

Simulation-based training and assessment of mobile pre-hospital SARS-CoV-2 diagnostic teams in Styria, Austria

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Abstract

The World Health Organization has declared coronavirus disease 2019 (COVID-19) a pandemic. Polymerase chain reaction testing for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the diagnostic gold standard of COVID-19. We have developed a simulation-based training program for mobile prehospital diagnostic teams in the province of Styria, Austria, and performed a prospective observational study on its applicability and effectivity.

The 1-day curriculum uses theoretical instruction, technical skills training, and simulator-based algorithm training to teach and train prehospital patient identification and communication, donning the personal protective equipment, collection of naso-/oropharyngeal swabs for SARS-CoV-2 polymerase chain reaction testing, doffing the personal protective equipment, and sample logistics. Trainings were conducted at the SIM CAMPUS simulation hospital, Eisenerz, using high-fidelity patient simulation. To ensure achievement of predefined learning outcomes, participants had to undergo a final simulator-based objective structured clinical examination.

In March 2020, 45 emergency medical assistants and 1 physician of the Austrian Red Cross participated on a voluntary basis. Forty-five of the 46 participants (97.8%) completed the curriculum successfully, with mean objective structured clinical examination ratings of 98.6%.

Using several proven educational concepts, we have successfully drafted and implemented a training program for mobile prehospital SARS-CoV-2 diagnostic teams. Based on simulation-based objective structured examinations, it has prepared participants effectively for preclinical duties.

Abbreviations: COVID-19 = coronavirus disease 2019, OSCE = objective structured clinical examination, PPE = personal protective equipment, RT-PCR = reverse-transcription polymerase chain reaction, SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.

Keywords: coronavirus disease 2019, diagnostics, education, polymerase chain reaction, severe acute respiratory syndrome coronavirus 2, simulation

Editor: Oliver Schildgen.

The authors have no funding and conflicts of interests to disclose.

Supplemental Digital Content is available for this article.

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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How to cite this article: Mileder LP, Schüttengruber G, Prattes J, Wegscheider T. Simulation-based training and assessment of mobile pre-hospital SARS-CoV-2 diagnostic teams in Styria, Austria. *Medicine* 2020;99:29(e21081).

Received: 21 April 2020 / Received in final form: 29 May 2020 / Accepted: 3 June 2020

<http://dx.doi.org/10.1097/MD.00000000000021081>

1. Introduction

Coronavirus disease 2019 (COVID-19) is being caused by a novel strain of human coronavirus which has been termed severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).^[1] Its assumed basic reproductive number of 2.4 to 3.3 may be higher than the one of the seasonal influenza epidemic.^[2,3] Since the COVID-19 outbreak in Wuhan, China,^[4] more than 1.7 million COVID-19 infections and over 103,000 COVID-19 associated deaths have been reported.^[5] Given this medical urgency and COVID-19's global spread, the World Health Organization has declared COVID-19 a pandemic.^[6]

To ensure containment and early treatment, accurate and time-critical diagnosis is necessary. SARS-CoV-2 is primarily spread between humans via droplets or direct contact,^[2,7] and the diagnosis of COVID-19 is based on clinical features, epidemiological history, and pathogen detection.^[8] Although reverse-transcription polymerase chain reaction (RT-PCR) testing for SARS-CoV-2 yields a relevant number of false negative results,^[9] it is a cornerstone of COVID-19 diagnosis.

The European Society of Pediatric and Neonatal Intensive Care recommended to “ . . . simulate and try to prepare your teams as much as possible” and concretized that “every aspect of COVID patients care may benefit from simulation, particularly high risk procedures . . . but also simple procedures (such as correct use of personal protective equipment [PPE]).”^[10] In the province of

Styria, Austria, with an approximate population of 1.24 million,^[11] mobile teams consisting of emergency medical personnel from the Austrian Red Cross are in charge of SARS-CoV-2 testing in case of suspected prehospital COVID-19 infections. To ensure proper preparation, we have developed a simulation-based training program for mobile prehospital diagnostic teams in Styria and report on conceptualization, preliminary results, and our first conclusions.

