Conference Summary

Respiratory Controversies in the Critical Care Setting

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Definitive evidence to settle the important clinical controversies we debated in this Journal Conference are not yet available. More randomized controlled trials are clearly needed for all of the topics presented. Additionally, neonatal and pediatric data are clearly lacking on most of these questions. The key points in many of the conversations on these controversial topics focused on the balance between efficacy and safety. When safety data exist without efficacy data, the uncontrolled variables often become the knowledge, experience, and support available in an individual intensive care unit. "New" therapies have the potential to help many patients but also have the potential to do great harm if clinicians do not follow standard guidelines and/or do not have the knowledge to use the therapy appropriately. It is clear that some current standards of care will be overthrown by future data while others will be finally substantiated. This Journal Conference queried the status quo to better enable clinicians to make informed decisions in the care of their critically ill patients. *Key words: respiratory, intensive care, controversies, mechanical ventilation, ARDS, monitoring modes, artificial airway, acute respiratory failure*. [Respir Care 2007;52(5):636–644. © 2007 Daedalus Enterprises]

Introduction

This RESPIRATORY CARE Journal Conference is the first to use the format of a pro/con debate. This atypical approach has allowed us to frame controversial clinical questions in a different way, by exploring the "extremes" of an issue and then working toward common ground. By all

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accounts, this format has succeeded wonderfully. Indeed, the discussions have been among the best we have encountered, and the voting process following these presentations was very enlightening.

Innovative Therapies When Accepted Therapies Fail?

Bruce Rubin and Ken Steinberg started us off with a provocative debate on an important overview topic. They were charged with addressing the issue of how clinicians should deal with innovative therapies when conventional therapies are failing. The key question is, when all conventional therapies are exhausted, how should innovative therapies be provided—if they should be provided at all? There was consensus among the conference presenters that certain criteria should be met if unproven therapies are offered. Specifically, there should be some rationale for the innovative therapy, there should be in vitro and/or clinical data supporting its use, and the patient/family must be informed of the known risks and benefits. Importantly, patients have long been deemed to have a constitutional right to seek unproven experimental therapies and must waive the right to sue under these circumstances. However, patients also have a constitutional right to not accept experimental therapies. Unproven therapies should never be forced on patients, and clinicians have an obligation to not "oversell" the innovative therapy and create false hope.

In the pharmaceutical world, the U.S. Food and Drug Administration (FDA) supports "thoughtful risk taking" when conventional therapies have been exhausted. Importantly, the FDA requires data collection under these circumstances, especially safety data and adverse events. The FDA also has the right to ban certain experimental drugs if judged unsafe or ineffective (eg, laetrile). Interestingly, devices and device applications are less regulated by the FDA, and most clinicians have fewer restraints in being innovative with these.

The controversy is not so much *whether* to use innovative therapies, but *how*. Basically, there are 2 approaches. One is to apply them in the context of structured investigations, which requires that all clinicians use a standardized approach with the innovative therapy, and data-collection is integral in the process. The advantage to this approach is that the innovative therapy can be carefully assessed and adjustments or changes in its application can be done systematically. The disadvantage is that it can be a cumbersome process in which individualized applications are difficult.

The other approach is to let clinicians apply innovative therapies in whatever way they think appropriate in their clinical judgment. The advantage to this is that clinical judgment can be brought to bear and that bedside adjustments to the innovative therapy can be done without the constraints of a protocol. This approach facilitates flexibility, individualization, and responsiveness. The disadvantages are the potential problems with communication and integrating the innovative therapy with the rest of the care plan (especially when caregivers are operating on a shift-by-shift basis). Data collection is also problematic with this approach, and, thus, the ability to learn about the value of the innovative therapy is reduced. Indeed, with this approach, harm and good from the innovative therapy can be difficult to separate, because a systematic assessment is not done.

The intensive care unit (ICU) is a rich breeding ground for innovative therapies, because there are dying patients who have exhausted all standard therapies. There are also desperate families who want to do everything possible. And there is ready access to novel devices, with encouragement from peers and developers. Finally, ICU caregivers are there because they have a strong "compulsion to act." Unfortunately, critical care has a bad track record with innovative therapies. Indeed, many management strategies and devices have gone by the wayside over the years because they were not studied properly, and harm was only determined years later in more careful studies (eg, large-tidal-volume ventilation, aggressive fluid administration, and drugs such as lidocaine). Put another way, the odds are good that the next innovative therapy tried in the ICU will be either useless or harmful.

