NIV : Post Surgical patients

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Remit and roadmap next 30-40 mins
NIV in post surgery patients

• Cardiac, Thoracic, Abdominal
• Rationale : physiological
• Prophylaxis
• Rescue
• NIV : future - next steps
• Trouble shooting/questions
Load/Capacity Balance

- Hyperinflation
- Weakness (and Sleep)
- Fatigue

CAPACITY

RESPIRATORY MUSCLES

- Ventilatory Drive
- Breathlessness
- Ventilatory failure

LOAD

Sleep Infection
Post op complications

• Related to either complications of surgery or general anaesthesia or co-morbidities.

• Several pulmonary pathophysiological modifications occurring during anaesthesia can persist for days following the surgery, thus increasing the risk of post op pulmonary complications.

• Induction of anaesthesia, upper abdominal and thoracic surgery are usually associated with a reduction in lung gas volumes promoting lower lobe atelectasis.

• Atelectasis usually occurs in the most dependent parts of the lung near the diaphragm.
• Bronchospasm
• Atelectasis
• Infection
• Pulmonary embolism
• ALI/ARDS
• Secretion
• Pneumothorax

• specific complications such as those occurring during cardiac surgery
• Pleural effusion
• Broncho-pleural fistula
• Phrenic nerve palsy
• Sternal wound infection
• Severe sepsis
Post op complications

• Dysfunction of the respiratory muscles, especially of the diaphragm can occur in first hours after surgery and may persist up to 1 or 2 weeks.

• Surgery may impair abdominal, thoracic and diaphragmatic muscles, inducing pain and reducing the phrenic output.

• All these factors can cause respiratory failure because of respiratory muscle impairment, with an increase in carbon dioxide and/or disorders of lung parenchyma, ventilation perfusion mismatching and hypoxemia.
The main expected benefits from applying NIV in post-operative pulmonary complications include:

- Increase in tidal volume
- Improvement in gas exchange
- Reduction of atelectasis and work of breathing without the need for endotracheal intubation, thus avoiding the risk of invasive mechanical ventilation
Non-invasive ventilation in postoperative patients: a systematic review

- 29 articles (N=2,279 patients) met the inclusion criteria
- 9 studies evaluated NIV in post-abdominal surgery, 3 in thoracic surgery, 8 in cardiac surgery, 3 in thoraco-abdominal surgery, 4 in bariatric surgery and 2 in post solid organ transplantation used both for prophylactic and therapeutic purposes
- NIV improved arterial blood gases in 15 of the 22 prophylactic and in 4 of the 7 therapeutic studies, respectively
- NIV reduced the intubation rate in 11 of the 29 studies and improved outcome in only one
- Conclusions: Despite limited data and necessity of new randomized trials, NIV could be considered as a prophylactic and therapeutic tool to improve gas exchange in postoperative patients
Table 1 Randomized controlled trials of non-invasive ventilation in abdominal/thoracic surgery

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<tr>
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<td>Stock et al. [21]</td>
<td>Elective abdominal surgery</td>
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### Table 2 Randomized control trials of noninvasive ventilation in thoracoabdominal and cardiac surgery

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### Table 3 Randomized controlled trials of noninvasive ventilation in bariatric surgery and after solid organ transplantation

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Major abdominal and thoracic surgeries are often complicated by hypoxemia and ARF during the postoperative period.

Pulmonary atelectasis is a frequent complication and may predispose to pneumonia.

Randomized studies have shown that CPAP decreases atelectasis and prevents pneumonia more effectively than standard therapy after upper abdominal surgery and that NIV significantly improves gas exchange and pulmonary function abnormalities after other procedures including thoracic, cardiac and vascular surgeries, liver resection, and thyroidectomy.

These studies support the use of CPAP or NIV in the postoperative setting, but more are needed before specific recommendations can be made.
One important point

• CPAP is not ventilation – it is a form of ventilatory support
• CPAP:
  • Increases FRC
  • Shifts position on PV curve
  • Alveolar recruitment
• Some ball-park figures

• TV: 500 mls
• TLC: 6L FRC 2-2.3 L
• RV: 1-1.2 L
• ERV 1L
• VC 5L
• Minute ventilation 5-6 Litres/min
• MV=RR (12/min) x TV
  (500mls) = 6L/min
• Abdominal surgery
Physiological Rationale

• Most often followed by diaphragmatic dysfunction and a marked decrease in vital capacity, which often leads to atelectasis and hypoxaemia.

• Data suggest that 30 to 50% of patients undergoing abdominal surgeries develop hypoxaemia postoperatively, and 8 to 10% require endotracheal intubation postoperatively.

• The beneficial effects of postoperative NIV have been demonstrated following laparoscopic surgeries for cholecystectomy, bariatric surgeries and thoraco-abdominal surgeries for aneurysm repair.
Prophylaxis

- Mainly CPAP studies
- One NIV Study:

- Demonstrated application of bilevel positive airway pressure (BiPAP) set at 12 and 4 cm PEEP significantly improved the peak expiratory flow rate, the forced vital capacity and the oxygen saturation on the first postoperative day

- In these patients, the beneficial effects of NIV was attributed to an improvement in lung inflation, prevention of alveolar collapse and reduced inspiratory threshold load
Therapeutic


• NIV : 2 year study : hypoxaemic respiratory failure

• N=72

• Reduced respiratory rate

• Significantly lower length of ICU stay
  (17.3 +/- 10.9 days vs 34.1 +/- 28.5 days, p < 0.01)

• Significantly lower mortality rate (6% vs 29%, p < 0.01)

• NIV: 3 year study N=16 received NIV v N=10 (no NIV: historical controls)

• After NIV treatment for 24 hours, the PaO(2)/FiO(2) ratio and PaCO(2) were improved significantly but no significant improvement was noted in non-NIV group

