NON-INVASIVE POSITIVE PRESSURE VENTILATION –THE GAPS

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DISCLOSURES

- Honorarium Respiratory Associates
- AARC SESG Committee
- AARC CPG Committee
- AARC Clinical Educator Task Force
- AARC 2025 Acute Care Section Chair Nominee
- ANY reference to any particular piece of equipment is not an endorsement for that product and I am not compensated by any medical supplier.

OBJECTIVES

- Identify knowledge gaps in the usage of NIPPV
- Discuss the use of commonly used modes
- Examine ways practitioners can correct and avoid misusage

THE FUTURE OF VENTILATION?

THE RESEARCH (CITED 261 TIMES)

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Original Research: Critical Care Medicine

Utilization of Noninvasive Ventilation in Acute Care Hospitals: A Regional Survey

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RESULTS

We obtained responses from 71 of the 82 hospitals (88%). The overall utilization rate for NPPV was 20% of ventilator starts, but we found enormous variation in the estimated utilization rates among different hospitals, from none to > 50%. The top two reasons given for lower utilization rates were a lack of physician knowledge and inadequate equipment. In the 19 hospitals that provided detailed information, COPD and congestive heart failure constituted 82% of the diagnoses of patients receiving NPPV, but NPPV was still used in only 33% of patients with these diagnoses receiving any form of mechanical ventilation.

CONCLUSION

The utilization rates for NPPV vary enormously among different acute care hospitals within the same region. The perceived reasons for lower utilization rates include lack of physician knowledge, insufficient respiratory therapist training, and inadequate equipment. Educational programs directed at individual institutions may be useful to enhance utilization rates.

Discussion

Our survey confirms our hypotheses that hospitals vary widely in their utilization of NPPV and that a substantial portion of hospitals have low utilization rates. We also found that, despite the prevalence of low utilizers, most respondents considered their experience with NPPV as good to excellent. Furthermore, larger institutions differed from smaller ones in that they used NPPV in a higher percentage of patients in whom mechanical ventilation was started and more often to facilitate weaning.

INDICATIONS/CONTRAINDICATIONS

CLINICAL INDICATIONS

- Refractory hypoxemia (CHF, pulmonary edema, pneumonia, Covid, OSA with obstruction and/or desaturation)
- Acute Respiratory Failure (COPD exacerbations, Asthma, neuromuscular disorders, OSA with respiratory failure or central apnea)
- Patient must be awake/alert
- Ability to remove mask if necessary
- Does not have a condition that cannot be corrected within a few hours/ or a day or two
- Ability to protect airway

CONTRAINDICATIONS

- Lethargy/confusion
- Inability to remove mask
- Inability to control secretions – pulmonary edema or bleeding
- Recent esophageal surgery or presence of varices
- Pathology that cannot be correct within a few hours or a day/two
- Claustrophobic (cannot tolerate mask)

ACUTE CPAP

- Primary goals of CPAP oxygenation
  - Wean FI02 before CPAP level to <60% to avoid hyperoxia
  - Weaning FI02 may require increasing CPAP level
  - Patient may be acute on chronic OSA patient (are home settings known?)
  - V60 has Cflex option that decreases flow and pressure on the onset of expiration for patient ease of expiration – what options are available on your ventilators?
  - A patient may state "I can't breathe" often this is due to working against continuous flow during expiratory phase – activating Cflex may help
  - Full face mask should be used for all acute CPAP patients. This allows for more control and less leakage
  - There is NO backup rate or apnea ventilation in CPAP

CHRONIC CPAP USAGE

- Incorrect orders remain an issue – especially when ordered by mid-level providers, residents or non-pulmonary providers
- CPAP levels of 5 (or less!) are rarely correct
- Consider BMI and history of patient
- Recently a patient with a BMI of 48 was placed on a CPAP of 4cmH20 which was the humidity setting on a home unit. Patient placed unit as ordered – order was not questioned.
- If order does not make sense, it most likely is incorrect.
- Advocate! Recommend AutoPap when settings are unknown or coach providers into doing more to discover sleep orders in the EHR, family members or DME.

