How to achieve adherence to a ventilation algorithm for critically ill children?

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ABSTRACT

Aims and objectives: To evaluate to what extent physicians on a paediatric intensive care unit (PICU) adhered to a newly implemented ventilation algorithm.

Background: PICUs worldwide use different ventilators with a wide variety of ventilation modes. We developed an algorithm, as part of a larger protocol, for choice of ventilation mode at time of admission.

Design: This study was performed in a level III PICU of a university children’s hospital and had an uncontrolled, pre-post test design with a period before implementation (T0) and two periods after implementation (T1 and T2).

Methods: An invasive ventilation algorithm targeted at two patient groups was implemented in October 2008. The algorithm distinguished between lung disease, in which pressure control was considered as the preferred mode, and no lung disease, in which pressure-regulated volume control was preferred. Nurses and physicians were instructed in the use of the algorithm before implementation.

Results: During three test periods, a total of 507 children with a median age of 5 months [interquartile range (IQR) 0–50] on conventional invasive mechanical ventilation were included. In patients with lung disease, pre-implementation adherence rate was 79% (67/85). At T1 it was 71% (51/72); at T2 84% (46/55). The slight improvement from T1 to T2 was statistically not significant ($p = 0.092$). In patients with no lung disease, the adherence rate rose statistically significantly from 66% at T0 (62/93) to 78% (79/101) at T1, and 84% at T2 (85/101) ($p = 0.015$).

Conclusion: Implementation of a new ventilation algorithm increased physicians’ adherence to this ventilation algorithm and the effect was sustained over time. This was achieved by education, reminders and organizational changes such as admission of postcardiac surgery patients with protocolized nursing care including preset ventilator settings.

Relevance to clinical practice: Interdisciplinary collaboration, effective communication, leadership support and organizational aspects may be effective strategies to improve adherence to protocols.

Key words: Adherence • Algorithm • Guideline • Infants • Ventilation mode

INTRODUCTION

Paediatric intensive care units (PICUs) worldwide use different ventilators with a wide variety of ventilation modes: high-frequency oscillation (HFO), pressure control (PC), synchronized intermittent mandatory ventilation (SIMV), pressure support (PS), pressure-regulated volume control (PRVC) and, more recently, neurally adjusted ventilator assist (NAVA) (Bengtsson and Edberg, 2010; Breatnach et al., 2010). An unambiguous international guideline is lacking; ventilator type and ventilation mode are often chosen based on the intensive care physician’s experience and preference, financial concerns or local PICU policy, independent of the underlying disease (Randolph et al., 2003; Turner and Arnold, 2007; Randolph, 2009).

The literature is scarce on the best ventilation mode in critically ill children beyond the newborn period (Duyndam et al., 2011). One study found that high-frequency ventilation was associated with better oxygenation after 72 h than was conventional ventilation (Dobyns et al., 2002). However, there was no evidence of reduced mortality and duration of ventilation. Furthermore, most trials were significantly underpowered as they included small numbers of children (Duyndam et al., 2011).
Because of a lack of a ventilation protocol for clinical practice, we developed an algorithm for guiding the choice of the most appropriate mode of ventilation upon admission of a child to our intensive care unit (ICU), either PC or PRVC. A different protocol applies in case of need of HFO at admission. HFO is not included in this algorithm because it is not often used. Separate protocols are in place for HFO and non-invasive ventilation.

This algorithm is based on evidence in the adult literature (Amato et al., 1998; The Acute Respiratory Distress Syndrome Network, 2000; Haitsma and Lachmann, 2006; Logan et al., 2007) and outcome of consensus meetings of all consultants of our unit. However, adherence to protocols and guidelines remains a difficult issue and successful implementation is time consuming (Sinuff et al., 2007; Sinuff et al., 2008; Cahill et al., 2010; Gurses et al., 2010; Ceelie et al., 2012). In this study we evaluated to what extent the physicians adhered to the ventilation algorithm.

METHODS

Design

The study had an uncontrolled, pre-post test design with a pretest (T0) from January 2008 to July 2008, and two post-tests: from May to November 2009 (T1) and from May to November 2010 (T2). The test periods were chosen to cover seasonal diseases. The T2 measurement served to evaluate the long-term sustainability of the implementation. The Erasmus MC Medical Ethics Review Board approved the study and owing to the non-invasive nature of the study waived the need for informed parental consent.