• Rate of re-intubation was significantly lower in NIV group (12.5% vs. 50.0%, p=0.040)

• Respiratory-cause mortality was significantly lower in NIV group than in non-NIV group (0.0% vs. 40.0%, p=0.007)

• All-cause mortality tended to be lower in NIV group (18.8% vs. 50.0%, p=0.100)

• NIV was tolerated in all 16 NIV group patients, and no severe NIV-related complications were observed

• NIV is effective in patients with respiratory failure and/or massive atelectasis after liver resection

- N= 25
- Helmet v facemask NPPV significantly improved PaO2/FIO2 in both groups
- Five of 25 helmet patients (20%) and 12 of 25 mask patients (48%) were intubated (p < 0.036)
- Main cause for NPPV failure in both groups was intolerance (mask 32% vs helmet 12%, p = 0.6)
- Heart rate, systolic blood pressure, respiratory rate, duration of NPPV, level of pressure support, and PEEP presented no differences between the 2 groups, nor did intensive-care-unit or hospital mortality
- Both the helmet and mask interfaces were effective in improving gas exchange and respiratory rate
- Global rate of NPPV complications (mask intolerance, major leaks that caused ventilator malfunction, and ventilator-associated pneumonia) was significantly higher in the mask group than in the helmet group (19 patients vs 4 patients, p < 0.03)

N=18: ten received NIV and eight received standard oxygen therapy

Study group had better partial oxygen pressure and lower maximal expiratory pressure levels in the postoperative state than the control group

Anastomotic dehiscence was not observed in any group

No significant difference between the control group and the study group relating to the loss of vital capacity, maximal inspiratory pressure in the postoperative period or the incidence of atelectasis

**CONCLUSION:** NIV in the postoperative period of gastroplasty was useful to improve oxygenation and did not increase the incidence of anastomotic dehiscence
Michelet P, D’Journo XB, Seinaye F, Forel JM, Papazian L, Thomas P


N= 36 Consecutive patients with ARF treated by NIV were matched for diagnosis, age within 5 years, sex, preoperative radiochemotherapy and Charlson co-morbidity index with 36 patients who received conventional treatment (control group)

NIV was associated with

• Lower re-intubation rate (9 v 23 patients; P = 0.008)
• Lower frequency of acute respiratory distress syndrome (8 v 19 patients; P = 0.015)
• Reduction in intensive care stay (mean (s.d.) 14(13) versus 22(18) days; P = 0.034)
• Anastomotic leakage was less common in patients receiving NPPV (two versus ten; P = 0.027)
• These patients also showed a greater improvement in gas exchange in the first 3 days after onset of ARF (P = 0.013)

CONCLUSION: The use of NPPV for the treatment of postoperative ARF may decrease the incidence of endotracheal intubation and related complications, without increasing the risk of anastomotic leakage after oesophagectomy.
Charlson index

• Charlson comorbidity index predicts the ten-year mortality for a patient who may have a range of comorbid conditions, such as heart disease, AIDS, or cancer (a total of 22 conditions)
• Each condition is assigned a score of 1, 2, 3, or 6, depending on the risk of dying associated with each one
• Scores are summed to provide a total score to predict mortality
• Clinical conditions and associated scores are as follows:
  • 1 each: Myocardial infarct, congestive heart failure, peripheral vascular disease, dementia, cerebrovascular disease, chronic lung disease, connective tissue disease, ulcer, chronic liver disease, diabetes.
  • 2 each: Hemiplegia, moderate or severe kidney disease, diabetes with end organ damage, tumor, leukemia, lymphoma.
  • 3 each: Moderate or severe liver disease.
  • 6 each: Malignant tumor, metastasis, AIDS.
  • disease burden an
For a physician, this score is helpful in deciding how aggressively to treat a condition. For example, a patient may have cancer with comorbid heart disease and diabetes. Co-morbidities may be so severe that the costs and risks of cancer treatment would outweigh its short-term benefit.

The Charlson index, especially the Charlson/Deyo, followed by the Elixhauser have been most commonly referred by the comparative studies of comorbidity and multimorbidity measures.

**Elixhauser comorbidity measure**

The Elixhauser comorbidity measure was developed using administrative data from a statewide California inpatient database from all non-federal inpatient community hospital stays in California ($n =1,779,167$).

Elixhauser comorbidity measure developed a list of 30 comorbidities relying on the ICD-9-CM coding manual. The comorbidities were not simplified as an index because each comorbidity affected outcomes (length of hospital stay, hospital changes, and mortality) differently among different patients groups.

Co-morbidities identified by the Elixhauser comorbidity measure are significantly associated with in-hospital mortality and include both acute and chronic conditions.
A word of caution though

• While using NIV in patients following upper gastrointestinal anastomosis, gastric inflation pressures should be carefully monitored as the risk of anastomotic leakage seems to be more if very high insufflation pressures are applied (more than 25 cm H$_2$O).

