Original Article

Assessment of Quality Indicators in Cytopathology – Measuring What Matters

Khushbu M Shah*, Sheetal D Kher, Utkarsh V Agrawal, Ritu R Singh, Vishal A Shah

Department of Pathology, GMERS Medical College, Gotri, Vadodara, Gujarat, India

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***Corresponding Author**:
Dr Khushbu M Shah
khushbumshah@gmail.com

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Abstract

Background: Laboratories play a crucial role in diagnosis and patient care. It is vital to assess, quantify, and improve the quality of laboratory functioning through continuous monitoring. This requires periodic evaluation of well-defined Quality Indicators (QI). The aim of this study was to evaluate and analyze QI in the department of cytopathology.

Materials and Methods: This retrospective descriptive study of one-year duration (1st July 2022 to 30th June 2023) was carried out in the Cytopathology section. Eleven QI were analyzed for all phases (pre-analytical, analytical, and post-analytical) of testing processes. The results were noted in terms of numbers, percentages, and ratios.

Results: In the pre-analytical phase, repeat FNACs were 11.5%, and the overall assessment of staining quality was found to be satisfactory. In the analytical phase, inconclusive diagnoses were 6.46%, positivity rates for the PAP test were 8.4%, ASC-US/SIL ratio was 2:1, and AUS: Malignant ratio in thyroid cytopathology was 5:1. The results of EQAS cycles were within consensus in 88% of cases, while discordance in cytopathology and histopathology correlation was noted in 3.33% of cases. In the post-analytical phase, the number of reports exceeding the defined TAT (turnaround time) was found to be 1.5%.

Conclusion: Continuous improvement of quality in laboratories requires monitoring in the form of QI. Assessment and analysis of QI is an effective tool to improve quality in cytopathology. Well-defined QI should be prepared for all aspects of laboratory work and periodically analyzed for monitoring and continuous improvement.

Keywords:

Continuous improvement, Cytopathology, Quality Indicators, Quality in laboratories

Introduction

The current era belongs to evidence-based medicine, with laboratories playing a crucial role in patient care by providing accurate diagnoses. Laboratory test results impact patient care immensely, making it necessary to assure the quality of laboratory work. Quality assurance (QA) is defined by the College of American Pathologists (CAP) as the systematic monitoring of Quality Control (QC) results and quality practice parameters to ensure that all systems are functioning appropriately [2]. Quality indicators are tools for the objective measurement of the current working practices in laboratories, providing guidance for future improvements. It is important to identify reliable quality indicators both for quantifying and improving the quality of laboratory work [3].

A Quality Indicator (QI) is defined as "an objective measure that potentially evaluates all critical care domains as defined by the Institute of Medicine, that is based on evidence associated with those domains, and can be implemented in a consistent and effective manner" [4]. Cytopathology, a branch of pathology that deals with the study of individual cells or clusters of cells, was a pioneer in the compliance of quality control and quality assurance since 1967 [2].

Various aspects of laboratory work that can affect the quality of results are divided into pre-analytical, analytical, and post-analytical phases. All these aspects must be monitored by appropriate QIs. This study aims to analyze and evaluate QIs in our cytopathology laboratory.

Materials and Methods

A retrospective and quantitative study was carried out in the cytopathology section of a tertiary care hospital for one year, from 1st July 2022 to 30th June 2023. All the samples (gynecological and non-gynecological) tested during this period were included in the study. These comprised FNACs (Fine Needle Aspiration Cytology), Papanicolaou (PAP) smears from the Department of Gynecology, samples for fluid cytopathology (pleural, peritoneal), Tzanck smears from the Department of Skin and Venereology, and sputum samples from the Department of TB and Chest Diseases (TBCD). Standard laboratory procedures were followed for processing and analyzing the samples. The Bethesda system was used for reporting PAP smears and thyroid cytopathology. Data and information were collected from respective registers, files, and documents. A total of 11 quality indicators were analyzed under the categories of pre-analytical, analytical, and post-analytical processes. QIs and their formulas are described in Table 1.