ACUTE BIPAP

- Primary goals of BiPAP – decrease work of breathing, decrease elevated PC02. (There are times when BiPAP is ordered for WOB when CPAP is actually a better choice examples to follow)
- ALWAYS titrate to patient work of breathing and minute ventilation –
  - EPAP =Oxygenation-potential autopeep- airway patency IPAP =Ventilation (Tidal Volume)
- Providers order settings which often are inadequate (too low or too high)
- Titrate for need – target a reasonable minute ventilation.
- Volumes 6-8 ml/kg ideal body weight! **Lung protection**
- Patient should look better after being placed on BiPAP with immediate titration with no accessory muscles usage.
- Set rate is a back up rate and is NOT active unless the patient stops or slows down breathing. Monitor **%Trigger** if patient has apnea episodes, decreases % triggers or is not progressing (PC02 not decreasing) Discuss with provider, intubation may be required. (% Trigger may not be available on all units)

CASE REVIEWS

- The following images were taken from actual patients
- Patient identifiers were removed
- The purpose of this discussion is to identify errors or potential changes that may have been made to more effectively treat these patients and their conditions.
- The intended outcome of this talk is to provoke critical thinking in non-invasively ventilated patients and discussions with providers

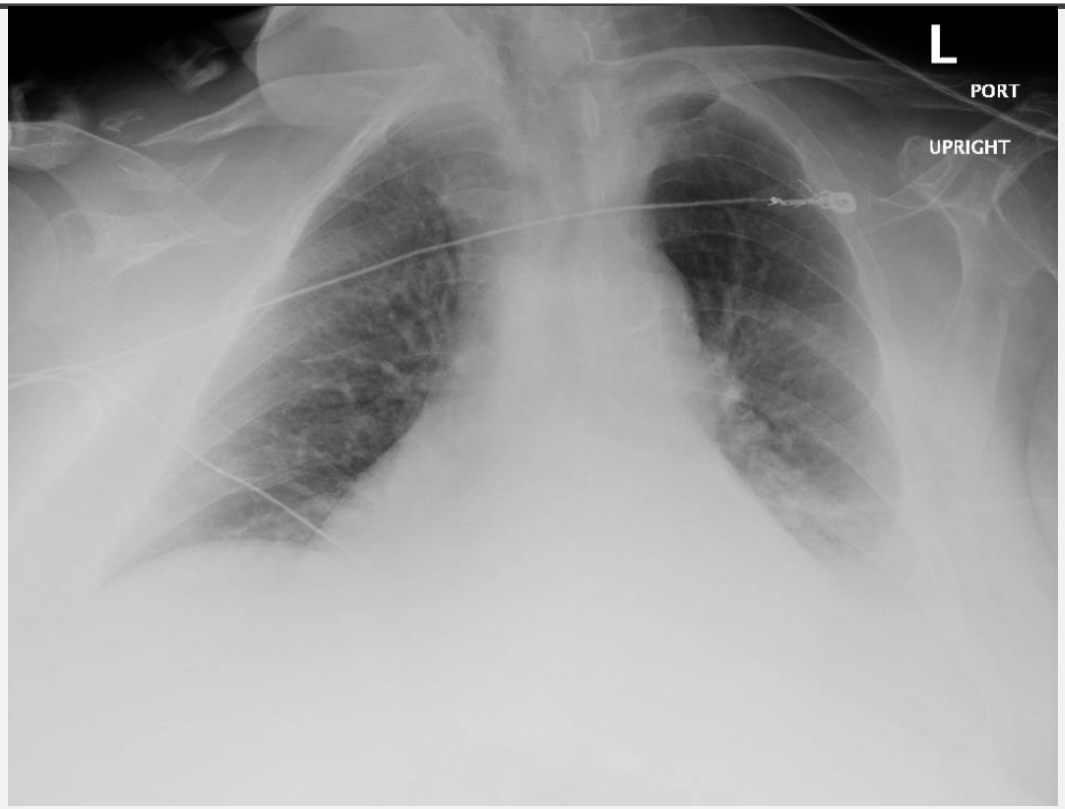
CASE 1 – ER PATIENT WITH NOTE AND OWN MACHINE REMOVED FROM HOME DEVICE PLACED ON CANNULA ABG OBTAINED A COUPLE HOURS LATER