At the end of this discussion, the group was polled on whether innovative therapies should be tried within a structured or protocolized procedure. Interestingly, it was a 50/50 split; half the group agreed that innovative therapies should be studied systematically, whereas the other half thought clinicians should be allowed to use innovative therapies guided by individualized clinical judgment.

Inhaled Antibiotics for Preventing and Treating Ventilator-Associated Pneumonia?

Neil MacIntyre and Bruce Rubin then took on the first clinical controversy. This debate was designed to discuss aerosolized antibiotics for both preventing and treating ventilator-associated pneumonia (VAP), but it quickly became apparent that we all agreed that there are no data to support the use of aerosolized antibiotics for treating established VAP, so the discussion was only on whether aerosolized antibiotics can prevent VAP.

The pro argument is that prophylactic aerosolized antibiotics make considerable sense. It is generally agreed that the pathogenesis of VAP involves bacterial entry into the airways and subsequent development of tracheobronchitis. Infection then spreads into the distal airways and parenchyma, producing VAP. The rationale is that aerosolized antibiotics might prevent tracheobronchitis or "nip VAP in the bud." Some indirect data support this proposition. First,

strategies to reduce bacterial entry into the lung, such as subglottic suctioning and semirecumbent patient position, clearly reduce the incidence of VAP. Second, aerosolized antibiotics reduce tracheobronchitis in other chronic airway diseases, such as cystic fibrosis. Finally, aerosolized antibiotics reduce bacterial load in intubated patients with tracheobronchitis. Perhaps most importantly, a recent meta-analysis of 5 clinical trials concluded that in patients at risk for VAP and who have evidence of tracheobronchitis, aerosolized antibiotics did indeed prevent VAP.[1]

There are several good arguments against using aerosolized antibiotics to prevent VAP. Chief among them is that wide use of aerosolized antibiotics has been shown in multiple studies to increase antibiotic resistance in bacteria in the ICU. In many of the clinical trials, antibiotic resistance was an important concern. With inhaled tobramycin, there is also concern about appropriate delivery, airway adverse effects, and caregiver exposure, as well as systemic absorption, which can lead to systemic toxicity such as renal failure. There is also the logistical issue that many antibiotics are not formulated for aerosol delivery.

At the end of this discussion the group was polled, and only one participant agreed that aerosolized antibiotics should be used to prevent VAP in patients with evidence of tracheobronchitis, whereas the rest of the group felt that additional studies are needed before they could recommend that strategy.

Capnography From Intubation to Extubation?

The third session focused on whether every mechanically ventilated patient should be monitored with capnography from intubation to extubation. This was debated by Ira Cheifetz and Tim Myers. All the conference participants agreed that capnography is the standard of care to confirm endotracheal intubation for all patients, regardless of the setting. The difficulty with this topic is that no definitive studies published to date have even attempted to address the use of capnography beyond this one specific application.

The use of capnography for the duration of mechanical ventilation is largely supported by patient-safety recommendations and an extrapolation of data from the operating room setting. If capnography is required to confirm the location of the endotracheal tube, then it seems reasonable that capnography should be applied for rapid detection of inadvertent extubation. Furthermore, if capnography is the standard of care in the operating room, should there not be the same standard in the ICU? A report by the Joint Commission (formerly the Joint Commission on Accreditation of Healthcare Organizations) in 2002 clearly supports the need for additional monitoring (ie, beyond standard ventilator monitoring and pulse oximetry) of the integrity of the ventilatory apparatus.[2] Furthermore, preliminary data support the use of capnography to optimize patient-ventilator interaction and decrease the duration of ventilation.[3]

Several participants stressed that a key component is knowing how to use the information capnography provides. Specifically, it is important to note that the end-tidal carbon dioxide concentration (P_{ETCO_2}) will not match the arterial carbon dioxide (P_{aCO_2}) value, and the difference between those values represents dead-space ventilation. Furthermore, changes in the difference between P_{ETCO_2} and P_{aCO_2} ($P_{(a\text{-}ET)CO_2}$) represent changes in dead space.

