

SUPPLEMENTAL DIGITAL CONTENT

Preparedness and Reorganization of Care for Coronavirus Disease 2019 Patients in a Swiss Intensive Care Unit: Characteristics and Outcomes of 129 Patients

Steve Primmaz, M.D.^{1*}; Christophe Le Terrier, M.D.^{1*}; Noémie Suh, M.D.^{1*}; François Ventura, M.D.^{1,2};
Filippo Boroli, M.D.¹; Karim Bendjelid, M.D.¹; Sara Cereghetti, M.D.¹; Raphaël Giraud, M.D.¹;
Claudia Heidegger, M.D.¹; Deborah Pugin, M.D.¹; Nils Siegenthaler, M.D.¹; Didier Tassaux, M.D.¹;
Jean-Clément Cabrol, M.D.¹; Nathan Dolet, M.D.⁵; Christoph Ellenberger, M.D.²; Gleicy Keli Barcelos, M.D.²;
Marc-Joseph Licker, M.D.²; Georges Savoldelli, M.D.²; Eduardo Schiffer, M.D.²; Angèle Gayet-Ageron, M.D.³;
Laurent Kaiser, M.D.⁴; Martin R. Tramèr, M.D.²; Jérôme Pugin, M.D.¹

*Contributed equally to this work

¹Division of Intensive Care; ²Division of Anaesthesiology; ³Clinical Trial Unit, Division of Clinical Epidemiology; ⁴Division of Infectious Diseases, Geneva University Hospitals and the University of Geneva Faculty of Medicine, Geneva, Switzerland

⁵ Department of Research, Department of Pediatric Surgery, University Hospital of Caen, France.

Corresponding author

Jérôme Pugin, M.D.

Division of Intensive Care

Geneva University Hospitals

4 Rue Gabrielle-Perret-Gentil

1211 Geneva 14, Switzerland

Tel.: +41 79 553 2207

E-mail jerome.pugin@unige.ch

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Figure S1 Intensive care unit reorganization plan

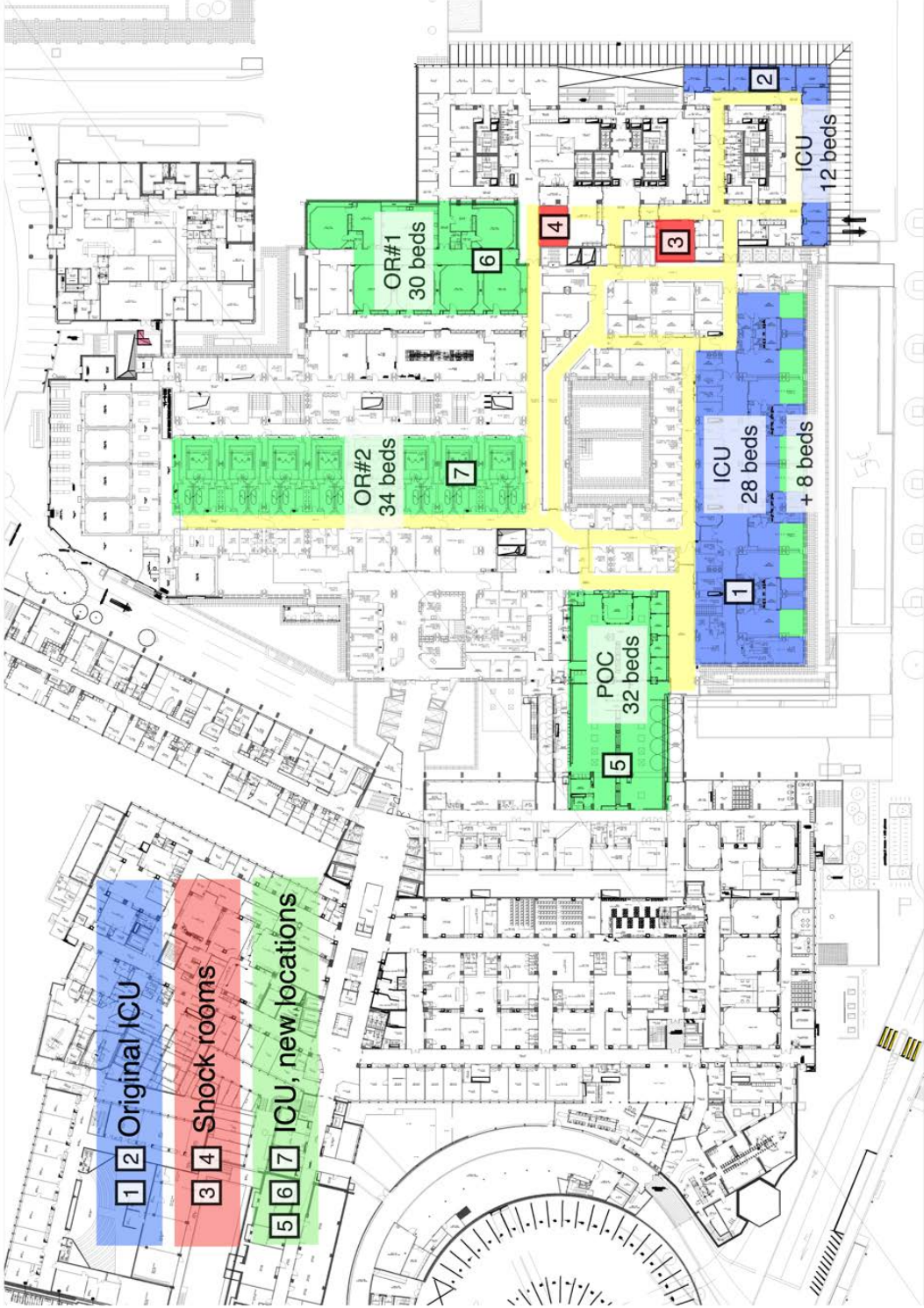


Figure S1 Intensive care unit reorganization plan
 The ICU expanded to other nearby locations. The total number of ICU beds was 110 (ICU, IMC, PACU, OR#1).
 Further plans included OR#2 for 34 supplemental beds
 ICU intensive care unit, IMC surgical intermediate care unit, POC post-operative care unit, OR operating rooms