Respiratory Therapist Signed
Respiratory Therapy Handoff

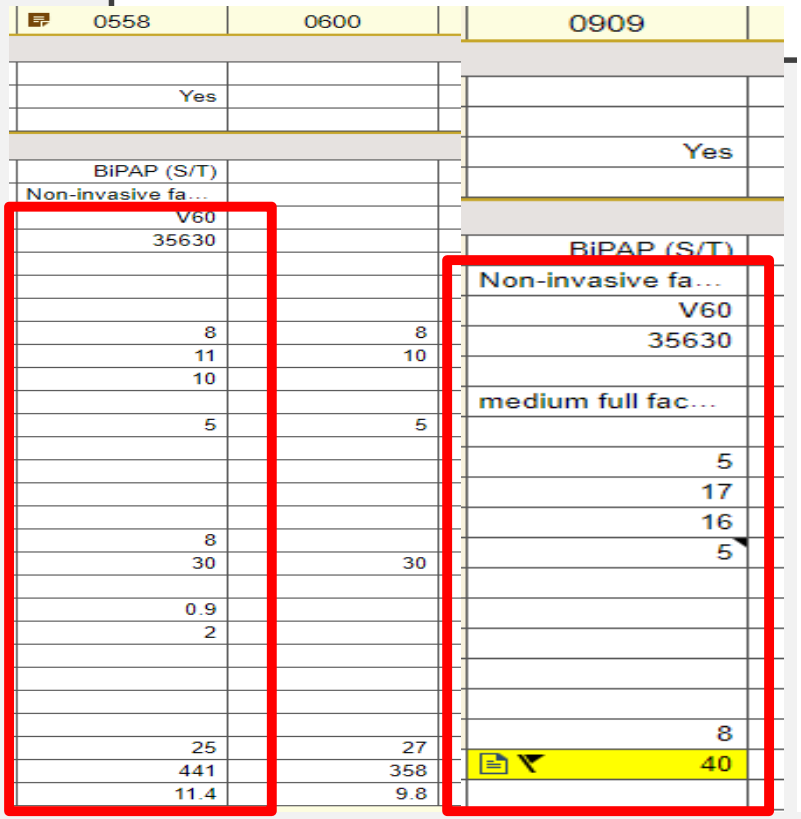
Signed
Pt noted on home device V-Auto Bipap , Max Ipap=25, Min Epap= 11, PS=4; Ti max=2.0; Ti min=0.3s

2025 2/19/25 05:42	2/19/25 06:45
85.3	129.0 ▲
96.2	99.2
70.2 ⇈	61.4 ▲
7.19 ⇊	7.23 ▼
530	5

CASE 1 CHEST X RAY – ED IMAGE – WOULD PEEP BE INDICATED HERE IF INTUBATED/VENTED?



CASE 1 CONTINUED- PLACED ON V60 10/5- IPAP INCREASED- FI02 INCREASED DUE TO DESATURATION- WHAT IS SIGNIFICATION REGARDING ORDER?



Order Information

Order Date/Time	Release Date/Time	Start Date/Time	End Date/Time
02/20/25 09:06 PM	02/20/25 09:06 PM	02/20/25 10:00 PM	Until Specified

Order Status Information

Order	Order Type	Status Activity	Order Status
Ventilator - Adult Non-Invasive Mode: Home CPAP/BiPAP/AVAPS/IVAPS	Respiratory Care [18]	Active Procedure [2]	Sent [2]

Order Details

Frequency	Duration	Priority	Order Class
At bedtime	Until Specified	Routine	HFH performed