The argument against continuous capnography is supported by multiple studies that found that $P_{(a\text{-}ET)CO_2}$ changes unpredictably in real-world settings. Thus, the clinical implications of the unpredictable relationship between P_{ETCO_2} and P_{aCO_2} can be important if the practitioner cannot appropriately apply the capnography data. Specific conditions discussed included congenital heart disease, coronary artery disease, head trauma, and obesity. Additionally, important concerns were raised as to whether current educational programs train clinicians to appropriately interpret the complex capnography data.

At the end of this discussion, 2 questions were asked of the panel of experts. First, the group was polled on the proposition that exhaled carbon dioxide should be monitored as a simple indicator of inadvertent extubation in all ventilated patients from intubation to extubation. Almost half of the participants agreed. Second, the group was polled on the proposition that capnography should be used with all ventilated patients to titrate mechanical ventilation support and "fine tune" the ventilator settings. A small minority of the group agreed, based on the currently available data.

Therapeutic Hypothermia After Cardiac Arrest?

The next controversy reviewed was whether all cardiac arrest patients should be treated with hypothermia, and this was addressed by Steve Deem and Bill Hurford. To frame the issue, it is important to note that 150,000 out-of-hospital and 300,000 in-hospital cardiac arrests occur each year, the mortality rate in these groups is very high, and the majority of survivors have substantial neurological deficit. Mild hypothermia (33°C) in ischemia reperfusion states blocks many enzymatic processes, reduces oxygen radicals, reduces oxygen consumption, and reduces neurotransmitter activity. In numerous animal studies, hypothermia after cardiac arrest improved neurological and mortality outcomes.

Two large human trials reported in 2002 found benefit from applied hypothermia at 33°C after ventricular fibrillation/ventricular tachycardia cardiac arrests.[4,5] In 2005 a large meta-analysis found a significant benefit from hypothermia after cardiac arrest.[6] In 2003, the International Liaison Committee on Resuscitation recommended hypo-

thermia after cardiac arrest, except in the presence of shock, coagulopathy, or arrhythmia.[7] Importantly, hypothermia is relatively easy to produce with intravenous iced saline and a cooling blanket.

The flip side of this argument is that the data that support post-arrest hypothermia are not as clear-cut as it might seem. In the positive trials, only 8% of the arrest patients were enrolled in the trials (ie, only those with ventricular fibrillation and without shock), so we must question the generalizability of the data. Moreover, the studies were unblinded and had predictable randomization schemes, which could introduce significant biases. Another concern is that the control groups were hyperthermic, with an average temperature of 38°C. This calls into question whether it was hypothermia or avoidance of hyperthermia that provided the benefit. There can also be important adverse effects from hypothermia, including electrolyte issues, arrhythmia, hypertension, hyperglycemia, infection, and coagulopathy.

All the participants agreed that patients should be treated with hypothermia after ventricular fibrillation/ventricular tachycardia arrest, but only a small minority of the group agreed that all other arrest patients should be treated with hypothermia. Interestingly, only a slight majority of the institutions represented at the conference offer hypothermia in their units.

Airway Pressure-Release Ventilation?

The next discussion addressed a ventilation mode that is available on most modern mechanical ventilators: airway pressure-release ventilation (APRV). The specific question asked of Tim Myers and Neil MacIntyre was whether APRV is an important new advantage in ventilatory support.

APRV is a patient/machine-triggered, pressure targeted/limited, time-cycled ventilation mode that is designed for patients with acute lung injury (ALI). The unique feature is that a high inspiratory-expiratory ratio can be applied, and spontaneous breathing is permitted during the long inflation. The conceptual advantage is that APRV can be used as an alternative to increasing the positive end-expiratory pressure (PEEP) and/or tidal volume (V_T) to increase mean pressure and lung recruitment. Proponents think that APRV decreases the risk of barotrauma and alveolar damage in patients with ALI and/or acute respiratory distress syndrome (ARDS), and provides better ventilation-perfusion matching, cardiac filling, and patient comfort than modes that do not allow spontaneous breaths.

In some respects, APRV is similar to the inverse-ratio ventilation approaches of the 1980s. The key difference is that APRV allows spontaneous breaths and therefore does not require the heavy sedation and/or neuromuscular blockade that was required with older inverse-ratio ventilation strategies. Moreover, the spontaneous breaths during APRV might allow better distribution of gases to dependent lung regions. One might then speculate that APRV should be used when oxygenation goals are not being achieved with modes that limit V_T and plateau pressure.