Figure S2 Temporal increase of staff compared to bed occupancy

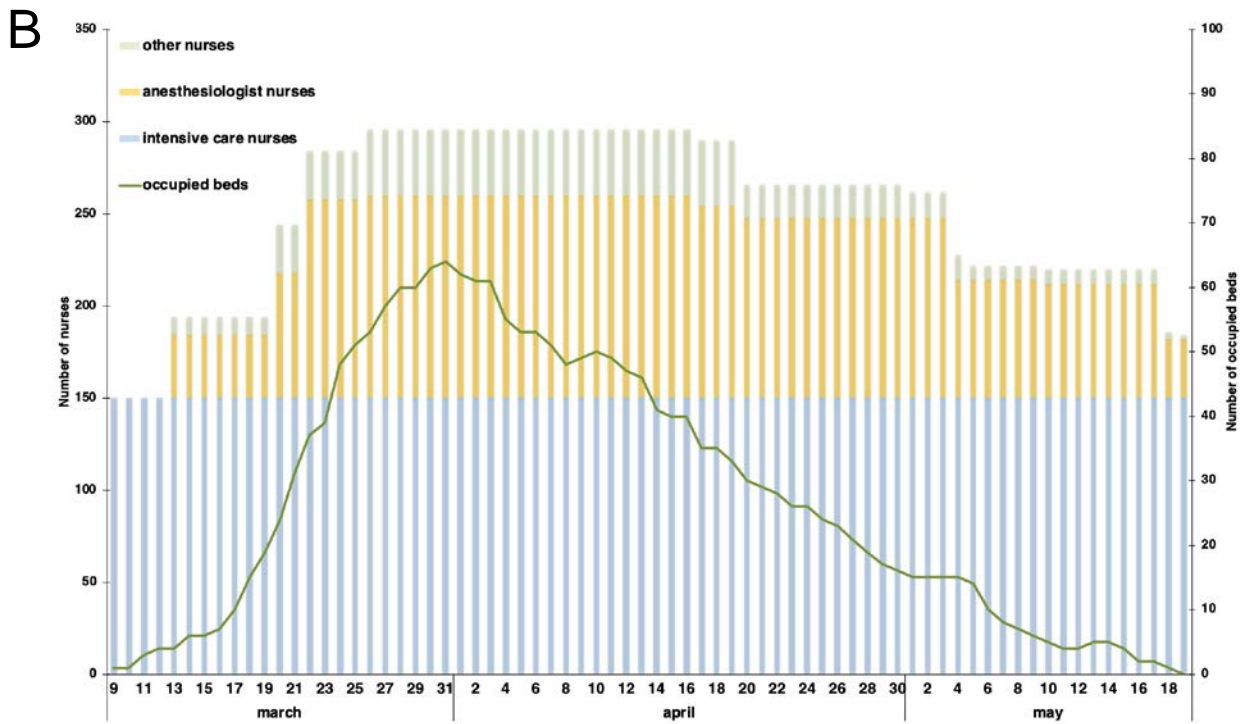
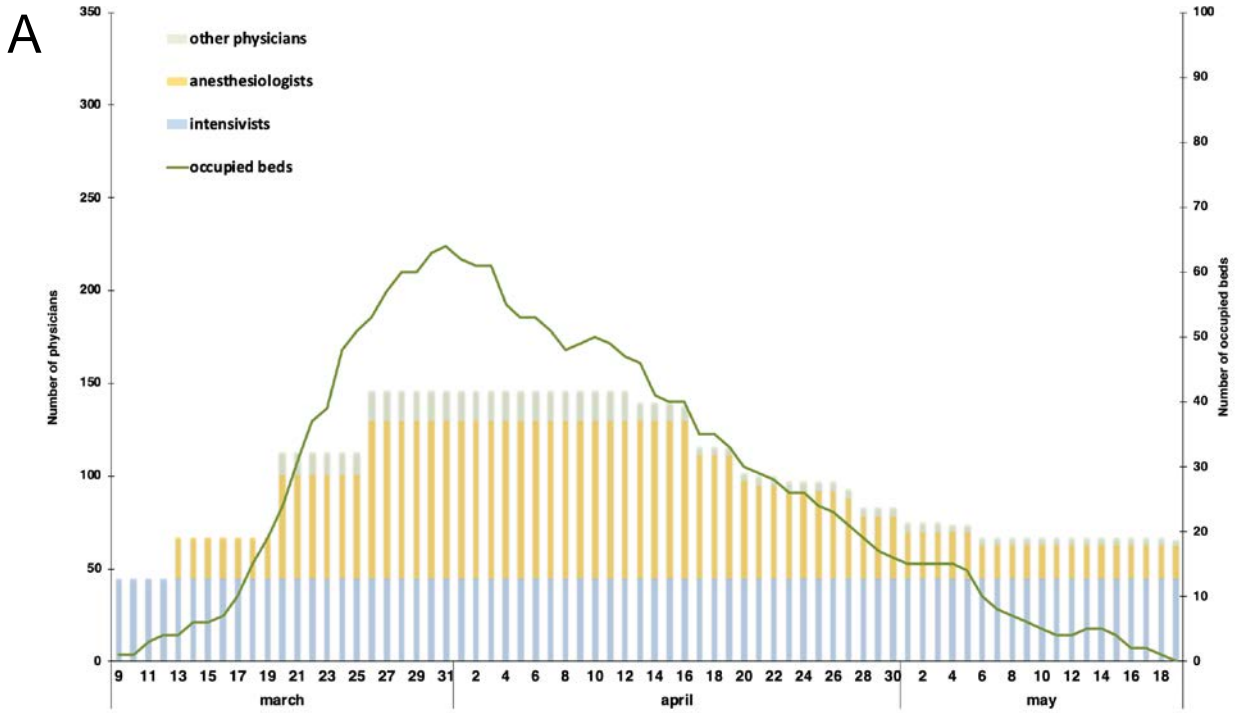


Figure S2 Temporal increase of staff compared to bed occupancy

a Number of physicians and tools beds occupied by COVID-19 patients in ICU

b Number of nurses, assitant nurses and total beds occupied by COVID-19 patients in ICU

Intensive care unit ICU Preparedness

Reorganization

The University hospitals of Geneva is one of the five university hospitals in Switzerland. The hospital has 1000 beds, a 30-bed medical and surgical intensive care unit (ICU), several intermediate care units totaling 50 beds.

The strategic plan decided at the beginning of March 2020 consisted in separating non-COVID-19 from COVID-19 patients while increasing bed capacity. Non-COVID-19 and suspected COVID-19 patients were allocated to unit 2 (12 bed-unit) in individual patient rooms. After receiving SARS-CoV-2 confirmation, intubated patients were moved to unit 1 (28 beds) where bed density was increased, adding 8 beds to the unit capacity. Non-COVID-19 patients that could not be treated in unit 2 were dispatched from the emergency division to a private hospital in Geneva, “La Tour” Hospital, which increased its ICU bed capacity 14 beds for non-COVID-19 patients.

A surgical intermediary care facility, as well as a large postoperative care facility, located close to the original ICU were converted and equipped within 48 hours to receive 30 additional ICU patients in large, open-space rooms. All elective surgery was interrupted and redirected to surrounding private hospitals, allowing anaesthesia staff to be re-allocated to the ICU. Each operating room (OR) was equipped to receive between 4 to 6 patients, adding 30 more ICU beds. A second operating zone (OR#2) was also equipped to receive 34 more patients, but in suboptimal conditions due to insufficient medical and nurse staffing. Finally, the maximal effective capacity of ICU beds was 110 and 144 in suboptimal conditions.

In the expanded locations, many beds were equipped with anaesthesia ventilators that were later changed with ICU ventilators (HAMILTON-T1 transport ventilator, Hamilton Medical AG®, Switzerland) obtained from the Swiss army.

Retired healthcare workers (HCWs) older than 65 years were not asked to come back to work in the ICU. Medical physicians, nurses, assistant nurses and physical therapists worked in 12.5-hour shifts. Patient care was organized in cells of 8 to 10 COVID-19 patients. Each cell was staffed with one ICU or anaesthetist fellow, one resident, at least one ICU specialized nurse, four nurses and two assistant nurses; one physical therapist was allocated to two cells. One attending physician, intensivist or anaesthetist supervised two cells and led daily bedside rounds for all patients. A 1-hour open session was held daily by the head of the ICU to review all COVID-19 cases. Thirty-six final-year medical students volunteered and were trained and employed for various functions in the ICU, including patient care, data collection and clinical research. Thirty Swiss army soldiers were also recruited and helped for manual tasks, as well as for passive mobilization and prone positioning of intubated patients.

The hospital COVID-19 organization included wards for patients with pneumonia requiring oxygen, and intermediate care units for patients requiring up to 80% of inspired oxygen on high-flow nasal oxygenation or continuous positive airway pressure without signs of respiratory failure.

Prevention and control of infection.

HCWs in the ICU COVID-19 units wore surgical garments, gloves, plastic glasses and surgical masks. FFP2 masks were used when HCWs were exposed to the patient's mouth and airways, during disconnection of the endotracheal tube, ventilator tubing and humidifiers, or when they were taking care of extubated patients within a 3-meter circle.[E1] HCWs with symptoms were asked to get a nasopharyngeal swab for SARS-CoV-2 PCR testing and were confined at home in case of positive results for 10 days or 2 days after the disappearance of symptoms.

Surveillance, diagnosis, and treatment of nosocomial infections.

Patients were followed daily by the clinical staff together with an infectious disease specialist. Superinfections were diagnosed using usual clinical, radiological and microbiological data, and motivated the addition or changes of antimicrobial therapies. When bacterial ventilator-associated pneumonia (VAP) was suspected, a mini-bronchoalveolar lavage (BAL) was performed (protected blind double catheter, Combicath®, Prodimed®, France) with quantitative bacterial cultures. VAP was diagnosed when Clinical Pulmonary Infection Score was superior to 6 points with quantitative culture of more than 10^3 bacteria/mL in mini-BAL fluid.[E2,E3] Antibiotic de-escalation was part of protocolized care in the case of negative microbiological results.

A VAP bundle was used.[E3] All patients were intubated using a Hi-Lo EVAC endotracheal tube (Shiley™ Evac Oral Tracheal Tube, SealGuard™, Murphy Eye, Covidien™, USA) with subglottic secretion drainage. Three to 5 mL of a suspension of topical antibiotics containing tobramycin, colistin and amphotericin B (selective oropharyngeal decontamination [SOD]) was instilled *via* the subglottic catheter every 8 hours.

All patients received an initial intravenous course of systemic antibiotic therapy with amoxicillin/clavulanic acid. De-escalation was based on procalcitonin levels on days 1 and 2, microbiological surveillance with tracheal aspirates, mini-BAL in the case of suspicion of VAP, and daily rounds with the infectious diseases attending physician.

