How Home Anterior Self-collected Nasal Swab Simplifies SARS-CoV2 Testing: New Surveillance Horizons in Public Health and Beyond.

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Short report

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Abstract

The sample collection procedure for SARS-Co-V2 identification has a strong impact on diagnostic capability, contact tracing approach, ultimately affecting the infection containment performance. This study demonstrates that self-collected nasal-swab has shown to be a valid and well tolerated procedure to Sars-CoV-2 surveillance in a healthcare system. More significantly, no performance adequacy difference was detected in self-administered swabs between HCW and non-HCW which allows to speculate that this procedure could be successfully extended to the entire population for mass screening.

Introduction

A rapid, low cost and comprehensive SARS-CoV-2 testing strategy can provide enormous benefits to the containment effort of the current pandemic. Nasopharyngeal and/or oropharyngeal swab performed by a trained healthcare worker (HCW) is the gold standard procedure recommended by Centers for Disease Control and Prevention (CDC)[1]. This sampling approach has a high economic burden, it reduces the number of HCWs potentially available for other tasks, it fastens the depletion of personal protective equipment and exposes the HCWs to the risk of infection. Simplified specimen collection procedures including nasal swabs are recognized as valid[2,3]. Moreover, there is growing evidence of the diagnostic reliability of self-collected swabs as a low-cost alternative to HCW-collected[4]. Even though data on the diagnostic accuracy of self-collected swabs for SARS-CoV-2 testing are scarce. Recent studies were performed mostly on specific subjects' groups and on small sample sizes so that further assessment is needed before the broad implementation of these alternatives[4]. Notably, a potential extension to the general population is limited by the significant percentage of HCWs among participants and the low prevalence of positive tests[5,6].

The present study aimed to assess the adequacy of unsupervised home self-collected nasal swabs using the expression of the housekeeping gene *RNASE P* as an indicator of sampling quality performance. The study was developed in the context of the "UFFA!" project for SARS-CoV-2 hospital active surveillance through simplified sampling procedures and it provides elements to extend the approach to the general population comparing the performance of HCW with non-HCWs.

Methods

Study Design and participants

This work is a cross-sectional study, started on 6th October 2020 and ended on 16th November 2020 at Meyer Children's University Hospital (Florence, Italy).

The participants were HCWs (medical doctors and nurses) and non-HCWs (administrative personnel) working at Meyer Children's University Hospital. All participants joined the surveillance program on a voluntary basis.

Group A performed home self-collected nasal swabs. Control group (group B) received nasopharyngeal swabs performed by trained staff in the same period in the hospital dedicated swabbing center.

Sample collection procedures

Group A (self-collection): HCWs and non-HCWs received a self-swab administration kit containing: a flocked tapered swab (ESwab, Copan, Brescia, Italy) and a tube, specimen labelling and transportation material and written instructions for the anterior nasal swab execution including a link to a video tutorial designed accordingly with international guidelines[1].Self-swabbing had to be performed at home just before coming to work, possibly within 30 minutes, and the swab, contained in a three-layer packaging, had to be delivered in a dedicated box that was checked every 30 minutes by the laboratory staff.

Group B (controls): nasopharyngeal swabs were collected as recommended in international guidelines[1] from trained nurses at the hospital swabbing center.

Laboratory analysis

The presence of house-keeping gene *RNase P* and SARS-CoV-2 RNA in the samples was evaluated through quantitative reverse transcription-polymerase chain reaction (qRT-PCR), as described in international guidelines[7]. The CT of the house-keeping gene *RNase P* and the SARS-CoV-2 positivity detection rate in group A and B was compared. A further comparison was carried out, within group A, between the HCWs and non-HCWs group.

Satisfaction survey

We invited all group A participants to voluntarily answer a web satisfaction survey, including 4 items:

1. Procedure
2. Home setting
3. Time saved
4. Instructions

The intensity of the discomfort caused by the procedure was evaluated through a numeric pain scale ranging 1 to 10 both in the self-collected and staff-collected swab. Results were compared and the occurrence of adverse events was registered.

