

Prospective, Randomized, Multi-center Trial of Initial Trophic Enteral Feeding Followed by Advancement to Full-Calorie Enteral Feeding vs. Early Advancement to Full-Calorie Enteral Feeding in Patients with Acute Lung Injury (ALI) or Acute Respiratory Distress Syndrome (ARDS)

**ARDS Clinical Network
Protocol Version III**

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TABLE OF CONTENTS

ABBREVIATIONS	6
PART I	7
STUDY SUMMARY	7
PART II	10
STUDY DESCRIPTION.....	10
1 BACKGROUND	10
1.1 INFLAMMATION IN ALI/ ARDS	11
1.2 ENTERAL NUTRITION IN CRITICAL ILLNESS.....	11
1.3 TIMING OF ENTERAL NUTRITION	11
1.4 VOLUME OF ENTERAL NUTRITION AND TROPHIC FEEDS.....	13
1.5 SUMMARY OF ENTERAL NUTRITION	14
1.6 OXIDATIVE STRESS AND ARDS	14
1.7 CALORIC RESTRICTION, ENERGY EXPENDITURE, AND OXIDATIVE STRESS	15
1.8 MEASUREMENT OF LONG TERM OUTCOMES AND ACUTE LUNG INJURY	15
2 OBJECTIVES	16
2.1 PRIMARY OBJECTIVES	16
2.2 SECONDARY OBJECTIVES	16
2.3 PRIMARY HYPOTHESES.....	16
2.4 SECONDARY HYPOTHESES	16
3 END POINTS	17
3.1 PRIMARY ENDPOINT	17
3.2 SECONDARY ENDPOINTS	17
3.3 OTHER ENDPOINTS	18
4 STUDY POPULATION AND ENROLLMENT	19
4.1 NUMBER/SOURCE/SCREENING.....	19
4.2 INCLUSION CRITERIA	19
4.3 EXCLUSION CRITERIA.....	20
4.4 ENROLLMENT, RANDOMIZATION, AND STUDY INITIATION TIME WINDOW	21
4.5 INFORMED CONSENT.....	21

4.6	RANDOMIZATION	21
4.7	MINORITIES AND WOMEN AND CHILDREN	22
5	STUDY PROCEDURES	22
5.1	ENTERAL FEEDING PROCEDURES.....	22
5.1.1	<i>Enteral Feeding Formula</i>	22
5.1.2	<i>Enteral Feeding Site</i>	22
5.1.3	<i>Enteral Feeding Rates</i>	22
5.1.4	<i>Gastric Residuals</i>	23
5.1.5	<i>Patient Position</i>	24
5.1.6	<i>Holding or Interrupting Enteral Feeds</i>	24
5.1.7	<i>Gastrointestinal Intolerances</i>	25
5.1.8	<i>Completion of Enteral Feeding Procedures</i>	27
5.1.9	<i>Premature Withdrawal from Treatment</i>	27
5.5	GLUCOSE CONTROL	27
5.6	VENTILATOR PROCEDURES	27
5.7	ON-STUDY FLUID MANAGEMENT.....	28
5.8	PROCEDURES AFTER RE-INTUBATION	28
6	DATA COLLECTION	28
6.1	BACKGROUND ASSESSMENTS	28
6.2	BASELINE ASSESSMENTS.....	28
6.3	ASSESSMENTS DURING STUDY	29
6.4	ASSESSMENTS AFTER HOSPITALIZATION	31
6.5	OTHER DATA COLLECTED.....	32
6.6	ENDPOINT DETERMINATIONS	33
7	STATISTICAL CONSIDERATIONS	33
	PRIMARY ENDPOINT DAVID: PLEASE COMMENT ON THE LACK OF AN INTERACTION WITH THE OMEGA FACTORIAL. SEE SECTION 4.1 WHERE WE ADDED SENTENCE TO DESCRIBE.	33
	SECONDARY ENDPOINTS.....	35
8	DATA COLLECTION AND SITE MONITORING	36
8.1	DATA COLLECTION.....	36
8.2	SITE MONITORING	36

9 RISK ASSESSMENT	36
9.1 RISKS OF ENTERAL FEEDINGS	37
9.2 RISKS OF FULL-CALORIE ENTERAL FEEDINGS	37
9.3 RISKS OF TROPHIC ENTERAL FEEDINGS	37
9.4 RISKS OF BLOOD DRAWS.....	37
9.5 RISK OF DEATH	37
9.6 MINIMIZATION OF RISKS	37
9.7 POTENTIAL BENEFITS	38
9.8 RISKS IN RELATION TO ANTICIPATED BENEFITS	38
10 HUMAN SUBJECTS.....	38
10.1 SELECTION OF SUBJECTS	39
<i>10.1.1 Equitable Selection of Subjects.....</i>	<i>39</i>
10.2 INFORMED CONSENT	39
10.3 CONTINUING CONSENT	39
10.4 IDENTIFICATION OF SURROGATES	40
10.5 JUSTIFICATION OF SURROGATE CONSENT	40
10.6 ADDITIONAL SAFEGUARDS FOR VULNERABLE SUBJECTS	41
10.7 CONFIDENTIALITY	41
11 ADVERSE EVENT REPORTING.....	41
11.1 CLINICAL OUTCOMES	42
11.2 ADVERSE EVENT REPORTING TIMELINE	43
APPENDICES.....	44
<i>A Identification of Ventilator-Associated Pneumonia.....</i>	<i>44</i>
<i>B Exclusion Definitions</i>	<i>45</i>
<i>C Trophic Feeding Protocol</i>	<i>47</i>
<i>D Full-calorie Feeding Protocol.....</i>	<i>48</i>
<i>E Time-Events Schedule</i>	<i>49</i>
<i>F Adverse Events</i>	<i>50</i>
<i>G Ventilator Procedures.....</i>	<i>52</i>
<i>H Conservative Fluid Management Approach</i>	<i>56</i>
<i>I Genetic Testing</i>	<i>57</i>
<i>J De-identified Data Elements for Screened, Non-Enrolled Subjects</i>	<i>58</i>

K Long Term Outcomes 59
L. Data and Safety Monitoring Board..... 64
M. AUDIT Questionnaire 65
REFERENCES..... 65
REFERENCES..... 66

ABBREVIATIONS

ALI = Acute Lung Injury
ARDS = Acute Respiratory Distress Syndrome
BMI = Body Mass Index
BUN = Blood Urea Nitrogen
CHF = Congestive Heart Failure
CPAP = Continuous Positive Airway Pressure
CPR = Cardiopulmonary resuscitation
CT = Computed Tomography
DBP = Diastolic Blood Pressure
DSMB = Data Safety Monitoring Board
FACTT = Fluid and Catheter Treatment Trial
FiO₂ = Fraction of Inspired Oxygen
GCS = Glasgow Coma Scale
GRV = Gastric Residual Volume
Home = Type of residence immediately prior to study hospitalization
ICU = Intensive Care Unit
IgA = Immunoglobulin A
IL-1 = Interleukin 1
IL-6 = Interleukin 6
IL-8 = Interleukin 8
IL-10 = Interleukin 10
IMV = Intermittent Mechanical Ventilation
INR = International Normalized Ratio
IVRS = Interactive Voice Response System
LTB₄ = Leukotriene B₄
mBW = measured body weight

NAC = N-acetylcysteine
NHLBI = National Heart Lung and Blood Institute
OR = Odds Ratio
PaCO₂ = Partial pressure of arterial carbon dioxide
PAI -1 = Plasminogen Activator Inhibitor 1
PaO₂ = Partial pressure of arterial oxygen
PAP = Pulmonary Artery Pressure
PB = Barometric Pressure
PBW = Predicted Body Weight
PCP = *Pneumocystis carinii* pneumonia
PEEP = Positive End-Expiratory Pressure
PEG = Percutaneous Endoscopic Gastrostomy
PIN = Personal Identification Number
Pplat = Plateau pressure
PS = Pressure Support Ventilation
ROS = Reactive Oxygen Species
SBP = Systolic Blood Pressure
SBT = Spontaneous Breathing Trial
SpO₂ = Oxygen Saturation
TNF = Tumor Necrosis Factor
TPN = Total Parenteral Nutrition
TxA₂ = Thromboxane A₂
VAP = Ventilator-associated Pneumonia
VFD = Ventilator-free Days
WBC = White Blood Cell

Part I

Study Summary

- **Titles:** Prospective, Randomized, Multi-center Trial of Initial Trophic Enteral Feeding Followed by Advancement to Full-calorie Enteral Feeding vs. Early Advancement to Full-calorie Enteral Feeding in Patients with Acute Lung Injury (ALI) or Acute Respiratory Distress Syndrome (ARDS)

- **Objectives:**
 1. To assess the safety and efficacy of initial trophic enteral feeding followed by advancement to full-calorie enteral feeding vs. initial advancement to full-calorie enteral feeding management strategies in reducing mortality and morbidity in patients with ALI or ARDS

- **Hypotheses:**
 1. Initial trophic feeding followed by full-calorie enteral feeding will improve clinical outcomes (specifically increase the number of ventilator-free days to day 28 and decrease the 60-day, hospital mortality) in patients with ALI or ARDS by reducing systemic inflammation and the number of feeding complications as compared to early, full-calorie enteral feeding.

- **Study Design:** Multi-center, prospective, randomized, controlled clinical trials.
 1. A maximum of 1000 patients will be enrolled.
 2. Patients randomized to trophic enteral feeds will receive trophic feeding rates (20 kcal / hr) for 144 hours prior to being advanced to full-calorie feeding rates which will continue for the duration of mechanical ventilation up to study day 28.
 3. Patients randomized to full-calorie enteral feeds will be advanced to full-calorie feeding rates on initiation of feeding and will continue to receive full-calorie feeds for the duration of mechanical ventilation up to study day 28.
 4. Patients will be followed to the earlier of 60 days or hospital discharge. In addition, vital status will be ascertained at 90 days.

- **Sample Size/Interim Monitoring:**
 - 1 This study compares the use of initial trophic enteral feeds followed by advancement to full-calorie enteral feeds versus initial full-calorie feeds in patients with ALI or ARDS. The trial will accrue a maximum of 1000 patients providing about 500 patients treated initially with trophic enteral feeds to be compared against about 500 patients treated initially with full-calorie enteral feeds. This provides 90 % power to detect an absolute difference of 2.25 ventilator-free days assuming a mean of 14 and standard deviation of 10.5 ventilator-free days (data from FACTT study) using a two sided $p = 0.05$ significance level.

- 2 The principal analysis will be intent-to-treat, based upon randomization assignment.
- 3 Trial progress will be evaluated by an independent Data and Safety Monitoring Board to determine if the study should stop for futility or efficacy. Interim analyses will be conducted after enrollment of approximately 100, 250, 500, and 750 patients. The study may be stopped if the difference between the numbers of ventilator-free days for the two treatments is greater than the O'Brien-Fleming boundary.
- 4 The DSMB will also monitor the trial for feasibility. Feasibility parameters will include accrual, the ability to follow the enteral nutrition and ventilator protocols, separation of the enteral feeding groups based on volume delivered data. If any of these parameters indicate that the trial is not feasible, the trial will be modified or terminated.
- 5 The trial will also be monitored by the DSMB for safety. Safety parameters will include mortality, vital sign and laboratory data, and adverse event reporting. If any of these parameters indicate to the DSMB that either of the interventions is not safe, the intervention will be modified or terminated.

- **Inclusion Criteria**

Patients will be eligible for inclusion if they meet all of the below criteria. Criteria 1-3 must all be present within a 24-hour time period:

Acute onset (defined below) of:

1. $\text{PaO}_2 / \text{FiO}_2 \leq 300$ (intubated). If altitude $> 1000\text{m}$, then $\text{PaO}_2 / \text{FiO}_2 \leq 300 \times (\text{PB}/760)$
2. Bilateral infiltrates consistent with pulmonary edema on frontal chest radiograph. The infiltrates may be patchy, diffuse, homogeneous, or asymmetric
3. Requirement for positive pressure ventilation via endotracheal tube, and
4. No clinical evidence of left -sided cardiac failure to account for bilateral pulmonary infiltrates.
5. Intention of primary medical team to enterally feed the patient

The 48-hour enrollment time window begins when criteria 1-3 are met. If a patient meets the first three inclusion criteria but has a PAOP (Pulmonary Arterial Wedge Pressure) greater than 18 mmHg, then the first four criteria must persist for more than 12 hours after the PAOP has declined to ≤ 18 mmHg, and still be within the 48-hour enrollment window.

“Acute onset” is defined as follows: the duration of the hypoxemia criterion (#1) and the chest radiograph criterion (#2) must be ≤ 28 days at the time of randomization. Opacities considered “consistent with pulmonary edema” include any opacities not fully explained by mass, atelectasis, or effusion or opacities known to be chronic (greater than 28 days). Vascular redistribution, indistinct vessels, and indistinct heart

borders alone are not considered “consistent with pulmonary edema” and thus would not count as qualifying opacities for this study.

- **Exclusion Criteria**

1. Age younger than 13 years
2. Greater than 48 hours since all inclusion criteria met
3. Neuromuscular disease that impairs ability to ventilate without assistance, such as cervical spinal cord injury at level C5 or higher, amyotrophic lateral sclerosis, Guillain-Barré Syndrome, or myasthenia gravis (see Appendix B)
4. Pregnant or breast-feeding
5. Severe chronic respiratory disease (see Appendix B for detailed exclusion criteria).
6. Burns greater than 40% total body surface area
7. Malignancy or other irreversible disease or condition for which 6-month mortality is estimated to be greater than 50% (see Appendix B).
8. Allogeneic bone marrow transplant in the last 5 years
9. Patient, surrogate, or physician not committed to full support (Exception: a patient will not be excluded if he/she would receive all supportive care except for attempts at resuscitation from cardiac arrest).
10. Severe chronic liver disease (Child-Pugh Score of 11-15)
11. Diffuse alveolar hemorrhage from vasculitis.
12. Morbid obesity (> 1kg/cm body weight)
13. No consent/inability to obtain consent
14. Unwillingness or inability to utilize the ARDS network 6 ml / kg PBW ventilation protocol
15. Moribund patient not expected to survive 24 hours
16. No intent to obtain central venous access for monitoring intravascular pressures.
17. > 72 hours since mechanical ventilation initiated
18. Refractory shock (See Appendix B)
19. Unable to obtain enteral access
20. Presence of partial or complete mechanical bowel obstruction, or ischemia, or infarction
21. Current TPN use or intent to use TPN within 7 days
22. Severe malnutrition with BMI < 18.5 or loss of > 30% total body weight in the previous 6 months
23. Laparotomy expected within 7 days
24. Unable to raise head of bed 30-45 degrees
25. Short-bowel syndrome or absence of gastrointestinal tract
26. Presence of high-output (> 500 cc/day) enterocutaneous fistula
27. Allergy to enteral formula.
28. Requirement for, or physician insistence on, enteral formula supplemented with omega-3 fatty acids (ex: Oxepa®, Impact®) or providing omega-3 fatty acid or GLA supplementation

- **Enrollment and Study Initiation Time Window:** All patients must be randomized within 48 hours of meeting inclusion criteria and within 72 hours of initiating mechanical

ventilation. The first three inclusion criteria may be met at either the Network or referring hospital. Following randomization, the low tidal volume protocol for mechanical ventilation must be initiated within one hour (if not already being utilized). Enteral feeds and the enteral feeding protocol must be initiated within 6 hours of randomization.

- **Efficacy:** Primary efficacy variable is ventilator-free days to study day 28. Ventilator free days (VFDs): the number of days after initiating unassisted breathing to day 28 after randomization, assuming a patient survives for at least two consecutive calendar days after initiating unassisted breathing and remains free of assisted breathing. This is a composite endpoint reflecting days free of mechanical ventilation to day 28 and mortality. Patients who die before day 28 have zero VFDs.
- **Secondary Efficacy Variables:**
 1. The secondary efficacy variable is mortality before discharge home, with unassisted breathing to day 60. Patients alive in hospital at day 60 will be considered to have survived.
 2. Mortality before hospital discharge home, with unassisted breathing, to day 90. Patients alive in hospital to day 90 will be considered to have survived.
 3. Number of ICU-free days at 28 days after randomization.
 4. Organ-failure free days to study day 28 (renal, hepatic, central nervous system, hematologic, cardiovascular)
 5. Incidence of Ventilator-associated pneumoniaSeveral other efficacy variables will also be analyzed, as outlined in the protocol.

Part II

Study Description

Prospective, Randomized, Multi-center Trial of Initial Trophic Enteral Feeding Followed by Advancement to Full-calorie Enteral Feeding vs. Early Advancement to Full-calorie Enteral Feeding in Patients with Acute Lung Injury (ALI) or Acute Respiratory Distress Syndrome (ARDS)

Protocol for the NIH ARDS Network

1 Background

The following background sections discuss biochemical effects which many hypothesize as possible mechanisms for the results seen in the phase II data presented. The purpose of this study, however, is to determine the effects on clinical outcomes of the proposed intervention.

These changes in clinical outcomes may be the result of the commonly hypothesized mechanisms or may result from other biochemical and/or clinical effects. Many of the proposed secondary outcomes are not meant to definitively establish the underlying mechanisms, but instead will explore biochemical endpoints to provide additional support or generate other hypotheses of how the interventions may result in different clinical outcomes.

1.1 Inflammation in ALI / ARDS

Early ALI/ARDS is pathologically characterized by neutrophilic lung inflammation, increased vascular permeability edema (Bernard, 2005; Ware, 2000) and intra-vascular and alveolar fibrin deposition (Idell, 2003; Abraham, 2000). Abundant evidence indicates the cytokines (e.g. tumor necrosis factor (TNF), and interleukin 8 (IL-8)) and the pro-inflammatory and pro-thrombotic fatty acid derivatives of cyclooxygenase (e.g. TxA_2) and 5-lipoxygenase (e.g. LTB_4) enzyme systems are mediators in the early phase of ALI/ARDS (Caironi, 2005; Gust, 1999; The Acute Respiratory Distress Syndrome Network, 2000). The ARDS network lower tidal volume ventilation trial produced significant clinical benefits, at least in part by reducing the inflammatory cytokine response (Parsons, 2005; The Acute Respiratory Distress Syndrome Network, 2000). It has also been recognized that ALI/ARDS, like severe sepsis, includes an exuberant pro-coagulant response in which fibrin is deposited in small vessels and alveoli (Abraham, 2000; Bernard, 2001; Idell, 2003; Idell, 1989).

