NIV &COVID

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Noninvasive ventilation

NIV describes the delivery of mechanical respiratory support .

NIV interface (nasal prongs or mask, face mask, or helmet)

Delivers: continuous positive airway pressure (CPAP) or bilevel positive airway support (BPAP) .

NIV reduce patient work of breathing/ improve respiratory gas exchange

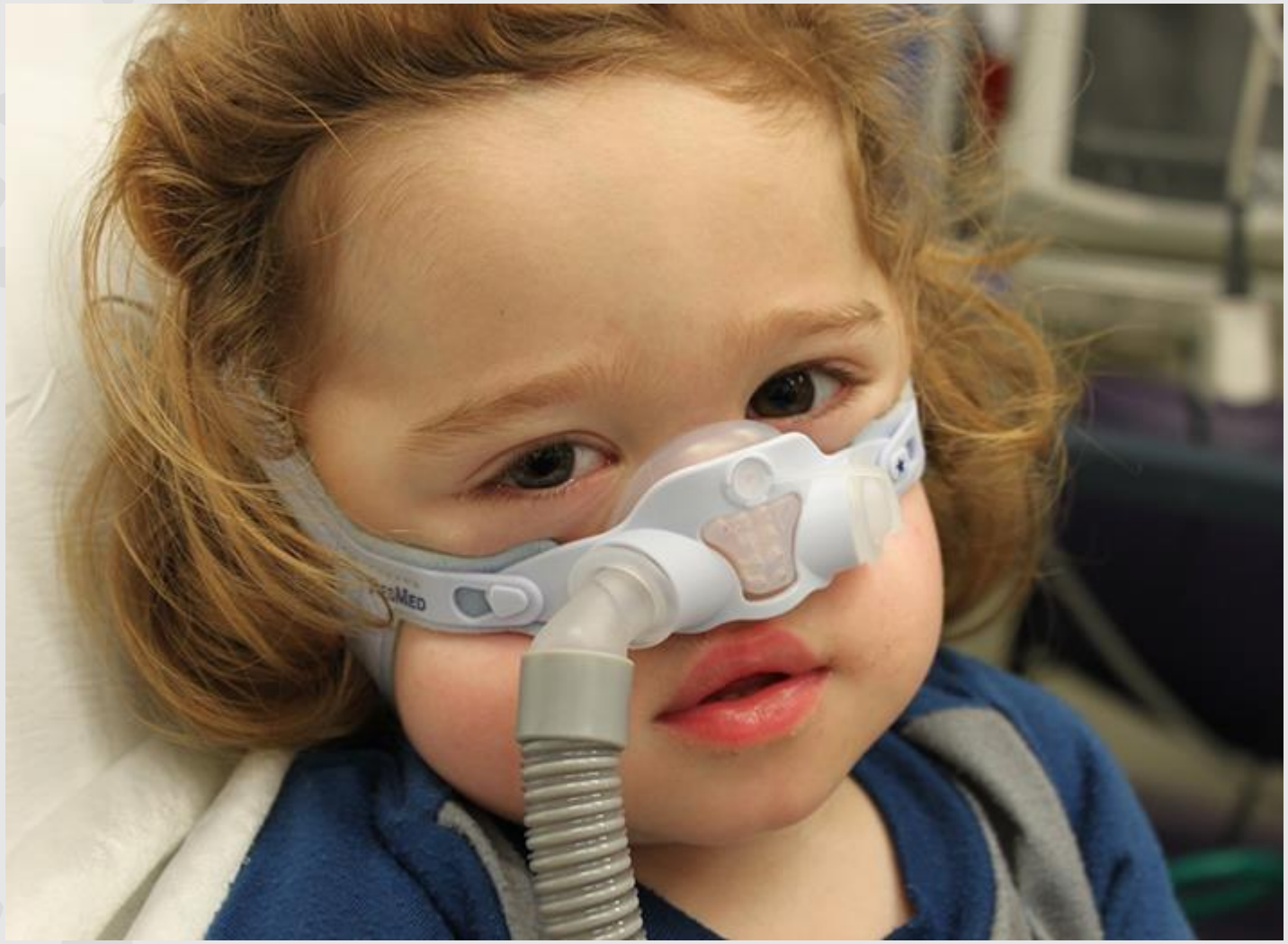
NIV can be initiated during critical care transport, in the emergency department, in an intensive care unit (ICU).

NIV three primary physiologic benefits :