References

- E1. Anfinrud P, Stadnytskyi V, Bax CE, Bax A (2020) Visualizing speech-generated oral fluid droplets with laser light scattering. *N Engl J Med*; <https://doi.org/10.1056/NEJMc2007800>
- E2. Landelle C, Nocquet Boyer V, Abbas M, et al (2018) Impact of a multifaceted prevention program on ventilator-associated pneumonia including selective oropharyngeal decontamination. *Intensive Care Med* 44(11): 1777–1786. <https://doi.org/10.1007/s00134-018-5227-4>
- E2. Pugin J, Auckenthaler R, Mili N, et al (1991) Diagnosis of ventilator-associated pneumonia by bacteriologic analysis of bronchoscopic and nonbronchoscopic “blind” bronchoalveolar lavage fluid. *Am J Respir Crit Care Med* 143(5):1121–1129. https://doi.org/10.1164/ajrccm/143.5_Pt_1.1121

COVID-19 specific ICU Protocols

Protocol 1 - Admission criteria for intensive care

PRINCIPLES and THERAPEUTIC LIMITATION

As part of the COVID-19 pandemic, the SAMS and the IDSS have published guidelines regarding admission and non-admission criteria for all COVID-19 and non-COVID-19 patients to intensive care.

(<https://www.assm.ch/fr/Ethique/Apercu-des-themes/Medecine-intensive.html>, accessed April 23, 2020)

The following criteria apply in a Level A situation: (intensive care beds available, but limited capacity)

Absence of the following non-admission criteria:

Level A

- Patient's decision against ICU admission (advance directives, etc.)
- Un-witnessed circulatory arrest, recurrent circulatory arrest, circulatory arrest without cardiopulmonary resuscitation (CPR)
- Oncological disease with a life expectancy <12 months
- Terminal neurodegenerative disease
- Severe and irreversible central neurological impairment
- Chronic disease:
 - New York Heart Association (NYHA) stage IV heart failure
 - Chronic obstructive pulmonary disease (COPD) GOLD 4 (D)
 - Child-Pugh stage liver cirrhosis >8
 - Severe dementia
 - Severe circulatory insufficiency refractory to initial treatment
- Estimated survival <12 months

➤ **If one of the non-admission criteria is met, the patient will not be admitted to intensive care.**

These same criteria apply for admission to the intermediate care wards for the hospitalization of a patient with infectious dyspnoea.

INTERMEDIATE CARE admission criteria

FiO₂ > 50% and SaO₂ <90% without signs of severe respiratory failure

- Usual admission criteria for other pathologies in a COVID+ (or suspected) patient.
--

➤ **Procedure for admission to intermediate care:**

Consultation Call 2.../ Bed management Call 3...

INTENSIVE CARE admission criteria

- **Needing hemodynamic support with vasopressor drugs (NE equivalent dose > 0.1 µg/kg/min)**
- **Needing invasive mechanical ventilation (intubated patient or patient at high risk of intubation), according to the criteria below:**

<u>From a hospital care unit or from pre-hospital care context</u>

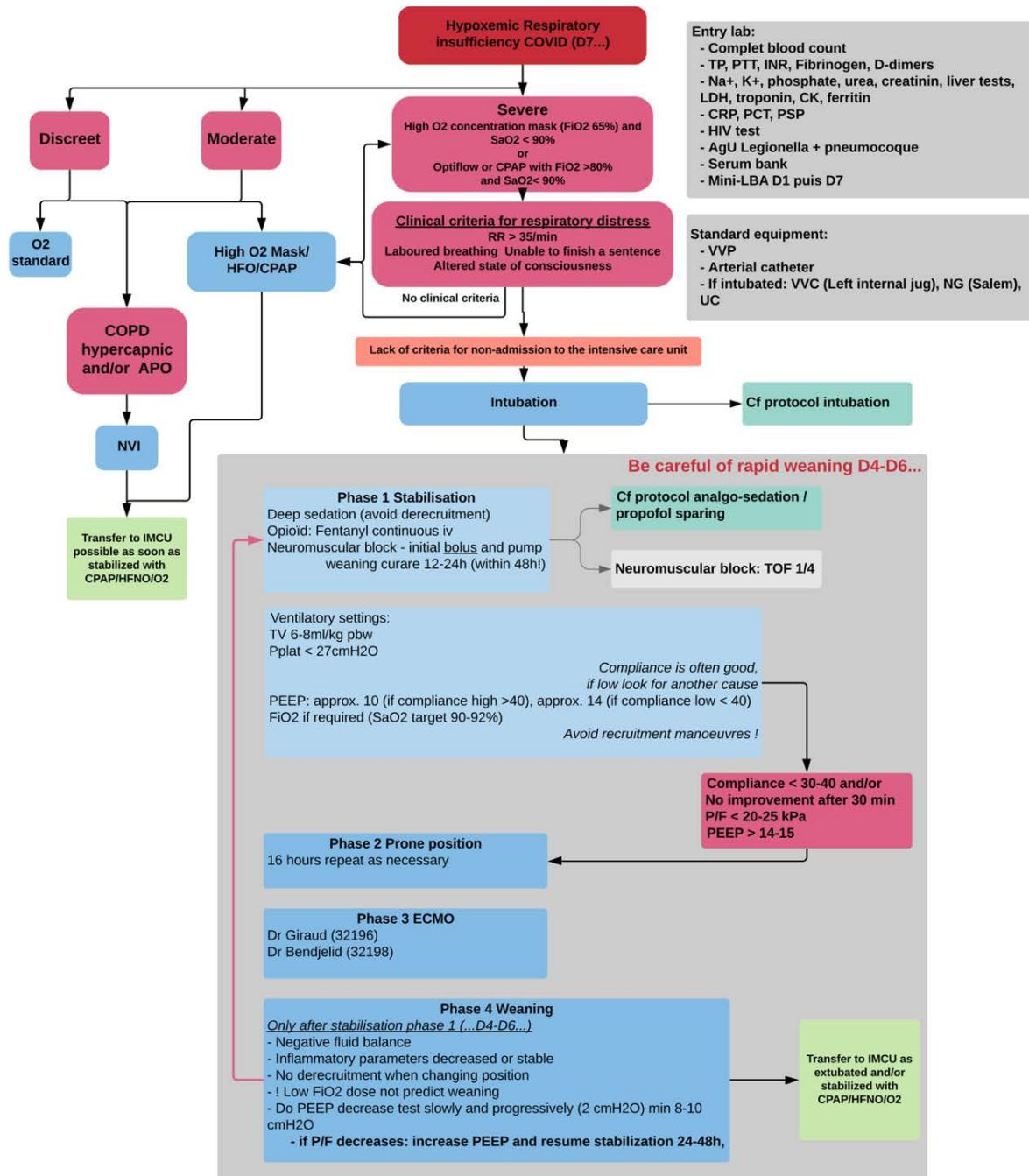
- FiO₂ > 50% and SaO₂ <90% with signs of severe respiratory failure
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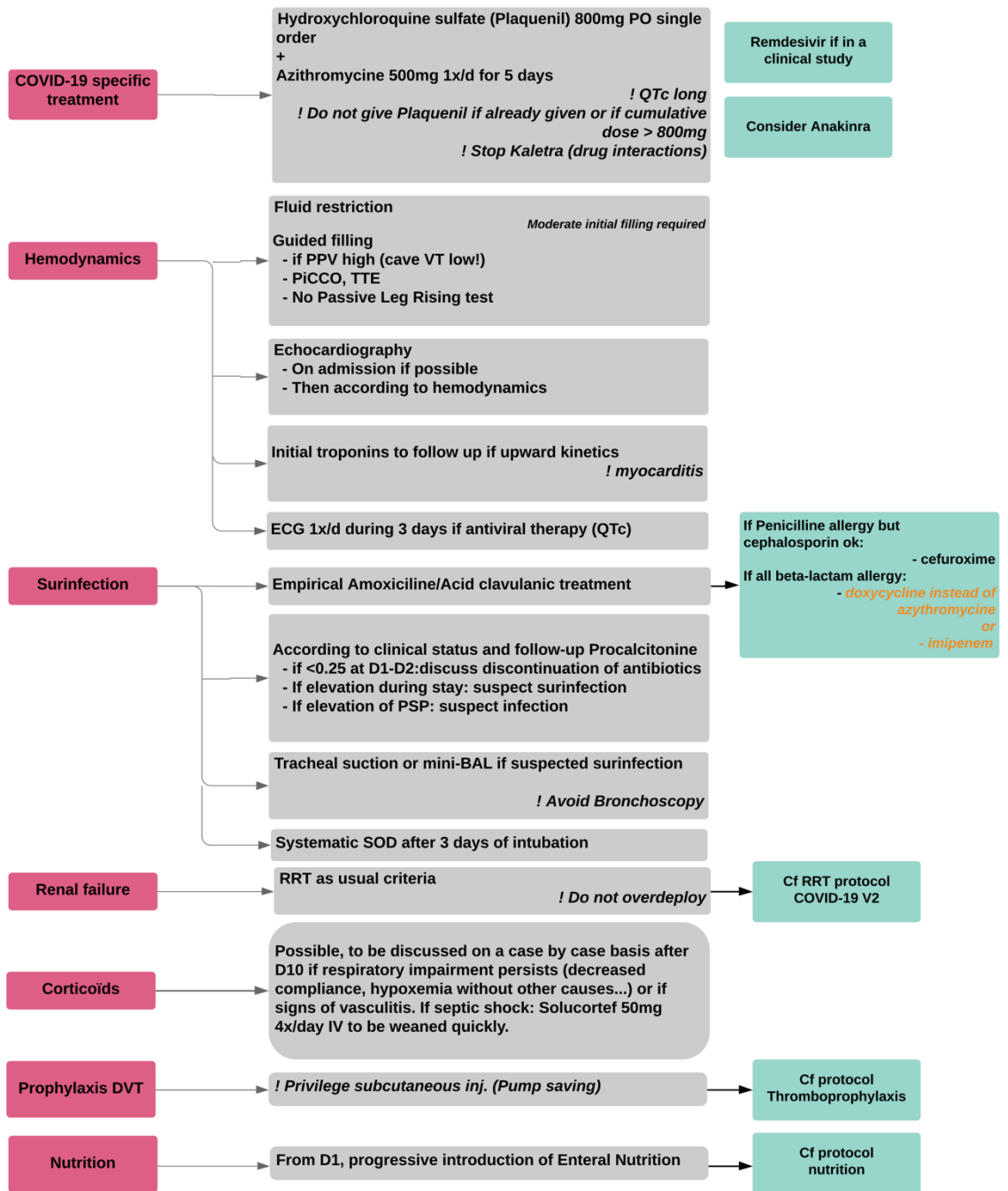
<u>From an intermediate care unit or emergency department</u>
--

