7th CHINA CHEST PAIN CENTERS CONGRESS,CCPCC
第七届中国胸痛中心大会
暨心血管病学进展论坛
2017年11月3日-5日 | 中国 · 广州

心肌梗死合并心衰患者机械通气的支持时机及撤机时机

首都医科大学附属北京朝阳医院
徐 立

心脏与呼吸衰竭的关系

AMI → 急性心力衰竭

↓

急性心源性肺水肿

↓ 弥散↓，V/Q失调 → 换气功能障碍

↓ 顺应性下降 → 通气功能障碍

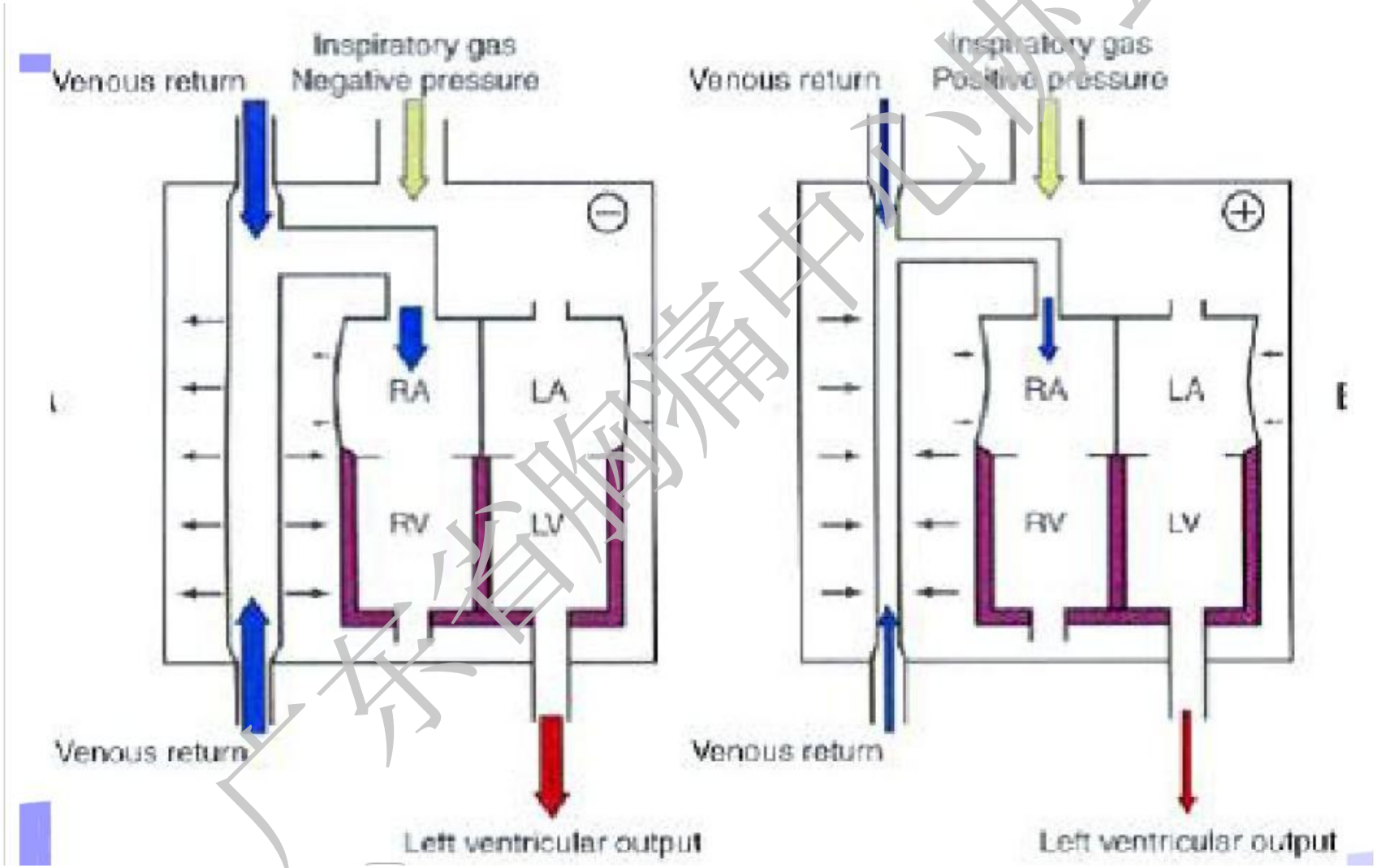
正压通气治疗AHF的机制

- 改善换气：改善氧合
  - 提高吸氧浓度
  - PEEP：减少肺水肿，萎陷肺泡复张——V/Q改善
- 改善通气：降低PaCO2
  - 肺顺应性改善
  - 呼吸肌氧供改善
- 减少呼吸做功：降低氧耗

