COLLEGE of AMERICAN PATHOLOGISTS

Supplemental Digital Content* | Methodology | March 2015

Interpretive Diagnostic Error Reduction in Surgical Pathology and Cytology:

Joint Guideline from the College of American Pathologists Pathology and Laboratory Quality Center and the Association of Directors of Anatomic and Surgical Pathology

Corresponding Author:
Raouf E. Nakhleh, MD

Authors :
Vania Nosé, MD, PhD
Lisa Fatheree, SCT(ASCP)
Christina Ventura, MT(ASCP)
Douglas McCrory, MD
Carol Colasacco SCT(ASCP), MLIS, AHIP

http://www.archivesofpathology.org/doi/abs/10.5858/arpa.2014-0511-SA
* The Supplemental Digital Content was not copyedited by *Archives of Pathology*

METHODS USED TO PRODUCE THE GUIDELINE

Panel Composition

The College of American Pathologists (CAP) Pathology and Laboratory Quality Center (the Center) and Association of Directors of Anatomic and Surgical Pathology (ADASP) convened an expert and advisory panel consisting of practicing pathologists with expertise in surgical pathology and cytology. CAP and ADASP approved the appointment of the project co-chairs (RN and VN) and panel members. These panel members and the methodologist served as the Expert Panel (EP) for the systematic evidence review.

Conflict of Interest (COI) Policy

Prior to acceptance on the expert or advisory panel, potential members completed the CAP conflict of interest (COI) disclosure process, whose policy and form (in effect April 2010) require disclosure of material financial interest in, or potential for benefit of significant value from, the guideline's development or its recommendations 12 months prior through the time of publication. The potential members completed the COI disclosure form, listing any relationship that could be interpreted as constituting an actual, potential, or apparent conflict. The CAP Center uses the following criteria:

Nominees who have the following conflicts may be excused from the panel:

a. Stock or equity interest in a commercial entity that would likely be affected by the guideline or white paper
b. Royalties or licensing fees from products that would likely be affected by the guideline or white paper
c. Employee of a commercial entity that would likely be affected by the guideline or white paper

Nominees who have the following potentially manageable direct conflicts may be appointed to the panel:

a. Patents for products covered by the guideline or white paper
b. Member of an advisory board of a commercial entity that would be affected by the guideline or white paper
c. Payments to cover costs of clinical trials, including travel expenses associated directly with the trial
d. Reimbursement from commercial entity for travel to scientific or educational meetings

Everyone was required to disclose conflicts prior to beginning and continuously throughout the project's timeline. Expert panel members' disclosed conflicts are listed in the appendix of the manuscript. The CAP and ADASP provided funding for the administration of the project; no industry funds were used in the development of the guideline. All panel members volunteered their time and were not compensated for their involvement.

CAP/ADASP Expert Panel Literature Review and Analysis

The expert panel met 26 times through teleconference webinars from December 2011 through June 12, 2014. Additional work was completed via electronic mail and the panel met in person October 12, 2013 to review evidence to date and draft recommendations.

All expert panelists participated in the systematic evidence review (SER) level of title-abstract, full-text review, and data extraction. The co-chairs (RN and VN) and methodologist (DM) performed the audit of data extraction. All articles were available as discussion or background references. All members of the expert panel participated in developing draft recommendations, reviewing open comment feedback, finalizing and approving recommendations and writing/editing of the manuscript.

Peer Review

An open comment period was held from December 2, 2013 through January 21, 2014. Five draft recommendations and three methodology questions were posted online on the CAP Web site www.cap.org. An announcement was sent to the following societies deemed to have interest:

CAP Board of Governors, Councils, Committees and Membership
Association of Directors of Anatomic and Surgical Pathology (ADASP)
American Society for Clinical Pathology (ASCP)
American Society of Cytopathology (ASC)
Papanicolaou Society of Cytology (PSC)
Arthur Purdy Stout Society (APSS)
Association of Pathology Chairs (APC)
Canadian Association of Pathologists (CAP-APC)
United States & Canadian Academy of Pathology (USCAP)
Quality Initiative in Interpretive Pathology (QIIP) Canadian Partnership Against Cancer
Society to Improve Diagnoses in Medicine (SIDM)
American Society of Clinical Oncologists (ASCO)
Veteran's Affairs (VA) and Department of Defense (DOD)
Centers for Disease Control and Prevention (CDC)
Centers for Medicare and Medicaid Services (CMS)

The website received 303 comments in total (Agree and Disagree responses were also captured). All the recommendations achieved between 87% to 93% agreement. Pairs of expert panel members were assigned 1 draft recommendation for which to review all comments received and provide an overall summary to the rest of the panel. Following panel discussion, and the final quality of evidence assessment, the panel members determined whether to maintain the original draft recommendation as is, revise it with minor language change, or consider it as a major recommendation change. Resolution of all changes was obtained by majority consensus of the panel using nominal group technique (rounds of email discussion and multiple edited recommendations) amongst the panel members. The final recommendations were approved by the expert panel with a formal vote. The panel considered the risks and benefits throughout the whole process in their considered judgment process.[1] Formal cost analysis or cost effectiveness was not performed.

An independent review panel (IRP) was assembled to review the guideline and recommend approval to the CAP. The IRP was masked to the expert panel and vetted through the COI process. Final approval was done by CAP Council on Scientific Affairs and ADASP Executive Board.

Assessing the Strength of Recommendations

Strength of recommendation is determined by the balance between desirable and undesirable consequences of alternative management strategies, quality of evidence, variability in values and preferences, resource use.[2]

The central question that the panel addressed in developing the guideline was *"What are the most effective ways to reduce interpretive diagnostic errors in Anatomic Pathology?"*

Development of recommendations requires that the panel review the identified evidence and make a series of key judgments:

1) What are the significant findings related to each KQ or outcome?

2) What is the overall quality of evidence supporting each KQ or outcome? Quality of evidence was assessed according to the GRADE framework as described below.[2] Summary of Findings tables or when sufficient information was not available, an alternative short evidence table format, were prepared for each question. To maintain consistency with previous CAP guideline language, quality of evidence is described as Convincing, Adequate or Inadequate as shown in Table 1.

3) What is the net balance of benefits and harms? The consideration of net balance of benefits and harms will focus on the laboratory redundancy, efficiency and feasibility in comparison to the reduction of errors or potential errors and their impact on patient outcomes.

4) What is the strength of each recommendation? The implications of a strong recommendation for clinicians is that most patients should receive the recommended course of action; while the implications of a weak recommendation are that different choices may be appropriate for different patients or that different management options may be preferred by different stakeholders. We used the current CAP designations for strength of recommendations of *strong recommendation, recommendation and expert consensus opinion* (Table 2), as determined by a considered judgment process in which the guideline panel weighs the quality of evidence, balance of benefits and harms, variability in values preference and data on costs or resource use.[1]

Dissemination Plans

CAP will host an Interpretive Diagnostic Error Reduction Through Targeted Case Reviews In Surgical Pathology And Cytology Resource web page which will include a link to the manuscript and supplemental digital content; summary of recommendations, teaching PowerPoint, and a frequently asked question (FAQ) document. The ADASP webpage will include a link to the CAP guideline resource page. The guideline will be promoted and presented at various professional society meetings including the College of American Pathologists, the United States and Canadian Academy of Pathology (USCAP), and the American Society of Clinical Pathology (ASCP).

SYSTEMATIC EVIDENCE REVIEW (SER)

The objectives of the SER were to investigate the most effective ways to reduce interpretive diagnostic errors in surgical pathology and cytology. If of sufficient quality, findings from this review could provide an evidence base to support development of the laboratory practice guideline. The scope of the SER and the key questions (KQs) were established by the EP in consultation with a methodologist.

Key Questions:
1. Does targeted review (either done at analytic or post-analytic phase) of surgical pathology or cytology cases (slides and/or reports) reduce the error rate (often measured as amended reports) or increase the rate of interpretive error detection compared to no review, random review or usual review procedures?
2. What methods of selecting cases for review have been shown to increase the rate of interpretive error detection compared to no review, random review or usual review procedures?

