ECMO and COVID-19
Experience from Paris

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Disclosures

- Received honoraria for lectures and consulting from
  - MAQUET, XENIOS, FRESENIUS
Logistics
ECMO COVID-19: French resources constraints

- Context of lack of ECMO devices and limited circuits
- Only one active mobile ECMO team on a 24 hour/7 day basis in Paris area
- ECMO machines and circuits are stored and spread in many centers
1. Need to reference where are the resources:
   - Which team could cannulate outside his center?
   - Update inventory on available ECMO machines and circuits?
   - What are the ICUs able to manage ECMO patients?
2. **Creation of an expert group** to propose ECMO indications in that context (regular reassessment)

3. **Centralization, regulation, and validation of all ECMO indications** in Paris area with a unique phone number

4. **Live count** on available ECMO machines and circuits
Indications
## COVID-19 Resources

### Summary of recommendations on the management of patients with COVID-19 and ARDS

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>COVID-19 with mild ARDS</th>
<th>COVID-19 with mod to severe ARDS</th>
<th>Rescue/adjunctive therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DO:</strong></td>
<td>Vt 4-8 ml/kg and $P_{\text{plat}} &lt; 30$ cm H$_2$O</td>
<td><strong>CONSIDER:</strong> Higher PEEP</td>
<td><strong>? UNCERTAIN:</strong> Antivirals, chloroquine, anti-IL6</td>
</tr>
<tr>
<td><strong>DO:</strong></td>
<td>Investigate for bacterial infection</td>
<td><strong>CONSIDER:</strong> NMBA boluses to facilitate ventilation targets</td>
<td><strong>? UNCERTAIN:</strong> NMBA infusion for 24 h</td>
</tr>
<tr>
<td><strong>DO:</strong></td>
<td>Target SpO$_2$ 92% - 96%</td>
<td><strong>CONSIDER:</strong> If PEEP responsive</td>
<td><strong>? UNCERTAIN:</strong> If proning, high P$_{\text{pl}}$ asynchrony</td>
</tr>
<tr>
<td><strong>CONSIDER:</strong></td>
<td>Conservative fluid strategy</td>
<td><strong>CONSIDER:</strong> Traditional recruitment maneuvers</td>
<td><strong>CONSIDER:</strong> NMBA infusion for 24 h</td>
</tr>
<tr>
<td><strong>CONSIDER:</strong></td>
<td>Empiric antibiotics</td>
<td><strong>CONSIDER:</strong> If proning, high P$_{\text{pl}}$ asynchrony</td>
<td><strong>CONSIDER:</strong> Prone ventilation 12 -16 h</td>
</tr>
<tr>
<td><strong>DO:</strong></td>
<td></td>
<td><strong>CONSIDER:</strong> Short course of systemic corticosteroids</td>
<td><strong>CONSIDER:</strong> Prone ventilation 12 -16 h</td>
</tr>
<tr>
<td><strong>DON'T DO:</strong></td>
<td></td>
<td></td>
<td><strong>CONSIDER:</strong> STOP if no quick response</td>
</tr>
<tr>
<td><strong>DON'T DO:</strong></td>
<td></td>
<td></td>
<td>A trial of inhaled nitric oxide</td>
</tr>
<tr>
<td><strong>? UNCERTAIN:</strong></td>
<td>Systemic corticosteroids</td>
<td></td>
<td><strong>CONSIDER:</strong> Follow local criteria for ECMO</td>
</tr>
<tr>
<td><strong>CONSIDER:</strong></td>
<td><strong>V-V ECMO or referral to ECMO center</strong></td>
<td></td>
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</tr>
</tbody>
</table>

ARDS = adult respiratory distress syndrome  
$P_{\text{plat}}$ = plateau pressure  
SpO$_2$ = peripheral capillary oxygen saturation  
PEEP = positive end-expiratory pressure  
NMBA = neuromuscular blocking agents  
ECMO = extracorporeal membrane oxygenation

Treat underlying cause of acute respiratory distress syndrome
Standard lung-protective ventilation strategy
Diuresis or resuscitation as appropriate

- \( \text{PaO}_2: \text{FiO}_2 < 150 \text{ mm Hg} \)
  - Strongly recommended
    - Prone positioning (unless contraindicated)
  - Recommend
    - Neuromuscular blockade
    - High PEEP strategy
  - Consider
    - Inhaled pulmonary vasodilators
    - Recruitment manoeuvres