Numerous animal studies and small clinical trials have compared APRV to controlled mechanical ventilation (including volume-targeted inverse-ratio ventilation) and they found that the physiologic premise of APRV is sound. Specifically, APRV can enhance gas exchange with higher mean pressure than conventional PEEP and V_T strategies.

However, there are several concerns about APRV. First, there is a general misconception that APRV limits the maximum stretch in the lung. This concept derives from the claim that because the airway pressure setting on the ventilator is clinician-controlled, the end-inspiratory stretching pressure in the lung is limited. However, APRV allows spontaneous breaths during the inflation, so the patient can generate additional end-inspiratory lung volume and, therefore, end-inspiratory lung stretch, during spontaneous breaths. The claim that APRV limits the inspiratory stretch to the set airway pressure is, thus, spurious.

More important, perhaps, is that 2 randomized clinical trials performed with APRV found questionable benefit. The first, by Putensen et al,[8] appeared to show a shorter ICU stay with APRV. However, careful inspection of the protocol revealed that the control group seemed to have a very "nonstandard" ventilator pattern, in that the ratio of P_{aO_2} to fraction of inspired oxygen (P_{aO_2}/F_{IO_2}) was dramatically lower from baseline, and paralysis was mandated for the first 3 days. Thus, the claim that APRV reduced ICU stay must be called into question because of the nonstandard approach to the control group. Perhaps a better randomized controlled trial was done by Varpula et al,[9] in which APRV had no advantage over a strategy of intermittent mandatory ventilation/pressure support with regard to gas exchange, lung mechanics, outcomes, or sedation.

The Journal Conference participants unanimously agreed that APRV offers no important new advantages in ventilation. Five of the group had used APRV, and eight had not.

ARDS Network PEEP/F_{IO_2} Table?

The next issue, addressed by Rich Kallet and Rich Branson, was whether the ARDS Network's PEEP/F_{IO_2} table[10] is the best guide for setting PEEP in patients with ALI or ARDS. There are several ways to approach the application of PEEP in such patients:

•Visual: use radiographic or other imaging techniques to determine when appropriate recruitment has occurred and when lung distension is unacceptable.

•Mechanical: use lung compliance measurements and/or the pressure-volume curve to determine when the lung is on the steepest portion of the pressure-volume curve.

•Gas exchange: set the PEEP either to maximize oxygenation or to provide a target P_{aO_2} in conjunction with the F_{IO_2}.

In essence, setting the PEEP is a balancing act to apply the appropriate PEEP for gas exchange while not increasing the end-expiratory lung volume to the point of overdistension.

Does the ARDS Network PEEP/F_{IO_2} table (which is a gas-exchange targeted strategy) provide the best approach to setting PEEP? The table was empirically derived by the ARDS Network's steering committee and was based on the concept that PEEP should only be used to provide an *acceptable* level of oxygenation (P_{aO_2} 55–80 mm Hg), not the maximum possible oxygenation. The table treats PEEP and F_{IO_2} changes as roughly equivalent steps. In the table the minimum and maximum PEEP are 5 cm H_2O and 24 cm H_2O, respectively. That maximum PEEP was suggested by numerous clinical studies as an appropriate upper limit as well as still allowing 11 cm H_2O to deliver a V_T while keeping the plateau pressure below 35 cm H_2O.

The advantages of the PEEP/F_{IO_2} table are: (1) it is rational, (2) it recognizes the balancing act between high distending pressure/VILI risk and gas exchange, and (3) it is easy to apply at the bedside. Importantly, in several ARDS Network trials the use of this table was associated with outcomes that are among the best recorded in the clinical literature. Interestingly, in the last 5 years, 3 additional randomized controlled trials[11–13] that used small V_T and compared more aggressive PEEP application to the ARDS Network PEEP/F_{IO_2} table approach failed to show superiority.