Detailed Scope Questions:
- Can a targeted review of cases lead to increased detection of errors?
- Is there a particular method (eg, prospective vs. retrospective, random reviews, etc.) that results in lower error rates? Or amended report rates? If yes, what is the method?
- Is there a particular type of diagnosis(es) (eg, malignant, benign, borderline) more prone to error? If yes, what?

- Is there a particular organ/system associated with a higher rate of error/disagreements revealed as problematic in the literature (eg, thyroid FNA, lymphoma, brain biopsy)? If yes, what?
- How does the error rate for multi-organ reviews compare with single organ reviews? (eg, internal and/or external)
- Do blinded reviews find more or less errors than non-blinded reviews?
- Can we learn anything from external review studies that can be applied to internal reviews (or vice-versa)?
- Can we establish an external error rate (benchmark) for surgical pathology or cytology?
- Can we establish an internal error rate (benchmark) for surgical pathology or cytology?
- What are the costs of conducting internal or external reviews?
- What is the effect on turn-around times (efficacy) for internal or external reviews?
- What is the effect on patient care when conducting internal or external reviews?
- Has there been improvement in reducing error reduction over time?
- What other factors (eg, standard criteria, clinical correlation, ancillary testing) are emphasized most frequently and with which organ system or diagnosis?

Search and Selection

The systematic literature search for relevant studies included a search of MEDLINE using the Ovid SP interface on November 12, 2013, with the date parameters of January 1992 through October 2012. Medical subject headings (MeSH) for the concept *pathology* (eg, Pathology, Surgical/ Pathology, Clinical; Pathology) were combined with MeSH terms for the concept *quality* (eg, Quality Assurance, Health Care; Quality Control; Quality Improvement; Reproducibility of Results; Diagnostic Errors). MeSH terms were supplemented with keywords (eg, histopathology, cytopathology, histology, or cytology; and second opinion, misinterpretation, or interpretation errors). A targeted concept of slide/case review included keywords such as targeted review, peer review, or random review and the keywords slide, case, or report. Limits were set for human studies published in English. The search was not limited by study design in order to capture editorials, letters, or commentaries that might be relevant and useful for discussion purposes. A literature refresh of the OvidSP search strategy was run on November 21, 2013, to identify relevant studies published since October 2012. The full Ovid search strategy is included in the appendix.

The Ovid search strategy was modified for PubMed (1/1/92-12/31/12), and Google Scholar (1/1/12 – 1/26/13). In addition, a handsearch of relevant journals (*American Journal of Clinical Pathology, American Journal of Surgical Pathology, Archives in Pathology and Laboratory Medicine, Cancer, Cancer Cytopathology, Diagnostic Cytopathology, Histopathology, Modern Pathology*) was completed for issues published from January 2008, through December 2012. A search for meeting abstracts was completed utilizing Biosis Previews (Web of Science) (1/1/2008-12/31/2012) and by handsearching published abstracts from relevant meetings (American Society of Cytopathology, American Society for Clinical Pathology, British Society for Clinical Cytology, College of American Pathologists, European Congress of Cytopathology, International Academy of Pathology, United States and Canadian Academy of Pathology) held from January 2008 through December 2012. Reference lists from included articles were scanned for additional relevant studies.

Two reviewers were used at all levels of review (eg, title/abstract, full article) and for data/information extraction. Conflicts were resolved by discussion or referral to the panel co-chairs for a decision. When article abstracts or document summaries were not available or a conflict was not resolved, full articles were reviewed.

Selection at all levels of the review was based on predetermined inclusion/exclusion criteria.

Inclusion criteria:

- Surgical pathology or cytology studies
- Original research addressing targeted review
- English language articles
- All study types were initially included

Exclusion criteria:

- Clinical pathology studies
- Additional diagnostic techniques, issues related to competency, use of checklists, standardized language, taxonomy or formatting
- Studies focused on pre-analytic specimen processes
- Post-analytic typographic errors
- Non-English studies
- Animal studies

Outcomes of Interest

We are interested in identifying discrepancies in interpretation between a primary pathologist review and a second pathologist review as a way of estimating the error rate. To the extent that erroneous readings can be identified in excess of an expected degree of disagreement, then a method of targeted review would be said to be effective. Thus, studies with a control group are desirable; as a practical matter, however, it is necessary to examine uncontrolled series, too. Studies had to report numbers of discrepant diagnoses among a defined population of specimens examined to allow calculation of a discrepancy rate.

We are not interested in discrepancies from the pre-analytic specimen process (ie, related to tissue collection and processing) or post-analytic errors (eg, typographic or transcription errors, amended reports), additional diagnostic techniques (eg, immunomarkers), issues related to competency, or the use of checklists, standardized language, taxonomy or formatting.

Various studies classify errors in different ways (eg, major versus minor). Recognizing that all errors are not alike, we assessed the severity of interpretive errors according to the clinical impact on a patient.[3] We considered the clinical impact of errors as follows: 1) diagnostic thinking (error results in a change in diagnosis or diagnostic category); 2) therapeutic efficacy (error results in a change in therapeutic choice); or 3) patient outcome efficacy (error results in a change in outcome (eg, procedure avoided); demonstrating this unequivocally may require long-term follow-up). We also considered the efficiency or cost (in terms of effort or dollars) that a targeted review strategy entails.

Data Extraction and Management

The data elements from an included article/document were extracted by one reviewer into standard data formats and tables developed using systematic review database software (DistillerSR, Evidence Partners Inc., Ottawa, Canada); a second reviewer confirmed accuracy and completeness. In all cases, the methodologist acted as either the primary or secondary reviewer. Any discrepancies in data extraction were resolved by discussion with the methodologist. A bibliographic database was established in EndNote (Thomson Reuters, Carlsbad, CA) to track all literature identified and reviewed during the study.

Environmental Scan

An environmental scan for established guidelines was performed including a targeted search of pathology organizations' web sites and a search of guideline clearinghouse websites (TRIP Database, Guidelines International Network, Agency for Healthcare Research and Quality) using the search terms "pathology or laboratory" and "guidelines or regulations."

Quality Assessment

Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach provides a system for rating quality of evidence and strength of recommendations that is explicit, comprehensive, transparent, and pragmatic and is increasingly being adopted by organizations worldwide.[2] The GRADE approach examines the quality of evidence as the level of individual studies and also at the review level. GRADE was used for rating the quality of evidence.

At the individual study level, we assessed studies according to three criteria: 1) study design rating; 2) risk of bias rating; and 3) applicability concerns. Study design was assessed according to the following hierarchy:

1) noncomparative studies (where a single method of targeted review is considered, in determining a single error rate)
2) comparative studies (where two or more methods of targeted review are independently applied and compared in one group of patients)
3) comparative studies (where two or more methods of targeted review are compared in different groups of patients
    a. historical (eg, a before-after series)
    b. concurrent (eg, comparison of two different institution's targeted review programs)
    c. quasi-randomized (concurrent, similar or identical sites, allocated with attempt to reduce bias beyond that provided by 3.a. or 3.b.)
    d. randomized

Risk of bias ratings were based on the following three criteria, rated as yes, no, or unclear:
1) Were review diagnoses independent, blinded from the primary diagnosis?
2) Was case selection done using explicit, objective and reproducible criteria?
3) Was interpretive error ascertained without confounding by pre- or post-analytic error?

Applicability concerns were assessed for three areas, rated as yes, no, or unclear:
1) Is study limited to particular organ systems, specimen types or diagnoses?
2) Is the inter-rater performance examined and acceptable?
3) Is there a distinction between major and minor errors based on impact on patient treatment or outcome?

At the review level, we examined the collection of studies according to the following domains:
1) Consistency
2) Directness
3) Precision
4) Magnitude of effect
5) Number of studies/patients

We developed a GRADE evidence table, and mapped the quality of evidence ratings to the CAP rating scheme according to table 1.