- \( \text{PaO}_2: \text{FiO}_2 \geq 150 \text{ mm Hg} \)
  - \( \text{pH} < 7.25 \text{ with } \text{PaCO}_2 \geq 60 \text{ mm Hg for } > 6 \text{ h}^* \)
    - No
      - Continue current management
    - Yes†
      - Contraindication to ECMO?‡
        - Yes
          - Consider adjunctive therapies§ as appropriate
        - No
          - Recommend ECMO¶

- Are any of the following criteria met?
  - \( \text{PaO}_2: \text{FiO}_2 < 80 \text{ mm Hg for } > 6 \text{ h} \)
  - \( \text{PaO}_2: \text{FiO}_2 < 50 \text{ mm Hg for } > 3 \text{ h} \)
  - \( \text{pH} < 7.25 \text{ with } \text{PaO}_2 \geq 60 \text{ mm Hg for } > 6 \text{ h}^* \)

Lancet Resp Med, 2019
Treat underlying cause of acute respiratory distress syndrome
Standard lung-protective ventilation strategy
Diuresis or resuscitation as appropriate

**PaO$_2$:FiO$_2$ <150 mm Hg**

- Strongly recommended
  - Prone positioning (unless contraindicated)
- **Recommend**
  - Neuromuscular blockade
  - High PEEP strategy

**PaO$_2$:FiO$_2$ ≥150 mm Hg**

- Is pH <7.25 with PaCO$_2$ ≥60 mm Hg for >6 h?  
  - No: Continue current
  - Yes: Contraindication to ECMO?

- Are any of the following criteria met?
  - PaO$_2$:FiO$_2$ <80 mm Hg for >6 h
  - PaO$_2$:FiO$_2$ <50 mm Hg for >3 h
  - pH <7.25 with PaO$_2$ ≥60 mm Hg for >6 h

- Contraindication to ECMO?
  - Yes: Consider adjunctive therapies as appropriate
  - No: Continue current management

**Recommend ECMO**
Contraindications

- Age > 65yrs
- Severe Comorbidities
  - Advanced COPD, cardiac failure, Cirrhosis (Child B/C), home O2...
- Severe immunocompromised status
  - Hematological cancer, advanced cancer...
- Cardiac arrest
  - Except witnessed, with bystander CPR, low-flow <15 minutes
- MV duration > 10 days
- Multiple organ failure
  - Except isolated AKI...
- BMI > 35 kg/m²
European/Euro-ELSO Survey for Adult ECMO-COVID-19 Patients

28 March 2020

2 ECMO
Maastricht - UMC: 0
Rotterdam - Erasmus UMC: 0
Leiden - UMC: 0
Utrecht - UMC: 2 V-V

6 ECMO
Leuven - University Hospital: 2 V-V
Aalst - OLV: 0
Brussels - Erasmus Hospital: 2 V-V
Antwerp - University Hospital: 1 V-V
Charleroi - CHU: 0
Ghent - University Hospital: 1 V-V

69 ECMO
Paris – Henri Mondor Hospital: 3 V-V
Paris – Pitié-Salpêtrière Hospital: 45 ECMO
Lyon - CHU: 1 V-V
Rennes – CHU: 0
Others: 20 ECMO

12 ECMO
Zaragoza - Universitary Hospital Miguel Servet: 1 V-V
Barcelona Vall d’Hebron University Hospital: 3
Catalunya - University Hospital Germans Trias i Pujol: 2
Catalunya - Hospital Clinic: 1
Madrid - Hospital 12 de Octubre: 1

Valladolid - University Clinic Hospital: 1
Bilbao - University Hospital Cruces Barakaldo: 2
Valencia - University Hospital Politécnica La Fe: 1
Others: 0

16 ECMO
London - Guy’s & St. Thomas Hospital and Others: 16 V-V

10 ECMO
Dusseldorf - University Hospital: 1 V-V-A
Nuremberg - Medical University Hospital: 0
Hannover - Medical School: 0
Leipzig - Heart Center: 0
Regensburg - University Hospital: 2 V-V
Essen - University Hospital: 0
Berlin - Heart Center: 0
Aachen - University Hospital: 5 V-V; 1 V-A
Kassel – ECMO Center: 1 V-V

2 ECMO
Stockholm - Karolinska University Hospital: 1 V-V; 1 V-A

0 ECMO
Moscow - Hospital: 0
St. Petersburg - Hospital: 0
Kemerovo – Hospital: 0
Chelyabinsk – Hospital: 0
Novosibirsk – Hospital: 0