• Use of the Ryle's tube on drainage may be useful to detect excessive insufflation, should it occur.
• Thoracic Surgery
Physiological Rationale

Pain

Reduced muscle tone due to general anaesthesia

Loss of functioning lung parenchyma

ALI : single lung ventilation

Resulting in sputum retention, lobar atelectasis, pneumonia and respiratory failure
Prophylaxis

- N=32: control 18 NIV 14
- RCT prophylactic use of NIV in patients with severe preoperative airflow obstruction (forced expiratory volume FEV1 <70%) undergoing lobectomy for carcinoma of the lung resulted in significant improvements in pulmonary function

- Patients who received NIV in the 7 days prior to surgery and 3 days after surgery had significantly higher paO\textsubscript{2} and better forced vital capacity (FVC) and FEV1 on days 1, 2 and 3 after surgery
- The incidence of major atelectasis was 14.2% in the NIPSV group and 38.9% in the no-NIPSV group (p=0.15).
- This group of patients also had a significantly lesser duration of hospital stay

• Studied 10 patients who received a trial of NIV following lung resection surgery and found that patients on NIV had improved oxygenation, which continued even one hour after withdrawing NIV support, with no associated increase in pleural air leaks
Therapeutic


- 113 (16.3%) experienced ARF, which was initially supported by NIV in 89 (78.7%), including 59 with hypoxemic ARF (66.3%) and 30 with hypercapnic ARF (33.7%)

- Reported that of the patients at risk for severe complications following lung resection surgeries, 16.3% eventually developed acute respiratory failure, which were both hypoxaemic and hypercapnic types

- Overall success rate of NIV in this group was 85.3%; however, the mortality associated with NIV failure was 46.1%

- In the same study, presence of cardiac co-morbidities and lack of initial response to NIV were found to be independently associated with NIV failure

Randomized prospective trial to compare standard therapy with and without nasal-mask NPPV in patients with acute hypoxemic respiratory insufficiency after lung resection

N= 48 patients who developed respiratory failure after lung resection: 24 in each arm NIV v No NIV

20.8% of patients assigned to the NIV group required intubation and invasive ventilation compared to 50% patients in the no-NIV group

Mortality rates too were significantly lower in the NIV group (13% vs 38%)
• Cardiac Surgery
Physiological Rationale

• Respiratory failure after cardiac surgery is associated with morbidity, mortality and decreased quality of life
• Incidence of respiratory failure varies from 5 to 20% in the literature
• In a study on 5,798 patients undergoing cardiac surgery over a 6-year period, Filsoufi et al. reported that combined valve and coronary artery bypass graft was associated with the highest incidence of respiratory failure, followed by aortic procedures
• Overall reported incidence of respiratory failure in the first group was 9.1% and mortality rate was 15.5%
• Patients with lower preoperative ejection fraction, those undergoing combined cardiac surgical procedures and those with severe SAPS II scores were reportedly at the greatest risk of developing postoperative respiratory failure
Prophylaxis


- Coronary artery bypass graft (CABG) surgery.
- Purpose was to compare the effect on lung function tests of conventional physiotherapy using incentive spirometry (IS) with non-invasive ventilation on continuous positive airway pressure (CPAP) and with non-invasive ventilation on bilevel positive airway pressure (BiPAP or NIV-2P)
- Ninety-six patients were randomly assigned to 1 of 3 groups: NIV-2P (1 h/3 h), CPAP (1 h/3 h) and IS (20/2 h)
- Pulmonary function tests and arterial blood gases analyses were obtained before surgery. On the 1st and 2nd postoperative days, these parameters were collected together with cardiac output and calculation of venous admixture.
- For the 3 groups a severe restrictive pulmonary defect was observed during the 1st postoperative day. On the 2nd postoperative day, in opposition to IS, intensive use of CPAP and NIV-2P reduced significantly the venous admixture (P<0.001) and improved VC, FEV1 and PaO2 (P<0.01).
- **CONCLUSION:** Preventive use of NIV can be considered as an effective means to decrease the negative effect of coronary surgery on pulmonary function
Therapeutic

- **Kilger E¹, Möhnle P, Nassau K, Beiras-Fernandez A, Lamm P, Frey L, Briegel J, Zwissler B, Weis F**

**Noninvasive mechanical ventilation in patients with acute respiratory failure after cardiac surgery**

In 2261 spontaneously breathing postoperative cardiac surgical patients after primarily successful extubation, 799 patients (35%) were diagnosed with ARF.

- Fifty-six patients (7%) did not tolerate NIV treatment.
- In 743 patients (33%) intermittent NIV was performed.
- In patients with ARF, ejection fraction was lower, combined cardiac surgical procedures were more frequent, postoperative mechanical ventilation time was longer, and the severity of illness score (SAPS II) was higher (P < .05).
- Duration of catecholamine support was longer, and transfusion rate was higher in the NIV group (P < .05); however, mortality did not differ between patients with ARF treated by NIV and patients without ARF.

**CONCLUSION:**

- Study demonstrates the feasibility of NIV in patients after cardiac surgery.
- These results might suggest that NIV should be considered as first-line ventilatory support in ARF after cardiac surgery. A large randomized trial is warranted to confirm these findings.
To analyze the use of noninvasive ventilation (NIV) in respiratory failure after extubation in patients after cardiac surgery, the factors associated with respiratory failure, and the need for reintubation.

**Design**: Retrospective observational study

Patients (n = 63) with respiratory failure after extubation after cardiac surgery over a 3-year period

Of 1,225 postsurgical patients, 63 (5.1%) underwent NIV for respiratory failure after extubation

Median time from extubation to the NIV application was 40 hours (18-96 hours).

Most frequent cause of respiratory failure was lobar atelectasis (25.4%)
• NIV failed in 52.4% of patients (33/63) who had a lower pH at 24 hours of treatment (7.35 v 7.42, \( p = 0.001 \)) and a higher hospital mortality (51.5% v 6.7%, \( p = 0.001 \)) than those in whom NIV was successful.

• An interval <24 hours from extubation to NIV was a predictive factor for NIV failure (odds ratio, 4.6; 95% confidence interval, 1.2-17.9), whereas obesity was associated with NIV success (odds ratio, 0.22; 95% confidence interval, 0.05-0.91).

• **Conclusions:**

• Reintubation was required in half of the NIV-treated patients and was associated with an increased hospital mortality rate.

