新冠病毒感染疫情期間
兒童插管與急救之特殊考量

高雄榮民總醫院
兒童醫學部
農寶仁

When to Intubate?

- no evidence-based guidelines.

- 一般原則:

  worsening hypoxemia and severe respiratory distress,
  refractory to oxygen supplementation, and
  noninvasive respiratory support

J Am Coll Emerg Physicians Open 2020;1:95-101
Emerg Med Pract 2020;22:1-28
Intensive Care Med 2020;46:837-40
Am J Respir Crit Care Med 2020;201:1319-20
Indian J Respir Care [serial online] 2021 [cited 2021 May 29];10, Suppl S1:24-8.

When to Intubate?

- Rapid progression over hours
- Lack of improvement on >50 L/minute of high flow oxygen and a fraction of inspired oxygen (FiO2) >0.6
- Evolving hypercapnia, increasing work of breathing, worsening mental status
- Hemodynamic instability or multiorgan failure
- Severe respiratory distress; exhaustion.
- Not able to maintain SpO2 > 90% on non-invasive oxygen supplementation
- PaO2/FiO2 < 200.
- PaO2/FiO2 < 300 with hypotension requiring vasopressor support
- GCS < 8 with threatened airway
- Decision to intubate should be taken on a case by case basis based on the clinician's discretion

Topic 127419 Version 92.0 uptodate

Indian J Pediatr. 2020 Jun;87(6):433-442.

When to Intubate?

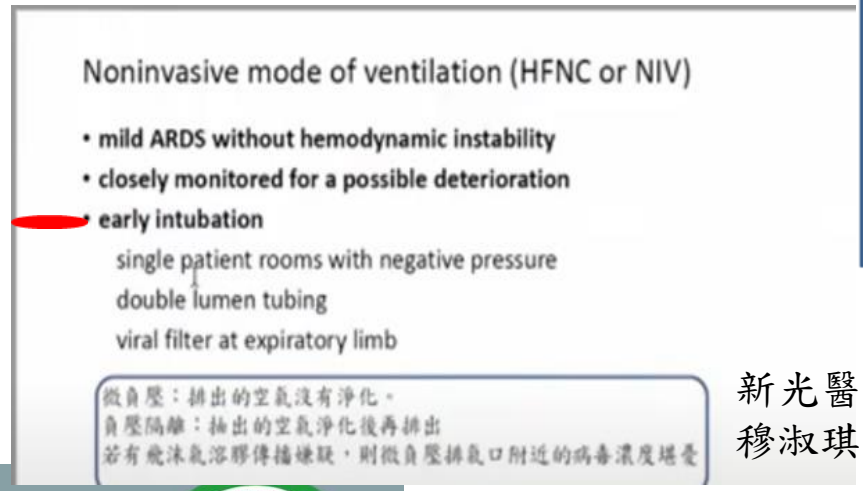
Topic 127419 Version 92.0 uptodate
Intensive Care Med 2020;46:837-40
Am J Respir Crit Care Med 2020;201:1319-20
J Am Coll Emerg Physicians Open 2020;1:95-101
Indian J Respir Care [serial online] 2021 [cited 2021 May 29];10, Suppl S1:24-8.
Last accessed on 2020 Sep 12
Lancet Respir Med 2020;8:e45

- Delaying intubation until the patient acutely decompensates is potentially harmful to the patient and healthcare workers and is not advised.
- Many experts with experience: suggest “early” intubation.
- Silent hypoxemia: a culprit in delayed intubation
- 專家意見:
- HFNC or NIV failure.

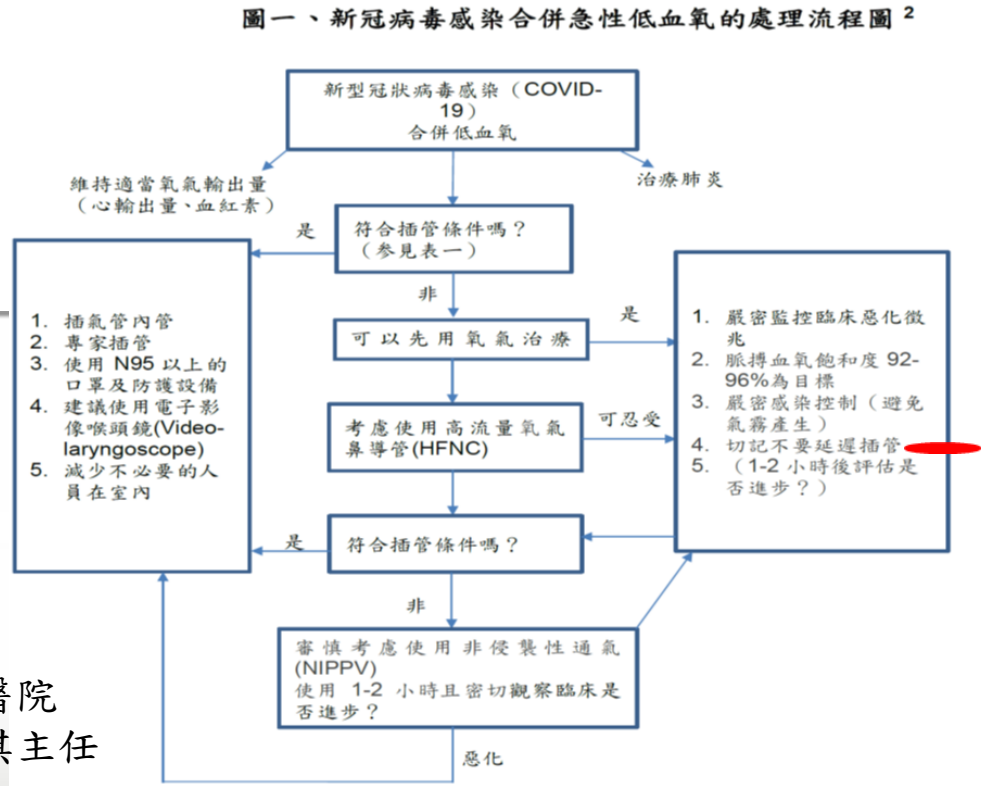
It is recommended to consider the
patient’s global clinical and physiological status
in the decision to intubate.

2021年6月6日 星期日 上午 09:30
美國紐約北岸大學醫院
長島猶太醫學中心感染科醫師
張凱銘醫師Kai-Ming Chang
【主題:新冠肺炎美國經驗大公開COVID-19 Recent Literature and Updates - Sharing of the US Experience】

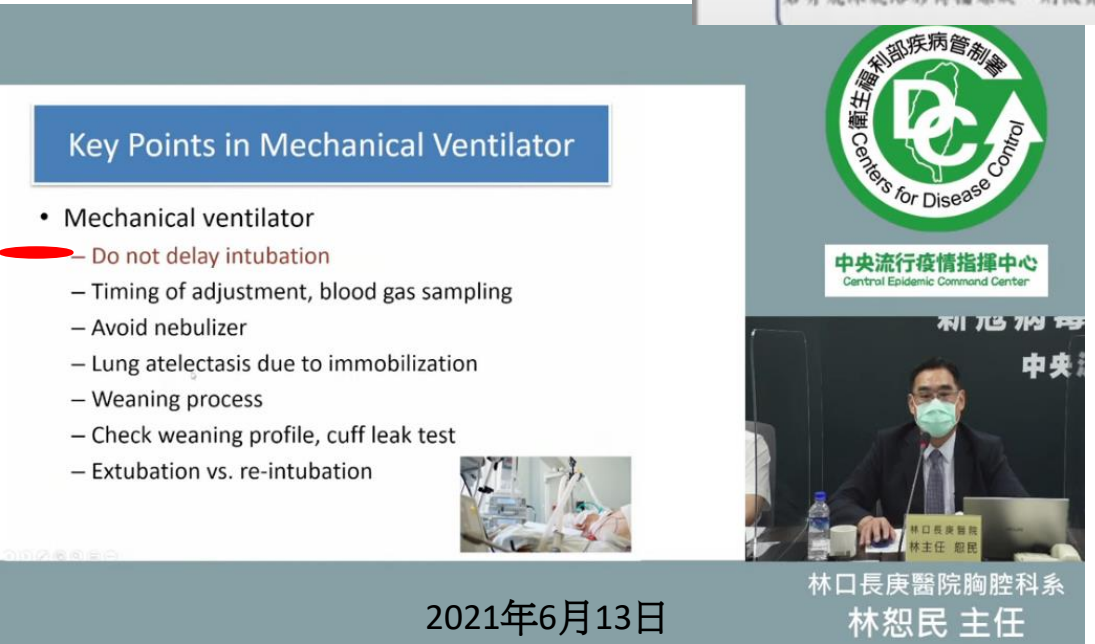
Early intubation?



新光醫院
穆淑琪主任



余忠仁院長 臺大醫院新竹台大分院
2021年6月12日



2021年6月13日

2021年6月16日 星期日 中午12:00
台北榮總胸腔部
呼吸感染免疫科
馮嘉毅主任

評論 高流量氧氣鼻導管於重症新冠肺炎病人的照護

$$\text{ROX index} = \frac{\text{SpO2/FiO2}}{\text{RR}}$$

Post intervention	2HR	6HR	12HR	anytime
ROX index	<2.85	<3.47	<3.85	>4.88
Decision	intubation	intubation	intubation	observation

Respiratory rate – Oxygenation index

不須抽血，不會增加醫療人員進出病室!

Respiratory Care June 2021, 66 (6) 891-896
Am J Respir Crit Care Med 2019,Vol 199, Iss 11, pp 1368–1376
Journal of Critical Care 35 (2016) 200–205

Table 4 Predicting power of high-flow nasal cannula failure by the pediatric respiratory rate-oxygenation index and pediatric respiratory rate-oxygenation index variation at 24 and 48 h of high-flow nasal cannula therapy

		Cutoff	Sensibility	Specificity	PPV	NPV
p-ROXI	24 h	66.7	86	79	23.1	98.8
	48 h	65.1	86	88	35.3	98.8
p-ROXV	24 h	24.0	86	65	14.6	98.6
	48 h	24.6	100	77	25.0	100

HFNC high-flow nasal cannula, *NPV* negative predictive value, *PPV* positive predictive value, *p-ROXI* pediatric respiratory rate-oxygenation index, *p-ROXV* pediatric respiratory rate-oxygenation index variation

Example of p-ROXI calculation:

$$\mathrm{SpO_2}/\mathrm{FiO_2}/\text{Respiratory rate z-score}$$

Example of p-ROXV calculation:

$$\text{First hour p-ROXV} = (\text{first hour p-ROXI} - \text{0-hour p-ROXI}) \times 100/\text{0-hour p-ROXI}$$

European Journal of Pediatrics https://doi.org/10.1007/s00431-020-03847-6

Key points of managing the airway

(1) minimize aerosolization and exposure;
minimizing the number of clinicians included

(2) maximize first-attempt intubation success
to reduce time and extent of exposure

(3) reduce personnel exposure by wearing personal protective equipment (PPE) or devices.

J Am Coll Emerg Physicians Open 2020;1:80-4
Indian J Respir Care [serial online] 2021 [cited 2021 May 29];10, Suppl S1:24-8.
Anesth Analg. 2020 Apr 20 : 10.1213/ANE.0000000000004872.Published online 2020 Apr 13. doi:10.1213/ANE.0000000000004872

Table 2. PeDI-C Recommendations for Airway Management in Pediatric Patients During the COVID-19 Pandemic

in negative pressure rooms when available.