1.2 Enteral Nutrition in Critical Illness

Experimental and clinical studies have shown that enteral nutrition has benefits over parenteral nutrition in the critically ill patient. Enteral nutrition has been reported to decrease intestinal bacterial translocation (Runyon, 1994; Wildhaber, 2005), reduce infection rates (Grahm, 1989; Kalfarentzos, 1997; Kudsk, 1992; Moore, F.A., 1992; Moore, F.A., 1989) and preserve gastrointestinal mucosal structure and function (Groos, 1996; Hadfield, 1995) as compared to parenteral nutrition. Clinical studies have shown that these findings translate into better outcomes (Gramlich, 2004; Kalfarentzos, 1997; Kudsk, 1992; Moore, F.A., 1992; Moore, F.A., 1989; Peter, 2005; Taylor, S.J., 1999; Windsor, 1998). However, there is no single standard for enteral nutrition and controversy continues to exist about most aspects of enteral feeding in the critically ill patient.

1.3 Timing of Enteral Nutrition

Recent observational data suggests enteral feeding within 48 hours of initiation of mechanical ventilation is associated with a shorter hospital length of stay and a reduction in mortality in patients with ARDS (Artinian, 2006; Stapleton, 2005). Clinical studies in critically ill surgical patients have reported that beginning enteral feeding early in the ICU and rapidly achieving full-calorie enteral feeding rates decreases infectious complications (Grahm, 1989), shortens hospital stay, decreases hypermetabolism and improves outcomes (Grahm, 1989; Gramlich, 2004; Moore, E.E., 1986; Moore, F.A., 1992; Taylor, S.J., 1999). Unfortunately, these trials were done in narrow sub-populations of critically ill surgical patients, were often not blinded or controlled, did not account for all the enrolled patients, included patients who were not mechanically ventilated, or were confounded by the use of supplemental parenteral nutrition. In addition, the benefits reported in these trials were often not consistently observed. Despite these limitations, these findings have resulted in a recent level II recommendation from the Canadian Clinical Practice

Guidelines to initiate enteral feeds within 24-48 hours of ICU admission in all critically ill patients (Heyland, 2003). However, it is difficult to be confident of the findings or extrapolate the results of these studies to the majority of critically ill patients, especially those mechanically ventilated in the medical intensive care unit. Marik and Zaloga (Marik, 2001) performed a meta-analysis of randomized controlled trials that compared enteral feeding initiated earlier or later than 36 hours of hospital admission or surgery in trauma, head-injured, post-operative, burn, and medical intensive care patients. Their analysis showed a significantly lower risk of infection and shortened length of hospital stay in patients who received early enteral nutrition. However, interpretation was limited because of heterogeneity between studies, and none of the studies of medical ICU patients met the quality criteria for inclusion. No significant difference was found in mortality, although vital status data were available for just 40% of the studies. Furthermore, a large retrospective database review recently found a lower mortality rate in critically ill, non-surgical patients who were fed within 48 hours of initiation of mechanical ventilation compared to those fed after 48 hours (Artinian, 2006). After controlling for all known confounders, the authors found that early enteral feeding was associated with a 20% decrease in ICU mortality and 25% decrease in hospital mortality, despite being independently associated with an increased risk of ventilator-associated pneumonia. Unfortunately, the retrospective nature of the study only allows determination of an association and not a cause and effect relationship.

To further complicate the picture, other clinical studies have shown no benefit to early initiation of enteral nutrition (Eyer, 1993; Ibrahim, 2002; Peck, 2004), and some even a trend towards increased number of infections with early enteral nutrition (Eyer, 1993; Ibrahim, 2002). A quasi-randomized, controlled trial by Ibrahim and colleagues found that early goal enteral feedings in mechanically ventilated medical patients had no effect on mortality, but increased the incidence of ventilator-associated pneumonia, length of ventilation and ICU stay (Ibrahim, 2002). This has caused some investigators to suggest that it is safe and possibly preferable to delay feeding for up to 1 to 2 weeks (Guidelines for the use of parenteral and enteral nutrition in adult and pediatric patients, 2002; Koretz, 1995). Unfortunately, these negative studies are also flawed with enrolling relatively small numbers of patients, lacking randomization, only analyzing a subset of the enrolled patients, or utilizing bolus-feeding techniques, which may increase the risk of aspiration.

Despite some consensus guideline recommendations on the acceptability of delaying enteral feeds (Cerra, 1997; Guidelines for the use of parenteral and enteral nutrition in adult and pediatric patients, 2002; Koretz, 1995), numerous surveys demonstrate clinician acceptance of the importance of early enteral feeding. Most clinicians report a practice of starting enteral nutrition early in the disease course for critically ill patients. Surveys of actual clinical practice, however, demonstrate that this is rarely the case. In most critically ill patients, enteral nutrition is not initiated for 2-4 days after intubation or ICU admission and many times, enteral feeds are advanced slowly to full-calorie rates over another couple of days (Barr, 2004; De Jonghe, 2001; Heyland, 2004; Heyland, 2003; Preiser, 1999; Rice, 2005). Similar practice occurs within the ARDS network sites. In the recently completed FACTT (National Heart, Lung, and Blood Institute Acute Respiratory Distress Syndrome (ARDS) Clinical Trials Network, 2006) study, only 67% of patients were receiving enteral feeds on day 2 and 75% on day 3. For patients still mechanically ventilated on day 7, 13% had never received any enteral nutrition.

1.4 Volume of Enteral Nutrition and Trophic Feeds

In addition to timing, the optimal volume of enteral feedings is also debated. Animal studies demonstrate a trophic effect of low-volume enteral feeding on the intestinal epithelial border. Trophic feeds are generally defined as a small volume of enteral nutrition insufficient for the patient's nutritional needs (usually < 25% of daily nutritional needs), but producing some positive gastrointestinal or systemic benefit (Sondheimer, 2004). Compared to enteral feeding abstinence, trophic feedings maintain intestinal microvilli height and structure, stimulate intestinal secretion of brush border enzymes, endogenous peptides, secretory IgA and bile salts, preserve epithelial cell tight junctions, increase intestinal motility and promote intestinal blood flow (Buchman, 1995; Groos, 1996; Hernandez, 1999). These local effects reduce systemic inflammation by helping prevent translocation of bacteria or bacterial products across the intestinal epithelial barrier and into the circulation (MacFie, 2006). In very low-birth weight infants, minimal enteral nutrition resulted in improved intestinal function and fewer septic complications, ventilator days, and hospital length of stay compared to parenteral nutrition with intestinal abstinence (McClure, 1999; McClure, 2000; McClure, 2002). Despite advocating for early enteral feeds, the Canadian Clinical Practice Guidelines admit the scarcity of data available regarding the optimal volume of early enteral feeds renders making any recommendation impossible (Heyland, 2003). Although the exact volume required to confer these effects in adult humans remains unknown, observational studies in mechanically ventilated patients (many of which did not have ARDS) have found that moderate volumes of feedings are associated with improved clinical outcomes, including lower risk of bloodstream infection (Rubinson, 2004) and lower mortality (Haddad, 2004). Other similarly designed studies have found that low volume feedings are associated with improved outcomes (Dickerson, 2002) in similar populations of critically ill patients. Furthermore, surveys of clinical practice suggest that only 55-75% of daily calories are administered to critically ill patients, even with the use of rigorous protocols (Barr, 2004; De Jonghe, 2001; Heyland, 2004; Heyland, 2003; Rice, 2005; Spain, 1999).

A phase II study comparing early trophic versus early full-calorie enteral feedings in patients requiring mechanical ventilation for at least 72 hours is currently ongoing. Although patients with acute lung injury are included, the study is not restricted to this population. In fact, of the first 100 patients, only 22% had acute lung injury. As a phase II study, the trial is powered to detect differences in biochemical endpoints and large differences in gastrointestinal intolerances, with planned enrollment of 200 patients. The study is progressing well, and an interim analysis evaluating safety, feasibility and separation of treatment arms has been conducted after the first 100 patients have been enrolled. This analysis found that administering trophic and full-calorie feeding rates are both feasible and safe. Patients randomized to the trophic arm received 220 ± 139 cc of enteral feedings per day compared to 950 ± 305 cc for the full-calorie group ($P < 0.001$). These represent 15% and 64% of calculated target feeding rates, respectively. The full-calorie group reaches goal feeding rates on average in 11 hours, with 75% reaching goal rates within 15 hours. Only 4% of the group never reached full-calorie feeding rates. No safety concerns were seen in either group.

The data from these first 100 patients demonstrate that conducting this proposed study is both feasible and safe and have been extremely helpful in informing the proposed ARDS Network design. The final results of this phase II study, however, are unlikely to significantly alter practice or the need for a large, phase III study with important clinical outcomes as endpoints in

patients with acute lung injury for many reasons. Like most single center studies, this study is powered to investigate mechanisms (i.e. effect of trophic and full-calorie enteral feedings on systemic inflammation) and is underpowered to detect significant differences in clinically relevant endpoints, such as mortality. This is especially true for patients with acute lung injury, which represent a subset of the population enrolled in the trial. In addition, administration of enteral feeding volumes in mechanically ventilated patients is widely variable in clinical practice without rigorous data supporting one practice over another. Lacking adequate statistical power to investigate clinical outcomes, the phase II study results will contribute to the argument for one practice, but are unlikely to definitively answer the clinical question. Regardless of which arm of the phase II study ultimately results in better biochemical endpoints, clinicians will desire data on the effects of that feeding practice on important clinical outcomes. Although biochemical endpoints help delineate mechanisms, well-designed, multi-center trials investigating the effects of different volumes of enteral nutrition on clinically important outcomes are needed to direct the standard practice of enteral feeding in patients with acute lung injury. The phase II study, however, has provided important feasibility and safety data and will provide important mechanistic data that will greatly complement the results of the proposed phase III trial.

1.5 Summary of Enteral Nutrition

A significant amount of time and resources are spent attempting to deliver enteral nutrition early in a patient's intensive care unit stay. Although there is general consensus that enteral nutrition is preferred over parenteral nutrition, the optimal timing, composition, and amount of enteral feeding is still unknown. Based on data from small surgical studies, some advocate that early enteral feeding improves outcomes in all critically ill patients, while others caution about interpreting the available data in mechanically ventilated, critically ill medical patients. The literature supports both improved and worsened outcomes when critically ill patients are fed as early as possible in their ICU stay, but no studies focus on patients with ALI/ARDS. There is biologic feasibility for both benefit and harm from early, more aggressive feeding, since more complete nutritional support may be accompanied by increased risk of hyperglycemia, uremia, or aspiration. Current practice is heterogeneous, and the reasons for this are uncertain. Further complicating the issue is the paucity of data on the optimal volume of enteral nutrition, especially early in the critical care course. In this trial, we will compare the clinical outcomes and systemic levels of inflammation of critically ill patients receiving initial trophic enteral feedings for 144 hours followed by advancement to full-calorie enteral feedings versus patients receiving initial full-calorie enteral feedings.

1.6 Oxidative Stress and ARDS

Oxidative stress is elevated with many disease states (Cracowski, 2000; Montuschi, 2000; Wood, 2000), and it is reasonable to postulate that levels of oxidative stress are even higher in illnesses representing more severe perturbations of the disease spectrum. In many critical illnesses, especially ones emanating from infection, macrophages are increased, recruited, and activated. The resultant increase in macrophage oxidative burst is vital in helping to overcome the inflammatory process. In addition, energy expenditure increases in critical illness. Studies have demonstrated that patients with sepsis and septic shock demonstrate elevated levels of oxidant stress (Goode, 1995; Gutteridge, 1999). Furthermore, the acute respiratory distress syndrome, a predominantly neutrophilic inflammatory process, also results in increased levels of oxidative

stress (Carpenter, 1998; Gutteridge, 1999; Schmidt, 2004). Some studies have suggested that levels of oxidative stress, as demonstrated by lipid peroxidation, correlate with worse outcomes in critically ill patients (Cowley, 1996). Studies of anti-oxidant therapy independently in patients with ARDS, however, are limited to trials investigating N-acetylcysteine (NAC). Despite demonstrating improved pulmonary physiology, three moderate-sized clinical trials investigating intravenous NAC failed to demonstrate any benefit in clinical outcomes, including no difference in 30-day or 60-day mortality, ventilator-free days, or ICU-free days (Bernard, 1997; Jepsen, 1992; Suter, 1994). Unfortunately, none of the studies measured changes in markers of oxidative stress. One study combining omega-3 fatty acid and anti-oxidant treatment, however, found normalization of low anti-oxidant levels, but no alteration in measures of oxidative stress (Bernard, 1997; Jepsen, 1992; Nelson, 2003; Suter, 1994).

1.7 Caloric Restriction, Energy Expenditure, and Oxidative Stress

Trophic feedings, as utilized in this proposal, provide an enteral feeding regimen low in calories compared to full-calorie feedings. Caloric restriction (Koubova, 2003) delays the development of a wide spectrum of diseases, including kidney disease, neoplasias, diabetes, and autoimmune diseases, resulting in prolonged survival in multiple species (Fernandes, 1976; Jolly, 2005; Lane, 2001; Sohal, 1996). Although the mechanism of its action remains unknown it has been proposed that caloric restriction reduces oxidative damage generated by ROS produced during respiration (Afanas'ev, 2005; Heilbronn, 2006). Normally about 3% of oxygen consumed is converted to ROS by mitochondria; hence as energy expenditure increases, the ROS burden increases. Likewise, reducing energy expenditure decreases formation of radical generating molecules. Caloric restriction effectively decreases energy expenditure (Heilbronn, 2006), and has been shown to decrease the production of ROS, resulting in less oxidative stress in animal models (Yu, 2005). We hypothesize that caloric restriction and decreasing inflammation through administration of trophic feedings will result in lower levels of oxidative stress.

1.8 Measurement of Long Term Outcomes and Acute Lung Injury

Emerging data indicate that survivors of acute lung injury have substantial disability after recovery from acute lung injury. After hospital discharge, only about one-third return to home and more than one-half reside in skilled nursing facilities or rehabilitation facilities (Rubenfeld, 2005). Up to one year later, most patients have serious deficits in health-related quality of life, functional performance, cognition, and employment (Herridge, 2003; Hopkins, 2005). Mortality and ventilator-free days, which have been the primary outcomes in most clinical trials of treatments for acute lung injury, do not capture these important longer-term decrements (Brower, 2004; Schoenfeld, 2002; The Acute Respiratory Distress Syndrome Network, 2000). Moreover, it has recently become clear that acute lung injury, contrary to previous belief, becomes a chronic, disabling pulmonary condition in many cases (Herridge, 2003). To capture the full impact of any treatment for acute lung injury, longer term outcomes must be assessed.

The effects of treatment for acute lung injury on short term mortality may not capture the full impact of treatment over the longer term. A treatment may have early benefit that is maintained, amplified, or attenuated over a longer time period. For example, an invasive strategy for diagnosing ventilator-associated pneumonia reduced 14 day mortality, but the benefit decreased thereafter and the mortality benefit was lost (Fagon, 2000). In addition, a treatment may improve

mortality but have additional deleterious effects that adversely affect long term outcomes such as health-related quality of life and functional performance. For example, parenteral corticosteroids, which may have some immediate benefit in late-phase ARDS, may have detrimental longer-term effects on muscle function and weakness that lead to impaired physical functioning (Herridge, 2003; Steinberg, 2006). To fully evaluate new therapies for acute lung injury, a broad spectrum of long term outcomes must be ascertained. Moreover, measurement of long-term outcomes is necessary to compare the cost-effectiveness of different strategies for ARDS (Angus, 2001).

2 Objectives

2.1 Primary Objectives

- Evaluate the efficacy and safety of initial trophic enteral feeds followed by advancement to full-calorie enteral feeding vs. initial advancement to full-calorie enteral feeding management strategies on mortality, ventilator-free days, ICU-free days, and organ failure in patients with Acute Lung Injury or Acute Respiratory Distress Syndrome

2.2 Secondary Objectives

To develop and analyze a clinical database of patients enrolled in the clinical trial who are well characterized and followed for 12 months for the purpose of answering questions about the natural history of ARDS and evaluating the effect of different interventions and patterns of supportive care.

2.3 Primary Hypotheses

- Initial trophic feeding followed by full-calorie enteral feeding will increase the number of ventilator-free days to study day 28 in patients with ALI or ARDS by reducing systemic inflammation and the number of feeding complications as compared to early, full-calorie enteral feeding.

2.4 Secondary Hypotheses

- The timing of advancing enteral feeds to full feeding rates will alter plasma IL-6 and IL-8 levels in patients with ALI or ARDS compared to early, full-calorie enteral feeding.
- Initial trophic feeding followed by full-calorie enteral feeding will decrease the incidence of gastrointestinal intolerances (vomiting, aspiration, regurgitation, diarrhea, elevated gastric residual volumes, and abdominal distention and cramping) compared to early, full-calorie enteral feeding.
- Initial trophic feeding followed by full-calorie enteral feeding will decrease the incidence of ventilator-associated pneumonia in patients with ALI or ARDS compared to early, full-calorie enteral feeding.
- Initial trophic feeding followed by full-calorie enteral feeding will decrease the incidence of developing bacteremia in patients with ALI or ARDS compared to early, full-calorie enteral feeding.

3 End Points

Analysis of primary and all secondary endpoints will be conducted on an intention to treat basis. A secondary analysis will be performed looking at patients who achieved greater than 70% of full-calorie feeds for the initial 6 days.

