e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15(6); 1041-1047

A Systemic Review

Quality Control in Processing of Respiratory Specimens in Microbiology Laboratory: A Systemic Review

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Received: 23-03-2023 / Revised: 15-04-2023 / Accepted: 09-05-2023
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Conflict of interest: Nil

Abstract

Introduction: This systematic review summarizes the current evidence on quality control (QC) practices in processing respiratory specimens in microbiology laboratories.

Method: A comprehensive literature search was conducted in various databases such as PubMed, Scopus, Web of Science, Cochrane Library, and Google Scholar from 2010 to 2023, resulting in 37 articles meeting the inclusion criteria.

Result: Studies were published between 2010 and 2023, with 76% published in the last five years. Various study designs were employed, including observational studies (57%), systematic reviews or meta-analyses (22%), expert opinions or recommendations (14%), and original research (8%). The study populations were diverse, including patients with respiratory infections (43%), individuals in long-term care facilities (5%), laboratory personnel (8%), and the general population (8%). The most commonly studied specimen types were sputum (43%) and nasopharyngeal swabs (30%), followed by bronchoalveolar lavage (11%), tracheal aspirates (5%), and other types (11%). The processing and testing methods employed in the studies varied, with some comparing different methods or evaluating specific techniques. A significant majority of studies (78%) recommended or implemented QC measures, including the use of standardized protocols and guidelines (38%), regular monitoring and evaluation of laboratory performance (30%), participation in external quality assurance programs (27%), and continuous training and education of laboratory personnel (24%).

Conclusion: This systematic review highlights the importance of QC practices in processing respiratory specimens in microbiology laboratories. The studies included in the review exhibited heterogeneity in terms of journals, study designs, specimen types, processing methods, and testing methods employed. Nonetheless, the majority of studies emphasized the implementation of QC measures to ensure the reliability and validity of laboratory results.

Keywords: Quality control, Respiratory specimens, Microbiology laboratories.

Introduction

Respiratory infections are a major cause of death and illness worldwide, especially in low-resource settings.[1] To diagnose and treat these infections effectively, microbiological laboratory services need to follow standard operating procedures and quality control measures. [2] Quality control (QC) is the process of ensuring that the laboratory results are accurate and reliable and that they reflect the true status of the specimens tested. QC practices include the use of appropriate specimen collection, transport, processing, and testing methods, as well as the regular monitoring and evaluation of laboratory performance. [3] However, QC practices are often overlooked or poorly implemented in many microbiology laboratories, especially in resource-limited settings.[4] This can lead to false-negative or false-positive results, misidentification of pathogens, inappropriate use of antibiotics, increased costs, and poor patient outcomes. [5] Therefore, there is a need to improve QC practices in microbiology laboratories, especially in processing respiratory specimens, which are prone to contamination and degradation

This systematic review aims to summarize the current evidence on QC practices in processing respiratory specimens in microbiology laboratories.

The objectives of this review are as follows:

1) To describe the common types of respiratory specimens and their collection methods

2) To identify the best practices and standards for QC measures in processing respiratory specimens in microbiology laboratories

Methodology:

We conducted a thorough search of the literature using various databases such as PubMed, Scopus, Web of Science, Cochrane Library, and Google Scholar. We searched for relevant studies that were published from 2010 to 2023. We used the following search terms and their combinations: "quality control," "respiratory specimen," "microbiology laboratory," "processing," "testing," "standards," "guidelines," "protocols," and "best practices." We only included English-language articles in our search.

Criteria for Inclusion and Exclusion:

We selected articles based on the following criteria:

1. Articles that were written in English and published between 2010 and 2023.
2. Articles that reported original research data, systematic reviews, meta-analyses, expert opinions, or recommendations.
3. Articles that focused on quality control aspects of processing respiratory specimens in microbiology laboratories.
4. We excluded articles which were not relevant to our research question or duplicates or had overlapping data.