Order Questions

Question	Answer
Mode	Home CPAP/BiPAP/AVAPS/IVAPS

Comments

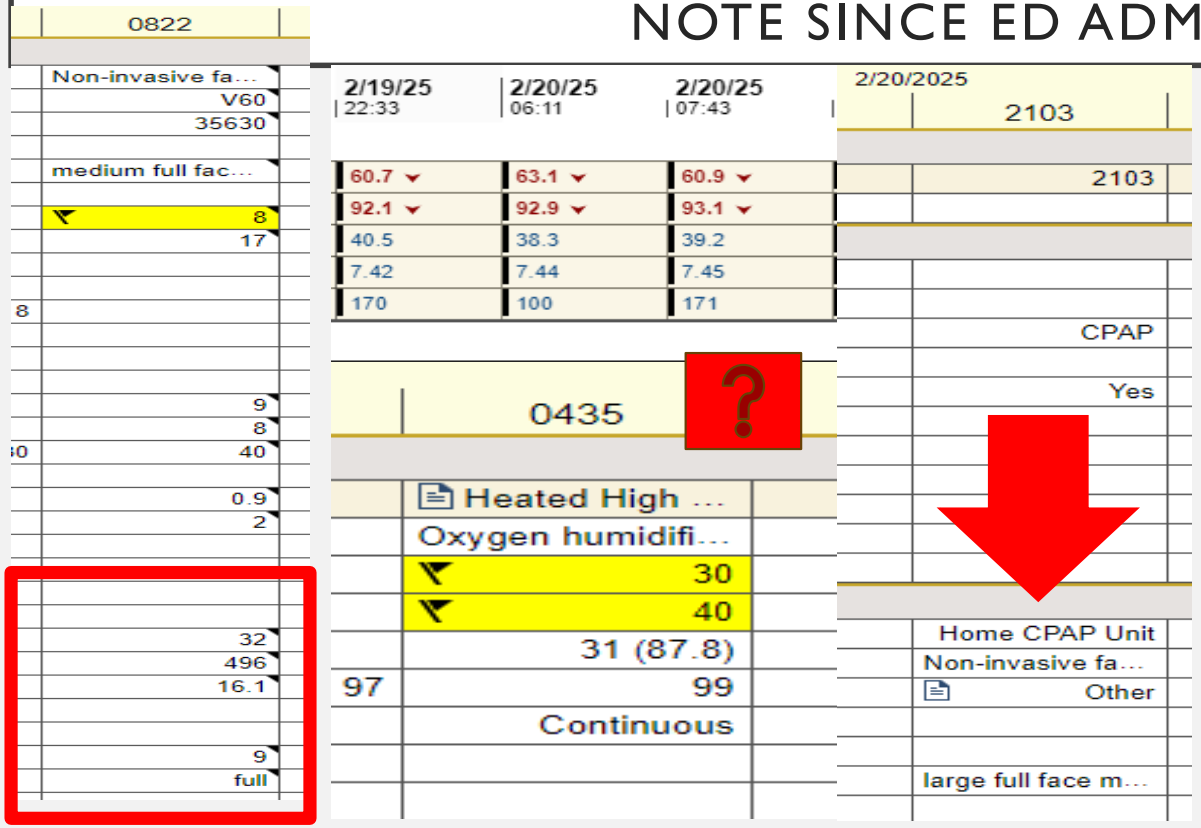
If patient utilizes vent at home and does not know the settings, search for sleep study or contact the DME company. Until that time, select AutoCPAP or AutoBiPAP order.

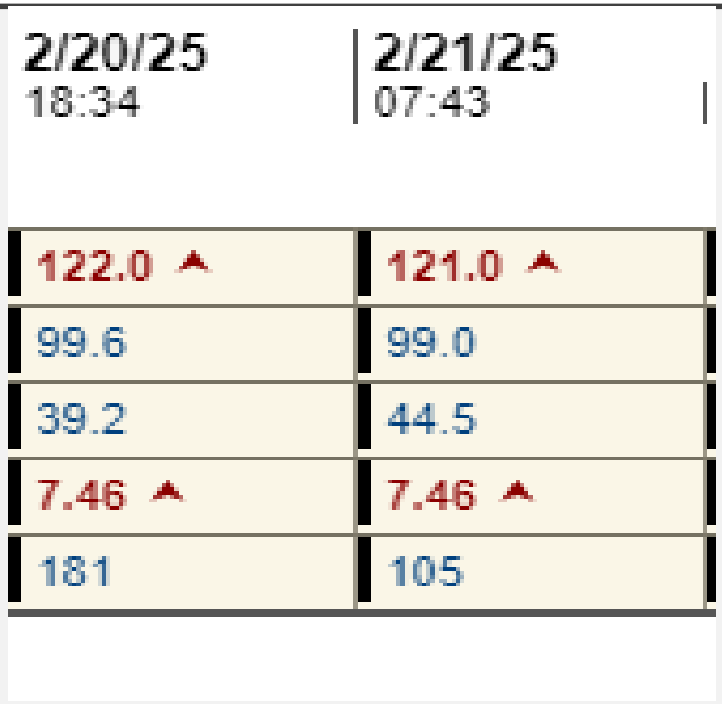
For AVAPS or IVAPS: If patient has acute hypercapnic respiratory failure, consult sleep medicine before ordering mode.

Reprint Requisition

Ventilator - Adult Non-Invasive Mode: Home CPAP/BiPAP/AVAPS/IVAPS (Order #95146477) on 2/20/25

CASE 1 CONT. - IN ICU REMAINED ON V60 FOR A COUPLE DAYS WITH VENTILATION OXYGENATION ISSUES- EPAP INCREASED AND ALTERNATED WITH HHFNC (NO CHANGE IN ORDER- NO HOME MACHINE SETTINGS) PATIENT PLACED ON HOME UNIT 2/20-2/21 IMPROVED BLOOD GASES. WHY WAS PATIENT NEVER PLACED ON (AT LEAST) HOME SETTINGS IN NOTE SINCE ED ADMISSION?