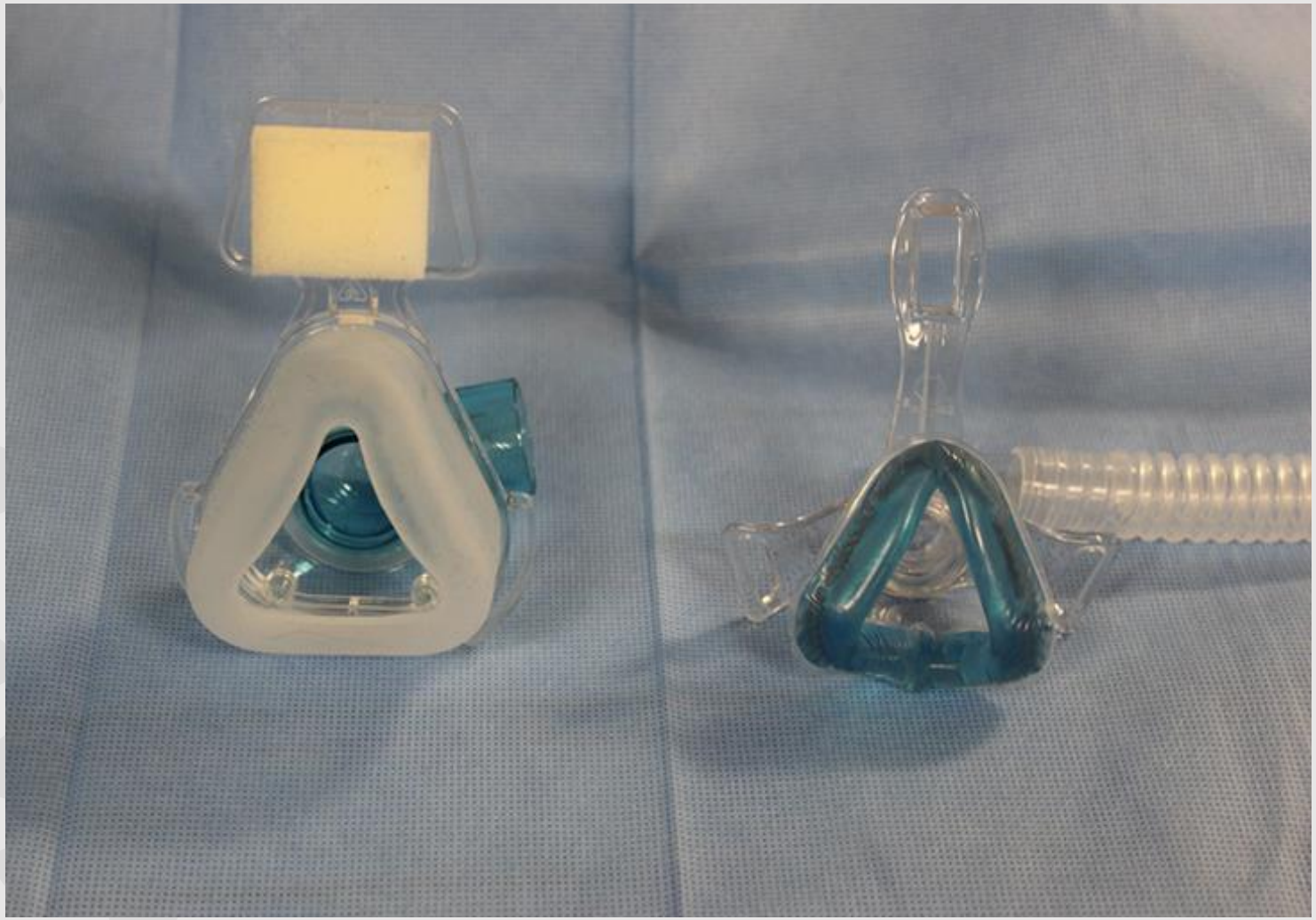
- Decreasing the patient's work of breathing
- Maintaining patency throughout the respiratory tract
- Recruiting alveoli, resulting in increased functional residual capacity (FRC) and decreased ventilation-perfusion (V-Q) mismatch.

