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The current and ideal state of anatomic pathology patient safety

Abstract: An anatomic pathology diagnostic error may be secondary to a number of active and latent technical and/or cognitive components, which may occur anywhere along the total testing process in clinical and/or laboratory domains. For the pathologist interpretive steps of diagnosis, we examine Kahneman's framework of *slow* and *fast thinking* to explain different causes of error in precision (agreement) and in accuracy (truth). The pathologist cognitive diagnostic process involves image pattern recognition and a *slow thinking* error may be caused by the application of different rationally-constructed mental maps of image criteria/patterns by different pathologists. This type of error is partly related to a system failure in standardizing the application of these maps. A *fast thinking* error involves the flawed leap from image pattern to incorrect diagnosis. In the ideal state, anatomic pathology systems would target these cognitive error causes as well as the technical latent factors that lead to error.

Keywords: anatomic pathology diagnostic error; error of accuracy (truth); error of precision (agreement); fast thinking error; slow thinking error.

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Investigations of anatomic pathology interobserver variability and secondary review methods to detect error have not shown that there has been a significant decrease in error rates since the Institute of Medicine (IOM) seminal report in the 1990s [1, 2]. Why?

Formal and informal methods of root cause analysis of anatomic pathology error have revealed the importance of optimizing work processes to decrease error frequency as well as to improve quality in the IOM domains of timeliness, efficiency, effectiveness, patient centeredness, and equity [3]. Using Spear and Bowen's concept of lean work [4], anatomic pathology testing consists of a large number of steps, or individual activities and hand-offs, from the pre-pre-analytic phase involving test choice to

the post-post-analytic phase incorporating the test diagnosis into clinical decision making. The anatomic pathology laboratory sits in the middle of the testing cycle.

An anatomic pathology diagnostic error occurs because of a failure in one or several of the steps in the testing pathway. For example, a diagnostic error may result when the wrong procurement procedure is ordered, an inadequate sample is obtained, a specimen is lost in transport, a pathologist renders an incorrect interpretation, or a clinician does not receive a report. Use of this frame has contributed to the development of a team approach to understanding anatomic pathology diagnosis and error, as both clinical practitioners and laboratory personnel need to be involved in improvement activities. Although diagnostic errors have an active component, a large number of latent system factors contribute to failures.

For the pathologist interpretation step, an anatomic pathology diagnostic error may be classified into one of two categories: an error of accuracy or an error of precision [2].

An error in diagnostic accuracy is an anatomic pathology diagnosis that does not correspond to the patient's disease [5]. An example is if a patient has lung cancer and the anatomic pathology diagnosis is *benign lung*. Based on the testing pathway model, the cause of this error could be secondary to a failure in any of a number of steps, such as those that involve the clinical sampling, processing, or interpretation activities or hand-offs.

An error in diagnostic precision is an anatomic pathology diagnosis that differs among pathologists who examine the same specimen. An example is if two pathologists examine the same lung biopsy tissue specimen and one pathologist renders a diagnosis of *adenocarcinoma* and the other pathologist renders a diagnosis of *no malignancy identified*. This specific error in precision also is an error in accuracy for at least one of the diagnoses, as both diagnoses cannot represent the true state of disease. In some circumstance, both pathologists are inaccurate.

Both errors in accuracy and precision fall within the IOM definition of error [1]. In the medical literature, many anatomic pathologists have preferred to use terms such as disagreement or discordance instead of "error in precision". The use of these terms highlights a unique aspect of physician decision making, which is outlined below.

When an anatomic pathologist examines a slide or a diagnostic image, she or he uses the cognitive steps of the process known as pattern recognition. In the current model of anatomic pathology education, trainees learn in an apprenticeship-based environment in which more experienced pathologists first teach diagnostic criteria.

A criterion describes a specific characteristic of: 1) cells (e.g., morphologic features of color, texture, and amount of cytoplasm), 2) the arrangement of cells (e.g., small clusters, sheets, or gland-like structures), and 3) the tissue architecture or the relationship of cellular and non-cellular components (e.g., invasion, necrosis, or microcalcification).

The combination of criteria is referred to as the pattern of a specific disease. All diseases have pattern spectra, reflecting variability of criteria levels of expression. For example, for the population of patients who have a squamous cell carcinoma, tumors will show different degrees of keratinization across the population of cells. Malignancies generally share similar patterns although the differentiation of malignancies and other diseases requires the identification of specific patterns.

Pathologists sometimes use other data, in addition to visual observations of hematoxylin and eosin slides or images, to render a diagnosis. These data include clinical history, surgical findings, molecular testing results, and visual observation of other ancillary tests such as histochemical and immunohistochemical studies.

In the first stages of learning, a novice pathologist examines a slide slowly and carefully to identify criteria and patterns. As a pathologist becomes more experienced, the criteria and patterns are identified more rapidly. The process of pattern recognition involves the use of a cognitive heuristic or a mental short cut that associates the criteria and pattern with a specific disease. Heuristics are simple, efficient rules, which explain how people make decisions, come to judgments, and solve problems, typically when facing complex problems or incomplete information.

Kahneman described two cognitive processes: *slow thinking* and *fast thinking* [6, 7]. *Slow thinking* consists of a rational, deliberate, methodical, and logical process of thinking. Novices practice *slow thinking* as they learn the process of recognizing criteria and patterns and associating these patterns with specific diseases. *Fast thinking* is the rapid process of quickly making associations, which all people use most of the time, each day. Experienced pathologists generally use *fast thinking* in their pattern recognition process.

