Adjuvants to Mechanical Ventilation for Acute Respiratory Distress Syndrome: Changes in Use Over Time, Adoption and De-adoption

Laveena Munshi, MD

Clinical Associate, Interdepartmental Division of CCM
Mount Sinai Hospital/University Health Network
University of Toronto
Institute of Health Policy, Management and Evaluation
1. Adoption of innovations/therapeutics in medicine

2. De-adoption of innovations/therapeutics in medicine

3. Changes in use, Adoption and De-adoption: Adjuvants to Mechanical Ventilation for ARDS

No disclosures
Understanding Adoption in Medicine
Adopting Innovations in Science

---

**THE INNOVATION**
- Relative advantage
- Compatibility
- Low complexity
- Trialability
- Observability
- Potential for reinvention
- Fuzzy boundaries
- Risk
- Task issues
- Nature of knowledge
- Required (tacit/explicit)
- Technical support

**COMMUNICATION AND INFLUENCE**
- **DIFFUSION** (informal, unplanned)
  - Social networks
  - Homophily
  - Peer opinion
  - Marketing
  - Expert opinion
  - Champions
  - Boundary spanners
  - Change agents

- **DISSEMINATION** (formal, planned)

**OUTER CONTEXT**
- Sociopolitical climate
- Incentives and mandates
- Interorganizational norm-setting and networks
- Environmental stability

---

**SYSTEM ANTECEDENTS FOR INNOVATION**
- Structure
- Size/maturity
- Formalization
- Differentiation
- Decentralization
- Slack resources
- Absorptive capacity for new knowledge
- Preexisting knowledge/skills base
- Ability to find, interpret, recodify, and integrate new knowledge
- Enablement of knowledge sharing via internal and external networks
- Receptive context for change
- Leadership and vision
- Good managerial relations
- Risk-taking climate
- Clear goals and priorities
- High-quality data capture

---

**SYSTEM READINESS FOR INNOVATION**
- Tension for change
- Innovation-system fit
- Power balances (supporters vs. opponents)
- Assessment of implications
- Dedicated time/resources
- Monitoring and feedback

---

**ADOPTER**
- Needs
- Motivation
- Values and goals
- Skills
- Learning style
- Social networks

**ASSIMILATION**
- Complex, nonlinear process
- “Soft periphery” elements

---

**IMPLEMENTATION PROCESS**
- Decision making devolved to frontline teams
- Hands-on approach by leaders and managers
- Human resource issues, especially training
- Dedicated resources
- Internal communication
- External collaboration
- Reinvention/development
- Feedback on progress

---

**USER SYSTEM**
- System antecedents
- System readiness
- Adoption/assimilation
- Implementation
- Consequences

**RESOURCE SYSTEM**
- The innovation
- Diffusion
- Dissemination
- Change agency

**LINKAGE**
- Design stage
  - Shared meanings and mission
  - Effective knowledge transfer
  - User involvement in specification
  - Capture of user-led innovation
- Implementation stage
  - Communication and information
  - User orientation
  - Product augmentation, e.g., technical help
  - Project management support
**Interpretation:** HOPE led to a striking and unprecedented increase, over 400%, in ramipril prescribing to elderly Ontario residents, including those not eligible for the trial. Many physicians are now prescribing ramipril for patients with diabetes or congestive heart failure.

*CMAJ* 2003;168(5):553-7
Impact of Randomized Trial Results on Acute Lung Injury Ventilator Therapy in Teaching Hospitals

Craig R. Weinert, Cynthia R. Gross, and William A. Marinelli

Division of Pulmonary, Allergy, and Critical Care Medicine and Clinical Outcomes Research Center, University of Minnesota Medical School, Minneapolis, Minnesota; Department of Experimental and Clinical Pharmacology, College of Pharmacy, University of Minnesota, Minneapolis, Minnesota; and Hennepin County Medical Center, Minneapolis, Minnesota

Am J Respir Crit Care Med Vol 167, pp 1304-1309, 2003

Figure 1. Clustered line graph of tidal volumes delivered for ALI Day 1, 2, or 3 over seven consecutive 1-year intervals. The leftmost line in each cluster represents Day 1, the middle line represents Day 2, and the rightmost line represents Day 3. Small squares represent means and the horizontal lines represent 95% confidence intervals.

