无创正压通气在急诊相关疾病的应用

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神用地上的尘土造人

将生气吹在他的鼻孔里

他就成了有灵的活人

…

圣经·创世纪

前言

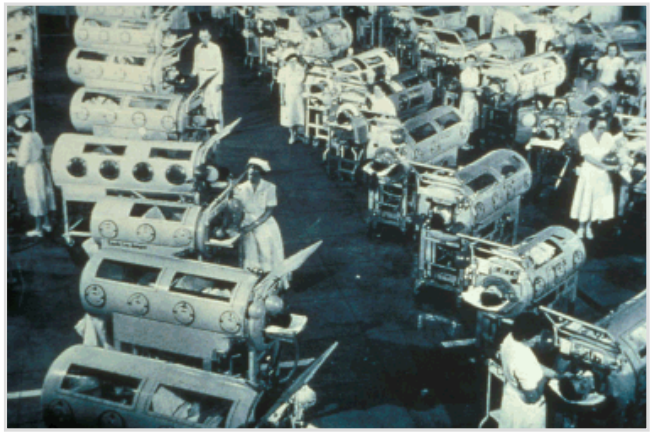
- 无创通气与有创通气最根本的区别在于人—机连接方式，前者无需建立人工气道，后者建立人工气道
- 广义的无创通气包括：无创正压通气、体外负压通气、高频通气、胸壁震荡通气、体外膈肌起搏等。
- 而近十几年所说的无创通气主要是指无创正压通气（NIPPV），是以经鼻或口鼻面罩实现人—机连接，从而达到机械通气的目的，此技术被认为是近十年来机械通气领域的重要进展，是目前治疗急性呼吸衰竭的主要方法之一

机械通气的起源

The era of intensive care medicine began with positive-pressure ventilation

- **Negative-pressure ventilators ("iron lungs")**
  - **Non-invasive ventilation first used in Boston Children's Hospital in 1928**
  - **Used extensively during polio outbreaks in 1940s – 1950s**
- **Positive-pressure ventilators**
  - **Invasive ventilation first used at Massachusetts General Hospital in 1955**
  - **Now the modern standard of mechanical ventilation**

The iron lung created negative pressure in abdomen as well as the chest, decreasing cardiac output.



Iron lung polio ward at Rancho Los Amigos Hospital in 1953.

现代无创正压通气的发展

Collin Sullivan

- 1981年瑞思迈公司创始人之一，世界著名呼吸病学家沙利文教授发明了现代无创正压呼吸机，成为无创通气发展史上的里程碑
- 1989年美国伟康公司研制出BiPAP呼吸机
- 1989年Meudri应用无创通气治疗急性呼吸衰竭
- 我国的无创通气技术从90年代末逐步发展起来

无创正压通气发展的新趋势

- 无创通气应用指征和范围逐渐扩大趋势
- 无创通气和有创通气结合的策略-序贯通气策略
- 机械通气地点发生新的变化
  - 无创通气开始进入ICU
  - 有创通气开始进入亚急性病房、康复中心和家庭
- 机械通气开始的时机发生变化
  - 无创正压通气更早期介入
- 动态把握无创和有创通气的转换时机
- 新一代涡轮呼吸机在一定程度上克服了传统无创呼吸机的不足，可兼作无创、有创通气

无创正压通气发展的新趋势

American Thoracic Society

International Consensus Conferences in Intensive Care Medicine: Noninvasive Positive Pressure Ventilation in Acute Respiratory Failure

ORGANIZED JOINTLY BY THE AMERICAN THORACIC SOCIETY, THE EUROPEAN RESPIRATORY SOCIETY, THE EUROPEAN SOCIETY OF INTENSIVE CARE MEDICINE, AND THE SOCIÉTÉ DE REANIMATION DE LANGUE FRANÇAISE, AND APPROVED BY THE ATS BOARD OF DIRECTORS, DECEMBER 2000

Noninvasive positive pressure ventilation (NPPV) was applied first to patients with chronic pulmonary disease but is now being used to support those with acute respiratory failure (ARF). An International Consensus Conference in Intensive Care Medicine considering the role of NPPV in ARF was held in Paris, France, from April 13–14, 2000; sponsored by the Critical Care Assembly of the American Thoracic Society (ATS), the European Respiratory Society (ERS), the European Society of Intensive Care Medicine (ESICM), and the Société de Réanimation de Langue Française (SRLF).

The methods of the Consensus were established by the National Institutes of Health (1) and adapted subsequently for use in critical care medicine (2). Briefly, the process comprised four phases. First, five key questions were formulated by the scientific advisors designed to address issues integral to the evaluation of noninvasive ventilatory support in its current and future roles. Second, a comprehensive literature search was performed and key articles precirculated to a jury of 10 clinician scientists who were not experts in the field under discussion. Third, authorities in NPPV selected by the Organizing Committee and scientific advisors delivered focused presentations during a two-day symposium attended by the jury and about 150 delegates. Each presentation was followed by debate and discussion. Finally, the jury summarized the available evidence in response to the questions over the two days immediately after the conference.

For the purposes of this report, NPPV was defined as any form of ventilatory support applied without the use of an endotracheal tube, and was considered to include continuous positive airway pressure (CPAP), with or without inspiratory pressure support; volume- and pressure-cycled systems; proportional assist ventilation (PAV), and adjuncts such as the use of helium-oxygen (heliox) gas mixtures. The term acute respiratory failure (ARF) was considered to include patients with acute lung injury (ALI) and acute respiratory distress syndrome (ARDS), those with acute exacerbations of obstructive airflow limitation (i.e., asthma and COPD); acutely decompensated patients with the obesity hypoventilation syndrome (OHS) and cardiogenic pulmonary edema (CPE); patients developing ARF in the perioperative period; and those with either difficulty weaning from invasive mechanical ventilatory support, or in whom endotracheal intubation (ETI) was considered inappropriate. The information presented to the jury was designed to address the following five questions.

QUESTION 1: WHAT ARE THE RATIONALE, POTENTIAL BENEFITS, AND GOALS FOR NPPV?

Patients require ventilatory assistance to reduce the Pa_{CO_2} (Figure 1) and/or to improve oxygenation (Figure 2). If they can receive appropriate noninvasive ventilatory assistance, patients are spared the discomfort and risks associated with endotracheal intubation (ETI). Although studies suggest that NPPV is associated with a reduced incidence of nosocomial pneumonia, methodological problems mandate reinvestigation of this issue. Potential benefits must be balanced against the discomfort of a nasal or facial mask and risks specific to NPPV (e.g., failure to provide sufficient oxygenation or CO_2 elimination, eye or nasal trauma, gastric distension/aspiration).

The goals of NPPV differ depending upon the clinical context. During acute decompensations of asthma or COPD, the goal is to reduce CO_2 by unloading the respiratory muscles and augmenting alveolar ventilation, thereby stabilizing arterial pH until the underlying problem can be reversed. When employed during episodes of hypoxemic ARF the goal is to ensure an adequate Pa_{O_2} until the underlying problem can be reversed. When applied continuously to patients with chronic ventilatory failure the goal of NIPPV is to provide sufficient oxygenation and/or CO_2 elimination to sustain life by reversing atelectasis or resting the respiratory muscles. When applied intermittently to patients with OHS, the goal is to limit sleep- and position-induced adverse changes in oxygenation and CO_2 elimination and their pathophysiological sequelae by stenting the upper airway, increasing lung volume, and augmenting alveolar ventilation. In cardiogenic pulmonary edema, the goal of NPPV is to improve oxygenation, reduce work of breathing, and increase cardiac output.