Statistical Analysis

Data were processed with StatPlus:mac, AnalystSoft Inc. v7. Results were expressed as median and interquartile ranges (IQRs), as appropriate. The Mann-Whitney U test or Kolmogorov-Smirnov Test were

used to compare group differences for continuous non-parametric independent samples. The categorical data were compared between groups using the χ2 test. P values < 0.05 were considered statistically significant.

Results

Between October 6 and November 16, 2020, 827 adults (527 women, 77% F, mean age 40.7 ± 13.1) participated in the study, 578 were HCWs (70%) and 249 were no-HCWs (29%) (group A). Group B included 1437 (977 women, 68% F, mean age 46.2 ± 11.7).

RNase P was detected in 827/827 (100%) and in 1437/1437 (100%) subjects for group A and group B, respectively. No swabs were found to be invalid.

The median CT values for the house-keeping *RNase P* were perfectly congruent in group A (self-collected swabs) and B (staff-collected swabs): respectively 23 (IQR 22.00–25.00) and 23 (IQR 21.00–25.00) (Fig. 1)

Sars-CoV-2 genome was detected in 11/827 self-collected swabs (positivity rate 1.33%) and 12/1437 staff-collected swabs (positivity rate 0.8%) with no statistically significant difference (X^2 p 0.27, OR 95% 1.58 CI 0.6928–3.59). The CT median values for N3 SARS-CoV2 were 18.5 (IQR 15.5 -25.25) in group A and 21 (IQR 16.5–28.00) in group B (Mann-Whitney U test p = 0.58). All positive self-collected swabs were confirmed positive by staff-collected swab.

Within group A, the expression of the house-keeping gene *RNase P* showed similar median CT values in self-swabs performed by HCWs and non-HCWs with congruent IQRs: respectively 23 (IQR 22.00–25.00) and 24 (IQR 22.00–25.00).

The tested subjects who participated in the survey were 490/827 (59%). Among participants, 92.5% were highly satisfied with self-collection swabbing at home (overall satisfaction score mean value 4.62 ± 0.69 SD), 99.2% of the participants stated that the procedure was easy to perform and 95.8% found the instructions very clear. One of the most appreciated aspects was the time saved, with 96.5% of participants who declared to have saved time compared to arranging an appointment for the staff-collected swab at the hospital and 95.1% were extremely satisfied of this aspect. The discomfort perceived during nasal self-swabbing was significantly lower than that perceived during staff-collected nasopharyngeal swabbing (mean values ± SD, 2.7 ± 1.6 vs 6.22 ± 1.16; Kolmogorov-Smirnov Test p < 0.0001). Two participants reported mild, self-limiting epistaxis after the procedure. No other adverse events were reported by participants after nasal swab self-collection at home.

Discussion

We demonstrated that nasal self-collected specimens were highly comparable to staff-collected nasopharyngeal specimens in terms collection adequacy and Sars-CoV-2 genome detection rates.

Considering the low prevalence of SARS-CoV-2 infection among the hospital personnel, the study would not have obtained enough positive results to validate the procedure in terms of sensitivity and specificity. This limitation, frequently encountered in literature, was overcome by using the housekeeping gene *RNase P* as an indicator of adequate swabbing performance. All specimens had detectable *RNase P*, CT values for *RNase P* and Sars-CoV2 RNA detection were almost identical in self-collected swabs compared with CT observed in staff-collected nasopharyngeal swabs. The magnitude of the CT differences, when present (Group A HCWs *vs* no-HCWs), was minimal (ΔCT = 1) and comparable to the difference between CT values that can be found if the same sample is analyzed twice at the same conditions.