Setting and patients

The study was performed in the 28-beds ICU of the Erasmus MC – Sophia Children’s Hospital, Rotterdam, the Netherlands, a level III referral academic hospital. This ICU consists of four 7-bed units, each with a specific focus: neurology, cardiology, (neonatal) surgery and high dependency care. The ICU also serves as one of the two national extracorporeal membrane oxygenation (ECMO) centres and provides all services in case of need of HFO at admission. HFO is not included in this algorithm because it is not often used. Separate protocols are in place for HFO and non-invasive ventilation.

The general purpose of our local ventilation strategy, as far as possible based on evidence, is to achieve the following conditions:

- $\text{pH} > 7.30$ and $< 7.48$
- $\text{PCO}_2: 5–8 \text{kPa}$
- $\text{PC}$ above Positive end expiratory pressure ($\text{PEEP}) \leq 15 \text{cm} \text{H}_2\text{O}$
- Tidal volume: 6 mL/kg (this was set in PRVC and pursued in PC)
- $\text{SpO}_2 > 95\%$; or a lower saturation in case of a cardiac disease with mixed circulation
- Inspiration time: 0.3–0.6 s for neonates and I:E ratio 1:2 for children aged above 6 months with an age-dependent frequency.

The algorithm was primarily designed to guide physicians in the choice of ventilation mode upon admission of a patient requiring invasive mechanical ventilation. Also, it accounted for conversion of ventilation mode in case a patient’s condition deteriorated. In addition, if ventilation with high pressures was needed (acute respiratory distress syndrome – ARDS) some of the above-mentioned conditions were to be modified: $\text{pH} \geq 7.20 < 7.48$; $\text{pCO}_2 \leq 9 \text{kPa}$; and $\text{SpO}_2 \geq 85\%$. 

The algorithm was based on evidence in the adult literature (Amato et al., 1998; The Acute Respiratory Distress Syndrome Network, 2000; Haitsma and Lachmann, 2006; Logan et al., 2007) and outcome of consensus meetings of all consultants of our unit. However, adherence to protocols and guidelines remains a difficult issue and successful implementation is time consuming (Sinuff et al., 2007; Sinuff et al., 2008; Cahill et al., 2010; Gurses et al., 2010; Ceelie et al., 2012). In this study we evaluated to what extent the physicians adhered to the ventilation algorithm.
In specific diseases such as pulmonary hypertension and traumatic brain injury (TBI), other target values for pH and PCO$_2$ are applied, described in different protocols (TBI: pCO$_2$ values between 4.5 and 5.0 kPa; for pulmonary hypertension initial normocapnia is the aim, provided that the needed inspiratory pressure is not too high. Otherwise permissive hypercapnia is accepted till values of ≥pH 7.20). IL ratio is also modified when lung condition deteriorates, dependent on the underlying disease. ECMO is indicated at oxygenation index around 40.

The algorithm was developed with two patient groups in mind: (1) those with lung disease, such as acute respiratory distress syndrome, pneumonia, or bronchiolitis and (2) without lung disease but receiving ventilation for epilepsy, postoperative care or TBI (Figure 1). The PC mode was assumed to be the most appropriate for group 1 because it maintains constant pressure not exceeding 15 cmH$_2$O above PEEP. Thus, volutrauma is potentially avoided and a tidal volume of 6 mL/kg is achieved. (The Acute Respiratory Distress Syndrome Network, 2000; Haitsma and Lachmann, 2006). PC is also suited in children at risk of compression atelectasis, in children with pulmonary hypertension (Logan et al., 2007), and to compensate for leakage around the tube.

The PRVC mode was considered the most appropriate for group 2 because it provides the lowest possible pressure at a constant tidal volume and achieves a more stable EtCO$_2$ and pCO$_2$. It has a decelerating inspiratory flow pattern with automatic adjustment of the inspiratory pressure for changes in compliance and resistance, resulting in a guaranteed constant tidal volume. However, volutrauma may occur when the pressure rises in case of deteriorating lungs with different dependent lung regions. Then the aerated lung regions will receive all the volume (higher than 6 mL/kg). There is no evidence for the use of PRVC in case of neurotrauma, although CO$_2$ has a direct influence on the diameter of the vessels of the brain and the blood volume and therefore influences the intracranial pressure. Because intracranial pressure (ICP) and CO$_2$ are inter-related, maintaining a constant CO$_2$ is indicated in case of brain injury. ICUs worldwide mostly use volume controlled ventilation for this purpose, but as PRVC provides constant tidal volume, we opted for this mode in TBI (Go and Singh, 2013).

