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INSTITUT MONDOR
DE RECHERCHE
BIOMÉDICALE



Solution frugale ventilatoire au cours de l'infection par le SARS-CoV2

Guillaume Carteaux

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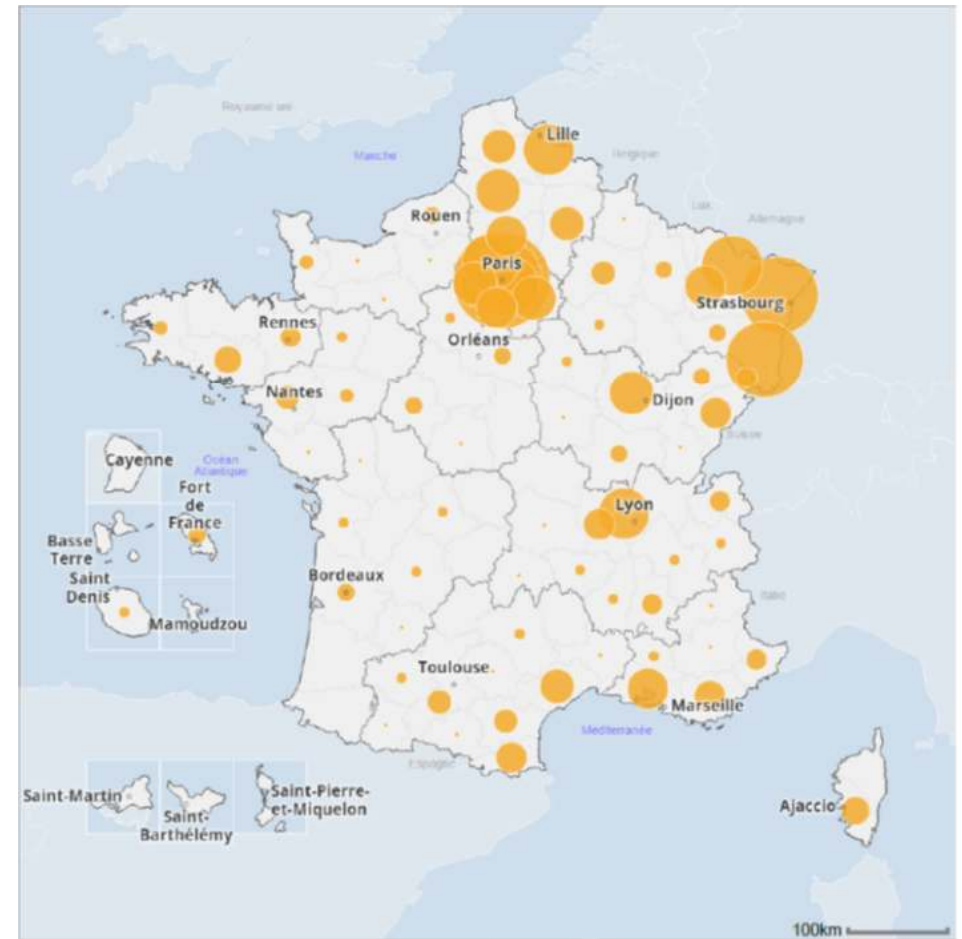
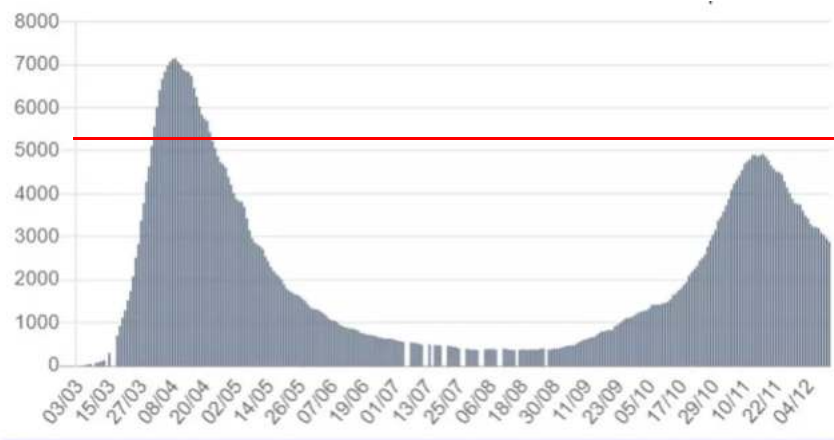
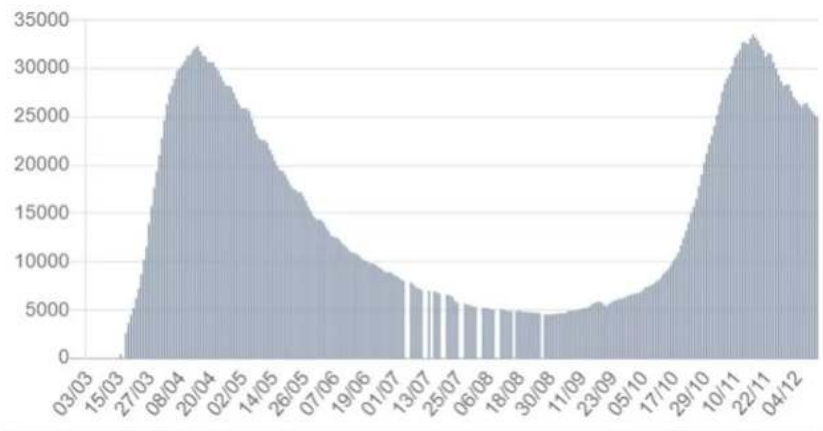
guillaume.carteaux@aphp.fr

Conflicts of interest

- Fees and/or travel expanses
 - Medtronic
 - Fisher and Paykel
 - Air Liquide Medical System
 - Löwenstein
 - Dräger



COVID-19: Un afflux massif de patients en détresse respiratoire aiguë hypoxémiante

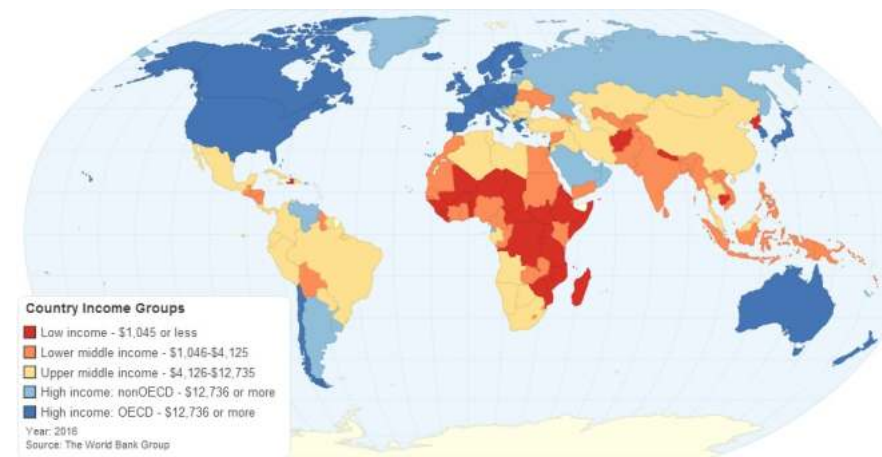




Hôpital Henri Mondor, Créteil, France



Hôpital militaire, Douala, Cameroun





Hôpital Henri Mondor, Créteil, France



Hôpital militaire, Douala, Cameroun

Pénurie de lits
réanimation

Coronavirus : vers une pénurie de respirateurs ?

Les soignants vont avoir besoin de respirateurs pour découvrir mercredi 25 mars l'indispensable pour sauver des vies

L'EXPRESS



ACTUALITÉS - LE CORONAVIRUS ÉCONOMIE - L'HEBDO - LIFESTYLE - SERVICES -

Le manque de respirateurs au coeur de la crise

Par Bruno D. Cot,

publié le 24/03/2020 à 08:30 , mis à jour le 25/03/2020 à 14:56



Podcasts



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Accueil / Santé / Virus / Coronavirus

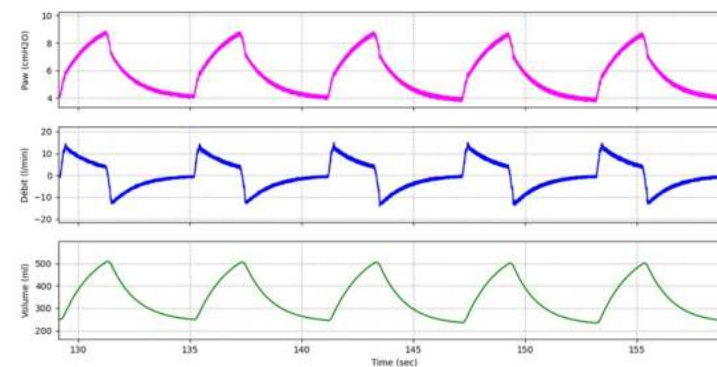
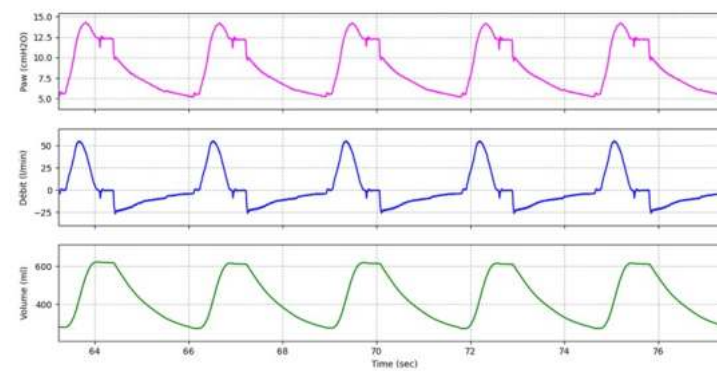
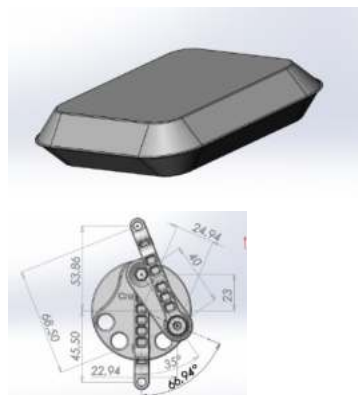
Coronavirus. Pénurie de respirateurs : face à une forte demande, l'industrie s'organise

Avec la crise sanitaire liée au Covid-19 en France, la demande de respirateurs est exponentielle et crée une pénurie. C'est le secteur des fabricants qui met les bouchées doubles pour honorer les commandes.