正压通气治疗AHF

- 改善心脏工作环境
  - 氧合及通气改善
  - 降低心脏前负荷
  - 降低心脏后负荷
- 为吗啡、安定等药物的使用保驾

降低前负荷



降低后负荷

- 心室后负荷与室壁张力正相关

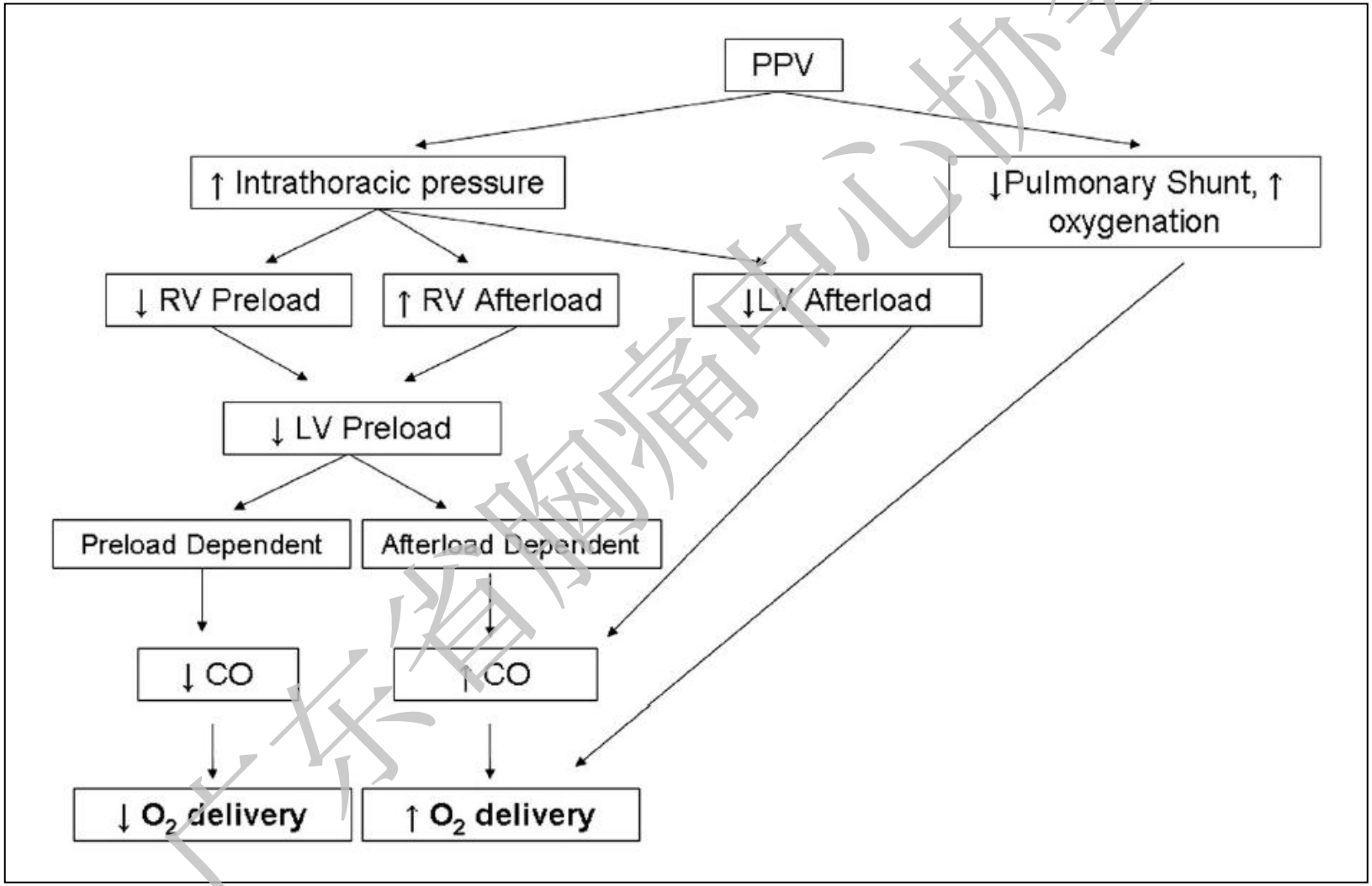
$$T = \frac{P_{tm} \times R}{2H}$$

$P_{tm} = P_{IC} - P_{pl}$

T：室壁张力，P_{tm}：跨心室壁压，R：心室腔半径，H：室壁厚度

P_{IC}：心腔内压，P_{pl}：胸腔内压

正压通气治疗对心功能的影响



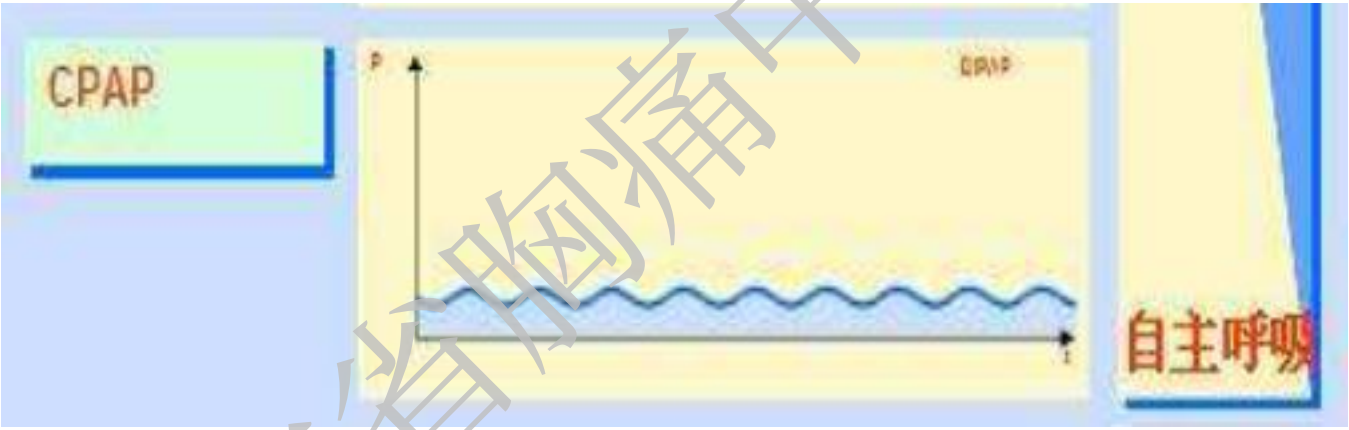
Heart. 2013; 99(24): 1812–1817

无创正压通气方式

- 无创正压通气(Non-invasive positive pressure ventilation,NPPV)是指不需要建立有创人工气道,通过接口器、鼻罩或面罩等连接患者和呼吸机而进行的辅助正压机械通气。
- 无创通气
  - 急救气囊
  - 麻醉面罩
  - 无创呼吸机

无创正压通气方式

CPAP：是指在自然呼吸状态下，吸气相和呼气相持续输送一定的正压，形成“气体支架”使上气道保持开放。使用CPAP一般从5cmH_2O起步逐渐增加，多数临床研究显示其有效范围是10~12.5cmH_2O