QUICK CASE #2

He initially presented to an outside hospital. Workup in the ED there showed an NSTEMI. He was started on heparin and cardiology was consulted. Nephrology was following and managing the patient's peritoneal dialysis. His initial chest x-ray showed pulmonary vascular congestion and he was diuresed while he was there. Echo was obtained that showed LVEF 40 to 45% with regional hypokinesis of the basal to mid inferior lateral wall, moderate LVH, grade 2 diastolic dysfunction, moderate MR he reportedly had some fluctuating hemoglobin, and was not taken for left heart cath right away as there was concern about if he was possibly bleeding somewhere. No bleeds were found, and on 2/21/2025, the patient was taken for left heart cath. Left heart cath apparently showed triple vessel disease, although I am not able to find a cath report in the documentation sent. He was then transferred to HFH for CTS eval and consideration of CABG.

The patient was seen and examined on arrival. He arrives on heparin drip. He has no chest pain at this time and is feeling overall well, although overwhelmed. He does have multiple risk factors for coronary disease including type 2 diabetes, hypertension, hyperlipidemia, history of 35-pack-year smoking, although quit 20 years ago as well as a relatively strong family history his father had multiple MIs starting in his 50s. The patient denies any lightheadedness, dizziness, headaches, chest pain, shortness of breath. No abdominal pain, nausea, vomiting, diarrhea. No lower extremity edema. He does have neurogenic bladder and regularly straight caths at home.

CASE # 2 CONT.

Ventilator - Adult Non-Invasive Mode: CPAP; PEEP (cmH20): 5 At bedtime

Comments: If patient utilizes vent at home and does not know the settings, search for sleep study or contact the D

For AVAPS or IVAPS: If patient has acute hypercapnic respiratory failure, consult sleep medicine before ordering m

Question	Answer
Mode	CPAP
PEEP (cmH20)	5

REFUSED

- Does not use at home, no sleep study ever performed- if there was, he would not use a CPAP of 5cmH20 – WHY?

Ht: 175.3 cm (5' 9")

Last Wt: 126.8 kg (279 lb 8.7 oz)

BMI: 41.28 kg/m^2 !

IF OSA IS SUSPECTED?

- Due to this patients BMI and comorbid conditions:
  - Perform overnight pulse oximetry study
  - If results are positive for nocturnal desaturation-
  - Consult sleep medicine for possible auto-titration study while in hospital
  - Refer to sleep clinic post discharge for more formalized testing
  - ”SOMETHING is NOT better than nothing. If we are doing to do it, do it right.

CASE #3

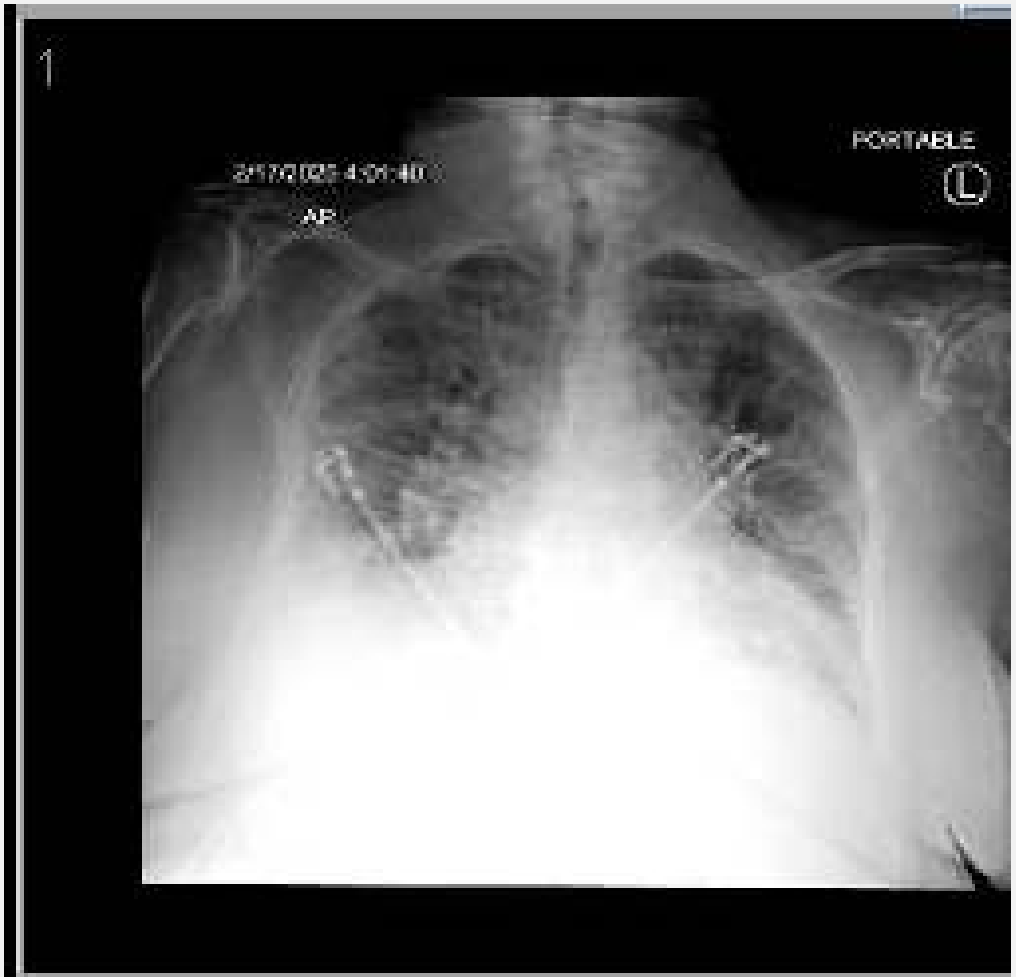
The patient was in her normal state of health until this Thursday when she began having worsening shortness of breath and nonproductive dry cough. She states that she has shortness of breath on and off and wasn't particularly concerned however on Sunday it worsened significantly. She alerted her neighbor who contacted her daughter who brought her to the ED for further evaluation. She denied any fevers, chills, chest pain (however did endorse b/l rib pain with coughing), abdominal pain, nausea, vomiting, diarrhea.