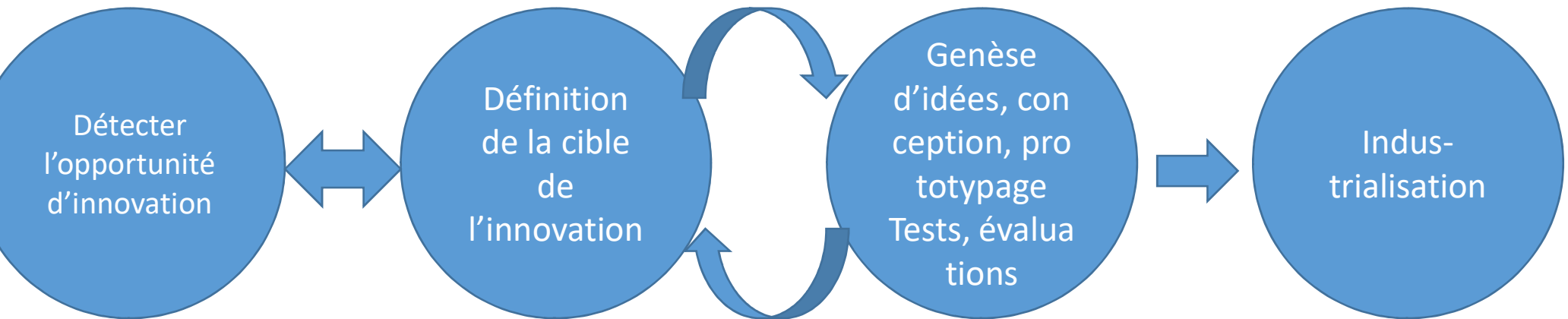




Patient Normal C60 R5

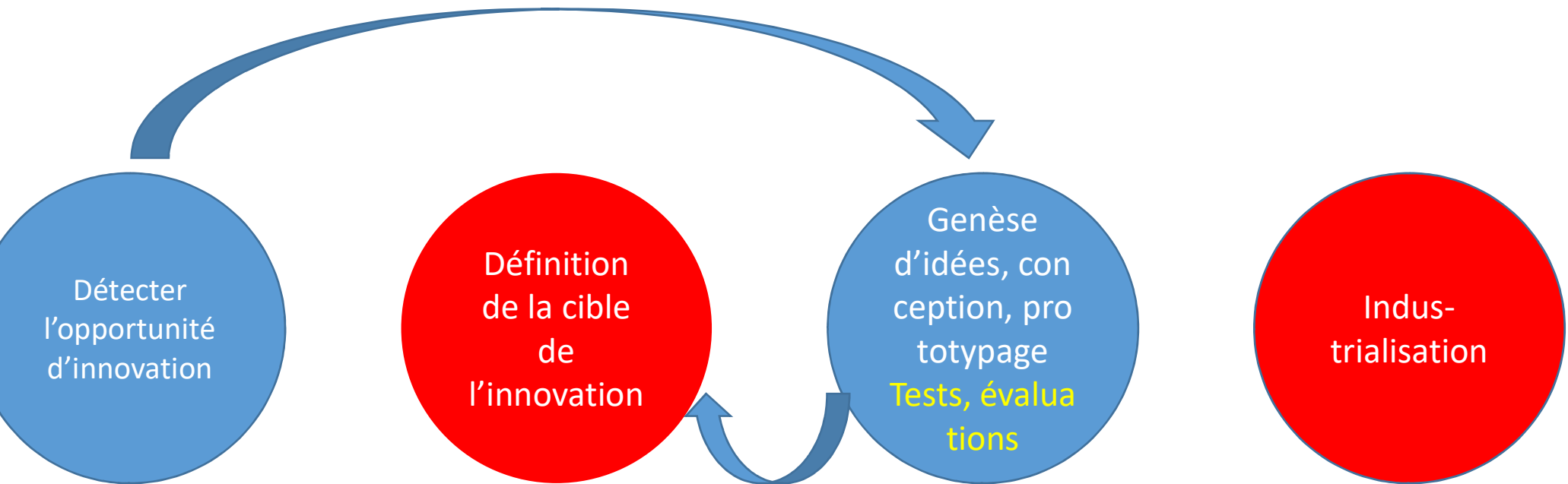
FR (cycles/min)	Vt (moyen)	PEP (cmH2O)
12	151,49	-1,32
17	179,66	-1,34
22	204,12	-1,43
27	217,76	-1,45
32	232,66	-1,66
37	240,24	-1,62
42	253,87	-1,47
47	255,01	-1,43
52	262,09	-1,9
57	270,48	-1,88

Processus d'innovation



Connaissance de la cible
Evaluation du **besoin**
Documentation

Processus d'innovation



Connaissance de la cible

Evaluation du **besoin** ➔

Documentation

contraintes

Assistance respiratoire

Personnel non qualifié en réanimation

Hors les murs de la réanimation....

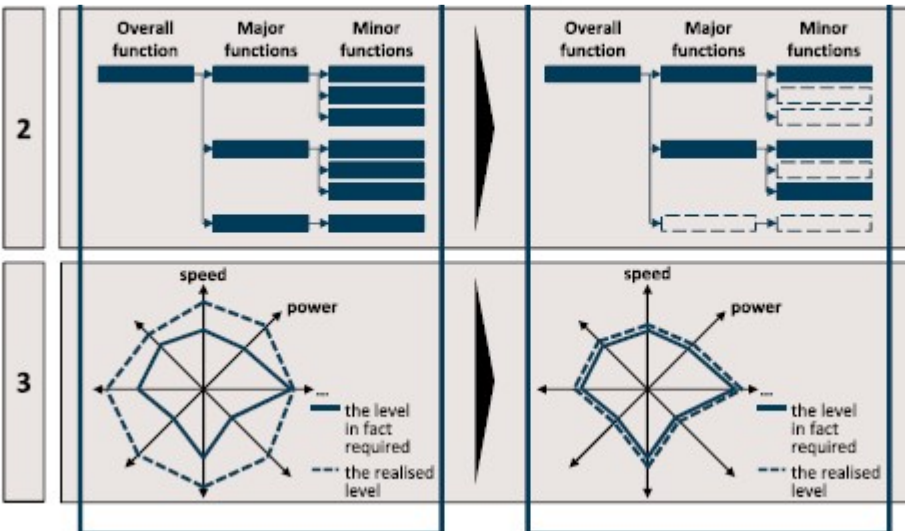
RESEARCH

What is frugal innovation? Three defining criteria

Timo Weyrauch* and Cornelius Herstatt



Concentration on core functionalities



Optimised performance level

- Product improvement and modification of existing products and services without challenging **what functionalities** are in fact needed
- Product improvement without challenging **what performance level** is in fact required for the intended purpose

Frugal innovation for critical care

Armand Mekontso Dessap^{1,2,3*} 

Intensive Care Med (2019) 45:252–2

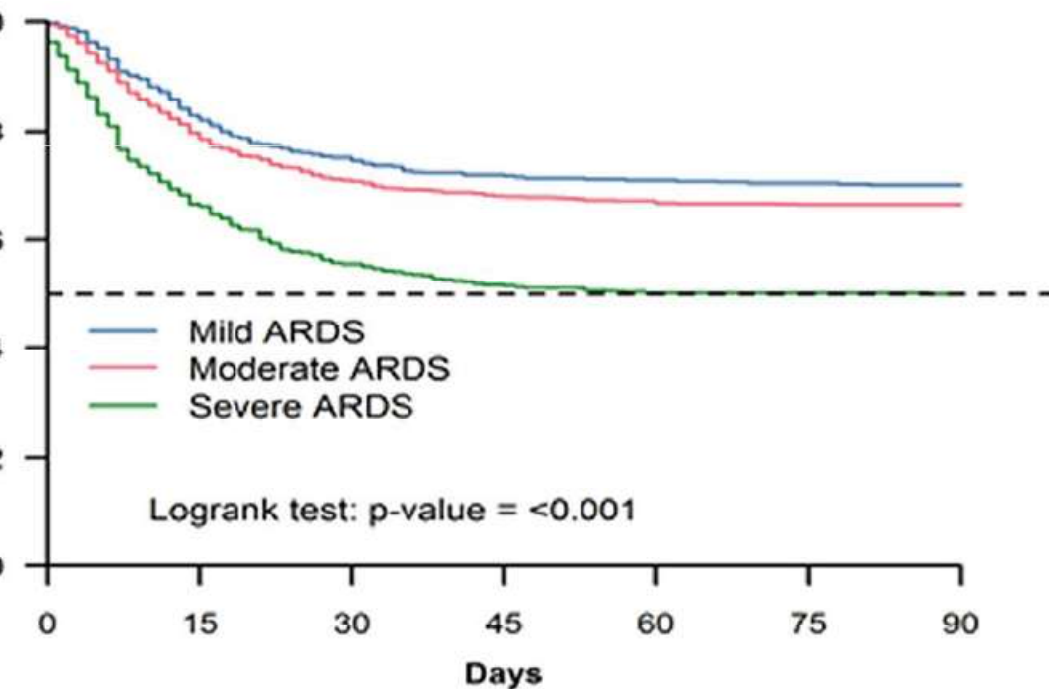
Characteristics	Conventional innovation	Frugal innovation
Characteristics of conventional and frugal innovation		
er	What would be nice to have	What do they need
ess	Top–down	Bottom–up
straints	Conceived as barriers	Conceived as opportunities
capabilities	Desirability and design	Functionality and focus on essential, high value and quality, rugged, adaptable, simple, user-friendly and easy to use
/resources	Exploiting all potentially available resources	Accessible and affordable, minimising the use of material and financial resources, sustainable
tion	High income settings	All settings (universally accessible)

