Lung Protective Ventilation

Thomas Bice, M.D.
ARDS and Lung Protective Ventilation

- Acute respiratory distress syndrome (ARDS) is a common complication of critical illness
- The only intervention with known benefit in mortality is the use of lung protective ventilation
- Our adherence to lung protective ventilation at UNC was poor
- Developed team to address barriers to lung protective ventilation
What is ARDS?

- Lung inflammatory response to many conditions:
  - Trauma
  - Shock
  - Sepsis
  - Surgery
What is “Lung Protective Ventilation?”

What is a “Normal” Tidal Volume?

- Most textbooks say 500 ml - for a healthy 70 kg man at rest
  - = ~ 7 ml/kg
- 2 problems:
  1. Critically ill patients come in all sizes
  2. None of them are at rest or as healthy as these two appear to be
Known Benefits of LPV

- ARMA trial - published in 2000!!!
  - Compared 12 vs. 6 ml/kg ideal body weight
  - 39.8% vs. 31% mortality
  - Number Needed to Treat (NNT) to prevent 1 death
    - 12 per acute stay

1ARDSNET NEJM 2000
Difficulties in Implementation

- Default ventilator settings:
  - Rate 15, Tidal Volume 500
- Perceived harm
  - Increased sedation use
  - Risk of delirium
  - Increased acidosis
- These can all be overcome!
Possible Harm?

- Secondary analysis of ARMA¹
  - No difference in sedation use
  - Reduced length of stay

¹Khan et al - Crit Care Med 2005
Should We Use LPV for All?

- ARDS can be a difficult syndrome to recognize early
- Many centers examining their own practice have shown that adherence is poor
- Several recent recommendations for ventilator management suggest that using LPV for all patients may improve the adherence in ARDS
- **There is NO harm involved with Lung Protective Ventilation!**
Project Goal

- 90% of patients ≤6.5 ml/kg IBW at 24 hours
- Average daily tidal volume ≤6.5 ml/kg IBW
How we did it...

- Designated Respiratory Therapy Clinical Specialists
- Changed default settings on all ventilators
  - Tidal volume = 400 ml
- Put kit together that includes all supplies necessary for initiation of mechanical ventilation, including tape measure!
- Placed chart on each ventilator with default starting points to achieve 80% goal at baseline
In order to achieve Lung Protective Ventilation for adult patients, please use the following initial tidal volumes until a height measurement can be obtained:

**Male Patient: 450 ml**  
**Female Patient: 350 ml**

<table>
<thead>
<tr>
<th>Height</th>
<th>6 ml/kg Tidal Volume</th>
<th>Height</th>
<th>6 ml/kg Tidal Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td></td>
</tr>
<tr>
<td>Inches</td>
<td>CM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>122</td>
<td>130</td>
<td>110</td>
</tr>
<tr>
<td>49</td>
<td>124</td>
<td>150</td>
<td>120</td>
</tr>
<tr>
<td>50</td>
<td>127</td>
<td>160</td>
<td>140</td>
</tr>
<tr>
<td>51</td>
<td>130</td>
<td>180</td>
<td>150</td>
</tr>
<tr>
<td>52</td>
<td>132</td>
<td>190</td>
<td>160</td>
</tr>
<tr>
<td>53</td>
<td>135</td>
<td>200</td>
<td>180</td>
</tr>
<tr>
<td>54</td>
<td>137</td>
<td>220</td>
<td>190</td>
</tr>
<tr>
<td>55</td>
<td>140</td>
<td>230</td>
<td>200</td>
</tr>
<tr>
<td>56</td>
<td>142</td>
<td>240</td>
<td>220</td>
</tr>
<tr>
<td>57</td>
<td>145</td>
<td>260</td>
<td>230</td>
</tr>
<tr>
<td>58</td>
<td>147</td>
<td>270</td>
<td>250</td>
</tr>
<tr>
<td>59</td>
<td>150</td>
<td>290</td>
<td>260</td>
</tr>
<tr>
<td>60</td>
<td>152</td>
<td>300</td>
<td>270</td>
</tr>
<tr>
<td>61</td>
<td>155</td>
<td>310</td>
<td>290</td>
</tr>
<tr>
<td>62</td>
<td>157</td>
<td>330</td>
<td>300</td>
</tr>
<tr>
<td>63</td>
<td>160</td>
<td>340</td>
<td>310</td>
</tr>
</tbody>
</table>
Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

WEEK

TIDAL VOLUME IN ML/KG

-36-34-32-30-28-26-24-22-20-18-16-14-12-10-8-6-4-2 1 3 5 7 9 11 13 15 17

-36-34-32-30-28-26-24-22-20-18-16-14-12-10-8-6-4-2 1 3 5 7 9 11 13 15 17

Average Tidal Volume at 24 hr
Average Initial Tidal Volume

TIDAL VOLUME IN ML/KG

WEEK

TIDAL VOLUME IN ML/KG

WEEK

-36 -34 -32 -30 -28 -26 -24 -22 -20 -18 -16 -14 -12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36

-36 -34 -32 -30 -28 -26 -24 -22 -20 -18 -16 -14 -12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36

5.4 5.9 6.4 6.9 7.4 7.9 8.4 8.9 9.4

5.4 5.9 6.4 6.9 7.4 7.9 8.4 8.9 9.4
MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

WEEK

-36 -34 -32 -30 -28 -26 -24 -22 -20 -18 -16 -14 -12 -10 -8 -6 -4 -2 1 3 5 7 9 11 13 15 17

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG

MICU Average Tidal Volume at 24 hr

TIDAL VOLUME IN ML/KG
MICU Average Initial Tidal Volume

Tidal Volume in ml/kg

WEEK

-36 -34 -32 -30 -28 -26 -24 -22 -20 -18 -16 -14 -12 -10 -8 -6 -4 -2 1 3 5 7 9 11 13 15 17
Main Results

- Initial tidal volumes: 49% are ≤6.5 ml/kg
- 24 hr tidal volumes: 59%
- MICU Initial: 55%
- MICU 24 hr: 70% → Up from 26%
- Still work to do, but tremendous improvement!
Potential Effects

- 36% of MICU patients have ARDS
- 147 MICU patients since intervention
- ~50 likely had ARDS
- Before study only 16 would have received LPV
- Now, at least 35 were on LPV
- NNT = 12 to prevent 1 death
- Therefore, potentially saved 3 lives in one ICU in 4 months
Struggles Along the Way

- Delays in education of staff, both RT and MD
- Continued resistance, before, during, and after education
- Opportunities for continued education and dialogue
Sustainment Plan

- Expanding Respiratory Therapy Clinical Specialists to all ICUs
- MVP QI Team = Mechanical Ventilation Process Quality Improvement Team
Thanks!

- Michael Garrett, RTCS - MICU
- Chris Biancaniello, RTCS - SICU
- Sarah Biancaniello, RTCS - NSIU
- Kathy Short, RT
- Shannon Carson, MD
- Lydia Chang, MD
- Sean Montgomery, MD
- Dedrick Jordan, MD
- Tom Caffey
- Institute for Healthcare Quality Improvement
Questions?