The argument against the ARDS Network PEEP/F_{IO_2} table is largely based on physiology. Specifically, the table is a "one size fits all" approach that does not take into account the fact that recruitability of alveolar units is quite variable among patients with ALI/ARDS. Thus, the table may under-recruit some patients and overdistend others. Thus, the fact that more aggressive PEEP/F_{IO_2} strategies have failed to improve outcomes, despite group improvements in P_{aO_2} and compliance, may suggest that some individuals were harmed while others were helped. A corollary to this concept is that in an individual patient the pressures to recruit severely injured regions (and thus produce physiologic benefit) may simultaneously produce overdistension and injury in less injured regions. On the other hand, these results may also simply indicate that recruitment above that needed to provide adequate oxygenation has little effect on VILI (and outcome) in the setting of small tidal distentions.

The discussion on PEEP/F_{IO_2} was quite lively. Some argued that the lung should be opened as much as possible, with individualized strategies, whereas others argued that the ARDS Network table is rational, has an excellent "track record," and provides the best risk/benefit ratio. The group was asked how many of the represented institutions used the ARDS Network table for routine clinical management, and the majority said that they did.

We also discussed whether ventilator-induced lung injury (VILI) is caused by (1) collapse/reopening of alveoli or (2) persistent atelectasis. Put another way, is VILI from fixed atelectasis or from cyclical atelectasis (recruitment/derecruitment stresses)? This is important because in this era of small V_T, which limits cyclical atelectasis, the role of PEEP in preventing VILI from fixed atelectasis may be less.

Adaptive Pressure Control Modes?

In the next session, Rich Branson and Rob Chatburn addressed dual-control (adaptive pressure control) ventilation modes. Adaptive pressure control modes use a feedback system to adjust the pressure control setting to assure a target volume. Pressure-targeted modes tend to be more comfortable for the patient, probably because flow is variable and thereby adjusts to patient demand. Unfortunately, the set inspiratory pressure may limit V_T delivery in the setting of worsening lung mechanics or decreasing patient effort, or provide excessive V_T in the setting of improving lung mechanics or increasing patient effort. In contrast, volume-targeted modes assure that the V_T is relatively constant, despite changing lung mechanics and/or patient effort, but the set flow may not synchronize well with active patient efforts. The idea of a dual-controlled mode is that we can use the advantages of variable flow by incorporating a feedback system to adjust the pressure level to assure a target volume.

The argument for adaptive pressure control modes is the attractiveness of delivering a target minute ventilation while maintaining a variable flow pattern. Numerous observational trials have indicated that these modes work as they are designed. However, no studies have been performed to determine if adaptive pressure control modes improve any meaningful clinical outcomes. Moreover, ventilator-applied pressure could rise to a very high level if the patient's lung mechanics seriously worsened and if the limits were not set properly.

During weaning the idea is to use adaptive pressure control modes to supply the minimum inspiratory pressure for a given clinician-selected V_T. However, there are 2 problems with this concept. First, there is no evidence that reducing the ventilator's contribution to an assisted breath facilitates weaning. Second, the clinician-set V_T guarantee is critical. If excessive, the ventilator will never reduce inspiratory pressure. If too low, the ventilator will drive the pressure down inappropriately and the patient may

experience fatigue. There have been no outcome studies of adaptive pressure control weaning, but, interestingly, new approaches that couple dual-control with additional inputs (eg, airway occlusion pressure 0.1 s after the onset of inspiratory effort, respiratory pattern, and end-tidal P_{CO_2}) may improve the utility of this strategy. Slightly more than half of the participants said that they use these dual-control modes routinely in their ICUs.

V_T of 6 mL/kg for Virtually All Mechanically Ventilated Patients?

Next, Ken Steinberg and Bob Kacmarek debated whether a V_T of 6 mL/kg should be used for virtually all patients with respiratory failure. Gone are the days when clinicians would use "large" V_T to normalize arterial blood gas values. Today everyone is focused on avoiding volutrauma and thus preventing secondary lung injury from overdistension. In 2000, the ARDS Network showed that a V_T of 6 mL/kg improves mortality, compared to 12 mL/kg V_T, in adult patients with ALI/ARDS.[10] But what about pediatric patients? And what about adult patients who are intubated for others reasons, such as dynamic hyperinflation/obstructive lung disease, cardiogenic pulmonary edema, bronchospasm, and nonpulmonary reasons (patients with normal lungs)? Furthermore, what about patients who are at risk for ALI? Does low-V_T ventilation prevent ALI? The pro argument started with this last question. The medical literature does indicate that higher V_T is associated with a higher risk of ALI. Tidal stretch, regardless of the lung's state, can injure the lungs. This point is further emphasized by the finding that permitting a certain degree of hypercapnia protects against VILI. Low-V_T ventilation reduces the risk of intrinsic PEEP and dynamic hyperinflation, protects against ALI, and improves hemodynamics. Emphasizing this stance is the fact that no adverse effects from low-V_T ventilation have been reported. The ARDS Network found that limiting alveolar distension saves lives. Based on the available data, it seems reasonable to conclude that low-V_T ventilation should be extrapolated to all patients unless new data prove otherwise.