Interface —

- Nasal cannula
- Nasal mask
- Full-face mask
- Helmet

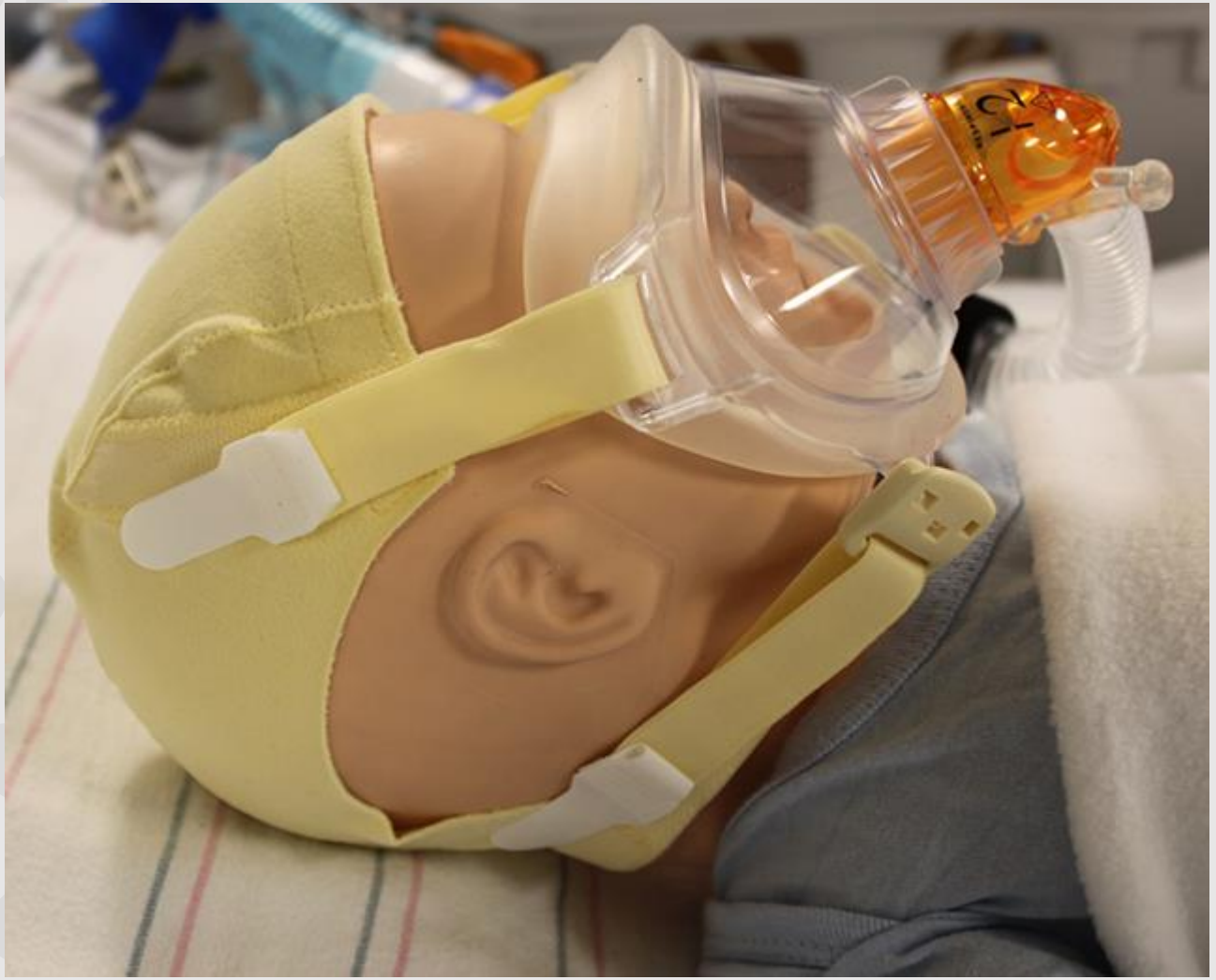


Noninvasive ventilation with a nasal mask

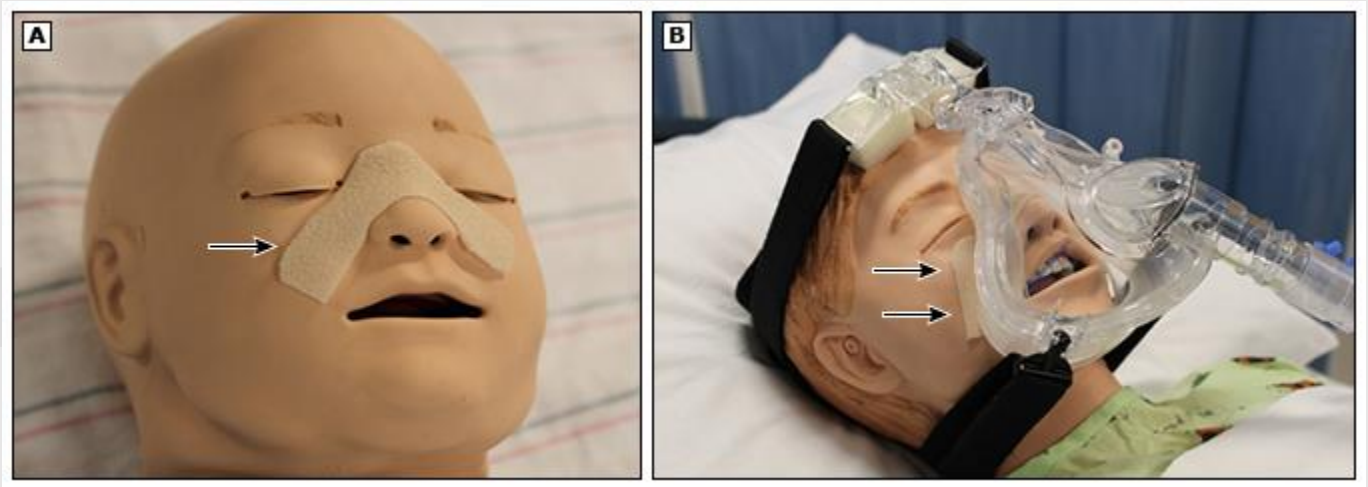


The mask on the left (white) contains an air cushion. The mask on the right (blue) has a gel cushion.