Jury and coauthor: Timothy W. Evans (London, UK, Chairman), Richard K. Albert (Denver, CO), Derek C. Angus (Pittsburgh, PA), Julian F. Bion (Birmingham, UK), Jean-Daniel Chiche (Paris, France), Scott K. Epstein (Boston, MA), Jean Yves Fagon (Paris, France), Marco Ranieri (Pisa, Italy), Jacob Iasha Sznajder (Chicago, IL), Antoni Torres (Barcelona, Spain), Keith R. Walley (Vancouver, BC, Canada).

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International Consensus Conference Committee: ATS: Arthur Slutsky (Toronto, ON, Canada), Catherine Sasson (Long Beach, CA); ERS: Antoni Torres (Barcelona, Spain); ESICM: Francois Lemaire (Creteil, France), Graham Ramsay (Maastrict, Netherlands); SRLF: Jordi Mancebo (Barcelona, Spain), Christian Richard (Paris, France).

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American Thoracic Society, European Respiratory Society, European Society of Intensive Care Medicine, et al. International consensus conferences in intensive care medicine: noninvasive positive pressure ventilation in acute respiratory failure. Am J Respir Crit Care Med, 2001, 163:283-291.

BTS GUIDELINE

Non-invasive ventilation in acute respiratory failure

British Thoracic Society Standards of Care Committee

Thorax 2002;57:192–211

INTRODUCTION

Nomenclature

Non-invasive ventilation (NIV) refers to the provision of ventilatory support through the patient's upper airway using a mask or similar device. This technique is distinguished from those which bypass the upper airway with a tracheal tube, laryngeal mask, or tracheostomy and are therefore considered invasive. In this document NIV refers to non-invasive positive pressure ventilation, and other less commonly used techniques such as external negative pressure or rocking beds will not be discussed. (NIPPV is an alternative abbreviation but it is more cumbersome and involves ambiguity as to whether "N" is for "non-invasive" or "nasal".)

Continuous positive airway pressure (CPAP) in this document refers to the non-invasive application of positive airway pressure, again using a face or nasal mask rather than in conjunction with invasive techniques. Although it might be open to debate as to whether the use of non-invasive CPAP in acute respiratory failure constitutes ventilatory support, it is included in this document because of the confusion which commonly arises between NIV and CPAP in clinical practice.

Background

One of the first descriptions of the use of NIV using nasal masks was for the treatment of hypoventilation at night in patients with neuromuscular disease.[1–3] This has proved to be so successful that it has become widely accepted as the standard method of non-invasive ventilation used in patients with chronic hypercapnic respiratory failure caused by chest wall deformity, neuromuscular disease, or impaired central respiratory drive. It has largely replaced other modalities such as external negative pressure ventilation and rocking beds.

Within a few years of its introduction, NIV was starting to be used in acute hypercapnic respiratory failure and in patients with abnormal lungs rather than an impaired respiratory pump. Initial anecdotal reports were followed by larger series and then by randomized trials. Analysis of these trials has shown that NIV is a valuable treatment for acute hypercapnic respiratory failure, as will be discussed under the section on Indications. It has a number of potential advantages, particularly the avoidance of tracheal intubation with its associated morbidity and mortality from problems such as pneumonia. Pressure on intensive care unit beds is oft en high, and NIV can be used in other clinical areas and also at an earlier stage than tracheal intubation. Intermittent ventilatory assistance is possible with NIV, allowing gradual weaning and also normal eating, drinking, and communication. Breaks from ventilatory support can be used for giving nebulised medication, physiotherapy, and expectoration.

A survey of acute admissions in Leeds has suggested that, if NIV was used in all patients with chronic obstructive pulmonary disease (COPD) with a pH of <7.35 (H^+ >45 nmol/l) after initial medical treatment, a typical district general hospital serving a population of 250 000 would expect to treat around 70 patients per year.[3]

- *Non-invasive ventilation has been shown to be an effective treatment for acute hypercapnic respiratory failure, particularly in chronic obstructive pulmonary disease. Facilities for NIV should be available 24 hours per day in all hospitals likely to admit such patients.* [A]

NIV is not suitable for all patients with respiratory failure. If used indiscriminately, patients who would be managed more appropriately by tracheal intubation will receive suboptimal treatment. Use of NIV in patients in whom it is unlikely to be beneficial is also undesirable. It is essential that NIV is applied in an appropriate clinical area by appropriately trained staff using the optimal ventilator mode, settings, and interface for that patient with adequate monitoring.

- *NIV should not be used as a substitute for tracheal intubation and invasive ventilation when the latter is clearly more appropriate.* [B]

Purpose of this document

The main aims of this document are to

- Set standards of care for patients receiving NIV in acute respiratory failure based on the available evidence and define minimum standards for the provision of an acute NIV service
- Identify which patients with acute respiratory failure should be considered for NIV or CPAP
- Describe the optimal application of different ventilatory modes and patient interfaces

Members of BTS Standards of Care Committee: S Bott, A Davison, M Elliott, W Kinnear (Chairman), R Paton, E Sawicka, L Turner (Secretary)

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Abbreviations: AHRF, acute hypercapnic respiratory failure; ARDS, acute respiratory distress syndrome; ASB, assisted spontaneous breathing; BMI, body mass index; CMV, continuous mandatory ventilation; COPD, chronic obstructive pulmonary disease; CPAP, continuous positive airways pressure ; EPAP , expiratory positive airways pressure; F_{IO_2}, fractionated inspired oxygen concentration; FRC_r, functional residual capacity; HDU, high dependency unit; ICU, intensive care unit; IE, inspiratory/expiratory; IPAP, inspiratory positive airways pressure; IPPV, intermittent positive pressure ventilation; LTOT, long term oxygen therapy; NIV, non-invasive ventilation; OSA, obstructive sleep apnoea; $Paco_2$, partial pressure of arterial carbon dioxide; Pao_2, partial pressure of arterial oxygen; PAV, proportional assist ventilation; PEEP, positive end expiratory pressure; PEEPi, Intrinsic PEEP; PS, pressure support; Sp_{O_2}, oxygen saturation; SMV, synchronised intermittent mandatory ventilation; S/T, spontaneous/timed; V/Q, ventilation perfusion.

British Thoracic Society Standards of Care Committee. Non-invasive ventilation in acute respiratory failure. Thorax, 2002, 57: 192-211.

无创正压通气发展的新趋势

诊治方案

编者按:近年来有创机械通气在我国发展很快,与其相比,无创通气则相对滞后,其重要原因之一可能是医生们对无创通气的疗效尚有疑虑,掌握无创通气应用方法不当、没有按正确的操作规程来实施,可能是疗效不理想或者患者不耐受的常见原因。中华医学会呼吸病学分会临床呼吸生理及 ICU 学组经过数次讨论,委托陈荣昌教授草拟了"无创正压通气临床应用中的几点建议"一文。本文之所以没有以"指南"的面目出现,是因为觉得临床实践尚有不足,希望读者在实践过程中不断总结出自己的宝贵经验,提出修改建议,使其更加完善。