If experienced pathologists encounter a challenging case they may move from *fast thinking* to *slow thinking* and more rationally analyze the criteria and patterns of a

case. In this example, they may recognize that the pattern they see does not readily correspond to a specific disease *mental map* and they need to think more carefully about the information before rendering a definitive diagnosis.

In 2011, our research team was funded by the Agency for Healthcare Research and Quality (AHRQ) to study the use of simulation in anatomic pathology education. We found that the cause of many anatomic pathologist cognitive errors was secondary to failure in several specific cognitive process steps. *Fast* and *slow thinking* failures are different causes of diagnostic interpretation error in precision (agreement) and in accuracy (truth).

Pathologists generally learn different *mental maps* of image criteria-pattern association with disease due to the differing experts from whom they initially trained. This lack of standardization results in errors in precision and accuracy. For example, my mental map image criteria/pattern of cancer microinvasion may be different from another pathologist's mental map. This is one reason why even pathologist experts sometimes lack precision.

In this frame, a pathologist may use *slow thinking* to make a diagnosis, but disagree with another pathologist who may also use *slow thinking* because of differences in the mental maps. This type of error is inherently related to system issues as it reflects the lack of standardized development and application of criteria.

Second, we found that failures in experienced pathologist *fast thinking* resulted in errors in accuracy and precision. These failures were often the result of bias, or quickly making the incorrect association between criteria-pattern and disease. In the AHRQ project, we found that *fast thinking* errors were associated with specific biases, which included anchoring bias (paying attention to only certain criteria and ignoring others), overconfidence bias, and do no harm bias. We derived a list of over 30 biases, although the majority of errors were secondary to a limited subset.

In the field of patient safety, most medical errors are slips or mistakes in processes that go unnoticed or unchecked. In the process of *slow thinking*, errors are less common as one rationally reviews cognitive associations. In the process of *fast thinking*, errors are more frequent as mental processes and associations are less checked.

As much of medical practice outside of anatomic pathology involves the association of patterns (e.g., signs, symptoms, physical findings, testing results, etc.) the concepts of non-standard criteria (*mental maps*) and bias also may be contributing factors to medical cognitive failures in general.

Interestingly, errors secondary to bias and to failures of standardizing mental maps are closely linked to a number of latent factors involving specimen quality, environment

(e.g., workload and stress), and educational methods. In fact, even though diagnostic errors had a cognitive component, in all cases, multiple system components easily could be identified that contributed to the error.

Regarding the question asked in the beginning, we conjecture that the rate of anatomic pathology error has remained constant because the solutions to the problem need to be implemented on a system level, as individual pathologists are not equipped and lack the capacity to change system factors.

Potential solutions to these cognitive causes of error include traditional methods of dealing with non-standard (cognitive) work and bias. Teamwork has been shown to reduce both sources of error.

Published interobserver variability studies repeatedly show that knowledge of specific criteria is critical for accurate diagnosis for specific subspecialty areas in anatomic pathology. These criteria were developed and are recognized by experts in these subspecialty areas. However, a proposed solution (often made by experts) is to develop referral networks to subspecialists, rather than to provide other formats to decrease error. These other formats include the development of checklists, paradigm shifts in education, use of digital imaging consultation for specific scenarios, and other best practices to limit the number of cases sent for consultation and efficiently use existing practices. These solutions generally will need to be implemented at the highest level of care (Level D) [3].

For non-standard work, or the application of non-standard criteria in this scenario, checklists have been shown to be helpful. Checklists will need to be developed by large groups of pathologists based on evidenced-based outcomes of criteria application, rather than on expert opinion. Our team also is studying how pathologist team sign-out may lower the probability of error by creating real-time consensus and the application of similar mental maps over time.

Kahneman and Tversky reported the use of reference class forecasting as a method to lessen the influence of bias

[6, 7]. Reference class forecasting may involve the study of case sets in which bias is prevalent in order to determine interventions that would limit bias. The practice of team sign-out is based on such an intervention, as other team members, who feel free to speak up when an error is occurring, may recognize cognitive biases in others.

In a more ideal state of anatomic pathology, *slow thinking* and *fast thinking* pathologist cognitive errors would be decreased through a number of mechanisms. *Slow thinking* errors could be reduced through a system based approach of pathologist teams reaching consensus on the agreement and application of diagnostic disease image criteria. Although experts have reached diagnostic consensus for some diseases in a number of subspecialties, the widespread application of these criteria to practice settings will need to occur through dissemination plans involving educational changes and other support mechanisms. Digital imaging support is one such mechanism that could have a large impact on standardizing image criteria.

Fast thinking errors also could be addressed through a team approach to decrease specific types of bias with the use of mechanisms such as bias checklists and secondary review processes. These mechanisms could introduce *slow thinking* in specific parts of the diagnostic process.

In summary, the changes necessary to decrease anatomic pathology error involve process changes within anatomic pathology laboratories to affect the technical components of care and changes within pathology systems that will affect training and the components of pathologists' cognitive work.

Conflict of interest statement: The author declares no conflict of interest.

Received September 23, 2013; accepted November 11, 2013

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