Original Investigation

Outcomes Knowledge May Bias Radiological Decision-making

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Rationale and Objectives: This research investigates whether an expectation of abnormality and prior knowledge might potentially influence the decision-making of radiologists, and discusses the implications for radiological expert witness testimony.

Materials and Methods: This study was a web-based perception experiment.

A total of 12 board-certified radiologists were asked to interpret 40 adult chest images (20 abnormal) twice and decide if pulmonary lesions were present. Before the first viewing, a general clinical history was given for all images: *cough for 3+ weeks*. This was called the "defendants read."

Two weeks later, the radiologists were asked to view the same dataset (unaware that the dataset was unchanged). For this reading, the radiologists were given the following information for all images: "*These images were reported normal but all of these patients have a lung tumour diagnosed on a subsequent radiograph 6 months later.*" They were also given the lobar location of the newly diagnosed tumor. This was called the "expert witness read."

Results: There was a significant difference in location-based sensitivity (W = –45, P = 0.02) between the two conditions with nodule detection increasing under the second condition. Specificity increased outside the lobe of interest (W = 727, P = < 0.0001) and decreased within the lobe of interest (W = –237, P = 0.03) significantly in the "expert witness" read. Case-based sensitivity and case-based specificity were unaffected.

Conclusions: This study showed evidence that increased clinical information affects the performance of radiologists. This effect may bias expert witnesses in radiological malpractice litigation.

Key Words: Bias; nodules; lung; expert witness; decision making.

INTRODUCTION

Radiology involves decision-making in situations of uncertainty and therefore cannot always produce perfect interpretations (1). The majority of these errors are not significant, or if significant, they are swiftly appreciated and corrected such that they do not cause harm to the patient. However, a number of radiological errors do injure patients and, consequently, medical malpractice lawsuits are brought (2). In certain malpractice cases, the radiologist (defendant) who misses a chest lesion may only have been provided with limited clinical information. However, at trial, the expert witness for the plaintiff is presented with all pertinent medical records and would therefore be cognizant of the location of perhaps a now-known tumor (3,4). Such a bias undoubtedly has implications for the legal system. Consider a defendant who, despite taking reasonable care, has made an error and has been sued. The defendant's level of care will be evaluated by an expert witness who already knows that it proved inadequate to avoid the plaintiff's injury. Consequently, the defendant's level of care will seem less reasonable and more erroneous. Perhaps the Medical Defence Union puts it a little more succinctly:

> "The initial chest x-ray should have been reported as abnormal. If it had been, he would have been diagnosed at the time and sought treatment. The defence argued that the tumour on the original x-ray was only obvious to see once the later films had been considered, as any reviewing radiologist expert would know exactly where to look." (5)

Berlin highlighted a case where a radiologist, acting as an expert witness, with full knowledge of the patient's medical history and outcome, testified that a tumor was visible on a radiograph reported normal 3 years previously (6). This inequitable advantage allows the expert witness to focus on the particular area of interest.

The possibility of a radiologist being the defendant in at least one lawsuit is 50% by the age of 60 years (7). Between 1985 and 2002, radiologists ranked sixth among the specialists in the number of claims for which they were defendants, despite comprising only 3.6% of all medical specialists (8,9). It is estimated that 40% of radiologists in the USA are taken

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to court approximately once every 5 years (10). Tort claims for negligent diagnostic errors result in billions of dollars in compensation annually (11).

Misdiagnosis of disease in medical imaging is due to search, perception, or cognition errors (12). Linked to these errors is the inadequacy of clinical information given to the radiologist by the referrer (13). Errors in diagnosis, among them is failure to diagnose lung cancer, are the most common grounds for bringing a malpractice suit against radiologists associated with the diagnosis of chest radiographs (14,15).

Despite this, there has been remarkably little research on the effect of a combination of abnormality prevalence expectation and clinical history (hindsight or outcome bias) in radiology (16). The assumption from government and the American College of Radiologists is that the main responsibility of the expert is to be an objective source of truth (17). Preferably, expert witnesses should impart unbiased evidence, the fundamental feature being the veracity of expert witness testimony. It should be reliable, impartial, and accurate, and provide an honest analysis of the standard of care. On occasion, not all medical experts may testify within these boundaries (18).

It is essential to reduce expert witness bias not only because there is an importance in finding the "truth," but also because the stakes are high (19). Awareness about the effect of bias is important for both the judiciary and the expert witnesses. The purpose of this paper is to investigate whether foreknowledge of the approximate location of a target creates a bias that facilitates target detection.

MATERIALS AND METHODS

Subjects

An invitation was posted on a number of radiological websites. Initially, 25 radiologists expressed an interest in the study, and of these, 15 undertook the first read. When these subjects were reinvited to complete the next stage of the experiment, just 12 completed the second read.

All subjects were board-certified radiologists, with a minimum of 5 years and a maximum of 25 years postboard certification. Three radiologists were from the USA, three from Europe, two from the United Kingdom, two from Australia, one from Asia, and one from the Middle East (Table 1).

Image Bank

The same image set of 40 adult postero-anterior digital chest images (high-resolution; 2048 × 2048 matrix size, 0.175 mm pixel size) was used for both conditions. The images were selected from a dataset created by the Japanese Society of Radiological Technology in cooperation with the Japanese Radiological Society (20). The lung nodules were categorized according to a degree of subtlety from 5 (obvious) to 1 (extremely subtle). The categorization and nodule presence or absence was validated by 20 radiologists (not involved in this study) using computerized tomography.

TABLE 1. Radiologist Demographics

	Board Certified (Yrs)	Country Certified
	15	Australia
	9	UK
	12	USA
	5	UK
	15	USA
	12	USA
	11	Bangladesh
	4	France
	8	Romania
	25	Australia
	3	Egypt
	8	Czech Republic
Median	10	
Mean	10.58	

TABLE 2. Location and Size of Nodules

Case	Conspicuity	Size (mm)	Size (Pixels)	Location
1	3	25	89.25	RUL
2	3	8	28.56	LUL
3	3	15	53.55	LLL
4	3	10	35.70	LLL
5	3	15	53.55	LUL
6	3	6	22.42	RUL
7	3	10	35.70	RUL
8	2	15	53.55	RUL
9	2	21	74.97	RUL
10	2	25	89.25	RLL
11	2	20	71.40	LLL
12	2	15	53.55	RUL
13	2	15	53.55	RUL
14	2	20	71.40	LLL
15	2	20	71.40	RLL
16	1	22	78.54	RUL
17	1	10	35.70	RUL
18	1	10	35.70	RUL
19	1	15	53.55	LLL
20	1	8	28.56	RUL

LUL Left upper lobe, RUL Right upper lobe LLL Left lower lobe RLL Right lower lobe.

The test set consisted of 40 images (20 normal, 20 abnormal), where each of the 20 abnormal images contained a single pulmonary nodule. Seven of these nodules had a subtlety categorization of three, eight were categorized as two, and the remaining five were regarded as a one. A total of 13 nodules were located in the right lung, and 7 nodules were located in the left lung (Table 2). The normal images had no identifying features.

Viewing

The images were uploaded to a Web site (www.perceptionstudy.net) (Fig 1) and were therefore accessible online