Data Analysis

Rates of discrepancy and major discrepancy were described for all studies, and subgroups based on type of specimen (surgical pathology, cytopathology or both), focusing on one organ or organ system (single-organ) versus multi-organ studies, and whether conducted within a single institution (internal) or reviews of cases diagnosed at a different institution (external). Studies were tested for homogeneity using Comprehensive Meta Analysis version 2.2.064. Nonparametric descriptive statistics including median, and 1st and 3rd quartiles were calculated using Excel.

Results

Among the 823 citations identified by electronic and hand searches, 141 were selected for inclusion. These included 130 published peer-reviewed articles, and 11 grey literature documents (Appendix 1). Among the extracted documents, 4 articles/documents did not meet minimum quality standards, presented incomplete data or data that were not in useable formats, or included only information based on expert opinion. These articles were not included in analyses or narrative summaries.

Of 137 studies included, 128 (91.4%) were single arm clinical case series. Of 12 comparative studies, 2 reported a comparison of 2 or more methods of targeted review in one group of patients; 6 compared targeted review methods in different historical cohorts (eg a before-after study), and 4 compare 2 or more targeted review methods in concurrent groups of patients. No studies used random allocation or other robust measures to control for potential bias.

Risk of bias assessments of included studies showed that review diagnoses were made independently (blinded from the primary diagnosis) in 30 (21.4%) studies, unclear in 2 (1.4%) and without blinding in 108 (77.1%). Case selection was done using explicit, objective and reproducible criteria in 56 (40%), and with unclear, subjective, non-reproducible or without criteria in 84 (59.3%). Interpretive error was ascertained without confounding by pre- or post-analytic error in 120 (85.7%), unclear in 2 (1.4%) and not in 18 (12.9%) studies.

Applicability concerns were as follows: Studies were limited to particular organ systems, specimen types or diagnoses in 111 (79.3%) cases, and not limited in 29 (20.7%) cases. Inter-rater performance was examined and acceptable in 29 (20.7%), unclear in 6 (4.3%), and not in 105 (75%) of studies. There was a distinction between major and minor errors based on impact on patient treatment or outcome in 78 (55.7%), unclear in 2 (1.4%), and not in 60 (42.9%) of studies.

Discrepancy rates and major discrepancy rates by study characteristics are provided in the manuscript.

The distribution of discrepancy rates shows that the variability was greater for studies of smaller sample size. The distribution of discrepancy rates by sample size is shown in figures 1 and 2, both of which show high variability in discrepancy rates for studies with smaller sample sizes, with larger studies tending to have lower discrepancy rates.

Evidence on each question was summarized in terms of study quality and effects in Evidence Profile Tables (Tables 3-5) which were used as the basis for quality of evidence determinations with the panel.

Table 1. Quality of Evidence Ratings: mapping from GRADE categories to CAP

GRADE	Definition	CAP	Definition
High	Further research is very unlikely to change our confidence in the estimate of effect.	High (Convincing)	High confidence that available evidence reflects true effect
Moderate	Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.	Intermediate (Adequate)	Moderate confidence that available evidence reflects true effect
Low	Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.	Low (Inadequate)	Little confidence that available evidence reflects true effect
Very low	Any estimate of effect is very uncertain.	Insufficient	Evidence is insufficient to discern net effect

342 Adapted from Guyatt et al[2] with permission from BMJ Publishing Group Ltd..
343

Table 2. Strength of Recommendations

CAP Designation	Recommendation	Rationale
Strong Recommendation	Recommend For or Against a particular pathology review practice (Can include must or should)	Supported by high (convincing) or intermediate (adequate) quality of evidence and clear benefit that outweighs any harms
Recommendation	Recommend For or Against a particular pathology review practice (Can include should or may)	Some limitations in quality of evidence (intermediate [adequate] or low [inadequate]), balance of benefits and harms, values, or costs but panel concludes that there is sufficient evidence to inform a recommendation.
Expert Consensus Opinion	Recommend For or Against a particular pathology review practice (Can include should or may)	Serious limitations in quality of evidence (low [inadequate] or insufficient), balance of benefits and harms, values or costs, but panel consensus is that a guideline is necessary.
No Recommendation	No recommendation for or against a particular pathology review practice	Insufficient evidence, confidence, or agreement to provide a recommendation.

Adapted from Teutsch et al[4] with permission from Macmillion Publishers Ltd. Modified by the CAP Pathology and Laboratory Quality Center.

Table 3: Evidence profile for Recommendation 1: Should case review be used for diagnostic evaluation of pathology materials?*

Quality assessment							No. of patients		Effect		Quality	Importance
No of studies	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Case review**	**Control**	**Relative (95% Confidence Interval)**	**Absolute**	**Quality**	**Importance**
Discrepancy Rate (follow-up 1 years; assessed with case review)												
122	observational studies[a]	no serious risk of bias	no serious inconsistency[b]	no serious indirectness[c]	no serious imprecision	none	27178/513268 (5.3%)	-	-	-	⊕⊕OO LOW	IMPORTANT
Major Discrepancy Rate (assessed with: case review)												
79	observational studies[a]	no serious risk of bias	no serious inconsistency[b]	no serious indirectness[d]	no serious imprecision	none	4416/179130 (2.5%)	-	-	-	⊕⊕OO LOW	CRITICAL
Inter-observer agreement												
27	observational studies	no serious risk of bias	Serious[d]	Serious[e]	no serious imprecision	reporting bias	-	- 0%	kappa ranged from 0.16 to 0.97	- -	⊕OOO VERY LOW	IMPORTANT

***Settings:** Pathology laboratories and practices

[a] Studies include single- and multi-institution case series that quantify diagnostic discrepancies or errors according to various definitions

[b] Although the magnitude of discrepancy rates vary considerably from study to study based on sample size, specimen type, single versus multi-organ, review type (internal versus external), and definition of discrepancy, studies are remarkably consistent in finding non-trivial discrepancy rates.

[c] Few studies reported the impact of discrepant diagnoses on treatment choice, and even fewer on patient outcome.

[d] Inter-rater reliability studies had high variability. Experts agreed better than non-experts.

[e] Inter-rater agreement studies usually used highly selected samples and small numbers of observations

357

Table 4: Evidence profile for Recommendation 2: Should prospective review versus retrospective review be used for diagnostic evaluation of pathology materials?

Quality assessment							No. of patients		Effect		Quality	Importance
No of studies	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Prospective review**	**Retrospective review**	**Relative (95% CI)**	**Absolute**		
Discrepancy Rate												
4	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	510/15515 (3.3%)	0.13%	RD ranged from -2.4 to 1.1	-	⊕⊕OO LOW	IMPORTANT
								3.4%		-		
								13%		-		
Major discrepancy												
2	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	32/6129 (0.52%)	0.1%	RD ranged from -0.1 to -0.5	-	⊕⊕OO LOW	IMPORTANT
								1.7%		-		

358 CI – confidence interval; RD – risk difference

359

360

Table 5: Evidence Profile for Recommendation 3: Should targeted case review versus random case review be used for diagnostic evaluation of pathology materials?