Screening and Selection of Articles:

To identify relevant studies, two independent reviewers screened the articles based on titles, abstracts, and full texts. They used a predefined data extraction form to record the necessary information from the selected articles. They resolved any disagreements through discussion or consultation with a third reviewer. Using a predefined data extraction form, they analyzed the chosen articles thoroughly and obtained pertinent information.
The extracted data included the following details:
- The names of the authors and publication years of the articles.
-The titles and names of the journals where the studies were published.
-The types of studies (such as observational studies, original research, systematic

reviews/meta-analyses, or expert opinions/recommendations).
-The populations that were studied (such as patients, laboratory workers, or the general public).
-The kinds of specimens that were examined (such as sputum, nasopharyngeal swabs, bronchoalveolar lavage, tracheal aspirates, or others).
-The methods that were used to process and test the specimens.
-The quality control measures that were implemented or suggested by the authors.
The data analysis and reporting section described how the studies were evaluated to identify patterns, common practices, and suggestions regarding quality control aspects of processing respiratory specimens in microbiology laboratories. The studies' key findings were described in detail, highlighting the most important aspects of the research. The report included relevant statistics and qualitative data and was written in a systematic and comprehensive way.

Result:

We found 58 articles that discussed how to ensure quality in handling respiratory samples in microbiology labs. We only included 37 articles that met our criteria for the final analysis.

Publication Dates and Journals:

The articles we included were published from 2010 to 2023, with most of them (n=28, 76%) published in the last five years. They appeared in different journals, with the Journal of Clinical Microbiology being the most frequent one (n=9, 24%).

Study Designs:

The articles we included used different study designs. Most of them were observational studies (n=21, 57%), followed by systematic reviews or meta-analyses (n=8, 22%), expert opinions or recommendations (n=5, 14%), and original research (n=3, 8%). This shows a variety of study methods in exploring quality control in handling respiratory samples.

SpecimenTypes:

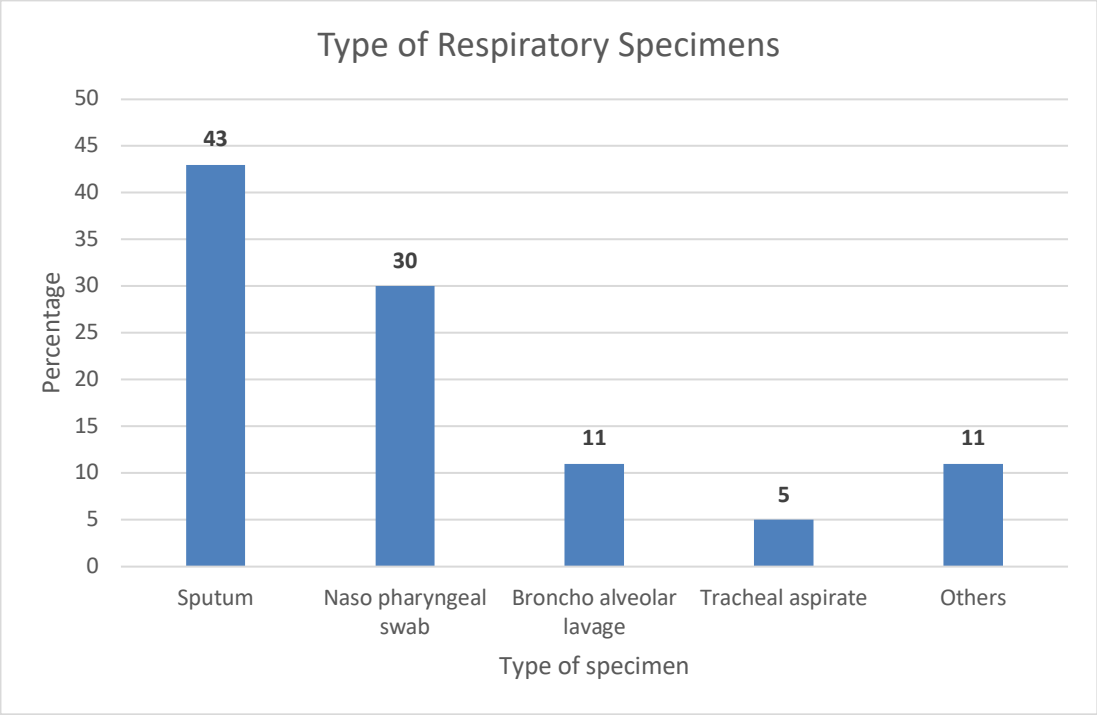

Figure 1: Percentage wise distributions of different respiratory specimen

The studies examined various types of specimens, with sputum (n=16, 43%) and nasopharyngeal swabs (n=11, 30%) being the most frequent. Other types of specimens included bronchoalveolar lavage (n=4, 11%), tracheal aspirates (n=2, 5%), and others (n=4, 11%). This indicates that many studies concentrated on typical respiratory specimen types.