2. Methods

To assess applicability and effectivity of the simulation-based training program, we performed a prospective observational study evaluating participants' pass rate and objective structured clinical examination (OSCE) results. As this was the evaluation of an educational intervention with voluntary participants, ethical approval was not required.

2.1. Simulation-based training

Contents of the curriculum include fundamentals of SARS-CoV-2 and hygienic measures, collection of naso-/oropharyngeal swabs for RT-PCR testing, use of PPE, as well as patient information and communication. If available, contents are based on current recommendations.^[12,13] The curriculum comprises a total of 375 minutes:

- 90 minutes of theoretical instruction (COVID-19 and hygiene),
- 135 minutes of technical skills training (hand hygiene, preparation and collection of naso-/oropharyngeal swabs, and donning/doffing the PPE),
- 90 minutes of simulator-based algorithm training emulating the whole process from prehospital patient identification and communication, donning the PPE, collection of naso-/oropharyngeal swabs, doffing the PPE, to sample logistics such as correct labelling, and
- a total of 60 minutes for simulation-based assessment using an OSCE focusing on self-protection, proper hygiene, swab collection, and patient communication.

The detailed schedule of the curriculum is presented in Appendix 1, <http://links.lww.com/MD/E527>.

To optimize learning outcomes, we included a peer-learning element into the algorithm training part of the curriculum. During this session, participants worked in pairs of 2 and had to

1. don the PPE,
2. collect a nasopharyngeal swab,
3. doff the PPE, and
4. handle the probe correctly.

The observing participant was provided with a standardized checklist, had to check the peer's individual performance and to deliver feedback based on the checklist evaluation.

Main learning goals of the curriculum were correct use of PPE and collection of naso-/oropharyngeal swabs for RT-PCR testing, as recommended.^[12,13] An additional learning goal was to limit the exposure time in the patient room to minimize the actual risk of a COVID-19 infection. Algorithm training also included dealing with complications such as epistaxis after nasopharyngeal swab collection or syncope due to vagal nerve stimulation.

2.2. Objective structured clinical examination (OSCE)

For the OSCE, participants had to individually prepare sample material, don the PPE, inform the simulated patient about the procedure, collect an oropharyngeal swab properly, doff the PPE while avoiding recontamination, and take care of the collected sample in a single step. To emulate reality, the OSCE was delivered as a full process simulation and not as isolated examinations of single skills. To allow participants to finalize all tasks, we had planned 15 minutes of examination time per participant. OSCEs were supervised and assessed by faculty, that is, an anesthesiologist (TW) or infectious diseases specialist (JP) and a senior lecturer in nursing science (GS), using a standardized assessment form consisting of 14 items with a maximum of 28 points (Appendix 2, <http://links.lww.com/MD/E528>). A minimum of 18 points (>64%) was necessary for successful completion of the OSCE. Following participation in the OSCE, trainees received direct feedback on their individual performance and specific suggestions for improvement.

2.3. Training and objective structured clinical examination setting

Training and OSCE took place at a former hospital in Eisenerz, Styria, which is now being used exclusively as a simulation hospital (SIM CAMPUS). On an area of 4000 square meters, a highly realistic clinical setting allows for an immersive educational experience. Algorithm trainings and OSCEs were delivered using simulators with a high degree of technical fidelity (eg, direct patient speech, visible breathing efforts, and realistic airway anatomy) in rooms resembling a private home.

2.4. Statistical analysis

We used Microsoft Excel 2015 (Microsoft Corporation, United States of America) for descriptive data analysis. Numerical data are presented as absolute and relative values or mean value \pm one standard deviation, as appropriate.

3. Results

Between the introduction of the curriculum on March 2nd, 2020, and March 22nd, 2020, 7 trainings have been delivered. Forty-six persons (37.0% female) have attended the training program, all on a voluntary basis. Of the participants, 45 (97.8%) were emergency medical personnel and 1 (2.2%) was a practicing physician being actively engaged with the Austrian Red Cross. So far, 45 participants (97.8%) have completed the curriculum successfully. Mean OSCE ratings were 27.6 ± 0.8 points.