• Early respiratory failure after extubation (≤24 hours) is a predictive factor for NIV failure.
Therapeutic

- **NIV after discharge from the Intensive Care Unit (ICU)** has never been described in the setting of cardiac surgery.
- **85 patients** received NIV in the main ward as treatment for respiratory failure.
- The patients had the following conditions: atelectasis (45 patients), pleural effusion (20 patients), pulmonary congestion (13 patients), diaphragm hemiparesis (6 patients), pneumonia (4 patients) or a combination of these conditions.
- **RESULTS:** 83 patients were discharged from the hospital in good condition and without need for further NIV treatment, while two died in-hospital.
- Four of the 85 patients had an immediate NIV failure, while eight patients had delayed NIV failure.
Only one patient had a NIV-related complication represented by hypotension after NIV institution. In this patient, NIV was interrupted with no consequences.

Major mistakes were mask malpositioning with excessive air leaks (7 patients), incorrect preparation of the circuit (one patient), and oxygen tube disconnection (one patient).

Minor mistakes (sub-optimal positioning of the face mask without excessive air leaks) were noted by the respiratory therapists for all patients and were managed by slightly modifying the mask position.

**CONCLUSION:**

Postoperative NIV is feasible, safe and effective in treating postoperative acute respiratory failure when applied in the cardiac surgical ward, preserving intensive care unit beds for surgical activity.

A respiratory therapy service managed the treatment in conjunction with ward nurses, while an anesthesiologist and a cardiologist served as consultants.
Non-invasive pressure support ventilation in patients with acute respiratory failure after bilateral lung transplantation

- Rocco M, Conti G, Antonelli M, Bufi M, Costa MG, Alampi D, Ruberto F, Stazi GV, Pietropaoli P.

**Author information**

To evaluate non-invasive ventilation (NIV) prospectively in a group of patients developing acute respiratory failure (ARF) after bilateral lung transplantation (BLT).

**SETTING:** General intensive care unit (ICU) of Rome "La Sapienza" University.

**PATIENTS:** Twenty-one patients (18 with cystic fibrosis) undergoing BLT.

**RESULTS:**

All consecutive patients developing ARF (according to predefined criteria) and requiring ventilatory support, received non-invasive pressure support ventilation through a face-mask (PEEP 5 cmH2O, PSV 14+/−2 cmH2O) for a mean period of 5+/−4 days. Eighteen out of 21 patients avoided intubation and were discharged from the ICU; 3 patients required intubation: 1 of them survived while 2 developed septic shock and died.

**CONCLUSIONS:** NIV administration was well tolerated and avoided intubation in the large majority of patients (86%); in NIV responders the rate of complications was low and ICU mortality nil. NIV should be considered as an interesting alternative to conventional ventilation in patients who require ventilatory support after BLT.
IDENTIFYING THE AT-RISK POPULATION

- A study by Silva et al. studied 521 patients over 5 years and reported that thoracic, cardiac and upper abdominal surgeries were associated with the highest risk of postoperative pulmonary complications.
- Predictors of postoperative respiratory failure in their study included:
  - Site of surgery
  - Duration of anaesthesia (more than 3.5 hours)
  - Severity of ASA classification (grades III and IV)
  - Other studies report, the at-risk population are those with
  - Underlying lung diseases
  - Age >60 years
  - ASA functional status II or greater
  - Obese patients
  - Underlying congestive cardiac failure
  - Obstructive sleep apnoea syndromes
The ASA physical status classification system

- A system for assessing the fitness of cases before surgery.
- In 1963 the American Society of Anesthesiologists (ASA) adopted the five-category physical status classification system; a sixth category was later added. These are:
  - Healthy person.
  - Mild systemic disease.
  - Severe systemic disease.
  - Severe systemic disease that is a constant threat to life.
  - A moribund person who is not expected to survive without the operation.
  - A declared brain-dead person whose organs are being removed for donor purposes.
• Acute NIV : reasons for failure
• Why use sedation during NIV?
• Evidence-base
• Survey data: sedation + NIV
• Delirium
• Our initial experience
• Acute NIV: reasons for failure
Improve success of NIV

- Increasing use of NIV in Acute Respiratory Failure (ARF)

- Tolerability - key to success is patient comfort

- Failure (10-30%): inadequate ventilation, interface intolerance, asynchrony, excessive air-pressure sensation, claustrophobia

- Agitation – relative contraindication
UK National audit data

- National Audits on AECOPD 2003 and 2008
- Kaul et al COPD: 2009; Jun;6(3):171-6

- Conducted by the Royal College of Physicians & British Thoracic Society

- 233 (94%) UK hospitals submitted data for 7529 prospectively recruited acute COPD admissions, documenting process of care and outcomes from a retrospective case note audit
• A low pH (<7.35) was noted at some time during admission for 26% (1714/6544) of patients

• NIV treatment was given to 31% (529/1714) with 16/529 also having invasive support

• 70 received invasive support alone

• 1095 receiving neither

• unknown for 20
Out of the 1095 who received no support

Reasons given as to why support was not given to acidotic patients:

- Medical inappropriateness: 321
- No facilities : 48
- Patient refused: 13
- Treatment failed: 3
- 710 patients reasons unknown
Potential reasons for unknown category

- Patients denied access to NIV
- Patients denied access to invasive ventilation
- Medically inappropriate for ventilatory support
- Failure of treatment
- Patient refusing support

- Perhaps sedation useful in some of these cases
Why use sedation during NIV?
Palliation

• When NIV is ceiling of care
• Symptom relief
• Relatives
• Communication critical
  (relatives/patient/nursing/crit car/resp/physio)
• Any misunderstanding here…problematic
Sedation: Cons

• Reduced respiratory drive

• Haemodynamic instability

• Risk of over-sedation & inadvertent need for intubation

• Safety – appropriate location

• Sedation + NIV = ETI: not necessarily true now
• Evidence-base
• JICS Volume 11, Number 3, July 2010

• Remifentanil sedation: a five year retrospective case series focusing on its role in non-invasive ventilation

• N Smallwood, B Peringathara, S Twigg
Purpose

• A retrospective observational study of practice in the intensive care unit (ICU) of a 700-bed district general hospital in the UK

• Aims: describe the indications for remifentanil sedation in current critical care practice, with particular reference to its use in patients who are unable to tolerate NIV
Method

• Controlled drug records were analysed over a five year period & each prescription of remifentanil matched against patient records to determine the indication, dose & duration of use, alongside significant clinical events.