Quality assessment							No. of patients		Effect		Quality	Importance
No. of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Targeted case review	Random case review	Relative (95% CI)	Absolute		
Discrepancy rate												
1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	50/380 (13.2%)	195/7444 (2.6%)	OR 5.6 (4.1 to 7.8)	105 more per 1000 (from 73 more to 147 more)	⊕⊕OO LOW	
Major discrepancy												
1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	12/380 (3.2%)	27/7444 (0.36%)	OR 9.0 (4.5 to 18)	28 more per 1000 (from 12 more to 58 more)	⊕⊕OO LOW	

CI – confidence interval; OR – Odds ratio

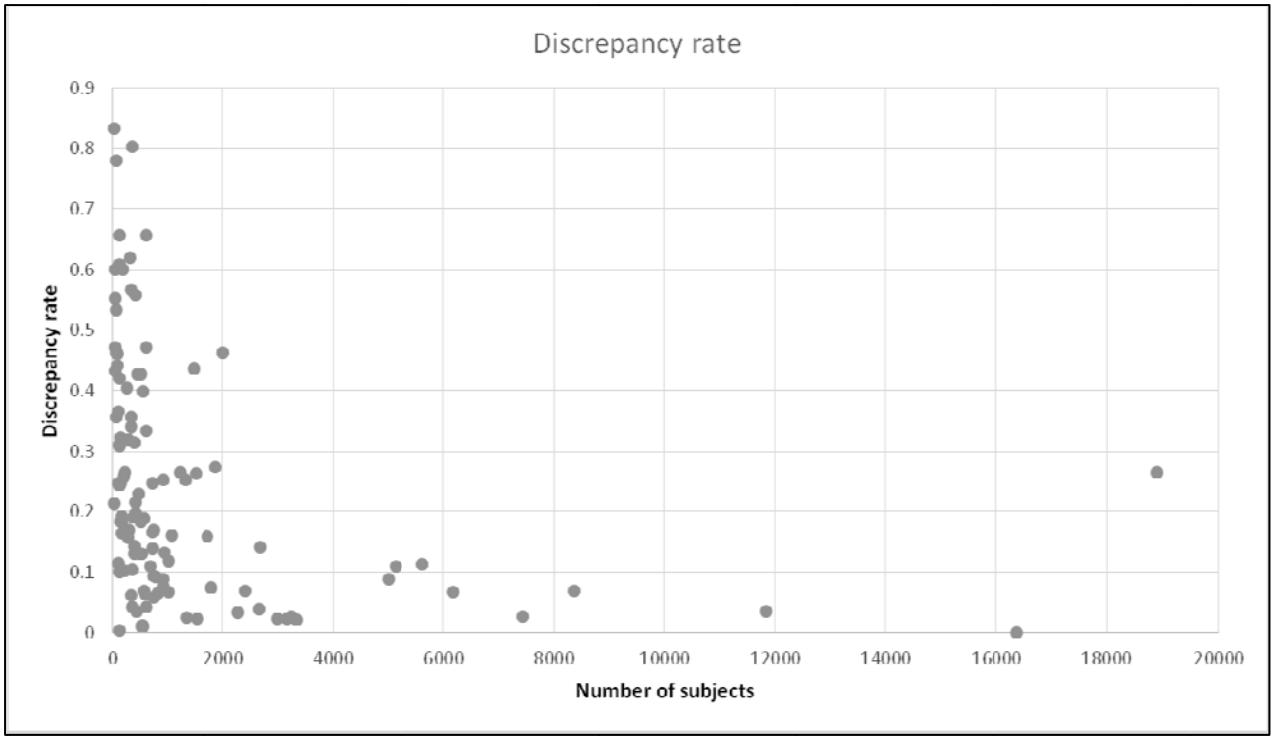


Figure 1: Discrepancy rate distribution by sample size[5-112]

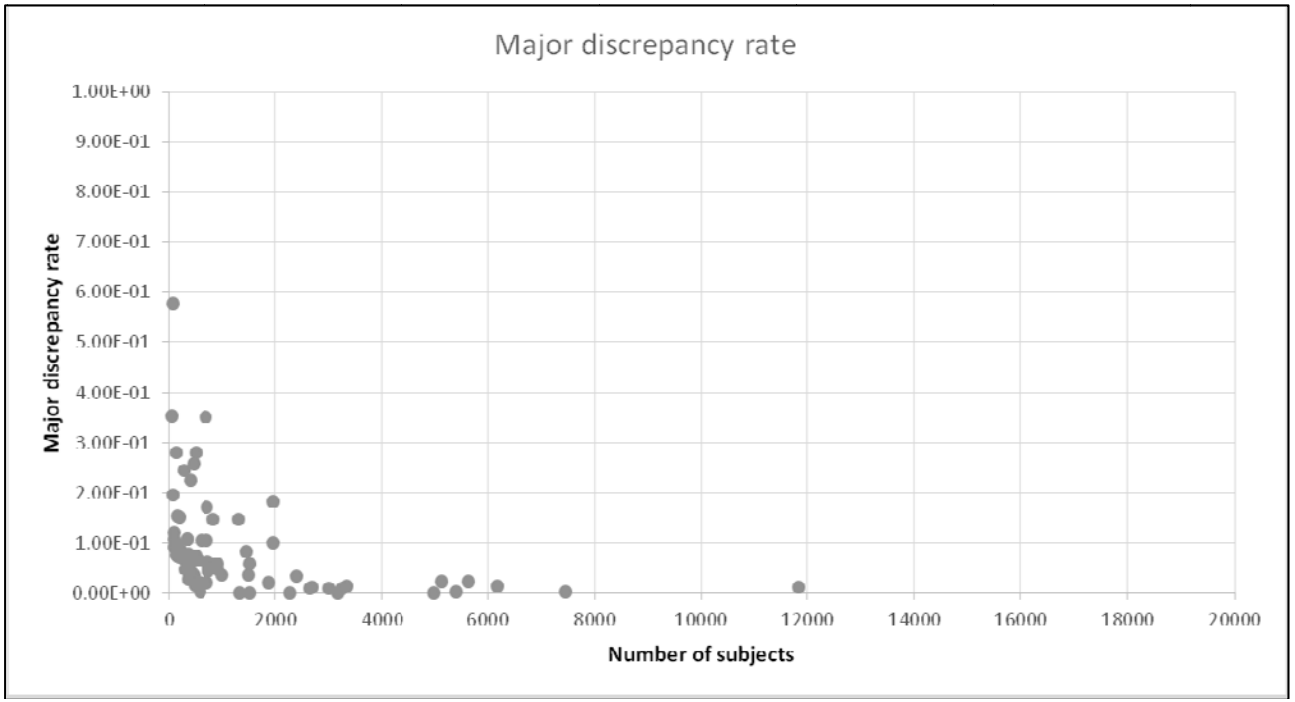
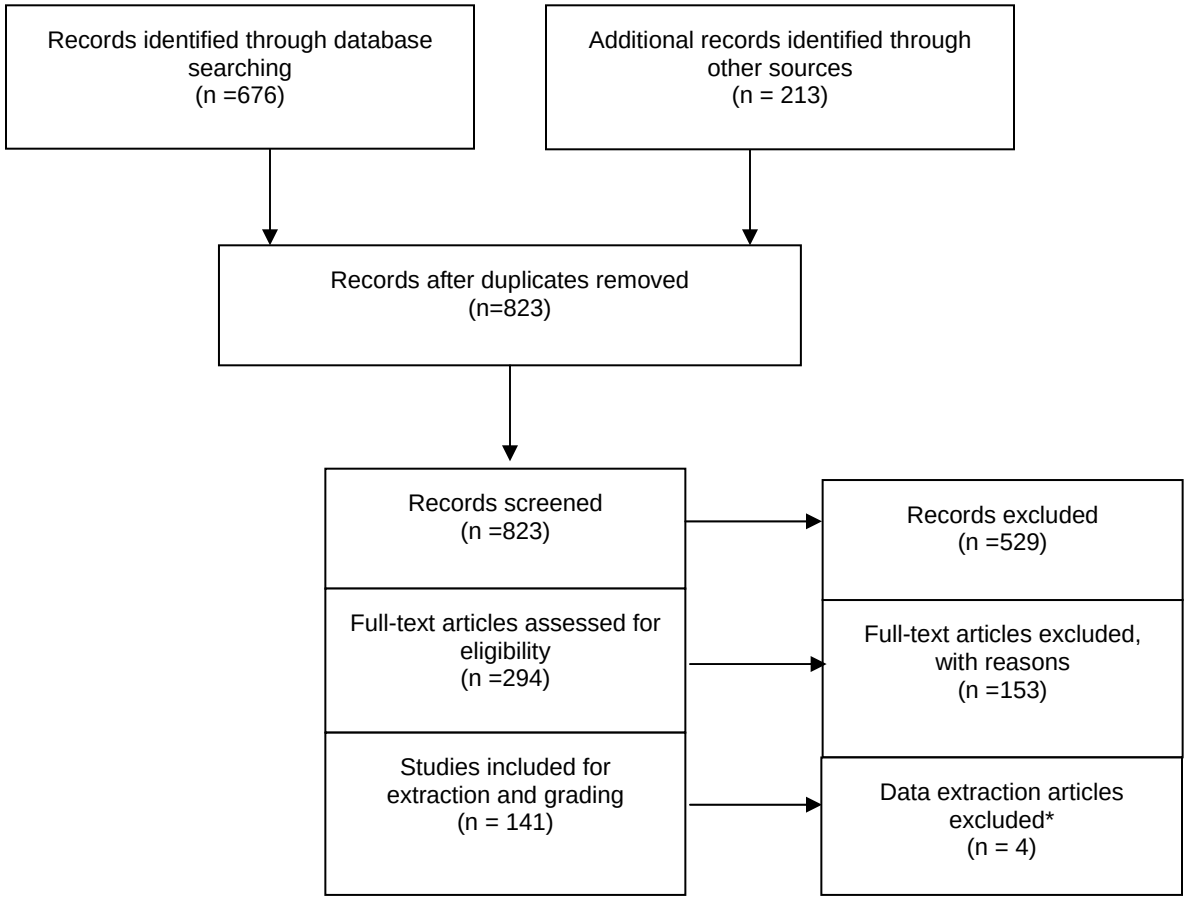