无创正压通气临床应用中的几点建议

中华医学会呼吸病学分会临床呼吸生理及 ICU 学组

人工通气当目前治疗或抢救严重呼吸衰竭常用的和有效的方法。常规的人工通气需要气管插管或气管切开(有创通气),给患者带来一定的痛苦,亦会引起多种并发症(如呼吸机相关性肺炎等)。并以,尽管其疗效确切可靠,临床上常常等到呼吸衰竭发展到相当严重,已危及生命时才考虑进行有创通气。随着医学的发展,临床上希望能够通过无创正压通气(NIPPV)的方法,减少急性呼吸衰竭的气管插管或气管切开以及相应的并发症;减少慢性呼吸衰竭呼吸机的依赖,减少患者的痛苦和医疗费用,提高生活的质量。自从 1989 年 Meduri 等报道了经面罩 NIPPV 治疗急性呼吸衰竭后,引起极大的关注[1]。近 10 多年来,无论从应用指征、应用方法学和作用机制等方面均有不少的报道,成为呼吸内科和危重监护医学的重要研究课题。然而,尽管 NIPPV 已经比较普遍在临床应用,但实际应用中仍存在比较多的问题,如:应用指征不一致,缺乏规范的操作程序、以及如何提高疗效和依从性等问题。建立规范的实施操作程序对提高依从性、临床疗效、减少不良反应和并发症具有重要的影响。为了提高认识和引起广大临床工作者的重视,中华医学会呼吸病学分会临床呼吸生理及 ICU 学组召开了专题研讨会,提出了 NIPPV 临床应用的一些建议,供临床工作中参考。

NIPPV 的基本操作程序:(1) 合适的工作监护条件;(2) 掌握适应证和禁忌证;(3) 患者的教育;(4) 摆好体位;(5) 选择和试配带合适的连接器;(6) 选择呼吸机;(7) 开动呼吸机、参数的初始化和连接患者;(8) 逐渐增加辅助通气的压力和容量(适应过程);(9) 严密的监护(漏气、咳痰等);(10) 疗效判断;(11) 决定治疗的时间和疗程;(12) 防治并发症和不良反应;(13) 辅助治疗(雾化、排痰等)。

一、建立开展NIPPV 的基础条件

首先明确 NIPPV 并不是低水平的人工通气,而是一种需要有较高应用技术的人工通气,要将 NIPPV 做好,必须具备有一定的基础条件[2,3]。

1. 人员培训:对负责 NIPPV 工作的人员进行适当的培训,掌握使用的适应证、工作程序,监测指标、疗效判断以及不良反应的防治等,才能保证工作的顺利开展。

2. 合适的工作地点:开始应用 NIPPV 的 4~8 h 需要有专人负责治疗和监护,才能提高疗效。当患者适应 NIPPV 治疗后或者病情改善后,可以无需专人监护。在 ICU,医务人员与患者比例比较高,文献报道的有效率也比较高。如果在普通病房开展 NIPPV 治疗,必须对医护人员进行规范的培训,争取增加 1~2 名专门负责 NIPPV 的工作,才能保证其疗效。

3. 改善NIPPV 的设备:采用的连接方法和呼吸机对疗效有一定的影响,争取逐步完善设备条件。

4. 认识NIPPV 与有创通气的区别:NIPPV 与有创正压通气的特点比较见表 1。由于连接方法的不同,NIPPV 的辅助通气效果不如有创通气稳定可靠,对患者的舒适性和配合性的要求比较高。因此需要有严格的操作程序和应用经验,才能提高疗效。

5. 具有监护和紧急插管的条件:当无创通气治疗失败后,有可能发展为严重的危及生命的呼吸衰

中华医学会呼吸病学分会呼吸生理与重症监护学组. 无创通气临床应用中的几点建议. 中华结核和呼吸杂志，2002，25：130-134

· 诊疗方案 ·

无创正压通气临床应用专家共识

中华医学会呼吸病学分会呼吸生理与重症监护学组
《中华结核和呼吸杂志》编辑委员会

相关术语

无创通气是指无需建立人工气道(如气管插管等)的机械通气方法,包括气道内正压通气和胸外负压通气等。无创正压通气(non-invasive positive pressure ventilation, NPPV 或 NIPPV)是指无创的正压通气方法,包括双水平正压通气(bi-level positive airway pressure, BiPAP)和持续气道内正压(continuous positive airway pressure, CPAP)等多种气道内正压通气模式。BiPAP 是注册的术语,其实质是压力支持(PSV)或压力控制(PCV)+呼气末正压(PEEP)。

推荐意见证据水平的说明:[A 级]:有随机对照试验,具备足够的数据;[B 级]:有限数据的随机对照试验依据;[C 级]:有随机的试验,观察性的研究依据;[D 级]:专家组的推荐意见,尚缺乏系统研究的依据。

概　述

气道内正压通气是目前治疗或抢救呼吸衰竭常用的有效方法。有创正压通气需要气管插管或气管切开,导致患者痛苦并可引起多种并发症(如呼吸机相关性肺炎等),故只能用于严重呼吸衰竭和有生命危险的患者。NPPV 的最大优点是无需建立有创人工气道。自 1989 年 Meduri 等报道 NPPV 用于治疗 COPD 急性加重期(AECOPD)导致的呼吸衰竭后,NPPV 的临床研究可分为 2 个阶段:第一阶段(1989—1995 年)主要是开放式观察研究,第二阶段(1995 年后)是依据循证医学原则的前瞻性随机对照研究(RCT)。近十多年来,随着临床应用研究的不断深入,其应用范畴不断扩展,已经成为临床上常用的辅助通气技术[1-6]。

NPPV 的临床应用是近十余年机械通气领域的重要进步之一,体现在以下几方面:(1) NPPV 由于"无创"的特点使机械通气的"早期应用"成为可能;(2) NPPV 减少了气管插管或气管切开的使用,从而减少人工气道的并发症;(3) NPPV 在单纯氧疗与有创通气之间,提供了"过渡性"的辅助通气选择:在决策是否应用有创通气有困难时,可尝试 NPPV 治疗;在撤机过程中,NPPV 可以作为一种"拾级"或"降低强度"的辅助通气方法,有助于成功撤机;(4) NPPV 作为一种短时或间歇的辅助通气方法扩展了机械通气的应用领域,如辅助进行纤维支气管镜检查、长期家庭应用、康复治疗、插管前准备等,随着 NPPV 技术的进步和临床研究的进展,形成了有创与无创通气相互密切配合的机械通气新时代,提高了呼吸衰竭救治的成功率。

为了指导和规范 NPPV 的临床应用,不少国家先后推出专家共识和指南。2001 年,美国胸科学会首先发表了 NPPV 临床应用的专家共识[5]。随后,美国胸科学会等也制定了临床应用指南[6]。众多的核心杂志也分别刊登专题综述和荟萃分析。中华医学会呼吸病学分会呼吸生理与重症监护学组也在 2002 年草拟了我国的《无创正压通气临床应用中的几点建议》[7]。随着研究的不断深入,NPPV 的临床应用也有了长足的进步。为此,中华医学会呼吸病学分会经过讨论后,对原来的"建议"进行修订,在增加新内容的同时,改为"专家共识",期望通过此专家共识的发表,为临床一线的医务工作者提供参考,促进我国 NPPV 临床应用的规范化,提高治疗水平。

NPPV 的应用指征和禁忌证

目前有关 NPPV 的应用指征尚无统一标准,与呼吸衰竭的严重程度、基础疾病、意识状态、感染的严重程度、是否存在多器官功能损害等多种因素相关,也与应用者的经验和治疗单位人力设备条件有关。NPPV 的应用指征可以从 3 个层面来考虑:(1) 总体应用指征;(2) 在不同疾病中的应用;(3) 在临床实施中动态决策 NPPV 的使用。

一、NPPV 的总体应用指征和临床切入点

NPPV 主要适合于轻中度呼吸衰竭的患者。在急性呼吸衰竭中,其参考的应用指征如下[1,5,6]:

1. 疾病的诊断和病情的可逆性评价适合使用 NPPV。

2. 有需要辅助通气的指标:(1) 中至重度的呼吸困难,表现为呼吸急促(COPD 患者的呼吸频率 > 24 次/min,充血性心力衰竭患者的呼吸频率 > 30 次/min);动用辅助呼吸肌或胸腹矛盾运动;(2) 血气异常[pH 值 < 7.35, $PaCO_2$ > 45 mm Hg(1 mm Hg = 0.133 kPa),或氧合指数 < 200 mm Hg(氧合指数:动脉血氧分压/吸入氧浓度)]。