In the PC mode, ventilation is adjusted to PS as soon as the patient is breathing spontaneously (triggering in the figure); in the PRVC mode, ventilation is adjusted to volume support. Sedation provided at the start of ventilation is reduced stepwise on the guidance of scores on the COMFORT behaviour scale (Ista et al., 2005).

A protocol for extubation readiness is not in place at our ICU, and a spontaneous breathing trial (SBT) is not used. The following extubation criteria are commonly used: cough/swallowing reflex present, respiratory indication solved, FiO$_2$ < 0.4, haemodynamically stable with little inotropic support, sufficient muscle strength, no excessive sputum, PEEP < 8 cmH$_2$O, proper fluid balance, no oedema, Glasgow coma score > 8, no or low-dose sedatives, pH between 7.35 and 7.45, no signs of infection (Randolph et al., 2002; Newth et al., 2009; Foronda et al., 2011). Separate protocols are in place for HFO and non-invasive ventilation.

Implementation

To enhance adherence, approval of the ventilation algorithm was sought from all medical staff before implementation. In July 2008, the ventilation practitioners instructed all physicians and critical care nurses how to use it. Newly recruited residents after July 2008 also received instruction and in addition were familiarized with the theory of ventilation and the ventilator software. All information was also made available in print and by e-mail. The algorithm was made available on each unit. A laminated version of the algorithm was placed at each ICU bed.

The algorithm was put into use in October 2008 after the ventilation practitioners had presented it to all physicians. Since 2010 all ICU staff are provided with a pocket manual that contains all PICU protocols including the ventilation algorithm. Furthermore, in 2010, the protocol for admission of TBI patients was changed to the effect that the PRVC mode became the preferred one for these patients. To ensure that this policy was adhered to, a sticker reminding of this ventilation mode was placed on a crash cart for patients with brain injury. For organizational and logistical reasons, from January 2010 cardiac surgery patients were directly admitted to our ICU for postoperative care. The protocol introduced since then prescribed PRVC as the preferred mode for these patients, unless they had serious pulmonary oedema. Extubation was attempted in these patients as soon as possible upon arrival at the ICU, usually within 6–12 h of admission. As such the postoperative cardiac surgery protocol included an algorithm for weaning off the ventilator. Before admission of these patients, nurses prepare the ventilator settings based on the cardiac weaning procedure described in the ventilation algorithm. The nurses are responsible for weaning but need to ask permission from the physician in charge for actual extubation.

Study procedure

All patients on conventional invasive mechanical ventilation during the three study periods were included.
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**Ventilation Algorithm**

**Lung diseases**
- ARDS, pneumonia, bronchiolitis
- Leakage along the tube
- Stomach problems, fat belly with compression atelectasis
- Pulmonary hypertension: with or without NO

**No lung diseases**
- Ventilation because of other reasons than lung disease
- Traumatic brain injury, where PCO₂ has to be stable

**Purpose Conventional ventilation:**
- pH > 7.30 < 7.48
- pCO₂: 5-8 kPa
- PC above PEEP ≤ 15 cmH₂O
- VT 6 ml/kg (ideal weight) (set in PRVC and pursued in PC)
- SpO₂ > 95%
- Ti: 0.3-0.6 sec. neonates
- I:E ratio 1:2 > 6 months

**Weaning criteria reached?**
- Cough/swallowing reflex present
- Respiration indication solved
- PaO₂/FiO₂ > 200 mmHg/26.7 kPa
- Hemodynamically stable/ little inotropic support
- Sufficient muscle strength
- No excessive mucus
- PEEP < 8 cmH₂O
- Proper fluid balance/ no signs of edema
- GCS > 8
- No sedative or low dose
- pH > 7.35 < 7.48
- No signs of infection

**Pressure Control**

**Pressure Support**

**Volume Support**

**Extubation**

**Pressure Regulated Volume Controlled**

**Figure 1** Ventilation protocol. PC, pressure control; PRVC, pressure-regulated volume control; PS, pressure support; VS, volume support; Ti, inspiration time; SpO₂, oxygen saturation; VT, tidal volume; NO, nitric oxygen; pCO₂, carbon dioxide partial pressure; ARDS, acute respiratory distress syndrome.