- OptiFlow® or CPAP with FiO₂ > 80% and SaO₂ <90% with signs of severe respiratory failure

- **Procedure for admission to intensive care:**
Intensive Care Consultation Call 3... for any patient whose respiratory condition is deteriorating and who has no criteria for non-admission.

Protocol 2 – ICU guidelines





Protocol 3 - Oxygen therapy and airway management

1. Basic principles

- Limit the number of intervenors in the room to the strict minimum during these procedures.
- Anticipate the necessary equipment and the roles of each intervenor.

2. Protective equipment

Any person present in the room during these procedures must wear the following protective equipment

- Surgical gown and cap
- Gloves
- FFP2 mask
- Protective goggles

3. Oxygen therapy and non-invasive ventilation

In general, the use of high-flow nasal oxygenation (HFNO) and non-invasive ventilation (NIV) in these patients implies the implementation of the protective measures mentioned above within a perimeter of 3 meters surrounding the patient. Beyond this perimeter, the wearing of a surgical mask is sufficient.

3.1 Concerning oxygen therapy with **standard nasal goggles and HFNO**

- Put a surgical mask on the patient according to tolerance.
- HFNO can be used to oxygenate hypoxemic patients.
- Favour early intubation.

3.2 Concerning NIV

- NIV should be reserved for situations of hypercapnic decompensated COPD or cardiogenic acute pulmonary oedema in the context of CoV-2 SARS infection and should not be used as supportive therapy in cases of severe viral pneumonia; in these cases, intubation should be preferred.
- Typical circuit: patient--NIV mask with good seal--corrugated connector--APHE patient filter + APHE filter also placed on the inlet to the expiratory venting circuit.

4. Intubation specifics

Airway management should be carried out by experienced personnel. Except in cases of anticipated difficult intubation or unique situations, the typical team intubating the patient should be composed of a physician anaesthetist and a specialized nurse anaesthetist. The other potential caregivers wait outside the care area and are ready to assist if necessary.

4.1 Preparation for intubation:

- Preparation of equipment outside the room/care area.
- Intubation equipment:
 - Prefer a video laryngoscope to limit exposure of the person performing the intubation or use the most practiced technique. AIRTRAQ® without a camera is strongly discouraged because of the proximity to the patient's ear-nose-throat sphere.
 - Mount a green APHE filter on the breathing circuit containing a closed suction device.
 - Prefer an EVAC orotracheal tube.
- Ventilator and its standard circuit to be prepared before induction:
 - Closed suction system
 - Corrugated connection
 - ABHE patient filter + APHE filter expiratory circuit
 - EtCO₂ sensor

4.2 Pre-oxygenation:

If NIV is used for this purpose (not recommended due to increased risk of exposure), take these precautions:

- Start ventilation only when the mask is applied without leaks and the circuit is connected.
- Prefer manual mask retention.
- Set low pressures: PEEP 5 cmH₂O, AI 8-10 cmH₂O.

If using bag and mask for pre-oxygenation.:

- Place mask first **without** gas flow
- **Once seal obtained**, open oxygen

- Help patient to maintain seal of the mask.
- Stop gas flow once loss of consciousness

4.3 Induction

Fast sequence induction.

If NIV preoxygenation is performed, NIV must be stopped before removing the mask from the patient's face.

No manual ventilation with oxygen bag/Mask. No HFNO.

4.4 After intubation

Once the intubation catheter is in place, inflate the balloon before starting ventilation directly with the ventilator.

Leaky procedures (balloon deflation, disconnection of the ventilator circuit) after intubation should be avoided. If disconnection is necessary, it should be done when the ventilator is not generating airflow. If disconnection of the ventilator is necessary: leave the APHE filter at the end of the intubation catheter for the time required for the disconnection procedure.

Be vigilant during periods of ventilation disruption!! (Set alarms!)

Protocol 4 - Protection of healthcare workers in the management of oxygen therapy

Procedure for any procedure that could generate droplet aerosolization:

- HFNO, CPAP, NIV
- Tracheal intubation, invasive ventilation and extubation
- Bronchoscopy and bronchial aspiration, naso- or oropharyngeal smears and ear-nose-throat care

Any person present in the room during these procedures must wear:

- Surgical gown and cap
- FFP2 mask
- Protective goggles

Dressing procedure, in the following order:

1. Alcohol-based hand rubbing
2. Surgical cap
3. Protective goggles
4. Protective mask FFP2 applied tightly to the nose
5. Surgical gown* with closed belt and without internal closure; hair covering
6. Non-sterile gloves: no visible skin between gown and gloves.

**For COVID "units" and COVID suspected case:*

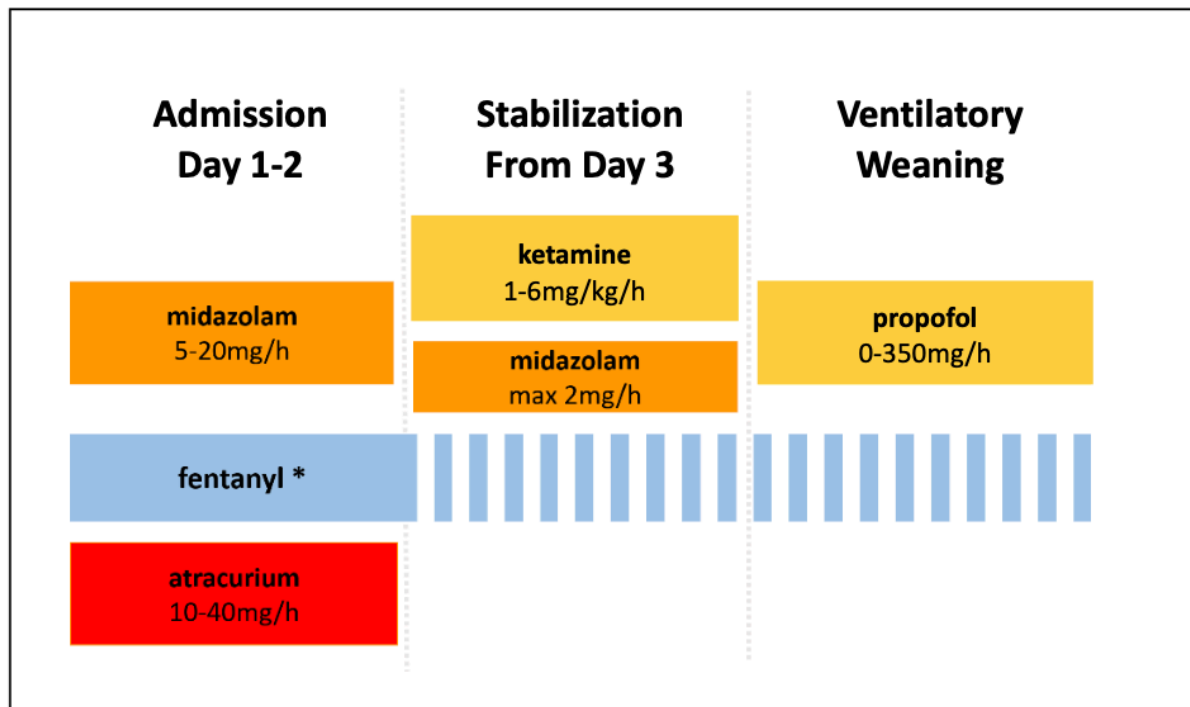
- *Surgical gowns may be kept within the care area.*
- *Mandatory change of gown in case of soiling.*
- *Gloves must then be changed and hand disinfection with an alcohol-based hand rub solution must be carried out before putting on other gloves.*

Removal procedure should be carried out in the following order, with disposed objects placed in the black bins.