Theme	Recommendations	Example Comments
Training	Context-sensitive simulation.	Pediatric patients; needs to be relevant to the perioperative and out of operating room procedures.
Cognitive aids	Develop, test, and share.	Need to address challenges related to processes, workflows, and clinical management. Development and testing should include nurses and other stakeholders.
Patient safety and clinical management	Use of sedation.	Coughing and crying can increase aerosolization.
	Parental presence at induction of anesthesia.	Should be avoided or minimized.
	IV induction.	Should minimize coughing and crying.
	Use of neuromuscular blockers for intubations.	Should be smooth and under clear plastic is needed.
	Extubation.	They can cause aerosolization, but a simple oxygen mask covering may prevent or reduce dispersion.
	Avoid nasal prongs.	
Staff safety	Personal protection equipment.	Needs to protect health care workers who are a scarce resource.
	Minimizing staff in the room.	Should work for the context of the operating room.
	Continued use of personal protection equipment during high-risk procedures or patients.	In centers with limited PPE supplies, PeDI-C felt that teams should be pared down to the minimum necessary, and cases should be consolidated into the fewest possible rooms to conserve PPE.
	High-risk staff (age, immunodeficiency, and pregnancy).	
	Anesthesia trainees.	

PLoS One. 2012;7:e35797.
Lymphat Res Biol. 2020.
N Engl J Med. 2020
Anesth Analg. 2020 Apr 20 : 10.1213/ANE.0000000000004872.Published online 2020 Apr 13. doi:10.1213/ANE.0000000000004872

流程列表

- 1. COVID-19 插管流程_20210520_第三版
- 2. COVID-19 胸管流程_20200211
- 3. COVID-19 胸部引流pigtail流程_20200214
- 4. COVID-19 ECMO流程_20200303
- 5. COVID-19 風險個案胃鏡流程及專責病房備物_20210305
- 6. COVID-19 洗腎流程
  - 6.1 COVID-19 急住門洗腎流程_20210604.V2
  - 6.2 COVID-19 血液透析流程_20200415
- 7. COVID-19 關懷流程(整合版)_20210604修

動力式與供氣式呼吸防護具呼吸防護 (PAPR)

可以提供舒適、整合的多種有害氣體防護，以提供呼吸、頭部、臉部、眼睛以及聽覺的保護。

插管防護

- 乙級PPE + PAPR (電動送風呼吸防護具, Powered Air Purifying Respirators)
- 重症專責病房

表二、個人防護裝備建議：

	呼吸防護		雙層手套	隔離衣 a.連身防護衣 b.防水隔離衣	全面罩護目裝備	髮帽
	外科口罩	N95 等級(含)以上口罩				
乙級防護	✓(N95 外)	✓	✓	✓a	✓	✓
丙級防護	✓(N95 外)	✓	✓	✓b	✓	✓

參考資料：

1. 台灣衛生福利部疾病管制署 新型冠狀病毒 SARS-CoV-2 感染臨床處置暫行指引第十版_20210514
2. 台灣衛生福利部疾病管制署，醫療機構因應嚴重特殊傳染性肺炎感染管制措施指引
3. 高雄榮民總醫院照護 COVID-19 各職類工作人員個人防護裝備_1090216 修

Powered Air-Purifying Respirators (PAPR) 動力空氣濾淨式呼吸防護具

KSVGH

插管流程 以下用藥步驟得依臨床情況增減變化。

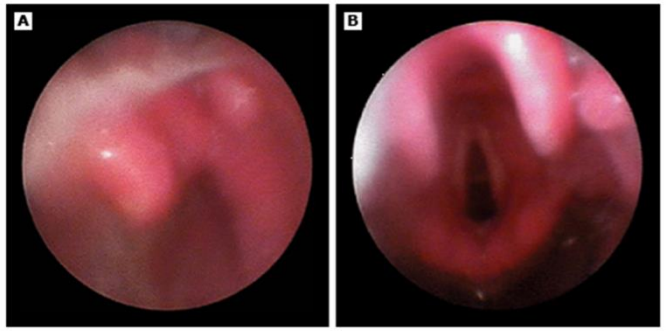
	情境	
	預期插管	**緊急插管**
插管人員 (著乙級防護及 PAPR*)	麻醉部醫師(聯絡插管專線 GSM: 79010)，行快速引導插管(RSI, Rapid Sequence Intubation)	臨床醫師負責，同步通知麻醉部支援 (聯絡插管專線 GSM: 79010)
病室內人員 (著乙級防護及 PAPR*)	麻醉部醫師 1 名、臨床醫師 1 名、W103 護理師 1 名	臨床醫師 1 名、W103 護理師 1 名 (麻醉部醫師在病室外 standby)
支援人員	臨床二線醫師	臨床二線醫師
前室 (著丙級防護)	**麻醉護理師**，在前室協助插管工具準備及消毒。	**W103 護理師**，在前室協助插管工具準備及消毒。
插管前給氧	NRM 給氧至少 3-5 分鐘 (麻醉抵達前可執行)	NRM 給氧，理想為至少 3-5 分鐘
插管前給藥	**RSI 流程(一般性給藥):** 1. fentanyl 1-3μg/kg	依病人(60Kg 成人)狀況可選擇其中一種 (表一):

各緊急處置聯絡窗口

處置	上班時段聯絡人	GSM	值班時段聯絡人	GSM
插管	麻醉科醫師	7[redacted]	麻醉科醫師	7[redacted]
Pig-tail	[redacted]醫師	7[redacted]	[redacted]醫師	7[redacted]
Chest tube	[redacted]主任	7[redacted]	[redacted]主任	7[redacted]
ECMO	[redacted]醫師	7[redacted]	[redacted]醫師	7[redacted]
重症	[redacted]醫師	7[redacted]	當日ICU值班醫師	
洗腎	當日值班醫師		當日值班醫師	
胃鏡	當日值班醫師		當日值班醫師	

KSVGH

View of glottis with and without external laryngeal manipulation



ELM improves the glottic view in more than 50 percent of patients with inadequate initial views. The photos show the view of the glottis without (A) and with (B) ELM.

ELM: external laryngeal manipulation.

Reproduced with permission from: Orebaugh SL. Direct laryngoscopy. In: Atlas of Airway Management: Techniques and Tools, Lippincott Williams & Wilkins, Philadelphia 2007. Copyright © 2007 Lippincott Williams & Wilkins. www.lww.com.

UpToDate

	(麻醉抵達前可執行)	
插管前給藥	**RSI 流程(一般性給藥):** 1. fentanyl 1-3μg/kg slow push or IV drip in 3min 2. lidocaine 0.5-1mg/kg IV push 3. propofol 1-2 mg/kg IV push 4. succinylcholine 0.3-1.1 mg/kg，或 rocuronium 1.2mg/kg	依病人(60Kg 成人)狀況可選擇其中一種(表一): A. O_2 saturation 差但血壓穩定意識清楚→ **midazolam** 1ml(1amp) (0.05-0.1mg/kg) **或 propofol** 6-12ml (1-2 mg/kg)，失去意識後抽取稀釋好的 **succinylcholine** 注射 5ml (事先 1amp 以 N/S 稀釋至 25ml) (0.3-1.1 mg/kg) B. O_2 saturation 差，血壓不穩定但尚有意識→ **midazolam** 1ml(1amp) (0.05-0.1mg/kg)(視情況減量)，失去意識後抽取稀釋好的 **succinylcholine** 注射 5ml(事先 1amp 以 N/S 稀釋至 25ml) (0.3-1.1 mg/kg) C. 病人 O_2 saturation 差，血壓不穩定且意識模糊→直接 **rocuronium** 7ml (1.2mg/kg) 後插管**

插管	● 等待 fasciculation 結束後執行插管(影像式) ● 若後續需要持續 sedation 以及 ventilator 使用可以補其他肌肉鬆弛劑	● 以影像式喉頭鏡挑起會厭，於螢幕上見聲帶開口，置入氣管內管，至適當深度後，拔除通條，接上呼吸氣。 ● 若要測定呼氣末二氧化碳，則**先**接上二氧化碳監測器再接上呼吸器。
呼氣末二氧化碳 $EtCO_2$ 測定	必要時，以二氧化碳監測器測定呼氣末二氧化碳，判別氣管內管是否置於氣管中(替代聽診器聽診)，$EtCO_2$>20 mmHg 即應為置於氣管中。	
開立 3434 chest X ray portable (收費碼: 40111)	照 portable CXR 以確認氣管內管位置是否適當	

*著 PAPR 時，乙級防護省略面罩及外科口罩

succinylcholine 可能造成 hyperkalemia 之副作用，故改用 **rocuronium

***$EtCO_2$: End tidal CO_2

****正常人的 End tidal CO_2 大約在 35-43mmHg 左右($PaCO_2$)

Appropriate PPE

- children shed the virus asymptomatically, even in stool, and infect others. 15% aymptomatic (1780)

[J Med Virol. 2020.; J Gastroenterol Hepatol; Emerg Microbes Infect. 2020;9:707–713.; Am J Gastroenterol. 2020. ; Eur J Pedia2020, 179:1029-1046]

- asymptomatic well infant reported high viral loads for 16 days.

[Clin Infect Dis. 2020;ciaa201.]

- Anywhere from 18% to 31% of COVID-19-positive passengers isolated on the Diamond Cruise ship never developed symptoms. (children included)

- Early periods of SARS-CoV-2 can lead to lower levels of sensitivity on screening tests.

[Radiology. 2020;200343.]

- A PPE coach should be available to ensure correct donning and doffing of PPE

[Anesth Analg. 2020 Apr 20 : 10.1213/ANE.0000000000004872.Published online 2020 Apr 13. doi: 10.1213/ANE.0000000000004872]

Case Preparation

- Plastic shield
- Prepare all drugs and equipment in advance
- Open trash can and sharps contaners
- No badges, keys, cell phones, pagers, and pens
  (Emergency phones may be kept in sealed bags to facilitate communication with other clinicians)

https://www.pediregistry.org/
Anesth Analg. 2020 Apr 20 : 10.1213/ANE.0000000000004872.

Premedication

- Use to reduce crying and aerosol generation
- Avoid nasal administration of premedication
  (because of the potential for high viral loads and
  the risk of coughing and sneezing)
- Avoid parental presence
  (to conserve PPE and reduce clinician exposure).
  --However, this will depend on the local infrastructure and
  practice especially in areas where PPE shortages are not of concern.

https://www.pediregistry.org/
Anesth Analg. 2020 Apr 20 : 10.1213/ANE.0000000000004872

Induction of Anesthesia/sedation

Intravenous

- Preferred method of induction
- Neuromuscular blocking agent recommended
- Consider rapid sequence induction

Mask induction (if required)

- Lowest possible flow
- Consider clear plastic barrier

Can J Anesth. 2020
Interim Guidance, 19 March 2020. Geneva, Switzerland:World Health Organization; 2020.
https://www.pediregistry.org/
Anesth Analg. 2020 Apr 20 : 10.1213/ANE.0000000000004872.

