

A Missing Critical Aspect of Critical Care

Early Mobilization in ICU

Dany Abou Abdallah, M.D.
Luther Midelfort Hospital
Mayo Health System

Case Presentation

- ID : 38 y/o previously healthy man
- CC: Admitted with fever and progressive dyspnea over 2 days duration
- PMH: None
- Meds: None
- Admitting Diagnosis:
 - Seasonal Influenza
 - Secondary MRSA Pneumonia

- Developed ARDS and MRSA bacteremia
 - On mechanical ventilation for 11 days
 - Required Prone Ventilation to ensure adequate oxygenation
- First 3 days
 - Hypotensive, on vasopressors
- Then stabilized
 - Remained on ventilator for poor oxygenation, then for rapid shallow breathing on SBTs
 - Received high doses of lorazepam for agitation, especially at night

Post-ICU course

- On transfer to ward
 - Too delirious to participate in therapy
 - Markedly weak
 - Transferred to SNF to complete antibiotics
 - Returned home 5 weeks after initial illness began
- 6 months later
 - Describes difficulty with concentration, memory
 - Recurring nightmares about spiders and suffocation
 - Regaining strength, still couldn't walk up 1 flight of stairs without stopping
 - Still not back to work

Long-term outcomes after critical illness

- Cognitive impairment is common
 - 100% of ALI survivors impaired at d/c
 - ~ 50% with persisting impairment at 1 year
- Anxiety, depression and post-traumatic stress seen in many survivors
 - 25-50% of survivors may be affected
- MOST survivors have persisting problems with physical function
- Prolonged disability is common

*Hopkins RO. AJRCCM1999
HerridgeMS. NEJM2003*

COULD EARLY MOBILIZATION HAVE HELPED THESE PATIENTS?

Outline

- ICU-acquired weakness
- Why mobilize critically ill patients
- A multidisciplinary approach at LM-MHS

Outline

- **ICU-acquired weakness**
- Why mobilize critically ill patients
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Why do critically ill patients develop weakness?

- Critical illness myopathy and neuropathy
 - Resulting from critical illness and its treatments
- Muscle dysfunction due to
 - Catabolism
 - Deconditioning
 - Immobility
- Other causes of weakness or impaired mobility
 - Pain
 - Contractures
 - Compression neuropathies
 - Heterotopic ossification

Table 1. Characteristics of Patients with the Acute Respiratory Distress Syndrome (ARDS) at Enrollment and in the ICU, According to Whether They Survived to Discharge.

Characteristic	Surviving Patients (N=117)	Patients Who Died (N=78)	P Value ^a
Age — yr	45	50	0.02
Median			
Interquartile range	36–58	39–66	
Male sex — no. (%)	66 (56)	48 (62)	0.55
Preexisting organ dysfunction — no. (%) ^b	72 (62)	69 (88)	<0.001
Preexisting pulmonary disease — no. (%) ^c	13 (11)	16 (21)	0.12
APACHE II score ^d	25	28	<0.001
Median			
Interquartile range	17–37	23–33	
Maximal Lung Injury Score ^e	3.7	4.0	0.002
Median			
Interquartile range	3.0–4.0	3.7–4.0	
Multiple Organ Dysfunction Score ^f	9	10	0.03
Day 0 (date of eligibility)			
Median	7–11	8–13	
Interquartile range			
Day 3	9	11	<0.001
Median			
Interquartile range	7–12	9–11	
Day 7	8	9	<0.001
Median			
Interquartile range	7–10	9–13	
Day 14	7	12	0.02
Median			
Interquartile range	5–9	8–15	
Risk factor for ARDS — no. (%) ^{g,h}			
Pneumonia	62 (53)	50 (64)	0.12
Sepsis	48 (41)	46 (59)	0.03
Trauma or burns	26 (22)	3 (4)	<0.001
Pancreatitis	10 (9)	3 (4)	0.20
Other	40 (34)	16 (21)	0.04
Requirement for renal-replacement therapy — no. (%)	14 (12)	26 (33)	0.004
Tracheostomy — no. (%)	60 (51)	33 (42)	<0.001
Days of ventilator use	21	13	0.001
Median			
Interquartile range	12–40	6–27	
Length of stay in ICU — days	25	13	<0.001
Median			
Interquartile range	15–49	8–27	
Length of hospitalization — days	48	18	<0.001
Median			
Interquartile range	27–77	10–51	

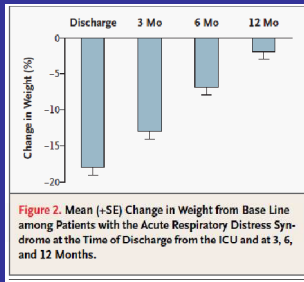


Figure 2. Mean (+SE) Change in Weight from Base Line among Patients with the Acute Respiratory Distress Syndrome at the Time of Discharge from the ICU and at 3, 6, and 12 Months.

