

Use of TestChest during Covid-19 pandemic

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1. Introduction

When the Covid-19 pandemic became a declared emergency in Switzerland, the Institute of Patient Safety and Simulation of the state of Grisons, Switzerland (GRIPS, Graubündner Institut für Patientensicherheit und Simulation) was commissioned to create training programs for teaching applications of respiratory care for Covid-19 patients. This included safe use of intensive care ventilators, non-invasive ventilation techniques (NIV) and high flow oxygen therapy. In addition to the basic skills of using those techniques, participants should learn how patients will respond – or not respond.

2. Lung simulator design

GRIPS owns a fully featured TestChest® and a NASCO Life/form® Advanced "Airway Larry" Airway Management Simulator. Both devices were combined to create a lung simulator suitable for invasive and non-invasive respiratory therapy. Based on information from the on-site ICU as well as international recommendations (Gattinoni L, Chiumello D, Caironi P, Busana M, Romitti F, Brazzi L, Camporota L: COVID-19 pneumonia: different respiratory treatment for different phenotypes? (2020) Intensive Care Medicine; DOI: 10.1007/s00134-020-06033-2), three (3) Covid-19 «patient types» were simulated:

- Patient 1, initial stage and responding to high-flow oxygen therapy.
- Patient 2, Type H Covid-19 patient, paralysed to reduce the impact of respiratory activity on lung tissue
- Patient 3, Type L Covid-19 patient

These cases were used in the trainings. The respiratory care devices were chosen to match availability in the departments/hospitals of the participants.

3. Implementation and goals of training

All participants shall know the potential infection pathways and the principles of protecting staff in connection with high-flow oxygen therapy, NIV and invasive ventilation.

All participants shall learn how to apply and control high flow oxygen therapy, NIV and invasive ventilation, particularly when treating Covid-19 patients.

After the training, all participants shall be competent to use and apply the devices available in their departments.

At the onset of each training, a brief presentation was given to provide participants with the physiologic and pathophysiologic know-how of respiratory support in Covid-19 patients. The then-valid recommendations to treat Covid-19 patients were highlighted.

The high flow oxygen therapy training session was started by explaining the function of the respiratory care device. Thereafter, the participants could explore different flow-rates and how they affect the end-expiratory pressure and oxygen concentrations. They could immediately experience the impact on arterial oxygenation saturation as provided by the pulse-oximeter connected to the finger-simulator of TestChest.

In the NIV training, the function of the respiratory care device was explained first. Thereafter, the participants could apply different levels of pressure support, CPAP levels and oxygen concentrations. Again, they could experience the impact of their settings on arterial oxygenation saturation as provided by the pulse-oximeter connected to TestChest.

The invasive ventilation training session was started with a thorough introduction to the ventilators used by the participants. Thereafter, the participants could apply different ventilation settings and find optimal settings for Covid-19 patients for both type H and L. The interpretation of ventilatory curves and the impact on arterial oxygenation was part of the training and experience.

4. Results

4.1. High flow oxygen therapy

All participants, nurses and physicians were new to high-flow oxygen therapy. After the introduction, the participants installed the device themselves and used it directly on the simulator. Before they could start, the baseline was set with the patient having a low oxygen saturation. The participants noticed the hypoxaemia threat to the patient immediately. This created a sense of urgency to initiate high-flow therapy as quickly as possible. After initial application, the participants tried to optimize the settings. The timeline was realistic since TestChest «reacted» based on the implemented physiological models (TestChest Physiological Model, neosim Chur, Switzerland, 2017, ISBN 978-3-9524884-0-9). This response was completely autonomous and without need for the instructor to intervene in the operation of TestChest. Such ad-hoc intervention would have been technically possible, but was in no case necessary.

One problem was to show the effect on end-expiratory pressure when patients close their mouth. The NASCO «Airway Larry» is not equipped with such a

feature so the mouth had to be closed by the trainer. Such action was of course not realistic – however, the demonstration could be done and the effect on end-expiratory pressure was clearly visible.

Furthermore it was necessary to choose the right prone-size to fit the nostrils of «Airway Larry» to avoid large leaks – a fact that is present in reality.

Because TestChest acted autonomously, the trainer could do all sorts of other failures to cause a drop in arterial saturation, for example a disconnection of the oxygen hose to the device. Such incidents prompted the users to pay attention to problems not related to the patient, yet with the physiology of TestChest acting like real and putting the participants under stress to find the root cause.

The first sessions were so successful that a repetition was requested by hospital administration.

4.2 NIV

The NIV training program was targeted at pulmonary and sleep-medicine clinicians, both nurses and physicians. The principle of NIV was known to all but they needed training on a device that was new to them.

The application of the masks on the «Airway Larry» was easier than the application of the high-flow oxygen therapy. As a start, a COPD patient was simulated and yielded faster response than with high-flow oxygen therapy.

The trainer challenged the participants by non-clinical incidents again with TestChest reacting accordingly. This put stress on the participants to find the cause of the problem, to eliminate it and to confirm resolution of the problem.

4.3 Invasive Ventilation

The participants of this program were clinicians trained in anesthesia and intensive care medicine, physicians and nurses. The ventilators used were known to some but not to all of them.

Prior to simulation, the participants were briefed on the principles of lung-protective ventilation in ARDS patients. During the session, the two different types of Covid-19 patients were simulated in the chronological order, Type H and Type L. Participants could explore different settings on TestChest which responded autonomously.

As part of the training, different devices and different settings were explored. The participants were impressed by the fact that there can be major differences between ventilators at apparently the same settings.

5. Feedback

The participants were impressed by the autonomous reaction of TestChest. They all agreed that without such autonomous reaction, the ambitious goals of the training would have not been achievable. Of particular mention was that it was possible to explore different settings on the «same» patient and actually compare outcome.

The trainers were impressed by the real-time and physiological reactions of TestChest. The autonomous function enabled the trainers to immediately answer to the needs of the participants without having to «fudge» the simulator. Such possibility is unprecedented.

6. Conclusions

The literally unlimited possibilities of TestChest and its clinically plausible reaction to adequate respiratory support as well as inadequate support makes this simulator an indispensable tool to train respiratory care. Combined with an intubation head, the set-up used was very realistic. Resistance, compliance, lung volumes and other respiratory system parameters can easily be set to represent desired pathologies. TestChest does the simulation accordingly, and automatically, and can thus be used even by inexperienced simulation-trainers.

The cases used were provided by neosim as part of the package. However, and although the cases provided were highly realistic, trainers should ultimately become familiar with the settings of TestChest to create their own cases.

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