1. Surgical gown and gloves
2. Alcohol-based hand rubbing
3. Glasses: (not thrown away, to be put aside for later disinfection**).
4. FFP2 protective mask and hair protection
5. Alcohol-based hand rubbing

***The disinfection of protective glasses is performed after using compresses and a 70° alcohol solution. Alcohol-based hand rubbing should be repeated after disinfection of the glasses.*

Protocol 5 – Sedation protocol in anticipation of propofol shortage



* The minimum effective dose of fentanyl should be used. Bolus administration should be favoured when starting the stabilization phase. The maximum dose of fentanyl in continuous infusion should not exceed 150mcg/h.

Cave:

- Caution is recommended when prescribing Kaletra® (lopinavir/ritonavir), a potent inhibitor of CYP3A (up to 1 week after discontinuation), thus increasing plasma concentration of midazolam by 5 to 10 times.
- Dose reductions in ketamine and fentanyl could be also considered.

This protocol will be updated to match the availability of the different drugs.

Protocol 6 – Change of endotracheal tube protocol

1. Operators

Team from the shock room

- 2 experienced fellows
- 1 intern from anaesthesia or intensive care
- 1 nurse

It is the most experienced operator that leads the procedure and changes the endotracheal tube (no teaching).

The attendings responsible for the shock room and for the COVID cell in which the patient is hospitalized are informed that the change of the endotracheal tube is necessary and present near the shock room.

2. Protection of the operators

The change of the endotracheal tube procedure has the same risk of viral contamination as the intubation procedure.

- All 4 operators are fully equipped:
 - TIVEK® overall
 - FFP2 mask
 - BOLLE full-face mask
 - Sterile gloves.

3. Place: shock room or COVID cell

Consider:

- Emergency of the procedure
- Patient transport
- Team availability

When possible, the procedure should be done in the shock room. If this is not possible, the shock room team will come into the COVID cell for the procedure.

4. Patient

- Search for **previous intubation indications** (CORMACK).
- Under general anaesthesia with **profound paralysis** (non-depolarizing neuromuscular blocker)
- Use assist-control ventilation
- FiO₂ 100%, 5 minutes before starting the procedure.
- **Installation:**
 - Bed pad under the head (no pillow).
 - Bed on “HARD” mode at adjusted height for the operator.
 - Strict dorsal position.
 - Fasting for at least 6 hours (if non-urgent).
 - In all cases: aspiration of gastric content before the procedure (if a feeding nasogastric tube is in place, put a larger one for aspiration);
 - Expired CO₂ captor must be ready.

5. Material

- Difficult intubation cart in the room
- Mc Grath® video laryngoscope with enough battery
- Introducers of different sizes
- Lubricant
- Standard laryngoscope
- Paediatric bronchoscope
- EVAC® endotracheal tubes of different sizes
- Guedel airways and facial mask corresponding to the patient’s morphology
- Self-inflating bag connected to a source of high-flow oxygen (>30 l/min)
- Yankauer suction catheter

- Expired CO2 captor
- Closed tracheal suction system
- Endotracheal tube holder

6. Before the procedure

Before the procedure, the leader briefs the team and explains the role of each member. He/she describes the procedure and the successive plans (A, B, C) in case of failure to change the endotracheal tube. Before the procedure starts, all operators can ask any questions or make suggestions in order to clarify the strategy and reach a consensus.

- Draw marks for possible cricothyroidotomy on the patient's neck.
- Do a **bronchoscopy using the paediatric bronchoscope** in order to evaluate the degree of stenosis of the endotracheal tube and choose the best introducer.
- Do a nasofibroscope with the same bronchoscope to see if there is glottic oedema. In case of doubt, do a video laryngoscopy.
- If the doubt subsists and it is not an emergency procedure, call the ear-nose-throat specialist.

In the absence of glottic oedema, the procedure can be performed.

7. Procedure (see next page for details)

The procedure is done by 3 operators: one (1) doing the laryngoscopy, a second one (2) next to the bed that will manipulate the endotracheal tubes and the introducer, and the nurse (N) that will manage the ventilator.

8. Documentation of the procedure

The procedure is then fully described in the patient's medical chart, including in the "Interventions" section with the mention "procedural anaesthesia".

Procedure after steps 1 to 6

OPERATORS	PLAN A	PLAN B	PLAN C
1	Expose patient's glottis using the video laryngoscope	Failure to see the glottis	Tracheotomy*
N	Stop the ventilator		
2	Disconnect the ventilator		
2	Put the previously lubricated Cook® introducer into the endotracheal tube (without any resistance) or <i>next to the endotracheal tube</i> **		
2	Deflate the endotracheal tube's balloon		
2	Pull out the endotracheal tube leaving the introducer inside		
2	Introduce a new endotracheal tube using the introducer	1. Use a smaller endotracheal tube 2. Standard laryngoscopy using a S-Guide® introducer	
1	Intubate under videolaryngoscopic control		
2	Inflate the balloon	3. Oxygenate using the Ventrain® on the Cook® introducer	Cricothyroidotomy
1	Pull out the introducer		
2	Connect the ventilator and the expired CO2 captor		
N	Start mechanical ventilation		
ALL	Control the expired CO2		
1	Secure the endotracheal tube		
2	Examine the patient		
ALL	Ask for a chest X-ray		

* If a paediatric bronchoscope can be inserted into the endotracheal tube and if the patient has a favourable anatomy (no short neck), a percutaneous tracheotomy can be done.

** If the endotracheal tube's stenosis is too important and the introducer cannot be inserted into the tube, the introducer can be inserted next to the endotracheal tube using the video laryngoscope. The endotracheal position of the introducer can be verified using the expired CO2 captor before changing the endotracheal tube.

Protocol 7 – Tracheostomy

1. Technique:

- **Favour the percutaneous approach**
- The surgical approach may be necessary.

In all cases, the tracheostomy will be performed at the patient's bedside: NOT IN THE OR

2. General indications for performing a tracheostomy:

- D10 of mechanical ventilation.
- Ventilatory weaning not possible in the next few days (patients needing inspiratory support and/or PEEP = patients without active sedation, but still dependent on positive pressure).
- Post-intubation swallowing disorders requiring possible re-intubation.
- Laryngeal oedema contraindicating extubation.

3. General contraindications:

- Patients approaching a withdrawal of therapeutic support context: (no improvement in gas exchange beyond D 10 of orotracheal intubation, persistent state of shock, multiorgan failure, etc.).
- Refusal of the patient/family representative.
- Patients in comfort care/therapeutic withdrawal scenario.
- Non-reversible major blood coagulation disorders/severe thrombocytopenia (< 50 G/l).
- FiO₂ > 40%.
- PEEP > 10 cmH₂O.

The indication/contraindication for percutaneous tracheostomy is decided by:

- The intensive care consultant in liaison with the ear-nose-throat specialist for patients on the ICU.
- The ear-nose-throat specialist on all other wards with intubated patients in liaison with the physician in charge of the unit.

4. Organization

SEND REQUEST BEFORE 4 pm BY EMAIL TO ...@hcuge.ch (intensive care consultant), include the identity and geographical location of patients who are candidates for a tracheostomy. The ICU consultant will send an email to ...@hcuge.ch (ear-nose-throat reference person) a list of patients scheduled for tracheostomy the following day) + inform by telephone the physiotherapist on duty call 3...

→ Carry out all tracheotomies in the afternoon.

→ For patients scheduled for tracheostomy the next day, visits to be scheduled AFTER 4:00 p.m. the day before

- Schedule a blood count + platelet + clotting (TP, PTT) for the next day at 6 am.
- Stop heparin at least 4 hours before the procedure if prophylactic/6 hours before if therapeutic.
- Stop clexane at least 12 hours before the procedure (attention: renal failure and accumulation).
- Patient taking aspirin +/- other antiplatelet agents:

→ NO CONTRAINDICATION to TRACHEOSTOMY, including PERCUTANEOUS.

- Patient fasted at least 6 hours before the procedure.