Figure 2: Major discrepancy rate distribution by sample size[5, 6, 8, 10, 11, 13-15, 17-20, 22-24, 31, 33, 36, 40, 42-44, 46, 50, 51, 53-55, 58-61, 64, 67-69, 74, 76, 78, 83, 84, 86-88, 91, 93, 94, 96, 97, 99-101, 106, 108, 110, 113-129]

APPENDIX

Appendix A: Literature Review Results
Adapted with permission from Moher et al.[130]



*Excluded based on expert opinion, did not meet minimum quality standards, presented incomplete data or data that were not in useable formats

Appendix B: Ovid MEDLINE Search Strategy

1. *Pathology/
2. *Pathology, Surgical/
3. Pathology, Clinical/
4. Pathology department, Hospital/
5. Cytodiagnosis/
6. Biopsy/
7. *"Diagnostic Techniques and Procedures"/
8. (pathology$ or cytolog$ or histolog$ or histopatholog$ or cytopatholog$).tw.
9. or/1-8

AND

1. *Medical Errors/
2. *"Referral and Consultation"/
3. *Quality Assurance, Health Care/
4. *Quality Control/
5. exp *Diagnostic Errors/
6. *Quality Improvement/
7. exp *"Peer Review"/
8. *"Root Cause Analysis"/
9. *Total Quality Management/
10. *"Reproducibility of Results"/
11. *"Sensitivity and Specificity"/
12. *Medical Audit/
13. *"Insurance Claim Review"/
14. *Malpractice/lj [Legislation & Jurisprudence]
15. performance improvement.tw.
16. ((corrected or amended) adj2 report$).tw.
17. (misinterpretation or misdiagnosis or medicolegal or "patient safety" or "second opinion").tw.
18. ((interpret$ or diagnostic) adj2 error$).tw.
19. (error adj2 (reduction or prevention or rate)).tw.
20. "diagnostic disagreement$".tw.
21. (quality adj3 (improvement or control or assurance or practice$ or measure$ or process$)).tw.
22. or/1-21

AND

1. ((routine or target$ or random$ or blind$ or peer$) adj4 review$).tw.
2. ((case$ or slide$ or report$) adj4 review$).tw.
3. or/1-2

Limits: Humans/English/1/1/1992-10/31/2012. Rerun on 11/21/2013 to include 10/31/2012-11/21/2013.

REFERENCES

1. Scottish Intercollegiate Guidelines Network (SIGN). SIGN 50: a guideline developer's handbook. Edinburgh: SIGN; 2014. (SIGN publication no. 50). [October 2014]. Available from URL: http://www.sign.ac.uk .
2. Guyatt GH, Oxman AD, Vist GE, et al. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. *BMJ*. 2008;336(7650):924-926.
3. Fryback DG, Thornbury JR. The efficacy of diagnostic imaging. *Med Decis Making*. 1991;11(2):88-94.
4. Teutsch SM, Bradley LA, Palomaki GE, et al. The evaluation of genomic applications in practice and prevention (EGAPP) initiative: methods of the EGAPP Working Group. *Genet Med*. 2009;11(1):3-14.
5. Abt AB, Abt LG, Olt GJ. The effect of interinstitution anatomic pathology consultation on patient care. *Arch Pathol Lab Med*. 1995;119(6):514-517.
6. Agarwal S, Wadhwa N. Revisiting old slides--how worthwhile is it? *Pathol Res Pract*. 2010;206(6):368-371.
7. Ahmed Z, Yaqoob N, Muzaffar S, Kayani N, Pervez S, Hasan SH. Diagnostic surgical pathology: the importance of second opinion in a developing country. *J Pak Med Assoc*. 2004;54(6):306-311.
8. Aldape K, Simmons ML, Davis RL, et al. Discrepancies in diagnoses of neuroepithelial neoplasms: the San Francisco Bay Area Adult Glioma Study. *Cancer*. 2000;88(10):2342-2349.
9. Allsbrook WC Jr, Mangold KA, Johnson MH, Lane RB, Lane CG, Epstein JI. Interobserver reproducibility of Gleason grading of prostatic carcinoma: general pathologist. *Hum Pathol*. 2001;32(1):81-88.
10. Al-Maghrabi JA, Sayadi HH. The importance of second opinion in surgical pathology referral material of lymphoma. *Saudi Med J*. 2012;33(4):399-405.
11. Arbiser ZK, Folpe AL, Weiss SW. Consultative (expert) second opinions in soft tissue pathology. Analysis of problem-prone diagnostic situations. *Am J Clin Pathol*. 2001;116(4):473-476.
12. Ascoli V, Bosco D, Carnovale Scalzo C. Cytologic re-evaluation of negative effusions from patients with malignant mesothelioma. *Pathologica*. 2011;103(6):318-324.
13. Bajaj J, Morgenstern N, Sugrue C, Wasserman J, Wasserman P. Clinical impact of second opinion in thyroid fine needle aspiration cytology (FNAC): a study of 922 interinstitutional consultations. *Diagn Cytopathol*. 2012;40(5):422-429.
14. Baloch ZW, Hendreen S, Gupta PK, et al. Interinstitutional review of thyroid fine-needle aspirations: impact on clinical management of thyroid nodules. *Diagn Cytopathol*. 2001;25(4):231-234.
15. Bejarano PA, Koehler A, Sherman KE. Second opinion pathology in liver biopsy interpretation. *Am J Gastroenterol*. 2001;96(11):3158-3164.
16. Berney DM, Fisher G, Kattan MW, et al. Pitfalls in the diagnosis of prostatic cancer: retrospective review of 1791 cases with clinical outcome. *Histopathology*. 2007;51(4):452-457.
17. Boiko PE, Piepkorn MW. Reliability of skin biopsy pathology. *J Am Board Fam Pract*. 1994;7(5):371-374.
18. Bomeisl PE Jr, Alam S, Wakely PE Jr. Interinstitutional consultation in fine-needle aspiration cytopathology: a study of 742 cases. *Cancer*. 2009;117(4):237-246.
19. Bruner JM, Inouye L, Fuller GN, Langford LA. Diagnostic discrepancies and their clinical impact in a neuropathology referral practice. *Cancer*. 1997;79(4):796-803.
20. Butler ST, Youker SR, Mandrell J, Flanagan KH, Fosko SW. The importance of reviewing pathology specimens before Mohs surgery. *Dermatol Surg*. 2009;35(3):407-412.
21. Castanon A, Ferryman S, Patnick J, Sasieni P. Review of cytology and histopathology as part of the NHS Cervical Screening Programme audit of invasive cervical cancers. *Cytopathology*. 2012;23(1):13-22.
22. Chafe S, Honore L, Pearcey R, Capstick V. An analysis of the impact of pathology review in gynecologic cancer. *Int J Radiat Oncol Biol Phys*. 2000;48(5):1433-1438.
23. Chan YM, Cheung AN, Cheng DK, Ng TY, Ngan HY, Wong LC. Pathology slide review in gynecologic oncology: routine or selective? *Gynecol Oncol*. 1999;75(2):267-271.
24. Clary KM, Silverman JF, Liu Y, et al. Cytohistologic discrepancies: a means to improve pathology practice and patient outcomes. *Am J Clin Pathol*. 2002;117(4):567-573.