3.1 Primary Endpoint

1. Ventilator-Free Days to study day 28

VFDs is a composite endpoint that is affected by mortality and duration of mechanical ventilation in survivors (Schoenfeld, 2002), which has been chosen as the primary endpoint for a number of reasons. VFDs provide a validated measure of improved lung function, even if overall mortality is only minimally altered. In addition to also possibly altering inflammation, full-calorie feedings may place patients at risk for aspiration, which may result in increased mortality, but will result in fewer ventilator-free days, even in non-fatal cases. Further, VFDs is a measure of a morbidity outcome and it is directly related to “days of assisted ventilation.” However, a trend in one treatment group toward early patient death would likely decrease the number of days of assisted ventilation. This example of decreased days of assisted ventilation is misleading as the treatment group actually had a worse outcome. Measuring ventilator days in survivors would offset the problem of early mortality decreasing ventilator days. However, if a treatment group had a favorable trend towards improved survival, but required additional ventilator days for survival, “average number of ventilator days in survivors” could also be misleading. VFDs represent a measurable outcome that is favorably affected by both shorter duration of assisted ventilation in survivors and lower mortality.

VFD to day 28 is defined as the number of days from the time of initiating unassisted breathing to day 28 after randomization, assuming survival for at least two consecutive calendar days after initiating unassisted breathing and remains free of assisted breathing to day 28. If a patient returns to assisted breathing and subsequently achieves unassisted breathing to day 28, VFD will be counted from the end of the last period of assisted breathing to day 28 unless a period of assisted breathing was less than 24 hours and the purpose of assisted breathing was a surgical procedure. If a patient was receiving assisted breathing at day 27 or dies prior to day 28, VFD will be zero. Patients transferred to another hospital or other health care facility prior to day 28 while still receiving assisted breathing will be followed to assess this efficacy measure. Unassisted breathing is defined as breathing with facemask or nasal prong oxygen (or room air) following extubation, T-tube breathing, breathing with continuous positive airway pressure (CPAP ≤ 5 cm H₂O without PS or IMV assistance), or tracheotomy mask breathing.

3.2 Secondary Endpoints

1. The secondary efficacy variable for the trial is mortality prior to hospital discharge with unassisted breathing. Patients alive in hospital at day 60 will be considered to have survived.

2. Mortality before hospital discharge home, with unassisted breathing, to day 90. Patients alive in hospital to day 90 will be considered to have survived
3. Number of ICU-free days at 28 days after randomization
4. Number of organ failure-free days at 28 days after randomization. Organ failure will be defined by previously validated definitions for renal, circulation, central nervous system, hematologic, and hepatic organ and system failures (Bernard, 1997).

Organ failure is defined as present on any date when the most abnormal vital signs or clinically available lab value meets the definition of clinically significant organ failure according to the Brussels Organ Failure Table. Patients will be followed for development of organ failures to death, hospital discharge or study day 28, whichever comes first. Each day a patient is alive and free of a given clinically significant organ failure will be scored as a failure-free day. Any day that a patient is alive and free of all 5 organ failures will represent days alive and free of all organ failure. Central nervous system dysfunction is evaluated using the Glasgow Coma Scale.

5. Number of days between the day of first meeting criteria for weaning-readiness (see Appendix G, section G.2.) and day 28 after randomization.
6. Mortality and VFDs in patients with pre-randomization $\text{PaO}_2/\text{FiO}_2 \leq 200$.
7. Change in plasma levels of IL-6, IL-8, VWF, SPD, and total protein concentrations from baseline to study day 3.
8. Ventilator free days and mortality prior to hospital discharge with unassisted breathing to day 60 and number of ventilator-free days to day 28 in patients with shock (defined in 2.1.2) at the time of randomization.

3.3 Other Endpoints

Many of these proposed outcomes are not meant to definitively establish the underlying mechanisms, but instead will explore biochemical endpoints to provide additional support or generate other hypotheses of how the interventions may result in different clinical outcomes.

1. Increase of $\text{PaO}_2 / \text{FiO}_2$ ratio on study days 1-7
2. Improvement in Lung Injury Score on study days 1-7
3. Number of gastrointestinal intolerances (aspiration, vomiting, regurgitation, diarrhea, elevated gastric residual volumes, abdominal distention and cramping) on study days 1-7
4. Level of systemic inflammation, as measured by plasma IL-6 and IL-8 levels.
- 5.
6. Measure of oxidative stress on days 3, 6 and 12 compared to baseline as measured by urinary levels of F_2 -isoprostane metabolites
7. Incidence of bacteremia .
8. Incidence of *Clostridium difficile* induced diarrhea.
9. Incidence of ventilator-associated pneumonia
10. Serum levels of markers of nutrition, including albumin and total protein levels between baseline and days 6 and 12.

Clostridium difficile diarrhea will be diagnosed by one or more daily stool specimen positive for cytotoxin assay or enzyme immunoassay. Patients with more than 3 liquid stools totaling more than an estimated 500 ml of stool per day, or those with systemic inflammatory response

syndrome unexplained by other infection, may have up to three daily stool samples sent for *C. difficile* investigation (either cytotoxin assay or enzyme immunoassay).

Bacteremia will only be considered if it develops greater than 24 hours after the initiation of study procedures and is documented with a positive blood culture. The primary medical team, using clinical judgment, will determine when blood cultures are sent. Coagulase negative (or thermo nuclease negative) *Staphylococci* or *Corynebacterium* bacteremia require the isolation of these organisms from at least two blood cultures drawn within 24 hours of each other containing the same organism in order to be deemed significant.

Ventilator-associated pneumonia (VAP) is a difficult diagnosis to make with certainty, especially in patients with underlying ALI or ARDS. However, for the purposes of this trial, an objective definition of VAP will be used in order to standardize the reporting and reduce bias during the first 6 days of enteral feeding given the unblinded administration of enteral feeding volumes. As such, VAP will be defined using the same scoring system as the ARDS network used for the LaSRS study (Calandra, 2005). The scoring system incorporates temperature, leukocyte count, sputum or tracheal aspirate Gram stain and culture, and chest radiograph results. This score will be calculated as available as long as the patient remains ventilated. The certainty of VAP will be graded as either suspected or possible vs. probable using the criteria listed in Appendix A.

4 Study Population and Enrollment

4.1 Number/Source/Screening

The trial will accrue a maximum of 1000 patients over a 3-4 year interval. Approximately 500 patient will be randomized to initial trophic feeding and 500 to initial full calorie feeding. The first 272 patients were enrolled in a 2 x 2 factorial design with an Omega 3 Fatty acid rich medical food versus a control isocaloric medical food. This portion of the trial was stopped by the DSMB for futility.

Patients with ALI or ARDS will be recruited from intensive care units at NIH ARDS Network centers. Study coordinators will visit intensive care units daily to identify potential candidates for enrollment (see inclusion criteria, section 4.2, and exclusion criteria, section 4.3. Permission to approach patients and/or their families will be requested from the attending physicians. All patients meeting the inclusion criteria will be entered on a screening log. If the patient is not enrolled, the screening log will include information explaining why enrollment did not occur (exclusion criteria, attending physician denial, patient refusal, etc. see Appendix L).

4.2 Inclusion Criteria

Patients will be eligible for inclusion if they meet all of the below criteria. Criteria 1-3 must all be present within a 24-hour time period:

Acute onset (defined below) of:

1. $PaO_2 / FiO_2 \leq 300$ (intubated). If altitude > 1000m, then $PaO_2 / FiO_2 \leq 300 \times (PB/760)$

2. Bilateral infiltrates consistent with pulmonary edema on frontal chest radiograph. The infiltrates may be patchy, diffuse, homogeneous, or asymmetric
3. Requirement for positive pressure ventilation via endotracheal tube, and
4. No clinical evidence of left -sided cardiac failure to account for bilateral pulmonary infiltrates.
5. Intention of primary medical team to enterally feed the patient

The 48-hour enrollment time window begins when criteria 1-3 are met. If a patient meets the first three inclusion criteria but has a PAOP (Pulmonary Arterial Wedge Pressure) greater than 18 mmHg, then the first four criteria must persist for more than 12 hours after the PAOP has declined to \leq 18 mmHg, and still be within the 48-hour enrollment window.

“Acute onset” is defined as follows: the duration of the hypoxemia criterion (#1) and the chest radiograph criterion (#2) must be \leq 28 days at the time of randomization. Opacities considered “consistent with pulmonary edema” include any opacities not fully explained by mass, atelectasis, or effusion or opacities known to be chronic (greater than 28 days). Vascular redistribution, indistinct vessels, and indistinct heart borders alone are not considered “consistent with pulmonary edema” and thus would not count as qualifying opacities for this study.

4.3 Exclusion Criteria

1. Age younger than 13 years.
2. Greater than 48 hours all since inclusion criteria met
3. Neuromuscular disease that impairs ability to ventilate with out assistance, such as cervical spinal cord injury at level C5 or higher, amyotrophic lateral sclerosis, Guillain-Barré Syndrome, or myasthenia gravis (See Appendix B)
4. Pregnant or breast-feeding
5. Severe chronic respiratory disease (See Appendix B for detailed exclusion criteria).
6. Burns greater than 40% total body surface area
7. Malignancy or other irreversible disease or condition for which 6-month mortality is estimated to be greater than 50% (See Appendix B).
8. Allogeneic bone marrow transplant within the last 5 years
9. Patient, surrogate, or physician not committed to full support (Exception: a patient will not be excluded if he/she would receive all supportive care except for attempts at resuscitation from cardiac arrest).
10. Severe chronic liver disease (Child-Pugh Score of 11-15)
11. Diffuse alveolar hemorrhage from vasculitis.
12. Morbid obesity ($>$ 1kg/cm body weight)
13. No consent/inability to obtain consent
14. Unwillingness or inability to utilize the ARDS network 6 ml / kg PBW ventilation protocol
15. Moribund patient not expected to survive 24 hours
16. No intent to obtain central venous access for monitoring intravascular pressures.

17. > 72 hours since mechanical ventilation initiated
18. Refractory shock (See Appendix B)
19. Unable to obtain enteral access
20. Presence of partial or complete mechanical bowel obstruction, or ischemia, or infarction
21. Current TPN use or intent to use TPN within 7 days
22. Severe malnutrition with BMI < 18.5 or loss of > 30% total body weight in the previous 6 months
23. Laparotomy expected within 7 days
24. Unable to raise head of bed 30-45 degrees
25. Short-bowel syndrome or absence of gastrointestinal tract
26. Presence of high-output (> 500 cc/day) enterocutaneous fistula
27. Allergy to enteral formula
28. Requirement for, or physician insistence on, enteral formula supplemented with omega-3 fatty acids (ex: Oxepa®, Impact®) or providing omega-3 fatty acid or GLA supplementation

4.4 Enrollment, Randomization, and Study Initiation Time Window

All patients must be randomized within 48 hours of meeting inclusion criteria for ALI (inclusion criteria 1-3) and within 72 hours of initiating mechanical ventilation. The window for randomization will begin at the time of meeting all inclusion criteria and/or the time of documentation of mechanical ventilation, regardless of hospital location. The first three inclusion criteria may be met at either the Network or referring hospital. Following randomization, the low tidal volume protocol for mechanical ventilation must be initiated within one hour (if not already being utilized). Enteral feeds and the enteral feeding protocol must be initiated within 6 hours of randomization.

4.5 Informed Consent

Informed consent will be obtained from each patient or surrogate prior to enrollment in the trial. No study procedures will be done prior to obtaining informed consent.

4.6 Randomization

After obtaining a signed and dated informed consent, the coordinating center will be called and an assignment, in the form of a study ID number, will be made by computer-generated randomization to initial trophic or initial full feedings.

Randomization will be accomplished with a web based randomization system. Each research coordinator will have a unique Personal Identification Number (PIN). The randomization will indicate to study personnel whether the patient is to receive initial trophic or initial full feedings.

The randomization will be stratified by institution, and by shock at study entry to one of the two study arms.

4.7 Minorities and Women and Children

Gender and racial patient subsets were considered by the NHLBI in selecting the Network Centers. The demographic profiles of the Centers selected for the Network show that the aggregate patient population contains representative proportions of minorities and women. Recruitment of minorities and women will be monitored by the Network Coordinating Center. If necessary, additional recruitment efforts will be made at specific centers to ensure that the aggregate patient sample contains appropriate gender and minority subsets.

Children will be enrolled who are 13 years and older. There is general agreement that children in this age range have pathophysiology and outcomes similar to adults with ALI. In addition the study procedures called for in the protocol can be readily carried out safely and effectively in this population.

5 Study Procedures

5.1 Enteral Feeding Procedures

5.1.1 Enteral Feeding Formula

Feedings in both groups will employ a sterile, commercially available standard enteral formula (not supplemented with n-3 fatty acids) used in the ICU. Any formula that does not contain supplemental n-3 fatty acids or anti-oxidants will be acceptable to use. Enteral formulas supplemented with n-3 fatty acids will not be allowed based upon the OMEGA study being stopped for futility. N-3 fatty acid supplementation will not be permitted during the study. The list of formulas that are not allowed includes: Oxepa®, Impact®, Peptamen AF®, Crucial®, Optimental® and Pivot 1.5®.

5.1.2 Enteral Feeding Site

The location and type of enteral feeding tube (nasogastric, nasoenteric, PEG, orogastric, oroenteric, etc.) will not be randomized, but will instead be determined by the patient's primary medical team. The location of the feeding will be documented on the case report form. Consideration should be made for advancing the feeding tube to a post-pyloric position in patients receiving gastric feeds who experience multiple elevated gastric residual volumes (see section 5.1.4) or vomiting (see section 5.1.7.4).

5.1.3 Enteral Feeding Rates

All patients will have enteral feeds started within 6 hours of being enrolled and randomized. Upon admission to the ICU, a full-calorie feeding rate should be determined. The full-calorie feeding rate will be calculated to deliver 25-35 kcal/kg PBW each day (Cerra, 1997). If a formal dietary evaluation is done, the dietary recommendation can be used as an acceptable alternative full-calorie rate.

The following formulas will be utilized to calculate predicted body weight (PBW):

For males: $PBW \text{ (kg)} = 50 + 2.3 [\text{height (inches)} - 60] = 50 + .91 (\text{height (cm)} - 152.4)$

For females: $PBW \text{ (kg)} = 45.5 + 2.3 [\text{height (inches)} - 60] = 45.5 + .91 (\text{height (cm)} - 152.4)$

5.1.3.1 Trophic Enteral Feeding Treatment Group (Trophic Feeding Group)

All patients randomized to trophic enteral feedings will have enteral feeds started at 20 kcal / hr and continued at this rate for 144 hours (see Trophic Feeding Protocol, Appendix C) provided gastric residuals remain at an acceptable level (see Gastric Residuals, section 5.1.4) and provided the patient remains on the ventilator. Thus, patients in the trophic feeding arm will receive 480 kcal, which is approximately 25% of total caloric goals each day. This caloric delivery lies within the range of data from published studies in animals and neonatal humans (Burrin, 2000; McClure, 2000; Ohta, 2003; Omura, 2000; Owens, 2002; Tyson, 2005). After 144 hours of trophic enteral feeds, the feeding rate will be advanced to full-calorie rates using the same protocol as for the full-calorie feeding treatment group (see section 5.1.3.2 and Appendix D) provided the patient remains on the ventilator.

5.1.3.2 Full-calorie Enteral Feeding Treatment Group (Full-calorie Feeding Group)

The full-calorie feeding group will have enteral feeds initiated at 25 cc / hr. If gastric residuals remain at an acceptable level (see Gastric Residuals, section 5.1.4), the feeding rate will be increased by 25 cc / hr every 6 hours until goal rate (as determined by the dietary evaluation if available) is achieved (see Full-calorie Feeding Protocol, Appendix D). This pattern of advancement is similar to advancement rates used in other feeding trials (Adam, 1997; Rice, 2005).

5.1.4 Gastric Residuals

The gastric residual volume (GRV) will be the amount of gastric contents able to be withdrawn from the gastric tube using a 60 cc syringe. If gastric residuals exceed 400 cc (McClave, 2002), the feeding rate will be adjusted according to the full-calorie feeding protocol (see Appendix D). If the patient has a post-pyloric feeding tube, gastric residuals will be measured only if a separate gastric port on the feeding tube or a separate gastric tube is in place. GRV in patients receiving post-pyloric feeding will only be considered significant if they exceed 400 cc and contain tube feeding formula. The aspiration of gastric juice in patients fed through post-pyloric tubes will not be considered gastric residual for the purpose of adjusting tube feeding rates unless it contains enteral formula.

Since a single, isolated, elevated gastric residual has been shown to be a poor predictor of enteral feeding tolerance (Mentec, 2001; Spain, 1999), enteral feeding rates will not be adjusted after a single elevated gastric residual. However, enteral feeding rates will be decreased or held if two or more GRVs are elevated (see Appendix D) as this likely represents impaired gastrointestinal tolerance of enteral feeding (Mentec, 2001; Spain, 1999).

The use of pro-kinetic agents and/or advancing the distal location of the feeding tube to a post-pyloric position should be considered in patients experiencing more than one episode of elevated gastric residual volume.

5.1.4.1 Gastric Residuals -Trophic Feeding Group

GRVs will be checked every 12 hours while patients are receiving trophic feeding rates. If GRV remains less than or equal to 400 cc, GRV will be replaced and tube feeds will continue at 20 kcal / hr (see Appendix C). If GRV exceeds 400 cc, 400 cc of the residual volume will be replaced, tube feeds will continue at 20 kcal / hr and GRV will be rechecked in 2 hours. If GRV remains greater than 400 cc, tube feeds will be held. GRV will be replaced (up to 400 cc) and gastric residual rechecked every 2 hours. Tube feeds will continue to be held until residual volume is less than or equal to 400 cc. Once residual volume is less than or equal to 400 cc, trophic tube feeds will be restarted at a rate of 20 kcal / hr.

When the trophic feeding group is advanced to full-calorie enteral feeds (after 144 hours of trophic feeds), GRVs will be checked according to the full-calorie feeding protocol (see section 5.1.4.2 and Appendix D).