On arrival to the ED the patient was hypertensive to the 180s/70s and tachyonic to the 20s. She was hypoxic to the 80s and was placed on 6L nasal cannula sating 94%

Labs were notable for Na of 132, Bicarb 16, AG 15, Cr 1.48(baseline of 1.1-1.3), Lactate of 1.2, **BNP 1224 (from 543 on 7/23)**, tropos 37>69, **wbc 15.9,** HGB 10.3, pl 329, D Dimer 3.39, COVID, FLU, RSV -ve. Electrocardiogram was NSR, with LVH

Initial Chest x ray with cardiomegaly and blunting of the bilateral costophrenic angles consistent with fluid overload. Due to her elevated D Dimer a CTPE was obtained which was -ve for PE, but did note Cardiomegaly and pulmonary edema with bilateral pleural effusions and adjacent atelectasis. she received procardia for her hypertension, 1 round of dounebs and lasix 20 mg

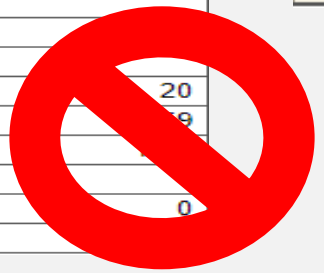
CASE #3 IMAGING



Female, 88 y.o., 5/23/1936

CASE #3 CONTINUED

BiPAP (S/T)
Non-invasive fa...
V60
35626
medium full fac...
No
5
13
10
5
8
40
1
2
20
0