Intravenous Placement and Induction of Anesthesia

- IV induction is preferred. (as inhalational induction may increase exposure)

- However, should assess the child's disposition to IV catheter placement as struggling to place a catheter may result in higher exposure to respiratory droplets if the child cries.

- rapid sequence induction

https://www.pediregistry.org/
Anesth Analg. 2020 Apr 20 : 10.1213/ANE.0000000000004872

Figure 2.
(A)A depiction of transparent drapes being used as an aerosolization barrier during
mask induction in a patient;
(B)video laryngoscopy intubation in a manikin;
(C)direct laryngoscopy in a real patient;
(D)drape technique using an anesthesia elbow and suction under the transparent drapes.

https://www.cna.com.tw/news/aloc/202004180064.aspx

美國FDA建議如使用插管防護箱，必須要在負壓環境下，因為防護箱會限制執行者的手部空間，降低成功率，增加低血氧時間，損害防護用具，增加醫療照護者暴露，移除防護箱也會影響部分醫療處置
余忠仁院長 臺大醫院新竹台大分院
2021年6月12日　　CDC演講
==========

美國人手肘太長，所以覺得不好用？

Airway device

- Cuffed tracheal tube preferred
- Video laryngoscopy preferred
- Most experienced laryngoscopist
- In-line closed suctioning preferred
- Laryngeal airway with good seal acceptable
- Simple face mask may reduce aerosol dispersion
- Nasal cannula, bag mask ventilation less desirable
- Avoid clinician exposure with leak checks, use equipment instead

https://www.pediregistry.org/
Anesth Analg. 2020 Apr 20 : 10.1213/ANE.0000000000004872.

Difficult Airway 1

Points to consider

- Assemble airway team
- Check equipment/ just in time review
- Most experienced airway manager to performed
- 1st-videolaryngoscopy
- 2nd-fibroscopic through LMA
- 3rd combined fiberoptic with video layngoscopy
- 4th- considered an invasive airway [Front of Neck Access FONA/surgical]

可用NRM(Non-rebreathing mask)過渡

https://www.pediregistry.org/
Anesth Analg. 2020 Apr 20 :

Difficult Airway 2

- Consider neuromuscular blocking agent
- If unable to avoid bag mask ventilation, use low tidal volumes with two-person techinique
- Avoid passive oxygenation if tolerated
- LMA as rescue device

https://www.pediregistry.org/
Anesth Analg. 2020 Apr 20 : 10.1213/ANE.0000000000004872.
Published online 2020 Apr 13. doi:
10.1213/ANE.0000000000004872

Emergency and Extubation

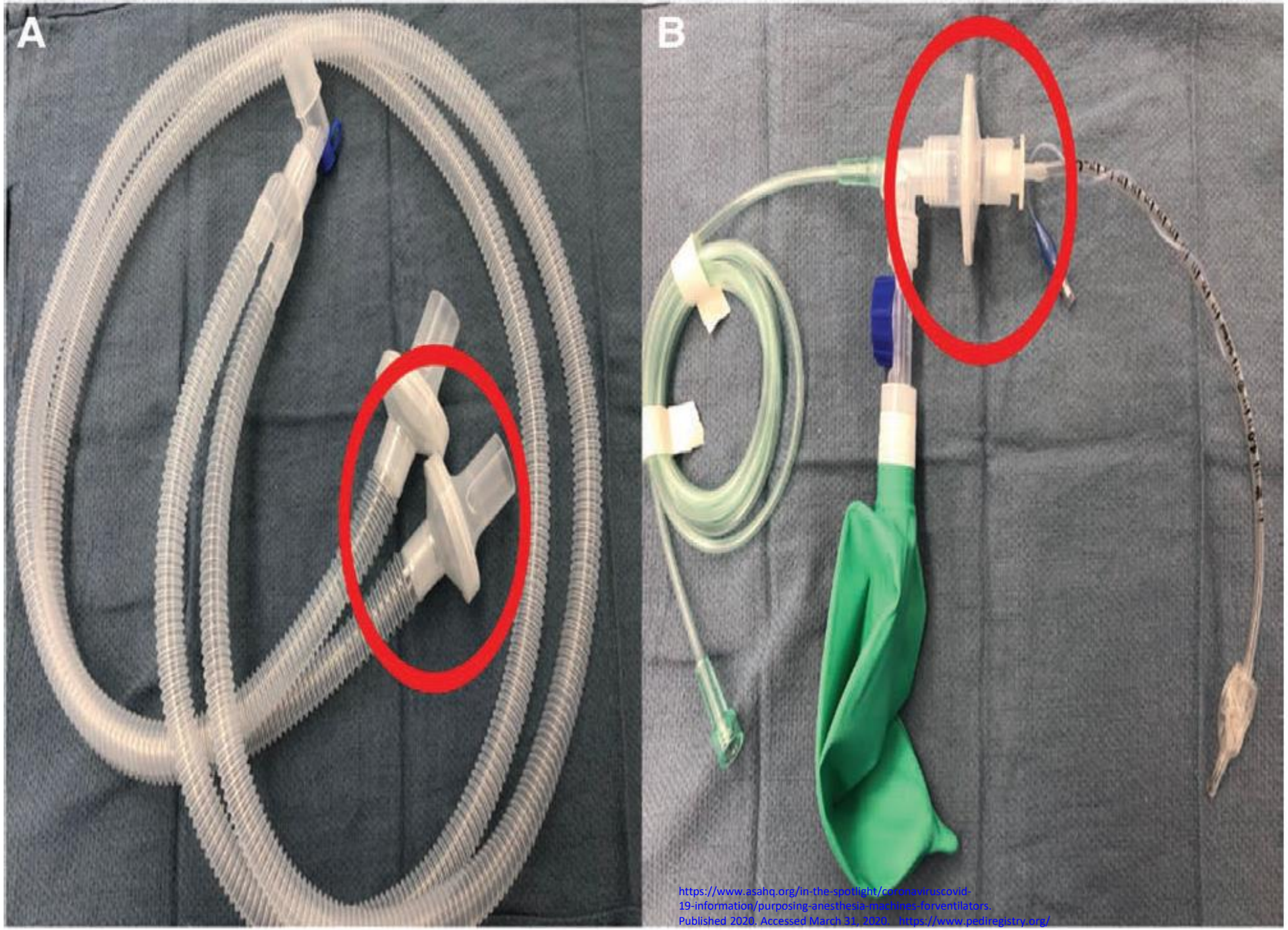
- In-line closed-suctioning preferred
- Clear plastic barrier in place
- Recover in the operating room
- Consider **deep extubation**
- Minimize coughing [TIVA, Dexmed, propofol, lidocaine]
- Avoid common patient area

https://www.pediregistry.org/
Anesth Analg. 2020 Apr 20 : 10.1213/ANE.0000000000004872.

Transporting Intubated Patients

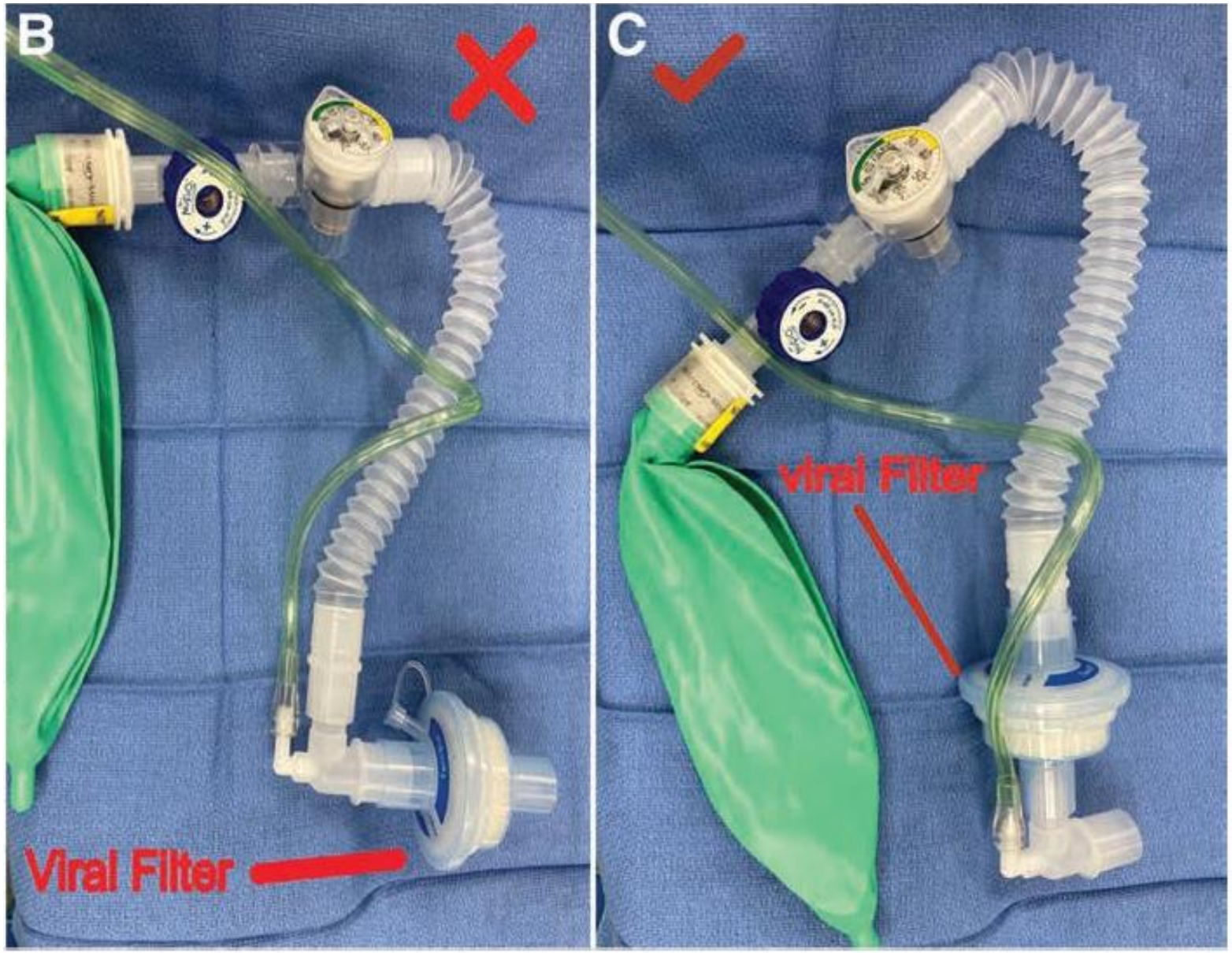
- a viral filter on patient side and expiratory limb of ventilators
- viral filter between endotracheal tube adaptor and manual transport circuit
- Consider optimizing sedation and/or neuromuscular blocking drug (weigh the risks and benefits)

https://www.asahq.org/in-the-spotlight/coronaviruscovid-19-information/purposing-anesthesia-machines-forventilators. Published 2020. Accessed March 31, 2020. https://www.pediregistry
Anesth Analg. 2020 Apr 20 : 10.1213/ANE.0000000000004872.



https://www.asahq.org/in-the-spotlight/coronaviruscovid-19-information/purposing-anesthesia-machines-forventilators. Published 2020. Accessed March 31, 2020. https://www.pediregistry.org/
Anesth Analg. 2020 Apr 20 : 10.1213/ANE.0000000000004872

Figure 3. A, Standard viral filters (red circle) present on inspiratory and expiratory limbs of an anesthesia circuit depending on manufacturer can be removed and used as a viral filter for a transport circuit for patient transport. B, Viral filter (red circle) removed from anesthesia circuit and inserted between the endotracheal tube adapter and transport circuit.



https://www.asahq.org/in-the-spotlight/coronaviruscovid-19-information/purposing-anesthesia-machines-forventilators. Published 2020. Accessed March 31, 2020. https://www.pediregistry.org/
Anesth Analg. 2020 Apr 20 : 10.1213/ANE.0000000000004872

Figure 4. B, A Mapleson D breathing circuit with a viral filter at the distal end. Not suitable for infants, neonates, and small children because of the dead space of the filter and potential rebreathing. C, A Mapleson D breathing circuit with a viral filter proximal to the fresh gas flow. Preferred in infants, neonates,and small children.