25. Coblentz TR, Mills SE, Theodorescu D. Impact of second opinion pathology in the definitive management of patients with bladder carcinoma. *Cancer*. 2001;91(7):1284-1290.
26. Coffin CS, Burak KW, Hart J, Gao ZH. The impact of pathologist experience on liver transplant biopsy interpretation. *Mod Pathol*. 2006;19(6):832-838.
27. Cook IS, McCormick D, Poller DN. Referrals for second opinion in surgical pathology: implications for management of cancer patients in the UK. *Eur J Surg Oncol*. 2001;27(6):589-594.
28. Corley DA, Kubo A, DeBoer J, Rumore GJ. Diagnosing Barrett's esophagus: reliability of clinical and pathologic diagnoses. *Gastrointest Endosc*. 2009;69(6):1004-1010.
29. Davidov T, Trooskin SZ, Shanker BA, et al. Routine second-opinion cytopathology review of thyroid fine needle aspiration biopsies reduces diagnostic thyroidectomy. *Surgery*. 2010;148(6):1294-1301.
30. Epstein JI, Walsh PC, Sanfilippo F. Clinical and cost impact of second-opinion pathology. Review of prostate biopsies prior to radical prostatectomy. *Am J Surg Pathol*. 1996;20(7):851-857.
31. Eskander RN, Baruah J, Nayak R, et al. Outside slide review in gynecologic oncology: impact on patient care and treatment. *Int J Gynecol Pathol*. 2013;32(3):293-298.
32. Fraser S, Lanasprе E, Pinto T, Goderya R, Chandra A. Thyroid FNA diagnosis: correlation between referral and review diagnosis in a network MDM. *Cytopathology*. 2011;22(4):ii.
33. Gaudi S, Zarandona JM, Raab SS, English JCI, Jukic DM. Discrepancies in dermatopathology diagnoses: the role of second review policies and dermatopathology fellowship training. *J Am Acad Dermatol*. 2013;68(1):119-128.
34. Gerhard R, da Cunha Santos G. Inter- and intraobserver reproducibility of thyroid fine needle aspiration cytology: an analysis of discrepant cases. *Cytopathology*. 2007;18(2):105-111.
35. Golfier F, Clerc J, Hajri T, et al. Contribution of referent pathologists to the quality of trophoblastic diseases diagnosis. *Hum Reprod*. 2011;26(10):2651-2657.
36. Hahm GK, Niemann TH, Lucas JG, Frankel WL. The value of second opinion in gastrointestinal and liver pathology. *Arch Pathol Lab Med*. 2001;125(6):736-739.
37. Haws B, St Romain P, Mammen J, Fraga GR. Secondary review of external histopathology on cutaneous oncology patients referred for sentinel lymph node biopsy: how often does it happen and is it worth it? *J Cutan Pathol*. 2012;39(9):844-849.
38. Idowu MO, Jain R, Pedigo MA, Powers CN. Is a second pathologist's review of ASC-H useful in reducing false negative diagnosis. *Mod Pathol*. 2008;21(suppl 1s):74A.
39. Jacques SM, Qureshi F, Munkarah A, Lawrence WD. Interinstitutional surgical pathology review in gynecologic oncology: II. Endometrial cancer in hysterectomy specimens. *Int J Gynecol Pathol*. 1998;17(1):42-45.
40. Jara-Lazaro AR, Thike AA, Tan PH. Diagnostic issues in second opinion consultations in prostate pathology. *Pathology*. 2010;42(1):6-14.
41. Jing X, Knoepp SM, Roh MH, et al. Group consensus review minimizes the diagnosis of "follicular lesion of undetermined significance" and improves cytohistologic concordance. *Diagn Cytopathol*. 2012;40(12):1037-1042.
42. Jones K, Jordan RC. Patterns of second-opinion diagnosis in oral and maxillofacial pathology. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2010;109(6):865-869.
43. Kamat S, Parwani AV, Khalbuss WE, et al. Use of a laboratory information system driven tool for pre-signout quality assurance of random cytopathology reports. *J Pathol Inform*. 2011;2:42.
44. Kennecke HF, Speers CH, Ennis CA, Gelmon K, Olivotto IA, Hayes M. Impact of routine pathology review on treatment for node-negative breast cancer. *J Clin Oncol*. 2012;30(18):2227-2231.
45. Kishimoto R, Saika T, Bekku K, et al. The clinical impact of pathological review on selection the treatment modality for localized prostate cancer in candidates for brachytherapy monotherapy. *World J Urol*. 2012;30(3):375-378.
46. Kronz JD, Milord R, Wilentz R, Weir EG, Schreiner SR, Epstein JI. Lesions missed on prostate biopsies in cases sent in for consultation. *Prostate*. 2003;54(4):310-314.
47. Kukreti V, Patterson B, Callum J, Etchells E, Crump M. Pathology the gold standard - a retrospective analysis of discordant "second-opinion" lymphoma pathology and its impact on patient care. *Blood*. 2006;108(11):348.
48. Kuroiwa K, Shiraishi T, Naito S. Discrepancy between local and central pathological review for radical prostatectomy specimens. *J Urol*. 2009;181(4, suppl):58.