Table 2. Recovery of Pulmonary Function among Patients with the Acute Respiratory Distress Syndrome during the First 12 Months after Discharge from the ICU.

Variable	3 Mo (N=71) ^a	6 Mo (N=77) ^b	12 Mo (N=80) ^c
<i>median (interquartile range)</i>			
Forced vital capacity (% of predicted)	72 (57–86)	80 (68–94)	85 (71–98)
Forced expiratory volume in one second (% of predicted)	75 (58–92)	85 (69–98)	86 (74–100)
Total lung capacity (% of predicted) ^d	92 (77–97)	92 (81–101)	95 (81–103)
Residual volume (% of predicted) ^d	107 (87–121)	97 (82–117)	105 (90–116)
Carbon monoxide diffusion capacity (% of predicted) ^{e,f}	63 (54–77)	70 (58–82)	72 (61–86)

Respiratory muscles are also affected

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Rapid Disuse Atrophy of Diaphragm Fibers in Mechanically Ventilated Humans

Sanford Levine, M.D., Taitan Nguyen, B.S.E., Nyali Taylor, M.D., M.P.H., Michael E. Friscia, M.D., Murat T. Budak, M.D., Ph.D., Pamela Rothenberg, B.A., Jianliang Zhu, M.D., Rajeev Sachdeva, M.D., Seema Sonnad, Ph.D., Larry R. Kaiser, M.D., Neal A. Rubinstein, M.D., Ph.D., Scott K. Powers, Ph.D., Ed.D., and Joseph B. Shrager, M.D.

Diaphragm atrophies on mechanical ventilation –Atrophic changes within 1 week on CMV

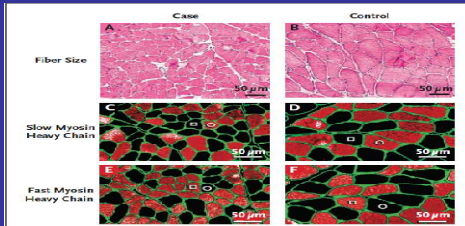


Figure 1. Comparison of Representative Case and Control Diaphragm-Biopsy Specimens with Respect to Fiber Size. The slow-twitch and fast-twitch fibers in the case specimens (Panels A, C, and E) are smaller than those in the control diaphragms (Panels B, D, and F). Panels A and B (hematoxylin and eosin) show that neither inflammatory infiltrate nor necrosis is present in case or control specimens. The sections in Panels C and D were preincubated with NCCQ7.5.4D antibody,^{10,11} which is specific for the slow myosin heavy chain, whereas sections in Panels E and F were preincubated with the MY32 antibody,^{20,21} which reacts with all fast myosin heavy chains. In addition, in each section, all fibers are outlined by an antibody reactive to laminin.^{20,21} In each of the sections, fibers reacting with the antibody appear orange/red, whereas fibers not reacting with the antibody appear black. In Panels C, D, E, and F, a representative slow-twitch fiber is indicated by an open circle and a fast-twitch fiber by an open square.

NEJM 2008

Nerve and muscle changes happen early in ICU

- Neuropathy and myopathy
- Changes detected within 2-3 days
- Loss of muscle thickness
- Most dramatic in first 2-3 weeks

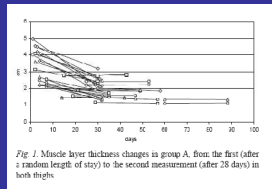


Fig 1. Muscle fiber thickness changes in group A, from the first (after a random length of stay) to the second measurement (after 28 days) in both thighs.

Bolton CM. ICM2000
Gruther W. J Rehab Med2008

Summary

- ICU-acquired weakness
 - Common
 - Underestimated by clinical examination
 - Associated with poor outcomes
 - Involves respiratory muscles
 - Begins early in the ICU stay
 - *Is likely worsened by immobility*

Outline

- ICU-acquired weakness
- **Why mobilize critically ill patients**
- A multidisciplinary approach at LMH-MHS

Potential benefits of activity during critical illness

- Effects on the body
 - Reducing muscle atrophy and weakness
 - Improving respiratory function
- Optimizing V/Q matching
- Increasing lung volumes
- Improving airway clearance
 - Increasing functional independence
 - Improving cardiovascular fitness
- Effects on the mind
 - Increasing psychological well being
 - Increasing level of consciousness

Stiller K. CritCare Clin2007

Bed rest might not be good for you!