The diffusion of anterior nasal swab home self-administration is undoubtedly time saving and allows a minor deployment of HCWs which is crucial during healthcare emergencies. This approach would reduce costs in terms of staff employed and PPE used, allowing at the same time an easier access to the test and thus enhancing contact tracing and reducing the risk of infection for patients and HCWs. Another advantage of the unsupervised home self-administration is the possibility to longitudinally follow the infectiveness of the infected home-isolated patients, saving on specific PPE, avoiding the access to the infected person's residence and therefore dramatically decreasing the risk of exposure. Previous studies have described a good accuracy of self-swabbing for influenza detection[8,9] and for Sars-CoV-2[5,6]. These results demonstrate that there is no difference between HCWs or non-HCWs in the accuracy of unsupervised home self-collected nasal swab, solving one of the major limitations[4,5] of available data and opening-up to the possibility of self-administration to the general population. Self-swabbing procedure could help screening a large number of subjects simultaneously, allowing prevalence point studies for hospital and other work settings. This procedure may play a pivotal role in simplifying and empowering active surveillance in hospital setting where extensive testing is critical to prevent SARS-CoV-2 transmission for HCWs and no-HCWs. It can be possible to speculate that this procedure could be successfully extended to the entire population for mass screening. Ongoing studies at Meyer Children's Hospital are evaluating the possibility to validate self-swabbing procedure with more rapid antigenic detection methods and whether it will be possible to apply this procedure in the pediatric population, for example as a periodic screening in the schools.

Conclusions

This study demonstrates that self-collected nasal-swab has shown to be a valid and well tolerated procedure to Sars-CoV-2 surveillance in a healthcare system. More significantly, no performance adequacy difference was detected in self-administered swabs between HCW and non-HCW which allows to speculate that this procedure could be successfully extended to the entire population for mass screening.

Abbreviations

SARS-CoV-2 : severe acute respiratory syndrome coronavirus 2

HCW : healthcare worker

CDC : Centers for Disease Control and Prevention

qRT-PCR : quantitative reverse transcription-polymerase chain reaction

CT : cycle threshold

IQRs : interquartile ranges

Declarations

Ethics approval and consent to participate

The “UFFA!” project was approved by Regional Ethical Committee of Meyer Children’s University Hospital (protocol UFFA no.222/220 approved on 01.10.2020, modified on 10.11.2020). All participants gave written informed consent prior to enrolment.

Consent for publication

All participants gave written informed consent prior to enrolment.

Availability of data and materials

Data and materials are available on request.

Competing interests

Authors declared no competing interests.

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Not applicable.

Authors' contributions

Prof Azzari, dr Resti and dr Zanobini conceptualized the study, coordinated and supervised data collection, critically revised the manuscript.

Dr Citera, dr Nieddu, dr Moriondo performed laboratory analysis and critically revised the manuscript.

Dr Guarnieri, dr Giovannini, collected data.

Dr Ricci and dr Lodi drafted the initial manuscript and performed statistical analysis.

All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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References

1. Centers for Disease Control and Prevention. Interim Guidelines for Collecting, Handling, and Testing Clinical Specimens for COVID-19. Available at: https://www.cdc.gov/coronavirus/2019-ncov/lab/guidelines-clinical-specimens.html. Accessed November 15, 2020
2. Péré H, Podglajen I, Wack M, Flamarion E, Mirault T, Goudot G, Hauw-Berlemont C, Le L, Caudron E, Carrabin S, Rodary J, Ribeyre T, Bélec L, Veyer D. Nasal Swab Sampling for SARS-CoV-2: a Convenient Alternative in Times of Nasopharyngeal Swab Shortage. J Clin Microbiol. 2020 May 26;58(6):e00721-20. doi: 10.1128/JCM.00721-20. PMID: 32295896; PMCID: PMC7269411.
3. Palmas G, Moriondo M, Trapani S, Ricci S, Calistri E, Pisano L, Perferi G, Galli L, Venturini E, Indolfi G, Azzari C. Nasal Swab as Preferred Clinical Specimen for COVID-19 Testing in Children. Pediatr Infect Dis J. 2020 Sep;39(9):e267-e270. doi: 10.1097/INF.0000000000002812. PMID: 32618933.
4. WHO. Diagnostic testing for SARS-CoV-2. Available at: https://www.who.int/publications/i/item/diagnostic-testing-for-sars-cov-2. Accessed November 15, 2020
5. McCulloch DJ, Kim AE, Wilcox NC, Logue JK, Greninger AL, Englund JA, Chu HY. Comparison of Unsupervised Home Self-collected Midnasal Swabs With Clinician-Collected Nasopharyngeal Swabs for Detection of SARS-CoV-2 Infection. JAMA Netw Open. 2020 Jul 1;3(7):e2016382. doi: 10.1001/jamanetworkopen.2020.16382. PMID: 32697321; PMCID: PMC7376392.
6. Wehrhahn MC, Robson J, Brown S, Bursle E, Byrne S, New D, Chong S, Newcombe JP, Siversten T, Hadlow N. Self-collection: An appropriate alternative during the SARS-CoV-2 pandemic. J Clin Virol. 2020 Jul;128:104417. doi: 10.1016/j.jcv.2020.104417. Epub 2020 May 4. PMID: 32403007; PMCID: PMC7198188.
7. Centers for Disease Control and Prevention. Research use only real-time RT-PCR protocol for identification of 2019-nCoV. Centers for Disease Control and Prevention (2020). Available at: https://www.cdc.gov/ coronavirus/2019-ncov/lab/rt-pcr-detection-instructions.html. Accessed November 15, 2020.
8. Esposito S, Molteni CG, Daleno C, Valzano A, Tagliabue C, Galeone C, Milani G, Fossali E, Marchisio P, Principi N. Collection by trained pediatricians or parents of mid-turbinate nasal flocked swabs for the detection of influenza viruses in childhood. Virol J. 2010 Apr 30;7:85. doi: 10.1186/1743-422X-7-85. PMID: 20433729; PMCID: PMC2873380.
9. Granados A, Quach S, McGeer A, Gubbay JB, Kwong JC. Detecting and quantifying influenza virus with self- versus investigator-collected mid-turbinate nasal swabs. J Med Virol. 2017 Jul;89(7):1295-1299. doi: 10.1002/jmv.24753. Epub 2017 Feb 27. PMID: 27943313.