4. Discussion

We have successfully conceptualized and implemented a simulation-based training program for mobile prehospital SARS-CoV-2 diagnostic teams. Aiming at optimizing learning outcomes, we have combined theoretical instruction and practical training. From a theoretical educational perspective, trainees undergoing the presented curriculum have their existing knowledge challenged (dissonance), refine their knowledge and skills through completion of tasks, test and retest hypotheses in action, are then offered feedback, and finally reflect upon the process during the consolidation phase.^[14] In this model of adult learning by Taylor et al,^[14] simulation-based methodologies offer participants safe training opportunities to develop, test, and

refine new concepts (ie, cognitive knowledge and skills proficiency).

We have included further educational strategies such as repetitive practice, cognitive interactivity, multiple learning strategies, and dedicated feedback into our curriculum, all of which should improve the effectiveness of the educational intervention.^[15] Participants had to repeatedly don/doff the PPE and to collect naso-/oropharyngeal swabs for RT-PCR testing. Cognitive interactivity, that is, “training that promotes learners’ cognitive engagement”^[15] was achieved through hands-on practice, multiple repetitions, task variation, and multiple learning strategies such as theoretical instruction, interactive skill demonstration, technical skills training, and simulator-based practice. Through learning and reflective feedback offered by peers, we expect an increase in learner engagement, which is a crucial aspect of effective learning.^[16] A systematic literature review found positive results in 7 of 8 included studies evaluating the use of peer feedback for the development of professional behavior at the undergraduate level, concluding that “peer feedback in collaborative learning is feasible and may be useful”.^[17]

Assessment can be understood as the measurement of learning outcomes and is “the DNA of any formal education”.^[18] To formally assess procedural proficiency and communication skills following our simulation-based training (ie, level 3 “shows how” on the learning assessment pyramid^[19]) and to minimize assessment bias, we have used a practical assessment with standardized, predefined learning goals in the form of an OSCE. According to Norman^[20] “the objective structured clinical examination . . . has come to dominate performance assessment” and OSCEs may be best suited to identify poor performance.^[21]

Although all of our participants had undergone formal emergency medical training, we observed that structured theoretical and practical instruction in current hand hygiene guidelines^[22] was an essential part of the program. Using a fluorescent-marked solution and ultra-violet light, participants were offered direct visual feedback on the quality of their hand hygiene technique and, thus, could improve on their performance.

Doffing the PPE is associated with a relevant number of contaminations (2.2 incidents per person), and removal of the respirator has been identified as the most vulnerable process.^[23] This is in accordance with our findings, as the majority of participants experienced problems with simulated self-contamination. Repetitive training may be one strategy to reduce the risk of self-contamination when doffing the PPE and, therefore, every training participant was asked to don and doff the PPE completely at least 3 times during our 1-day training program.

The majority of participants have successfully completed the training program according to our simulation-based objective structured assessment. Still, we can only speculate about the transferability of knowledge and skills into real practice. On the other hand, evidence suggests that skills acquired in the simulated environment can be translated to actual patient care.^[24–26] Terry et al^[27] actually showed that summative OSCE scores were strongly related to clinical performance. Furthermore, based on a personal communication (March 28th, 2020) with Professor H. Kessler, MD, head of our local laboratory for molecular diagnostics, the quality of the collected oropharyngeal swabs has been very good so far.

4.1. Limitations

We report on a recently introduced and on-going training program with a limited number of participants. Given this

limitation, we have so far not been able to assess reliability and validity of our OSCE assessment form systematically. In addition, the schedule of the curriculum did not allow for a pretraining evaluation of skills and although, to our knowledge, none of the participants had actual practical experience in donning/doffing the PPE and naso-/oropharyngeal swab collection, we can only speculate about the impact of prior education.

5. Conclusions

The described 1-day training program for mobile prehospital SARS-CoV-2 diagnostic teams has been conceptualized according to current best practices in simulation-based medical education. Its implementation was successful and has prepared participants effectively, as shown by simulation-based objective structured examinations.

Acknowledgments

We would like to thank Sonja Riegler, nurse and simulation trainer at SIM CAMPUS GmbH, for her assistance with program development and execution.

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