Clinical characteristics and day-90 outcomes in 4244 critically ill adults with COVID-19: a prospective cohort study



ICU Group on behalf of the REVA Network and the COVID-ICU Investigators*

Intensive Care Med

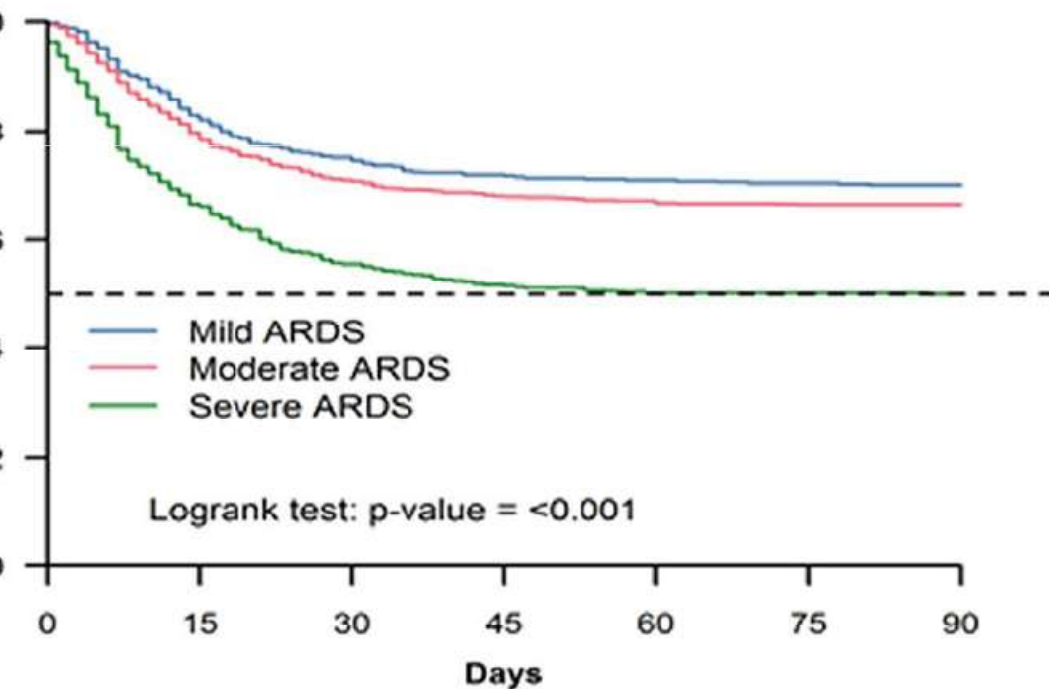


Clinical characteristics and day-90 outcomes in 4244 critically ill adults with COVID-19: a prospective cohort study

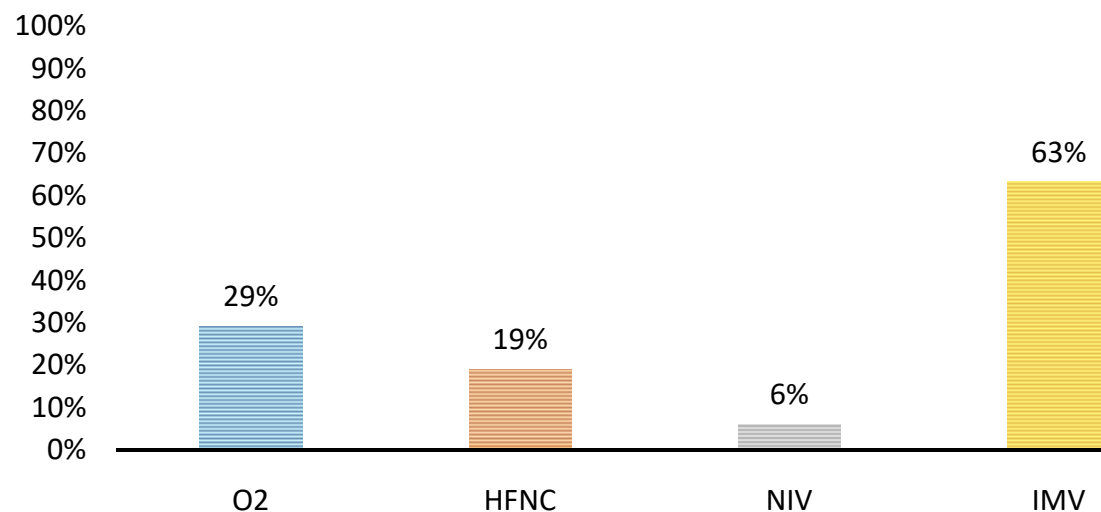


ICU Group on behalf of the REVA Network and the COVID-ICU Investigators*

Intensive Care Med



FIRST 24H IN ICU (N = 4244)



Support ventilatoire – COVID-19

Besoins

- Oxygénation (O₂)
- Assistance respiratoire (Pression positive)

Contraintes

- Afflux massif de patients
- Pénuries de lits de réanimation
 - Lits
 - Assistance respiratoire
 - Oxygène
 - Personnel formé
- Risque infectieux

Solution

- Oxygénation (O₂)
- Assistance respiratoire (Pression positive)
- Disponibilité
- Utilisation hors les murs de la réanimation
- Économe en oxygène
- Simplicité d'utilisation
- Formation
- Protection / risque infectieux

Support non invasif

ICUs in Paris – 379 COVID-19 patients with AHRF

O₂: n = 233

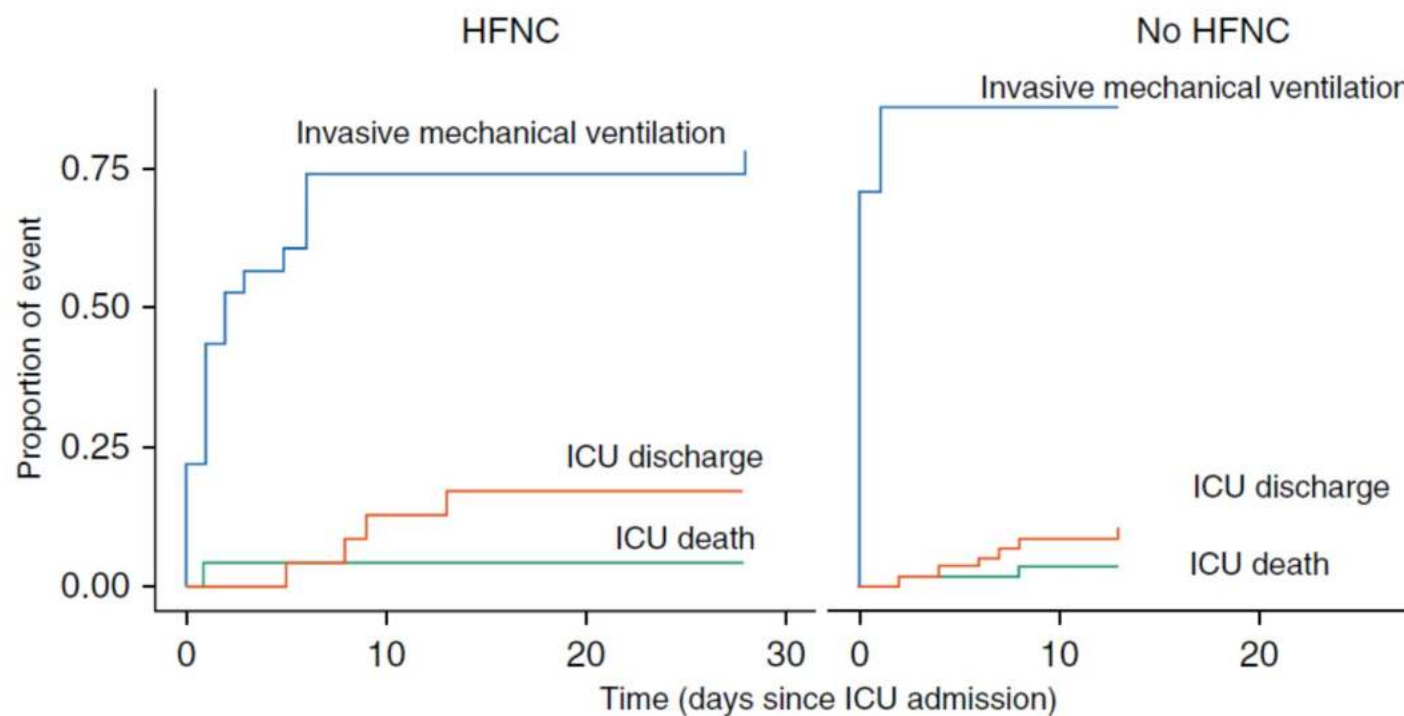
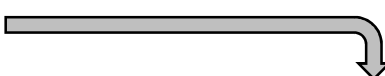
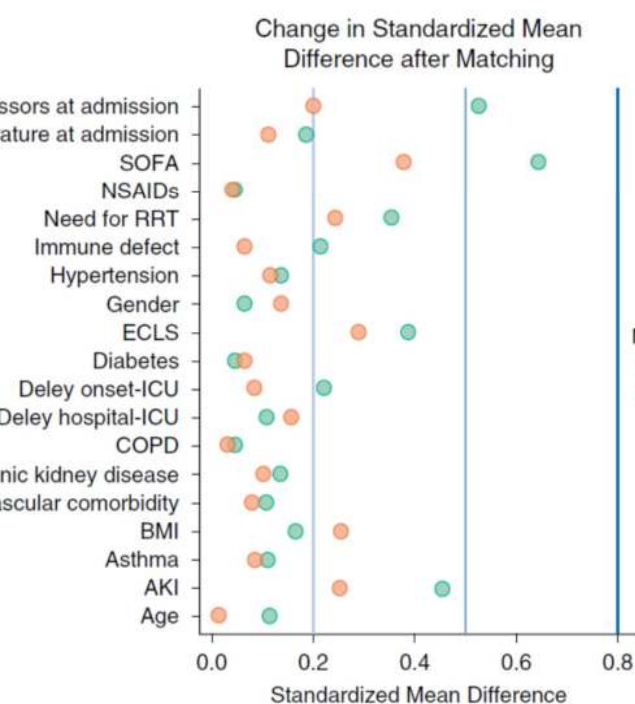
HFNC: n = 146