The con argument strongly emphasized that the real culprit in VILI is the transpulmonary pressure, not the V_T per se. Physiology would indicate that you cannot overdistend the lungs if there is not an increase in the transpulmonary pressure, so the key factor in lung injury is the plateau pressure, not the V_T. A meta-analysis subsequent to the ARDS Network low-V_T study indicated that low V_T is associated with lower mortality but that that association disappears if the plateau pressure is $\leq$ 30 cm H_2O (even if the V_T is $>$ 6 mL/kg).[14] If the key component of the equation is plateau pressure (ie, $\leq$ 30 cm H_2O), then markedly sedating a patient with a low plateau pressure may not be in the patient's best interest.

Furthermore, the ARDS Network study[10] clearly demonstrated that 6 mL/kg V_T is better than 12 mL/kg for the population studied. However, it remains unclear whether a V_T between 6 mL/kg and 12 mL/kg (or even less than 6 mL/kg) might be even better. The conclusion of the con side of the argument is that plateau pressure determines mortality—not V_T.

The question posed to the group was straightforward: should 6 mL/kg be initially used for virtually all patients with respiratory failure? Five said yes, and eight said no.

Noninvasive Ventilation for All Forms of Acute Respiratory Failure?

The next topic moved us away from conventional mechanical ventilation to the world of noninvasive ventilation. This clinically important topic was debated by Dean Hess and Hank Fessler. All agreed that there is convincing evidence that noninvasive positive-pressure ventilation should be used for adult patients with chronic obstructive pulmonary disease (COPD) and cardiogenic pulmonary edema. This debate therefore focused on whether noninvasive ventilation should be used for other forms of acute respiratory failure. This issue is increasingly frequent in critical care units, as there have been tremendous advancements in noninvasive ventilation technology over the past several years, both in terms of gas-delivery devices and patient interfaces.

Noninvasive ventilation for acute respiratory failure is strongly supported by 7 systematic reviews that all concluded that noninvasive ventilation decreases the intubation rate and mortality in adult patients.[15–21] These findings were noted across diverse patient populations, beyond COPD and cardiogenic pulmonary edema. More specifically, noninvasive ventilation for hypoxemic respiratory failure yields a lower intubation rate than does standard management. It can be further concluded that noninvasive ventilation decreases the risk for VAP. Of course there must be some common-sense exclusions to noninvasive ventilation, including patients who are unable to protect their airway and those who are unable or unwilling to wear the necessary device interface.

On the other hand, data indicate that noninvasive ventilation does not work to rescue patients in respiratory distress after extubation, and it may increase mortality in those patients. Furthermore, the con stance points out that one of the larger meta-analyses that supposedly supported the use of noninvasive ventilation showed no difference in the reintubation or mortality rates in the subset of patients with hypercapnia. Thus, the alternative interpretation of the literature is that noninvasive ventilation should not be used in patients with a high likelihood of failure, and noninvasive ventilation has no proven advantage over the more traditional approach of invasive positive-pressure

ventilation for patients in acute respiratory failure caused by etiologies other than COPD and cardiogenic pulmonary edema.

Two questions were posed to the group, both of which yielded unanimous answers. First, everyone agreed that noninvasive ventilation should not be used routinely for all forms of acute respiratory failure. On the other hand, everyone indicated that they routinely use noninvasive ventilation for some patients with acute respiratory failure beyond the proven categories of COPD and cardiogenic pulmonary edema. Based on the discussion, it was apparent that the types of patients with acute respiratory failure who are supported with noninvasive ventilation do differ among institutions.

Heliox for Ventilated Patients?

The next debate brought helium-oxygen mixture (heliox) to the forefront. Bill Hurford and Ira Cheifetz debated whether heliox is indicated for mechanically ventilated patients. Although the physics of gas movement and the available literature support the use of heliox for nonintubated patients, the value of heliox for intubated patients remains much less clear. The data on heliox in mechanical ventilation are very limited.