5.1.4.2 Gastric Residuals – Full-calorie Feeding Group

Gastric residuals in the full-calorie feeding group will be checked every 6 to 12 hours according to the full-calorie feeding protocol (see Appendix D). If GRV remains less than or equal to 400 cc, GRV will be replaced tube feeds will be advanced or maintained if already at full-calorie rate. After the first episode of GRV greater than 400 cc, 400 cc of the GRV will be replaced, the feeding rate will be maintained at the current rate and residuals will be rechecked in 2 hours. After the second episode of GRV greater than 400 cc, tube feeds will be held. 400 cc of the GRV will be replaced and rechecked every 2 hours. Tube feeds will continue to be held until gastric residuals are less than 400 cc. Once GRV is less than or equal to 400 cc, GRV will be replaced and tube feeds will be restarted at 25 cc / hr less than the previous rate.

5.1.5 Patient Position

To decrease the risk of aspiration and nosocomial pneumonia, patients will be maintained in the semi-recumbent position (head of bed raised 30-45 degrees) at all times possible (Drakulovic, 1999; Mentec, 2001; Spain, 1999). Exceptions to the semi-recumbent position will include times when tube feeds are turned off because a patient is: having a bedside procedure performed, bathing, or hypotensive requiring flat or reverse Trendelenburg positioning.

5.1.6 Holding or Interrupting Enteral Feeds

Enteral feeds held for less than 30 consecutive minutes will not be considered interrupted, but when held for 30 minutes or more should be reported as interrupted on the case report form.

Enteral feeds should be held for no more than 4 hours prior to procedures, including surgical procedures in the operating room, and in anticipation of extubation. Alternatively, feedings can be continued up to the time of the procedure or extubation and the gastric volume, including enteral feeds, can be removed using manual suction through a 60 cc syringe. Post-procedure, or if patient deemed not ready for extubation, feedings should be restarted at the prior rate.

If enteral feeding is stopped for any reason other than gastrointestinal intolerance (see Gastrointestinal Intolerances, Section 5.1.7), then tube feeds are to be restarted at prior rate.

5.1.7 Gastrointestinal Intolerances

The action taken if a patient has one of the following gastrointestinal intolerances will be standardized. However, the patient's primary medical team will determine whether or not the patient fulfills the criteria for meeting the definition of the specific gastrointestinal intolerance.

5.1.7.1 Abdominal Distention/Cramping

Abdominal distention or cramping is defined as the presence of a tense abdomen, rigidity, guarding or rebound on exam.

For patients receiving trophic feeds, enteral feeds will be held for abdominal cramping or distention. Enteral feeding will be resumed at 20 kcal / hr in this group after 6 hours or improvement of distention or cramping, whichever occurs first.

When abdominal distention or cramping occurs in patients randomized to full-calorie feeding rates, the enteral feeding rate will be decreased by 25 cc / hr to a minimum rate of 10 cc / hr. The abdomen will be re-evaluated 6 hours later. If the distention or cramping is improved, the enteral feeds will be advanced to full-calorie rates per the full-calorie feeding protocol as long as GRVs are acceptable (see Appendix D). If, after 6 hours, the abdominal distention or cramping is not improved, then enteral feeding will be held and resumed at the 25 cc less/ hr rate after 6 additional hours or improvement of the abdominal distention or cramping, which ever occurs first.

5.1.7.2 Aspiration

Aspiration is defined as the presence of food in the lungs. This will be determined by the primary medical team, but will include visualization of enteral feeds in the endotracheal tube or enteral formula suctioned from the endotracheal tube.

When aspiration occurs, the tube will be checked to confirm that it terminates in the correct location (gastric or post-pyloric). The manner in which the tube position is confirmed will be determined by the primary medical team, but will include either auscultation of air forced through the tube or obtaining a radiographic study. If the feeding tube terminates in the esophagus, it should be repositioned and tube feeds restarted at 25 cc / hr less than the previous rate (minimum of 10 cc / hr) for the full-calorie feeding group and 20 kcal / hr for the trophic feeding group. If the feeding tube terminates distal to the esophagus, enteral feeds will be held for 6 hours. After 6 hours, enteral feeds will be restarted at 25 cc / hr less than the previous rate (minimum of 10 cc / hr) for the full-calorie feeding group and 20 kcal / hr for the trophic feeding group.

5.1.7.3 Regurgitation

Regurgitation is defined as the presence of enteral feeds in the oropharynx or nasopharynx on routine oral care.

When regurgitation occurs, the tube will be checked to confirm that it terminates in the correct location (gastric or post-pyloric). The manner in which the tube position is confirmed will be determined by the primary medical team, but will include either auscultation of air forced

through the tube or obtaining a radiographic study. If the feeding tube terminates proximal to the stomach, it will be repositioned and enteral feedings will continue at the previous rate. If the tube is in the correct position (i.e. gastric or post-pyloric), a GRV will be checked. If the GRV is greater than 400 cc, the enteral feeds will be held for 6 hours. After 6 hours, the enteral feeds will be restarted at 25 cc / hr less than the previous rate (minimum of 10 cc / hr) for the full-calorie feeding group and 20 kcal / hr for the trophic feeding group. If the gastric residual is less than 400 cc, the residual will be replaced and the enteral feeds will continue at the current rate.

5.1.7.4 Vomiting

Vomiting is defined as the forceful expulsion of gastric contents from the oropharynx or nasopharynx.

When vomiting occurs, enteral feeds will be held for 6 hours. Six hours after the last episode of vomiting, enteral feeds will be restarted at 25 cc / hr less than the previous rate (minimum of 10 cc / hr) for the full-calorie feeding group, and 20 kcal / hr for the trophic feeding group.

The use of pro-kinetic agents and/or advancing the distal location of the feeding tube to a post-pyloric position should be considered in patients who experience vomiting.

5.1.7.5 Diarrhea

Diarrhea is defined as more than 3 liquid bowel movements totaling more than an estimated 500 cc in a 24-hour period.

Since diarrhea is rarely caused solely by enteral feeds (Kandil, 1993), the treatment of diarrhea may include discontinuation of laxatives and/or pro-kinetics, initiation of anti-diarrheals, treatment for *C. difficile* infection, or addition of fiber to the diet. The treatment will be determined by the patient's primary medical team, but will not include decreasing the enteral feeding rate unless the primary medical team feels that the patient's health is at risk because of the severity or nature of the diarrhea.

5.1.7.6 Constipation

Constipation is defined as the absence of a bowel movement requiring a specific intervention (i.e. enema, laxative, disimpaction, etc.) at the discretion of the primary medical team.

The treatment will be determined by the patient's primary medical team, but will not include decreasing the enteral feeding rate unless the primary medical team feels that the patient's health is at risk because of the severity or nature of the constipation.

5.1.7.7 Use of Prokinetic Agents

The use of prokinetic agents, including erythromycin and metoclopramide is not protocolized. Use of these agents will vary between centers and investigators. It is reasonable to administer these agents in a patient who experiences elevated GRV, aspiration, or vomiting, but the final decision is left to the discretion of the primary medical team. The use of prokinetic agents will be prospectively collected on the case report form.

5.1.8 Completion of Enteral Feeding Procedures

Patients will be considered to have completed the study enteral procedures if any of the following conditions occur:

1. Death
2. Hospital discharge
3. Alive 28 days after randomization
4. Extubation or 48 hours of UAB, whichever occurs first (see Definition of Unassisted Breathing, Appendix G)

5.1.9 Premature Withdrawal from Treatment

The feeding protocol will be discontinued in any patient who develops an abdominal process requiring emergent surgical exploration or repair, or an allergy to the enteral feeding formula. Data will continue to be collected prospectively in these patients until day 28 after randomization or hospital discharge, whichever occurs first.

5.5 Glucose Control

As levels of hyperglycemia are likely to vary with different volumes of enteral feeds and can confound the results of this study, glucose control protocols will be utilized to maintain tight control of hyperglycemia in all study patients. Each participating institution will utilize their own standard management, including institution-specific insulin drip protocols, to maintain blood sugars within at least a target range of 80 –150 mg / dL. The use of protocols with tighter ranges of blood sugar control (i.e. 80 – 110 mg / dL) will be allowed at institutions where this is standard practice for the care of critically ill patients. After both the first 100 and 250 patients, the DSMB will evaluate the blood glucose levels for the trophic versus full-calorie feeding groups for the first 6 days of the study. If the blood glucose levels between the two groups are not adequately similar, the tight glucose control requirements may be adjusted in an attempt to make these values similar over the remaining course of the study.

5.6 Ventilator Procedures

Ventilator management, including weaning, will be a simplified version of the 6 ml / kg PBW lung protective ventilation protocol from ARDSNet Study 01 – ARMA (See Appendix G) (The Acute Respiratory Distress Syndrome Network, 2000). If not already being utilized, this low tidal volume protocol for mechanical ventilation must be initiated within one hour of randomization.

Since the time a patient achieves unassisted ventilation affects some secondary endpoints, and because recent evidence-based consensus recommendations have identified a best practice for weaning, a weaning strategy will also be controlled by protocol rules in accordance with these evidence-based recommendations. This will assure similar weaning methods and provide potential benefit to both study groups. This newer weaning strategy is a simplified version of the protocolized weaning strategy used in prior ARDS Network studies (see Appendix G, section G.2.).

5.7 On-Study Fluid Management

Fluid management during shock will be unrestricted. However, in patients not in shock, a conservative fluid approach will be required for all patients enrolled in the study. This conservative fluid management approach will represent a simplification of the algorithm utilized in the ARDS Network FACTT study (see Appendix H). If not already being utilized, this conservative fluid management approach must be initiated within four hours of randomization, and continued until UAB or study day seven, whichever occurs first.

5.8 Procedures After Re-Intubation

In the event patients are extubated but re-intubated within the 28-day treatment period, ventilator and feeding procedures should be resumed and continued through day 28.

6 Data Collection

6.1 Background Assessments

1. Demographic and Admission Data
2. Pertinent Medical History and Physical Examination
3. Height; measured Body Weight (mBW); calculated predicted body weight (PBW); body mass index (BMI)
4. Time on ventilator prior to enrollment
5. Type and location of ICU Admission
 - a. Medical
 - b. Surgical scheduled
 - c. Surgical unscheduled
 - d. Trauma
6. Risk factors for ALI/ARDS (sepsis, aspiration, trauma, pneumonia, drug overdose, other)
7. Presence of following chronic diseases:
 - a. Metastatic cancer (proven by surgery, computed tomographic scan, biopsy or other documented method)
 - b. Hematologic malignancy (ex: lymphoma, acute leukemia, or multiple myeloma)
 - c. AIDS with complications (ex: PCP pneumonia, Kaposi's sarcoma, lymphoma, tuberculosis, or toxoplasmosis).
8. Weight loss in the last 6 months

6.2 Baseline Assessments

The following information will be recorded during the 24-hour interval encompassing the 12 hours prior to randomization and the 12 hours after randomization. If more than one value is

available for this 24-hour period, the value closest to the time of enrollment will be recorded. If no values are available from the 12 hours prior to randomization, then values will be measured during the 12 hours post randomization and prior to initiation of enteral feeds.

1. Vital Signs: heart rate (beats / min), systemic systolic and diastolic BP (mmHg), body temperature ($^{\circ}\text{C}$)
2. Ventilator mode, rate, minute ventilation, tidal volume, FiO_2 , PEEP, plateau, peak, and mean airway pressures
3. Arterial pO_2 , pCO_2 , pH and SpO_2
4. Serum electrolytes, magnesium, phosphorous, BUN, creatinine, bilirubin, and glucose
5. Blood hemoglobin, hematocrit, WBC, and platelets, Prothrombin time (PT)
6. Serum total protein, albumin
7. Glasgow Coma Score
8. Frontal Chest Radiograph – radiographic lung injury score (# of quadrants)
9. Administration of the following medications (Y / N):
 - (a) Sedatives
 - (b) Vasopressors
 - (c) Pro-kinetic agents (cisapride, metoclopramide, lactulose, sorbitol, or erythromycin)
10. Location of feeding tube (orogastric, nasogastric, oro-enteral, naso-enteral, PEG or jejunostomy tube)
11. Presumed site of infection, if sepsis is the etiology of ALI / ARDS
12. APACHE III score
13. Blood for DNA banking (appendix K)
14. Blood for cytokines, mediators, and markers of inflammation. Plasma obtained from two, 10 ml EDTA anti-coagulated blood samples will be divided immediately after centrifugation into 4 equal 2 ml aliquots in specified tubes and frozen at -70°C .
15. Urine for F_2 - isoprostane metabolites. Urine obtained from the patients will be collected in an 8 ml sample tube and divided into 4 equal aliquots in specified tubes and frozen at -70°C .

6.3 Assessments During Study

The following data will provide the basis for assessing protocol compliance and safety as well as between-group differences in several efficacy variables. Data for each of the variables will be recorded on the days shown in the Time-Events schedule (Appendix E) or until death, discharge from the intensive care unit, or unassisted ventilation for 48 hours.

Reference Measurements

The following parameters will be measured and recorded between 4:00 and 10:00 A.M. using the values closest to 8:00 A.M. on the days specified in the Time-Events schedule (Appendix E). The following conditions will be ensured prior to measurements: no endobronchial suctioning

for 10 minutes; no invasive procedures or ventilator changes for 30 minutes. All vascular pressures will be zero-referenced to the mid-axillary line.

1. If receiving positive pressure ventilation:
 - (a) Ventilator mode
 - (b) PEEP level
 - (c) Total minute ventilation
 - (d) Tidal Volume
 - (e) Plateau airway pressures
2. FiO_2
3. PaO_2 , $PaCO_2$, pH, and SpO_2
4. Hemodynamic values
 - (a) Systemic arterial systolic, diastolic and mean blood pressures
 - (b) Heart Rate (beats/min)

Values for the following variables will be recorded for the dates shown in the Time-Events Schedule (Appendix E). If the measurements are not obtained during the 6-hour reference interval (4:00 to 10:00 A.M.), then the value obtained closest in time to the reference interval on the respective date will be recorded. If more than one value is obtained during the reference interval, then the value obtained closest to 8:00 A.M. will be recorded.

5. Blood hemoglobin concentration, white blood cell count, prothrombin time (PT), and platelet count.
6. Serum electrolytes, creatinine, and glucose
7. Units of insulin at time of daily glucose value (infusion) or total insulin in the 6 hours prior to the glucose value (subcutaneous)
8. Serum total protein, albumin, magnesium, phosphorus
9. Requirements for the following medications (Y / N):
 - (a) Sedatives and narcotics
 - (b) Neuromuscular blocking agents
 - (c) Vasopressors
 - (d) Pro-kinetic agents (e.g. metoclopramide, erythromycin, lactulose, or sorbitol)
 - (e) Laxatives and fiber products
 - (f) Anti-diarrheal agents
 - (g) Methylprednisolone equivalents greater than 20 mg
10. Frontal Chest Radiograph – Lung Injury Score
11. Brussels Score data (Bernard, 1997)
 - (a) Worst PaO_2 / FiO_2 ratio for the date.
 - (b) Worst systolic blood pressure for that date
 - (c) Worst creatinine, bilirubin, and platelet count for the date
 - (d) Use of vasopressors
 - (e) Glasgow Coma Score

Consistent with the above ethical sensibilities regarding the participation of decisionally incapable subjects in research and the previous assessment of risks and benefits in the previous section, the present trial presents a balance of risks and potential direct benefits that is *similar* to that available in the clinical setting, with the exception of the additional blood draws.

10.6 Additional Safeguards for Vulnerable Subjects

The present research will involve subjects who might be vulnerable to coercion or undue influence. As required in 45CFR46.111(b), we recommend that additional safeguards be included to protect the rights and welfare of these subjects. Such safeguards might include, but are not limited to: a) assessment of the potential subject's capacity to provide informed consent, b) requirement for subject's assent, c) the availability of the LAR to monitor the subject's subsequent participation and withdrawal from the study; d) augmented consent processes. The specific nature of the additional safeguards will be left to the discretion of the individual IRBs.

Minors (13-18 years old)

This study will enroll minors between the ages of 13-18. As this is a vulnerable population the consent form will include a section for obtaining assent for the minor coupled with permission from a parent for both study enrollment and continuation. The assent for continuation will be invoked when surrogate consent is obtained initially (subject not able to self enroll due to illness). In accordance to the decision matrix provided in 45 CFR 46, Children as subjects of research (<http://www.hhs.gov/ohrp/panels/407-01pnl/riskcat.htm>) we have designed the IRB approved project assent form to require one parental permission signature, as the study is greater than minimal risk with the potential for direct benefit to the subject (46.405).

10.7 Confidentiality

Federal regulations at 45 CFR 46 111 (a) (7) requires that when appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of data. To maintain confidentiality, all laboratory specimens, evaluation forms, and reports will be identified only by a coded number. The coded number will be generated at random by a computer, and only the study investigators will have access to the codes. All records will be kept in a locked, password protected computer. All computer entry and networking programs will be done with coded numbers only. All paper case report forms will be maintained in a locked cabinet inside a locked office. Clinical information will not be released without the written permission of the patient, except as necessary for monitoring by the National Heart, Lung, and Blood Institute, and the ARDS Clinical Coordinating Center.

11 Adverse Event Reporting

Investigators will determine daily if any clinical adverse experiences occur during the period from enrollment through study day 23 or ICU discharge, whichever occurs first. The investigator will evaluate any changes in laboratory values and physical signs and will determine if the change is clinically important and different from what is expected in the course of treatment of patients with ALI or ARDS.

For this trial, a reportable adverse event is defined as:

1. Any clinically important untoward medical occurrence in a patient receiving study solution or undergoing study procedures which is different from what is expected in the clinical course of a patient with ALI, or:
2. Any clinically important, untoward medical occurrence that is thought to be associated with any component of the study solution (i.e. omega-3 fatty acids, gamma-linolenic acid, or anti-oxidants), or nutritional procedures, regardless of the “expectedness” of the event for the course of a patient with ALI.
3. The following protocol specified adverse events should always be reported as adverse events:
 - a. Hypersensitivity to enteral feeds
 - b. Intestinal ischemia or infarction

The investigator will evaluate any changes in laboratory values and physical signs and will determine if the change is clinically important and different from what is expected in the clinical course patients with ALI. *Expected events for ALI* are untoward clinical occurrences that are perceived by the investigator to occur with reasonable frequency in the day to day care of patients with ALI treated in an intensive care unit with mechanical ventilation. Examples of adverse events that are expected in the course of ALI include transient hypoxemia, agitation, delirium, nosocomial infections, intolerance of gastric feeding, skin breakdown, and gastrointestinal bleeding. Such events, which are often the focus of prevention efforts as part of usual ICU care, will not be considered reportable adverse events unless the event is considered by the investigator to be associated with the study drug or procedures, or unexpectedly severe or frequent for an individual patient with ALI. Examples of unexpectedly frequent adverse events would be repeated episodes of unexplained hypoxemia, in contrast to an isolated episode of transient hypoxemia (eg. SpO₂ ~85%), particularly if related to positioning of suctioning. This latter event would not be considered unexpected by nature, severity or frequency.