3. 排除有应用 NPPV 的禁忌证。

NPPV 的临床切入点见图 1[7]。NPPV 主要应用于呼吸衰竭的早期干预,避免发展为危及生命的呼吸衰竭;也可以用于辅助早期撤机。但对于有明确有创通气指征者,除非是拒绝插管,否则不宜首先应用 NPPV 替代气管插管[1,5,6,7]。

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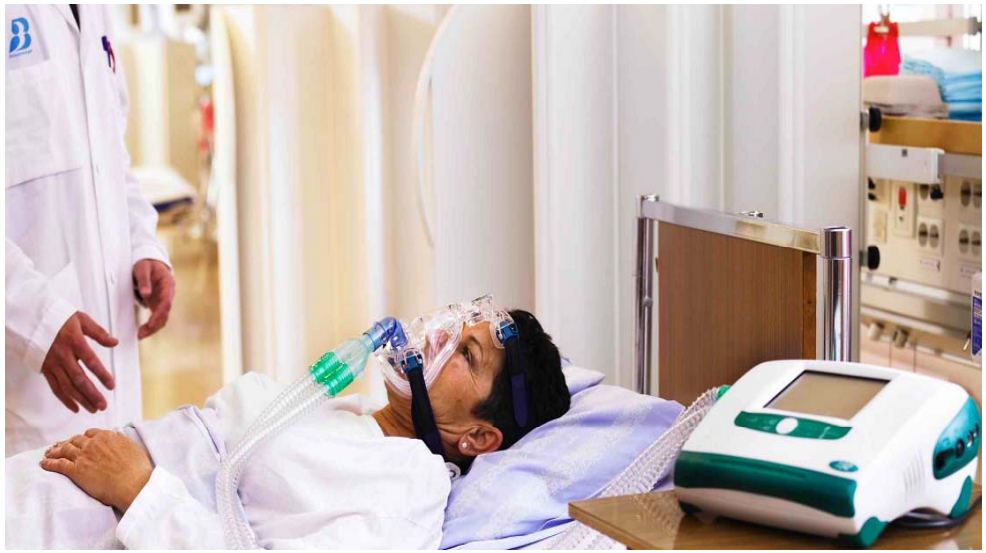
中华医学会呼吸病学分会呼吸生理与重症监护学组《中华结核和呼吸杂志》编辑委员会. 无创正压通气临床应用专家共识. 中华结核和呼吸杂志，2009，32：86-98

回顾机械通气的历史，其过程是从有创到无创（体外负压箱式呼吸机）再回到有创，最终进入有创与无创共存的时代。有创与无创通气各有其不同的适应证，二者的关系是相互补充而不是相互替代，因此也不存在孰优孰劣的问题



- 无创
- 正压“漏气”通气

无创正压通气的特点

❖ 无创

- 患者痛苦小，易上易下，可试用和间断试用
- 保留上气道，避免人工气道并发症
- 缺乏气道保护能力

❖ 正压“漏气”通气

- 正压通气：增大患者的肺容积，改善氧合和通气
- 漏气：降低人机协调性和通气效果，辅助水平相对较低，需要病人的主动配合

无创与有创呼吸机的区别

无创呼吸机

- 高流量低压力，漏气补偿能力较好
- 监测报警系统简单
- 通气模式少
- 多无空-氧混合器

有创呼吸机

- 低流量高压力，漏气补偿能力较差
- 监测报警系统完善
- 通气模式多
- 多有空-氧混合器

成功应用无创正压通气

- 成功应用无创正压通气的基础
  - 全面了解无创通气之“能”与“不能”
  - 正确掌握应用指征
  - 规范的临床操作
- 无创通气的应用是技术性与艺术性的结合

无创正压通气应用指征

- 呼吸衰竭的严重程度
- 基础疾病
- 意识状态
- 感染的严重程度
- 是否存在多器官功能损害
- 应用者的经验
- 治疗单位的人力设备

无统一标准

对无创通气应用的把握

- 在与非机械通气治疗的对比中动态把握无创应用指征
- 在与有创通气的对比中动态把握无创应用指征
- 动态和辩证把握无创通气向有创通气切换的时机
- 由于NIPPV的气道保护能力和通气保障性较低等原因，气管插管进行有创通气仍是治疗严重的急性呼吸衰竭的“金标准”
- 充分考虑本单位机械通气经验、专业知识、人员配备、设备条件

关键词：对比 动态；孰更有效I好用？代价、副作用更小？

无创正压通气治疗目标

急性期治疗

-避免插管

-减轻症状

-改善气体交换

-减少患者的痛苦

-减少无创正压通气的时间及并发症发生

-减少住ICU和住院时间

-减少住院费用

慢性期治疗

-减轻或改善症状

-减少急性发作次数

-提高生活质量

-提高生存率

无创通气的模式

- BiPAP（BILEVEL）是最常用的模式
  - —BiPAP（BILEVEL）相当于PSV+PEEP

- PCV作为背景通气模式

能用于无创通气呼吸机的最低配置

- 提供双相（吸气相和呼气相）的压力控制/压力支持
- 提供的最高压力至少为25cmH_2O
- 提供满足患者吸气需求的高流量气体（40-100L/min）
- 提供至少40次/分的通气频率
- 具备一些基本的报警功能：如管路断开、断电等

无创正压通气禁忌症

- 缺乏气道保护能力
  - 昏迷，呕吐，气道分泌物多且排出困难
- 无自主呼吸或自主呼吸微弱
  - 正压通气：增大患者的肺容积，改善氧合和通气
- 无法应用面罩
  - 面部创伤，烧伤或畸形
- 无法配合无创正压通气
  - 紧张，不合作或精神疾病，神志不清
- 肠梗阻，消化道手术后
- 合并严重肺外脏器功能不全
  - 消化道大出血，血液动力学难以维持

不同病种推荐用无创正压通气

Table 1—*Evidence To Support Use of NPPV for Different Types of Acute Respiratory Failure*

Type of Evidence	Evidence
Strong (multiple controlled trials)	COPD exacerbations
	Acute cardiogenic pulmonary edema*
	Immunocompromised patients
	Facilitation of weaning in COPD patients
Less strong (single controlled trial or multiple case series)	Asthma
	Cystic fibrosis
	Postoperative respiratory failure
	Avoidance of extubation failure
	DNI patients
Weak (few case series or case reports)	Upper airway obstruction
	Acute respiratory distress syndrome (ARDS)
	Trauma
	Obstructive sleep apnea, obesity hypoventilation

*Evidence strongest for CPAP.