The pro argument for heliox (regardless of intubation status) focuses on the physics of gas exchange. For both intubated and nonintubated patients, heliox improves gas flow though constricted airways and reduces air trapping (intrinsic PEEP). There are no data that suggest that the benefits of heliox are not the same for ventilated patients as for extubated patients. Although the data that show improved clinical outcomes with heliox for mechanically ventilated patients are very limited, the available data do support heliox use, at least for status asthmaticus. It is important to note that no studies have reported any adverse effects from heliox. As helium is biologically inert, it should have an excellent safety profile. Technical complications remain a concern, but they can be minimized with the knowledge of the technology available.

The con argument focuses on the very limited available evidence on heliox in mechanically ventilated patients. Most of the studies in nonintubated patients have been promising but not definitive. Additionally, all the heliox studies so far have been small, and very few were randomized. Technical limitations remain a major concern.

The group was polled on whether they would use heliox with a mechanically ventilated patient with airway obstruction and who was in extremis. All but two (who represented one institution) said they would. Everyone agreed that additional heliox-compatible/calibrated equipment is needed before more widespread use of heliox can be recommended.

High-Frequency Oscillatory Ventilation for Adults?

The next debate was on high-frequency oscillatory ventilation (HFOV). High-frequency ventilation has long been a standard ventilatory strategy for neonates, infants, children, and adolescents. However, only recently has this technology been used in the adult arena. Hank Fessler and Dean Hess debated whether HFOV offers benefits over conventional ventilation for adults with ARDS.

The overall objectives of HFOV are to greatly decrease the V_T, improve lung recruitment, decrease lung inflammation, and minimize secondary lung injury. The proponents of high-frequency ventilation focus on the theory that less is better when it comes to V_T, because lower V_T minimizes the cyclical stretch that injures the lung. The available clinical data do show a clear trend toward better survival with lower V_T. This finding, along with the convincing pre-clinical data and the tremendous experience in the neonatal and pediatric populations, support the use of HFOV in adults with ARDS.

The argument that HFOV does not offer benefits over conventional ventilation in adults is that the randomized controlled studies of adult patients with ALI did not show better survival with HFOV. There are several reports of impressive HFOV successes in adults who "failed" conventional ventilation.[22–24] However, it is unclear what "failed" meant in most of those publications. "Failed oxygenation" is not clinically relevant, because the ARDS Network low-V_T study[10] indicated that increasing the P_{aO_2} does not improve survival. Furthermore, in these cases HFOV was often performed as a rescue therapy. But what was the patient being rescued from? Poor gas exchange? Although HFOV can probably be used safely in adults, the con argument is that there simply are no data in the adult population to convincingly support HFOV over conventional ventilation.

The group agreed that the available data basically support equivalence between HFOV and conventional ventilation—assuming both are appropriately performed. Only a small minority of the conference participants agreed that HFOV offers benefits over conventional ventilation in adult patients with ARDS. Somewhat surprising was that only 2 members of the group had used HFOV with adult ARDS patients during the past year. When asked who believed that every hospital that manages severe acute respiratory failure in adults should have an oscillator, no one answered in the affirmative.

Ventilator Weaning Protocols?

After the debate over high-frequency ventilation, the focus turned 180° to weaning and whether protocols should be used to wean all mechanically ventilated patients. Rob Chatburn and Steve Deem had the honors for this debate.

Although much has been written in the medical literature on this topic, the controversy clearly continues. It is well accepted that weaning consumes a majority of the time on the ventilator. It is also generally agreed that delayed or premature extubation can be harmful. Iatrogenic factors, including improper assessment and management, can significantly impact the success of weaning.

The argument in favor of protocols is based on the belief that practice variability from "ad hoc" decision making reduces the use of the best evidence-based practices, increases the risk of iatrogenic harm, and prevents systematic analysis of best practice. Protocols operationalize best practices and thus reduce the occurrence of bad practice. Protocols raise overall care across the continuum to best practice, especially if they are iterative, with a constant review of deviations and subsequent modifications. As with evolution, protocols should be continually updated to encourage good deviations while reducing bad deviations. The bottom line of the pro argument is that numerous randomized controlled trials (Grade A evidence) have shown that protocols shorten weaning time for adult patients.