11.1 Clinical Outcomes

Events leading to death and organ failure are being systematically captured in the case report forms and will be systematically analyzed per protocol as part of the safety and efficacy analysis. The following clinical outcomes will not be considered to be adverse events *if the investigator determines the outcomes were not study solution or procedure-related*:

1. Death
2. Respiratory: worsening hypoxia, prolonged need for ventilation, hypoxemia, hypercarbia, respiratory acidosis, high airway pressures.
3. Circulatory: circulatory shock requiring vasopressors.
4. Hepatic: hepatic injury that leads to a rising bilirubin.
5. Renal: rising creatinine.
6. Coagulopathy: falling platelet count.

In addition, patients with acute lung injury who receive enteral nutrition often experience gastrointestinal intolerances (see Section 5.1.7). These gastrointestinal intolerances, including diarrhea, vomiting, constipation, nausea, and abdominal distention will be systematically collected and analyzed as part of the protocol. As such, they will not be considered to be adverse

events. Similarly, patients with acute lung injury also often have elevated gastric residual volumes, which are also being systematically collected and analyzed as part of the protocol and will not be considered an adverse event.

An event will be considered to be study-related if the event follows a reasonable temporal sequence from the study drug/procedure and could readily have been produced by the study drug/procedure. An event will be considered to be *unexpected for study drug* if it is not identified in the study protocol.

11.2 Adverse Event Reporting Timeline

Investigators will report all serious, and unexpected, and study-related adverse events, as defined in Appendix F, to the Clinical Coordinating Center by telephone, fax, or email within 24 hours. The local Institutional Review Board must also be notified in a timely manner. The investigator will then submit a detailed written report to the Clinical Coordinating Center and the Institutional Review Board no later than 5 days after the investigator discovers the event.

The Clinical Coordinating Center will report all serious, unexpected, and study-related adverse events to the NHLBI within 24 hours. A written report will be sent to the DSMB within 15 calendar days and these reports will be sent to investigators for submission to their respective Institutional Review Boards. The DSMB will also review all adverse events during scheduled interim analyses. The Clinical Coordinating Center will distribute the written summary of the DSMB's periodic review of adverse events to investigators for submission to their respective Institutional Review Boards in accordance with NIH guidelines.

APPENDICES

A Identification of Ventilator-Associated Pneumonia

Suspected or Possible Pneumonia: patient must meet at least one criterion from two categories below (i, ii or iii).

Probable Pneumonia: patient must meet at least one criterion from all three categories below (i and ii and iii).

- i. Chest radiograph shows new infiltrate corresponding in size (although not necessarily to segmental anatomical boundaries) to at least one segment or cavitation with an air-fluid level within an area of infiltrate (*i.e.*, not a simple subpleural air cyst). The qualifying radiographic abnormality must persist over at least 48 hours with no decrease in its size.
- ii. New onset of or increase in fever ($T \geq 38.3^{\circ}\text{C}$ or increase $\geq 1^{\circ}\text{C}$ over the previous 24 hour T_{max} if T already $\geq 38.3^{\circ}\text{C}$) or new hypothermia ($T \leq 36.0^{\circ}\text{C}$) or increase in WBC (WBC $> 10,000$ and a 25% increase or an increase in band forms to $> 10\%$ of total WBC) or new decrease in WBC to $< 4,000$.
- iii. Bacteriological confirmation of pulmonary infection (can be any of the following):
 - quantitative culture of tracheal secretions with $> 10^6$ cfu/mm³
 - quantitative culture of bronchoalveolar lavage with $> 10^4$ cfu/mm³
 - quantitative culture of protected specimen brush with $> 10^3$ cfu/mm³
 - positive Gram stain with $\geq 3+$ of at least one type of bacteria.
 - positive semi-quantitative sputum culture with $\geq 3+$ growth of at least one type of potentially pathogenic bacteria
 - positive blood culture for bacterial pathogen also identified in sputum or other respiratory specimens
 - positive Gram stain or culture of pleural fluid for bacterial pathogen

Only one episode will be considered to be present during the 28-day period for the following due to difficulty in defining successful therapy during this time period.

B Exclusion Definitions

1. Malignant and Irreversible Conditions

- a. Poorly controlled neoplasms (proven by surgery, computed tomographic scan, biopsy or other documented method)
- b. Known HIV positive with known end stage processes (e.g., progressive multifocal leukoencephalopathy, systemic mycobacterium avium infection) with known CD4 count < 50.
- c. Prior cardiac arrest requiring CPR without fully demonstrated neurologic recovery
- d. New York Heart Association Class IV subjects (defined as subjects who have cardiac disease resulting in inability to carry out physical activity without discomfort. Symptoms of cardiac insufficiency or of anginal syndrome may be present even at rest. If any physical activity is undertaken, discomfort is increased).
- e. Chronic respiratory condition making patient respirator dependent.

2. Refractory Shock

Refractory shock is defined as the requirement of any of the following to obtain a blood pressure adequate for perfusion of tissues

- a. Dopamine infusion at rate ≥ 15 mcg / kg / min
- b. Dobutamine infusion at rate ≥ 15 mcg / kg / min
- c. Epinephrine or Norepinephrine infusion at rate ≥ 30 mcg / min
- d. Phenylephrine infusion at rate ≥ 50 mcg / min
- e. Milrinone infusion at rate ≥ 0.5 mcg / kg / min
- f. Vasopressin infusion at rate > 0.04 U / min
- g. Intra-aortic Balloon Pump

3. Child-Pugh Score (Pugh, 1973)

Points	Class
5-6	A
7-9	B
≥ 10	C

Measurement	Numerical Score for Increasing Abnormality		
	1	2	3
Ascites	None	Present	Tense
Encephalopathy	None	Grade I or II	Grade III or IV
Bilirubin (mg/dl)	< 2	2-3	> 3
Albumin (g/L)	> 35	28-35	< 28
Prothrombin time (sec. prolonged)	1-4	4-10	> 10

4. Neuromuscular Disease Impairing the Ability to Ventilate Spontaneously

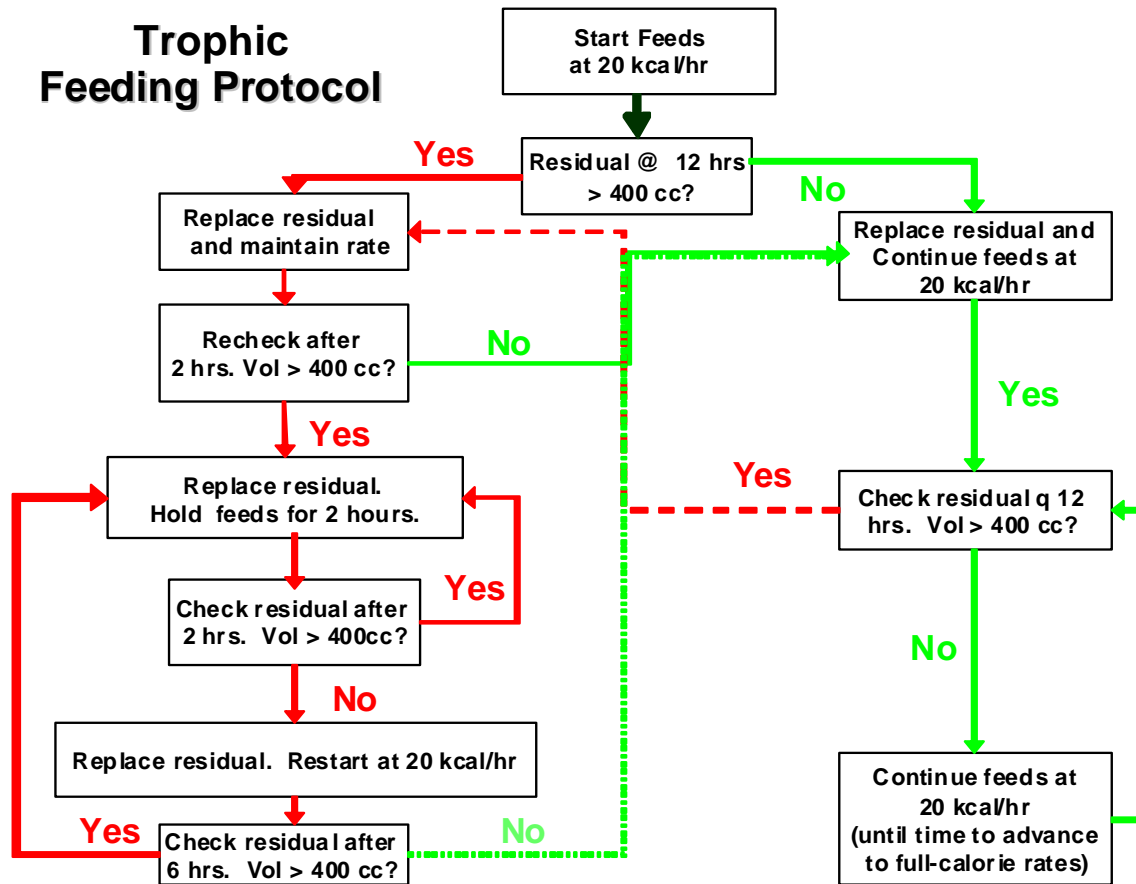
- a. Amyotrophic lateral sclerosis
- b. Guillain-Barré Syndrome
- c. Myasthenia gravis
- d. Upper spinal cord injury at level C5 or above
- e. Kyphoscoliosis or chest wall deformity resulting in severe exercise restriction (unable to climb stairs or perform household duties), secondary polycythemia, or respirator dependence

5. Severe Chronic Respiratory Disease

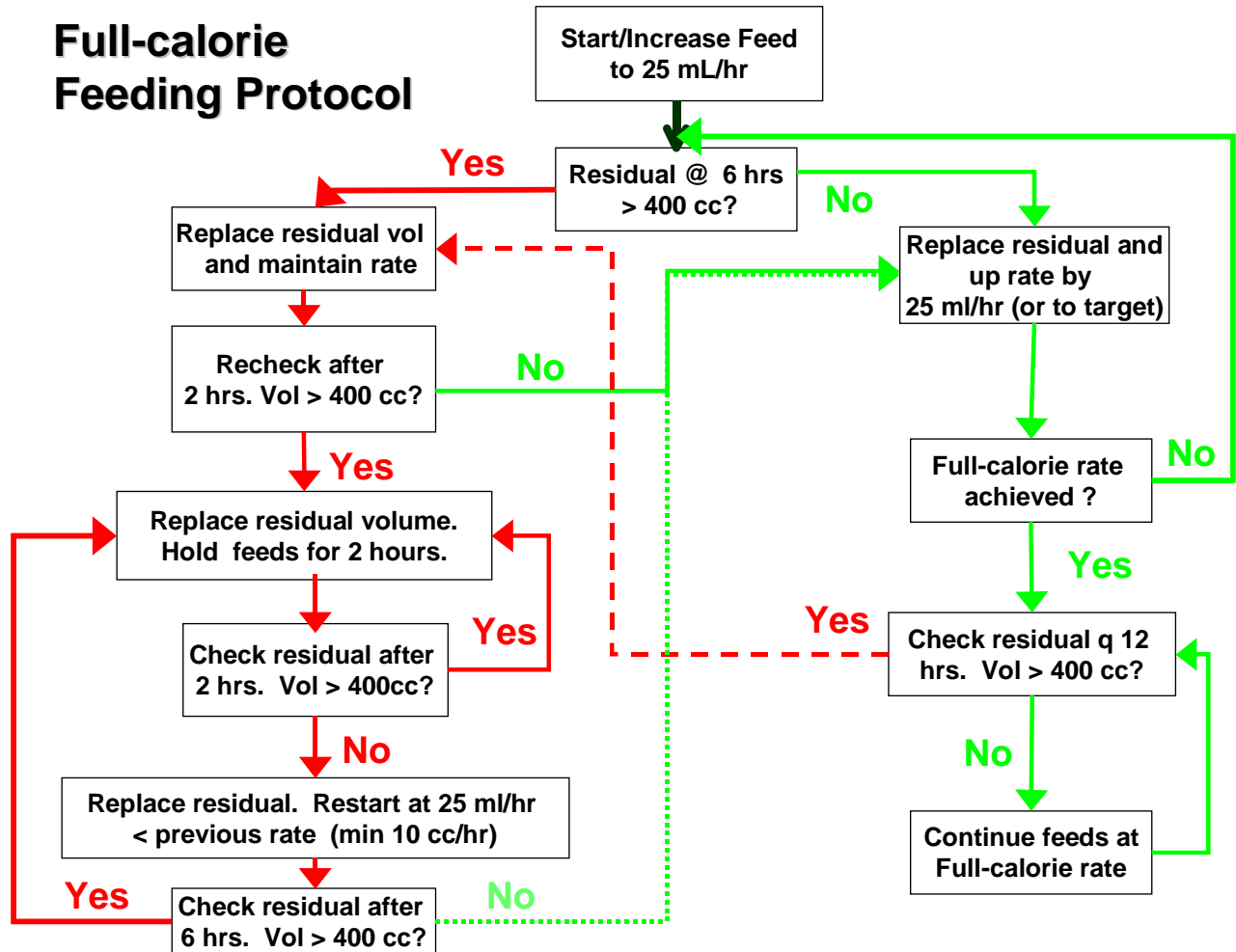
Any of the following is considered severe chronic respiratory disease and excludes a patient from being eligible for enrollment:

1. FEV₁ less than 20 ml/kg PBW (e.g. 1.4 L for a 70 kg person), or
2. FEV₁/VC less than 50% predicted, or
3. Chronic hypercapnia (PaCO₂ greater than 45 mmHg) and/or chronic hypoxemia (PaO₂ less than 55 mmHg) on F₁O₂ = 0.21, or
4. Radiographic x-ray evidence of any chronic over-inflation or chronic interstitial infiltration, or
5. Hospitalization within the past six months for respiratory failure in patients with chronic respiratory disease. (PaCO₂ greater than 50 mmHg or PaO₂ less than 55 mmHg or O₂-Sat < 88% on FiO₂ = .21).
6. Chronic restrictive, obstructive, neuromuscular, chest wall or pulmonary vascular disease resulting in severe exercise restriction, e.g., unable to climb stairs or perform household duties, secondary polycythemia, severe pulmonary hypertension (mean PAP greater than 40 mmHg), or respirator dependency.

C Trophic Feeding Protocol



D Full-calorie Feeding Protocol



E Time-Events Schedule

Measurement/Event	Day 0	1	2	3	4	5	6	7	8	9	10	11	12	14	21	28	60
Demographics, History & Physical, Height, Weight	X																
Etiology of ARDS, site of sepsis if septic etiology	X																
APACHE III Score ^C	X																
HCG (in females)	X																
Vital Signs (HR, SBP, DBP, Temp °C) *	X	X	X	X	X	X	X	X	X	X	X						
Central Venous Pressure *	A	A	A	A	A	A	A	A	A	A	A						
Fluids (In and Out) *	X	X	X	X	X	X	X	X									
Brussels Score ^B ~	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Glasgow Coma Scale	X							X									X**
Ventilator Parameters (including FiO ₂) *#	X	X	X	X	X		X						X		X	X	
Arterial Blood Gases (PaO ₂ , PaCO ₂ , pH) and SpO ₂	X	A	A	A	A		A						A		A	A	
Serum Glucose, Na+, K+, HCO ₃ -, Hgb	X	A	A	A	A	A	A	A	A	A	A	A	A				
Creatinine, Platelets, Bilirubin, BUN Hct,	X																
Chest X-ray (# quadrants for lung injury score)	A	A	A	A	A	A	A	A	A	A	A						
Record Sedatives, narcotics, pressors * (Y/N)	X	X	X	X	X	X	X	X	X	X	X	X	X				
Serum magnesium and phosphorus	X	X	A	X	A	A	A	A	X	A	A	A	A				
Total Protein and Albumin	X	X	A	A	A	A	A	X	A	A	A	A	X				
Ventilator-Associated Pneumonia assessment ^V	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	
Insulin dose at time of glucose level	A	A	A	A	A	A	A	A	A	A	A	A	A				
Location of Feeding tube (e.g., gastric, post-pyloric) *	X	A	A	A	A	A	A	A	A	A	A	A	A				
Volume of tube feeds / Calories delivered *		X	X	X	X	X	X	X	X	X	X	X	X				
Number and type of Gastrointestinal Intolerances *		X	X	X	X	X	X	X	X	X	X	X	X				
Pro-kinetic agents, anti-diarrheals, anti-emetics * (Y/N)	X	X	X	X	X	X	X	X	X	X	X	X	X				
Prothrombin Time	A	A	A	A	A	A	A	A	A	A	A	A	A				
Plasma for Cytokines IL-6 and IL-8	X			X			X						X				
Urine isoprostane metabolites	X			X			X										
Whole blood for DNA	X																
Episode of bacteremia (record positive blood cultures) *		A	A	A	A	A	A	A	A	A	A	A	A	A			
<i>Clostridium difficile</i> diarrhea tests		A	A	A	A	A	A	A	A	A	A	A	A	A			
Vital Status §																X	X

X=Required

A=When available

^C=Labs not available in the 24 hours before randomization must be obtained

^V = VAP assessment from available CXR, sputum culture, gram stain and WBC until extubated or day 28, whichever occurs first

*= Data gathered at times indicated or until 48 hours UAB, whichever occurs first

**=On day 28 or hospital discharge dates.

^B=Records clinically available creatinine, platelets, bilirubin, SBP and vasopressor use

--Data gathered on days 0-28 or until d/c from study hospital

#=Measure during reference period (0600-1000); other values may be obtained closest to 0800 on the specified calendar date

§=Measure at 90 days and 12 months as part of Long Term outcome.

