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Research Article

Team experience of nasopharyngeal samples reception, decontamination, and sorting during the COVID-19 pandemic (2020) at Institut Pasteur Côte d’Ivoire

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ABSTRACT

Molecular testing sensitivity, which allows for early diagnosis of the 2019 coronavirus disease (COVID-19), could be affected by sample quality, storage, and transportation timeframe to the laboratory, along with bias related to the pre-analytic phase. The present study reports the selection and decontamination of nasopharyngeal samples during COVID-19 management at the Institut Pasteur Côte d’Ivoire. The objective of this work was to organize sample reception management and report a complete picture of sample selection and decontamination in the context of diagnosis activity decentralization.

An administrative note creating the selection and decontamination unit of nasopharyngeal samples initiated activities in May 2020. The required human resources and necessary materials were identified and put in place. Daily activity consisted of receiving, sorting, decontaminating, and sending nasopharyngeal samples to different diagnostic laboratories. Nonconformities were recorded monthly.

After a six-month period of activities, from a total amount of 11,401 containers received and decontaminated, 174,085 samples were selected. A proportion of 92.0% of these specimens met the diagnostic standards, while 7.0% that were found acceptable showed minor irregularities. Nevertheless, a rate of 1.0% of samples with major abnormalities could not be used for COVID-19 testing and, therefore, were rejected. Additionally, the non-conformity rate was reduced by 2.4% after the first term activity.

Sorting and decontamination of nasopharyngeal samples are crucial steps in biosafety optimization for the technical staff and quality improvement of sample care.

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1. Introduction

The 2019 coronavirus disease (COVID-19) caused by the type-2 severe respiratory syndrome (SARS-CoV-2) was first diagnosed in Wuhan, China in December 2019. It has rapidly spread worldwide and become a global public health concern; a pandemic was declared on March 11th; 2020. Since then, COVID-19 has affected numerous countries in the world, including Côte d’Ivoire. Since the first diagnosis of a case of COVID-19 in Côte d’Ivoire (March 11, 2020) to December 31, 2020, the country recorded 22,490 people affected by COVID-19, with 0.6% (137 people) of those cases resulting in death.

Because of the public health emergency, and based on its success during the 2014 Ebola epidemic, Côte d’Ivoire started managing the COVID-19 crisis by elaborating on a national response plan. The Institut Pasteur Côte d’Ivoire (IPCI), a regional and national public reference institution, was given the mission to coordinate the COVID-19 diagnosis efforts for the country, with a target of 2,000 to 3,000 tests per day. Since then, it has utilized its expertise and human resources to carry out standard operational procedures.

The reference method for early SARS-CoV-2 infection diagnosis is based on ribonucleic acid detection, using real-time polymerase chain reaction (RT-PCR) performed on nasopharyngeal speci-
It has been proven that molecular testing has approximately 100% specificity. This is because the designed primers are specific for the gene sequence targets of SARS-CoV-2. Nevertheless, sensitivity could be influenced by sample quality, storage conditions, and transportation time frame to the laboratory, with additional errors related to the pre-analytic phase.¹³,¹⁴

The first term report (March–May 2020) of the COVID-19 management at the IPCI revealed an increase in abnormalities not associated with nasopharyngeal sampling and transportation requirements. These abnormalities, which brought about several non-conformities, stimulated the need to decentralize diagnostic activities by creating a transversal group dedicated to the organization of nasopharyngeal specimen reception, decontamination, and sorting.

The present study aimed to share experiences garnered by the sorting and decontamination group (SDG) regarding organizational control and qualitative management during the COVID-19 pandemic.

### 2. Methodology

This prospective study was carried out at the Institut Pasteur Côte d’Ivoire (IPCI), site of Adiopodoumé, from June to November 2020, and dealt with nasopharyngeal samples collected for SARS-CoV-2 detection. This study was first based on a diagnosis organization in place by the Ivorian government with technical support from the IPCI. Second, it was based on the first term activity reports of different sections involved in the pre-analytic phase of SARS-CoV-2 detection by RT-PCR during the COVID-19 pandemic.