Despite the evidence supporting weaning protocols, some believe that protocols replace thinking and thus retard innovations and advancements, and impair education. Protocols can quickly become standards of care that stifle future questioning and challenges. An important concept we discussed was whether the protocols are derived from individuals or from groups. Individual-derived protocols may not represent the best decision making process.

The argument against routine use of weaning protocols acknowledges the numerous randomized controlled trials but also points out some major flaws in those studies. The control groups often did not receive state-of-the-art management. The mortality and hospital stay results are less impressive than the duration-of-weaning outcomes. It is also important to note that implementing protocols can be difficult. Protocols clearly will not work without real buy-in from the multidisciplinary clinical team.

The group response to the proposition that weaning protocols should be used for all mechanically ventilated patients was overwhelmingly positive; there were only 2 dissenting votes.

Recruitment Maneuvers in ALI and/or ARDS?

One of the most controversial topics closed out the 38th Journal Conference. Bob Kacmarek and Rich Kallet debated whether recruitment maneuvers should be routinely used for patients with ALI/ARDS. Acutely injured lungs have collapsed alveoli that open at variable points throughout the entire inspiratory phase. A recruitment maneuver takes the lung quickly to total lung capacity, then moves the lung down the deflation limb of the pressure-volume curve to an appropriate PEEP, to prevent derecruitment.

The argument in favor of recruitment maneuvers is simply that they open the lungs and then keep them open at the lowest possible distending pressure, to limit stretch injury and minimize the risk of toxicity from high F_{IO_2}. The proponents think that the risks of recruitment maneuvers are "overblown." Multiple clinical studies have shown very few adverse effects, including mild hypotension (which can be managed with fluid administration) and the need for additional sedation (often only transient increases). Proponents further argue that if the PEEP is set appropriately, the need to repeat the maneuver can be greatly minimized.

The argument against recruitment maneuvers is that they can cause clinically important cardiac compromise and barotrauma, which can be compounded if PEEP is not appropriately set and the recruitment maneuver must be repeated. These concerns might be lessened only when performed by "appropriately fearful" experienced clinicians who can best optimize the associated risks and benefits. Most importantly, no data indicate that recruitment maneuvers improve any meaningful clinical outcome; rather, they only provide transient improvements in oxygenation. A strongly debated secondary issue was the idea of allowing some lung units to remain closed ("permissive atelectasis") while using small V_T (6 mL/kg) to ventilate the open lung units, on the premise that lower intrathoracic pressure coupled with the reduction in open-closing stresses would limit VILI.

The final question to the group was whether to use lung recruitment maneuvers in patients with ALI and/or ARDS. Despite the seemingly increased use of recruitment maneuvers over the past few years, surprisingly, only 25% of the group agreed.

Conclusion

We clearly need more randomized controlled trials on all of the topics debated. We especially need additional neonatal and pediatric data in most areas. The discussions on many of the topics focused on the balance between efficacy and safety. When safety data exist without efficacy data, the uncontrolled variables often become the knowledge, experience, and support available in an individual ICU. "New" therapies have the potential to help many patients, but also have the potential to do great harm if clinicians do not follow standard guidelines and/or do not have the knowledge to use the therapy appropriately. The theme of the initial debate on "ICU Adventurism" permeated most of the discussions.

The primary goal of this Journal Conference was to query the status quo to better enable clinicians to make informed decisions in the care of critically ill patients. The

controversies were selected to provoke thought and speculation, stimulate discussion, and encourage further scientific investigation. The first 2 of these 3 goals have already been at least partially achieved. Perhaps this Journal Conference will lead to accomplishment of the third goal in the near future.

As we stated at the outset, we are extremely grateful to the contributing presenters/authors of this RESPIRATORY CARE Journal Conference for their dedication, expertise, and willingness to "go out on a limb" and try this unique format for a publication. Their incredible enthusiasm, flexibility, and, of course, tremendous expertise have been essential to the success of this conference. We also very much appreciate the support of RESPIRATORY CARE and the American Respiratory Care Foundation for their assistance with and sponsorship of this important Journal Conference. This was truly an outstanding experience for all of the participants. We hope that this and the previous issue of RESPIRATORY CARE have conveyed the excellent presentations and discussions among the panel of experts and will help clinicians to further improve the respiratory care of their patients.

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