreproductive purposes has also gained popularity, however, this use is far less common than reproductive applications.[1]

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As with any diagnostic test used in the medical and surgical decision process, the validity and usefulness of ultrasonography for detection of disease first needs to be judged in comparison with other testing options. Comparisons are made between the test of interest, referred to as the index test, and a gold standard test or reference standard test. Technically, the gold standard test is 100% accurate. An imperfect reference standard may also be used for comparison when a gold standard is unavailable or not feasible. For example, pneumonia could be diagnosed in a study using a reference standard, such as the presence of fever AND nasal discharge AND cough AND dyspnea (a definition that may be specific but lacks sensitivity), but the gold standard examination would be necropsy and isolation of pathogens which cannot be performed routinely because of obvious side effects.

Comparative diagnostic test studies with binomial (2 levels) categorical outcomes, such as diseased and nondiseased, summarize the characteristics of an index test using sensitivity (Se, number of patients who had an index test positive and are gold standard test positive ÷ number of patients who are gold standard test positive expressed as a proportion or percentage) and specificity (Sp, number of patients who had an index test negative and gold standard test negative ÷ number of patients who are gold standard test negative) (**Table 1**). If an imperfect reference standard is used, then the relative sensitivity (index test positive and reference standard positive ÷ test positive based on imperfect reference standard) and relative specificity (index test negative and reference standard negative ÷ negative based on imperfect reference standard) can be calculated. Many investigators do not distinguish between true and relative summary measures. However, designing studies to accurately measure sensitivity and specificity requires careful planning. Apart from random error, sources of systematic bias can create biased measures of Se and Sp; as a consequence, it is important that practitioners understand these systematic biases.

The objective of this article is to review the specific challenges and standards for reporting diagnostic (STARD) accuracy studies, and the methodological issues that can introduce bias into studies reporting ultrasonography as a diagnostic test in bovine medical and surgical disorders. As an outline of the article, the following topics are covered:

- Phases of testing assessment and study designs
- Reporting guidelines for diagnostic test assessment studies relating to imaging

Table 1
Determination of accuracy of the parameters of ultrasonography (index test) compared with a reference standard test that may or may not be a gold standard test

	Reference Standard +	Reference Standard −	
Ultrasonography +	TP	FP	TP + FP
Ultrasonography −	FN	TN	FN + TN
	TP + FN	FP + TN	n

TP + FN = positive cases (reference standard positive cases); TN + FP = negative cases (reference standard negative cases); TP + FP = cases that were ultrasonography positive; FN + TN = cases that were ultrasonography negative; n = total number of cases included in the study. Accuracy measurement: Se = TP/(TP + FN); Sp = TN/(TN + FP); these accuracy measures (sensitivity and specificity) are relative sensitivity and relative specificity if the reference standard used is not 100% accurate; PPV = TP/(TP + FP); NPV = TN/(TN + FN); PLR = Se/(1 − Sp); NLR = (1 − Se)/Sp; DOR = PLR/NLR = TP × TN/(FP × FN) = (Se × Sp)/((1 − Se) × (1 − Sp)).

Abbreviations: DOR, diagnostic odds ratio; FN, false-negative cases; FP, false-positive cases; NLR, negative likelihood ratio; PLR, positive likelihood ratio; TN, true-negative cases; TP, true-positive cases.