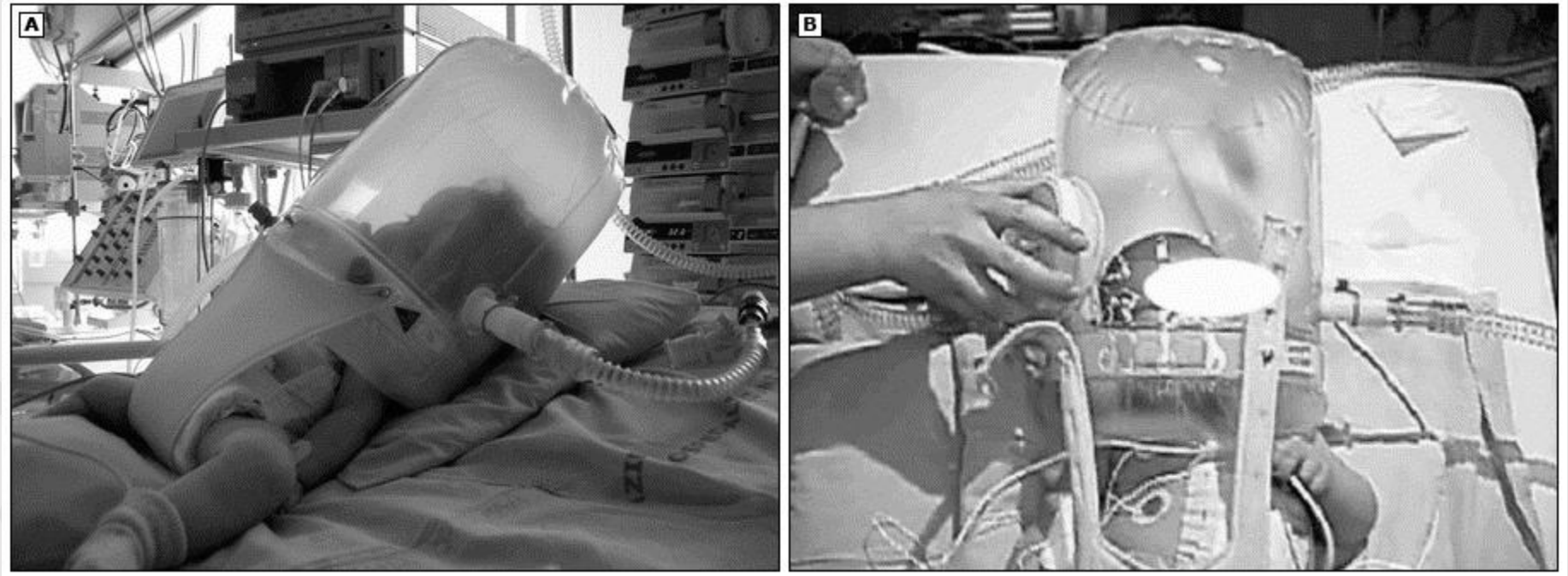
Full-face mask for noninvasive ventilation



Head cap to support use of a face mask for noninvasive ventilation in an infant



Hydrocolloid dressing is placed beneath the noninvasive ventilation interface for skin protection



Helmet for noninvasive ventilation

The adaptor for delivery of inhaled medication during noninvasive ventilation contains two ports. The arrow shows the reservoir for medication. The arrowhead identifies the port for attaching the aerosol generator.

Modes of ventilation —

- **Continuous positive airway pressure (CPAP)** –
  CPAP provides a constant, programmed level entire respiratory cycle.
  It is the equivalent of positive end-expiratory pressure (PEEP).

- **Noninvasive positive pressure ventilation (NIPPV)** –
NIPPV delivers two set levels of positive airway pressure,
one during inspiration (IPAP)
 and one during expiration (EPAP).

Acute respiratory distress syndrome (ARDS)

Most patients with ARDS require invasive mechanical ventilation.

Bilevel NIV for patient with mild ARDS who is hemodynamically stable, easily oxygenated, and has no contraindications to its use.

Most clinicians use invasive mechanical ventilation for patients with moderate or severe ARDS (arterial oxygen tension/fraction of inspired oxygen [PaO_2/FiO_2] ≤200 mmHg on positive end-expiratory pressure (PEEP) ≥5 cm H_2O).

Importantly, when NIV is implemented, frequent evaluation is necessary and clinicians should have a low threshold for intubation.

Efficacy for patients with the following conditions :

- **Status asthmaticus(COVID)**
- **Pneumonia (COVID)**
- **Pulmonary edema(COVID)**
- **Cystic fibrosis**
- **Acute chest syndrome**
- **Dynamic upper airway obstruction caused by tracheomalacia, laryngomalacia, and Pierre Robin syndrome**

clinical or laboratory parameters for initiating NIV including :

- Moderate to severe dyspnea not responsive to supplemental oxygen or other therapies
- Persistent tachypnea caused by respiratory illness (respiratory rate >75th percentile for age
- Hypoxemia ([FiO_2] >0.5 to maintain SaO_2 >94 percent)
- Respiratory acidosis (arterial pH <7.35 or venous pH <7.30)

CONTRAINDICATIONS

The need for immediate endotracheal intubation based upon clinical assessment is an **absolute contraindication** to initiating NIV.

Situations where NIV should **not** be used include :

- Cardiopulmonary arrest
- Acutely impaired mental status(Glasgow coma score <8 or rapidly declining or patients with status epilepticus)
- High aspiration risk (absence of airway protective reflexes or inability to clear secretions)
- Need for airway protection (epiglottitis, progressive upper airway edema, or burns)

NIV is also typically avoided in patients with the following conditions :

- Hemodynamic instability requiring high or escalating levels of vasopressor support
- Upper gastrointestinal bleed
- Facial injuries or anomalies (large lacerations, or facial bone fractures,crouzon syndrome,micrognathia)
- Untreated pneumothorax, although NIV is acceptable once a chest tube is in place

PATIENT SELECTION

- Not contraindications to NIV
- Likelihood a patient will tolerate the planned mode of support
- NIV will be adequate to stabilize and/or reverse the current respiratory status
- Not in patients with need for airway protection (at high aspiration risk or with altered mental status)

Monitoring —

including continuous cardiorespiratory and pulse oximetry, frequent blood pressure measurement, and ongoing monitoring of ventilation (frequent blood gas measurements or transcutaneous CO_2).

Face masks……in school-age children and adolescents .