Propensity score matched analysis: O₂ 137 / HFNC 137



Disponibilité

Consommation d'O₂



- ☑ Simplicité
- ☑ Utilisation hors les murs de la réanimation
- ☑ Utilisation par du personnel non entraîné



centres en Italie:

53 patients COVID-19
 9 (10%) ont reçu un support non invasif en
 hors de la réanimation

85% = **CPAP**

majorité = Helmet



Bellani *et al.* Ann Am Thorac Soc

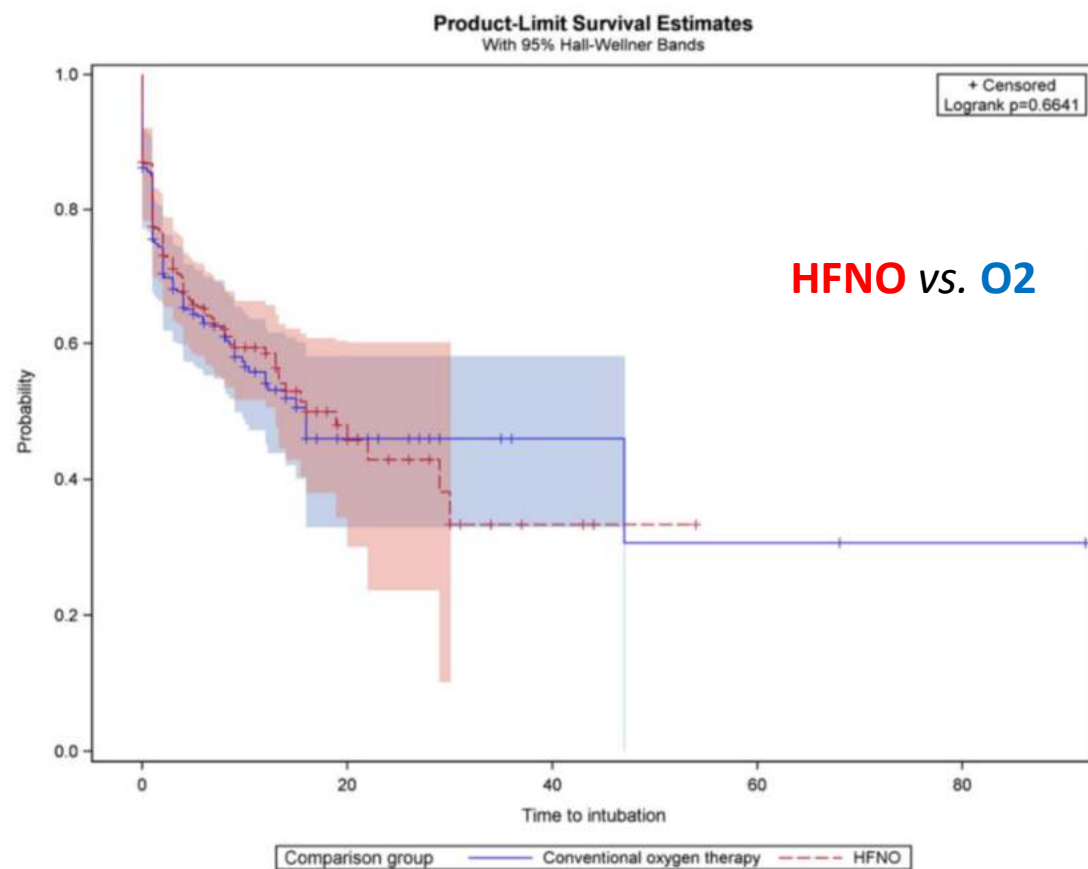
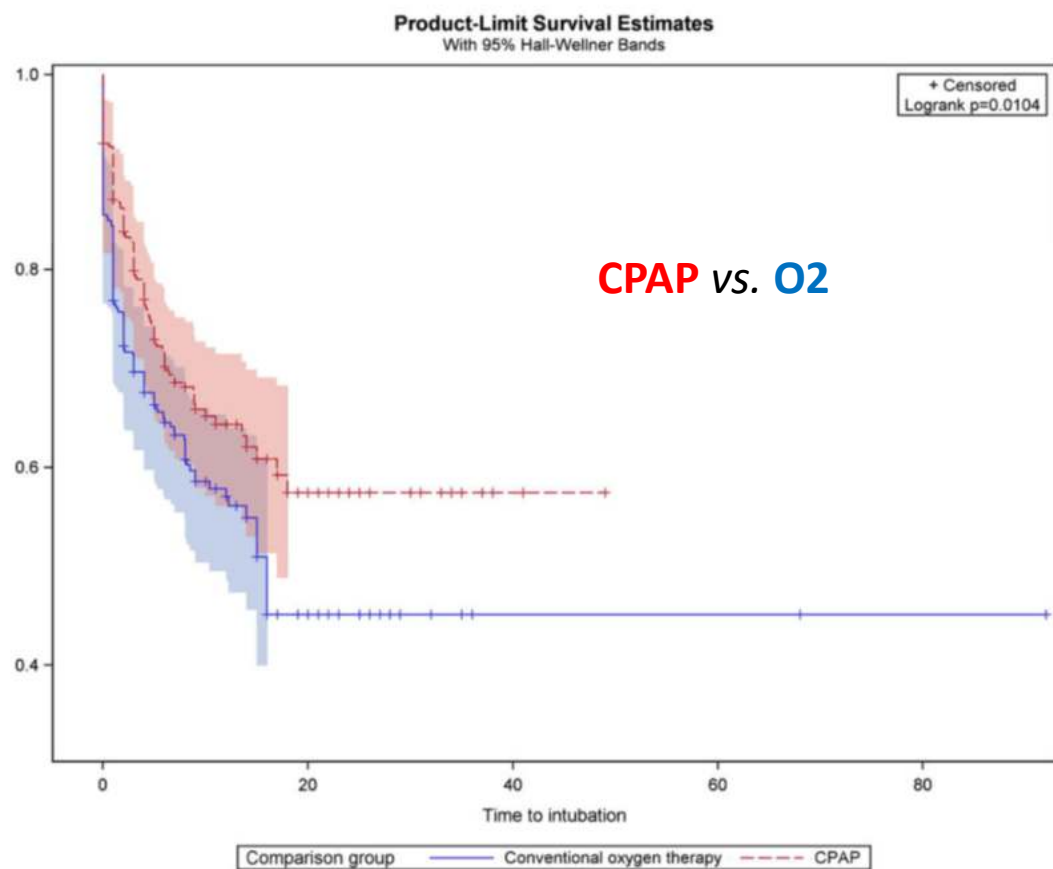
RECOVERY-RS (pre-print)