#### 2.1. Sample receipt organization

The sample sorting and decontamination group of the IPCI was created by an administrative decision in May 2020 and included human resources with diverse skillsets. The aforementioned group focused on the need to address several abnormalities frequently encountered in nasopharyngeal samples obtained from collection centers. Additionally, collaboration among pandemic management personnel was reinforced. This favored the introduction of the Laboratory Management Information System (LIS) into the collection of patients’ socio-epidemiological data and sample monitoring. The aim was to improve diagnostic services according to the recommendations established.⁶,⁸,¹⁰,¹³

One of the objectives of the sorting and decontamination group was to build up the capacity of personnel transporting and collecting nasopharyngeal samples. Thus, training sessions focused on methods of sampling, packaging, and transportation to the laboratory. Concerning abnormalities commonly encountered during sorting and decontamination of samples, alternatives have been proposed to help reduce some risks. These include, in particular, sample labels that have been detached, lost, or deleted because of inappropriate transport conditions, namely cold chains with frozen ice packs or sample decontamination. Specifically, the team proposed protecting the self-adhesive labels (barcode sample) or sample label (names on the tube), with transparent adhesive tape after tube identification.

During activity planning and execution of sorting and decontamination, the biosecurity rules along with documentary system organization and data management,⁶,⁹,¹¹ were maintained.

#### 2.2. Sample decontamination, sorting, and transmission to the laboratory

Nasopharyngeal specimens were received at the IPCI 24 h/day from the national surveillance and epidemic disease response network. These samples originated not only from the Tropical Infectious Disease Services (TIDS), but also from sample collection centers and the rapid response teams (RRT). Some other samples were collected from the Abidjan suburbs, namely “Grand Abidjan”, and from remote areas.

Once received, the external part of the sample container was decontaminated under a BSL-2 hood by spraying with sodium hypochlorite (0.5%). Then, the container was opened and the specimens were decontaminated using the same procedure, followed by a contact time of 15 min.¹¹,¹² Sorting consisted of controlling compliance for samples received according to the recommended criteria and requirements.⁹,¹¹,¹²

- The samples were transported in tertiary packaging with two well-frozen ice packs, guaranteeing their integrity from the collection site to the laboratory.
- The number of samples in the container did not exceed 20.
- Each sample in the container must be in secondary packaging containing absorbent paper.
- The sample tube containing a sufficient amount of virus transport medium (VTM) was properly closed with a readable label.
- The sample label (name or barcode) is protected by transparent adhesive tape.
- Patient epidemiological records must specify the date of collection, name and first name, age, gender, clinical information, geographic location, phone number, and additional information.
- The epidemiological record recorded on the Laboratory Information System (LIS) must be available on a platform dedicated to patient sample monitoring.

Once all these criteria had been verified, samples meeting all requirements were recorded in the recommendations book prior to being sent to the laboratory for diagnosis. Non-compliant samples were accepted depending on whether non-compliance would affect the performance of the test.

#### 2.3. Non-compliance management

According to predefined criteria for accepting a sample, 12 non-compliant (NC) indicators were regularly identified and classified as minor (mNC) (because they did not influence the result quality) or major (MNC) and immediately rejected because they would negatively affect the results.

There are seven mNC indicators: thawed out ice packs or lack of ice packs, container content greater than 20 samples, label tube not protected by transparent adhesive tape, epidemiological record not dated or not accompanied by a sample, or transportation time to laboratory greater than 24 h.

Five MNC indicators were regularly detected, including epidemiological record absence, tube label absent or unreadable, viral transport medium (VTM) absent, or container content soiled.

Based on recommendations,³ all non-compliant situations were recorded in the notebook provided for this purpose. Any MNC (rejected) event was reported to the team that carried out the sampling either by telephone, if needed, or through a report indicating the reason for rejection, followed by corrective measures.