Infrastructure

- negative pressure room for aerosol-generating medical procedure
- Ensure **adequate air exchange**
- If negative pressure room are **not** available, use high-efficiency particulate air (HEPA) filters as appropriate for square footage

Anesth Analg. 2020
https://www.pediregistry.org/
Anesth Analg. 2020 Apr 20 : 10.1213/ANE.0000000000004872.

Interim Guidance for Basic and Advanced Life Support in Children and Neonates With Suspected or Confirmed COVID-19

- COVID-19 is highly transmissible, particularly during resuscitation.

- The challenge is to ensure that patients with or without COVID-19 who experience cardiac arrest get the best possible chance of survival **without compromising the safety of rescuers,**

  who will be needed to care for future patients.

Pediatrics May 2020, e20201405; DOI: https://doi.org/10.1542/peds.2020-1405

Summary of adjustments to CPR algorithms in suspected or confirmed COVID-19 patients.

Reduce provider exposure

- Don PPE before entering the room/scene
- Limit personnel
- Consider using mechanical CPR devices for adolescents who meet height and weight criteria
- Communicate COVID-19 status to any new providers

Pediatrics May 2020, e20201405; DOI: https://doi.org/10.1542/peds.2020-1405

Summary of adjustments to CPR algorithms in suspected or confirmed COVID-19 patients.

Prioritize oxygenation and ventilation strategies with lower aerosolization risk

- Use a HEPA filter, if available, for all ventilation
- Intubate early with a cuffed tube, if possible, and connect to mechanical ventilator, when able
- Engage the intubator with highest chance of first-pass success
- Pause chest compressions to intubate
- Consider use of video laryngoscopy, if available
- Before intubation, use a bag-mask device (or T-piece in neonates) with a HEPA filter and a tight seal
- If intubation delayed, consider supraglottic airway
- Minimize closed circuit disconnections

Pediatrics May 2020, e20201405; DOI: https://doi.org/10.1542/peds.2020-1405

European Resuscitation Council COVID-19 guidelines executive summary

Paediatric basic and advanced life support with suspected or confirmed COVID-19

7 Country/17 medical centers

Out-of-hospital

- Check for responsiveness - in an unresponsive child,
  assess breathing **visually** (**chest rise**).
  Do **not** approach the child's mouth or nose at this stage.
  Cardiac arrest is defined by 'being unresponsive and not breathing normally'.

- Once cardiac arrest is identified,
  rescuers should provide at least compression-only CPR.
  Place a surgical **mask** or other face **mask** (if available) over
  the child's mouth and nose before commencing chest compressions

  或以衣物遮口鼻

RESUSCITATION153(2020)45-55

Paediatric basic and advanced life support with suspected or confirmed COVID-19

Children are susceptible to COVID-19 but often seem to have only mild disease.[33–39] Very young children and children with co-morbid diseases may be more prone to severe illness.[40,41]

In approximately 70% of paediatric out-of-hospital cardiac arrests, rescuers are likely to be family members and therefore, if the child is infected with SARS-CoV-2, they are likely to have had previous exposure to the virus. They might also consider their personal risk far less important than the potential benefit for the child. This is unlikely to be true for random bystanders. Healthcare providers may also value the benefit for the child higher than their personal risk, but they should be aware of their responsibility towards their relatives, colleagues and the wider community as well.[42]

Basic life support for children

- Check for *responsiveness* - in an unresponsive child, assess *breathing* visually (chest rise). Do not approach the child's mouth or nose at this stage. Cardiac arrest is defined by 'being unresponsive and not breathing normally'.
- Untrained lay rescuers will likely have called the EMS dispatcher (112/national emergency number) at the start; trained providers should do so before starting chest compressions. In cases where there are two or more rescuers, a second rescuer should call the EMS immediately.

Healthcare providers may also value the benefit for the child higher than their personal risk,

but they should be aware of their responsibility towards their relatives, colleagues and the wider community as well.

RESUSCITATION153(2020)45-55

Table 1 – ILCOR treatment recommendations for cardiopulmonary resuscitation (CPR) in patients with COVID-19.

- We suggest that chest compressions and cardiopulmonary resuscitation have the potential to generate aerosols (weak recommendation, very low certainty evidence).
- We suggest that in the current COVID-19 pandemic lay rescuers consider compression-only resuscitation and public-access defibrillation (good practice statement).
- We suggest that in the current COVID-19 pandemic, lay rescuers who are willing, trained and able to do so, may wish to deliver rescue breaths to children in addition to chest compressions (good practice statement).
- We suggest that in the current COVID-19 pandemic, healthcare professionals should use personal protective equipment for aerosol-generating procedures during resuscitation (weak recommendation, very low certainty evidence).
- We suggest that it may be reasonable for healthcare providers to consider defibrillation before donning aerosol generating personal protective equipment in situations where the provider assesses the benefits may exceed the risks (good practice statement).

Pediatric RESEARCH

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SPECIAL ARTICLE OPEN

COVID-19 PICU guidelines: for high- and limited-resource settings

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11 contrys/15 medical centers

Ventilation

1. In children with COVID-19 infection and hypoxemia, begin supplemental oxygen therapy by low-flow nasal cannula when oxygen saturations (SpO2) are **<90%.** If the patient continues with hypoxemia, oxygen delivery via a face mask with reservoir bag should be initiated.
Strong
2. Children with COVID-19 that remain with increased work of breathing and hypoxemia should be escalated to high flow nasal cannula (HFNC) if available. Patients with progressive respiratory distress or where HFNC is unavailable can be escalated to noninvasive positive pressure ventilation (NIPPV), bubble continuous positive airway pressure (bCPAP) or bilevel positive airway pressure (BiPAP).
Strong
3. Children with COVID-19 **failing NIPPV should be escalated to mechanical ventilation**.
Strong
4. In children with COVID-19 requiring intubation, the procedure should be done by a **trained** and **skilled** health-care provider.
Strong
5. Children with COVID-19 requiring intubation should be intubated with a **cuffed** endotracheal tube.
Strong
6. For children with COVID-19 requiring intubation, use of **video laryngoscopy** should be considered for intubation.
Weak
7. Personal protective equipment (**PPE**) should be worn for **intubation** and **extubation** of all children with COVID-19.
Strong
8. For children with COVID-19 requiring mechanical ventilation, tidal volumes should be limited to 6 ml/kg.
Weak
9. For children with COVID-19 requiring mechanical ventilation, positive end expiratory pressure (PEEP) titration should be individualized to each patient and their phase of ARDS.
Weak
10. For children with COVID-19 requiring mechanical ventilation, prone position should be considered in patients with ARDS and severe hypoxemia.
Weak
11. For children with COVID-19 requiring mechanical ventilation with refractory hypoxemia, use of Inhaled nitric oxide is not recommended.
Insufficient evidence
12. For children with COVID-19 requiring mechanical ventilation, high-frequency oscillatory ventilation (HFOV) is not recommended for routine application but may be considered in select cases.
Insufficient evidence

Pediatric Research (2020) 88:705–716

Hemodynamic support

13. For children with COVID-19 and shock admitted to health systems with PICU availability (ventilatory support and access to vasoactive amines), administer bolus fluids, **10–20 ml/kg** per bolus up to **40–60 ml/kg**, over the first hour of resuscitation.
Weak
14. For children with COVID-19 and shock admitted to health systems without PICU availability (no ventilatory support and access to vasoactive amines):
a. Patients without hypotension, no fluid bolus should be administered, and maintenance fluids should be initiated.
Strong
b. Patients with hypotension, administer bolus fluids, 10–20 ml/kg per bolus up to 40 ml/kg, over the first hour of resuscitation.
Weak
15. In children with COVID-19 and shock, **crystalloid solutions** should be administered, instead of colloids, for the initial fluid resuscitation. Specifically, we recommend use of balanced solutions over 0.9% saline.
Weak
16. In children with COVID-19 and shock, age-appropriate mean arterial pressure (MAP) should be targeted. In settings where accurate MAPs cannot be easily obtained, systolic blood pressure is an acceptable option.
Strong
17. In children with COVID-19 and shock, consider the use of advanced hemodynamic variables, when available (measurements of cardiac index, systemic vascular resistance, and central venous oxygen saturation); these along with clinical variables at the bedside can guide resuscitation.
Weak

Pediatric Research (2020) 88:705–716

Hemodynamic support

18. In children with COVID-19 and shock, in addition to clinical evaluation, trends in blood lactate levels can help guide resuscitation.
Weak
19. In children with COVID-19 and shock, **epinephrine** or **norepinephrine** should be administered, instead of dopamine. Diluted solution can be initiated through a peripheral intravenous catheter if central venous access is not available.
Best practice
20. In children with COVID-19 and shock who need high doses of catecholamines, consider initiating vasopressin.
Best practice
21. In children with COVID-19 and shock, recommendations regarding the use of inodilators cannot be made. But in clinical practice, inodilators such as milrinone, dobutamine or levosimendan could be used when there are signs of tissue hypoperfusion and cardiac dysfunction, despite high doses of catecholamines.
Best practice
22. In children with COVID-19 and **refractory shock**, consider anti-inflammatory doses of **glucocorticoids**.
Insufficient evidence
23. In a pediatric patient with COVID-19 and severe disease, a thorough cardiac evaluation should be conducted including an EKG, echocardiography and cardiac biomarker levels (troponin, CK and CK MB).
Strong
24. **Glucocorticoid anti-inflammatory therapy** and **IVIG** are potential suggested treatments for children with COVID-19-related **myocarditis**.
Insufficient evidence

Epinephrine
should be considered as the first-line agent in patients with myocardial dysfunction;
norepinephrine
for patients with low systemic vascular resistance,

as recommended in Surviving Sepsis Campaign (SSC) guidelines.