~10 ml/kg
<1% received 6 ml/kg
Evidence is only one part of adoption

Plausibility  Rationale
Prior probability

Evidence
Uncertainty

Mode  Delivery
Press

Belief about effect of therapy

Decision

Patient Factors

Benefits  Risks

Feasibility

Physician Preferences

Applicability

Alternatives  Costs  Availability

Physiologic Response
New Gadgets
Anecdotal experience/Hunches
Personal Values

Rubenfeld GD. Understanding why we agree on the evidence but disagree on the medicine. Respir Care. 2001;46(12):1442-1449.
Understanding De-Adoption in Medicine
Effect of Published Scientific Evidence on Glycemic Control in Adult Intensive Care Units

Daniel J. Niven, MD, MSc; Gordon D. Rubenfeld, MD, MSc; Andrew A. Kramer, PhD; Henry T. Stelfox, MD, PhD

Original Investigation | LESS IS MORE

Tight Glycemic Control

Hypoglycemia
Trends in the Use of the Pulmonary Artery Catheter in the United States, 1993-2004

Renda Soylemez Wiener, MD
H. Gilbert Welch, MD, MPH

Is It Time to Pull the Pulmonary Artery Catheter?

James E. Dalen, MD, MPH
Roger C. Bone, MD

JAMA, September 18, 1996—Vol 276, No. 11

Bedside Echocardiography
Non invasive hemodynamic monitoring
Evolution of the Evidence

Lung Protective Ventilation
The New England Journal of Medicine

PEEP

Corticosteroids

Fluid

ECMO

iNO

NMBA

HFO

Evolution of the Evidence

Comparison of Two Fluid-Management Strategies in Acute Lung Injury

Prone Positioning
Adjuvants to ARDS: Changes over time
STUDY OBJECTIVE

1. To evaluate **temporal changes** in use of adjuvant strategies to mechanical ventilation for acute respiratory failure (2008-2013)

2. To evaluate adoption/de-adoption practices with regard to landmark publications
Methods

Cohort patients undergoing mechanical ventilation for respiratory failure (2008-2013)

OUTCOME: Use of adjuvant strategies to mechanical ventilation
- Extracorporeal Membrane Oxygenation
- Inhaled Pulmonary Vasodilators
- Neuromuscular Blockading Agents
- High Frequency Oscillation

EXCLUSION:
- Pulmonary Hypertension
- Cardiac Surgery
- Transplant

Final Cohort for Analysis
n = 514,913
(Acute Resp Failure “ARF”)

Sensitivity Analysis
n = 70,435
(“ARDS”)

MV first two days
Sepsis & Respiratory Failure & Pneumonia
### Reflects an ARDS Cohort, Outcomes, Broad Population

<table>
<thead>
<tr>
<th>HOSPITAL VARIABLES</th>
<th>543 hospitals</th>
<th>532 hospitals</th>
</tr>
</thead>
<tbody>
<tr>
<td>URBAN</td>
<td>89%</td>
<td>88%</td>
</tr>
<tr>
<td>TEACHING</td>
<td>44%</td>
<td>42%</td>
</tr>
<tr>
<td><strong>BEDSIZE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large ≥ 400 beds</td>
<td>50%</td>
<td>48%</td>
</tr>
<tr>
<td>Medium 200-399 beds</td>
<td>36%</td>
<td>38%</td>
</tr>
<tr>
<td>Small &lt; 200 beds</td>
<td>13%</td>
<td>14%</td>
</tr>
<tr>
<td><strong>LOCATION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Midwest</td>
<td>18%</td>
<td>19%</td>
</tr>
<tr>
<td>Northeast</td>
<td>18%</td>
<td>18%</td>
</tr>
<tr>
<td>South</td>
<td>47%</td>
<td>45%</td>
</tr>
<tr>
<td>West</td>
<td>17%</td>
<td>19%</td>
</tr>
<tr>
<td><strong>LOCATION PRE-ADMISSION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ER</td>
<td>76%</td>
<td>81%</td>
</tr>
<tr>
<td>ELECTIVE</td>
<td>8%</td>
<td>3%</td>
</tr>
<tr>
<td>TRAUMA</td>
<td>2%</td>
<td>0.4%</td>
</tr>
<tr>
<td>OTHER</td>
<td>14%</td>
<td>17%</td>
</tr>
</tbody>
</table>
Acute Respiratory Failure
(514,809)