Full face mask as the initial interface for any infant or child with more severe hypoxia or hypercarbia .

Sedation with dexmedetomidine or midazolam may facilitate initiation of NIV in anxious or agitated patients.

IF too agitated to tolerate NIV or in whom mask seal is not achievable, invasive ventilation should not be delayed if the patient needs additional support.

Selecting the mode of ventilation —

- **Continuous positive airway pressure (CPAP)** – CPAP can reduce dynamic upper airway obstruction (tracheomalacia, laryngomalacia, and oropharyngeal hypotonia), apnea, and work of breathing related to acute respiratory failure in infants and children, particularly when hypoxemia is the obstructive sleep apnea.

- **Bilevel PAP (BPAP)** – BPAP is often selected for patients in need of a greater level of respiratory support, including those who do not show timely improvement with CPAP.

Initial settings —
A variety of approaches to initial NIV settings have been described . Initial pressures will vary by mode of ventilation, etiology, severity of underlying disease, and patient tolerance.

- **Continuous positive airway pressure (CPAP)** –
CPAP is often start…… 5 cm H_2O and titrated .

Safe use of initial pressures of 8 to 10 cm H_2O with titrating up or down as needed to maintain oxyhemoglobin saturation in an acceptable range (92 to 95 percent).

- **Bilevel positive airway pressure (BPAP)** –
BPAP is often initiated with an expiratory PAP (EPAP) 5 cm H_2O and an inspiratory PAP (IPAP) of 8 to 10 cm H_2O. Final IPAP pressures of 15 to 22 cm H_2O are common .

- **Fraction of inspired oxygen (FiO_2)**

Most commonly, the goal is to increase the PEEP (EPAP or CPAP) so that the FiO_2 can be weaned to 50 percent or less.

Back-up ventilation rate –
For patients with intermittent apnea or hypopnea.

Assessment of effectiveness

Close monitoring and careful reassessment, especially over the first one to two hours after initiation.

- **Respiratory rate and heart rate** – Reduction in respiratory rate is a reliable sign of effective response to NIV.

- **Dyspnea**

- **O_2 requirement**

- **Hypercarbia**

PREDICTORS OF FAILURE

- **Underlying diagnosis** – In one retrospective observational pediatric study, the diagnose of acute respiratory distress syndrome (ARDS) were identified as risk factors for NIV failure. Only 22 percent of ARDS patients treated with NIV avoided endotracheal intubation. Essouri S, Chevret L, Durand P, et al. Noninvasive positive pressure ventilation: five years of experience in a pediatric intensive care unit. Pediatr Crit Care Med 2006; 7:329.

- **Markers of illness severity** – Patients with high severity of overall illness as measured by Pediatric Risk of Mortality (PRISM) and Pediatric Logistic Organ Dysfunction (PLOD) scoring were noted to be more likely to fail NIV. Essouri S, Chevret L, Durand P, et al. Noninvasive positive pressure ventilation: five years of experience in a pediatric intensive care unit. Pediatr Crit Care Med 2006; 7:329.

.Response to treatment –

- ❑ lack of significant decrease in respiratory rate
- ❑ Persistently elevated fraction of inspired oxygen (FiO_2) requirement
- ❑ pH <7.25 on blood gas analysis

BENEFITS AND RISKS

- Laryngeal or tracheal injury
- Interruption of the natural airway clearance mechanisms, potentially resulting in ventilator-associated pneumonia
- Potential adverse effects or complications related to sedation with or without neuromuscular blockade

RISKS

- Delay endotracheal intubation
- Insufficient positive end-expiratory pressure if there is a large air leak.

COMPLICATIONS

.Major

•**Barotrauma** – Tension pneumothorax, pneumomediastinum, or massive subcutaneous emphysema have all occurred . rates of barotrauma range from 1.4 to 9.0 percent .
Carroll CL, Zucker AR. Barotrauma not related to type of positive pressure ventilation during severe asthma exacerbations in children. J Asthma 2008; 45:421.

•**Aspiration** –with full-face mask and higher ventilatory settings.

•**Hemodynamic instability** – Hemodynamic instability is a potential concern with decreasing venous return and cardiac output.

•Minor

•**Skin break down** – Facial skin irritation, breakdown, and ulcerationwith using nasal or oronasal masks.

•**Nasal mucosal trauma** –

•**Gastric distension** –when inspiratory pressures exceed lower esophageal sphincter pressure (normally 10 mmHg) or when the patient swallows air (during crying).

We avoid prophylactic attempts to decompress the stomach in patients on NIV using an oro- or naso-gastric tube as this may increase the risk of vomiting.

•**Eye irritation or injury** – Ocular trauma, primarily corneal abrasion or ulceration, can occur if the edge of the mask is in contact with the eye surface.

Eye irritation or conjunctivitis can occur if a poorly fitting mask permits air leak at the nasal bridge across the eyes.

- A subset analysis of data from the Large Observational Study to Understand the Global Impact of Severe Acute Respiratory Failure (LUNG-SAFE) reported that use of NIV in patients with severe ARDS (PaO_2/FiO_2 ratio <150 mmHg) was an independent predictor for mortality, such that clinicians should be wary of its use in patients with this degree of hypoxemia . Bellani G, Laffey JG, Pham T, et al. Noninvasive Ventilation of Patients with Acute Respiratory Distress Syndrome. Insights from the LUNG SAFE Study. Am J Respir Crit Care Med 2017; 195:67.