F Adverse Events

1. Procedures for Reporting Adverse Events

Assuring patient safety is an essential component of this protocol. Each participating investigator has primary responsibility for the safety of the individual participants under his or her care. The Principal Investigator will evaluate all adverse events. The Study Coordinator must view patient records for possible adverse events throughout the study period. All adverse events occurring within the study period must be reported in the participants' case report forms.

Investigators will report all *serious, unexpected, and study-related* adverse events to the Clinical Coordinating Center by telephone, fax, or email within 24 hours. The local Institutional Review Board must also be notified in a timely manner. The investigator will then submit a detailed written report to the Clinical Coordinating Center and the local Institutional Review Board no later than 5 days after the investigator discovers the event.

2. Definitions of Adverse Events

A *serious* adverse event is any event that is fatal or immediately life threatening, is permanently disabling, or severely incapacitating, or requires or prolongs inpatient hospitalization. Important medical events that may not result in death, be life threatening, or require hospitalization may be considered serious adverse events when, based upon appropriate medical judgment, they may jeopardize the patient or subject and may require medical or surgical intervention to prevent one of the outcomes listed above.

Life-threatening means that the patient was, in the view of the investigator, at immediate risk of death from the reaction as it occurred. This definition does not include a reaction that, had it occurred in a more serious form, might have caused death. Assessment of the cause of the event has no bearing on the assessment of the event's severity.

An *unexpected* event is any experience not identified by the type, severity, or frequency in the current study protocol or an event that is unexpected in the course of treatment for ALI or ARDS.

Adverse events will be considered to be study-related if the event follows a reasonable temporal sequence from a study procedure and could readily have been produced by the study procedure.

Organ failures related to ALI or ARDS or the patient's underlying condition should not be reported as adverse events *if the investigator determines the outcomes were not study solution or procedure-related* since they are systematically captured by the protocol data collection.

The following protocol-specified events should always be reported as adverse events:

- a. Hypersensitivity to enteral feeds
- b. Intestinal ischemia or infarction

G Ventilator Procedures

G.1 Ventilator Management

A modified, simplified version of the ARDS Network lung protective lower tidal volume strategy will be used in this trial. This strategy, which was associated with unprecedented low mortality rates in three previous ARDS Network trials (ARMA, ALVEOLI, and FACTT), will ensure that study subjects receive the beneficial effects of lung protection as part of their participation in this trial (Brower, 2004; The Acute Respiratory Distress Syndrome Network, 2000). ARDS Network personnel have substantial experience in the application of this protocol from the three completed trials noted above.

1. Any mode of ventilation capable of delivering the prescribed tidal volume (6ml/kg PBW, +/- 2ml/kg) may be used, provided the V_T target is monitored and adjusted appropriately. During APRV, tidal volume is defined as the sum of the volume that results from the ventilator pressure-release and an estimation of the average spontaneous V_T .
2. Tidal Volume (V_t) Goal: 6 ml / kg PBW
Predicted body weight (PBW) is calculated from age, gender, and height (heel to crown) according to the following equations:
Males: $PBW \text{ (kg)} = 50 + 2.3 [\text{height (inches)} - 60]$
Females: $PBW \text{ (kg)} = 45.5 + 2.3 [\text{height (inches)} - 60]$
3. Measure and record inspiratory plateau pressure (Pplat) according to ICU routine (at least every four hours and after changes in V_t and PEEP recommended)
4. If $P_{plat} > 30 \text{ cm H}_2\text{O}$, reduce V_t to 5 ml / kg and then to 4 ml / kg PBW if necessary to decrease P_{plat} to $\leq 30 \text{ cm H}_2\text{O}$.
5. If $V_t < 6 \text{ ml / kg PBW}$ and $P_{plat} < 25 \text{ cm H}_2\text{O}$, raise V_t by 1 ml / kg PBW to a maximum of 6 ml / kg.
6. If "severe dyspnea" (more than 3 double breaths per minute or airway pressure remains at or below PEEP level during inspiration), then raise V_t to 7 or 8 ml / kg PBW if P_{plat} remains below 30 cm H_2O . If P_{plat} exceeds 30 cm H_2O with V_t of 7 or 8 ml / kg PBW, then revert to lower V_t and consider more sedation.
7. If $\text{pH} < 7.15$, V_t may be raised and P_{plat} limit suspended (not required).
8. Oxygenation target: $55 \text{ mmHg} < \text{PaO}_2 < 80 \text{ mm Hg}$ or $88\% < \text{SpO}_2 < 95\%$. When both PaO_2 and SpO_2 are available simultaneously, the PaO_2 criterion will take precedence.
9. Minimum PEEP = 5 cm H_2O
10. Adjust FiO_2 or PEEP upward within 5 minutes of consistent measurements below the oxygenation target range

11. Adjust FiO₂ or PEEP downward within 30 minutes of consistent measurements above the oxygenation target range.
12. There are no requirements for maintaining a specific PEEP to FiO₂ ratio. The lower PEEP / higher FiO₂ table represents a consensus approach developed by ARDS Network investigators in 1995. The higher PEEP / lower FiO₂ table (ALVEOLI) yielded equivalent results in a randomized trial (Brower, 2004) and would be acceptable and perhaps preferable in patients who appear to respond with substantial increase in arterial oxygenation in the transition from lower to higher PEEP.

Lower ELV/Higher FiO₂ Treatment Group

FiO ₂	.30	.40	.40	.50	.50	.60	.70	.70	.70	.80	.90	.90	.90	1.0
PEEP	5	5	8	8	10	10	10	12	14	14	14	16	18	18-24

Higher ELV/Lower FiO₂ Study Group

FiO ₂	.30	.30	.30	.30	.30	.40	.40	.50	.50	.50 – .80	.80	.90	1.0	1.0
PEEP	5	8	10	12	14	14	16	16	18	20	22	22	22	24

(Levels of PEEP in these FiO₂ / PEEP scales represent levels set on the ventilator, not levels of total-PEEP, auto-PEEP, or intrinsic-PEEP.)

13. No specific rules for respiratory rate, but incremental increase in the RR to maximum set rate of 35 if pH < 7.30.
14. No specific rules about I:E. Recommend that duration of Inspiration be ≤ duration of Expiration.
15. Bicarbonate is allowed (neither encouraged nor discouraged) if pH < 7.30.

Changes in more than one ventilator setting driven by measurements of PaO₂, pH, and Pplat may be performed simultaneously, if necessary.

G.2 Weaning

G.2.1 Commencement of Weaning

Patients will be assessed for the following weaning readiness criteria each day between 0600 and 1000. If a patient procedure, test, or other extenuating circumstance prevents assessment for these criteria between 0600 and 1000, then the assessment and initiation of subsequent weaning procedures may be delayed for up to six hours.

- (a) At least 12 hours since enrollment in the trial.
- (b) FiO₂ ≤ 0.40 and PEEP ≤ 8 cm H₂O or FiO₂ ≤ 0.50 and PEEP = 5 cm H₂O
- (c) Values of both PEEP and FiO₂ ≤ values from previous day (comparing Reference Measurement values, section 6.3).
- (d) Not receiving neuromuscular blocking agents and without neuromuscular blockade

- (e) Patient exhibiting inspiratory efforts. If no efforts are evident at baseline, ventilator set rate will be decreased to 50 % of baseline level for up to 5 minutes to detect inspiratory efforts.
- (f) Systolic arterial pressure ≥ 90 mm Hg without vasopressor support (≤ 5 mcg / kg / min dopamine or dobutamine will not be considered a vasopressor).

G.2.2 Spontaneous Breathing Trial Procedure and Assessment for Unassisted Breathing

If criteria a-f above are met, then initiate a trial of up to 120 minutes of spontaneous breathing with $F_{iO_2} \leq 0.5$ using any of the following approaches:

1. Pressure support ≤ 5 cm H₂O, PEEP ≤ 5 cm H₂O
2. CPAP ≤ 5 cm H₂O
3. T-piece
4. Tracheostomy mask

Monitor for tolerance using the following:

1. SpO₂ $\geq 90\%$ and / or PaO₂ ≥ 60 mmHg
2. Mean spontaneous tidal volume ≥ 4 ml / kg PBW (if measured)
3. Respiratory Rate ≤ 35 / min
4. pH ≥ 7.30 (if measured)
5. No respiratory distress (defined as 2 or more of the following):
 - a. Heart rate $\geq 120\%$ of the 0600 rate (≤ 5 min at $> 120\%$ may be tolerated)
 - b. Marked use of accessory muscles
 - c. Abdominal paradox
 - d. Diaphoresis
 - e. Marked subjective dyspnea.

If any of the goals 1-5 are not met, revert to previous ventilator settings or to PS + 10 cm H₂O with Positive End-expiratory Pressure and FiO₂ = previous settings and reassess for weaning the next morning.

The clinical team may decide to change mode of support during spontaneous breathing (PS = 5, CPAP, tracheostomy mask, or T-piece) at any time.

G.2.3 Decision to remove ventilatory support

For intubated patients, if tolerance criteria for spontaneous breathing trial (1-5 above) are

met for at least 30 minutes, the clinical team may decide to extubate. However, the spontaneous breathing trial can continue for up to 120 minutes if tolerance remains in question. If any of criteria 1-5 are not met during unassisted breathing (or 120 minutes has passed without clear tolerance), then the ventilator settings that were in use before the attempt to wean will be restored and the patient will be reassessed for weaning (see section G.2.1) the following day.

G.3 Definition of Unassisted Breathing

- (a) Extubated with face mask, nasal prong oxygen, or room air, OR
- (b) T-tube breathing, OR
- (c) Tracheostomy mask breathing, OR
- (d) CPAP ≤ 5 without PS or IMV assistance

G.4 Completion of Ventilator Procedures

Patients will be considered to have completed the study ventilator procedures if any of the following conditions occur:

- a. Death
- b. Hospital discharge
- c. Alive 28 days after enrollment

If a patient requires positive pressure ventilation after a period of unassisted breathing, the study ventilator procedures will resume unless the patient was discharged from the hospital or > 28 days elapsed since enrollment.

G.5 Removal from the Ventilator Management Protocol

Patients may be removed from the 6 ml / kg tidal volume ventilation requirement if they develop neurologic conditions where hypercapnia would be contraindicated (e.g., intracranial bleeding, GCS ≤ 8 , cerebral edema, mass effect [midline shift on CT scan], papilledema, intracranial pressure monitoring, fixed pupils).

H Conservative Fluid Management Approach

This fluid protocol captures the primary positive outcome of the FACTT trial on increasing ventilator free days. This protocol should be initiated within four hours of randomization in enrolled patients, and continued until UAB or study day 7, whichever occurs first.

1. Discontinue maintenance fluids.
2. Continue medications and nutrition.
3. Manage electrolytes and blood products per usual practice.
4. For shock, use any combination of fluid boluses[#] and vasopressor(s) to achieve MAP \geq 60 mmHg as fast as possible. Wean vasopressors as quickly as tolerated beginning four hours after blood pressure has stabilized.
5. Withhold diuretic therapy in renal failure[§] and until 12 hours after last fluid bolus or vasopressor given.

		MAP \geq 60 mm Hg AND off vasopressors for \geq 12 hours	
		Average urine output < 0.5 ml/kg/hr	Average urine output \geq 0.5 ml/kg/hr
PAOP			
>8	> 12	Furosemide* Reassess in 1 hour	Furosemide* Reassess in 4 hours
4-8	8-12	Give fluid bolus as fast as possible [#] Reassess in 1 hour	No intervention Reassess in 4 hours
< 4	< 8		

§ Renal failure is defined as dialysis dependence, oliguria with serum creatinine > 3mg/dl, or oliguria with serum creatinine 0-3 with urinary indices indicative of acute renal failure.

[#] Recommended fluid bolus= 15 mL / kg crystalloid (round to nearest 250 mL) or 1 Unit packed red cells or 25 grams albumin

* Recommended Furosemide dosing = begin with 20 mg bolus or 3 mg / hr infusion or last known effective dose. Double each subsequent dose until goal achieved (oliguria reversal or intravascular pressure target) or maximum infusion rate of 24 mg / hr or 160 mg bolus reached. Do not exceed 620 mg / day. Also, if patient has heart failure, consider treatment with dobutamine.

I Genetic Testing

Portions of the blood specimens as specified in this protocol will be used for genetic analyses either for beta-receptor polymorphisms as part of an ancillary study, or for future genetic studies of ARDS that are presently undefined. ALI is a complex inflammatory condition of the lungs, and many of the inflammatory pathways thought to be involved in lung injury are associated with genetic polymorphisms. It is likely that there are, as yet undetermined, important gene/environment interactions that impact on clinical outcome. Thus it is important to collect and store DNA from large, carefully described cohorts of patients with ALI to facilitate discovery in this field with the aim to better understand the pathogenesis of ARDS and how treatment may be tailored to individual patient needs.

Genetic analysis will involve, in part, the analysis of genomic DNA and will attempt to link genotypic information to the extensive phenotypic information measured as part of this study. A layered informed consent will be used to obtain the study subjects' consent for genetic testing as follows: 1) consent for genetic studies related to ARDS, or; 2) consent for future studies not necessarily related to ARDS. The level of consent for testing (e.g. none, for ARDS studies, for future studies, or all studies) will be recorded in the Case Report Forms and stored in the Clinical Coordinating Center Data Base. All patients who recover decision-making capacity will be approached for written re-consent for genetic testing.

Two 7.5 ml EDTA plastic monovette tubes will be used to collect up to 10 ml of blood on each patient with consent for genetic testing. Samples will be labeled with pre-printed label with the subjects ARDSNet study number. DNA extraction will be done centrally.

Following extraction, DNA will be sent to a central repository to be stored (as described below). DNA will first be stored the extraction laboratory for seven years and then shipped to the central repository. Random number will identify samples during shipment, extraction, and storage in the central repository. In the future, when approved studies for genetic testing are received at the CCC, the CCC will identify samples that have the necessary level of informed consent for genetic testing. The CCC will then instruct the repository to prepare the appropriate samples for shipment. The key relating the ARDSNet study number to the specimen number will be kept at the CCC in a locked file. The CCC does not record nor store unique patient identifiers (such as initials, date of birth, hospital record numbers, addresses, phone numbers, etc.) in the data base. All data released by the CCC for genetic studies will be linked to the specimen but will be de-identified. The link (key) between the de-identified database and the patient will be removed two years after the primary publication.

Should patients or surrogates revoke their consent for genetic testing, the clinical sites will notify the CCC. The CCC will then contact the repository and request that all samples collected for genetic analysis for that patient be destroyed. Confirmation of destruction of samples will be sent to the CCC and forwarded to the clinical site.

J De-identified Data Elements for Screened, Non-Enrolled Subjects

- Was onset of ALI acute?
- Did frontal CXR show bilateral infiltrates consistent with pulmonary edema?
- Number of quadrants with opacities?
- Is patient intubated?
- PaO₂
- FiO₂
- Was there evidence of left atrial hypertension?
- Month of the year that patient met screening criteria (1-12).
- Gender
- Ethnicity
- Age (if age >89, 89 will be entered for age)
- Patient location (e.g. MICU, SICU, etc.) and if regularly screened
- Reason(s) patient excluded from study.
- If not excluded, not enrolled, why?
- Lung injury category (e.g. sepsis, pneumonia)
- If lung injury category=sepsis, site of infection

K Long Term Outcomes

K.1 Phone Surveys for Survivors from All 12 ARDSNet Study Sites

Table 1 summarizes the proposed measurement instruments and their rationale for each of the outcome domains evaluated in the phone-based assessments of ALI survivors from all ARDSNet study sites. These domains and instruments were determined based on a comprehensive assessment performed by the ARDSNet Long-Term Outcomes Committee and by the investigators for this proposed study.

Table 1. Phone assessments of ALI survivors from all 12 ARDSNet study sites at 6 and 12 months

Outcome Domain	Instrument	Rationale	No. of items; Time Req'd; Scale
Mortality	Custom (date & cause of death)*	- Used in existing long-term ALI study (2)	3 item; <1 min.
Physical function	Functional Performance Inventory - Short Form (FPI-SF)	-Developed in chronic pulmonary patients -Comprehensive, reliable and valid (11;12)	32 items; 5 minutes; Continuous
Mental health			
a) Depression & General Anxiety	Hospital anxiety & depression (HAD) scale (13)	-Most widely used survey in medical patients(14) -Separate subscale for depression & anxiety -Reliable and validated in medical patients (14) -Highly correlated with psychiatric evaluation (13;15)	14 items; 5 minutes (2) Continuous
b) Post-traumatic stress disorder	Impact of Events Scale – Revised (IES-R) (16)	-IES is the most commonly used instrument for assessing PTSD in the ICU (15) -Revised version (IES-R) follows DSM-IV (17) criteria -Reliable and valid (16;18)	22 items; 3 minutes (2) Continuous
Cognitive status	Telephone Mini-Mental State Examination (TMMSE) (19;20)	-MMSE is the most widely used instrument -TMMSE is designed specifically for phone use -Reliable and valid (19;20)	16 items; 5 minutes; Continuous
Health-related quality of life			
a) Generic	1. SF-36 version 2 (21)	-Most widely used instrument, esp in ALI (1-3;6-7) -Reliable and validated in ICU patients (23) -US population norms available (21)	36 items; 6 minutes; Continuous
	2. EQ-5D (EuroQOL) (22)	-Feasible for patients with inattention& fatigue (6;22) -Recommended for use in ICU patients (5) -Provides utility estimate with US norms (24)	6 items; 2 minutes (2) Continuous
b) Fatigue	Functional Assessment of Chronic Illness Therapy (FACIT)	-Designed for patients with chronic illness -Assesses both functional & emotional impact (25;26) -Reliable and validated (27;28)	13 items; 3 minutes (25) Continuous
Return to work	Custom instrument	-Developed & used in large cohort of ALI survivors (2)	12 item; 2 min. Categorical
Health care utilization	University of Toronto ARDS Outcome study instrument (4)	-Developed and used in large longitudinal cohort of ALI survivors (4)	27 items; 8 minutes; Continuous

* Also will be determined from a National Death Index via participant's Social Security Number.