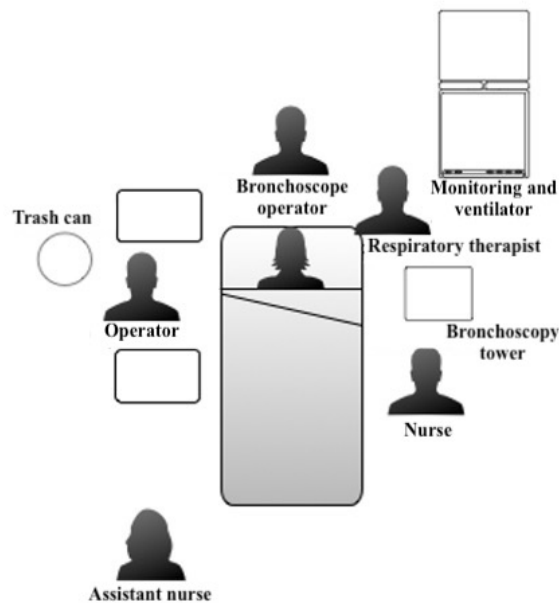
4.2 Personal equipment: (operator, bronchoscope, respiratory therapist and nurse)

- Surgical cap/orthopaedic cap
- Protective glasses
- FFP2 mask
- Sterile surgical gown
- Sterile gloves

4.3 Performing the procedure:

- General anaesthesia (hypnotics + opiates + neuromuscular blocking agents) + basic monitoring + capnometry
- 100% FiO₂
- Level dorsal position
- Shoulder cushion for cervical hyper-extension
- Arms placed along the body
- Accessible venous access (central venous access is preferred)
- Perform pre-procedure mouth care with Chlorhexamed® Mouth Care.
- Suction of tracheal secretions by nurse in charge + gastric emptying through nasogastric tube (NGT).
- In any ventilatory mode, it is necessary to increase the pressure alarm during the procedure in order to guarantee an acceptable minute ventilation.

4.4 Staff placement during the procedure



4.5 Performing the procedure:

- Operator (performs tracheostomy),
- A bronchoscope operator
- A respiratory physiotherapist (bronchoscope/ventilation management)
- A nurse (drugs, monitoring)

SPECIAL INSTRUCTIONS FOR COVID PATIENTS:



- **PUNCTURE OF THE TRACHEA WITH A SYRINGE AT THE END OF THE CANNULA (NO AIR LEAKAGE)**
- **PLACE A COMPRESS AROUND THE GUIDE ON THE TRACHEOSTOMY PORT AT EACH MANIPULATION.**
- **VENTILATION STOPS WHEN THE INTERNAL DILATOR IS REMOVED**
- **RESUMPTION OF VENTILATION WHEN THE TRACHEOSTOMY BALLOON IS INFLATED**

INTENSIVE CARE: Operators: EAR-NOSE-THROAT specialist/INTENSIVE CARE consultant.

Post-interventional intermediate care ward: Operator = ear-nose-throat specialist. Bronchoscope operator = anaesthesiologist

- **Obligatory chest X-ray after the procedure.**
- **Resume anticoagulation 4-6 hours after the procedure according to the operator's instructions.**

5. Transfer of tracheostomy patients to the intermediate care ward:

Anticipate the day before, (prevent IAG: consult "continuous care" (call 3...) and regulations concerning "respiratory support" in pneumology (call 3... or 3...).

- Awake, calm, collaborating patients (no continuous intravenous sedation): SAS 3-4
- Spontaneous breathing
- $FiO_2 < 40\%$.
- $EN < 25 / \text{min}$
- $PEEP < 6 \text{ cmH}_2\text{O}$
- $AI < 10 \text{ cmH}_2\text{O}$

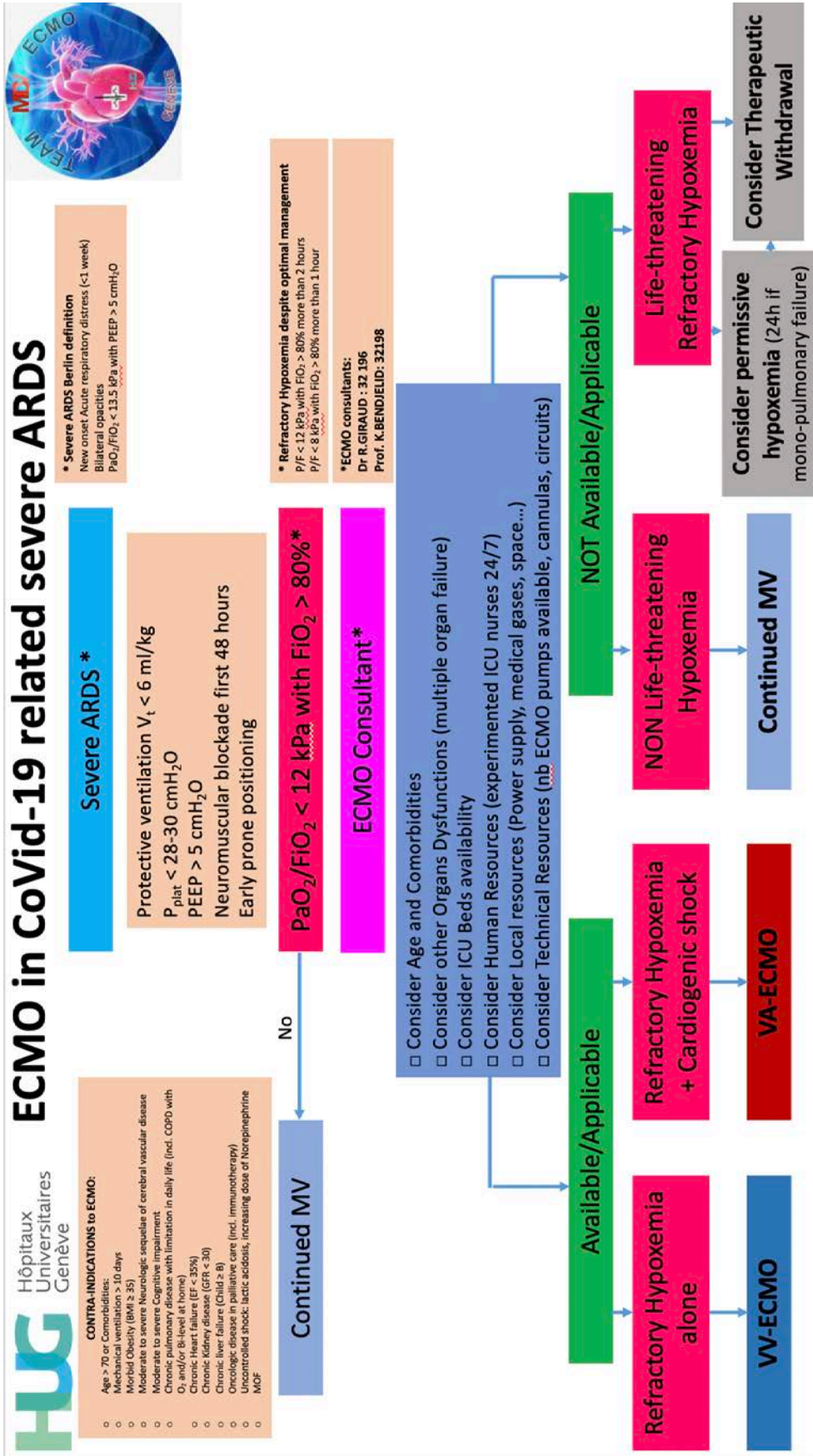
- Secretions kept to a minimum (tracheal aspiration > 4 hours)

Medical consultation of the ear-nose-throat specialist to the continuing care wards each morning in order to evaluate and supervise cannula weaning of tracheotomized patients on the unit.

Procedure of the hospital:

<https://vdoc-prod.hcuge.ch/vdocportal/portal/action/WebdriveActionEvent/oid/025-00005j-387/fname/Trach%C3%A9o%20percutan%C3%A9e%20SI%2010.05.2019.pdf>

Protocol 8 – Extracorporeal membrane oxygenation (ECMO) criteria



Protocol 9 – Renal replacement therapy (RRT)

I. Subject

The purpose of this protocol is to specify the modalities and methods of prescribing RRT in patients with COVID-19.

II. General

Renal impairment during COVID-19 is common, with acute renal failure reported in up to 23% of patients. Thus, in view of the potentially large number of patients requiring RRT, a modified and graded implementation of the usual RRT protocol currently in use in the ICU has been developed.

III. RRT methods

The method of choice in the ICU is continuous venovenous hemodiafiltration (CVVHDF), with the ultrafiltration amount adapted according to the duration of the RRT, itself defined by the number of Prismaflex® devices mobilized.

Given the very pro-coagulant tendency of infected patients, the pre-dilution to post-dilution ratio has been reversed from 2/3 - 1/3.

Solutions used:

- Dialysate: prismsol 4 (K⁺ = 4mmol/L);
 - Possible use of hemosol B0 (K⁺ = 0mmol/L) in case of life-threatening hyperkalaemia, (K⁺ analysis every 30min).
- Reinjection: prismsol 4.
- Blood pre-pump: prismsol 4.