The initial ventilation mode was chosen by the physicians. In all three periods we recorded the initial ventilation mode set for newly admitted patients and recorded the reason for ventilation as an indication to what mode this patient should have been assigned. Patients on HFO and non-invasive ventilation were excluded. Patients were not excluded because of their condition. Data were retrieved from the electronic patient data management system that prospectively stores data of all physiological parameters, laboratory results, medication, procedures, assessments and care plans.

**Outcome measure**
Adherence to the ventilation algorithm was measured as: number of patients with correct ventilation mode.
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Table 1 Demographic characteristics

<table>
<thead>
<tr>
<th></th>
<th>T0</th>
<th>T1</th>
<th>T2</th>
<th>p-value</th>
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</thead>
<tbody>
<tr>
<td>Gender (male/female)</td>
<td>91/87 (51-1/48-9%)</td>
<td>94/79 (54-3/45-7%)</td>
<td>86/70 (55-1/45-7%)</td>
<td>0-73*</td>
</tr>
<tr>
<td>Age</td>
<td>0-12 months</td>
<td>105 (59%)</td>
<td>97 (56-1%)</td>
<td>95 (60-9%)</td>
</tr>
<tr>
<td></td>
<td>1-3 years</td>
<td>33 (18-5%)</td>
<td>27 (15-6%)</td>
<td>19 (12-2%)</td>
</tr>
<tr>
<td></td>
<td>4-12 years</td>
<td>26 (14-6%)</td>
<td>32 (18-5%)</td>
<td>25 (16%)</td>
</tr>
<tr>
<td></td>
<td>&gt;12 years</td>
<td>14 (7-9%)</td>
<td>17 (9-8%)</td>
<td>17 (10-9%)</td>
</tr>
<tr>
<td>Median age in months (IQR)</td>
<td>4 (0-211)</td>
<td>8 (0–233)</td>
<td>4.5 (0–218)</td>
<td>0-60†</td>
</tr>
<tr>
<td>Reason for ventilation</td>
<td>14</td>
<td>9</td>
<td>13</td>
<td>&lt;0-001</td>
</tr>
<tr>
<td>Cardiac</td>
<td>22</td>
<td>31</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Respiratory failure – acute pulmonary (e.g. bronchiolitis, pneumonia)</td>
<td>36</td>
<td>34</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Respiratory failure – upper airway</td>
<td>2</td>
<td>8</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Respiratory failure – others</td>
<td>6</td>
<td>7</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Neurologic – e.g. trauma injury, epilepsy</td>
<td>16</td>
<td>15</td>
<td>19</td>
<td></td>
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<tr>
<td>Hypoplastic lung</td>
<td>18</td>
<td>15</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Shock/sepsis/ECMO/Resuscitation</td>
<td>5</td>
<td>7</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Trauma</td>
<td>23</td>
<td>25</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Postoperative – abdominal</td>
<td>28</td>
<td>20</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Others‡</td>
<td>8</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
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</table>

*Chi-squared test.
†Kruskal-Wallis test.
‡Congenital diseases such as oesophageal atresia, pulmonary hypertension, meconium aspiration, metabolic diseases and neuromuscular diseases.

According to the algorithm divided by the total number of ventilated patients during the study period in question.

Statistical analysis
Patients’ characteristics, reason for admission and initial mode of ventilation are summarized by descriptive statistics. Data are presented as percentages: mean (standard deviation) for normally distributed data; median and IQR (interquartile range) for non-normally distributed data. Background characteristics for the pre- and post-test groups were compared using chi-squared (categorical variables) and Kruskal-Wallis test for continuous variables. In all three test periods, the difference in adherence to the protocol was compared and tested for the two groups (lung disease versus no lung disease) with the chi-squared test. A p-value of 0.05 (two-sided) was considered statistically significant. Data were analyzed using IBM SPSS® version 18.

RESULTS
During the three study periods 615 patients received ventilator support. In total, 108 patients were excluded for analysis (HFO, n = 31; non-invasive (home) ventilation, n = 87). Thus, analysis was performed on 507 patients, with a median age of 5 months (IQR 0–50) (T0: N = 178; T1: N = 173; T2: N = 156). Age and gender were not significantly different between the three periods. However, the reason for ventilation significantly differed between the periods is the admission of direct postoperative cardiac patients during T2 (Table 1).