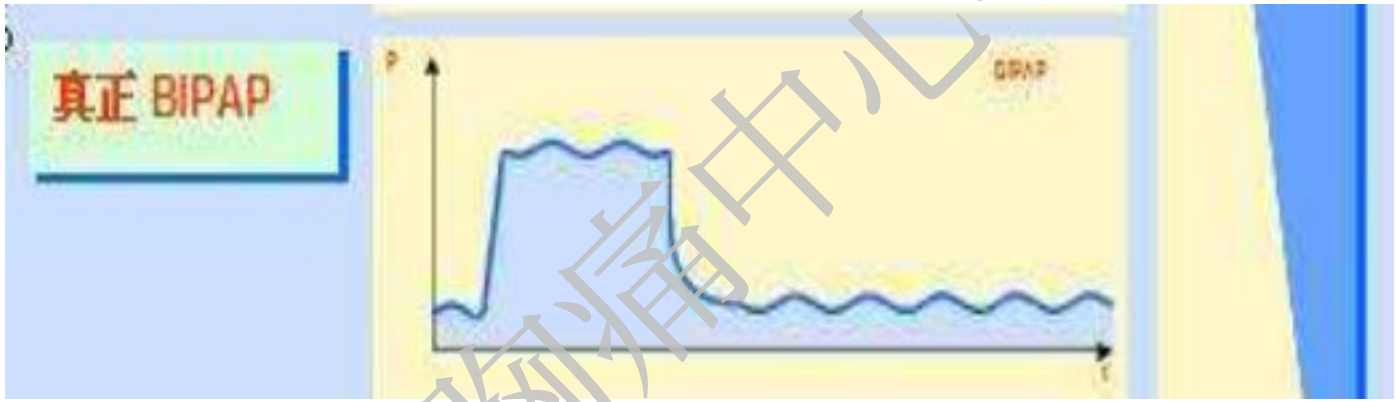
CPAP简单易用、相对价廉，耐受性好；缺点是辅助通 气的效果较差。不能根据患者的需要自动调整压力水平和潮气量的大小，也不适用 于**CO2**潴留较重的患者。

无创正压通气方式

BPAP：通过分别设置和调整IPAP和EPAP解除上气 道阻塞和塌陷

吸气相正压 (inspiratory positive airway pressure，IPAP)

呼气压 (expiratory positive airway pressure，EPAP)



•**IPAP**和**EPAP**之间的压力差，保证足够潮气量。通过扩大压力差来增强吸气力量支持和肺泡通气量，从而降低**CO2**水平，同时减轻呼吸肌负荷。

•**EPAP**可维持上气道开放、消除阻塞型睡眠呼吸暂停、增加功能残气量、防止肺泡萎陷

•**IPAP**从**6~8cmH$_2$O**开始， **EPAP**从**4~5cmH$_2$O**开始,逐渐增加,初始时可以每**3~5**分钟调节**1**次,每次调节**1~2cmH$_2$O**,,以不超过吸气压力/呼气压力**=25/5cmH$_2$O**为宜

Meta-analysis: Noninvasive Ventilation in Acute Cardiogenic Pulmonary Edema

Cui-Lian Weng, MD; Yun-Tao Zhao, PhD; Qing-Hua Liu, MM; Chang-Jun Fu, PhD; Feng Sun, PhD; Yan-Liang Ma, MD; Yan-Wen Chen, MD; and Quan-Ying He, MD

Background: Noninvasive ventilation (NIV) is commonly used to treat patients with acute cardiogenic pulmonary edema (ACPE), but the findings of a recent large clinical trial suggest that NIV may be less effective for ACPE than previously thought.

Purpose: To provide an estimate of the effect of NIV on clinical outcomes in patients with ACPE that incorporates recent trial evidence and explore ways to interpret that evidence in the context of preceding evidence that favors NIV.

Data Sources: PubMed and EMBASE from 1966 to December 2009, Cochrane Central Register of Controlled Trials and conference proceedings through December 2009, and reference lists, without language restriction.

Study Selection: Randomized trials that compared continuous positive airway pressure and bilevel ventilation with standard therapy or each other.

Data Extraction: Two independent reviewers extracted data. Outcomes examined were mortality, intubation rate, and incidence of new myocardial infarction (MI).