- Immobility contributes to
 - Muscle atrophy
 - Switch of muscle myosin isoforms from slow to fast twitch
 - Inflammation (local and systemic)
 - Metabolic changes: insulin resistance, decreased protein synthesis, and decreased fatty acid metabolism
- Effects are amplified during critical illness



Needham DM. JAMA2008

Can we mobilize ICU patients?

- Is it safe?
 - And, if so, for which patients?
- Is it feasible?
- Is it helpful?

“Early activity is feasible and safe in respiratory failure patients”

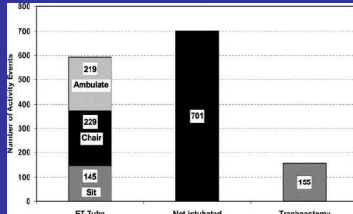
- Prospective cohort study
 - 8 bed RICU
 - Included all patients with >4 days MV
 - 3 criteria to begin activity (guidelines)
- Neurologic (response to verbal stimulus)
- Respiratory (FIO₂<0.6 and PEEP <10)
- Circulatory (no orthostasis or vasopressors)
- Intervention: progressive increase in activity
 - Sit on bed, sit in chair, ambulate (twice daily)
- Team: PT, RT, RN and critical care technician
- Outcome: Ambulation > 100 ft at ICU d/c



Bailey P. CCM 2007

Intubated patients were able to participate

- Enrolled: 103 patients
 - Nearly all transferred from other ICUs (med, surg)
 - Mean time to transfer: 10.5 days
 - 89% on MV at RICU admission
- Ambulation occurred by RICU day 3 (mean)



Bailey P. CCM 2007

Safety and feasibility

- Safety
 - 14 adverse events out of 1449 activity events
 - Fall to knees (5)
 - SBP < 90 (4—all orthostatic)
 - SBP > 200 (1)
 - O2 desaturation to <80% (3—all rapidly resolved)
 - Removal of nasal feeding tube (1)
- Feasibility
 - No change in staffing was needed for protocol
- RN: patient 1:2
- RT: patient 1:4
- PT: no increasing in staffing (? Ratio)

Bailey P. CCM 2007

“Early intensive care unit mobility therapy in the treatment of acute respiratory failure”

- Prospective cohort study
 - Block allocation design
- Study question:
 - Does a mobility protocol and team increase the proportion of ICU patients receiving PT?
- Population: MICU patients requiring MV on admission
- Intervention: Mobility Team (RN, PT, NA) initiating progressive protocol within 48 hours of MV
 - Control: RN-PROM, positioning
- Outcome: proportion of hospital survivors receiving PT



Morris PE. CCM 2008

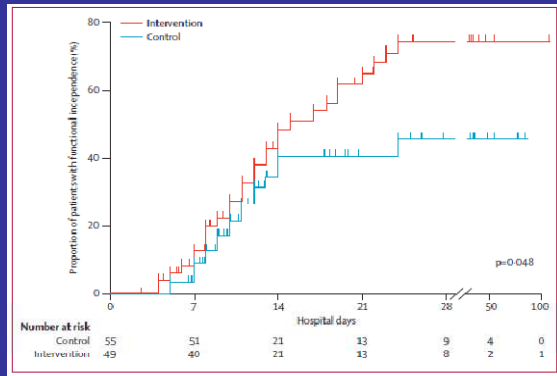


Figure 2: Probability of return to independent functional status in intervention and control groups

Benefits of early mobilization of critically ill patients: preliminary evidence

- Improves patient outcomes
 - Duration of mechanical ventilation
 - Delirium
 - Length of hospital stay
 - Functional independence at hospital discharge
- Saves hospitals \$\$
- Even with increased staff

Benefits of early mobilization of critically ill patients: pure Conjecture

- Improved muscle mass, strength and function
 - Short and long-term
- Decreased sedation use
- Improved communication with critically ill patients
- Increased satisfaction with ICU care of
 - Patients
 - Families
 - Clinical staff
- Enhance the team approach in the ICU

We're probably not doing as much therapy as we think we are...

- National PT Survey data
 - PTs responded therapy is indicated for ICU pts
 - variable timing, frequency and intensity
- Small observational pilot project: JHH
 - Observed MICU for 13 weeks
 - Found 21/32 eligible patients had orders for PT
 - 19 patients received a total of 50 treatments
- 12% of MICU days
 - Barriers: sedation, unavailability of staff
 - New impairments in physical function were common at hospital discharge

*Hodgin KE. CCM2009
Zanni JM. JCC2009*

Let's get moving!



Mr. C, a 56-year-old man with severe chronic obstructive pulmonary disease and acute renal failure, ambulating on day 4 after admission to the medical intensive care unit while receiving mechanical ventilation via an oral endotracheal tube.