Timothy Liesching,et al. CHEST 2003,124:699-713

无创正压通气在急性呼衰应用指征

- **积极推荐（level A-有随机对照试验，具备足够的数据）**
  - AECOPD-中度呼吸性酸中毒（7.25<pH<7.35）
  - 急性心源性肺水肿（CPAP）
  - 免疫抑制患者呼吸衰竭
  - COPD患者辅助撤机—序贯通气策略
- **可以应用（level B-有限数据的随机对照试验依据）**
  - 社区获得性肺炎（COPD患者）
  - 术后呼吸衰竭
  - 非COPD患者的辅助撤机
  - 胸部创伤
  - 辅助支气管纤维镜检查

无创正压通气在急性呼衰应用指征

- 应用证据不足（level C-非随机的试验，观察性的研究依据）
  - 非COPD社区获得性肺炎、ARDS、严重创伤
  - 拒绝气管插管呼吸衰竭，如伴有严重意识障碍或有气管插管指征的AECOPD患者，不推荐常规使用NPPV。只有在患者及其家属明确拒绝气管插管
  - 哮喘严重急性发作

无创正压通气在慢性呼衰应用指征

- 应用证据不足（level C-非随机的试验，观察性的研究依据）
  - 稳定期COPD
  - 胸廓畸形或神经肌肉疾病（不伴咳嗽无力和吞咽困难）
- 没有证据，为专家意见（level D-专家组的推荐意见，尚缺乏系统的研究依据）
  - 肺囊性纤维化
  - 支扩

无创正压通气在急诊科的应用选择

CHEST

Official publication of the American College of Chest Physicians

CHEST ONLINE

Use of a Ventilatory Support System (BiPAP) for Acute Respiratory Failure in the Emergency Department

Janet M. Poponick, Jeffrey P. Renston, Richard P. Bennett and Charles L. Emerman

Chest 1999;116;166-171
DOI 10.1378/chest.116.1.166

The online version of this article, along with updated information and services can be found online on the World Wide Web at:
http://chestjournal.chestpubs.org/content/116/1/166.full.html

Study objectives: **Bilevel pressure ventilation has had proven success in the treatment of acute respiratory failure (ARF). The purpose of this study was to identify patient characteristics early in the course of acute illness that can predict the successful use of bilevel pressure ventilation.**
Methods: **Ventilatory assistance using a ventilatory support system (BiPAP model ST-D; Respironics; Murrysville, PA) was considered a treatment option for stable patients with ARF. The system was titrated to patient comfort. Once stable settings had been achieved for 30 min, a posttrial arterial blood gas (ABG) measurement was obtained. Patient charts were reviewed for pretrial and posttrial ABG levels, along with demographics, APACHE (acute physiology and chronic health evaluation) II score, Glasgow Coma Scale (GCS), and length of stay (LOS) data.**
Results: **Bilevel pressure ventilation trials were performed on 58 patients. In 43 patients (74.1%), the trials were successful. Of the 15 patients (25.9%) in whom the trials were not successful, 13 patients required intubation. The pretrial ABG levels did not predict success, as there were no significant differences between the success and failure groups for pH and $Paco_2$, respectively: 7.26 vs 7.26 mm Hg and 75.3 vs 72.8 mm Hg. After 30 min, posttrial ABG levels for pH and $Paco_2$ predicted successful avoidance of intubation: 7.34 vs 7.27 mm Hg ($p < 0.002$) and 61.9 vs 73.0 mm Hg ($p < 0.04$), respectively. There were no significant differences between the success and failure groups in age, gender, GCS, or APACHE II. There were differences between the success and failure groups for LOS data (ventilator days, ICU days, and hospital days): 1.8 vs 10.4 days ($p < 0.01$), 4.2 vs 12.3 days ($p < 0.02$), and 7.5 vs 15.6 days ($p < 0.02$), respectively.**
Conclusion: **Successful treatment with bilevel pressure ventilation could not be predicted by pretrial data (including pH and $Paco_2$) obtained in the emergency department; however, a successful outcome could be determined quickly with a 30-min trial. Successful treatment with bilevel pressure ventilation significantly reduced LOS data.**
Clinical implications: **Our inability to predict success based on initial data supports the use of bilevel pressure ventilation trials for all stable patients with ARF. If the patient's condition fails to improve within 30 min, intubation amd mechanical ventilation is indicated.**
(CHEST 1999; 116:166–171)

Key words: acute respiratory failure; bilevel pressure ventilation; BiPAP; noninvasive positive pressure ventilation

Abbreviations: ABG = arterial blood gas; APACHE = acute physiology and chronic health evaluation; ARF = acute respiratory failure; CHF = congestive heart failure; CPAP = continuous positive airway pressure; ED = emergency department; EMG di = diaphragm electromyogram; IPAP = inspiratory positive airway pressure; EPAP = expiratory positive airway pressure; GCS = Glasgow Coma Scale; LOS = length of stay; PEEP = positive end-expiratory pressure; PSV = pressure support ventilation; Vt = tidal volume

The Use of Noninvasive Positive Pressure Ventilation in the Emergency Department*

Results of a Randomized Clinical Trial

Kelly A. Wood, MD; Larry Lewis, MD; Benjamin Von Harz, RRT; and Marin H. Kollef, MD, FCCP

Objective: **To determine whether the use of noninvasive positive pressure ventilation (NPPV) in the emergency department (ED) will reduce the need for tracheal intubation and mechanical ventilation.**
Design: **Randomized, controlled, prospective clinical trial.**
Setting: **ED of Barnes-Jewish Hospital, a university-affiliated teaching hospital.**
Patients: **Twenty-seven patients meeting a predetermined definition of acute respiratory distress requiring hospital admission.**
Interventions: **Conventional medical therapy for the various etiologies of acute respiratory distress and the application of NPPV.**
Measurements and results: **The primary outcome measure was the need for tracheal intubation and mechanical ventilation. Secondary outcomes also assessed included hospital mortality, hospital length of stay, acquired organ system derangements, and the utilization of respiratory care personnel. Sixteen patients (59.3%) were randomly assigned to receive conventional medical therapy plus NPPV, and 11 patients (40.7%) were randomly assigned to receive conventional medical therapy without NPPV. The two groups were similar at the time of randomization in the ED with regard to demographic characteristics, hospital admission diagnoses, and severity of illness. Tracheal intubation and mechanical ventilation was required in seven patients (43.8%) receiving conventional medical therapy plus NPPV and in five patients (45.5%) receiving conventional medical therapy alone (relative risk=0.96; 95% confidence interval=0.41 to 2.26; p=0.930). There was a trend towards a greater hospital mortality rate among patients in the NPPV group (25%) compared to patients in the conventional medical therapy group (0.0%) (p=0.123). Among patients who subsequently required mechanical ventilation, those in the NPPV group had a longer time interval from ED arrival to the start of mechanical ventilation compared to patients in the conventional medical therapy group (26.0±27.0 h vs 4.8±6.9 h; p=0.055).**
Conclusions: **We conclude that the application of NPPV in the ED may delay tracheal intubation and the initiation of mechanical ventilation in some patients with acute respiratory distress. We also demonstrated that the application of NPPV was associated with an increased hospital mortality rate. Based on these preliminary observations, larger clinical investigations are required to determine if adverse patient outcomes can be attributed to the early application of NPPV in the ED. Additionally, improved patient selection criteria for the optimal administration of NPPV in the ED need to be developed.** ***(CHEST 1998; 113:1339-46)***

Key words: acute respiratory failure; critical care; mechanical ventilation; noninvasive positive pressure ventilation; outcomes

Abbreviations: APACHE=acute physiology and chronic health evaluation; CI=confidence interval; ED=emergency department; EPAP=expiratory positive airway pressure; IPAP=inspiratory positive airway pressure; NPPV=noninvasive positive pressure ventilation; SaO_2=arterial saturation oxygen

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This research was supported in part by a grant from the American Lung Association of Eastern Missouri.
Manuscript received August 20, 1997; revision accepted October 31, 1997.
Reprint requests: Marin H. Kollef, MD, FCCP, Pulmonary and Critical Care Division, Washington University School of Medicine, Box 8052, 660 South Euclid Avenue, St. Louis, MO 63110; email: mkollef@pulmonary.wustl.edu

The management of acute respiratory distress is common in the emergency department (ED) setting. Traditionally, endotracheal intubation and mechanical ventilation have been employed in patients with acute respiratory distress who are unable to meet their ventilatory requirements. However, this form of medical management can be associated with various adverse outcomes, including infectious (eg, nosocomial pneumonia, sinusitis) and noninfectious (eg, barotrauma, oral or laryngeal trauma,