Data Synthesis: Compared with standard therapy, continuous positive airway pressure reduced mortality (relative risk [RR], 0.64 [95% CI, 0.44 to 0.92]) and need for intubation (RR, 0.44 [CI, 0.32 to 0.60]) but not incidence of new MI (RR, 1.07 [CI, 0.84 to 1.37]). The effect was more prominent in trials in which myocardial ischemia or infarction caused ACPE in higher proportions of patients (RR, 0.92 [CI, 0.76 to 1.10] when 10% of patients had ischemia or MI vs. 0.43 [CI, 0.17 to 1.07] when 50% had ischemia or MI). Bilevel ventilation reduced the need for intubation (RR, 0.54 [CI, 0.33 to 0.86]) but did not reduce mortality or new MI. No differences were detected between continuous positive airway pressure and bilevel ventilation on any clinical outcomes for which they were directly compared.

Limitations: The quality of the evidence base was limited. Definitions, cause, and severity of ACPE differed among the trials, as did patient characteristics and clinical settings.

Conclusion: Although a recent large trial contradicts results from previous studies, the evidence in aggregate still supports the use of NIV for patients with ACPE. Continuous positive airway pressure reduces mortality more in patients with ACPE secondary to acute myocardial ischemia or infarction.

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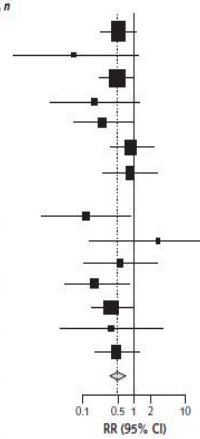
For author affiliations, see end of text.

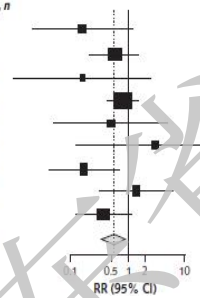
降低插管有创通气发生率

Figure 2. Forest plot for need for intubation.

Study, Year (Reference)	CPAP Events, *n*	CPAP Patients, *n*	Standard Therapy Events, *n*	Standard Therapy Patients, *n*	RR (95% CI)	W (random), %
Räsänen et al, 1985 (24)	6	20	12	20	0.50 (0.23–1.07)	17.1
Bersten et al, 1991 (25)	0	19	7	20	0.07 (0.00–1.15)	1.3
Lin et al, 1995 (26)	8	50	18	50	0.44 (0.21–0.93)	18.3
Takeda et al, 1997 (27)	1	15	6	15	0.17 (0.02–1.22)	2.5
Takeda et al, 1998 (28)	2	11	8	11	0.25 (0.07–0.92)	5.8
Delclaux et al, 2000 (29)	6	22	6	20	0.91 (0.35–2.36)	10.8
Park et al, 2001 (43)	3	9	4	10	0.83 (0.25–2.76)	6.9
Kelly et al, 2002 (30)	0	27	0	31		0
Hao et al, 2002 (31)	1	25	9	26	0.12 (0.02–0.85)	2.5
Crane et al, 2004 (44)	1	20	0	20	3.00 (0.13–69.42)	1
L'Her et al, 2004 (32)	2	43	4	46	0.53 (0.10–2.77)	3.6
Park et al, 2004 (45)	2	27	11	26	0.18 (0.04–0.72)	5
Plaisance et al, 2007 (17)	6	63	16	61	0.36 (0.15–0.87)	13.1
Gray et al, 2009 (12)	1	346	3	367	0.35 (0.04–3.38)	1.9
Ghanem et al, 2009 (19)	5	44	10	41	0.47 (0.17–1.25)	10.2
Random-effects model	44	741	114	764	0.44 (0.32–0.60)	100



Study, Year (Reference)	Bilevel Ventilation Events, *n*	Bilevel Ventilation Patients, *n*	Standard Therapy Events, *n*	Standard Therapy Patients, *n*	RR (95% CI)	W (random), %
Masip et al, 2000 (33)	1	19	6	18	0.16 (0.02–1.19)	5.2
Levitt, 2001 (34)	5	21	7	17	0.58 (0.22–1.50)	18.9
Park et al, 2001 (43)	0	7	4	10	0.16 (0.01–2.48)	2.8
Nava et al, 2003 (35)	13	65	16	65	0.81 (0.41–1.55)	32.3
Ferrer et al, 2003 (36)	1	15	2	15	0.50 (0.05–4.94)	4.1
Crane et al, 2004 (44)	1	20	0	20	3.00 (0.13–69.42)	2.2
Park et al, 2004 (45)	2	27	11	26	0.18 (0.04–0.72)	10
Gray et al, 2009 (12)	4	356	3	367	1.37 (0.31–6.10)	9
Ghanem et al, 2009 (19)	4	44	10	41	0.37 (0.13–1.10)	15.6
Random-effects model	31	574	59	579	0.54 (0.33–0.86)	100