In case of intense activity using the Prismaflex® devices (>8), support by the nephrology department will be provided, allowing intermittent haemodialysis (IHD) to be carried out in a limited number of patients (nephrologist on duty: call 3...).

IV. Anticoagulation method

Heparin anticoagulation is preferred in this situation because of its ease of use.

Given the very pro-coagulant tendency of patients, the first priming of the circuit during preparation should be with 1 bag of 1000mL 0.9% NaCl containing 10,000 IU of Liquémine® (instead of the usual 5,000 IU).

In addition, the maintenance dosage of Liquémine® on the Prismaflex should be increased to 25,000 IU/24h (instead of the usual 10,000 IU).

The heparin dose should then be titrated to a target anti-Xa patient of 0.3 IU/mL.

For patients already on curative anticoagulation: increase the dosage of Liquémine® by 20%, then monitor anti-Xa at H4.

The anticoagulation lock of the vascular catheter after treatment is achieved with Taurolock HEP500®.

V. Vascular approach and catheter

The vascular approach of choice is the femoral approach, preferably the left side.
The length of the catheter to be used is preferably 25 cm.

VI. Prescribing methods

A. ICU internal resources

A total of 11 Prismaflex® machines are available for continuous hemodiafiltration.

1.Situation n°1: up to 4 Prismaflex® used

The protocol is a 24-hour CVVHDF (see Annex 1).

2.Situation n°2: between 5 and 9 Prismaflex® used

The protocol is a CVVHDF of 12h/24h (see Annex 2).

3.Situation n°3: More than 9 Prismaflex® used

The protocol is of a CVVHDF of 6h/24h (see Annex 3).

B. Resources external to the ICU

In the case of transition to situation n°3, a nurse from the haemodialysis service will be delegated to the ICU in order to be able to perform IHD in a limited number of patients (maximum 3 patients per day). The treatment prescription will be given by the nephrology medical team.

C. Metabolic emergencies in situation n°3

In the case of a metabolic emergency (life-threatening hyperkalaemia, major metabolic acidosis, etc.), give priority to an initial IHD by the nephrology team and then carry out a relay by CVVHDF 6 h/24 h.

VII. Monitoring

If the monitoring parameters are not automatically imported into the software, a printable monitoring sheet containing the main elements of the prescription/treatment is provided in Appendix 4.

Protocol 10 – Thromboprophylaxis

To our knowledge, the risk of deep vein thrombosis (DVT)/arterial thrombosis (AT) in patients with COVID-19 has not been documented, with no data available in the literature to date. It is possible that this risk is higher than in usual ICU patients (~10%), because COVID-19 patients have prolonged stays, with complete bed rest, frequent paralysis, and significant activation of coagulation in the context of inflammation.

Several hospitals in the midst of the epidemic have reported a propensity for venous and arterial thrombosis in COVID-19 patients in the ICU. However, the actual risk remains difficult to estimate in the absence of data. Considering this perception, which is shared by several ICUs, and the desire to intensify thrombosis prevention in these patients, we suggest the following dosing regimen for patients with COVID-19 in intensive care.

Suggestions for the management of thromboprophylaxis for COVID-19 patients in the ICU of Geneva University Hospitals

1. Thromboprophylaxis is indicated in all COVID-19 patients in the ICU. Pharmacological thromboprophylaxis is recommended in all patients, except those at very high risk of bleeding where thromboprophylaxis alone with intermittent compression boots is preferred for as long as the risk of bleeding persists.

GFR Cockcroft	Weight < 100 kg	Weight ≥ 100 kg
≥ 30ml/min	Enoxaparine 40mg s.c. 2x/d	Enoxaparine 60 mg 2x/d
< 30ml/min	HNF sc 5000 UI 3x/d or HNF iv 15000 UI/24 h	HNF sc 10000 UI 2x/d or HNF iv 20000 UI/24 h

2. Drug table and dose, based on weight and GFR
 - The heparin dose should NOT be adjusted for D-dimer levels.
 - There is NO indication for routine anti-Xa activity analysis at these doses.
3. There is NO indication for routine screening for DVT by venous compression ultrasound regardless of D-dimer rate.
4. There is insufficient evidence to justify the introduction of a therapeutic dose of anticoagulation as a preventive measure.

Platelet count monitoring is necessary and heparin-induced thrombocytopenia must be suspected according to the usual criteria (4T score).

Protocol 11 – Nutrition

1. Calculation of nutritional requirements

Acute phase: 20 kcal/kg*.

Post-acute phase (usually from D 4 onwards): 25 kcal/kg*.

*Current weight: if body mass index (BMI) <25 kg/m².

Ideal weight calculated with a BMI of 22.5 kg/m²: if BMI > 25 kg/m².

2. Practically

Before beginning enteral nutrition:

- Benerva® 300 mg intravenous or oral unique dose.
- Mg, K and P plasma assays and correction as necessary.

3. Enteral nutrition (EN) by pump

A. Intubated patient

- D 1: Jevity® 250 ml (250 kcal) or Novasource® 250 ml (375 kcal) over 24 hours.
- Increase EN in 250-500 ml/day increments to energy target, monitoring plasma Mg, K, and P levels daily and correcting as needed.
- As soon as the energy target is reached (80-100%), possibility to change the Jevity® for a more concentrated BN as needed (limitation of water intake, diarrhoea): Promote Fibre Plus® 500 ml (655 kcal) or Novasource GI Forte® 500 ml (775 kcal)

B. Patient not intubated

- Half-seated position of the patient during any EN administration (risk of Broncho aspiration).
- D 1: Jevity® 250 ml (250 kcal) or Novasource® 250 ml (375 kcal) over 24 hours.
- Increase EN in increments of 250-500 ml/day up to 1000 kcal/d, monitoring plasma Mg, K, and P levels daily and correcting as needed. Possibility to increase energy intake on medical request (assess bone intake +/- additional parenteral nutrition).

If EN progression is not possible (digestive disorders, ileus)

Diarrhoea without infectious origin:

- Change in the type of EN product (see above); or
- EN reduction with parenteral nutrition (PN) supplementation via the central venous route: Omegaflex special®, available in 625 ml (740 kcal), 1250 ml (1475 kcal) or 1875 ml (2215 kcal) pouches + 1 Cernevit® ampoule + 1 Addaven® ampoule in each PN pouch.

Vomiting (non-intubated patients): Decrease or even stop the EN and start PN.

Ileus: stop EN (contraindicated), start PN

1. EN in the absence of a pump

A. Intubated patient

EN per bolus

- J1: Jevity® 250 mL (250 kcal) or Novasource® 250 mL (375 kcal) per 100-200 mL bolus by syringe.
- Progression in 250-500 ml increments of EN to energy target. The number of boluses is to be determined according to the energy target. Daily control of the Mg K and P plasma dosages and correction if necessary.

EN by gravity

- J1: delivery speed regulated by the clamp on the nasogastric tube to 100 ml in 60 min. Jevity® 250 ml (250 kcal) or Novasource® 250 ml (375 kcal).
- Increase NE in 250-500 ml/day increments to energy target, with daily monitoring of Mg K and P plasma levels and correction as necessary.
- As soon as the energy target is reached (80-100%), possibility to change the Jevity for a more concentrated EN as needed (limitation of water intake, diarrhoea): Promote Fibre Plus® 500 ml (655 kcal) or Novasource GI Forte® 500 ml (775 kcal).

B. Patient not intubated

- Half-seated position of the patient during any EN administration (risk of gastric content aspiration).

EN per bolus

- J1: Jevity 250 mL (250 kcal) or Novasource® 250 mL (375 kcal) per 100-200 mL bolus by syringe to the nasogastric tube
- Aim for an energy target of 1000 kcal/d.

EN by gravity

- J1: delivery speed regulated by the clamp on the nasogastric tube to 100 ml in 60 min. Jevity® 250 ml (250 kcal) or Novasource® 250 ml (375 kcal).
- Increase of EN in steps of 250-500 ml/day up to 1000 kcal/d, by daily monitoring of Mg K and P plasma levels and correcting them if necessary.

Note that nutritional support should be re-evaluated at discharge from intensive care - intermediate care.

Protocol 12 – Communication with families

Dear Colleagues,

Families are unable to visit their loved ones because of the pandemic, so phone calls are increasing due to their concerns.

For this reason, and in order to facilitate physician-family contact, we have implemented the following actions:

Order of 10 smartphones for videoconferencing

These 10 smartphones (1 per treatment box), which allow calls outside Switzerland, will be carried by the treatment box supervisor (day and night).

Method: Promote videoconferencing with the possibility of visualization during the conversation (preferably WhatsApp®).