• Where patients received NIV, the duration of use and days of remifentanil sedation (if appropriate) were recorded.

• During the study period a total of 3,259 patients were admitted to ICU, of whom 469 (14.4%) received remifentanil.
Results

• The majority of patients, n=286 (61.0%) received remifentanil while not intubated

• For 232 (81.1%) it was prescribed to enable them to tolerate NIV

• In this group, the mean duration of remifentanil infusion was 2.55 days, with the mean dose 4.55 mg/day, equivalent to approximately 0.04 μg/kg/min
Results

• Of the patients requiring sedation to tolerate NIV, 120 (51.7%) were not intubated at any point during their admission

• Intubation was deemed inappropriate for 50 (21.3%), of these patients of whom 22 (44.0%) survived to unit discharge
Safety Data

• Analysis did not specifically look at the incidence of hypotension or respiratory depression on commencing remifentanil

• There were no documented incidences of significant cardiorespiratory depression related to remifentanil use during the study period

• This is in keeping with previous work using remifentanil as an agent during conscious sedation
Conclusion

• Due to its unique pharmacokinetic profile, remifentanil is used in a variety of specific clinical situations in our practice, in both intubated and non-intubated patients.

• In particular, we provide data to confirm its role as a safe and effective sedative in patients who are unable to tolerate NIV.

• Target-controlled infusion (TCI) of propofol for sedation in patients with non-invasive ventilation failure due to low tolerance: a preliminary study

• Clouzeau B, Bui HN, Vargas F, Grenouillet-Delacre M, Guilhon E, Gruson D, Hilbert G
Purpose

• Non-invasive ventilation (NIV) in critically ill patients is associated with a high failure rate

• This prospective study assessed the feasibility and safety of target-controlled infusion (TCI) of propofol for conscious sedation during NIV in patients with NIV failure due to low tolerance
Methods

- Ten patients with NIV failure due to discomfort, agitation and/or refusal to continue with this ventilatory support were included; seven had acute respiratory failure and three had acute hypercapnic respiratory failure

- Patients were sedated by TCI of propofol during NIV sessions

- Blood gas analysis, cardiorespiratory and ventilatory parameters, propofol concentration (Cpt) required, comfort and adverse events were recorded
Results

- Patients received a total of 85 NIV sessions, totalling 180 h of NIV under TCI of propofol.

- NIV under TCI of propofol significantly improved arterial blood gas analyses: mean Pa/FiO2 ratio increased from $167 \pm 68$ pre-session to $195 \pm 68$ post-session ($p < 0.05$), mean PaCO(2) decreased from $57.8 \pm 15.3$ to $49 \pm 9.8$ mmHg ($p < 0.05$) and mean pH increased from $7.36 \pm 0.04$ to $7.4 \pm 0.03$ ($p < 0.05$).

- Three patients required endotracheal intubation, two due to evolution of underlying disease and one because of a seizure disorder.

- Eight patients were discharged from the intensive care unit and two died.
Conclusion

• This preliminary study shows that in a selected population, TCI of propofol can facilitate acceptance of NIV.

• Within the limits of a pilot study, TCI of propofol seems to be safe and effective for the treatment of NIV failure due to low tolerance.
• How and by whom is sedation used in NIV
• Survey of sedation practices during noninvasive positive-pressure ventilation to treat acute respiratory failure

• Devlin et al

• Crit Care Med 2007 Vol. 35, No. 10
Survey (web-based)

• 1st extensive view of sedation practices in patients with ARF who receive NIV

• Identify current practices, beliefs, and attitudes of pulmonologists & intensivists toward sedation and restraint therapy in patients receiving NIV
Survey (web –based)

- 2,985 physicians & 790 (27%) responded
- Response rate ~ 42% among Europeans & 19% among North Americans
- Most frequent location of admission ARF patients was medical/mixed medical-surgical ICU (79%)
Sedation and Analgesia use in ARF treated with NIV

- 15% never used sedation

- 6% never used analgesia for ARF patients treated with NIV
North Americans v Europeans

- Sedation and analgesic therapy more commonly used by North Americans than Europeans ($p < 0.01$)
  - 41% vs. 24% for sedation
  - 48% vs. 35% for analgesic therapy
Critical Care vs. Non-Critical Care Physicians

- 42% vs. 24% for sedation
- 50% vs. 34% for analgesic therapy
- all $p < 0.01$
Preferred sedation drug choices: regimen of choice

• Benzodiazepines alone (33%) or opioids alone (29%) most frequently chosen

• Lorazepam alone (18%), Midazolam (15%), morphine (21%) & fentanyl (8%)

• Propofol-containing regimens (7%)

• Dexmedetomidine-containing regimens (5%)

selective -2 adrenergic receptor agonist with sedative, analgesic, anxiolytic, and sympatholytic effects and without respiratory depressant effects
North Americans v Europeans

• North Americans were more likely to choose a benzodiazepine-only regimen
  • 39% vs 25% ($p < .001$)
  • Dexmedetomidine containing regimen:
    6% vs. 0% ($p < .001$)

• But less likely to choose a regimen containing an opioid only: 26% vs. 37 ($p < .009$)
  haloperidol: 11% vs. 20 ($p < .002$)
  propofol: 1% vs. 13% ($p < .0005$)
Most influential factors on choice of sedation