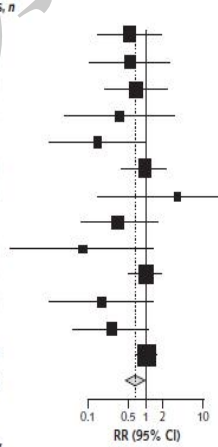


Study, Year (Reference) Bilevel Ventilation CPAP RR (95% CI) W (random), %

降低住院死亡率

Figure 1. Forest plot for in-hospital mortality.

Study, Year (Reference)	CPAP Events, *n*	CPAP Patients, *n*	Standard Therapy Events, *n*	Standard Therapy Patients, *n*	RR (95% CI)	W (random), %
Räsänen et al, 1985 (24)	3	20	6	20	0.50 (0.14–1.73)	7.2
Bersten et al, 1991 (25)	2	19	4	20	0.53 (0.11–2.55)	4.7
Lin et al, 1995 (26)	4	50	6	50	0.67 (0.20–2.22)	7.6
Takeda et al, 1997 (27)	1	15	3	15	0.33 (0.04–2.85)	2.7
Takeda et al, 1998 (28)	1	11	7	11	0.14 (0.02–0.98)	3.3
Delclaux et al, 2000 (29)	7	22	7	20	0.91 (0.39–2.14)	12.9
Park et al, 2001 (43)	1	9	0	10	3.32 (0.15–72.00)	1.3
Kelly et al, 2002 (30)	2	27	7	31	0.33 (0.07–1.45)	5.3
Crane et al, 2004 (44)	0	20	6	20	0.08 (0.00–1.28)	1.6
L'Her et al, 2004 (32)	12	43	14	46	0.92 (0.48–1.76)	18.5
Park et al, 2004 (45)	1	27	6	26	0.16 (0.02–1.24)	2.9
Plaisance et al, 2007 (17)	2	63	8	61	0.24 (0.05–1.09)	5.1
Gray et al, 2009 (12)	33	346	36	367	0.97 (0.62–1.52)	26.8
Random-effects model	69	672	110	697	0.64 (0.44–0.92)	100



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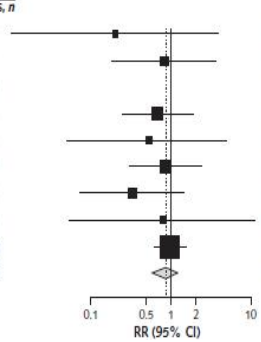
Levitt, 2001 (34)	3	21	3	17	0.81 (0.19–3.51)	5.5
Park et al, 2001 (43)	0	7	0	10		0
Nava et al, 2003 (35)	6	65	9	65	0.67 (0.25–1.77)	12.5
Ferrer et al, 2003 (36)	1	15	2	15	0.50 (0.05–4.94)	2.3
Crane et al, 2004 (44)	5	20	6	20	0.83 (0.30–2.29)	11.6
Park et al, 2004 (45)	2	27	6	26	0.32 (0.07–1.45)	5.2
Weitz et al, 2007 (13)	1	13	1	10	0.77 (0.05–10.85)	1.7
Gray et al, 2009 (12)	34	356	36	367	0.97 (0.62–1.52)	59.8
Random-effects model	52	543	65	548	0.82 (0.58–1.15)	100



Annals of Internal Medicine , 2010 , 152 (9) :590

强调早期应用

- NIPPV应用越早效果越好，在很多情况下是病情加重，药物治疗效果不好时才被动使用，往往错失良机而直接使用了有创呼吸机通气治疗。
- NIPPV有效的压力值调节需要时间，急性肺水肿发作时可供缓解的时间窗较短。如果得不到及时缓解，将很快进入到需要插管行有创机械通气治疗阶段。此时患者将出现低血压和意识障碍，有创机械通气改善心功能的作用十分有限。