1272 patients

380 (29.9%): CPAP

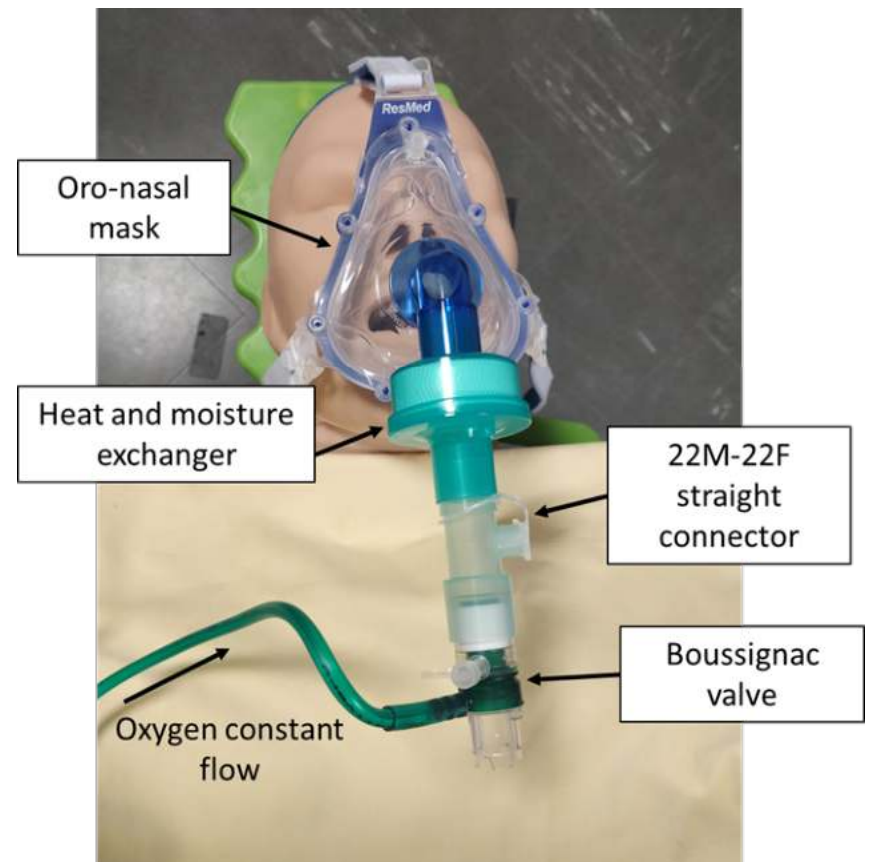
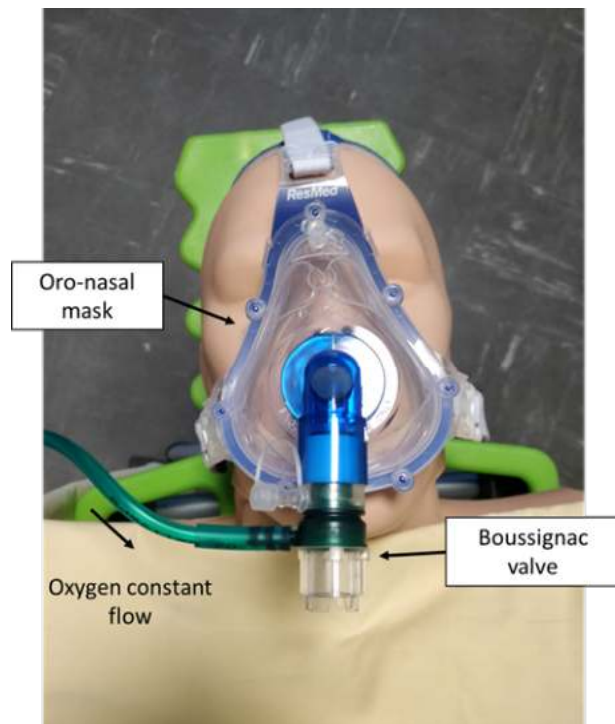
417 (32.8%): HFNO

475 (37.3%): O2



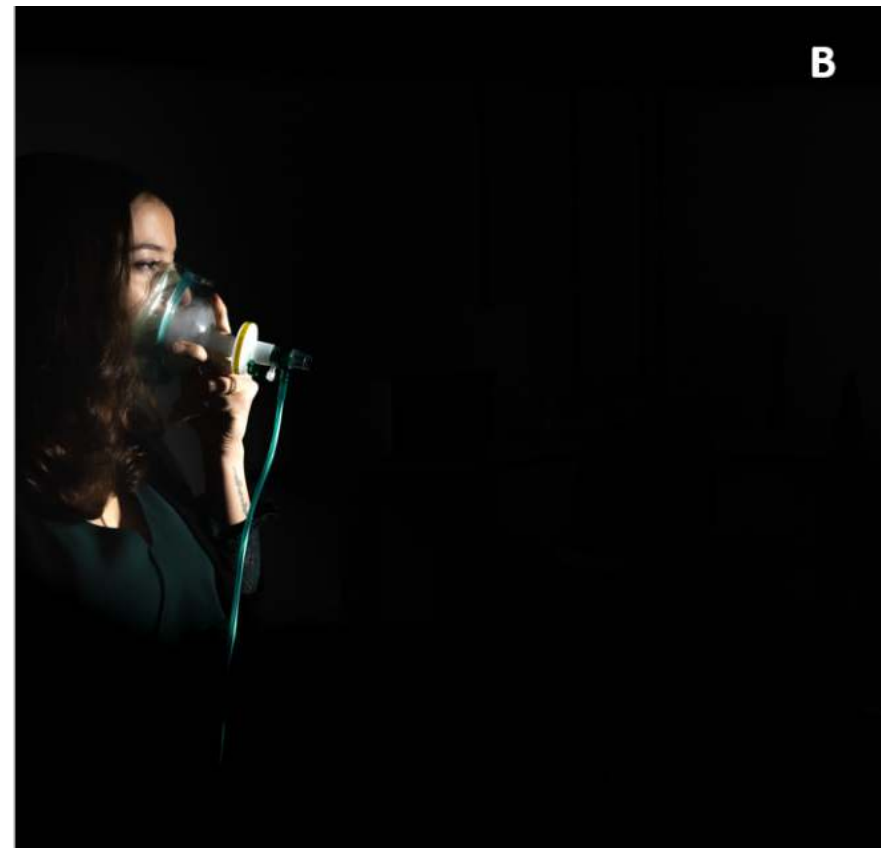


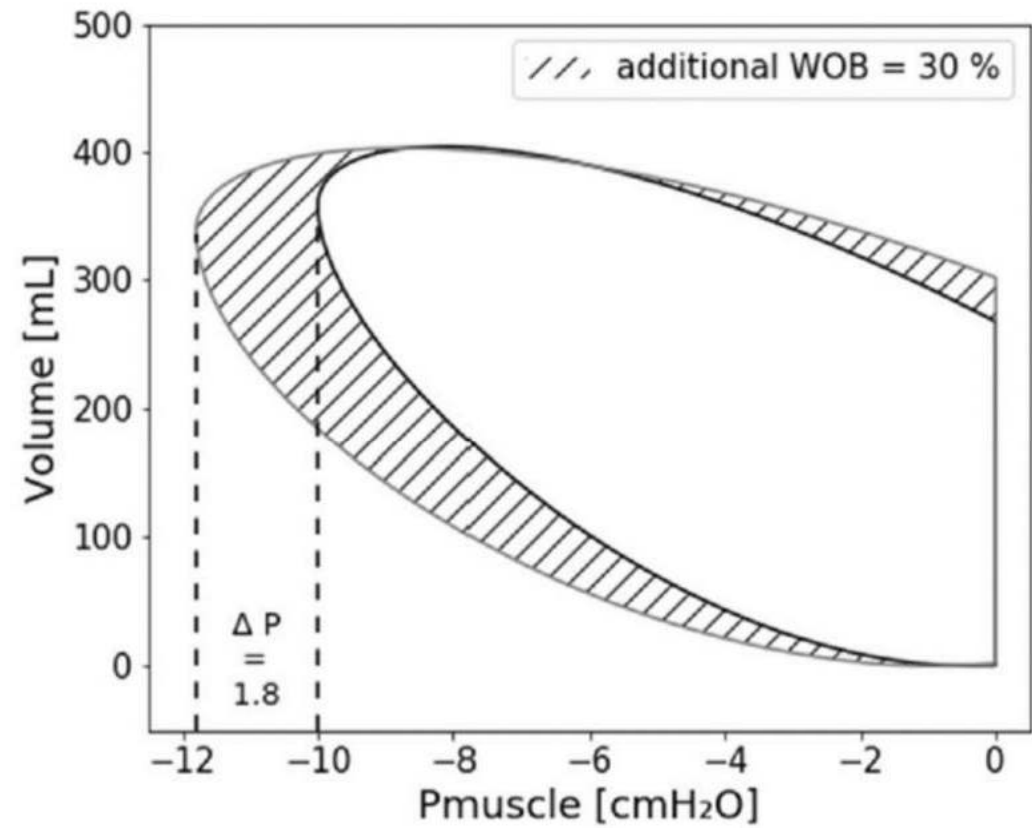
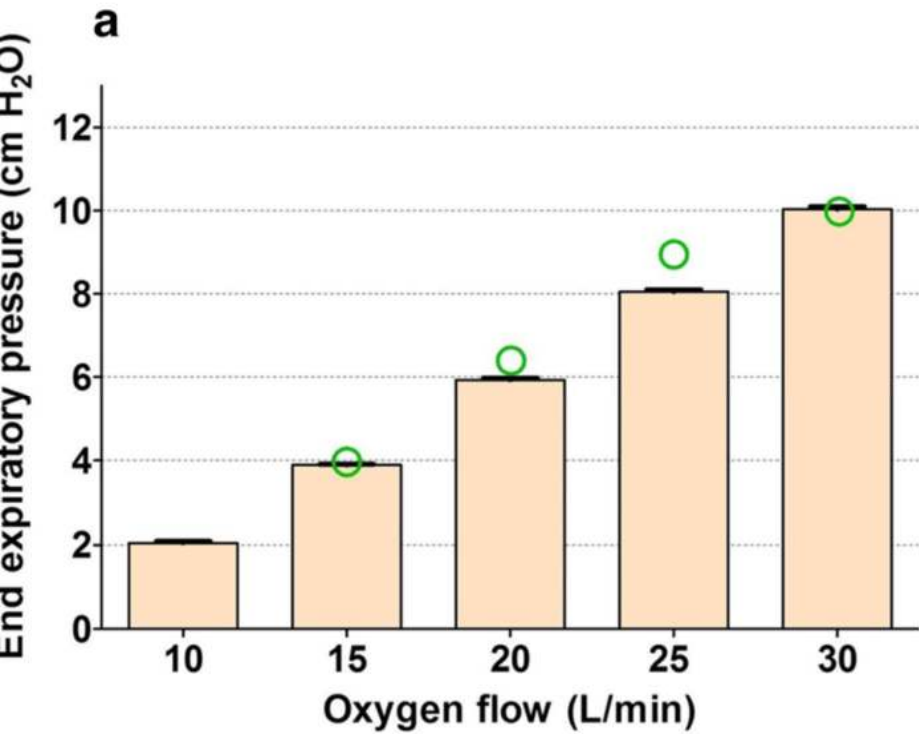
Georges Boussignac