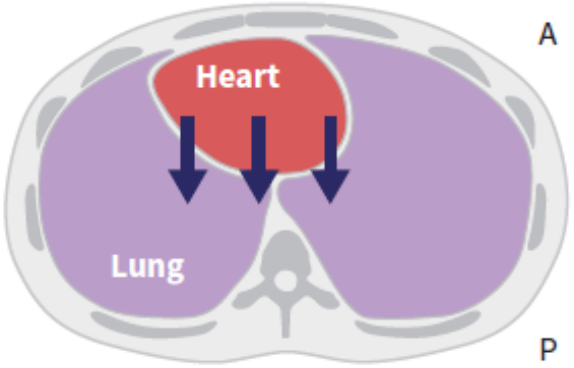
Pediatric Research (2020) 88:705–716

CPR/Resuscitation

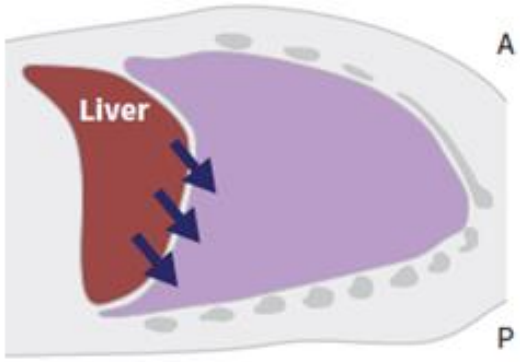
30. **Limit the number of personnel** in the room for pediatric patients with COVID-19 that require CPR.
Best practice
31. For COVID-19 pediatric patients that have arrested
follow standard cardiac arrest guidelines for CPR ratios, and treatments.
Best practice
32. For intubated patients, recommendations include:
a. Increase the FIO2 to 1.0.
b. Change mode to Pressure Control Ventilation and limit pressure as needed to generate adequate chest rise.
c. Adjusting the trigger to Off will prevent the ventilator from auto-triggering with chest compressions and may prevent hyperventilation.
d. Adjust respiratory rate to 10/min for adults and children.
e. Adjust PEEP level to balance lung volumes and venous return.
f. If return of spontaneous circulation is achieved, set ventilator settings as appropriate to patient's clinical condition
Best practice

Pediatric Research (2020) 88:705–716

supine



Gravitational pressure of heart and mediastinum on the lungs.

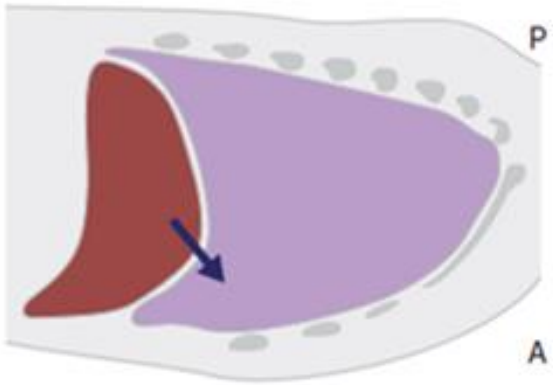


Compressive effects of the abdominal organs on the lungs.

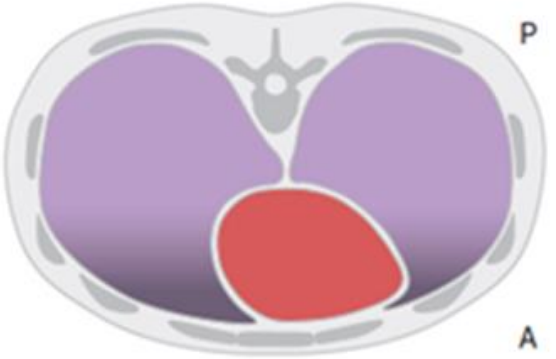
Expansion of the chest wall and overall less homogeneous chest wall compliance.

prone

Decreased gravitational pressure of heart and mediastinum on the lungs.



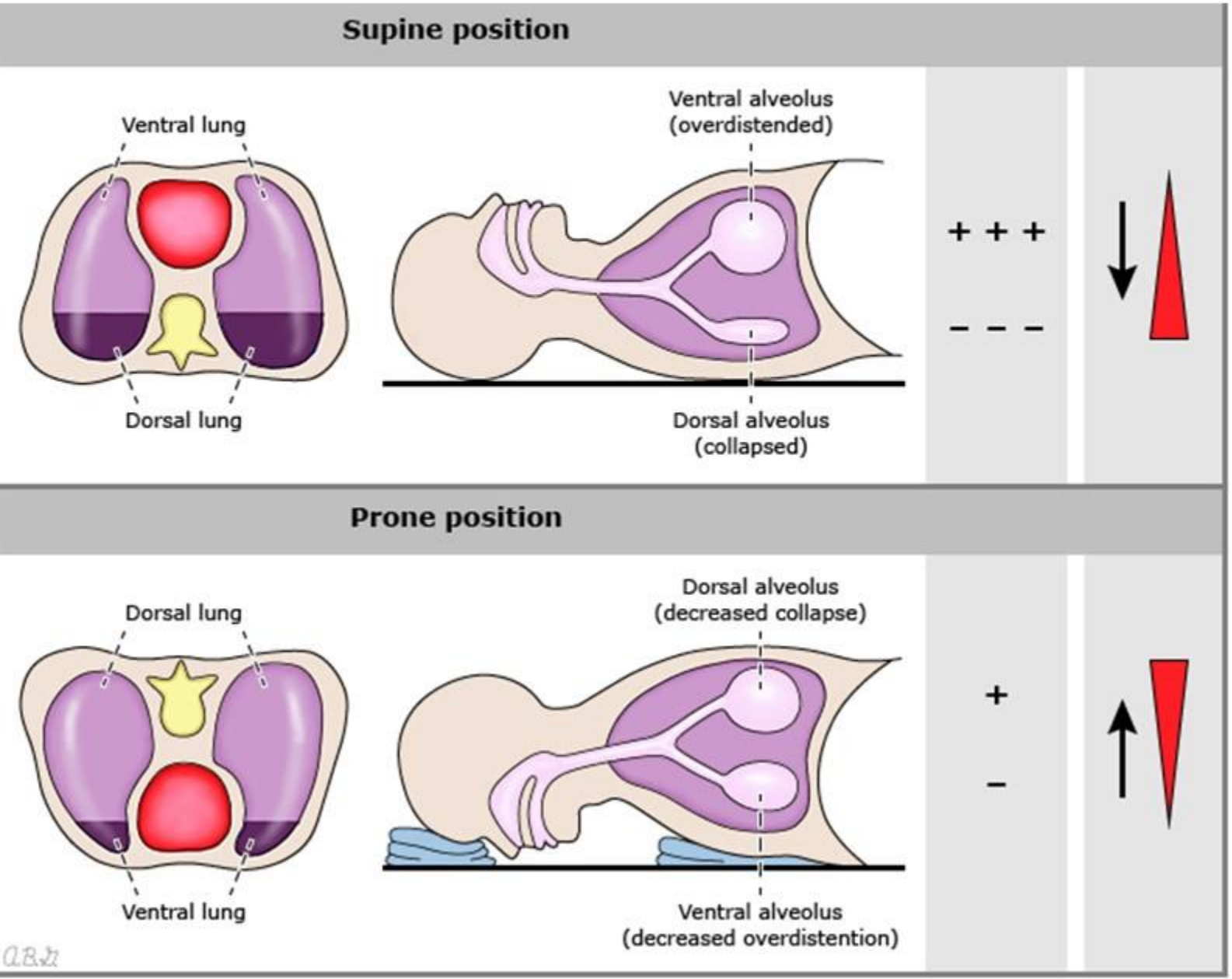
Decreased compressive effects of the abdominal organs on the lungs.



More homogeneous chest wall compliance due to restriction of anterior chest wall movement.

CMAJ 2020 November 23;192:E1532-7.

Physiology of prone positioning in acute respiratory distress syndrome



Distending pressure of lung is determined by the transpulmonary pressure (PTP).

When an individual is supine, the ventral PTP (+++) significantly exceeds the dorsal PTP (——) resulting in greater expansion of the ventral alveoli than the dorsal alveoli; this effect is exaggerated in ARDS such that ventral alveoli become overdistended and dorsal alveoli become atelectatic (dark purple).

Prone positioning reduces the difference between the dorsal and ventral PTP, making ventilation more homogeneous, leading to a decrease in ventral alveolar overinflation and dorsal alveolar collapse and recruitment of alveoli that had collapsed during the supine ventilation.

In ARDS, there is substantial ventilation-perfusion mismatch in the supine position, since **blood flow** and **alveolar collapse** are both greatest in the dependent portions of the lung. When prone, ventilation/perfusion matching improves since the previously dependent lung continues to receive the majority of the blood flow as alveoli reopen, while the newly dependent lung continues to receive the minority of the blood flow as alveoli begin to collapse. NOTE: The terms dorsal and ventral are anatomy based, rather than gravity based.

CPR/Resuscitation

33. Patients who are prone at the time of arrest:

- **without** an advanced airway
  → **place them supine** and continue resuscitation.
- **with** an advanced airway
  →**avoid** turning the patient to the supine position unless able to do so without risk of equipment disconnections and aerosolization.

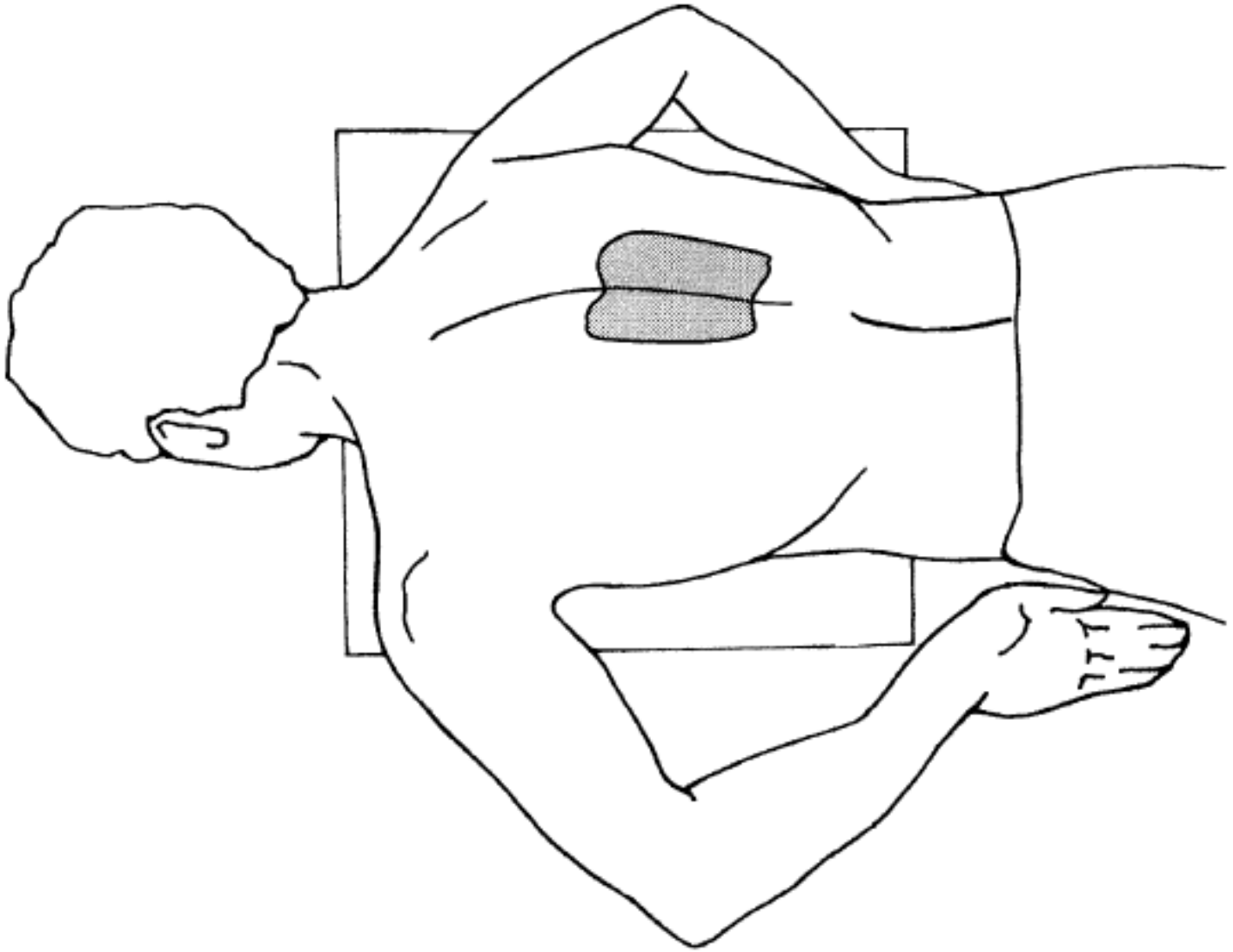
Best practice

Pediatric Research (2020) 88:705–716
Resuscitation 57, 279–285 (2003).