ARDS (70,435)

NMBA (10,230)

ECMO (195)

IPV (1,837)

HFO (66)
ECMO Rates/1000 persons
sex and age adjusted

**CESAR**
October 2009
Intercept change p 0.32
Slope change p 0.28

**ARF**

**ARDS**

<table>
<thead>
<tr>
<th>Strength of Evidence</th>
<th>Risk/Benefit</th>
<th>Modality and Medium Of Delivery</th>
<th>Alternatives Cost Availability</th>
<th>Physician Preferences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physiologic Rationale</td>
<td>High risks (non expert ctrs) Perceived Benefit</td>
<td>Lots of Associated Press, H1N1</td>
<td>Yes (Alternatives) Costs (High) Not always available</td>
<td>Instant Physiologic Gratification, Rescue, Anecdotal</td>
</tr>
</tbody>
</table>
iPV Rates/1000 persons
sex and age adjusted

ARF

“ARDS”

p < 0.001
iNO Rates/1000 persons
sex and age adjusted

ARF

“ARDS”

COCHRANE Rev
June 2010
Intercept change p 0.32
Slope change p 0.28

p = 0.51

p = 0.56

Strength of Evidence
Risk/Benefit
Modality and Medium Of Delivery
Alternatives Costs Availability
Physician Preferences

Good
High (renal failure)
Persistent Clear Message
?? Center Dependent High Cost
Instant Gratification Physiologic Benefit Rescue
cNMBA Rates/1000 persons
sex and age adjusted

ACURASYS
September 2010
Intercept change p 0.74
Slope change p 0.57

p 0.29

Absence of Adoption:
1. Early adoption pre-time period
2. Slow adoption

Strength of Evidence | Risk/Benefit | Modality and Medium Of Delivery | Alternatives Costs Availability | Physician Preferences
--- | --- | --- | --- | ---
Debated (why mortality benefit) | Low risk? | Not a lot of associated press | Yes Low Costs Available | Delayed gratification
HFO Rates/1000 persons
sex and age adjusted

ARF
OSCILLATE
February 2013
No cases after October 2012

“ARDS”

Strength of Evidence
Risk/Benefit
Modality and Medium Of Delivery
Alternatives
Physician Preferences

Strong
High risk
Strong (multiple papers)
Yes

Experience? Esthetics?
IMPLICATIONS

• Adoption and De-adoption Art vs. Science

• Variability between Critical Care and Other Specialities:
  • Characteristics of underlying condition (MI vs. ARDS)
  • Characteristics of innovation or intervention (ASA vs LPV)
  • Quality of evidence (1M vs. 1T person trials)/Delivery
  • Consistency of evidence over time or over jurisdictions

• Ideally evaluate practices at a population-based level

• Particularly challenging in ARDS

• Even more challenging when evaluating therapies that are used infrequently and challenging to identify
CONCLUSIONS

Changes in use do not necessarily follow what evidence may suggest

evidence $\neq$ recommended best practice $\neq$ bedside medicine

The more inconsistent the evidence, the greater role the additional factors play in adoption/de-adoption – particularly true for ARDS

Questions:
Are these patterns of adoption/de-adoption similar across countries?
Teaching vs. non-teaching centers
Rescue vs. non-rescue interventions
Evidence
Acknowledgements

Dr. Gordon Rubenfeld
Dr. Eddy Fan
Dr. Hannah Wunsch
Dr. Niall Ferguson
Dr. Hayley Gershengorn
Dr. Therese Stukel

Clinician Scientist Training Program Department of Medicine
Canadian Institute for Health Research Fellowship
Thank You.