Boussignac CPAP device

Without filter





Morin F congrès Réanimation

Carteaux *et al.* Ann Intensive Care



Continuous positive airway pressure respiratory support during COVID-19 pandemic: a frugal approach from bench to bedside

Intermediate care units

Non-ICU doctors
Non-ICU nurses

Training +++

Constraints:

Social distancing

Lack of trainers

Guillaume Carteaux^{1,2,3*}, Manuella Pons^{2,19†}, François Morin^{4†}, Samuel Tuffet^{1,2,3}, Arnaud Lesimple^{5,6}, Bilal Badat⁶, Anne-Fleur Haudebourg^{1,2,3}, François Perier^{1,2,3}, Yvon Deplante², Constance Guillaud⁷, Frédéric Schlemmer^{3,8}, Elena Fois⁹, Nicolas Mongardon¹⁰, Mehdi Khellaf¹¹, Karim Jaffal¹², Camille Deguillaud¹³, Philippe Grimbert¹⁴, Raphaëlle Huguet¹³, Keyvan Razazi^{1,2,3}, Nicolas de Prost^{1,2,3}, François Templier⁴, François Beloncle^{5,15}, Alain Mercat^{5,15}, Laurent Brochard^{16,17}, Vincent Audard^{14,18}, Pascal Lim^{3,13}, Jean-Christophe Richard^{15,20}, Dominique Savary^{4,21} and Armand Mekontso Dessap^{1,2,3}



Continuous positive airway pressure respiratory support during COVID-19 pandemic: a frugal approach from bench to bedside

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Video tutorial
< 5 min



Continuous positive airway pressure respiratory support during COVID-19 pneumonia: a frugal approach from bench to bedside

Intermediate care units

Non-ICU doctors
Non-ICU nurses

Training +++

Constraints:

Social distancing
Lack of trainers

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Video tutorial
< 5 min



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> 55 000
learners

<https://www.fun-mooc.fr/courses/course-v1:UPEC+169003+archiveouvert/about>



Continuous positive airway pressure respiratory support during COVID-19 pneumonia: a frugal approach from bench to bedside

h  85 « full code » patients

0%: indication for ICU admission

%: indication for intubation

Guillaume Carteaux^{1,2,3*} , Manuella Pons^{2,19†}, François Morin^{4†}, Samuel Tuffet^{1,2,3}, Arnaud Lesimple^{5,6}, Bilal Badat⁶, Anne-Fleur Haudebourg^{1,2,3}, François Perier^{1,2,3}, Yvon Deplante², Constance Guillaud⁷, Frédéric Schlemmer^{3,8}, Elena Fois⁹, Nicolas Mongardon¹⁰, Mehdi Khellaf¹¹, Karim Jaffal¹², Camille Deguilla¹³, Philippe Grimbert¹⁴, Raphaëlle Huguet¹³, Keyvan Razazi^{1,2,3}, Nicolas de Prost^{1,2,3}, François Templier⁴, François Beloncle^{5,15}, Alain Mercat^{5,15}, Laurent Brochard^{16,17}, Vincent Audard^{14,18}, Pascal Lim^{3,13}, Jean-Christophe Richard^{15,20}, Dominique Savary^{4,21} and Armand Mekontso Dessap^{1,2,3}



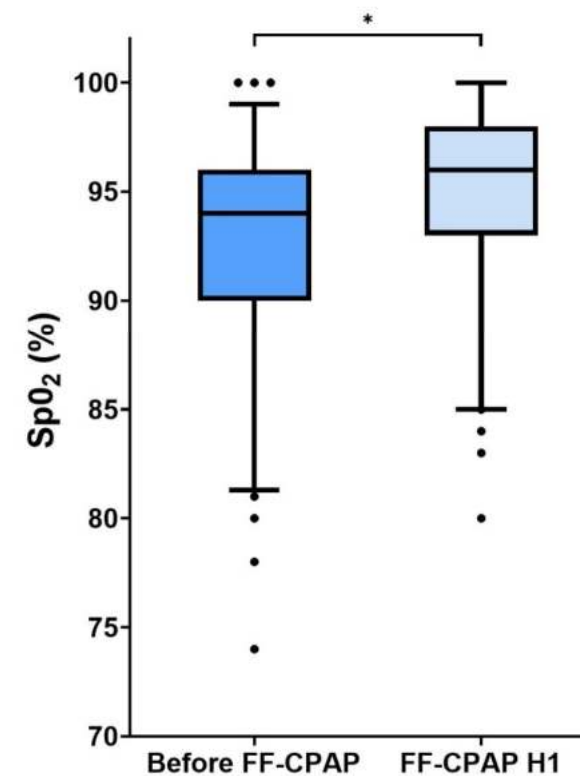
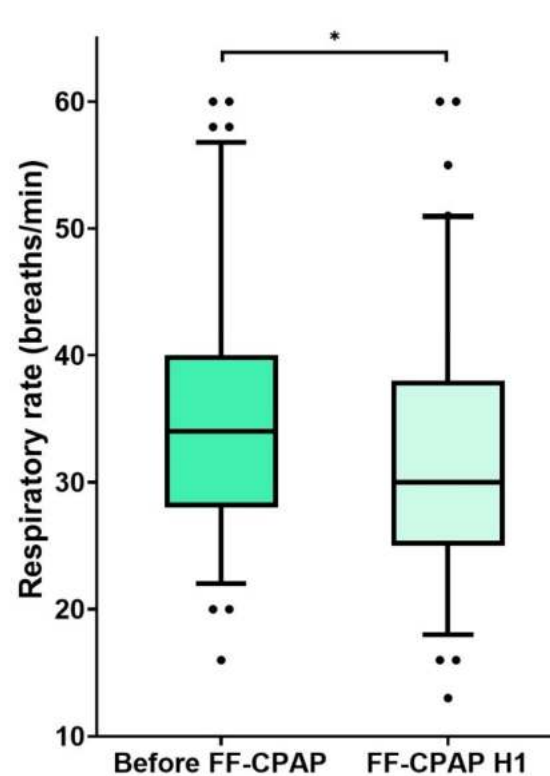
Continuous positive airway pressure respiratory support during COVID-19 sepsis: a frugal approach from bench to bedside

h  85 « full code » patients

0%: indication for ICU admission

%: indication for intubation

Guillaume Carteaux^{1,2,3*}, Manuella Pons^{2,19†}, François Morin^{4†}, Samuel Tuffet^{1,2,3}, Arnaud Lesimple^{5,6}, Bilal Badat⁶, Anne-Fleur Haudebourg^{1,2,3}, François Perier^{1,2,3}, Yvon Deplante², Constance Guillaud⁷, Frédéric Schlemmer^{3,8}, Elena Fois⁹, Nicolas Mongardon¹⁰, Mehdi Khellaf¹¹, Karim Jaffal¹², Camille Deguilla¹³, Philippe Grimbert¹⁴, Raphaëlle Huguet¹³, Keyvan Razazi^{1,2,3}, Nicolas de Prost^{1,2,3}, François Templier⁴, François Beloncle^{5,15}, Alain Mercat^{5,15}, Laurent Brochard^{16,17}, Vincent Audard^{14,18}, Pascal Lim^{3,13}, Jean-Christophe Richard^{15,20}, Dominique Savary^{4,21} and Armand Mekontso Dessap^{1,2,3}