无创正压通气在急诊科的应用选择

Original Research

A Survey of the Use of Noninvasive Ventilation in Academic Emergency Departments in the United States

Dean R Hess PhD RRT, Jessica M Pang, and Carlos A Camargo Jr MD DrPH

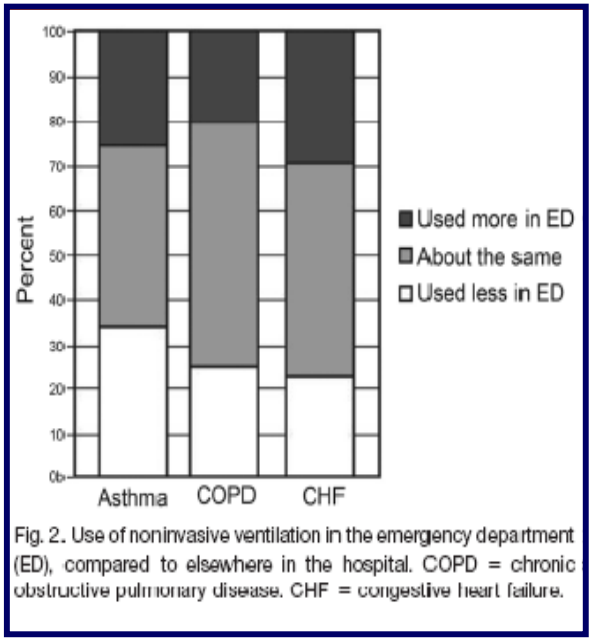

Fig. 2. Use of noninvasive ventilation in the emergency department (ED), compared to elsewhere in the hospital. COPD = chronic obstructive pulmonary disease. CHF = congestive heart failure.

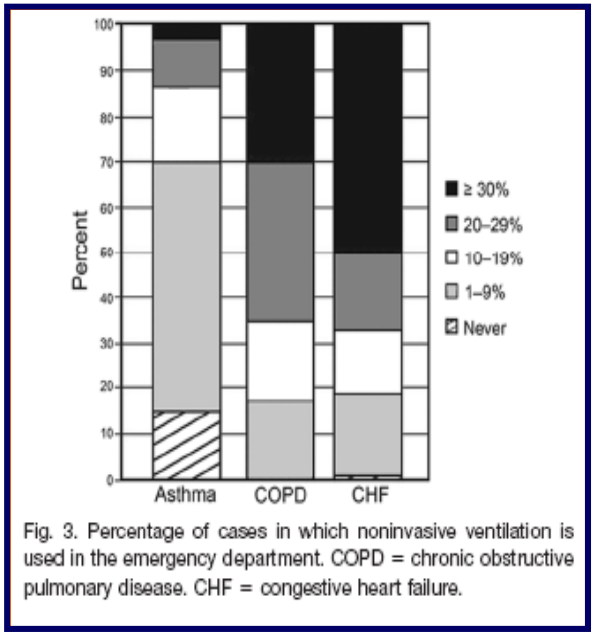

Fig. 3. Percentage of cases in which noninvasive ventilation is used in the emergency department. COPD = chronic obstructive pulmonary disease. CHF = congestive heart failure.

A Survey of the Use of Noninvasive Ventilation in Academic Emergency Departments in the United States. Respir Care 2009;54(10):1306 –1312.

无创正压通气在急诊科的应用选择

- COPD急性加重（中度）
- 急性心源性肺水肿
- 免疫抑制患者
- SARS
- 撤机（序贯通气）

无创正压通气治疗AECOPD

Review

Clinical review: Noninvasive ventilation in the clinical setting – experience from the past 10 years

Massimo Antonelli[1], Mariano Alberto Pennisi[2] and Luca Montini[3]

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Critical Care 2005, 9:98-103 (DOI 10.1186/cc2933)

无创通气对AECOPD治疗已成为一线干预手段，它确保了气管插管率、感染率和死亡率的下降

Abstract

This brief review analyses the progress of noninvasive ventilation (NIV) over the last decade. NIV has gained the dignity of first line intervention for acute exacerbation of chronic obstructive pulmonary disease, assuring reduction of the intubation rate, rate of infection and mortality. Despite positive results, NIV still remains controversial as a treatment for acute hypoxemic respiratory failure, largely due to the different pathophysiology of hypoxemia. The infection rate reduction effect achieved by NIV application is crucial for immunocompromised patients for whom the endotracheal intubation represents a high risk. Improvements in skills acquired with experience over time progressively allowed successful treatment of more severe patients.

Keywords COPD, helmet, hypoxemic respiratory failure, immunocompromised, noninvasive ventilation

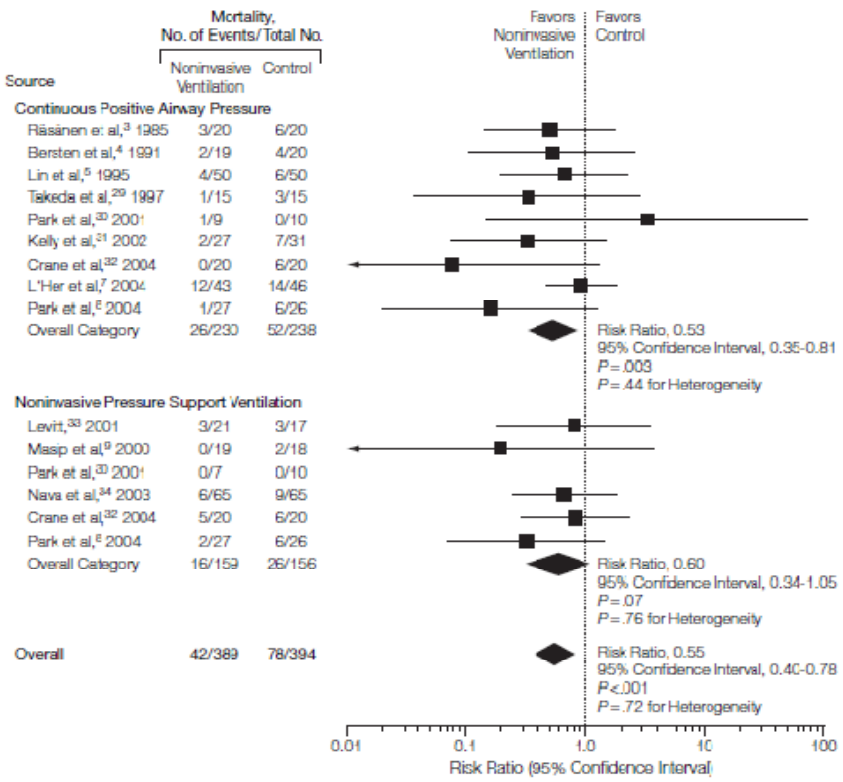
无创正压通气治疗AECOPD

- 轻度（动脉血pH＞7.35，PaCO2＞45mmHg）：宜早期应用NPPV，改善呼吸肌疲劳[C级]
- 中度（7.25＜ pH＜7.35及明显呼吸困难，辅助呼吸肌参与，呼吸频率＞25次/分）：推荐应用NPPV[A级]
- 重度（pH＜7.25）：在严密观察的前提下可短时间（1-2小时）试用NPPV[C级]
- 伴严重意识障碍：不宜行NPPV[D级]

无创正压通气治疗急性心源性肺水肿

- 扩张肺泡增加FRC
  - 改善氧合
  - 改善肺的顺应性
  - 减少呼吸功耗
- 心室充盈压较高而心室功能差时
  - 使心包压力增加而跨壁压下降，后负荷下降，心功能改善
- 心室充盈压相对较低而心室功能良好
  - 减少静脉回流而降低前负荷
- 首选CPAP
- 若存在高碳酸血症或呼吸困难不缓解换用S/T