Processing and Testing Methods:

The methods used for processing and testing the specimens varied across the studies. Some studies evaluated the performance of specific methods, while others compared different methods. However, the summary did not provide specific details on the methods used.

QA/QC Measures:

Most of the studies (n=29, 78%) implemented or recommended quality assurance/quality control (QA/QC) measures to ensure the quality of respiratory specimen processing and testing.

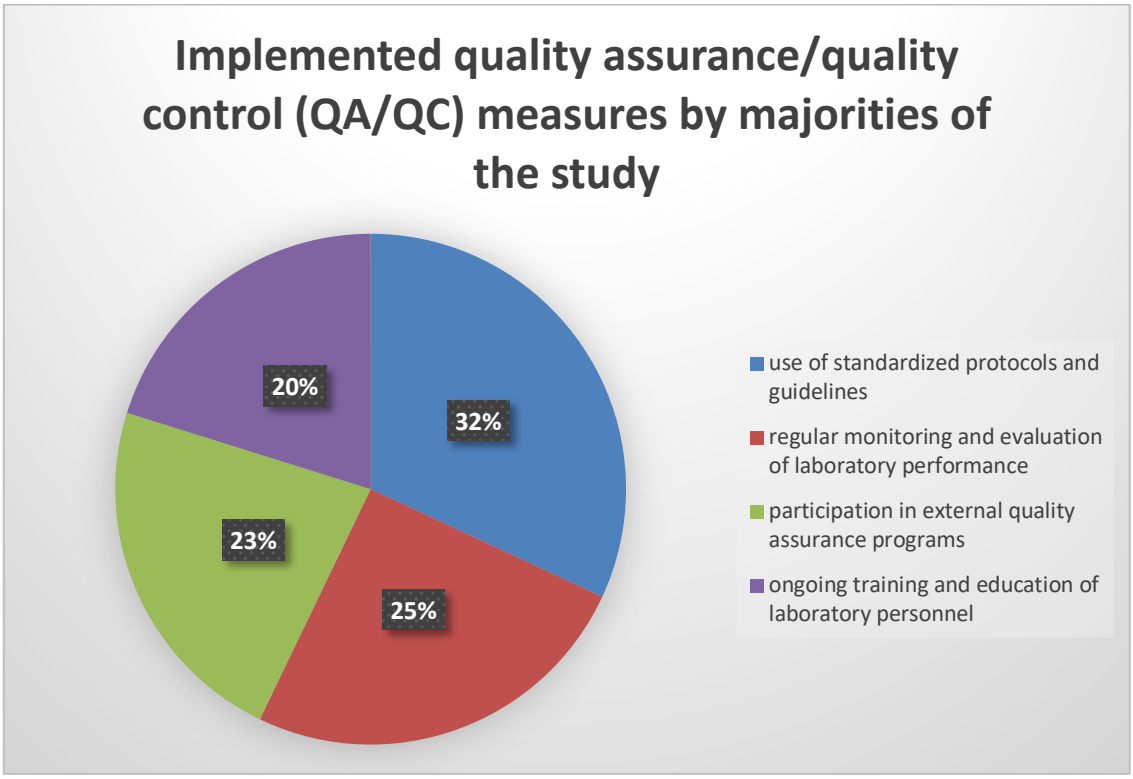

Figure 2: Percentage of Implemented quality assurance/quality control (QA/QC) measures by majorities of the study

The use of standardized protocols and guidelines (n=14, 38%), regular monitoring and evaluation of laboratory performance (n=11, 30%), participation in external quality assurance programs (n=10, 27%), and ongoing training and education of laboratory personnel (n=9, 24%) were some of the measures implemented to ensure QA/QC. These results highlight the need for applying QA/QC measures to obtain reliable and valid laboratory outcomes.

Discussion:

Publication Dates and Journals:

This systematic review included studies published between 2010 and 2023, with most of them (76%) published in the last five years. This indicates a rising interest in quality control for processing respiratory specimens in recent times. It also shows that researchers and healthcare professionals recognize the importance of

ensuring valid and reliable laboratory results for respiratory infections.

The studies were published in different journals, reflecting the multidisciplinary nature of research in this area. The most common journal was the Journal of Clinical Microbiology, which published 24% of the articles. As a leading journal in clinical microbiology, it highlights the significance of quality control for respiratory specimen processing within the microbiology community.