Continuous positive airway pressure respiratory support during COVID-19 septic: a frugal approach from bench side

h  85 « full code » patients

0%: indication for ICU admission

%: indication for intubation

%: improvement

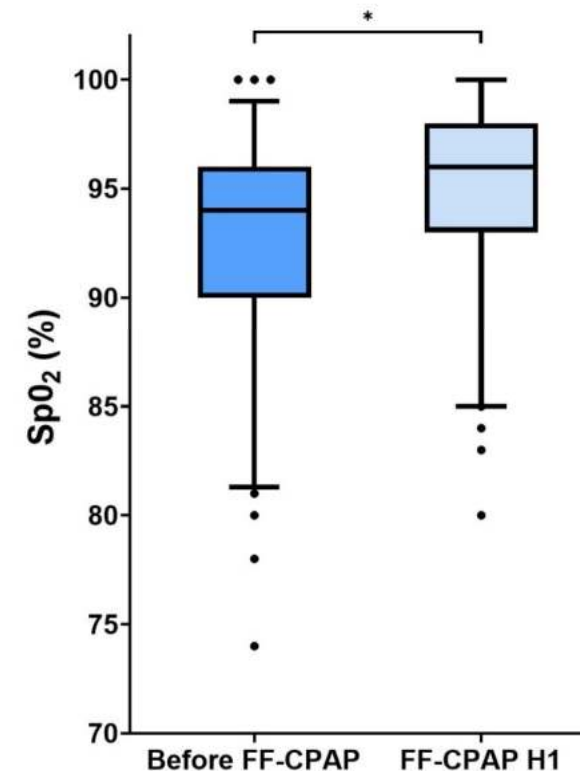
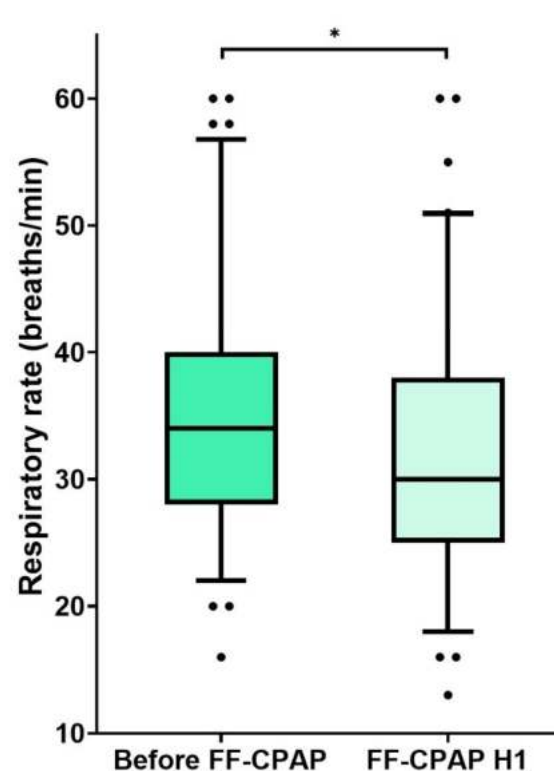
%: intubation after 2 (2-3) days

%: no ICU admission

patients with indication for intubation:

% not intubated

Guillaume Carteaux^{1,2,3*}, Manuella Pons^{2,19†}, François Morin^{4†}, Samuel Tuffet^{1,2,3}, Arnaud Lesimple^{5,6}, Bilal Badat⁶, Anne-Fleur Haudebourg^{1,2,3}, François Perier^{1,2,3}, Yvon Deplante², Constance Guillaud⁷, Frédéric Schlemmer^{3,8}, Elena Fois⁹, Nicolas Mongardon¹⁰, Mehdi Khellaf¹¹, Karim Jaffal¹², Camille Deguilla¹³, Philippe Grimbert¹⁴, Raphaëlle Huguet¹³, Keyvan Razazi^{1,2,3}, Nicolas de Prost^{1,2,3}, François Templier⁴, François Beloncle^{5,15}, Alain Mercat^{5,15}, Laurent Brochard^{16,17}, Vincent Audard^{14,18}, Pascal Lim^{3,13}, Jean-Christophe Richard^{15,20}, Dominique Savary^{4,21} and Armand Mekontso Dessap^{1,2,3}



OS ONE

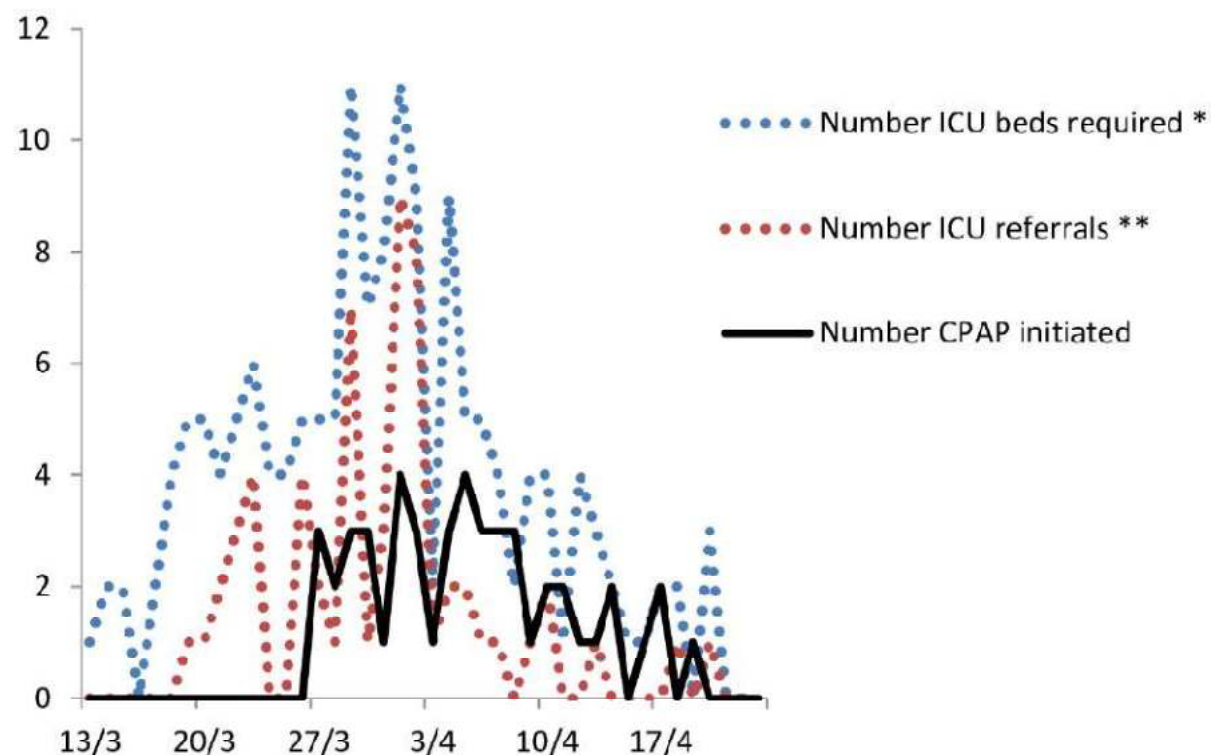
CH ARTICLE

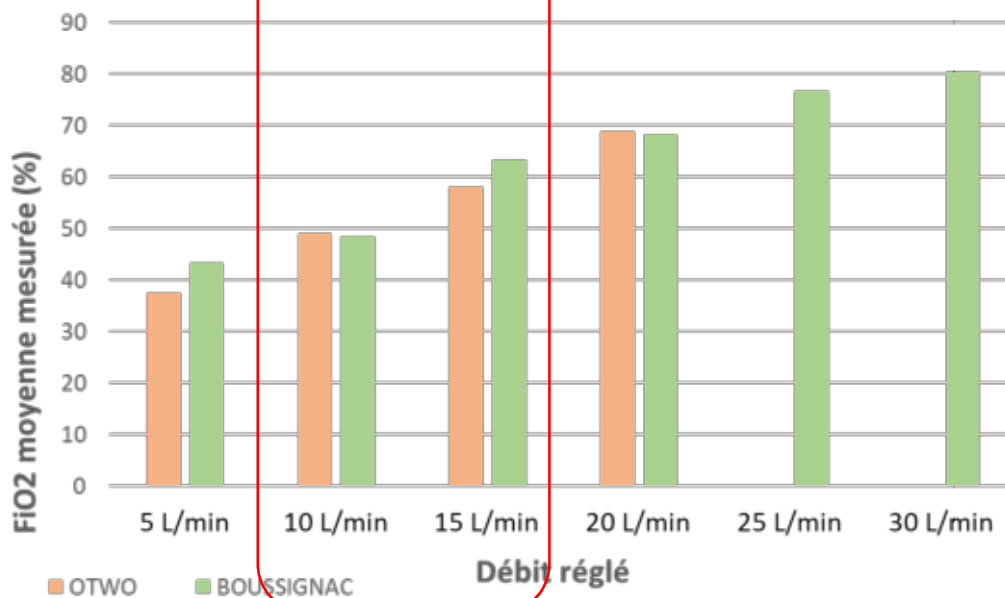
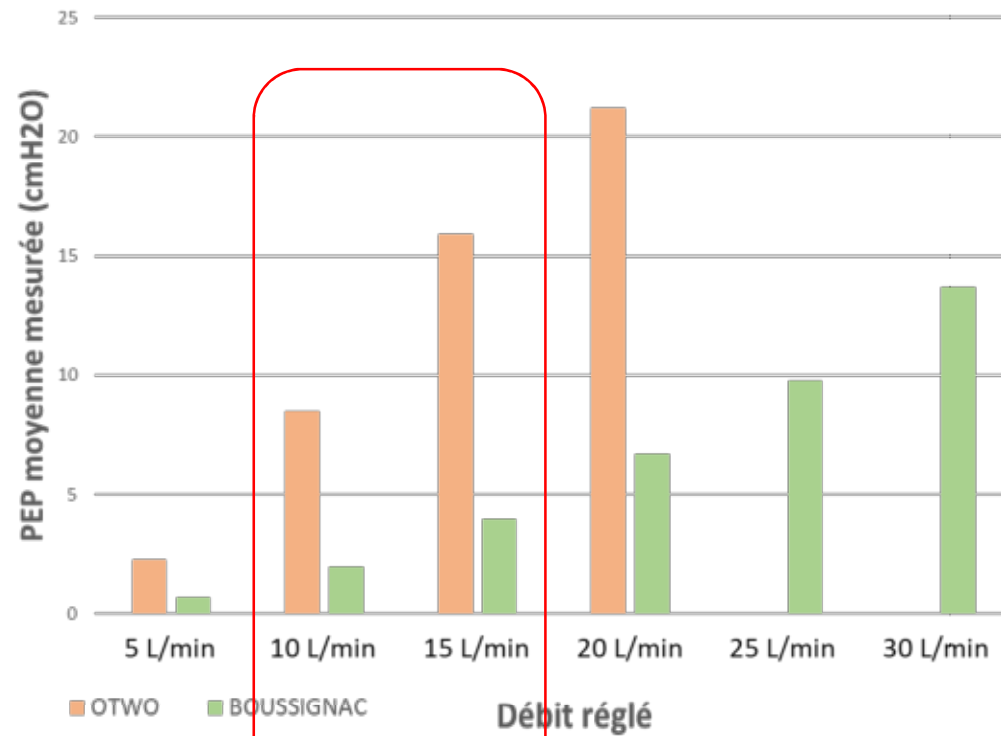
Continuous Positive Airway Pressure (CPAP)
-mask ventilation is an easy and cheap
on to manage a massive influx of patients
presenting acute respiratory failure during
SARS-CoV-2 outbreak: A retrospective
ort study