Figure 2. Effects of Noninvasive Ventilation on Death

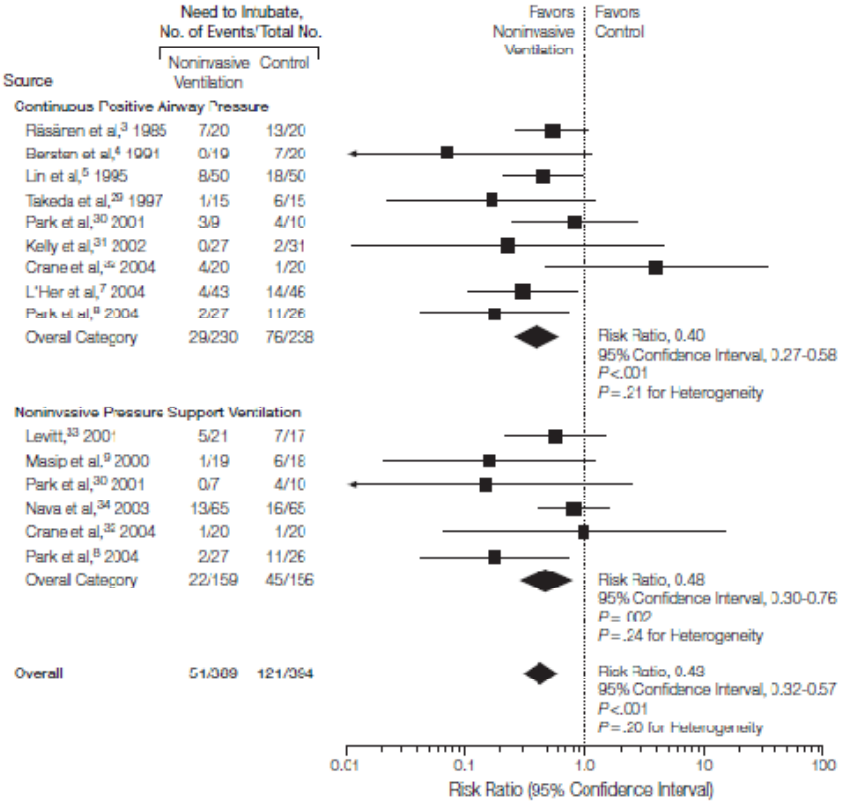


Data markers are proportional to the amount of data contributed by each trial.

病死率

气管插管率

Figure 3. Effects of Noninvasive Ventilation on Need to Intubate



Efficacy and safety of non-invasive ventilation in the treatment of acute cardiogenic pulmonary edema – a systematic review and meta-analysis

João C Winck[1], Luís F Azevedo[2,3], Altamiro Costa-Pereira[2,3], Massimo Antonelli[4] and Jeremy C Wyatt[5]

Critical Care 2006, 10:R69 (doi:10.1186/cc4905)

- CPAP 和 NIPPV治疗ACPE疗效确切
- CPAP和NIPPV均能降低插管率和病死率
- CPAP与常规治疗相比能显著降低病死率
- CPAP治疗并未增加心肌梗塞的发生率
- CPAP简单有效，推荐为ACPE一线治疗
- 合并高碳酸血症者NIPPV并未显示优势

无创正压通气治疗免疫抑制患者

❖有创通气病死率高

- 在迄今为止完成两项针对免疫抑制患者应用机械通气的RCT中发现，一旦发生VAP，ICU病死率将高达100%

Hillbert G,et al.Clin Pulm Med 2004;11:175-182

无创正压通气治疗免疫抑制患者

- 爱滋病肺
- 非爱滋病免疫缺陷肺部并发症
- 血液系统恶性肿瘤
- 高强度化疗后肺部并发症
- 骨髓移植肺部并发症
- 实体器官移植后肺并发症
- 其他免疫抑制状态

无创正压通气治疗免疫抑制患者

Immunocompromised Patients: Evidence is accumulating to support the use of NPPV in immunocompromised patients with acute respiratory failure. Among 40 patients who developed acute respiratory failure following solid organ transplant, those randomized to receive NPPV more often had increases in PaO_2/FIO_2 ratios (60% vs 25%, respectively; $p = 0.03$), lower intubation rates (20% vs 70%, respectively; $p = 0.05$), and lower mortality rates (20% vs 50%, respectively; $p = 0.05$) than conventionally treated control subjects.[52] In addition, the

Antonelli M, Conti G, Bufi M, et al. Noninvasive ventilation for treatment of acute respiratory failure in patients undergoing solid organ transplantation: a randomized trial. JAMA 2000; 283:235–241

无创正压通气治疗免疫抑制患者

- 朝阳医院RICU连续收治13例肾移植术后2-4个月，因肺部感染所致急性呼吸衰竭
- 一开始便接受NIPPV的12例患者
  - 均存活
  - 8例成功接受NIPPV
  - 4例NIPPV失败转换为有创通气

有创通气是NIPPV失败时必不可少的补救手段

无创正压通气治疗SARS

- 约20%以上SARS患者出现急性呼吸衰竭，是致死的主要原因，插管机械通气是改善呼吸衰竭的重要手段，但上机后病死率达50%以上，NIPPV的应用可避免插管通气相关的并发症，降低插管率，已被SARS相关指南推荐为重要治疗手段之一

有创-无创序贯通气的概念

❖概念

Positive pressure ventilation

Invasive MV **Noninvasive MV**

- 以两种方式实施正压通气
- 缩短有创通气时间
- 有创向无创的切换点是关键

❖欲行序贯通气，需有无创通气

有创-无创序贯通气治疗

- Nava等临床试验表明：有创-无创序贯通气可缩短有创通气时间，减少相关并发症，减轻护理工作量，缩短病程和住院时间，降低病死率，减轻医疗负担

Table 2. Randomized Controlled Trials of Noninvasive Ventilation to Allow Earlier Extubation

First Author	Year	Patients (*n*)	Percent With COPD	Benefits of NIV
Nava[3]	1998	50	100	↓ Mechanical ventilation days
				↓ ICU stay
				↓ 60-d weaning failure
				↓ Pneumonia
				↑ 60-d survival
Girault[2]	1999	53	76	↓ Duration of intubation
Ferrer[1]	2003	43	58	↓ Duration of intubation
				↓ ICU stay
				↓ Hospital stay
				↓ Tracheostomy
				↓ Nosocomial pneumonia
				↑ ICU survival
				↑ 90-d survival
Hill[32]	2000	21	33	↓ Duration of intubation
Chen[31]	2001	24	100	↓ Duration of intubation
				↓ Hospital stay
				↓ Nosocomial pneumonia
Rabie[34]	2004	37	100	↓ Duration of intubation
				↓ Weaning failure
				↓ ICU stay
				↓ Hospital stay
				↓ Nosocomial pneumonia
Trevisan[33]	2008	65	35*	↓ Complications
Girault[35]	2009	208	100	None

* Included patients with chronic obstructive pulmonary disease (COPD) and asthma.
ICU = intensive care unit.