- The type of mask worn may impact outcome. In a single-center unblinded trial of 83 patients with mild or moderate ARDS, helmet-delivered NIV reduced the need for intubation (18 versus 62 percent) compared with NIV delivered through a full face mask helmet-delivered NIV was also associated with a higher rate of ventilator-free days, shorter ICU stay, and lower 90-day mortality without an increase in adverse effects. Patel BK, Wolfe KS, Pohlman AS, et al. Effect of Noninvasive Ventilation Delivered by Helmet vs Face Mask on the Rate of Endotracheal Intubation in Patients With Acute Respiratory Distress Syndrome: A Randomized Clinical Trial. JAMA 2016; 315:2435.

A prospective observational study involving consecutive subjects of mild to moderate ARDS treated with NIV using an oronasal mask, Patients were monitored clinically with serial arterial blood gas analysis. The use of NIV was successful in 18 (44%) subjects, while 23 subjects required intubation.
Use of NIV in mild to moderate ARDS helped in avoiding intubation in about 44% of the subjects. A baseline APACHE II score of >17 and a PaO2 /FiO2 ratio<150 at 1hr predicts NIV failure . Sehgal IS, Chaudhuri S, Dhooria S, Agarwal R, Chaudhry D. A study on the role of noninvasive ventilation in mild-to-moderate acute respiratory distress syndrome. Indian J Crit Care Med 2015;19:593-9.

2,813 patients with ARDS that NIV failure occurred in 37.5% of patients (22.2% in mild, 42.3% in moderate and 47.1% in severe ARDS).

NIV appears to be associated with higher ICU mortality in patients with a PaO2/FiO2 lower than 150 mmHg.

Bellani, G., Laffey, J. G., Pham, T., Madotto, F., Fan, E., Brochard, L., Esteban, A., Gattinoni, L., Bumbasirevic, V., Piquilloud, L., van Haren, F., Larsson, A., McAuley, D. F., Bauer, P. R., Arabi, Y. M., Ranieri, M., Antonelli, M., Rubenfeld, G. D., Thompson, B. T., ... Pesenti, A. (2017). Noninvasive Ventilation of Patients with Acute Respiratory Distress Syndrome: Insights from the LUNG SAFE Study. American Journal of Respiratory and Critical Care Medicine, 195(1), 67-77.

Noninvasive ventilation (NIV) has a well-established role in the treatment of acute-on-chronic respiratory failure and cardiogenic pulmonary edema. ARDS could be a risk factor for NIV failure, and in these patients, delayed endotracheal intubation can lead to an increased mortality. The use of NIV in ARDS is still debated, and it is important to be aware of the potential limitations and pitfalls of this treatment, which, when properly applied, could reduce the incidence of endotracheal intubation.

The factors related to the patient include baseline severity of the patient condition, as assessed with the SAPS II, SOFA, or APACHE II scores. A SAPS II score exceeding 35 an average maximum SOFA score of 9 or an APACHE II score exceeding 17 were associated with the need of endotracheal intubation.

A factor often demonstrated to be associated with the outcome of NIV is the change of the PaO2/FiO2 ratio. Some cut-off values have been defined: a PaO2/FiO2 ratio of less than 146 mm Hg after 1 hour of NIV predicts failure, or in general a decline or small improvement of the PaO2/FiO2 ratio.

HACOR is a new score ,has been developed and validated to easily predict the probability of NIV failure at the bedside.The HACOR score assesses 5 parameters already demonstrated to be associated with a high rate of NIV failure (heart rate, acidosis, consciousness, oxygenation, and respiratory rate) and ranges from 0 to 25 points . cut- -off value of 5 after 1 hour of NIV was found to have a high diagnostic accuracy for predicting NIV failure.Alice Grassi , Giuseppe Foti, John G. Laffey, Giacomo Bellani. Noninvasive mechanical ventilation in early acute respiratory distress syndrome. Pol Arch Intern Med. 2017; 127 (9): 614-620.
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TABLE 1 The HACOR score

Variable	Category	Assigned points
Heart rate, beats/min	≤120	0
	≥121	1
pH	≥7.35	0
	7.30–7.34	2
	7.25–7.29	3
	<7.25	4
Glasgow Coma Scale	15	0
	13–14	2
	11–12	5
	≤10	10
PaO_2/FiO_2 ratio, mm Hg	≥201	0
	176–200	2
	151–175	3
	126–150	4
	101–125	5
	≤100	6
Respiratory rate, breaths/min	≤30	0
	31–35	1
	36–40	2
	41–45	3
	≥46	4

Abbreviations: FiO_2, fraction of inspired oxygen; PaO_2, partial pressure of oxygen

A VTe higher than 9.5 ml/kg PBW during the first 4 hours of NIV was an independent predictor of failure .

The reasons for this finding, could be twofold: a higher VTe is a marker of more severe disease or a high-er VTe is a cause of ventilation-induced lung injury, further aggravating the lung injury. Alice Grassi , Giuseppe Foti, John G. Laffey, Giacomo Bellani. Noninvasive mechanical ventilation in early acute respiratory distress syndrome. Pol Arch Intern Med. 2017; 127 (9): 614-620.

PubMed and Embase databases for relevant studies published between 1995 and 2009, results suggest an almost 50%NIV failure rate in patients with ALI/ARDS, so NIV should be cautiously used in patients withALI/ARDS.