Figures

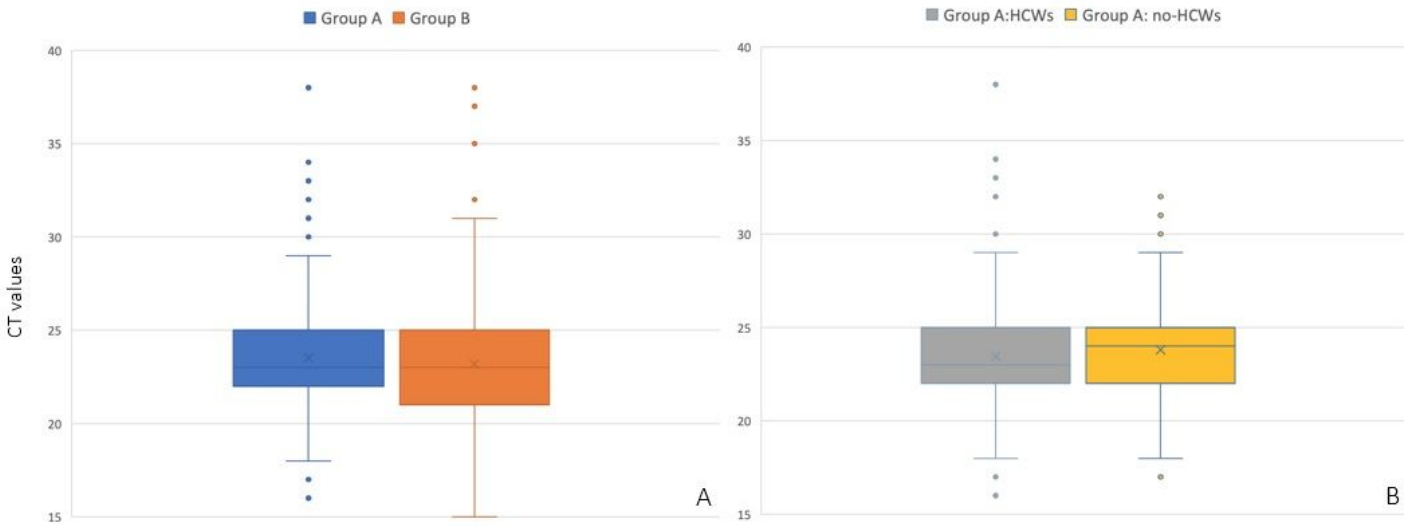

Figure 1

A) The CT median values and IQRs of house-keeping gene RNase P in group A (blue), group B (orange). B) The CT median values and IQRs of house-keeping gene RNase P group A HCWs (grey) and group A no-HCWs (yellow)