Lung disease
Before implementation of the ventilation algorithm (T0), 67 of the 85 patients (79%) with lung disease were ventilated according to the algorithm (PC). After implementation, this held true for 51 of 72 patients (71%) in period T1, and 46 of 55 patients (84%) in period T2 (p = 0.215). Adherence to the algorithm slightly improved from T1 to T2 (p = 0.092) (Table 2).

No lung disease
At T0, 62 of the 93 patients (66%) with lung disease or no lung disease were ventilated according to the algorithm (PRVC). After implementation this held true for 79 of 101 patients (78%) in period T1, and 85 of 101 patients (84%) in period T2 (Table 2). This means that adherence statistically significantly improved from 66% at T0 to 78% at T1 to 84% at T2 (p = 0.015).

Related factors for (non) adherence
Adherence to the algorithm (correct choice of ventilation mode) was not statistically significant associated
Table 2  Adherence rates

<table>
<thead>
<tr>
<th></th>
<th>T0 January to July 2008 (n = 178)</th>
<th>T1 May to November 2009 (n = 173)</th>
<th>T2 May to November 2010 (n = 156)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung disease (PC)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Ventilated according to the algorithm*</td>
<td>67 (79%)</td>
<td>51 (71%)</td>
<td>46 (84%)</td>
<td>p = 0.215</td>
</tr>
<tr>
<td>No lung disease (PRVC)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ventilated according to the algorithm†</td>
<td>62 (66%)</td>
<td>79 (78%)</td>
<td>85 (84%)</td>
<td>p = 0.015‡</td>
</tr>
</tbody>
</table>

*p = 0.092 (between T1 and T2).
† Between T0 and T1: p = 0.072 and between T0 and T2: p = 0.005.
‡ p-value of 0.05 was considered statistically significant.

with patient’s age, shift (day versus evening/night), reason for ventilation (lung disease versus no lung disease) and unit (p = 0.52, p = 0.16, p = 0.84 and p = 0.06 respectively). In the cardiology unit, however, adherence to the algorithm increased significantly from 74% at T0 to 91% at T2 (p = 0.018). Adherence to the algorithm in cardiac and postoperative cardiac surgery patients increased significantly from 68% at T0 to 90% at T2 (p = 0.027).

Adherence to the algorithm in TBI patients seems to have increased. In 2010, only one patient was ventilated with PC rather than the prescribed PRVC. This also applies to the patients with acute respiratory failure during period T2 who were then mostly ventilated with the prescribed PC.

DISCUSSION

Implementation of a ventilation algorithm for PICU patients resulted in higher adherence to the ventilation algorithm in comparison to the pretest periods, especially for patients without lung disease. Adherence was not associated with patient factors (e.g. age), shift or reason for ventilation (lung disease versus no lung disease). Adherence to the ventilation algorithm tended to be best among postcardiac surgery patients, who receive protocolized nursing care including preset ventilator settings. The improvement in adherence regarding patients with lung disease is less marked. Before implementation adherence was even better (79%) than during the first post-test period (71%). It would seem that even after education and approval of the algorithm, physicians need time to put personal preferences aside. Still, adherence had increased during the second post-test (84%). Regrettably, still too many postoperative patients with abdominal problems were not ventilated as the algorithm dictated. This violation is perhaps easily overlooked; it would be easier to remember that the first choice of ventilation for postoperative patients is PRVC, except for those who have undergone abdominal surgery. A reminder sticker on the ventilator, in combination with feedback in case of violations, could perhaps optimize adherence for this patient group. The use of cuffed tubes versus uncuffed tubes might have played a role as well. The data do not indicate, however, if PC in case of no lung disease was chosen on the grounds of leakage along the tube. If so, the choice was right. If any leakage usually occurs later than in the first hour of ventilation, we assume that leakage will not have greatly influenced the choice of initial ventilation.

We speculate that the relatively high adherence rates (>80%) in the final post-test period can be ascribed to the fact that all newly appointed physicians and residents were well instructed. Furthermore, nurses – provided with a pocket manual of the ventilation algorithm – reminded physicians of the correct ventilation mode in cardiac surgery patients. We also assume that the use of reminders, such as a sticker on the crash car for TBI patients, increased adherence to the ventilation algorithm. This is consistent with the literature in the ICU and other health care settings (Cheung et al., 2012; Sinuff et al., 2013).