There is a need for a uniform NIV protocol for patients with ALI/ARDS.

Ritesh Agarwal MD DM, Ashutosh N Aggarwal MD DM, and Dheeraj Gupta MD DM. Role of Noninvasive Ventilation inAcute Lung Injury/Acute Respiratory Distress Syndrome:A Proportion Meta-analysis. Respir Care 2010;55(12):1653–1660.

مدیریت راه هوایی کودک مبتلا یا مشکوک به COVID-19

اسامی نویسندگان این بخش: دکتر بهاره یغمایی با همکاری دکتر عباس حسنی، دکتر مسعود محمدپور، دکتر میثم شریف‌زاده، دکتر زینب نجفی و دکتر بهداد قریب

توجه: بدون پوشش محافظت شخصی مناسب *(PPE) وارد اتاق نشوید!

آمادگی جهت اینتوبه کردن

چیدمان تیم مسئول

داخل اتاق
- پزشک ماهر در اینتوبه کردن
- فرد ماهر در اینتوبه کردن از گروه بیهوشی
- پرستار جهت تزریق داروها

خارج اتاق
- سرپرستار یا پرستار مسوول شیفت
- پرستار جهت آماده کردن داروها یا وسایل بر حسب نیاز
- رزیدنت یا اینترن جهت ثبت داروها و مراحل کار در پرونده

وسایل

- لوله تراشه سایز مناسب کاف دار
- LMA**
- Oral Airway
- ET Co2 Monitor
- آمبو بگ و ماسک با سایز مناسب
- در صورت امکان HEPA filter***
- NGT
- ساکشن و کاتتر ساکشن
- اکسیژن
- لارنگوسکوپ (ترجیحا ویدئو لارنگوسکوپ)
- چسب آماده شده جهت ثابت کردن لوله تراشه

داروها

- Atropine 0.02 mg/Kg
- Ketamine 2 mg/Kg
- Rocuronium 1.2 mg/Kg

Or

- Cisatracurium 0.2 mg/Kg

پوشش حفاظت شخصی

- گان
- دستکش
- عینک ایمنی یا شیلد صورت
- ماسک N95 سایز مناسب

* PPE: Personal Protective Equipment

** LMA: Laryngeal Mask Airway

*** HEPA filter: High Efficiency Particulate Air filter

اینتوبه کردن بیمار

قبل از اینتوبه کردن

Pre-Oxygenation: اکسیژن ۱۰۰٪ به مدت ۵ دقیقه با ماسک رزروار یا هود

- قبل از برداشتن ماسک یا هود از صورت کودک، اکسیژن را قطع کنید تا آئروسل‌های راه هوایی کودک کمتر پخش شود.

Rapid Sequence Intubation:

- تا حد امکان از آمبوبگ و ماسک استفاده نشود ولی در کودکان کوچک و بیماری جدی ریه امکان‌پذیر نخواهد بود.

نکات مهم در استفاده از آمبوبگ و ماسک

- برای اطمینان از محکم بودن ماسک روی صورت کودک، به خصوص در کودک بزرگتر جهت جلوگیری از پخش آئروسل‌ها PPV دو نفره انجام شود.
- زمان آمبوبگ و ماسک حداقل باشد.

اینتوبه کردن

۱) برای حفظ فاصله بیشتر در صورت امکان از ویدئو لارنگوسکوپ برای اینتوبه کردن بیمار استفاده شود.
۲) مطمئن باشیم که بیمار آماده‌ی اینتوبه کردن است و حین انجام آن سرفه نمی‌کند.
۳) بعد از اینتوبه کردن بلافاصله کاف لوله تراشه پر شود.
۴) لوله تراشه به HEPA filter وصل شود.
۵) از محل مناسب لوله تراشه با ET co2 و گوش کردن به ریه‌ها مطمئن شوید.
۶) لوله تراشه را کلامپ کنید.
۷) بیمار را به ونتیلاتور وصل کنید.
8) لوله تراشه را ثابت کنید.

بعد از اینتوبه کردن

- در صورت امکان از ساکشن بسته استفاده کنید
- تا حد ممکن لوله تراشه و لوله‌های ونتیلاتور جدا نشوند
- کلامپ کردن لوله تراشه قبل از جدا کردن لوله تراشه از ونتیلاتور
- در زمان پروسیجرهای تولید کننده آئروسل *(AGP)** مثل اینتوباسیون، حداقل نفرات در اتاق باشند
- صحبت با اعضای تیم راجع به کار گروهی انجام شده فراموش نشود (Hot Debriefing) .

بهتر است پوشش حفاظت شخصی را با نظارت همکار خارج کنیم چراکه هنگام خارج کردن پوشش بیشترین احتمال آلودگی وجود دارد.