The samples received from June to November 2020 were counted. The non-compliant proportions were determined and classified by sample collection sites (TIDS, RRT, COVID-19 centers) and system type (Paper System or LIS). The proportion of non-compliance was determined by dividing the sum of non-compliant samples by the number of samples received per month.
3. Results

3.1. Review of sorting and decontamination activities from June to November 2020

3.1.1. Distribution of samples received by collection site

After six months of activities, 11,401 containers with 174,085 samples were received, decontaminated, and sorted. Most of them originated from collection centers for COVID-19 diagnosis (86.6%), while 10.9% and 2.5% were from RRT and TIDS, respectively (Fig. 1).

3.1.2. Variation in the quality indicators of samples received

The trend of sample quality indicators showed an increase in the proportion of compliant samples from June to November 2020 (Fig. 2).

Of the 174,085 samples received, 92.2% were found to be adequate (compliant) for the COVID-19 diagnosis test, while 7.0% had minor errors but were accepted for testing. However, 1% of the samples that showed major abnormalities were rejected (Fig. 3).

3.2. Review of non-compliant samples from June to November 2020

3.2.1. Distribution of non-compliant samples per collection site

Twelve non-compliant indicators were identified. Of these, the seven that were classified as minor constituted 92.5% of all non-compliant cases (Fig. 4). These cases resulted from label protection failure, which represented 67.2% of non-compliant cases, with 31.8% originating from COVID-19 sample collection centers and 23.4% from the TIDS (Fig. 4a).

Five major non-compliant indicators frequently appeared in 7.5% of the non-compliant cases. From these major indicators, samples with no epidemiological sheet constituted the majority of cases, with 1.1% and 1.0% occurring from the TIDS and COVID-19 sample collection centers, respectively, followed by containers with soiled content and unreadable labels (Fig. 4b).

3.2.2. Distribution of non-compliant samples per data collection system

When utilizing the laboratory computer system, the majority of the mNC cases (47.8%) involved the label not being protected (Fig. 5a).

As for the MNC cases, the paper system revealed more errors, and 2.1% of the samples received were without epidemiological sheets, followed by the indicator of soiled samples (Fig. 5b).

Fig. 1. Distribution of nasopharyngeal samples received from June to November 2020 by collection site. (a), TIDS: Tropical Infectious Disease Services; (b), RRT: Rapid Response Teams.

Fig. 2. Variation (%) of nasopharyngeal sample quality from June to November 2020.

Fig. 3. Distribution (%) of nasopharyngeal sample quality from June to November 2020. (c), mNC: Minor Non-Compliant; (d), MNC: Major Non-Compliant.

4. Discussion

The establishment of a new management strategy for receiving samples from May 2020 was in agreement with the overall vision of the response plan developed by the Ivorian National Crisis Committee. The aim of this study was to improve laboratory service delivery systems. The analysis of results obtained using this strategy could allow us to indicate how the reorganization of sample reception was imperative in May 2020. In the response plan, it was predicted that the incidence of infection could reach 30 cases per 100,000 inhabitants, with an epidemic peak expected in April 2020, ending at 8,000 cases. This hypothesis turned out to be probable, as demonstrated by the observed disease activity from June to August.

According to the results, the highest number of samples was received in the month of June. Thereafter, a progressive decrease in the number of samples received per month was observed until August. This suggests that the epidemic peak would probably have been reached between April and June. It should also be noted that this was the first time that the IPCI faced an epidemic of such a scale, with a strong increase in laboratory activities, which justified the decentralization of activities and strengthening of resources. This has reduced the risk of contamination of people involved in the diagnosis chain as well as the spread of the virus in the environment.