Research has shown that consistent use of evidence-based guidelines can significantly increase the extent to which patients receive recommended therapies (Cahill et al., 2010; Gurses et al., 2010). However, it is a great challenge to stimulate consistent use of these guidelines and protocols. Apart from attempts to change behaviour, this requires insight in all influencing factors (e.g. human behavioural, organizational, provider characteristics). Therefore, identifying potential influencing factors, e.g. with the barrier identification and mitigation tool (Gurses et al., 2010), can improve adherence to new protocols. Unfortunately, scarce data are available to guide decisions on optimal strategies to implement guidelines and protocols in the ICU (Ista et al., 2009; Cahill et al., 2010; Ceelie et al., 2012). On the one hand, it has been suggested that guideline implementation strategies tailored to overcome barriers to change might be more effective than the multifaceted ‘one size fits all’ strategy. On the
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other hand, multifaceted implementation strategies were considered important enablers of protocol and guideline adherence (Sinuff et al., 2008; Baker et al., 2010). One example is education tailored to the specific learning needs of the ICU team combined with bedside reminders, audit and visual feedback (Sinuff et al., 2007; Baker et al., 2010; Kastrup et al., 2011). Also, we believe – and previous studies have demonstrated this – that ICU culture qualities such as interdisciplinary collaboration, effective communication and leadership support are associated with better quality of care (Davies et al., 2000; Stein-Parbury and Liaschenko, 2007). This is also confirmed in two recent studies about interdisciplinary collaborative decision-making regarding ventilation and weaning (Rose et al., 2011; Blackwood et al., 2013). Enhanced communication and collaboration between professionals could probably avoid unnecessary prolonged ventilation and weaning (Rose et al., 2011; Blackwood et al., 2013). We speculate that manipulating these specific organizational characteristics (interdisciplinary collaboration, effective communication, leadership support and organizational aspects like nurse-to-patient ratio and ongoing education) may be an effective strategy to improve adherence to protocols, which deserves to be explored and evaluated in further implementation projects (Sinuff et al., 2013). However, ICU culture qualities on our unit also need to be further studied.

Regarding strengths and limitations, the strength of this study is the prospective data collection. The limitation is the lack of a control group or randomization. However, it would have been difficult to blind physicians or other ICU staff to the study. Second, reasons for non-adherence with the algorithm were not documented in the patient data management system.

Implications for nurses in the implementation of new algorithms
Care for ICU patients will benefit from interdisciplinary collaboration, also when new algorithms or protocols are implemented, related to either nursing care or medical care. To improve physicians’ adherence to a medical algorithm, nurses should remind physicians of the steps to take. Nurses are always present at the bedside and as such represent the patient. In summary, the following measures may successfully improve adherence:

• A well thought-out implementation plan, with attention to potential barriers and facilitators is a crucial first step.
• Use reminders as pocket manuals and stickers.
• Provide repeated education about the algorithm and the results of its use (performance feedback).
• Provide leadership support at doctor’s and nursing level.
• Report non-adherence through safety first reports and feedback when protocol violations occur.

CONCLUSION
Implementation of a new ventilation algorithm increased physicians’ adherence to this ventilation algorithm and the effect was sustained over time. This result was achieved by education, reminders and organizational changes such as protocolized admission of postcardiac surgery patients with protocolized nursing care including preset ventilator settings.

Interdisciplinary collaboration between physicians and nurses, effective communication, leadership support and organizational aspects like nurse-to-patient ratio and ongoing education may be effective strategies to improve adherence to protocols.

WHAT IS KNOWN ABOUT THIS TOPIC
• An unambiguous international ventilation guideline for children is lacking; ventilator type and ventilation mode are often chosen on the basis of the intensive care physician’s experience and preference, financial concerns or local PICU policy, independent of the underlying disease.
• The literature is scarce on the best ventilation mode in critically ill children beyond the newborn period.
• Adherence to protocols and guidelines remains a difficult issue and successful implementation is time consuming.

WHAT THIS PAPER ADDS
• Implementation of a new ventilation algorithm in a large PICU increased physicians’ adherence to a ventilation algorithm and the effect was sustained over time; this was also accomplished with the help of nurses and the following measures.
• A well thought-out implementation plan, with attention to potential barriers and facilitators is a crucial first step.
• Ongoing attempts to improve adherence, for example, by performance feedback are crucial to achieve a safety culture.
REFERENCES