• Clinical experience with the agent
• Lack of effect on respiratory drive
• But not cost
• Factors did not differ between North American and European respondents
Method of Administration

• Most respondents administered sedation by:
  Intermittent intravenous bolus ~78%
  Continuous infusion ~ 30%
  By mouth 11%
Sedation protocol

- Few institutions (14%) had a sedation protocol

- Despite 51% of respondents agreeing protocols useful to optimize sedation therapy in the NIV population

- Clinical assessment preferred (63%) method to assess sedation followed by sedation scales (e.g., Ramsay Scale, Sedation-Agitation Scale) (32%)
Ideal Nurse /Patient ratio

• Most often believed to be
  1:2 (65%), 1:3 (26%) and 1:1 (9%)

• Respondents reported that this ratio influenced the decision to use sedatives in patients receiving NIV
Monitoring Sedation

• Nurses (67%) & physicians (28%) were the healthcare professionals most responsible

• Other professionals (i.e., respiratory therapists, physician assistant/nurse practitioners, or pharmacists) very rarely involved
Most physicians infrequently use sedation & analgesic therapy for NIV to treat acute respiratory failure

Practices vary widely within and between specialties & geographic regions
• What happens in the UK?
UK NIV Survey

- National NIV Survey (telephone)
- Krishnan et al – ERS 2010 (abstract)
- 235 hospital units contacted
- 98% response rate: repeated in 125 units
- Kappa value ~ 0.9 (ie very good)

Q15 Do you use any sedation or have a sedation protocol, when applying NIV?
Results

• Some form of sedation is in use in approximately half of the UK centres surveyed (N=113)

• Only a few using sedation protocols

• Ranging from antipsychotic drugs such as haloperidol to anaesthetic agents such as propofol & remifentanyl

• Combinations of drugs were common
Results

• The most frequently used drugs were benzodiazepines, used alone in 26% of centres and also frequently in combination with other agents

• Goes against RCP/BTS guidelines

• Delirium
Delirium
The American Psychiatric Association defines delirium as ‘a disturbance of consciousness, attention, cognition and perception which develops over a short period of time (usually hours to days) and tends to fluctuate during the course of the day’

Delirium is an acute confusional state characterised by fluctuating mental status, inattention, and either disorganized thinking or altered level of consciousness
Three sub-types of delirium described

- Hypoactive delirium – Patients appear subdued, withdrawn and have a poor response to stimulus

Hyperactive delirium – Patients may display agitation or aggression and may experience delusions or hallucinations

- Mixed delirium – Patients fluctuate between hypo and hyperactive subtypes
Delirium

Patients who develop delirium during hospitalization are associated with:

- Higher mortality rates (in hospital and post-discharge)
- Prolonged hospital stay
- Increased cost, and long-term disability
Post-operative Delirium

• Common, particularly after cardiac surgery

• The incidence in the UK in ventilated critically ill patients is 55% to 69%

• Important adverse prognostic indicator
  • Delirious patients are 2 to 3 times more likely to die

• Each additional day spent in delirium is associated with a 20% increase risk of prolonged hospitalization and a 10% increased risk of death
Causes

1. Hypoxia, hypercapnia, hypotension
2. Drugs (analgesia, sedation et cetera)
3. Alcohol
   (usually withdrawal but occasionally intoxication)
4. Sepsis
5. Pain
Causes

6. Retention of urine/blocked catheter (likely to have a catheter intra-op so blockage possible)

7. Electrolyte-fluid disturbance

8. Hypoglycaemia

9. Stroke + intra-cranial/sub-arachnoid haemorrhage

Dangerous to assume they are normally like this!
Many predisposing and precipitating factors

• More commonly associated with: transfusion, post-op infection, respiratory failure, long operation, increasing age, male

• The single most important modifiable risk factor in critical care is the use of sedative drugs
• Our experience: preliminary data
Background

- HH CT ICU: ~ 100 patient/month

- **Indications for admission** (categorised by speciality):
  - post-cardiac surgery 71.2%
  - cardiology 12%
  - post-transplant 8%
  - ventricular assist device 4.3%
  - post-thoracic surgery 3.1%
  - thoracic medicine 1.4%

- Delirium: post cardiac surgery high incidence
Our experience

• Over 6 month period:
• N=16: 10 male : Mean (SD) age: 57 (17)
• Median age: 56 (49-79)
• Mean (SD) BMI: 25.7 (6.9)
• Speciality
  – Cardiac Surgery: 8
  – Cardiology: 1
  – Transplant 4
  – VAD 3
All patients had delirium

- **RASS \( \geq 2 \)**

<table>
<thead>
<tr>
<th>Target RASS</th>
<th>RASS Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ 4</td>
<td>Combative, violent, danger to staff</td>
</tr>
<tr>
<td>+ 3</td>
<td>Pulls or removes tube(s) or catheters; aggressive</td>
</tr>
<tr>
<td>+ 2</td>
<td>Frequent nonpurposeful movement, fights ventilator</td>
</tr>
<tr>
<td>+ 1</td>
<td>Anxious, apprehensive, but not aggressive</td>
</tr>
<tr>
<td>0</td>
<td>Alert and calm</td>
</tr>
<tr>
<td>- 1</td>
<td>awakens to voice (eye opening/contact) ( &gt;10 \text{ sec} )</td>
</tr>
<tr>
<td>- 2</td>
<td>light sedation, briefly awakens to voice (eye opening/contact) ( &lt;10 \text{ sec} )</td>
</tr>
<tr>
<td>- 3</td>
<td>moderate sedation, movement or eye opening. No eye contact</td>
</tr>
<tr>
<td>- 4</td>
<td>deep sedation, no response to voice, but movement or eye opening to physical stimulation</td>
</tr>
<tr>
<td>- 5</td>
<td>Unarousable, no response to voice or physical stimulation</td>
</tr>
</tbody>
</table>
Indications