احیای کودک مبتلا یا مشکوک به COVID-19

پوشش حفاظت شخصی

- گان
- دستکش
- عینک ایمنی یا شیلد صورت
- ماسک N95 سایز مناسب

تیم احیاء

تیم داخل اتاق

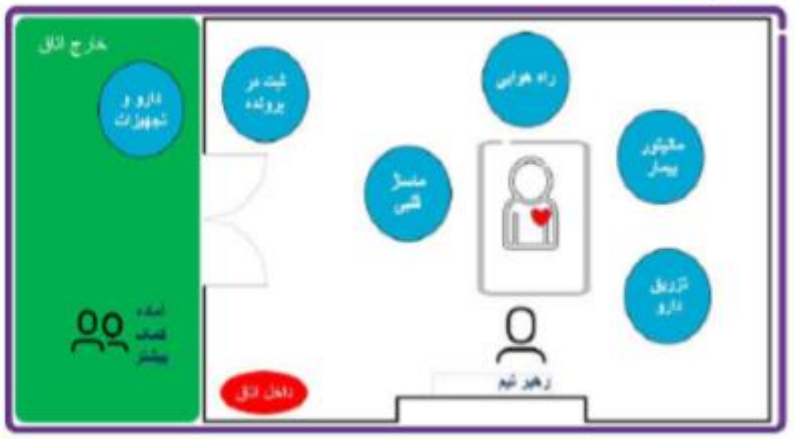
۱) رهبر تیم
۲) راه هوایی
۳) تزریق داروها
۴) ماساژ قلبی
۵) مانیتورکردن بیمار / جابه‌جایی با فرد مسوول ماساژ قلبی
۶) ثبت در پرونده/ارتباط با بیرون اتاق در صورت نیاز به دارو یا تجهیزات اضافه

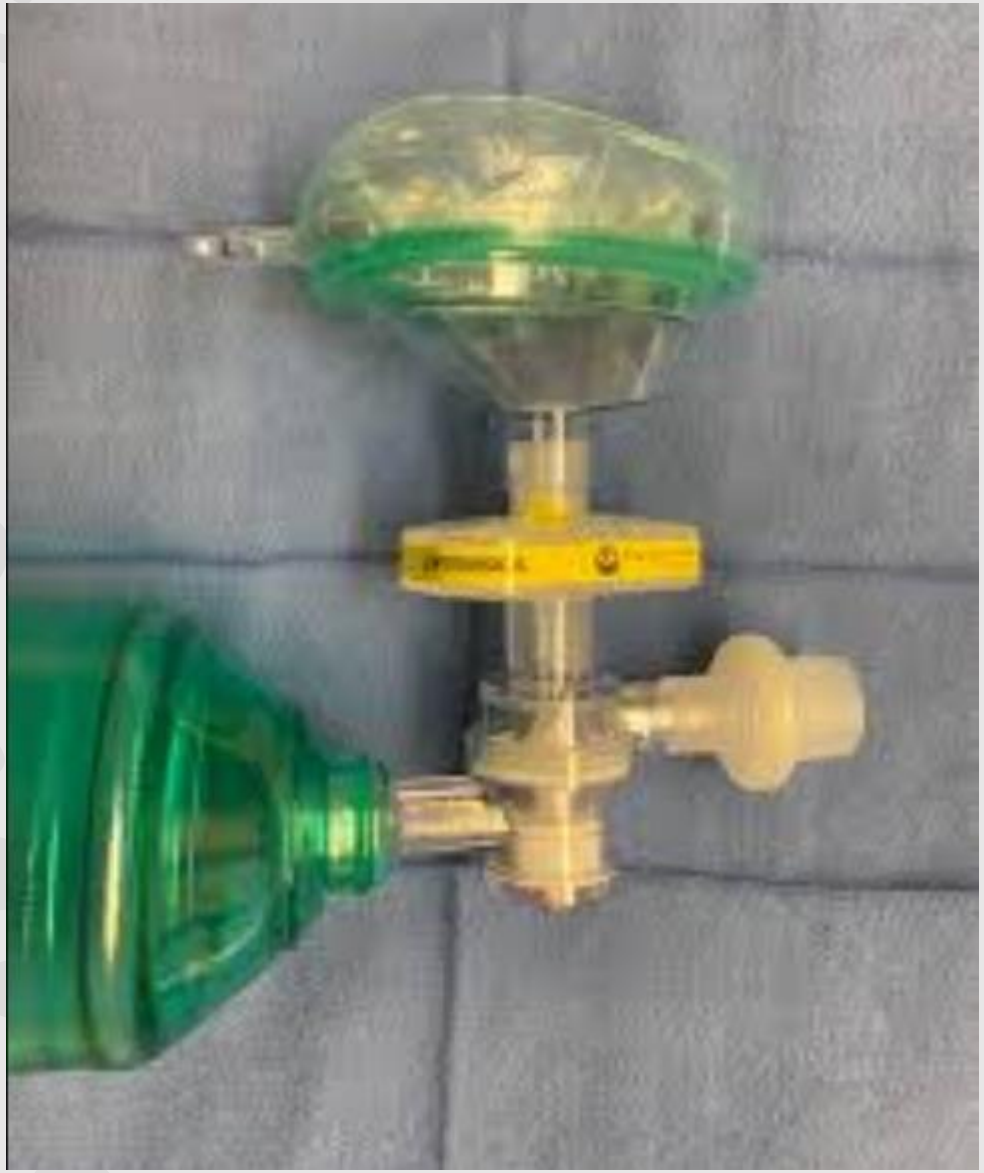
تیم خارج اتاق

۷) آماده کردن داروها و تجهیزات
۸) افراد بیشتر بر حسب شرایط و سناریو بیمار به تیم اضافه خواهند شد.

نرولی کد، خارج از اتاق قرار دارد.

اتاق احیاء





باسپاس