0 ECMO
Vilnius - University Hospital

1 ECMO
Poland Centers: 1 V-V

1 ECMO
Prague - University Hospital: 1 V-V

3 ECMO
Innsbruck - University Hospital: 1 V-V
St. Polten – Hospital: 1 V-V
Vienna – Medical University Hospital: 1 V-V
Others: 0

27 ECMO
Bergamo – Papa Giovanni XXIII Hospital: 3 V-V
Bologna - S.Orsola Hospital: 3 V-V
Milan – Niguarda Hospital: 2 V-V
Milan – S. Donato Hospital: 1 V-V
Milan – S. Raffaele Hospital: 5 V-V
Turin – S. Giovanni Bosco Hospital: 1 V-V
Turin – Mauriziano Hospital: 0
Pavia – S. Matteo Polliclinic: 3 V-V
Patrierno - ISMETT: 0
Brescia - Spedali Civili: 1 V-V
Venezia/Mestre Hospital: 2 V-V
 Udine – University Hospital: 0
Monza – S. Gerardo Hospital: 3 V-V, 1 V-A
Ancona – Riiuniti Hospital: 3 V-V
Vicenza Hospital: 0
Puglia – GVM & Research: 0
Alessandria – S. Giorgio Clinic Hospital: 0
Rome – S. Camillo Hospital: 0
Cesena – Bualinii Hospital: 1 V-V

4 ECMO
Porto – San Joao Hospital: 4 V-V

0 ECMO
Greek Centers: 0
European/Euro-ELSO Survey for Adult ECMO-COVID-19 Patients

28 March 2020

Overall 154 ECMO cases
ECMO in Paris area

First case
Feb 25,
Massive PE
after 6 days of
MV, Cardiac
Arrest, rescue
VA-ECMO
Deceased,
multiple organ
failure

Implantations

 Courtesy Dr Guillaume Lebreton
Paris Experience

- La Pitié-Salpêtrière hospital
  - 49 cases

- Other Paris Hospitals
  - 32 cases
La Pitié’s experience (April 2nd)

- 25 ECMO patients out of 25 ICU beds
- 24 VV/1 VAV
- Age 49 (40-55) yrs
- 17 males
- ECMO after 4 (2-6) days of MV
- Repeated prone positionning before ECMO for all
- On ECMO for 9 (6-13) days (02/04/2020)

- PP on ECMO for all
- 5 ECMO weaning so far (1 VA, 4VV), no extubation for now...
ECMO in Paris area

Au 30 mars 2020

Nombre d'ECMO: 108
ECMO en cours: 82
Nombre de décès: 14
Nombre de sevrage: 11

ECMO COVID IDF
Activité Journalière

En cours
Sevrage
Mort

Courtesy Dr Guillaume Lebreton
Devenir des patients (par date d’implantation)

ECMO COVID IDF

Au 30 mars 2020

Nombre d’ECMO : 108
ECMO en cours : 82
Nombre de décès : 14
Nombre de sevrage : 11

Date d’implantation de l’ECMO

Mort
Sevrage
En cours

Courtespy Dr Guillaume Lebreton
ECMO-COVID 19 management: specific points

- **High risk of thrombosis**
  - 7/35 PE diagnosed
  - 2 membrane thrombosis

- Full anticoagulation on ECMO aPTT >2, anti Xa 0.3-0.5

- CT pulmonary angiography if dilated RV and pulmonary acidosis before ECMO
ECMO-COVID 19 management: specific points

- **SARS-CoV-2 scavenging?**
  - Study on 15 patients with positive plasma RNA detection and 13 without plasma RNA detection
  - SARS-CoV-2 was never detected in the gas outlet side of the oxygenator
ECMO-COVID 19 management: specific points

- Please be patient...long ECMO runs are expected!

Male, 49yrs
D1 ECMO

Intra alveolar hemorrhage +++
D10 ECMO

D21 ECMO
ECMO weaning, P/F 240
Conclusions

• Most patients stabilized while on ECMO
  • VERY VERY severe lung disease
  • Frequently associated with kidney injury

• NOT ALL PATIENTS DIE ON ECMO
  • Some patients have been weaned after <10 days of support
  • Others may require weeks of support

• TOO EARLY TO DRAW ANY CONCLUSIONS

• We need time to evaluate our results