The family member's name and phone number should be entered into the phone's contact list. The family member should be called with WhatsApp® (medical assistants will initiate this).

Call Process

In order to avoid any breach of confidentiality, it is vital to ask for identification before giving confidential information.

During telephone contacts, please offer the family the possibility of a videoconference to see their loved one, explaining clearly what they are going to see.

The physician should summarize the clinical situation, then introduce the nurse in charge, before approaching the patient. The smartphone should be brought to the patient's ear so that the family can talk to the patient.

This will allow them to realize the seriousness of the situation and allow them to grieve in the event of death.

This technology has the advantage of allowing confined families deprived of visits to be present with their relatives. The goal, apart from maintaining the patient-family bond, is to reduce post-traumatic stress.

A psychiatric team is available to support the family and carers in these moments. Two psychologists are assigned to this service. A family support hotline is also being set up.

2. The medical team in charge of the patient must have telephone contact with the family at least every 48 hours.

Due to the heavy workload, it seems reasonable to suggest 5 patients a day

INFORMATION TO RELATIVES

Patient		Family contact		April																
				cell	Last name + First name	Name + phone	who	friday 17	video	saturday 18	video	sunday 19	video	monday 20	video	tuesday 21	video	wednesday 22	video	thursday 23
					Nurse															
					Physician															
					Nurse															
					Physician															
					Nurse															
					Physician															
					Nurse															
					Physician															
					Nurse															
					Physician															

Protocol 13 – Patient’s diary

DIARY: WRITE FOR YOUR LOVED ONE IN INTENSIVE CARE

Accompanying a loved one in the intensive care unit during this moment is proving more difficult than ever.

The logbook: why? A place for memories

This logbook has a double purpose:

First, it is for you. We suggest that you write your own diary and note down what you would have wished to communicate to your loved one (description of a significant event, progress made, encouragement, communication with the care team, etc.) and to give voice to your emotions that are being experienced at a distance. This will certainly help you to cope better with this difficult episode.

You should choose the form you are most comfortable with (pen and paper, computer, etc.) and perhaps you may feel you also want to illustrate the diary with children's drawings or family photos.

It is also for your loved one. Patients do not always remember their stay on the intensive care unit, which is experienced as a journey without consciousness. Sometimes this lack of memory related to the ICU stay can be a source of anxiety for the patient.

We will also create an ICU unit diary for your loved one, which we will keep on the hospital computer. The nursing staff will write down their feelings or the highlights of the hospitalization. This will help your loved one to reconstruct the events in the future and allow them to know what happened during the time they were in our care.

We will give this diary to your loved one after they leave the intensive care unit, before they return home. We will also contact you after your loved one returns home to ensure that the diary has been received and, if necessary, send it to you.

We will be happy to answer any questions you may have concerning this diary and our heartfelt feelings go to you at this difficult time:

Dr..., intern intensive care physician

Protocol 14 – End of life care

Two levels of end-of-life management are defined, depending on the evolution of the situation of overcrowding in intensive care and the number of patients in this situation:

- **Level A:** Therapeutic withdrawal is possible in intensive care rooms A and X, as well as in the room designated JUL+ if the capacity and medical resources allow it. In this phase the palliative care-COVID unit partners with the intensive care team.
- **Level B:** When the capacity of the intensive care beds is exceeded, withdrawal can be performed in another location.

SPECIFICITIES OF THERAPEUTIC WITHDRAWAL IN THE ICU

1) DECISION OF THERAPEUTIC WITHDRAWAL

The decision must be taken in accordance with the current legal framework and the ethical principles in force (see video link). It is a multidisciplinary decision. The treatment withdrawal process must be the subject of a plan defined in advance by the physicians and nurses in charge of the patient.

2) PALLIATIVE CARE TEAM: to be involved as early as possible in this process.

- Nurse on duty 24/7: 2... or physician on duty: 3...
- Dr...., palliative care assistant physician is present in the unit from Monday to Friday from 9 am to 6 pm, call 3....

3) END-OF-LIFE ICON: Place the end-of-life icon near the patient.

4) MONITORING/EQUIPMENT: Remove any non-essential monitoring (leave the pulse oximeter) and unnecessary equipment (UF, etc.).

5) SEDATION AND ANALGESIA: The priority remains the comfort of the patient and the pain relief and sedation is to be continued throughout the procedure:

- When the patient does not have pain relief/sedation in progress, it is recommended to introduce intravenous analgesic treatment according to the CPOT scale (CPOT>0).
- 1st line drugs: **Midazolam (Pump) and Morphine (Pump).**
- Increase intravenous analgesia **only** if the patient shows signs of pain or discomfort as assessed by a validated scale (target CPOT =0)
- Increase sedation if the patient responds to tactile or painful stimulation or call (SAS 1 or RASS-PAL - 5).
- Limit nursing interventions to those centred on comfort.

6) REDUCING VENTILATION: no extubation in view of the risk of infection.

- reduce the FiO₂ to 0.21, reduce the PEEP to 0 cm H₂O, change the ventilator settings:
 - in controlled mode, decrease respiratory rate and tidal volume
 - in spontaneous mode, reduce the inspiratory aid and place the patient on an open circuit, such as the COBB (mini filter at end of tube).

7) WITHDRAWAL OF VASOACTIVE MEDICATIONS: slowly decrease all vasoactive drugs to zero.

8) HYDRATION: Minimum intravenous, but maximal mouth care with swabs, etc.

9) FAMILY: the family (maximum 2 persons) have the possibility to see the patient or the body while respecting the COVID measures in force (see below) for a reasonable period of time in the current infectious context (<2 hours). It is not possible for the family to bring personal clothing. Family enter the unit by the administrative corridor (to avoid passing through the ward). The family and relatives present are advised not to kiss the deceased.

10) AUTOPSY: The possibility of performing an autopsy on patients who have died from COVID should be actively suggested to the relatives of the deceased. This will improve our understanding of the disease and help in the future treatment of COVID patients.

Medical autopsy lasts a maximum of 4 hours and the body is returned directly to the funeral home within 24 hours; the face is left untouched and any other sutures are not visible under the sheets.

SUPPORT FOR RELATIVES AND EMPLOYEES

1. **RELIGIOUS CLERGY:** Religious professionals are available to accompany the family at this time: (24/7 guard: call 0...)
2. **PSYCHIATRIC SUPPORT:** To be contacted in an emergency situation for support to members of a family during a complicated withdrawal process (telephone number varies according to contact time):
 - Mobile PSYCHIATRE REFERENT: call 3... (Monday to Friday from 8 am to 7 pm)
 - Mobile EMERGENCY: call 3... (Monday to Sunday from 8 am to 10.30 pm)
 - Mobile PSYCHIATRIC EMERGENCY SORTER (UAUP): call 3... (Monday to Sunday from 10:30 pm to 8 am).
3. **FAMILY SUPPORT + BROCHURE:** Give the family the list of undertakers (available in the booklet present in the "Death checklist" binders available in all COVID sectors or the hospital brochure "Practical information in the event of a death", which also contains the HOTLINE family support number (call 0...) (7 days a week from 9 am to 6 pm).
4. **PSYCHOLOGISTS:** Available for employees:
 - Dr...
 - Dr...
5. **SUPPLEMENTARY MATERIALS:** Video presentation (5 min) summarizing the ethical and practical aspects of therapeutic withdrawal by Prof..., Dr... and Ms...

Video [Link](#)

GENERAL: BODY CARE

- After the death of patients with suspected or confirmed CoV-2 SARS infection, the Basic Measures and the Specific Measures "CONTACT" and "DROPLETS" are followed until the body is taken to the mortuary.
- Washing the body is performed according to the usual procedure.
- Make sure the identification bracelet with the name of the deceased is on the wrist or the ankle.
- Request transportation on i-transport 24-hr a day, 7 days a week, specifying the destination: mortuary room mortuary CMU 912390 and by ticking the box "No return transport".
- The body is transported to the mortuary and handled according to usual procedures.
- There is no recommendation as to the use of a cover to wrap the body.

SPECIAL FUNERAL RITES

The practice of religious funeral rites may exceptionally be organized on the premises of the CMU mortuary suite. In these situations, contact Dr.... (call 3...), or Mr..., manager of the morgue at the Cluse-Roseraie site (call 3...).

CERTIFICATE OF DEATH

Completed by the physician in charge of the patient (HUG). The death certificate must clearly state "The body can be transported without danger of contagion".

To discuss a particular situation, contact the Forensic Medicine Guard (call 0... (24/24).

DECLARATION OF DEATH

The medical assistant, after the signature of the physician in charge on the certificate has been obtained, sends the form "Declaration of clinical results following death" to the following link:

<https://www.bag.admin.ch/infreporting> within 24 h.