Alviset¹, Quentin Riller¹, Jérôme Aboab¹, Kelly Dilworth², Pierre-
Billy³, Yannis Lombardi¹, Mathilde Azzi¹, Luis Ferreira Vargas¹, Laurent Laine¹,
Lermuzeaux¹, Nathalie Mémain¹, Daniel Silva¹, Tona Tchoubou¹,
shmorova¹, Hanane Dabbagh⁴, Simon Escoda⁵, Rémi Lefrançois⁶,
e Nardi⁷, Armand Ngima⁸, Vincent loos^{1*}

14, 2020

49 CPAP, 80% out of the ICU



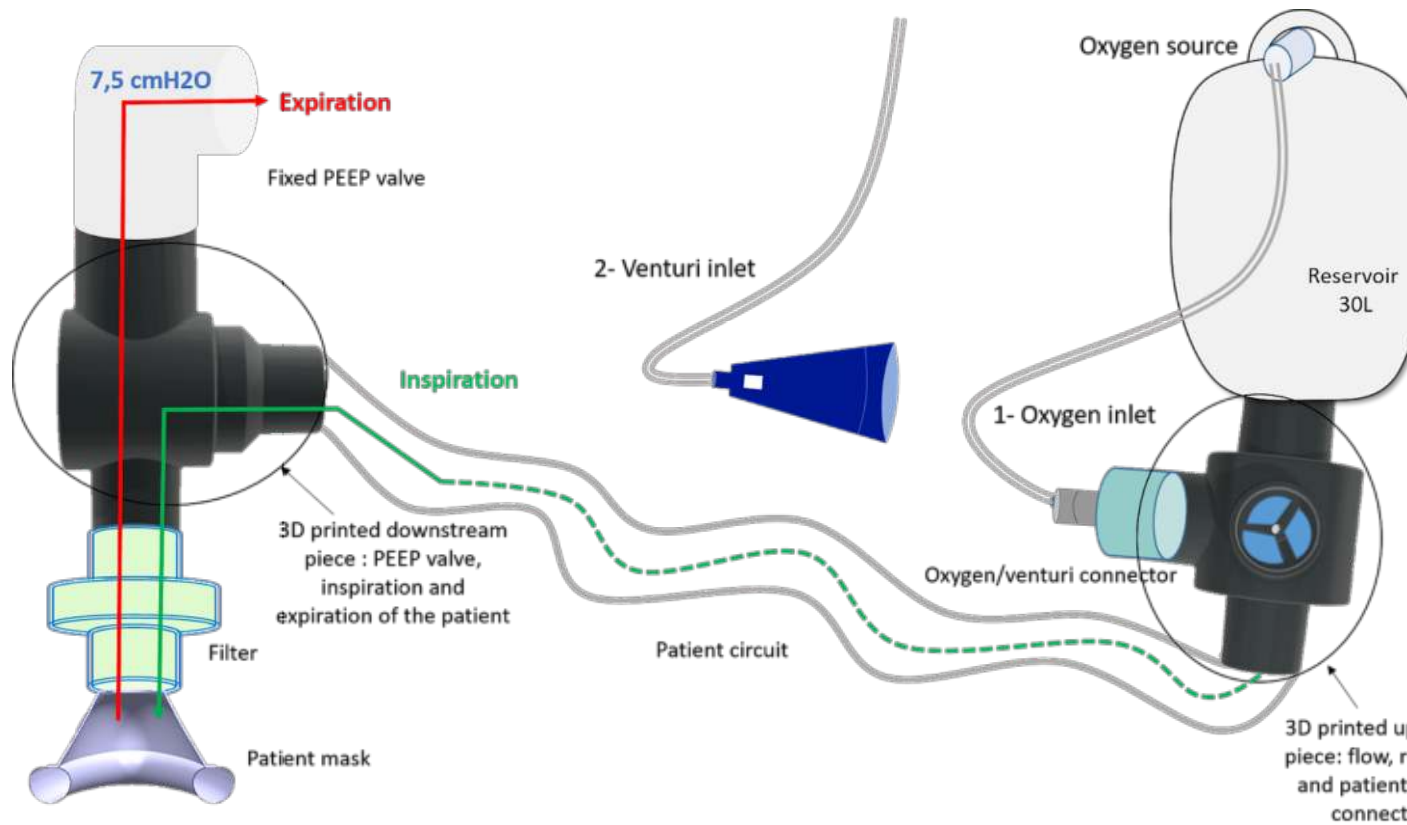


CPAP de Boussignac

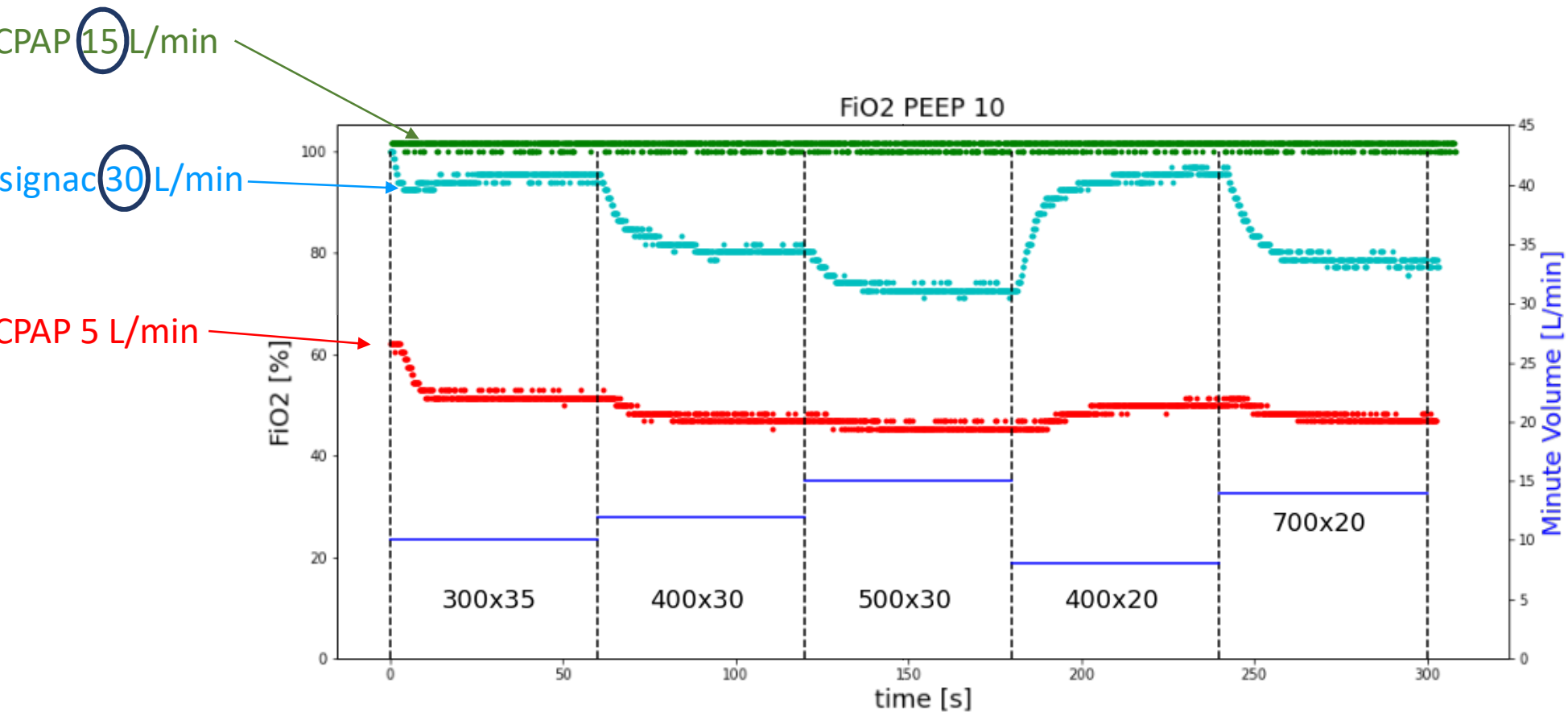


CPAP O-two

BAG-CPAP: prototype design



RESULTS: Evaluation of FiO2 according to various simulated patient efforts



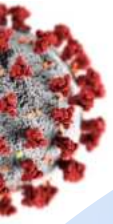
ors crise: nos environnements contraints



Support ventilatoire: les leçons de la crise

Solution frugale ventilatoire

= centrée sur le besoin



Efficienne

Oxygène (FiO_2)

Pression cible



Economie des ressources



Utilisation hors réanimation

Environnement

Personnels

Formation

Simplicité