Quality indicators in the pre-analytical phase included the percentage of repeat FNACs, the number of forms rejected, and the daily assessment of staining quality (for nuclear and cytoplasmic staining). First slides of each stain—H & E (Haematoxylin and Eosin), PAP (Papanicolaou), and MGG (May Grunwald Giemsa)—were screened daily for quality of stain by a cytopathologist.

Quality indicators in the analytical phase included the percentage of inconclusive diagnoses (descriptive and uncategorizable diagnoses), percentage of intra-lab quality control (review of two pre-selected FNAs by the hematology and histopathology department in-charges), positivity rate for PAP tests, ASCUS/SIL (Atypical Squamous Cells of Undetermined Significance/Squamous Intraepithelial Lesion) ratio, QI for thyroid FNA [5], tests with unsatisfactory EQAS (External Quality Assurance Scheme), and discordance in cytopathology-histopathology correlation, defined as the total number of tests not correlating with histology diagnosis divided by the total number of tests referred to histopathology [6].

The quality indicator in the post-analytical phase was the percentage of reports outside the turnaround time (TAT). For quality indicators of thyroid FNAs, the Bethesda classification update in 2020 was followed, which includes two indicators: (1) AUS (Atypia of Undetermined Significance) as category III of The Bethesda System for Reporting Thyroid Cytopathology (TBSRTC), and (2) ratio of AUS: Malignancy.

Results

In the present study conducted in the cytopathology laboratory over one year, a total of 1169 samples were studied, including 767 FNAs, 285 PAP smears, and 117 body fluids (pleural fluid, ascitic fluid, pericardial fluid, and bronchoalveolar lavage). Various quality indicators were evaluated in terms of percentages and ratios.

Pre-analytical Phase: During the study period, a total of 942 slides were screened, of which 275 of H & E (99.27%), 274 of PAP (98.91%), 273 of MGG (98.55%), and 111 AFB (Acid-Fast Bacilli) (100%) were found to be satisfactory for nuclear and

cytoplasmic staining. The results are tabulated in Table 2.

Analytical Phase: For intra-lab quality control, 24 samples were reviewed (12 gynecological samples and 12 non-gynecological samples). During the study period, our institute participated in two external quality assurance schemes (EQAS). A total of 120 cases were available for cytopathology-histopathology correlation. The results are recorded in Table 3.

Post-analytical Phase: The percentage of reports exceeding TAT was 1.5%.

Table 1: Quality indicators to be evaluated during the study period

Pre-analytical phase	1. Percentage of Repeat FNA: No. of repeat FNAC/ Total no. of FNAC 2. Percentage of Forms rejected: No. of forms rejected/ Total no. of samples received) x 100 3. Assessment of staining quality: No. of IQC stained slides regarded as unsatisfactory / Total number of slides stained for IQC x 100
Analytical phase	4. Percentage of Inconclusive diagnosis: (No. of descriptive diagnosis/ Total no. of cases reported) x 100 5. Percentage of Intra-lab quality control: (No. of cases with concordance diagnosis/Total no. of cases examined under intra laboratory quality control) x 100 6. Percentage of positivity rates for PAP test: (No. of abnormal tests/Total no. of satisfactory tests) x 100 7. ASC-US/SIL ratio (<3:1): No of tests compatible with ASC-US/No. of tests with LSIL and HSIL] [5] (Ratio should be no greater than 3:1) 8. Quality indicator (QI) for thyroid FNA based on 'The Bethesda System of Reporting Thyroid Cytopathology (TBSRTC)', 3rd edition, 2018 [5]: a. Atypia of Undetermined Significance (AUS) b. AUS: Malignant ratio (Should not exceed 3.0) 9. Tests with unsatisfactory EQAS (External Quality Assurance Scheme): (No. of unacceptable performance in EQAS samples per year/ Total no. of EQAS samples received) x 100 10. Percentage In-concordance in histopathology-cytopathology correlation: No. of deviation of histo-cytology results/Total no. of cases correlated) [6]
Post-analytical phase	11. Percentage Reports outside the specified TAT*: [(No. of reports exceeding TAT/Total no. of reports issued) x 100
FNAC, Fine needle aspiration cytology; IQC, Internal quality control; PAP, Papanicolaou; ASC-US/SIL, Atypical squamous cells of undetermined significance/Squamous Intraepithelial lesion; LSIL, low grade squamous intraepithelial lesion; HSIL, high grade squamous intraepithelial lesion; QI, Quality Indicators; TBSRTC, The Bethesda System of Reporting Thyroid Cytopathology; AUS, Atypia of Undetermined Significance; EQAS, External Quality Assurance Scheme; TAT, Turnaround time Turnaround time for any laboratory test is defined as time a specimen is accessioned in the laboratory to the time the report is signed out of finalized. In our study it was counted as three working days. Turnaround time for any laboratory test is defined as time a specimen is accessioned in the laboratory to the time the report is signed out of finalized. In our study it was counted as three working days.	