34. For children with COVID-19 that require PICU admission, address the goals of care with the parents or proxy as life sustaining therapies are being escalated.

Best practice

Pediatric Research (2020) 88:705–716



placing defibrillator pads in the anterior-posterior position ; provide CPR with the patient remaining prone with hands in the standard position over the T7/10 vertebral bodies.

Resuscitation 57, 279–285 (2003).
Pediatric Research (2020) 88:705–716

Patient in prone position*/This drawing represents a figure in the prone position on the sternal counter-pulsation device. The shaded area represents where the rescuer would compress during reverse CPR, approximately over the thoracic vertebral bodies numbers 7 -10 (artwork by Amanda Deligtisch, MD with permission).

Resuscitation 57, 279–285 (2003).

Suggested positions for defibrillator pads placement.

a: antero-posterior placement;

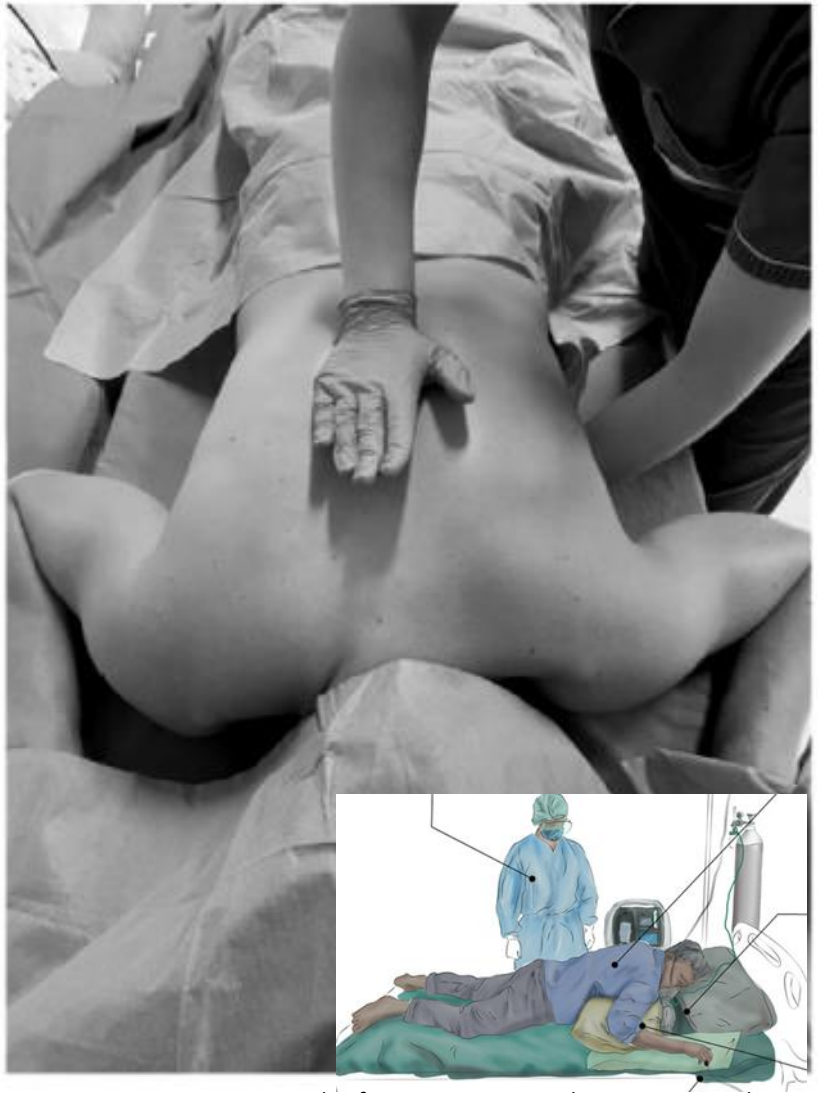
b:bi-axillary placement;

c: postero-lateral placement.

American Journal of Emergency Medicine 38 (2020) 2416–2424

a)

b)



c)

This figure appears in color at www.ajtmh.org.

Suggested position of rescuer's hands in reverse cardiopulmonary resuscitation. The figure shows the position of rescuer's hands, as described in available literature, for compressions during reverse cardiopulmonary resuscitation. Panel a) midline position; panel b) lateral position; c) one-hand technique with sternal counterpressure.

American Journal of Emergency Medicine 38 (2020) 2416–2424

CPR in the prone position

優點[1]

costo-vertebral joints:

- more rigid:allow more forceful compressions

sternal costo-chondral junctions:

- easily damaged.

Increased force:

- generate higher pressures in the intra-thoracic venous and arterial conduits (thoracic-pump) and the compressed ventricles (cardiac-pump) improving forward flow.

Resuscitation 57, 279–285 (2003).

CPR in the prone position

優點2

reverse CPR should correct an important mechanical inefficiency of standard CPR:

- In the supine position:

  each anterior sternal compression forces the **diaphragm inferiorly**,

  displacing the **abdominal structures anteriorly**,

  dissipating the compression's force.

- In the prone position:

  places the abdomen in contact with a firm surface,

  restricting the movement of the abdominal structures and should,

  therefore, enhance the compression's efficiency.

Resuscitation 57, 279–285 (2003).

CPR in the prone position

缺點[1]

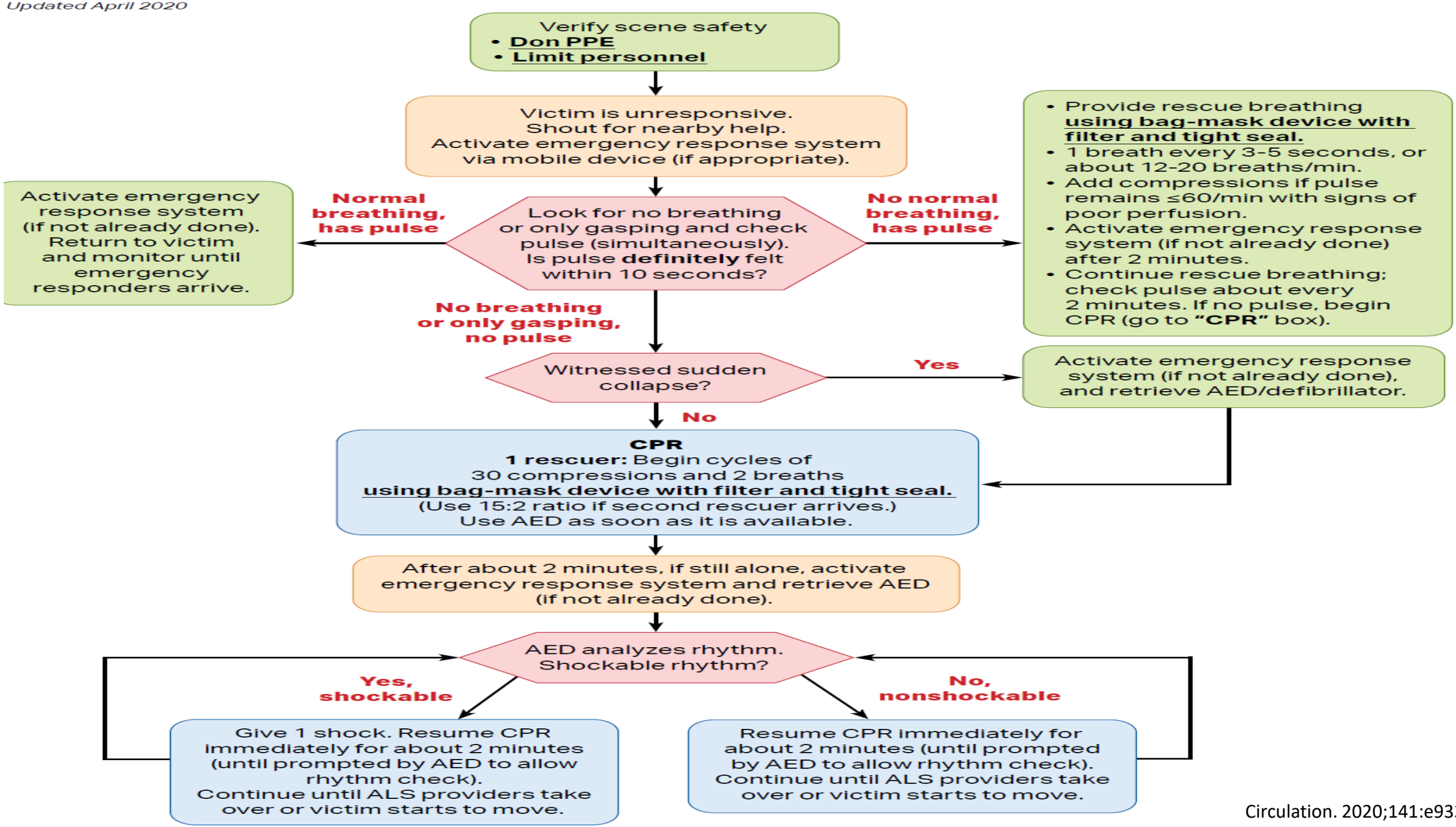
several aspects of care are more difficult to perform including:

- neurologic assessment
- central venous and arterial access
- physical examination
- tracheal tube insertion and maintenance.

Resuscitation 57, 279–285 (2003).