			67.6 ▼
			94.4
			49.6 ▲
			7.47 ▲
			433

53.1 ▲	56.0 ▲	48.0	
85.9 ▲	87.7 ▲	88.2 ▲	
40.4	39.1	47.2 ▲	
7.31 ▼	7.32 ▼	7.49 ▲	

5		5
10		11
	5	
40		40
19		15
1544		1216
26.3		20.2

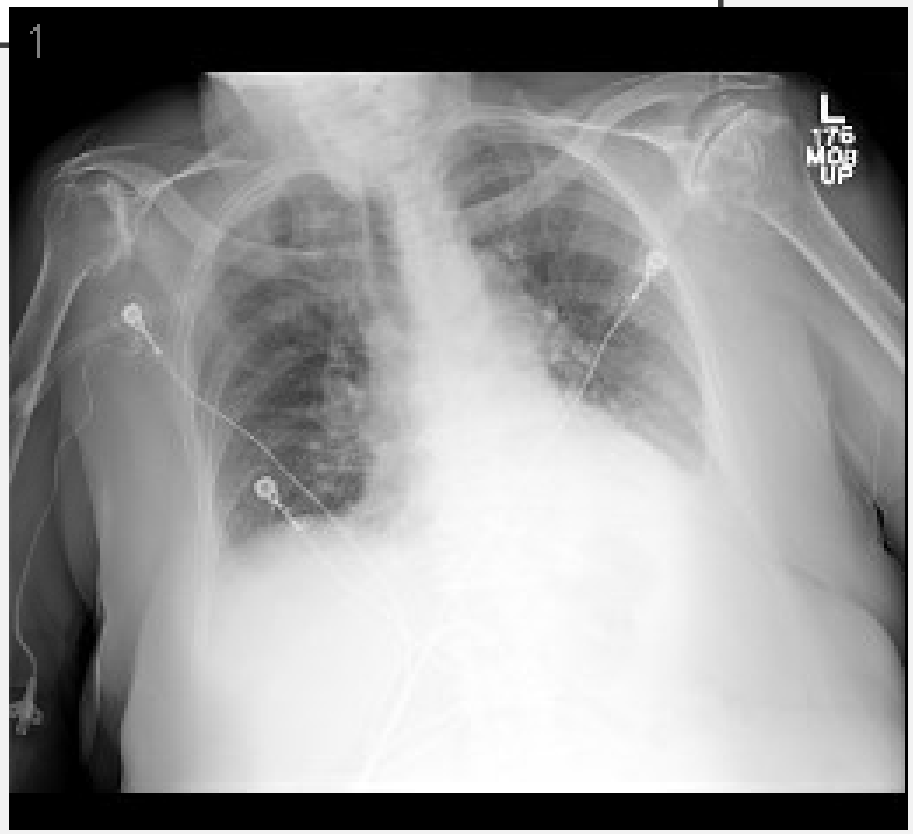
CASE 3 CONT. ADMITTED TO ICU (2/16)

	1050	1059	
		Heated High …	
		Heated humidifi…	
		50	
		100	
		31 (87.8)	
95	! 79	91	

- Therapies attempted:
- Standard Nasal cannula
- BiPAP
- Non Heated High Flow Nasal Cannula
- Heated High Flow Nasal Cannula
- Oxygenation issues remain **8** days later (2/25/2025)

CASE 3 - MORE

- Only 2 therapies had not been attempted:
- Intubation and Mechanical Ventilation
- CPAP! The clearly indicated therapy for refractory hypoxemia – CPAP was initiated days later with continued diuresis and cardiac supportive medications…. Patient improved and was transferred to cardiac GPU



CASE #4 (LAST CASE)

Per pt, she fell 3 days ago, and since then has had severe low back pain worsening with movement. She also has occasional urinary incontinence, which she attributes to pain preventing timely bathroom access. No bowel/bladder incontinence or saddle anesthesia.

CT lumbar spine shows transverse fracture lucency at the base of the L4 inferior articular process (chronic), L4-5 discectomy changes, and a ***pseudojoint between the left L6 TP and S1 concerning for Bertolotti syndrome with degenerative changes***. Posterior disc bulge and left paracentral disc protrusion at L4-5 noted. MRI shows postoperative changes with left hemilaminectomy at L4-5, left paracentral disc protrusion causing left subarticular zone stenosis impinging on the descending left L5 nerve. No high-grade spinal canal or neuroforaminal stenosis. NSG recommends ***L pseudojoint injection*** for diagnosis and pain management prior to outpatient follow-up. Pt admitted for pain management.

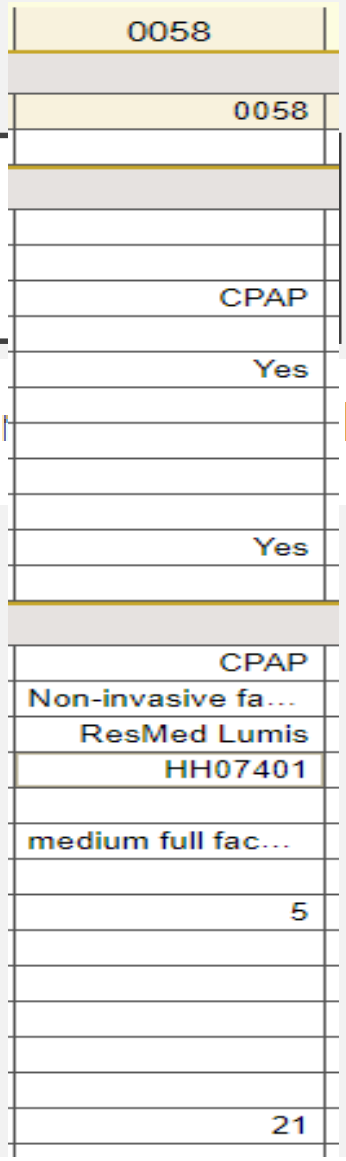
CASE #4

None (Room Air)	None (Room Air)	None (Room Air)	None (Room Air)	None (Room Air)	Non
		Room air	Room air	Room air	
	97	100	100	97	