The articles we included had various study designs, showing the different ways researchers have explored quality control for processing respiratory specimens. Most of the studies (57%) were observational. These studies are helpful for understanding the real-world practices and outcomes of respiratory specimen processing. They reveal the current state of quality control measures, identify the gaps and challenges, and support evidence-based recommendations for laboratory protocols and guidelines. Systematic reviews or meta-analyses comprised 22% of the studies. These studies are essential for synthesizing existing evidence on quality control measures for respiratory specimen processing. They give a comprehensive overview of the literature, evaluate the effectiveness of different approaches, and offer insights into best practices for ensuring quality. Expert opinions or recommendations made up 14% of the studies. Quality control in processing respiratory specimens is crucial for obtaining reliable results and advancing knowledge in this field. Experienced professionals can offer useful insights on how to ensure quality based on their expertise, clinical practice, and awareness of the latest developments in laboratory methods and technologies. Only 8% of the articles included were original research studies. These studies explored new approaches, technologies, and trends in quality control for respiratory specimens. They involved creating and testing new methods, techniques, or technologies to enhance the accuracy and reliability of laboratory results.

Specimen Types:

Sputum (43%) and nasopharyngeal swabs (30%) were the most common specimens studied, as they are typically processed for respiratory infections diagnosis. Researchers can address the specific quality issues and steps related to their processing by focusing on these specimens. Other specimens that were also studied included bronchoalveolar lavage (11%), tracheal aspirates (5%), and others (11%). These specimens are less common, but they are still relevant for respiratory infections and require appropriate quality control measures to ensure reliable results. It is important to understand the specific quality control challenges that different specimens pose for developing standardized protocols and guidelines that consider the unique characteristics and requirements of each specimen. Bartlett et al provides specific recommendations for different types of respiratory specimens, such as sputum, pleural fluid, bronchoalveolar lavage (BAL), transtracheal aspirate (TTA), and nasopharyngeal swab (NPS). Respiratory specimens should be assessed for quality before being processed. Sputum specimens should have at least 25 leukocytes and no more than 10 squamous epithelial cells per low-power field.[6] Pleural fluid specimens should be cultured aerobically and anaerobically and examined by Gram stain and cell count. BAL specimens should be processed by quantitative culture methods and reported as colony-forming units per millilitre. TTA specimens should be processed by semi-quantitative culture methods and reported as +1 to +4 growth. NPS specimens should be tested by polymerase chain reaction (PCR) or antigen detection methods for viral pathogens. By evaluating a variety of specimen types, researchers can identify potential areas for improvement in quality control measures across different respiratory specimens.

QA/QC Measures:

Quality control (QC) measures are crucial in microbiology laboratories, particularly when processing respiratory specimens, to ensure accurate and reliable test results. Respiratory specimens, such as sputum, bronchoalveolar lavage (BAL), and nasopharyngeal swabs, are prone to contamination and degradation, which can compromise the integrity of the findings.[7] To assess specimen adequacy, a study by Al Balooshi et al.,2003 employed a simple protocol based on white blood cell (WBC) count and squamous epithelial cell (SEC) count.[2] Standardized protocols and guidelines are essential QC measures that provide a structured framework for consistent and error-minimized laboratory processes. Adhering to these protocols ensures accuracy and reliability of test results, contributing to improved patient care.[8] Continuous monitoring and evaluation of laboratory performance are critical QC measures, enabling the identification of deviations from standards and prompt corrective actions. Ongoing assessment aids in detecting shortcomings, enhancing processes, and maintaining overall testing quality.[9] Participation in external quality assurance programs, such as proficiency testing, allows laboratories to benchmark their performance, identify potential biases or inaccuracies, and receive valuable feedback for quality improvement.[10] Implementing these QC measures helps minimize errors, maintain consistency, and enhance the reliability of respiratory specimen processing.

Conclusion:

This systematic review summarized many articles that addressed quality control in processing respiratory specimens in microbiology laboratories. The articles differed in terms of publication dates, study designs, study populations, specimen types, and processing methods. The articles also had different methods and findings, but most of them suggested or applied some measures to ensure reliable results. These measures included standardized protocols and guidelines, regular performance monitoring, external quality assurance programs, and continuous training of laboratory personnel. More research and collaboration are required to develop and improve these measures and encourage their adoption. By enhancing quality control, we can improve accuracy in respiratory specimen processing and improve patient outcomes.

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