Administration of phone surveys will be centralized at 2 sites: Johns Hopkins and LDS Hospital, where the 2 Principal Investigators are affiliated. Being in different time zones, this 2-site approach will allow flexibility in accessing patients across the US while also concentrating our oversight activities. Manuals of Operations will be used for training, reference and quality assurance review.

NOTES:

(1) Estimated time for completion. This was based on pilot testing, published estimates and the experience of the ARDS Network investigators. The full telephone interview will be piloted prior to implementation.

(2) Return to Work assessment. There are no pre-existing comprehensive survey instruments for measuring return to work and work disability in patients with lung disease. We derived our custom-made instrument from an approach used by one member of the Long-term Outcomes Committee (Dr. Eisner and colleagues) to measure work disability in asthma and COPD.

K.2 Statistical Considerations for Long Term Outcomes

A number of dichotomous and continuous measures of long-term efficacy of the treatment will be analyzed.

Dichotomous measures:

- 1) Survival times will be compared for the treatment arms using log rank test.
- 2) Proportions of patients alive without major disabilities will be compared between the treatment arms using Cochran-Mantel-Haenszel test. Major disability is defined for surviving patients that are prevented from working due to a respiratory condition.
- 3) Proportions of patients alive without disability in activities of daily living (ADL) or instrumental activities of daily living (IADL) will be compared across treatment arms using Cochran-Mantel-Haenszel test. Major disability ADL and IADL are defined based on functional performance inventory for a patient who has at least one activity in the “body care” and “maintaining household” subscales, respectively, that s/he cannot perform at all due to health reasons or does it with much difficulty.

Each of the comparisons will be done based on the data collected at 6 months, and 1-year follow up times.

Continuous measures:

- 1) Primary measure of disability defined by functional performance inventory.
- 2) Eight subscales and two summary measures of the SF-36 instrument
- 3) Depression measure defined by Beck Depression Inventory II
- 4) Cognitive measure

Continuous measures will be analyzed using analysis of variance stratified by the treatment arm.

Each of the comparisons we will be done based on the data collected at 6 months, and at 12 months follow up times. We will compare the raw continuous measures in the groups of

patients available for the follow up. There is a concern that those patients that survive and are contactable to obtain information will potentially belong to different populations for different treatment arms. If true, this will make comparison between the treatment arms no longer randomized. To address this we will compare the treatment arms using survival average causal effect (SACE). This method (Hayden 2005) uses concepts of casual inference by adjusting the estimates of the population parameters based on the model covariates. First the expected probabilities of survival and ability to contact and obtain information from a patient are computed using logistic regression. Then estimates are weighted by these computed survival and contactability to correct for potential differences in the patient populations across treatment arms selected by survival and contactability of patients. The model depends on the assumption that conditional on the values of the covariates the probabilities of a patient surviving and being contactable are independent across treatment arms. The effects of this assumption will be evaluated via a sensitivity analysis.

K.3 Citations for M1 (Choice of survey instruments)

1. Herridge MS, Cheung AM, Tansey CM, Matte-Martyn A, Diaz-Granados N, Al Saidi F, Cooper AB, Guest CB, Mazer CD, Mehta S, Stewart TE, Barr A, Cook D, Slutsky AS. One-year outcomes in survivors of the acute respiratory distress syndrome. *N.Engl.J.Med.* 2003;683-93.
2. Needham DM, Dennison CR, Dowdy DW, Mendez-Tellez PA, Ciesla N, Desai SV, Sevransky J, Shanholtz C, Scharfstein D, Herridge MS, Pronovost PJ. Study protocol: The Improving Care of Acute Lung Injury Patients (ICAP) study. *Crit Care* 2005;R9 <http://ccforum.com/content/10/1/R9>.
3. Hopkins RO, Weaver LK, Collingridge D, Parkinson RB, Chan KJ, Orme JF, Jr. Two-year cognitive, emotional, and quality-of-life outcomes in acute respiratory distress syndrome. *Am.J Respir.Crit Care Med* 2005;340-7.
4. Cheung AM, Tansey CM, Tomlinson G, Diaz-Granados N, Matte A, Barr A, Mehta S, Mazer CD, Guest CB, Stewart TE, Al Saidi F, Cooper AB, Cook D, Slutsky AS, Herridge MS. Two-year outcomes, health care utilization and costs in survivors of the acute respiratory distress syndrome. *American Journal of Respiratory and Critical Care Medicine* 2006;In press.
5. Angus DC, Carlet J. Surviving intensive care: a report from the 2002 Brussels Roundtable. *Intensive Care Med.* 2003;368-77.
6. Dowdy DW, Eid MP, Sedrakyan A, Mendez-Tellez PA, Pronovost PJ, Herridge MS, Needham DM. Quality of life in adult survivors of critical illness: A systematic review of the literature. *Intensive Care Medicine* 2005;611-20.
7. Dowdy DW, Eid MP, Dennison CR, Mendez-Tellez PA, Herridge MS, Guallar E, Pronovost PJ, Needham DM. Quality of life after acute respiratory distress syndrome: a meta-analysis. *Intensive Care Medicine* 2006;1115-24.

8. Leidy NK. Psychometric properties of the functional performance inventory in patients with chronic obstructive pulmonary disease. *Nurs.Res.* 1999;20-8.
9. Leidy NK, Knebel A. Clinical validation of the Functional Performance Inventory in patients with chronic obstructive pulmonary disease. *Respiratory Care* 1999;932-9.
10. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. *Acta Psychiatr.Scand.* 1983;361-70.
11. Herrmann C. International experiences with the Hospital Anxiety and Depression Scale--a review of validation data and clinical results. *J Psychosom.Res.* 1997;17-41.
12. Hayes JA, Black NA, Jenkinson C, Young JD, Rowan KM, Daly K, Ridley S. Outcome measures for adult critical care: a systematic review. *Health Technol.Assess.* 2000;1-111.
13. Weiss DS. The Impact of Event Scale - Revised. In: Wilson JP, Keane TM, eds. *Assessing Psychological Trauma and PTSD: A Practitioner's Handbook.* New York: Guilford Press, 2004;168-189.
14. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders.* Washington, D.C.: American Psychiatric Association, 1994.
15. Horowitz M, Wilner N, Alvarez W. Impact of Event Scale: a measure of subjective stress. *Psychosom.Med* 1979;209-18.
16. Newkirk LA, Kim JM, Thompson JM, Tinklenberg JR, Yesavage JA, Taylor JL. Validation of a 26-point telephone version of the Mini-Mental State Examination. *J Geriatr.Psychiatry Neurol.* 2004;81-7.
17. Roccaforte WH, Burke WJ, Bayer BL, Wengel SP. Validation of a telephone version of the mini-mental state examination. *J Am.Geriatr.Soc.* 1992;697-702.
18. Ware JE, Jr., Kosinski M, Dewey JE. *How to Score Version 2 of the SF-36 Health Survey.* Lincoln, RI: QualityMetric Incorporated, 2000.
19. The EuroQol Group. EuroQol--a new facility for the measurement of health-related quality of life. *Health Policy* 1990;199-208.
20. Chrispin PS, Scotton H, Rogers J, Lloyd D, Ridley SA. Short Form 36 in the intensive care unit: assessment of acceptability, reliability and validity of the questionnaire. *Anaesthesia* 1997;15-23.
21. Shaw JW, Johnson JA, Coons SJ. US valuation of the EQ-5D health states: development and testing of the D1 valuation model. *Medical Care* 2005;203-20.
22. Cella D, Lai JS, Chang CH, Peterman A, Slavin M. Fatigue in cancer patients compared with fatigue in the general United States population. *Cancer* 2002;528-38.

23. Mallinson T, Cella D, Cashy J, Holzner B. Giving meaning to measure: linking self-reported fatigue and function to performance of everyday activities. *J Pain Symptom Manage*. 2006;229-41.
24. Cella D, Nowinski CJ. Measuring quality of life in chronic illness: the functional assessment of chronic illness therapy measurement system. *Arch Phys Med Rehabil*. 2002;S10-S17.
25. Webster K, Cella D, Yost K. The Functional Assessment of Chronic Illness Therapy (FACIT) Measurement System: properties, applications, and interpretation. *Health Qual Life Outcomes*. 2003;79.
26. Ware J, Jr., Kosinski M, Keller SD. A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. *Medical Care* 1996;220-33.
27. Guyatt GH, Sullivan MJ, Thompson PJ, Fallen EL, Pugsley SO, Taylor DW, Berman LB. The 6-minute walk: a new measure of exercise capacity in patients with chronic heart failure. *Can Med Assoc J* 1985;919-23.
28. Enright PL, Sherrill DL. Reference equations for the six-minute walk in healthy adults. *Am J Respir Crit Care Med* 1998;1384-7.

L. Data and Safety Monitoring Board

The principal role of the DSMB is to regularly monitor data from this trial, review and assess the performance of its operations, and make recommendations, as appropriate, to the NHLBI with respect to:

- Review of adverse events
- Interim results of the study for evidence of efficacy or adverse events
- Possible early termination of the trial because of early attainment of study objectives, safety concerns, or inadequate performance
- Possible modifications in the clinical trial protocol
- The performance of individual centers

The NHLBI ARDS Network DSMB is appointed by the Director, NHLBI. The DSMB reviews all new protocols for safety following review by an independent NHLBI Protocol Review Committee. The DSMB will consist of members with expertise in acute lung injury, biostatistics, ethics, and clinical trials. Ad hoc members have been appointed with particular expertise where necessary. Appointment of all members is contingent upon the absence of any conflicts of interest. All the members of the DSMB are voting members. The DSMB will review data prepared by the CCC. Decisions regarding issues such as stopping guidelines or whether the DSMB may at times remain blinded to study group identity will be made jointly by the DSMB members and the NHLBI representatives. The Principal Investigator and the Medical Monitor of the CCC will be responsible for the preparation of DSMB and adverse event reports and may review unblinded data. DSMB meetings will be scheduled by the NHLBI at intervals as described in section 7, and the DSMB will review the protocol during its first meeting. When appropriate, conference calls may be held in place of face-to-face meetings. Recommendations to end, modify, or continue the trial will be prepared by the DSMB executive secretary for review by Director, NHLBI, no more than two working days after a DSMB meeting. When appropriate, conference calls may be held in place of face-to-face meetings. Recommendations for major changes, such as stopping, will be communicated immediately, and followed by a written summary. The NHLBI will act on recommendations expeditiously; the NHLBI Project Officer or Program Scientist will communicate the recommendations promptly to the ARDS Network Steering Committee and the CCC with instructions for reporting to local IRBs when appropriate. The executive secretary of the DSMB will be responsible for preparing the minutes for each meeting or conference call. Details of the NHLBI policies regarding DSMBs can be found at the following URL: http://www.nhlbi.nih.gov/funding/policies/dsmb_inst.htm

The ARDS Network Steering Committee is comprised of the Principal Investigators and Co-investigators of all the Clinical sites, the CCC, and the NHLBI Project Officer who represents the NHLBI. All sites and the CCC have one vote, which is advisory to the NHLBI.

M. AUDIT Questionnaire

The Alcohol Use Disorders Identification Test (Babor, 1992)

The Alcohol Consumption Questionnaire is important to administer because there is a common association between alcohol abuse and Acute Lung Injury (ALI) (Moss, 1996). It will be important to have this information for a subgroup analysis. Knowledge of alcohol abuse will also help the primary team better care for the patient and improve patient outcome, as there are alcohol specific disorders in critically ill patients that often are not diagnosed and therefore not treated effectively. This survey will not be completed on subjects less than 18 years of age.

<p>1. How often do you have a drink containing alcohol?</p> <p>(0) Never [Skip to Qs 9-10] (1) Monthly or less (2) 2 to 4 times a month (3) 2 to 3 times a week (4) 4 or more times a week</p> <input type="checkbox"/>	<p>6. How often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking session?</p> <p>(0) Never (1) Less than monthly (2) Monthly (3) Weekly (4) Daily or almost daily</p> <input type="checkbox"/>
<p>2. How many drinks containing alcohol do you have on a typical day when you are drinking?</p> <p>(0) 1 or 2 (1) 3 or 4 (2) 5 or 6 (3) 7, 8, or 9 (4) 10 or more</p> <input type="checkbox"/>	<p>7. How often during the last year have you had a feeling of guilt or remorse after drinking?</p> <p>(0) Never (1) Less than monthly (2) Monthly (3) Weekly (4) Daily or almost daily</p> <input type="checkbox"/>
<p>3. How often do you have six or more drinks on one occasion?</p> <p>(0) Never (1) Less than monthly (2) Monthly (3) Weekly (4) Daily or almost daily</p> <p><i>Skip to Questions 9 and 10 if Total Score for Questions 2 and 3 = 0</i></p> <input type="checkbox"/>	<p>8. How often during the last year have you been unable to remember what happened the night before because you had been drinking?</p> <p>(0) Never (1) Less than monthly (2) Monthly (3) Weekly (4) Daily or almost daily</p> <input type="checkbox"/>
<p>4. How often during the last year have you found that you were not able to stop drinking once you had started?</p> <p>(0) Never (1) Less than monthly (2) Monthly (3) Weekly (4) Daily or almost daily</p> <input type="checkbox"/>	<p>9. Have you or someone else been injured as a result of your drinking?</p> <p>(0) No (2) Yes, but not in the last year (4) Yes, during the last year</p> <input type="checkbox"/>
<p>5. How often during the last year have you failed to do what was normally expected from you because of drinking?</p> <p>(0) Never (1) Less than monthly (2) Monthly (3) Weekly (4) Daily or almost daily</p> <input type="checkbox"/>	<p>10. Has a relative or friend or a doctor or another health worker been concerned about your drinking or suggested you cut down?</p> <p>(0) No (2) Yes, but not in the last year (4) Yes, during the last year</p> <input type="checkbox"/>
<p style="text-align: right;">Record total of specific items here <input type="checkbox"/></p> <p><i>If total is greater than recommended cut-off, consult User's Manual.</i></p>	

References

1. Abraham, E (2000). Coagulation abnormalities in acute lung injury and sepsis. *Am J Respir Cell Mol Biol* 22(4): 401-404.
2. Adam, S and Batson, S (1997). A study of problems associated with the delivery of enteral feed in critically ill patients in five icus in the uk. *Intensive Care Med.* 23(3): 261-266.
3. Afanas'ev, IB (2005). Free radical mechanisms of aging processes under physiological conditions. *Biogerontology.* 6(4): 283-290.
4. American College of Physicians (1989). Cognitively impaired subjects. *Ann Int Med* 111: 843-8.
5. Angus, DC, Musthafa, AA, et al. (2001). Quality-adjusted survival in the first year after the acute respiratory distress syndrome. *Am J Respir Crit Care Med* 163(6): 1389-94.
6. Artinian, V, Krayem, H, et al. (2006). Effects of early enteral feeding on the outcome of critically ill mechanically ventilated medical patients. *Chest* 129(4): 960-967.
7. Babor TF, de la Fuente JR, Saunders J, Grant M. The Alcohol Use Disorders Identification Test: Guidelines for use in primary health care. World Health Organization (1992).
8. Barr, J, Hecht, M, et al. (2004). Outcomes in critically ill patients before and after the implementation of an evidence-based nutritional management protocol. *Chest* 125(4): 1446-1457.
9. Bernard, GR (1997). The brussels score. *Sepsis* 1: 43-44.
10. Bernard, GR (2005). Acute respiratory distress syndrome: A historical perspective. *Am J Respir Crit Care Med.* 172(7): 798-806.
11. Bernard, GR, Korley, V, et al. (1991). Persistent generation of peptido leukotrienes in patients with the adult respiratory distress syndrome. *Am Rev Respir Dis.* 144(2): 263-267.
12. Bernard, GR, Vincent, JL, et al. (2001). Efficacy and safety of recombinant human activated protein c for severe sepsis. *N Engl J Med* 344(10): 699-709.
13. Bernard, GR, Wheeler, AP, et al. (1997). A trial of antioxidants n-acetylcysteine and procysteine in ards. The antioxidant in ards study group. *Chest* 112(1): 164-172.
14. Bernard, GR, Wheeler, AP, et al. (1997). The effects of ibuprofen on the physiology and survival of patients with sepsis. The ibuprofen in sepsis study group. *N Engl J Med* 336(13): 912-918.

15. Brower, RG, Lanken, PN, et al. (2004). Higher versus lower positive end-expiratory pressures in patients with the acute respiratory distress syndrome. *N Engl J Med* 351(4): 327-36.
16. Buchman, AL, Moukarzel, AA, et al. (1995). Parenteral nutrition is associated with intestinal morphologic and functional changes in humans. *J Parenter Enteral Nutr.* 19(6): 453-460.
17. Burrin, DG, Stoll, B, et al. (2000). Minimal enteral nutrient requirements for intestinal growth in neonatal piglets: How much is enough? *71(6): 1603-10.*
18. Caironi, P, Ichinose, F, et al. (2005). 5-lipoxygenase deficiency prevents respiratory failure during ventilator-induced lung injury. *Am J Respir Crit Care Med.* 172(3): 334-343.
19. Calandra T, Cohen J; International Sepsis Forum Definition of Infection in the ICU Consensus Conference. The international sepsis forum consensus conference on definitions of infection in the intensive care unit. *Crit Care Med.* 2005 Jul;33(7):1538-48.
20. Carpenter, CT, Price, PV, et al. (1998). Exhaled breath condensate isoprostanes are elevated in patients with acute lung injury or ards. *Chest* 114(6): 1653-1659.
21. Cerra, FB, Benitez, MR, et al. (1997). Applied nutrition in icu patients. A consensus statement of the american college of chest physicians. *Chest* 111(3): 769-778.
22. Chaintreuil, J, Monnier, L, et al. (1984). Effects of dietary gamma-linolenate supplementation on serum lipids and platelet function in insulin-dependent diabetic patients. *Hum Nutr Clin Nutr.* 38(2): 121-130.
23. Chollet-Martin, S, Rousset, F, et al. (1994). Cytokines in adult respiratory distress syndrome. *Lancet* 344(8934): 1440.
24. Cowley, HC, Bacon, PJ, et al. (1996). Plasma antioxidant potential in severe sepsis: A comparison of survivors and nonsurvivors. *Crit Care Med.* 24(7): 1179-1183.
25. Cracowski, JL, Tremel, F, et al. (2000). Increased formation of f(2)-isoprostanes in patients with severe heart failure. *Heart* 84(4): 439-440.
26. De Jonghe, B, Appere-De-Vechi, C, et al. (2001). A prospective survey of nutritional support practices in intensive care unit patients: What is prescribed? What is delivered? *Crit Care Med* 29(1): 8-12.
27. DeMets, DL and Ware, JH (1982). Asymmetric group sequential boundaries for monitoring clinical trials. *Biometrika* 69: 661-663.
28. Dickerson, RN, Boschert, KJ, et al. (2002). Hypocaloric enteral tube feeding in critically ill obese patients. *Nutrition* 18(3): 241-246.