Table 2: Results of Quality Indicators of Pre-analytical phase

Sr. No.	Quality Indicators	Number (%)
1.	Percentage of Repeat FNA	**88 (11.5%)**
2.	Number of forms rejected	**0 (0%)**
3.	Assessment of staining quality	**933 (99%)**
FNA, Fine Needle Aspiration		

Table 3: Results of Quality Indicators of Analytical Phase

Sr. No.	Quality Indicators	Number (%)
1.	Percentage of Inconclusive diagnosis	**87 (7.48%)**
2.	Percentage of Intra-lab quality control	**24 (100%)**
3.	Percentage of positivity rates for PAP test	**7.7%**
4.	ASC-US/SIL ratio	**2:1**
5.	Quality indicator (QI) for thyroid FNA	
	AUS	**5 (0.8%)**
	AUS: Malignant ratio	**5:1**
6.	Tests with unsatisfactory EQAS	**4 (88%)**
7.	% in-concordance in histo-cyto correlation	**3.33%**
PAP, Papanicolaou; ASC-US/SIL, Atypical squamous cells of undetermined significance/Squamous Intraepithelial lesion; AUS, Atypia of undetermined significance; EQAS, External quality assurance scheme		

Discussion

Pre-analytical phase:

A. The percentage of repeat FNAC was 11.5%, while in a study conducted by Sinha et al., it was found to be 3.01% [1]. The main reasons for this could be inadequate material, drying artifacts, FNA conducted by newly posted academic postgraduate residents, inconsistent cyto-clinical correlation, and deep-seated lesions [2]. Criteria followed at our laboratory to consider FNA/fluid/PAP smear as unsatisfactory for evaluation include:

   1. Scanty squamous epithelial components, especially for PAP smears, i.e., less than 10% of squamous cells.
   2. Obscuring cells in the form of RBCs, inflammatory infiltrates, poor fixation, air-drying artifacts, and contamination.
   3. Induction training should be given to both residents and technicians regarding proper aspiration, smearing, and staining techniques. Safety measures should also be inculcated to prevent breakage of slides while expelling the material on the slide from the hub.

B. On assessing the staining quality, the present study showed 0.95% of cases with unsatisfactory staining, while this was 0.12% and 2.45% in studies by Sinha et al. [1] and Doshi PR et al. [2]. Highly satisfactory staining quality can be ascribed to well-trained, experienced technical staff, along with expert cytopathologists.

Analytical phase:

A. The percentage of positivity for PAP tests was 8.4% in the current study, while in studies conducted by Doshi PR et al. [2], Davey et al. from the US [7], and Nygard JF et al. from Norway [8], it was found to be 4.4%, 6.8%, and 4.9%, respectively.

B. The ASCUS/SIL ratio in the present study was 2:1, while it was 3:2, 3:2, 3:2.6, and 1:5 in studies by Rajagopal et al. [9], Renshaw et al. [10], Chebib et al. [11], and Catteau et al. [12]. Renshaw AA et al. demonstrated an ASC/SIL ratio of less than 1.5 as a marker for inadequate screening. This is because a lower ratio means a more specific diagnosis was made, which can only happen at the cost of decreased sensitivity. As a result, the main utility of ASCUS/SIL as a screening tool gets compromised. Hence, ideally, a ratio of less than 2:1 or 3:1 should be maintained [13]. The PAP test carries the

risk of false-negative reporting, the majority of which are due to inter- and intra-operator variabilities and microscopic errors [14]. Our results ascertain that the ASCUS category was not being overused.