“肺部感染控制窗”作为序贯通气切换点

- 肺部感染控制窗

  pulmonary infection control window PIC window

- 出现“PIC窗”时
  - 痰液引流问题已得到较好的解决
  - 严重呼吸衰竭得以纠正
  - 仍存在呼吸肌疲劳和呼吸力学异常
- 出窗后继续有创通气可能招致VAP

王辰等提出以肺部感染控制窗（PIC窗）的出现作为切换点

肺部感染控制窗的判断标准

- 支气管-肺部感染影较前明显吸收，无明显融合斑片影
- 痰量较前明显减少，痰色转白或变浅，黏度降低
- 同时至少伴有下述指征中的1项
  - 外周血白细胞计数低于10000个/mm^3

    或较前下降2000个/mm^3以上
  - 体温较前下降并低于38°C

以“PIC”窗为切换点行序贯通气的要点

- 合理应用抗生素、有效的气道管理
- “朝思暮想”地去发现PIC窗
  - 细致的临床观察
- 在“窗”出现的早期拔管
  - 拔管后立即使用无创通气
- 规范的无创通气操作

无创正压通气病例选择要点

- 没有禁忌症
- 合作能力较好
- 气道保护能力强
- 病情不太重
- NPPV治疗短期内（1-2小时）的反应好
- 基本应用成熟的病种

选择合适的无创正压通气病人

- 适合行无创通气的患者
- 可以尝试无创通气的患者
- 不宜行无创通气的患者

无创正压通气试用原则

- 没有禁忌症
- 试用1-2小时
- 密切观察
- 及时转换有创正压通气

无创正压通气治疗成功的预测因素

- 合作能力
  - 神志较好
  - 依从性好
  - 人机同步较好
- 气道保护能力
  - 漏气量小
  - 分泌物少或自主咳嗽咳痰能力较强
- 疾病严重程度
  - APACHⅡ评分较低
  - 开始时$PaCO_2 < 92mmHg$，$pH > 7.10$
- 无创正压通气短期内（1-2小时）的反应
  - 紧张，不合作或精神疾病，神志不清
  - pH升高，$PaCO_2$，及呼吸频率降低

无创正压通气应用环境与操作培训

治疗环境：ICU vs 普通病房？

- 对于pH＜7.3的患者，不宜在普通病房内行NIPPV

Thorax,2002,57:192-221

培训教育

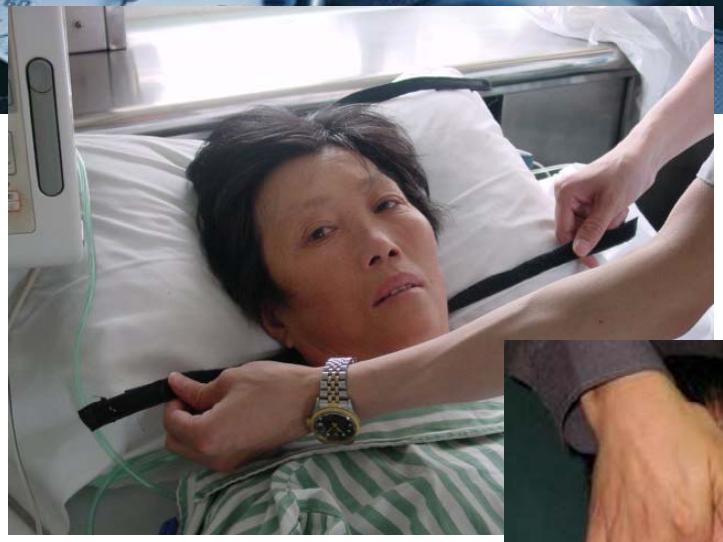
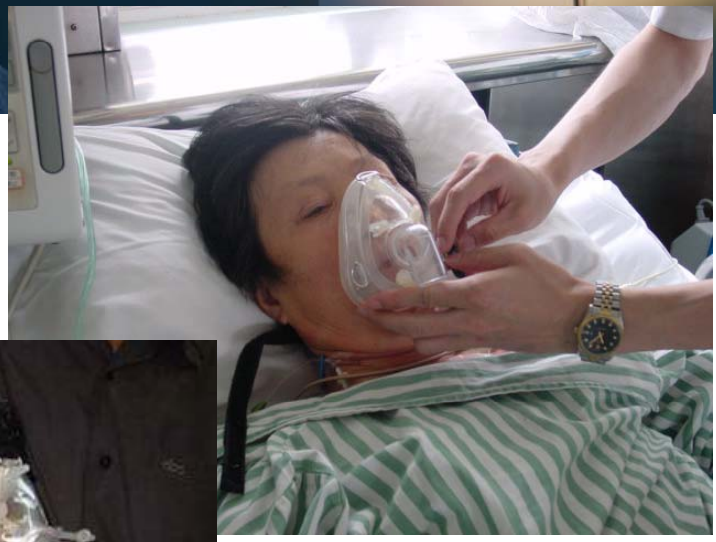
- 操作人员
- 患者
- 家属

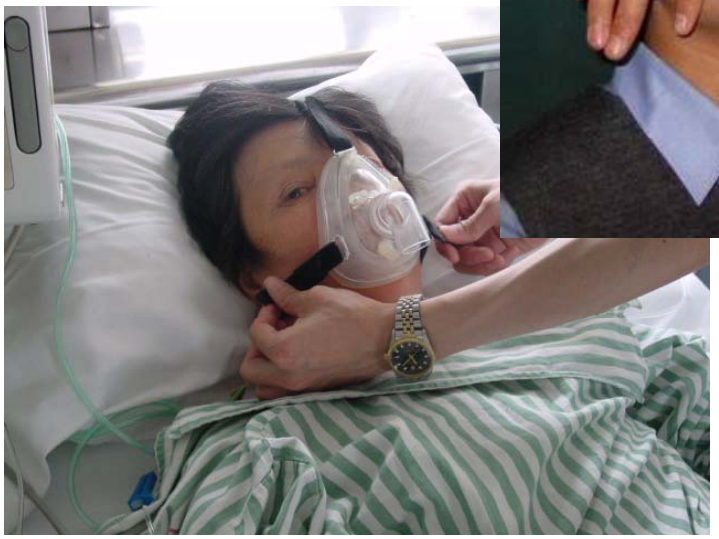
患者教育

- 接受无创通气的必要性
- 行无创通气后可能出现的问题及相应措施
- 强调在治疗开始
  - 要尽可能长时间连续应用NIPPV
  - 不能因无创通气影响排痰
- 教会患者及家属连接和拆除面罩的方法

机器与患者适应性连接

- 准备工作
  - 患者半卧位
  - 选择合适的鼻/面罩和呼吸机
- 三个步骤
  - 将面罩正确置于患者面部
  - 连接、开动呼吸机
  - 正确地用固定带固定鼻/面罩




参数调节

低→高、逐步调节

- 初始EPAP 4cmH_2O、IPAP 8cmH_2O，

  或CPAP 4cmH_2O

- 经过5-20分钟逐步增加至合适的水平

床旁监测

- 鼻/面罩与面颊接触部是否漏气
  - 漏气的危害：影响人-机协调性
- 人-机协调性判断
  - 主要是指患者呼-吸气时相与呼吸机高-低压力转换是否一致
  - 望、闻、问、切
- 观察通气效果
- 与患者交流，予以指导和鼓励

通气效果判断

- 呼吸困难症状缓解
- 辅助呼吸肌动用消失/减少
- 可见较明显的胸廓起伏、呼吸音清晰
- 呼吸频率及心率减慢
- SpO_2及血气指标改善

终止无创通气的标准

- 出现如下情况需加用有创人工气道的保护和支持
  - 行无创通气后2小时内呼吸困难症状无缓解，指标无改善
  - 出现呕吐、严重上消化道出血
  - 气道分泌物增多，排痰困难
  - 出现低血压、严重心律失常等循环系统异常表现
- 无创通气的撤机
  - 较有创通气更为灵活

大量研究及临床实践表明

- NIPPV应采用个体地治疗方案
- NIPPV通常在应用0.5-1h即出现疗效
- NIPPV如无效而拖延插管时间并不增加并发症及死亡率
- 成功的NIPPV能使患者避免插管以及由此带来的并发症
- 早期应用NIPPV防止呼吸肌过度疲劳，改善疾病预后


北京积水潭医院
谢谢！