49. Kwon JS, Francis JA, Qiu F, Weir MM, Ettler HC. When is a pathology review indicated in endometrial cancer? *Obstet Gynecol*. 2007;110(6):1224-1230.
50. LaCasce AS, Kho ME, Friedberg JW, et al. Comparison of referring and final pathology for patients with non-Hodgkin's lymphoma in the National Comprehensive Cancer Network. *J Clin Oncol*. 2008;26(31):5107-5112.
51. Layfield LJ, Jones C, Rowe L, Gopez EV. Institutional review of outside cytology materials: a retrospective analysis of two institutions' experiences. *Diagn Cytopathol*. 2002;26(1):45-48.
52. Lehnhardt M, Daigeler A, Hauser J, et al. The value of expert second opinion in diagnosis of soft tissue sarcomas. *J Surg Oncol*. 2008;97(1):40-43.
53. Lester JF, Dojcinov SD, Attanoos RL, et al. The clinical impact of expert pathological review on lymphoma management: a regional experience. *Br J Haematol*. 2003;123(3):463-468.
54. Lind AC, Bewtra C, Healy JC, Sims KL. Prospective peer review in surgical pathology. *Am J Clin Pathol*. 1995;104(5):560-566.
55. Lueck N, Jensen C, Cohen MB, Weydert JA. Mandatory second opinion in cytopathology. *Cancer*. 2009;117(2):82-91.
56. Lurkin A, Ducimetiere F, Vince DR, et al. Epidemiological evaluation of concordance between initial diagnosis and central pathology review in a comprehensive and prospective series of sarcoma patients in the Rhone-Alpes region. *BMC Cancer*. 2010;10:150.
57. Lytwyn A, Salit IE, Raboud J, et al. Interobserver agreement in the interpretation of anal intraepithelial neoplasia. *Cancer*. 2005;103(7):1447-1456.
58. Manion E, Cohen MB, Weydert J. Mandatory second opinion in surgical pathology referral material: clinical consequences of major disagreements. *Am J Surg Pathol*. 2008;32(5):732-737.
59. Matasar MJ, Shi W, Silberstien J, et al. Expert second-opinion pathology review of lymphoma in the era of the World Health Organization classification. *Ann Oncol*. 2012;23(1):159-166.
60. McBroom HM, Ramsay AD. The clinicopathological meeting. A means of auditing diagnostic performance. *Am J Surg Pathol*. 1993;17(1):75-80.
61. McGinnis KS, Lessin SR, Elder DE, et al. Pathology review of cases presenting to a multidisciplinary pigmented lesion clinic. *Arch Dermatol*. 2002;138(5):617-621.
62. Mellink WA, Henzen-Logmans SC, Bongaerts AH, Ooijen BV, Rodenburg CJ, Wiggers TH. Discrepancy between second and first opinion in surgical oncological patients. *Eur J Surg Oncol*. 2006;32(1):108-112.
63. Murali R, Hughes MT, Fitzgerald P, Thompson JF, Scolyer RA. Interobserver variation in the histopathologic reporting of key prognostic parameters, particularly Clark level, affects pathologic staging of primary cutaneous melanoma. *Ann Surg*. 2009;249(4):641-647.
64. Murphy WM, Rivera-Ramirez I, Luciani LG, Wajsman Z. Second opinion of anatomical pathology: a complex issue not easily reduced to matters of right and wrong. *J Urol*. 2001;165(6 Pt 1):1957-1959.
65. Nguyen PL, Schultz D, Renshaw AA, et al. The impact of pathology review on treatment recommendations for patients with adenocarcinoma of the prostate. *Urol Oncol*. 2004;22(4):295-299.
66. Novis D. Routine review of surgical pathology cases as a method by which to reduce diagnostic errors in a community hospital. *Pathol Case Rev*. 2005;10(2):63-67.
67. Owens SR, Dhir R, Yousem SA, et al. The development and testing of a laboratory information system-driven tool for pre-sign-out quality assurance of random surgical pathology reports. *Am J Clin Pathol*. 2010;133(6):836-841.
68. Owens SR, Wiehagen LT, Kelly SM, et al. Initial experience with a novel pre-sign-out quality assurance tool for review of random surgical pathology diagnoses in a subspecialty-based university practice. *Am J Surg Pathol*. 2010;34(9):1319-1323.
69. Park JH, Kim HK, Kang SW, et al. Second opinion in thyroid fine-needle aspiration biopsy by the Bethesda system. *Endocr J*. 2012;59(3):205-212.
70. Pinto Sanchez MI, Smecuol E, Vazquez H, Mazure R, Maurino E, Bai JC. Very high rate of misdiagnosis of celiac disease in clinical practice. *Acta Gastroenterol Latinoam*. 2009;39(4):250-253.
71. Pomianowska E, Grzyb K, Westgaard A, Clausen OP, Gladhaug IP. Reclassification of tumour origin in resected periampullary adenocarcinomas reveals underestimation of distal bile duct cancer. *Eur J Surg Oncol*. 2012;38(11):1043-1050.
72. Pongpruttipan T, Sitthinamsuwan P, Rungkaew P, Ruangchira-urai R, Vongjirad A, Sukpanichnant S. Pitfalls in classifying lymphomas. *J Med Assoc Thai*. 2007;90(6):1129-1136.

73. Prayson RA, Agamanolis DP, Cohen ML, et al. Interobserver reproducibility among neuropathologists and surgical pathologists in fibrillary astrocytoma grading. *J Neurol Sci*. 2000;175(1):33-39.
74. Proctor IE, McNamara C, Rodriguez-Justo M, Isaacson PG, Ramsay A. Importance of expert central review in the diagnosis of lymphoid malignancies in a regional cancer network. *J Clin Oncol*. 2011;29(11):1431-1435.
75. Qureshi A, Loya A, Azam M, Hussain M, Mushtaq S, Mahmood T. Study of parameters to ensure quality control in histopathology reporting: a meta-analysis at a tertiary care center. *Indian J Pathol Microbiol*. 2012;55(2):180-182.
76. Raab SS, Geisinger EM, Parwani AV, Jensen C, Vrbin CM, Grzybicki DM. Effect of double viewing needle core prostate biopsy tissues on error reduction. *Mod Pathol*. 2008;21 (suppl 1s):358A.
77. Raab SS, Grzybicki DM, Janosky JE, et al. Clinical impact and frequency of anatomic pathology errors in cancer diagnoses. *Cancer*. 2005;104(10):2205-2213.
78. Raab SS, Grzybicki DM, Mahood LK, Parwani AV, Kuan S-F, Rao UN. Effectiveness of random and focused review in detecting surgical pathology error. *Am J Clin Pathol*. 2008;130(6):905-912.
79. Raab SS, Nakhleh RE, Ruby SG. Patient safety in anatomic pathology: measuring discrepancy frequencies and causes. *Arch Pathol Lab Med*. 2005;129(4):459-466.
80. Rakovitch E, Mihai A, Pignol JP, et al. Is expert breast pathology assessment necessary for the management of ductal carcinoma in situ? *Breast Cancer Res Treat*. 2004;87(3):265-272.
81. Ramsay AD, Gallagher PJ. Local audit of surgical pathology. 18 month's experience of peer review-based quality assessment in an English teaching hospital. *Am J Surg Pathol*. 1992;16(5):476-482.
82. Randall RL, Bruckner JD, Papenhausen MD, Thurman T, Conrad EUI. Errors in diagnosis and margin determination of soft-tissue sarcomas initially treated at non-tertiary centers. *Orthopedics*. 2004;27(2):209-212.
83. Ray-Coquard I, Montesco MC, Coindre JM, et al. Sarcoma: concordance between initial diagnosis and centralized expert review in a population-based study within three European regions. *Ann Oncol*. 2012;23(9):2442-2449.
84. Renshaw AA, Cartagena N, Granter SR, Gould EW. Agreement and error rates using blinded review to evaluate surgical pathology of biopsy material. *Am J Clin Pathol*. 2003;119(6):797-800.
85. Renshaw AA, Gould EW. Measuring the value of review of pathology material by a second pathologist. *Am J Clin Pathol*. 2006;125(5):737-739.
86. Renshaw AA, Gould EW. Correlation of workload with disagreement and amendment rates in surgical pathology and nongynecologic cytology. *Am J Clin Pathol*. 2006;125(6):820-822.
87. Renshaw AA, Pinnar NE, Jiroutek MR, Young ML. Blinded review as a method for quality improvement in surgical pathology. *Arch Pathol Lab Med*. 2002;126(8):961-963.
88. Renshaw AA, Pinnar NE, Jiroutek MR, Young ML. Quantifying the value of in-house consultation in surgical pathology. *Am J Clin Pathol*. 2002;117(5):751-754.
89. Saglam O, Pederson A, Zhang Z, Stone CH, Kini S. Retrospective review and analysis of pancreaticobiliary specimens with discordant cytohistologic correlation. *Cancer Cytopathology*. 2008;114(s5):421-422.
90. Santillan AA, Messina JL, Marzban SS, Crespo G, Sondak VK, Zager JS. Pathology review of thin melanoma and melanoma in situ in a multidisciplinary melanoma clinic: impact on treatment decisions. *J Clin Oncol*. 2010;28(3):481-486.
91. Santoso JT, Coleman RL, Voet RL, Bernstein SG, Lifshitz S, Miller D. Pathology slide review in gynecologic oncology. *Obstet Gynecol*. 1998;91(5 Pt 1):730-734.
92. Scott CB, Nelson JS, Farnan NC, et al. Central pathology review in clinical trials for patients with malignant glioma. A Report of Radiation Therapy Oncology Group 83-02. *Cancer*. 1995;76(2):307-313.
93. Selman AE, Niemann TH, Fowler JM, Copeland LJ. Quality assurance of second opinion pathology in gynecologic oncology. *Obstet Gynecol*. 1999;94(2):302-306.
94. Sharif MA, Hamdani SN. Second opinion and discrepancy in the diagnosis of soft tissue lesions at surgical pathology. *Indian J Pathol Microbiol*. 2010;53(3):460-464.
95. Shoo BA, Sagebiel RW, Kashani-Sabet M. Discordance in the histopathologic diagnosis of melanoma at a melanoma referral center. *J Am Acad Dermatol*. 2010;62(5):751-756.
96. Staradub VL, Messenger KA, Hao N, Wiley EL, Morrow M. Changes in breast cancer therapy because of pathology second opinions. *Ann Surg Oncol*. 2002;9(10):982-987.