C. On evaluating QI for thyroid FNA, AUS and malignant cases were noted to be 5 and 1, respectively. The AUS ratio was found to be 5:1, which was reported as 0.5, 1.0, 1.8, and 2.1, respectively, in studies by Jo [15], Kim [16], Renshaw [17], and VanderLaan [18]. The AUS ratio considers possible variations in cancer prevalence among different patient populations, which AUS alone would not. This ratio generally falls within the range of 1.0 to 3.0. A figure of >3 indicates over-diagnosing AUS or under-diagnosing malignancy, while a ratio of <1 is attributable to a low AUS rate. The latter is associated with low diagnostic sensitivity [19]. In this case, our result indicates overuse of the AUS category.

D. Of the 120 samples evaluated for cytopathology and histopathology correlation, the concordance rate in the current study was found to be 96.67%, while it was 93.3% in the study by Sinha et al. [1]. Our study reflects good concordance between cytopathology and histopathology reports. The causes of discordance can include FNA from non-representative areas or inadequate smears. The investigators recommend the use of guided aspiration in the case of tiny, deep-seated lesions.

Post-analytical phase:

A. Reports outside the specified TAT in the present study were 1.5%, compared to 2.08% in the study by Sinha et al. [1]. Delays in reporting can be due to improperly filled requisition forms, the requirement of additional clinical information, and transcriptional errors, as recommended by Gupta et al. [20] and Mehrotra et al. [21]. There can be variability among laboratories in deciding the start and end times of the TAT cycle. This helps examine the functionality of overall service, including slide preparation, cytotechnologist screening, and pathologist sign-out. It is also relatable to customer satisfaction, given the increasing demand for prompt reporting [22].

As far as the pre-analytical phase is concerned, SOPs (Standard Operating Procedures) are essential documents/reference sources for understanding sample accession, identification, processing (phases of fixation, dehydration), and rejection criteria. These should be documented and displayed in the laboratory in a manner that is accessible to all working staff. Periodic calibration of equipment, such as centrifuges, should be ensured.

In the case of analytical phase processes, two major approaches for quality control are internal quality control, applied within the laboratory, and external quality assurance (EQAS), done at the inter-laboratory level. Essential steps that prove fruitful in improving these include conducting academic activities such as clinico-pathological correlation meetings, intradepartmental discussions, and CME (Continued Medical Education) programs. Additionally, establishing a hierarchical form of reporting and holding blinded random case reviews are other steps for achieving better quality standards.

To ensure that the criteria set for turnaround time of reporting are followed, it is necessary to sensitize residents/interns of clinical branches about the importance of properly filling out requisition forms. Similarly, residents posted in cytopathology should be emphasized to avoid erroneous data entry and transcriptional errors as much as possible. It is also essential that support staff involved in the verification and dispatch of reports are properly trained.

The most important hallmark for ensuring quality in cytopathology, which affects sensitivity, is sample adequacy, while for proper interpretation, the crucial step is sample preparation. Implementing QC in cytopathology becomes challenging, as its services are more qualitative than quantitative. Additionally, the inherent qualities of this discipline, such as the lack of objective numerical data, descriptive reports, the subjectivity of individual reports, bias, and non-uniformity of reporting patterns, make it a more

daunting task to assess and implement QC in cytopathology. Proper coordination between technical and managerial activities, along with qualified and competent cytopathologists, is required to achieve efficient, effective, error-free, and accurate diagnostic reports.

Conclusion

Continuous improvement of quality in laboratories requires monitoring in the form of QIs. In the case of cytopathology, microscopy is directly associated with quality. Assessment and analysis of QIs is a feasible and effective tool to measure quality in objective and digital forms in a cytopathology laboratory. To avoid false positives, various internal and external tools of assessment should be employed. Training personnel is fundamental to maintaining standard quality skills, along with continuous education programs. With this, the results of such studies can significantly improve the cytological process in sampling and interpretation and overall reduce errors in reporting. Well-defined QIs should be available in all laboratories for monitoring and continuous improvement, especially whenever quality is deteriorating. The root cause analysis that follows these aids in improving quality healthcare and patient care.

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