– 7 episodes for Type 2 RF
– 9 episodes for Type 1 RF
– bi-basal collapse/pulmonary oedema + secretion retention/pain (drain sites)
– Also afforded awake Bronchoscopy n=8
Remifentanyl

- Dose range: 0.01 – 0.25μg/kg/min

- Duration (hrs) mean: 14.45 hrs range 5-31
• **NIV**
  - NIV total time in hrs: mean (SD) : 18 (8)

• **pH**
  - lowest pH 7.16
  - those with pH < 7.25 were reintubated: metabolic acidosis also
  - mean time to correct 6 hours
Outcomes

• Mortality
  ▪ 1 died: cause unrelated to sedation/NIV
    Died many days later: recurrent VAPs and organ failure

• Re-intubation
  – 4 reintubated: 2 with metabolic acidosis
  – 12 resolved + came off NIV
Outcomes

• LOS
  – Median: 15 days
  – 25-75% IQR: 8-29 days

• LOS (no tracheostomy) n=12
  – Median: 8 days
  – 25-75% IQR: 4.5-12.5

• LOS (Tracheostomy) n=4
  – Median: 29.5 days
  – 25-75% IQR: 26.5-31.75
Overall Outcome data

- Survival
- Re-intubation
- LOS
- ICU discharge
- Trach
- Re-admission rate
<table>
<thead>
<tr>
<th></th>
<th>Mortality rate</th>
<th>Length of stay (days, median 25-75% IQR)</th>
<th>Reintubation rate</th>
<th>Tracheostomy rate</th>
<th>Age mean (SD)</th>
<th>BMI Mean (SD)</th>
<th>Baseline serum Creatinine mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All admissions (n=650)</td>
<td>8% (52/650)</td>
<td>2 (1-5)</td>
<td>10.5% (68/650)</td>
<td>10.3% (67/650)</td>
<td>64 (14)</td>
<td>27 (5)</td>
<td>98 (64)</td>
</tr>
<tr>
<td>Tracheostomy (n=67)</td>
<td>20.9% (14/67)</td>
<td>26 (14.5-37.5)</td>
<td>55.2% (37/67)</td>
<td>-</td>
<td>60 (16)</td>
<td>26 (6)</td>
<td>98 (53)</td>
</tr>
<tr>
<td>Reintubations (n=67)</td>
<td>11.9% (8/67)</td>
<td>11 (4.75-26.5)</td>
<td>-</td>
<td>47.8% (32/67)</td>
<td>63 (16)</td>
<td>25 (7)</td>
<td>100 (55)</td>
</tr>
<tr>
<td>Readmissions</td>
<td>13.6%</td>
<td>5</td>
<td>72.7%</td>
<td>15.9%</td>
<td>65</td>
<td>25</td>
<td>117</td>
</tr>
</tbody>
</table>
Judicious use of sedation during NIV could be one of the valuable options for some of these patients at risk of intubation.

Although different sedatives have been used in published studies, the objectives of sedation are similar: allowing mitigation of patient discomfort and obtaining the desired level of sedation.

Whatever the sedative used, the goal is to achieve sedation to a point where the patients are awake and arousable and comfortable.

Pilot studies suggest that continuous infusion of a single sedative agent may decrease patient discomfort, with no significant effects on respiratory drive, respiratory pattern, or haemodynamics.
• Next stage
• NIV success – quality indicator (driver)

• Need more robust studies

• Need guidelines – safe practice & governance

• ICS/BTS joint initiative
Summary

- Sound clinico-physiological basis: survival & palliation
- Evidence-base growing
- Safety & Feasibility – more data
- Sedation is being used: UK, US and Europe
- Guidance: practice is ahead of evidence-base
## Riker Sedation-Agitation Scale (SAS)

<table>
<thead>
<tr>
<th>Score</th>
<th>Term</th>
<th>Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Dangerous Agitation</td>
<td>Pulling at ET tube, trying to remove catheters, climbing over bedrail, striking at staff, thrashing side-to-side</td>
</tr>
<tr>
<td>6</td>
<td>Very Agitated</td>
<td>Requiring restraint and frequent verbal reminding of limits, biting ETT</td>
</tr>
<tr>
<td>5</td>
<td>Agitated</td>
<td>Anxious or physically agitated, calms to verbal instructions</td>
</tr>
<tr>
<td>4</td>
<td>Calm and Cooperative</td>
<td>Calm, easily arousable, follows commands</td>
</tr>
<tr>
<td>3</td>
<td>Sedated</td>
<td>Difficult to arouse but awakens to verbal stimull or gentle shaking, follows simple commands but drifts off again</td>
</tr>
<tr>
<td>2</td>
<td>Very Sedated</td>
<td>Arouses to physical stimull but does not communicate or follow commands, may move spontaneously</td>
</tr>
<tr>
<td>1</td>
<td>Unarousable</td>
<td>Minimal or no response to noxious stimull, does not communicate or follow commands</td>
</tr>
</tbody>
</table>
The assessment tool most commonly employed in UK clinical practice is the Confusion Assessment Method for the Intensive Care Unit (CAM-ICU)

• Specifically validated for use on the intensive care

Easy and quick to perform and good inter-observer reliability

• CAM-ICU, performed once every 24 hours, directly assesses the patient performing tasks to command and can be used during mechanical ventilation
Table 1. The Confusion Assessment Method for the Intensive Care Unit (CAM-ICU)

- features and descriptions absent present

I. Acute onset or fluctuating course*
   - A. Is there evidence of an acute change in mental status from the baseline?
   - B. Or, did the (abnormal) behavior fluctuate during the past 24 hours, that is, tend to come and go or increase and decrease in severity as evidenced by fluctuations on the Richmond Agitation Sedation Scale (RASS) or the Glasgow Coma Scale?