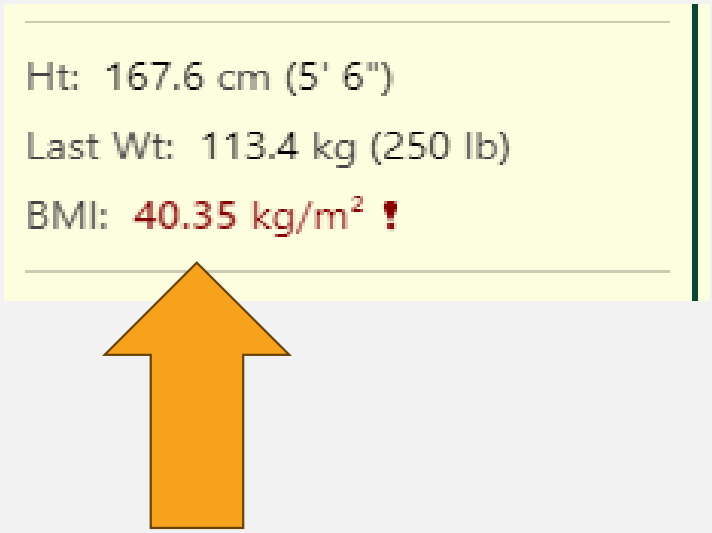
- No history of OSA, no SOB, no WOB, no ABG/VBG, no chest x ray, no desaturation, no oxygen use, no history of smoking, no home usage at all.

CASE #4

› Ventilator - Adult Non-Invasive Mode: CPAP; PEEP (cmH20): 5 Start: 02/21/25 2350, At bedtime, Until Specified, R Comm ho...



CASE #4



- This patient was placed on NPPV without question.
- Were assumptions made on this patient due to BMI despite absolutely no other symptoms, complaints or history?
- Does this add to waste and increase in costs in healthcare related to staff, time and equipment? What if this patient had no insurance, would this additional cost be justified for self-pay patient?

CONSIDERATIONS IN NPPV

- Know your equipment – designated non-invasive ventilators versus critical care ventilators- acute machines versus chronic
- Acute machines are usually associated with EHR, whereas chronic equipment is not
- Are acute patients located in the intensive care unit or are patients located in other less monitored areas
- Know the differences between your masks – are they made for the device you are using? Vented versus non-vented masks (single versus dual limb circuits)
- Where is the exhalation port and where are you placing nebulizers?
- Do NOT give patients single patient use masks to take home if you do not know the equipment they are using at home and what type of mask.

CONSIDERATIONS IN NPPV

- What is the patient history?
- Why are they here?
- Look at labs, x-rays and other diagnostic tests for clues!
- Is there other options available to you that may be more appropriate for the patient? Providers are willing if you can always connect it to the why and will appreciate you knowledge and suggestions.
- You can always TRY! If it does not work, there are options.

CONSIDERATIONS IN NPPV

- Be careful with auto-titrating modes including IVAPS/AVAPS
- LOOK at patient parameters once you have placed them on the device
  - Work of breathing
  - Tidal volumes
  - RR
  - Check frequently !!! These patients are acutely ill, do not set them and forget them.
  - Remember back up rates on non-invasive equipment are just that, they do not function as "set" rates on a ventilator, which also means the I time cannot be set for spontaneous breaths.

CONSIDERATIONS IN NPPV

- When NPPV is set appropriately the patient should look better within minutes.
- Do not leave the bedside until the patient has stabilized
- If the mask does not "quite fit" CHANGE IT – do NOT over tighten an ill-fitting mask
- Are there additional "comfort" features on your equipment that can be activated for better tolerance? Rise/Slope – expiratory flow termination?
- ARF patients usually will tolerate lower (faster) Rise times, where hypoxic patients prefer higher (slower) Rise.
- Many designated NPPV ventilators do NOT reset after using on a previous patient – review ALL settings and alarms on every new patient

CONCLUDING

- Respiratory therapists should be the absolute experts in non-invasive ventilation
- Non-invasive ventilation if far more time consuming than intubation, but if we use NPPV successfully – there is decrease in ICU LOS, hospital LOS, decrease in overall cost, and improved mortality and morbidity (used successfully in the ED – ICU admission can be avoided in many cases all together)
- Research has shown that healthcare providers with the most knowledge regarding NPPV are educated Respiratory Therapists and Pulmonologists, we should have the expertise to guide those practitioners with limited knowledge in choosing the best therapy choice for our patients that will provide the best outcomes.

THE END?