29. Drakulovic, MB, Torres, A, et al. (1999). Supine body position as a risk factor for nosocomial pneumonia in mechanically ventilated patients: A randomised trial. *Lancet* 354(9193): 1851-1858.
30. Dresser, R (1999). Research involving persons with mental disabilities: A review of policy issues and proposals. National bioethics advisory commission. Rockville, U.S. Government Printing Office: 5-28.
31. Eyer, SD, Micon, LT, et al. (1993). Early enteral feeding does not attenuate metabolic response after blunt trauma. *J Trauma* 34(5): 639-643.
32. Fagon, JY, Chastre, J, et al. (2000). Invasive and noninvasive strategies for management of suspected ventilator-associated pneumonia. A randomized trial. *Ann Intern Med.* 132(8): 621-630.
33. Fernandes, G, Yunis, EJ, et al. (1976). Suppression of adenocarcinoma by the immunological consequences of calorie restriction. *Nature* 263(5577): 504-507.
34. Goode, HF, Cowley, HC, et al. (1995). Decreased antioxidant status and increased lipid peroxidation in patients with septic shock and secondary organ dysfunction. *Crit Care Med.* 23(4): 646-651.
35. Graham, TW, Zadrozny, DB, et al. (1989). The benefits of early jejunal hyperalimentation in the head-injured patient. *Neurosurgery* 25(5): 729-735.
36. Gramlich, L, Kichian, K, et al. (2004). Does enteral nutrition compared to parenteral nutrition result in better outcomes in critically ill adult patients? A systematic review of the literature. *Nutrition* 20(10): 843-848.
37. Groos, S, Hunefeld, G, et al. (1996). Parenteral versus enteral nutrition: Morphological changes in human adult intestinal mucosa. *J Submicrosc Cytol Pathol.* 28(1): 61-74.
38. Guidelines for the use of parenteral and enteral nutrition in adult and pediatric patients. (2002). *J Parenter Enteral Nutr.* 26(1 Suppl): 1SA-138SA.
39. Gust, R, Kozlowski, JK, et al. (1999). Role of cyclooxygenase-2 in oleic acid-induced acute lung injury. *Am J Respir Crit Care Med.* 160(4): 1165-1170.
40. Gutteridge, JM and Mitchell, J (1999). Redox imbalance in the critically ill. *Br Med Bull.* 55(1): 49-75.
41. Haddad, SH, Arabi, Y, et al. (2004). Relation between caloric intake and outcome of the critically ill patients. *Am J Respir Crit Care Med.* 31: A83.
42. Hadfield, RJ, Sinclair, DG, et al. (1995). Effects of enteral and parenteral nutrition on gut mucosal permeability in the critically ill. *Am J Respir Crit Care Med.* 152(5 Pt 1): 1545-1548.

43. Harris, WS (1997). N-3 fatty acids and serum lipoproteins: Human studies. *Am J Clin Nutr.* 65(5 Suppl): 1645S-1654S.
44. Heilbronn, LK, de Jonge, L, et al. (2006). Effect of 6-month calorie restriction on biomarkers of longevity, metabolic adaptation, and oxidative stress in overweight individuals: A randomized controlled trial. *JAMA* 295(13): 1539-1548.
45. Hernandez, G, Velasco, N, et al. (1999). Gut mucosal atrophy after a short enteral fasting period in critically ill patients. *J Crit Care* 14(2): 73-77.
46. Herridge, MS, Cheung, AM, et al. (2003). One-year outcomes in survivors of the acute respiratory distress syndrome. *N Engl J Med* 348(8): 683-93.
47. Heyland, DK, Dhaliwal, R, et al. (2004). Validation of the canadian clinical practice guidelines for nutrition support in mechanically ventilated, critically ill adult patients: Results of a prospective observational study. *Crit Care Med.* 32(11): 2260-2266.
48. Heyland, DK, Dhaliwal, R, et al. (2003). Canadian clinical practice guidelines for nutrition support in mechanically ventilated, critically ill adult patients. *J Parenter Enteral Nutr.* 27(5): 355-373.
49. Heyland, DK, Schroter-Noppe, D, et al. (2003). Nutrition support in the critical care setting: Current practice in canadian icus--opportunities for improvement? *J Parenter Enteral Nutr.* 27(1): 74-83.
50. Hopkins, RO, Weaver, LK, et al. (2005). Two-year cognitive, emotional, and quality-of-life outcomes in acute respiratory distress syndrome. *Am J Respir Crit Care Med* 171(4): 340-7.
51. Ibrahim, EH, Mehringer, L, et al. (2002). Early versus late enteral feeding of mechanically ventilated patients: Results of a clinical trial. *J Parenter Enteral Nutr.* 26(3): 174-181.
52. Idell, S (2003). Coagulation, fibrinolysis, and fibrin deposition in acute lung injury. *Crit Care Med.* 31(4 Suppl): S213-S220.
53. Idell, S, James, KK, et al. (1989). Local abnormalities in coagulation and fibrinolytic pathways predispose to alveolar fibrin deposition in the adult respiratory distress syndrome. *J Clin Invest* 84(2): 695-705.
54. Jepsen, S, Herlevsen, P, et al. (1992). Antioxidant treatment with n-acetylcysteine during adult respiratory distress syndrome: A prospective, randomized, placebo-controlled study. *Crit Care Med.* 20(7): 918-923.
55. Jolly, CA (2005). Diet manipulation and prevention of aging, cancer and autoimmune disease. *Curr Opin Clin Nutr Metab Care* 8(4): 382-387.

56. Kalfarentzos, F, Kehagias, J, et al. (1997). Enteral nutrition is superior to parenteral nutrition in severe acute pancreatitis: Results of a randomized prospective trial. *Br J Surg.* 84(12): 1665-1669.
57. Kandil, HE, Opper, FH, et al. (1993). Marked resistance of normal subjects to tube-feeding-induced diarrhea: The role of magnesium. *Am J Clin Nutr.* 57(1): 73-80.
58. Koretz, RL (1995). Nutritional supplementation in the icu. How critical is nutrition for the critically ill? *Am J Respir Crit Care Med.* 151(2 Pt 1): 570-573.
59. Koubova, J and Guarente, L (2003). How does calorie restriction work? *Genes Dev.* 17(3): 313-321.
60. Kris-Etherton, PM, Harris, WS, et al. (2002). Fish consumption, fish oil, omega-3 fatty acids, and cardiovascular disease. *Circulation* 106(21): 2747-2757.
61. Kudsk, KA, Croce, MA, et al. (1992). Enteral versus parenteral feeding. Effects on septic morbidity after blunt and penetrating abdominal trauma. *Ann Surg.* 215(5): 503-511.
62. Lane, MA, Black, A, et al. (2001). Caloric restriction in primates. *Ann NY Acad Sci.* 928: 287-295.
63. MacFie, J, Reddy, BS, et al. (2006). Bacterial translocation studied in 927 patients over 13 years. *Br J Surg.* 93(1): 87-93.
64. Marik, PE and Zaloga, GP (2001). Early enteral nutrition in acutely ill patients: A systematic review. *Crit Care Med.* 29(12): 2264-2270.
65. McClave, SA, DeMeo, MT, et al. (2002). North american summit on aspiration in the critically ill patient: Consensus statement. *J Parenter Enteral Nutr.* 26(6 Suppl): S80-S85.
66. McClure, RJ and Newell, SJ (1999). Randomised controlled trial of trophic feeding and gut motility. *Arch Dis Child Fetal Neonatal Ed* 80(1): F54-F58.
67. McClure, RJ and Newell, SJ (2000). Randomised controlled study of clinical outcome following trophic feeding. *Arch Dis Child Fetal Neonatal Ed* 82(1): F29-F33.
68. McClure, RJ and Newell, SJ (2002). Randomized controlled study of digestive enzyme activity following trophic feeding. *Acta Paediatr.* 91(3): 292-296.
69. Mentec, H, Dupont, H, et al. (2001). Upper digestive intolerance during enteral nutrition in critically ill patients: Frequency, risk factors, and complications. *Crit Care Med.* 29(10): 1955-1961.
70. Montuschi, P, Collins, JV, et al. (2000). Exhaled 8-isoprostane as an in vivo biomarker of lung oxidative stress in patients with copd and healthy smokers. *Am J Respir Crit Care Med.* 162(3 Pt 1): 1175-1177.

71. Moore, EE and Jones, TN (1986). Benefits of immediate jejunostomy feeding after major abdominal trauma--a prospective, randomized study. *J Trauma* 26(10): 874-881.
72. Moore, FA, Feliciano, DV, et al. (1992). Early enteral feeding, compared with parenteral, reduces postoperative septic complications. The results of a meta-analysis. *Ann Surg.* 216(2): 172-183.
73. Moore, FA, Moore, EE, et al. (1989). Ten versus tpn following major abdominal trauma--reduced septic morbidity. *J Trauma* 29(7): 916-922.
74. Morphake, P, Bariety, J, et al. (1994). Alteration of cyclosporine (csa)-induced nephrotoxicity by gamma linolenic acid (gla) and eicosapentaenoic acid (epa) in wistar rats. *Prostaglandins Leukot Essent Fatty Acids* 50(1): 29-35.
75. Morrow, JD and Roberts, LJ (1999). Mass spectrometric quantification of f2-isoprostanes in biological fluids and tissues as measure of oxidant stress. *Methods Enzymol.* 300: 3-12.
76. Moss M, Bucher B, Moore FA, Moore EE, Parsons PE. The role of chronic alcohol abuse in the development of acute respiratory distress syndrome in adults. *JAMA.* 275(1):50-4, 1996 Jan 3.
77. National Bioethics Advisory Committee (NBAC) (1998). Research involving persons with mental disorders that may affect decisionmaking capacity. Rockville, U.S. Government Printing Office.
78. National Death Index. <http://www.cdc.gov/nchs/r&d/ndi.htm>. Last update: 2000. Accessed: May 31, 2001.
79. National Heart, Lung, and Blood Institute Acute Respiratory Distress Syndrome (ARDS) Clinical Trials Network; Wiedemann HP, Wheeler AP, Bernard GR, Thompson BT, Hayden D, deBoisblanc B, Connors AF Jr, Hite RD, Harabin AL. Comparison of Two Fluid-Management Strategies in Acute Lung Injury. **N Engl J Med.** 354 (24):2564-2575. Epub 2006 May 21.
80. National Institutes of Health. Nih policy on reporting race and ethnicity data: Subjects in clinical research. 08/08/2001. 05/09/2006. <http://grants2.nih.gov/grants/guide/notice-files/NOT-OD-01-053.html>.
81. Nelson, JL, DeMichele, SJ, et al. (2003). Effect of enteral feeding with eicosapentaenoic acid, gamma-linolenic acid, and antioxidants on antioxidant status in patients with acute respiratory distress syndrome. *J Parenter Enteral Nutr.* 27(2): 98-104.
82. Office of Human Research Protections (OHRP). Compliance determination letters. http://ohrp.osophs.dhhs.gov/detrm_lettrs/.
83. Ohta, K, Omura, K, et al. (2003). The effects of an additive small amount of a low residual diet against total parenteral nutrition-induced gut mucosal barrier. 185(1): 79-85.

84. Omura, K, Hirano, K, et al. (2000). Small amount of low-residue diet with parenteral nutrition can prevent decreases in intestinal mucosal integrity. *231(1): 112-8.*
85. Owens, L, Burrin, DG, et al. (2002). Minimal enteral feeding induces maturation of intestinal motor function but not mucosal growth in neonatal dogs. *132(9): 2717-22.*
86. Palombo, JD, DeMichele, SJ, et al. (1996). Rapid modulation of lung and liver macrophage phospholipid fatty acids in endotoxemic rats by continuous enteral feeding with n-3 and gamma-linolenic fatty acids. *Am J Clin Nutr. 63(2): 208-219.*
87. Pampallona, S and Tsiatis, A (1994). Group sequential designs for one-sided and two-sided hypothesis testing with provision for early stopping in favor of the null hypothesis. *J Stat Plan Inference 42: 19-35.*
88. Parsons, PE, Eisner, MD, et al. (2005). Lower tidal volume ventilation and plasma cytokine markers of inflammation in patients with acute lung injury. *Crit Care Med. 33(1): 1-6.*
89. Peck, MD, Kessler, M, et al. (2004). Early enteral nutrition does not decrease hypermetabolism associated with burn injury. *J Trauma 57(6): 1143-1149.*
90. Peter, JV, Moran, JL, et al. (2005). A metaanalysis of treatment outcomes of early enteral versus early parenteral nutrition in hospitalized patients. *Crit Care Med. 33(1): 213-220.*
91. Preiser, JC, Berre, J, et al. (1999). Management of nutrition in european intensive care units: Results of a questionnaire. Working group on metabolism and nutrition of the european society of intensive care medicine. *Intensive Care Med. 25(1): 95-101.*
92. Pugh, RN, Murray-Lyon, IM, et al. (1973). Transection of the oesophagus for bleeding oesophageal varices. *Br J Surg. 60(8): 646-649.*
93. Rice, TW, Swope, T, et al. (2005). Variation in enteral nutrition delivery in mechanically ventilated patients. *Nutrition 21(7-8): 786-792.*
94. Rubenfeld, GD, Caldwell, E, et al. (2005). Incidence and outcomes of acute lung injury. *N Engl J Med 353(16): 1685-93.*
95. Rubinson, L, Diette, GB, et al. (2004). Low caloric intake is associated with nosocomial bloodstream infections in patients in the medical intensive care unit. *Crit Care Med. 32(2): 350-357.*
96. Runyon, BA, Squier, S, et al. (1994). Translocation of gut bacteria in rats with cirrhosis to mesenteric lymph nodes partially explains the pathogenesis of spontaneous bacterial peritonitis. *J Hepatol. 21(5): 792-796.*
97. Sanders, TA and Hinds, A (1992). The influence of a fish oil high in docosahexaenoic acid on plasma lipoprotein and vitamin e concentrations and haemostatic function in healthy male volunteers. *Br J Nutr. 68(1): 163-173.*

98. Schmidt, R, Luboinski, T, et al. (2004). Alveolar antioxidant status in patients with acute respiratory distress syndrome. *Eur Respir J.* 24(6): 994-999.
99. Schoenfeld, DA and Bernard, GR (2002). Statistical evaluation of ventilator-free days as an efficacy measure in clinical trials of treatments for acute respiratory distress syndrome. *Crit Care Med* 30(8): 1772-7.
100. Sohal, RS and Weindruch, R (1996). Oxidative stress, caloric restriction, and aging. *Science* 273(5271): 59-63.
101. Sondheimer, JM (2004). A critical perspective on trophic feeding. *J Pediatr Gastroenterol Nutr.* 38(3): 237-238.
102. Spain, DA, McClave, SA, et al. (1999). Infusion protocol improves delivery of enteral tube feeding in the critical care unit. *J Parenter Enteral Nutr.* 23(5): 288-292.
103. Stapleton, R, Steinberg, KP, et al. (2005). Early versus delayed enteral feeding in medical icu patients with acute lung injury. *Proc Amer Thor Soc* 2: A36.
104. Steinberg, KP, Hudson, LD, et al. (2006). Efficacy and safety of corticosteroids for persistent acute respiratory distress syndrome. *N Engl J Med.* 354(16): 1671-1684.
105. Suter, PM, Domenighetti, G, et al. (1994). N-acetylcysteine enhances recovery from acute lung injury in man. A randomized, double-blind, placebo-controlled clinical study. *Chest* 105(1): 190-194.
106. Taylor, SJ, Fettes, SB, et al. (1999). Prospective, randomized, controlled trial to determine the effect of early enhanced enteral nutrition on clinical outcome in mechanically ventilated patients suffering head injury. *Crit Care Med.* 27(11): 2525-2531.
107. The Acute Respiratory Distress Syndrome Network (2000). Ketoconazole for early treatment of acute lung injury and acute respiratory distress syndrome: A randomized controlled trial. The ards network. *JAMA* 283(15): 1995-2002.
108. The Acute Respiratory Distress Syndrome Network (2000). Ventilation with lower tidal volumes as compared with traditional tidal volumes for acute lung injury and the acute respiratory distress syndrome. The acute respiratory distress syndrome network. *N Engl J Med.* 342(18): 1301-1308.
109. Tyson, JE and Kennedy, KA (2005). Trophic feedings for parenterally fed infants. (3): CD000504.
110. Ware, LB and Matthay, MA (2000). The acute respiratory distress syndrome. *N Engl J Med.* 342(18): 1334-1349.
111. Wildhaber, BE, Yang, H, et al. (2005). Lack of enteral nutrition--effects on the intestinal immune system. *J Surg Res.* 123(1): 8-16.

112. Windsor, AC, Kanwar, S, et al. (1998). Compared with parenteral nutrition, enteral feeding attenuates the acute phase response and improves disease severity in acute pancreatitis. *Gut* 42(3): 431-435.
113. Wood, LG, Fitzgerald, DA, et al. (2000). Lipid peroxidation as determined by plasma isoprostanes is related to disease severity in mild asthma. *Lipids* 35(9): 967-974.
114. Yu, BP (2005). Membrane alteration as a basis of aging and the protective effects of calorie restriction. *Mech Ageing Dev.* 126(9): 1003-1010.