无创呼吸机使用时机：指南推荐

2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation

The Task Force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC)

Non-invasive positive pressure ventilation (continuous positive airway pressure, biphasic positive airway pressure) should be considered in patients with respiratory distress (respiratory rate >25 breaths/min, SaO_2 <90%) without hypotension.[410,411,417–419]	IIa	B

2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure

The Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC)

Oxygen therapy is recommended in patients with AHF and SpO_2 <90% or PaO_2 <60 mmHg (8.0 kPa) to correct hypoxaemia.	I	C
Non-invasive positive pressure ventilation (CPAP, BiPAP) should be considered in patients with respiratory distress (respiratory rate >25 breaths/min, SpO_2 <90%) and started as soon as possible in order to decrease respiratory distress and reduce the rate of mechanical endotracheal intubation. Non-invasive positive pressure ventilation can reduce blood pressure and should be used with caution in hypotensive patients. Blood pressure should be monitored regularly when this treatment is used.	IIa	B

无创呼吸机使用时机：指南推荐

· 98 ·　中华心血管病杂志 2014 年 2 月第 42 卷第 2 期　Chin J Cardiol, February 2014, Vol. 42 No. 2

· 指南与共识 ·

中国心力衰竭诊断和治疗指南 2014

中华医学会心血管病学分会　中华心血管病杂志编辑委员会

- 吸氧：适用于低氧血症和呼吸困难明显，尤其指端血氧饱和度＜90%的患者。如需吸氧，应尽早采用，使患者SaO2 ≥95%(伴COPD者SaO2 ≥90%）。
- 无创呼吸机辅助通气（Ⅱa类，B级）推荐用于常规吸氧和药物治疗仍不能纠正的肺水肿合并呼吸衰竭，呼吸频率>20次/分,能配合呼吸机通气的患者。但不建议用于收缩压＜85mmHg的患者。

及时调整

在临床情况改善时应及时降低压力值，避免持续高压力加重心肌缺血，降低心输出量和血压

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2014, Vol. 21, No. 4, p. 449
DOI: 10.5603/CJ.2014.0054

ISSN 1897–5593

VIA MEDICA

LETTER TO THE EDITOR

The double-edged sword of mechanical ventilation for patients with cardiogenic shock

NIV禁忌证患者应评价直接有创机械通气指证

绝对禁忌症	相对禁忌症
•心跳呼吸停止 •昏迷、自主呼吸弱 •误吸可能性高 •合并其他器官功能衰竭（血流动力学不稳定，消化道大出血/穿孔，严重脑部疾病等） •面部创伤/术后/畸形（正压通气） •不合作	•气道分泌物多/排痰障碍 •严重感染 •极度紧张 •严重的氧血症（PaCO2＜45 mmHg）/严重酸中毒（pH≤7.20） •近期上腹部手术后（尤其是需要严格胃肠减压者） •严重肥胖
胸腹部手术后创伤（胸外负压通气）	

及时转换：有创呼吸机使用时机

必要时应该及时转换有创通气：

- 病情发展迅速或继续恶化，肺水肿明显，大量粉红色泡沫痰
- 神志不清或意识淡漠
- 严重心源性休克和心律失常
- 肺部感染严重，痰液粘稠量多，患者排痰不力
- 人机配合不佳，无法耐受
- 血气指标继续恶化：缺氧进一步加重；出现或加重CO_2潴留

有创呼吸机使用时机：指南推荐

2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation

The Task Force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC)

Patient intubation is indicated in patients with respiratory failure or exhaustion, leading to hypoxaemia, hypercapnia, or acidosis, and if non-invasive ventilation is not tolerated.	I	C

2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure

The Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC)

Intubation is recommended, if respiratory failure, leading to hypoxaemia (PaO_2 <60 mmHg (8.0 kPa)), hypercapnia ($PaCO_2$ >50 mmHg (6.65 kPa)) and acidosis (pH <7.35), cannot be managed non-invasively.	I	C