97. Swapp RE, Aubry MC, Salomao DR, Cheville JC. Outside case review of surgical pathology for referred patients: the impact on patient care. *Arch Pathol Lab Med*. 2013;137(2):233-240.
98. Tan YY, Kebebew E, Reiff E, et al. Does routine consultation of thyroid fine-needle aspiration cytology change surgical management? *J Am Coll Surg*. 2007;205(1):8-12.
99. Tatsas A, Herman J, Hruban R, et al. Second opinion in pancreatic cytopathology. *CytoJournal*. 2011;8(suppl 1):S89.
100. Thomas CW, Bainbridge TC, Thomson TA, McGahan CE, Morris WJ. Clinical impact of second pathology opinion: a longitudinal study of central genitourinary pathology review before prostate brachytherapy. *Brachytherapy*. 2007;6(2):135-141.
101. Trotter MJ, Bruecks AK. Interpretation of skin biopsies by general pathologists: diagnostic discrepancy rate measured by blinded review. *Arch Pathol Lab Med*. 2003;127(11):1489-1492.
102. Tsuda H, Akiyama F, Kurosumi M, Sakamoto G, Watanabe T. Monitoring of interobserver agreement in nuclear atypia scoring of node-negative breast carcinomas judged at individual collaborating hospitals in the National Surgical Adjuvant Study of Breast Cancer (NSAS-BC) protocol. *Jpn J Clin Oncol*. 1999;29(9):413-420.
103. van Dijk MC, Aben KK, van Hees F, et al. Expert review remains important in the histopathological diagnosis of cutaneous melanocytic lesions. *Histopathology*. 2008;52(2):139-146.
104. van Rhijn BW, van der Kwast TH, Kakiashvili DM, et al. Pathological stage review is indicated in primary pT1 bladder cancer. *BJU Int*. 2010;106(2):206-211.
105. Vivino FB, Gala I, Hermann GA. Change in final diagnosis on second evaluation of labial minor salivary gland biopsies. *J Rheumatol*. 2002;29(5):938-944.
106. Wayment RO, Bourne A, Kay P, Tarter TH. Second opinion pathology in tertiary care of patients with urologic malignancies. *Urol Oncol*. 2011;29(2):194-198.
107. Wechsler J, Bastuji-Garin S, Spatz A, et al. Reliability of the histopathologic diagnosis of malignant melanoma in childhood. *Arch Dermatol*. 2002;138(5):625-628.
108. Weir MM, Jan E, Colgan TJ. Interinstitutional pathology consultations. A reassessment. *Am J Clin Pathol*. 2003;120(3):405-412.
109. Westra WH, Kronz JD, Eisele DW. The impact of second opinion surgical pathology on the practice of head and neck surgery: a decade experience at a large referral hospital. *Head Neck*. 2002;24(7):684-693.
110. Whitehead ME, Fitzwater JE, Lindley SK, Kern SB, Ulirsch RC, Winecoff WFI. Quality assurance of histopathologic diagnoses: a prospective audit of three thousand cases. *Am J Clin Pathol*. 1984;81(4):487-491.
111. Wurzer JC, Al-Saleem TI, Hanlon AL, Freedman GM, Patchefsky A, Hanks GE. Histopathologic review of prostate biopsies from patients referred to a comprehensive cancer center: correlation of pathologic findings, analysis of cost, and impact on treatment. *Cancer*. 1998;83(4):753-759.
112. Zaino RJ, Kauderer J, Trimble CL, et al. Reproducibility of the diagnosis of atypical endometrial hyperplasia: a Gynecologic Oncology Group study. *Cancer*. 2006;106(4):804-811.
113. Brimo F, Schultz L, Epstein JI. The value of mandatory second opinion pathology review of prostate needle biopsy interpretation before radical prostatectomy. *J Urol*. 2010;184(1):126-130.
114. Brochez L, Verhaeghe E, Grosshans E, et al. Inter-observer variation in the histopathological diagnosis of clinically suspicious pigmented skin lesions. *J Pathol*. 2002;196(4):459-466.
115. Chan TY, Epstein JI. Patient and urologist driven second opinion of prostate needle biopsies. *J Urol*. 2005;174(4 Pt 1):1390-1394.
116. Dhir R, Parwani AV, Zynger DL. Impact of bladder biopsy second review on pathological stage and subsequent patient management. *Lab Invest*. 2009;89(suppl 1):165A.
117. Fajardo DA, Miyamoto H, Miller JS, Lee TK, Epstein JI. Identification of Gleason pattern 5 on prostatic needle core biopsy: frequency of underdiagnosis and relation to morphology. *Am J Surg Pathol*. 2011;35(11):1706-1711.
118. Khazai L, Middleton LP, Goktepe N, Liu BT, Sahin AA. Breast pathology second review identifies clinically significant discrepancies in 10% of cases. *Lab Invest*. 2012;92(suppl 1):46A.
119. Kommoss S, Pfisterer J, Reuss A, et al. Specialized pathology review in patients with ovarian cancer: highly recommended to assure adequate treatment. Results from a prospective study. *Lab Invest*. 2012;92(suppl 1):281A.

120. Kronz JD, Westra WH, Epstein JI. Mandatory second opinion surgical pathology at a large referral hospital. *Cancer*. 1999;86(11):2426-2435.
121. Li X, Heller K, Cangiarella J, Simsir A. Interinstitutional second opinion in thyroid cytology: should second opinion be mandated prior to definitive surgery if fine needle aspiration was performed elsewhere? *CytoJournal*. 2011;8(3):S63.
122. Price JA, Grunfeld E, Barnes PJ, Rheaume DE, Rayson D. Inter-institutional pathology consultations for breast cancer: impact on clinical oncology therapy recommendations. *Curr Oncol*. 2010;17(1):25-32.
123. Raab SS, Stone CH, Jensen CS, et al. Double slide viewing as a cytology quality improvement initiative. *Am J Clin Pathol*. 2006;125(4):526-533.
124. Renshaw AA, Gould EW. Comparison of disagreement and error rates for three types of interdepartmental consultations. *Am J Clin Pathol*. 2005;124(6):878-882.
125. Renshaw AA, Gould EW. Comparison of disagreement and amendment rates by tissue type and diagnosis: identifying cases for directed blinded review. *Am J Clin Pathol*. 2006;126(5):736-739.
126. Renshaw AA, Gould EW. Increasing agreement over time in interlaboratory anatomic pathology consultation material. *Am J Clin Pathol*. 2013;140(2):215-218.
127. Safrin RE, Bark CJ. Surgical pathology sign-out. Routine review of every case by a second pathologist. *Am J Surg Pathol*. 1993;17(11):1190-1192.
128. Tavora F, Fajardo DA, Lee TK, et al. Small endoscopic biopsies of the ureter and renal pelvis: pathologic pitfalls. *Am J Surg Pathol*. 2009;33(10):1540-1546.
129. Tsung JS. Institutional pathology consultation. *Am J Surg Pathol*. 2004;28(3):399-402.
130. Moher D, Liberati A, Tetzlaff J, Altman D. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med*. 2009;6(7):e1000097.