Therefore, systematic decontamination of containers and samples has proven to be imperative and has shown advantages, both in terms of biosecurity and environmental protection. Since the
start of diagnostic activities, no case of staff contamination has been reported. In addition, the risk of contamination was further reduced by the activity of sample decontamination. The risk was also reduced among sample transportation agents by strengthening their biosecurity knowledge and skills as part of the IPCI initiative, in addition to following the proposals from expert reports.3

Before the creation of the sorting and decontamination group, non-conforming situations, even though they were important and diverse, could not be assessed continuously. This made it difficult to identify the contributions of sample non-compliance in the working chain. Therefore, the establishment of a documentation system was essential to compensate for this deficit. This not only allowed for quality control over nasopharyngeal samples, but also corrected certain abnormalities and ensured optimal functioning of the laboratory. Thus, the six-month sorting work brought about 12 indicators of non-compliance. Analysis of the results revealed a monthly proportion of non-compliant samples for the first month of 13.1%; this proportion fell three months later to 10.7%, with a decrease of 2.4%. In addition, the proportion of compliant samples increased from 86.9% to 89.3%, suggesting that decontamination of samples, some samples lose their self-adhesive label due to lack of protection by transparent adhesive tape. To avoid this type of error, following recommendations,3,13,14,16collection and transport officers were trained to carry out quality sampling. However, this situation contributed to the loss of certain labels; as a result, the non-compliance rate was related to labels, particularly for barcode samples.

Analysis of the MNC indicators revealed frequent irregularities for samples without information sheets (7.5% of NC). This led to rejection of the sample, because patient results cannot be available, even if a diagnosis is made. This was one of the reasons for complaints from patients who did not receive their results within the prescribed time. Another major error often encountered was related to containers whose contents were soiled due to a poorly closed sample or a crack that allowed the transport medium to flow. This abnormality was observed in 1.8% of the non-compliant samples. It increased the contamination risk of samples in the vicinity, and could therefore lead to false positives, especially in cases of defective secondary packaging.

The highest mNC indicator was the absence of label protection, as a result, the non-compliance rate was related to labels, particularly for barcode samples. This increased the contamination risk of samples in the vicinity, and could therefore lead to false positives, especially in cases of defective secondary packaging.

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to achieve a quality sample. However, the significant proportion of MCN linked to label absence (nearly 0.4%) justified the interest in protecting labels with transparent adhesive tape.

Alternately, for the MNC, the absence of an epidemiological information sheet was more common in the paper system (2.1% of MNCs from PS vs. 1.8% from LIS). These results could be linked to the fact that some packaging was poorly produced and caused a loss of epidemiological sheets during transportation. To reduce such risks and the difficulties associated with the increase in activities, including the number of epidemiological sheets that needed to be manually filed, the LIS was introduced in June 2020 to replace the PS. Despite these arrangements, 1.8% of barcode samples were not recorded in the LIS, which also revealed failures in the LIS. Ultimately, this work made it possible to remedy many non-compliant situations.

5. Conclusion

The sorting and decontamination activity of nasopharyngeal samples at the IPCI improved the management of samples by increasing the number of compliant samples by 2.4% after three months. Continuous assessment of sample quality will likely reduce the proportion of non-compliant samples and improve early diagnosis services related to SARS-SARS-CoV-2 in Côte d’Ivoire.

CRediT authorship contribution statement

Kouamé Innocent Kolia: Conceptualization, Formal analysis, Investigation, Methodology, Resources, Validation, Writing - original draft, Writing - review & editing. Kipré Bertin Guédé: Conceptualization, Formal analysis, Investigation, Methodology, Resources, Validation, Writing - review & editing. Kan Stéphane Kouassi: Conceptualization, Investigation, Methodology, Project administration, Resources, Supervision, Validation. Koby Albert Obro: Conceptualization, Formal analysis, Investigation, Methodology, Writing - review & editing. Kpadraux Danielle Odegué: Conceptualization, Investigation, Methodology, Resources, Writing - review & editing. Sylvie Mireil Sina-Kouamé: Conceptualization, Investigation, Methodology, Resources, Writing - review & editing. Banga Victor Yepri: Investigation, Methodology. Mireille Dosso: Conceptualization, Project administration, Resources, Supervision, Validation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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