II. Inattention†
- Did the patient have difficulty focusing attention as evidenced by a score of less than 8 correct answers on either the visual or auditory components of the Attention Screening Examination (ASE)?

III. Disorganized thinking
   - Is there evidence of disorganized or incoherent thinking as evidenced by incorrect answers to three or more of the 4 questions and inability to follow the commands?
   - Questions
     - 1. Will a stone float on water?
     - 2. Are there fish in the sea?
     - 3. Does 1 pound weigh more than 2 pounds?
     - 4. Can you use a hammer to pound a nail?
   - Commands
     - 1. Are you having unclear thinking?
     - 2. Hold up this many fingers. (Examiner holds 2 fingers in front of the patient.)
   - 3. Now do the same thing with the other hand (without holding the 2 fingers in front of the patient). (If the patient is already extubated from the ventilator, determine whether the patient’s thinking is disorganized or incoherent, such as rambling or irrelevant conversation, unclear or illogical flow of ideas, or unpredictable switching from subject to subject.)

IV. Altered level of consciousness
   - Is the patient’s level of consciousness anything other than alert, such as being vigilant or lethargic or in a stupor or coma?
   - alert: spontaneously fully aware of environment and interacts appropriately
   - vigilant: hyperalert
   - lethargic: drowsy but easily aroused, unaware of some elements in the environment or not spontaneously interacting with the interviewer; becomes fully aware and appropriately interactive when prodded minimally
   - stupor: difficult to arouse, unaware of some or all elements in the environment or not spontaneously interacting with the interviewer; becomes incompletely aware when prodded strongly; can be aroused only by vigorous and repeated stimuli and as soon as the stimulus ceases, stuporous subject lapses back into unresponsive state
   - coma: unarousable, unaware of all elements in the environment with no spontaneous interaction or awareness of the interviewer so that the interview is impossible even with maximal prodding

Overall CAM-ICU Assessment (Features 1 and 2 and either Feature 3 or 4): Yes____ No____
The Confusion Assessment Method (CAM) should be used as a screening tool for delirium. It is easy to use and in addition to good observation skills helps to identify whether a patient has delirium. The CAM should be used on admission and frequently throughout admission to detect improvement/deterioration in confusional state.

**CONFUSION ASSESSMENT METHOD TO BE UNDERTAKEN BY MEDICAL OR NURSING STAFF IF DELIRIUM IS SUSPECTED:**

- **Acute Onset and Fluctuating**
  - Is there evidence of acute change in mental status from the patient’s ‘baseline’? Has the patient had any fluctuation in mental status in the past 24 hours as evidenced by fluctuation on a sedation scale (RASS, GCS)?

- **Inattention**
  - Does the patient have difficulty focusing attention, such as are they easily distracted or do they have difficulty keeping track of what is being said? **Letters Attention Test:** Say to the patient, ‘‘I am going to read you a series of 10 letters. Whenever you hear the letter ‘A’, indicate by squeezing my hand’’. Read letters from the following letter list in a normal tone 3 seconds apart:
    - S A V E A H A H A A R T
  - Errors are counted when patient fails to squeeze on the letter ‘’A’’ and when the patient squeezes on any letter other than ‘’A’’.

- **Disorganized thinking**
  - Is the patient’s thinking disorganized or incoherent? Is the conversation rambling or irrelevant, unclear with an illogical flow of ideas or unpredictable switching from one subject to another? **Command:** Say to patient: ‘‘Hold up this many fingers’’ (Hold 2 fingers in front of patient). ‘’Now do the same thing with the other hand’’ (Do not repeat number of fingers)* If pt is unable to move both arms, for 2nd part of command ask patient to ‘’Add one more finger’’. An error is counted if patient is unable to complete the entire command.

- **Altered level of consciousness**
  - Present if the actual RASS score is anything other than alert and calm (zero).
    - THE PATIENT IS DIAGNOSED WITH DELIRIUM, ACCORDING TO CAM, IF FEATURES 1 AND 2 EITHER 3 OR 4 ARE PRESENT.
SAPS II

- Designed to measure the severity of disease for patients admitted to Intensive care units aged >15
- 24 hours after admission to the ICU, the measurement has been completed and resulted in an integer point score between 0 and 163 and a predicted mortality between 0% and 100%
- No new score can be calculated during the stay
- If a patient is discharged from the ICU and readmitted, a new SAPS II score can be calculated.
- This scoring system is mostly used to:
  - describe the morbidity of a patient when comparing the outcome with other patients
  - describe the morbidity of a group of patients when comparing the outcome with another group of patients
SAPS II Calculation

• The point score is calculated from 12 routine physiological measurements during the first 24 hours, information about previous health status and some information obtained at admission.

• The calculation method is optimized for paper schemas.

• In contrast to APACHE II, the resulting value is much better at comparing patients with different diseases.

• The calculation method results in a predicted mortality, that is pure statistics.

• It does not tell the individual patient's chance of survival.

• Main purpose of this calculation is to provide a value that can be averaged for a group of patients, since it gives very unprecise values to calculate an average of the scores of a group of patients.
SAPS II : 12 PARAMETERS

- Age
- Heart Rate
- Systolic Blood Pressure
- Temperature
- Glasgow Coma Scale
- Mechanical Ventilation or CPAP
- PaO2
- FiO2
- Urine Output
- Blood Urea Nitrogen
- Sodium
- Potassium
- Bicarbonate
- Bilirubin
- White Blood Cell
- Chronic diseases
- Type of admission