有创呼吸机使用时机：指南推荐

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· 指南与共识 ·

中国心力衰竭诊断和治疗指南 2014

中华医学会心血管病学分会　中华心血管病杂志编辑委员会

气道插管和人工机械通气：应用指征为心肺复苏时、严重呼吸衰竭经常规治疗不能改善者，尤其是出现明显的呼吸性和代谢性酸中毒，并影响到意识状态的患者。

使用呼吸机判断治疗有效的依据

- 昏迷患者神志清醒，烦躁患者转安静
- 患者呼吸与机械通气同步。
- 双肺呼吸音对称，胸廓运动均匀。
- 血气分析结果逐步好转。
- 血压基本正常。

撤机前工作

- 应掌握好呼吸机模式的运用时机，使患者呼吸肌有休息，有锻练，使其尽快过渡到自主呼吸
- 血液动力学稳定，镇静剂逐渐减量，进入唤醒模式，应用自主通气模式。
- 对于无合并严重肺部基础疾患的心衰患者，应考虑尽早脱机，避免呼吸机相关肺炎。
- 心功能稳定后，及时调节镇静剂剂量，行脱机评估
- 同步间歇指令通气 (SIMV)：逐渐减少SIMV次数，相对增加了自主呼吸次数，减至SIMV4次／分时，患者仍能耐受，其VT不低于350ml，血气分析基本正常，可考虑撤机。
- 持续气道呼正压通气（CPAP）：自主呼吸时，吸气与呼气期均保持气道正压。可防止肺泡萎陷，增加功能残气，改善肺顺应性。CPAP多在自主呼吸较好的情况下应用，可用于撤机前。

撤离呼吸机治疗的条件和标准

- 病人一般情况好转和稳定，神志清楚，感染控 制，循环平稳，能自主摄入一定的热量，营养状态和肌力良好。
- 呼吸功能明显改善：
  - 自主呼吸增强，常与呼吸机对抗。
  - 咳嗽有力，能自主排痰。
  - 吸痰等暂时断开呼吸机时病人无明显的呼吸 困难，无缺氧和CO_2潴留表现，血压、心 率稳定。
  - 降低机械通气量，病人能自主代偿。

撤离呼吸机治疗的条件和标准

- 临床观察心功能稳定，无心绞痛发作。
- 血气分析在一段时间内稳定
- 酸碱及水电解质失衡得到纠正
- 吞咽反射恢复，上呼吸道通畅，下颌活动良好
- 向病人讲明撤离呼吸机的目的和要求，病人能够予以配合

撤离呼吸机治疗的条件和标准

- R<25/min
- VT：>10ml/kg，VE：<10L/min
- FiO2<50%，PEEP<5cmH2O

- PH: 7.35～7.45
- PaO2: 60～100mmHg；PaCO2: 35～45mmHg

脱机失败，应恢复机械通气

- 患者躁动，出汗，紫绀，呼吸窘迫
- 心动过速： HR>110/min或较原基数增加20/min
- 呼吸急促： R>30/min或较原基数增加10/min
- 血压明显上升或下降：舒张压> 100mmHg，或较原基数升高或下降>20mmHg
- SaO2<85%，PaO2<60mmHg； PaCO2增加8mmHg伴pH下降
- VE增加>5L/min

拔管方法

- 准备好吸引器、面罩、开口器等物品。
- 拔管前先将口、鼻、咽喉及气管内的分泌物吸引干净，放掉套囊中的气体，再次吸引气管。
- 拔管前吸入 50-100%氧气1-2分钟。拔出导管前让病人深呼吸几次。
- 将吸引管插入导管并越出内端口，一边作气管内吸引，一边随同气管导管一起慢慢拔出，以便将存留在气管与导管外壁缝隙中的分泌物一并吸出

拔管方法

- 拔除导管后，继续吸引口、咽部的分泌物，并将头偏向一侧，以防呕吐误吸。
- 密切观察呼吸道是否通畅，托起下颌，面罩给氧，必要时可放入口咽通气道或鼻咽通气管。
- 拔管后若发生喉痉挛或呼吸不好，应面罩紧闭加压吸氧，必要时再度插管。严重喉痉挛者可给予镇静剂或肌松药后，再次插管
- 拔管后可行NIPPV过渡

谢 谢！