BLS Healthcare Provider
Pediatric Cardiac Arrest Algorithm for the Single Rescuer for Suspected or Confirmed COVID-19 Patients

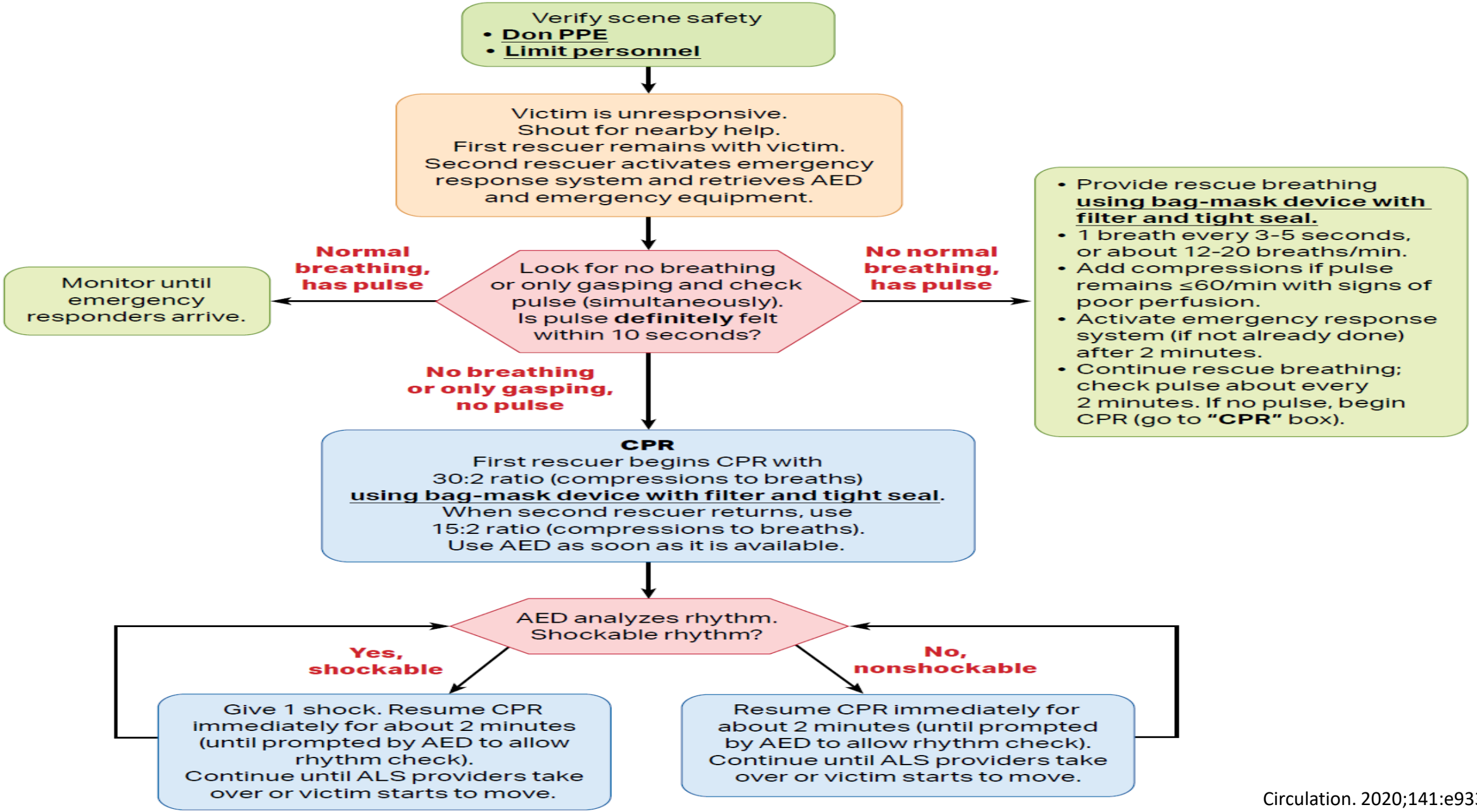
Updated April 2020



Circulation. 2020;141:e933–e943.

BLS Healthcare Provider
Pediatric Cardiac Arrest Algorithm for 2 or More Rescuers for Suspected or Confirmed COVID-19 Patients

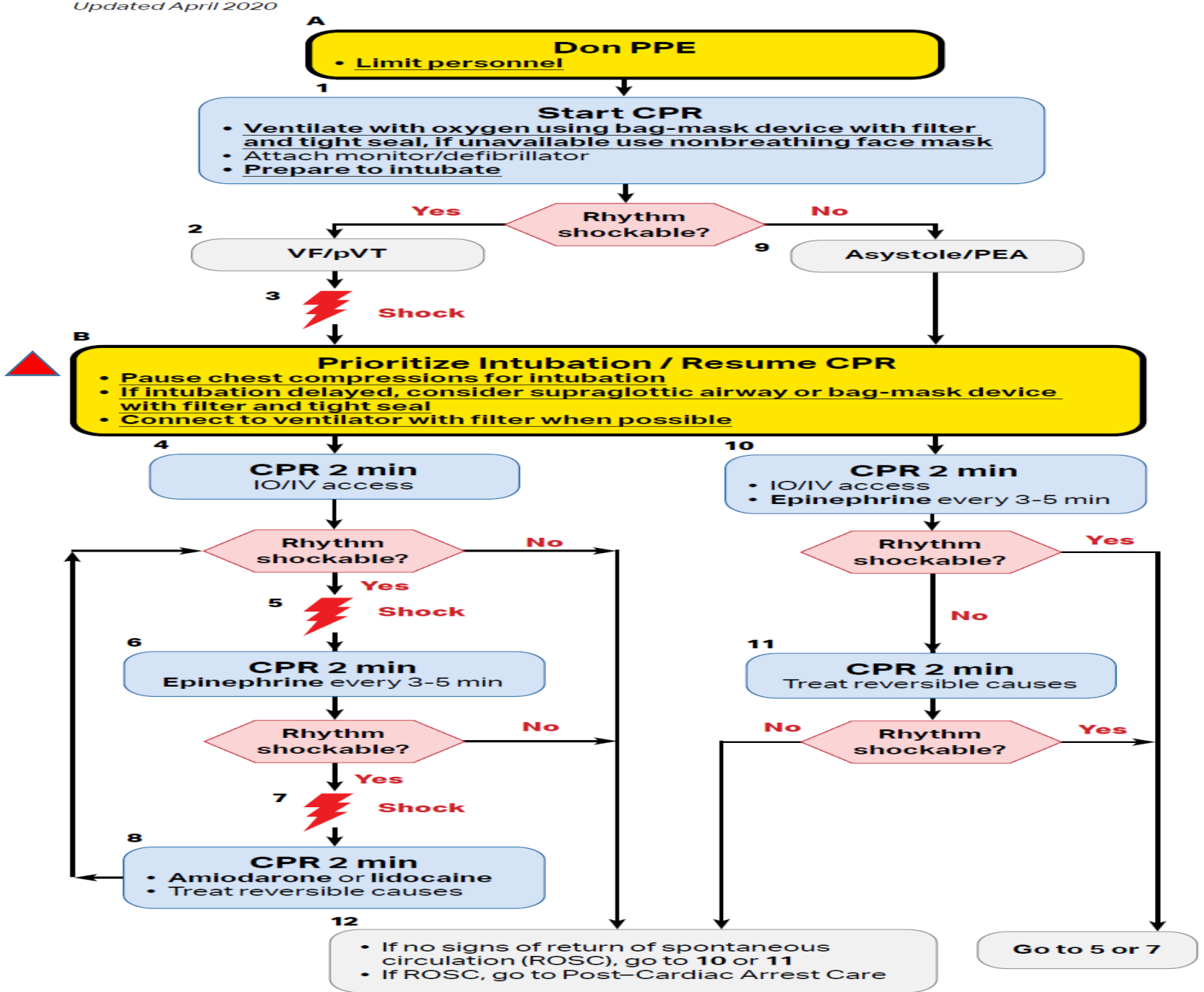
Updated April 2020



Circulation. 2020;141:e933–e943.

Pediatric Cardiac Arrest Algorithm for Suspected or Confirmed COVID-19 Patients

Updated April 2020



CPR Quality

- Push hard (≥⅓ of anteroposterior diameter of chest) and fast (100–120/min) and allow complete chest recoil.
- Minimize interruptions in compressions.
- Avoid excessive ventilation.
- Change compressor every 2 minutes, or sooner if fatigued.
- If no advanced airway, 15:2 compression-ventilation ratio.

Shock Energy for Defibrillation

First shock 2 J/kg, second shock 4 J/kg, subsequent shocks ≥4 J/kg, maximum 10 J/kg or adult dose

Advanced Airway

- **Minimize closed-circuit disconnection**
- **Use intubator with highest likelihood of first pass success**
- **Consider video laryngoscopy**
- **Prefer cuffed endotracheal tube if available**
- Endotracheal intubation or supraglottic advanced airway
- Waveform capnography or capnometry to confirm and monitor ET tube placement
- Once advanced airway in place, give 1 breath every 6 seconds (10 breaths/min) with continuous chest compressions

Drug Therapy

- **Epinephrine IO/IV dose:** 0.01 mg/kg (0.1 mL/kg of the 0.1 mg/mL concentration). Repeat every 3–5 minutes.
- **Amiodarone IO/IV dose:** 5 mg/kg bolus during cardiac arrest. May repeat up to 2 times for refractory VF/pulseless VT.
  or
  Lidocaine IO/IV dose: Initial: 1 mg/kg loading dose. Maintenance: 20–50 mcg/kg per minute infusion (repeat bolus dose if infusion initiated >15 minutes after initial bolus therapy).

Return of Spontaneous Circulation (ROSC)

- Pulse and blood pressure
- Spontaneous arterial pressure waves with intra-arterial monitoring

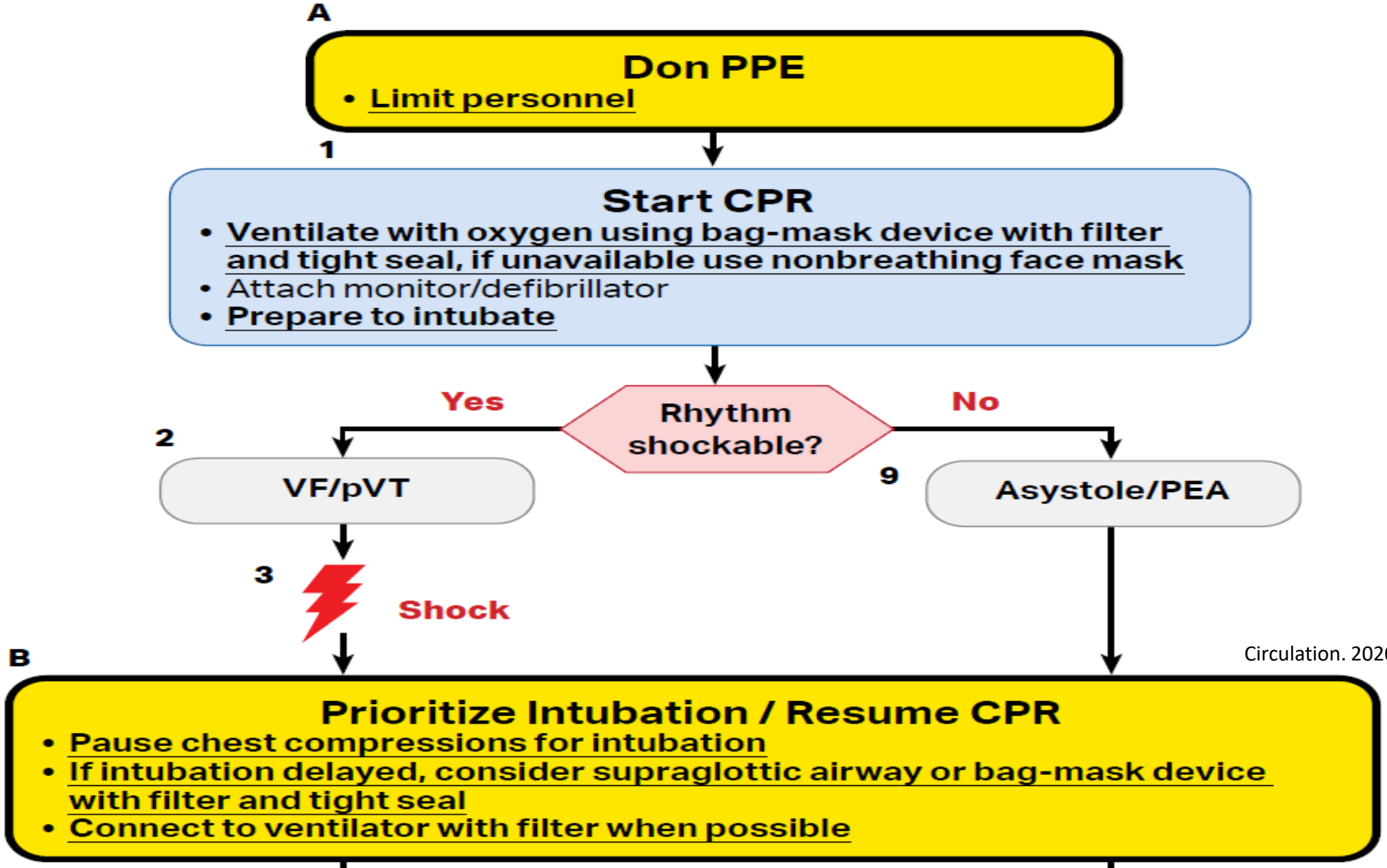
Reversible Causes

- **H**ypovolemia
- **H**ypoxia
- **H**ydrogen ion (acidosis)
- **H**ypoglycemia
- **H**ypo-/hyperkalemia
- **H**ypothermia
- **T**ension pneumothorax
- **T**amponade, cardiac
- **T**oxins
- **T**hrombosis, pulmonary
- **T**hrombosis, coronary

Circulation. 2020;141:e933–e943.

Pediatric Cardiac Arrest Algorithm for Suspected or Confirmed COVID-19 Patients

Updated April 2020



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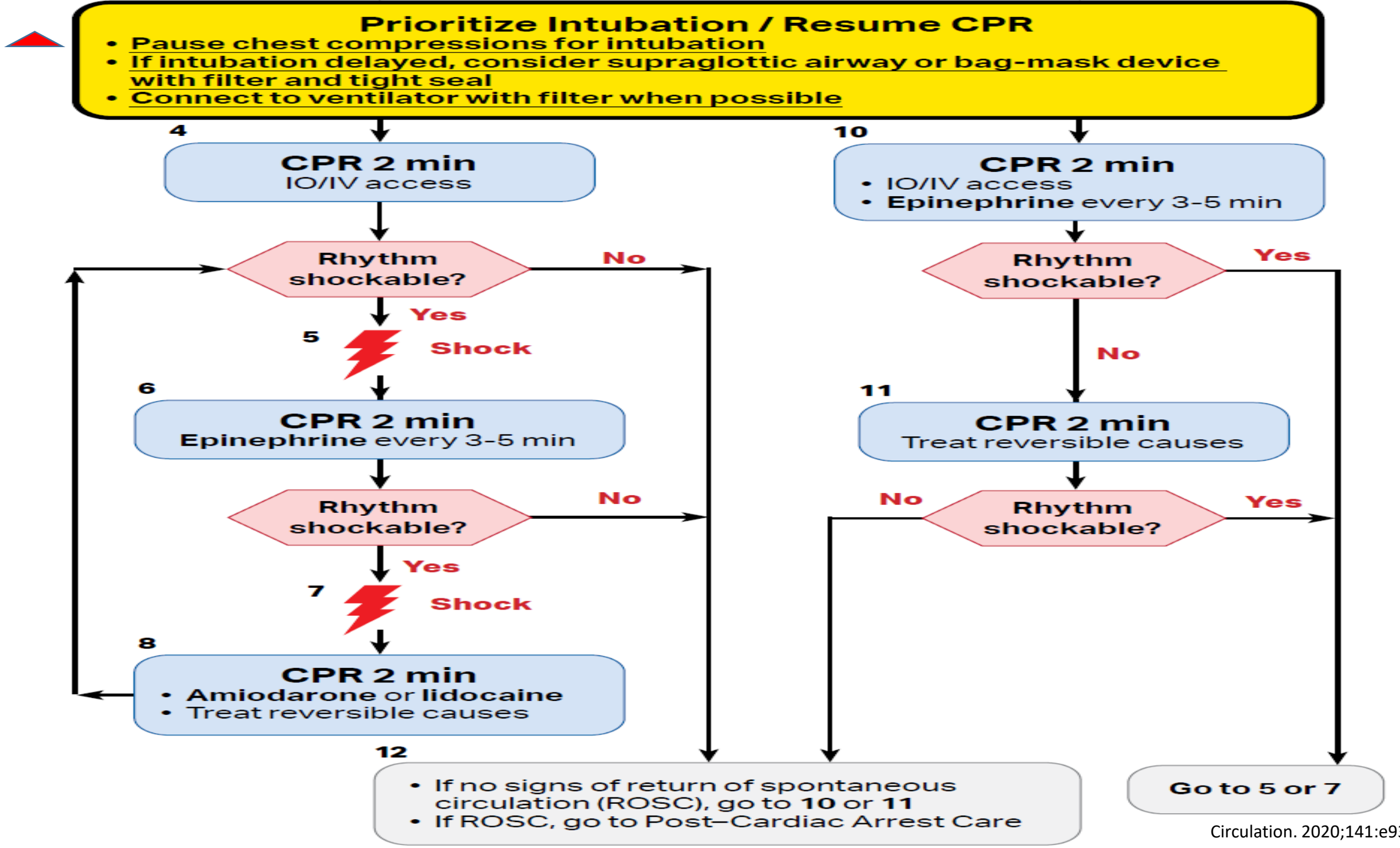

Circulation. 2020;141:e933–e943.

新冠病毒感染疫情期間兒童插管與急救之特殊考量 **摘要**1

[插管注意事項]-1:

- 勿延遲插管(須特別注意隱形缺氧)。
- 儘可能減少飛沫產生與暴露:

1.各醫院皆應對人員加強訓練，個人防護裝備的穿脫平時應在有經驗的指導者確認下做演練。

2.負壓隔離室為優先，確認能有足夠的空氣交換，如果沒有負壓隔離室，應使用高效能空氣粒子過濾器(HEPA)。

3.不建議家屬在場，非必要人員(含醫護人員)不要進入，以減少暴露及防護裝備的消耗。

4.患者及進行插管的團隊，身上的配件、鑰匙、手機、和手術室外使用的筆勿帶進場。可以保留緊急電話裝在密封袋裡，方便與其他人聯絡。

5.在開始鎮靜或麻醉之前應準備好所有藥品和設備。

新冠病毒感染疫情期間兒童插管與急救之特殊考量 **摘要**2

[插管注意事項]-2:

6.觸碰式屏幕，應放置塑料屏蔽。

7.執行插管者以有經驗人員優先。

8.執行插管者至少戴N95等級以上口罩，若能著動力空氣濾淨式呼吸防護具(PAPR)則更佳。徹底穿好個人防護裝備(PPE)。

9.在操作區以塑膠布垂降掩蔽患者頭胸及接近患者口鼻的工作者的手肘。

10.將患者先行鎮靜或麻醉(可加以神經肌肉鬆弛劑)，事前鎮靜以靜脈注射為宜，但若事先評估病童屬力大高抗拒性而可能使靜脈注射不易者，可以使用面罩式誘導麻醉，但須以大範圍塑膠布垂降掩蔽形成包覆區，在包覆區內操作(不建議以鼻管方式給予先行鎮靜或麻醉，以免誘發咳嗽，噴嚏)。

新冠病毒感染疫情期間兒童插管與急救之特殊考量 **摘要**3

[插管注意事項]-3:

11.選擇有cuff的氣管內管，用影像式喉頭鏡，以快速引導插管(Rapid Sequence Intubation, RSI)方式進行，迅速將cuff打起。插管完成後，建議使用拋棄式EtCO2確認位置。若插管不順，以非再吸入性面罩(Non-rebreathing mask,NRM)接續，或再以支氣管鏡輔喉頭罩（LMA）插管，若無法成功，再以NRM接續，繼而支氣管鏡與影像式喉頭鏡併用。必要時進行頸前氣道手術(環甲膜切開術或氣管切開術)(front-of-neck airway, front-of-neck access; FONA: surgical cricothyroidotomy or tracheostomy）。

12.患者與呼吸器管路間應有病毒過濾裝置，呼吸器的進氣口與出氣口之間也應有病毒過濾裝置。

13.若需抽痰時，宜在封閉管路內進行(In-line closed-suctioning)。

14.依標準動作卸下防護裝備(PPE)，並依標準規範離開病室。

新冠病毒感染疫情期間兒童插管與急救之特殊考量 **摘要**4

[拔管注意事項]:

先以防水外科口罩遮蔽口鼻，可選擇深度拔管(為防止病人剛清醒時易咳嗽、掙扎，在病人將退麻醉尚未清醒，不能活動狀態下進行，但需謹慎小心)。

[急救注意事項]:

病人急救的處置方式，原則上與2020年公布的PALS完全相同，但須遵守[插管注意事項]，並強調

1.個人防護裝備必須齊備

2.人員限制

3.插管瞬間應停止壓胸

4.使用面罩給氧時應注意密合度

5.避免管路鬆脫

新冠病毒感染疫情期間兒童插管與急救之特殊考量 **摘要**5

[俯臥者急救特別注意事項]:

若患者身處俯臥姿勢，面臨CPR時

1. 已銜接呼吸管路:不須將病人翻正，以免管路鬆脫，飛沫散出，並可爭取急救時間。應將前胸塞硬板，或抽掉如枕頭等軟質的物品，立即於第七至第十胸椎區域實施背後按壓。
2. 若尚未接呼吸管路:為考慮插管的便利性、鼻胃管的置入與中央靜脈導管的置放，應將病人翻正，再施予CPR。
3. 去顫電擊貼片可置於後背及前胸各一，或兩側胸旁腋下處，或置於後背及左側胸旁腋下處。

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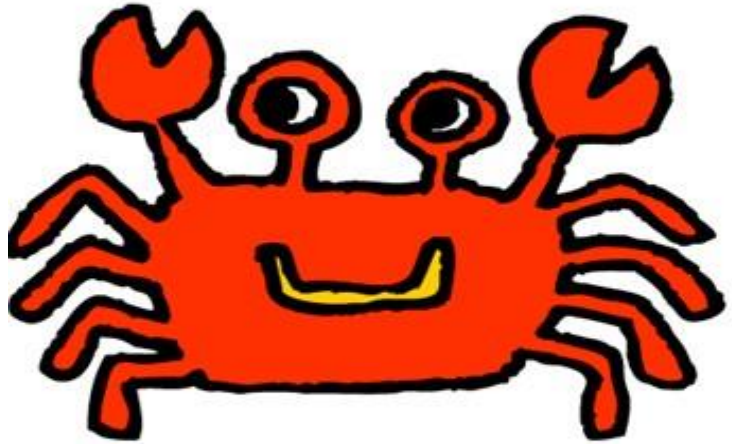

Thank You

多蟹多謝

高雄榮總農寶仁鞠躬