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The impact of physical medicine and rehabilitation consultation on clinical outcomes in the surgical intensive care unit

A prospective observational cohort study

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Abstract

The impact of a physical medicine and rehabilitation (PM&R) consultation on clinical outcomes in critically ill surgical patients remains unclear. The aim of this study is to examine whether the patients who received PM&R consultation will demonstrate better clinical outcomes in terms of the differences in clinical outcomes including muscle mass and strength, intensive care unit (ICU) length of stay (LOS) and functional outcomes between the PM&R consultation and no PM&R consultation and between early PM&R consultation and late PM&R consultation in critically ill surgical patients.

A prospective observational cohort study was undergone in 65-year-old or older patients who were admitted > 24 hours in the surgical intensive care unit (SICU) in a tertiary care hospital. Data collection included patients' characteristic, muscle mass and muscle strength, and clinical outcomes.

Ninety surgical patients were enrolled and PM&R was consulted in 37 patients (36.7%). There was no significant difference in muscle mass and function between consulted and no consulted groups. PM&R consulted group showed worse in clinical outcomes including functional outcomes at hospital discharge, longer duration of mechanical ventilation, ICU, and hospital LOS as compared with no PM&R consulted group. The median time of rehabilitation consultation was 6 days and there were no significant differences in clinical outcomes between early (≤ 6 days) and late (> 6 days) consultation.

PM&R consultation did not improve muscle mass, functional outcomes at hospital discharge, and ICU LOS in critically ill surgical patients. The key to success might include the PM&R consultation with both intensified physical therapy and early start of mobilization or the rigid mobilization protocol.

Abbreviations: ADL = activities of daily living, APACHE II = Acute Physiology and Chronic Health Evaluation II, BIVA = bioimpedance vector analysis, CAM−ICU = confusion assessment method for the ICU, FAC = functional ambulation category, ICU = Intensive care unit, ICUAW = intensive care unit-acquired weakness, IQRs = interquartile range, LOS = length of stay, MRC-SS = Medical Research Council Sum Score, PM&R = physical medicine and rehabilitation, RCT = randomized controlled trial, SD = standard deviation, SOFA = Sequential Organ Failure Assessment score, SOMS = SICU optimal mobilization score.

Keywords: consultation, critically ill, physical medicine and rehabilitation, surgery

1. Introduction

Intensive care unit-acquired weakness (ICUAW) is a clinically detected weakness in critically ill patients and there is no plausible etiology other than critical illness.[1] Approximately 46% of the patients with severe sepsis, multiple organ failure, or prolonged mechanical ventilation will develop ICUAW.[1] Muscle weakness is associated with the difficult weaning ventilator, cognitive impairment, deep venous thrombosis, risk of pneumonia, urinary tract infection, and

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The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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infected bed sore.[2] These adverse events result in the prolonged length of hospital stay and increase in hospital mortality.

Reducing deep sedation, increasing rehabilitation therapy and mobilization as soon as possible after admission to the intensive care units (ICUs) are all essential interventions to improve neuromuscular and physical function.[2] Recent systematic review and meta-analysis demonstrated that patient mobilization and physical rehabilitation in the ICU appeared safe with a low incidence of potential adverse events for example, hemodynamic changes and desaturation.[3]

Regarding the mobilization protocol in the ICU, guidelines are not defined for the specific evaluation tools or goals, the details in the protocol is depended on the discretion of each hospital or ICU.[4,5] A physical medicine and rehabilitation (PM&R) consultation is the main service to perform this process. Previous studies[6] using a mobility protocol that initiated early physical therapy (within 48–72 hours after ICU admission) after ICU admission demonstrated that an early mobilization protocol was associated with decreased ICU and hospital length of stay in the intervention group compared with patients who received usual care. Recently, a randomized controlled trial [7] compared early exercise and mobilization in patients who had been on mechanical ventilation for less than 72 hours to patients who received usual care resulted in a shorter duration of delirium and more ventilator-free days in the intervention group. In addition, up to our knowledge, the impact of early mobilization on the muscle mass has not been previously reported. The previous study found that bioelectric impedance was feasible for measuring muscle mass in mechanically ventilated ICU patients.[8] In this study, we decided to use BioImpedance Vector Analysis (BIVA) to measure muscle mass, handgrip, and quadriceps strength to measure muscle strength and compared these measurement in patients between PM&R consultation and no PM&R consultation group.

In the nutshell, the previous studies demonstrated that the early rehabilitation with multidisciplinary team should improve clinical and functional outcomes. Although the majority of academic hospitals have access to ICU patients PM&R consultation, other nonacademic institutions have not had the access to this service. In our hospital, even though the PM&R service is present, the mobilization protocol has not been established in SICUs. Moreover, there has been a controversial regarding the definition of "early," it might be different in each institution depending on the local protocol, policy, and resources. Consequently, we would like to investigate whether the patients who receive PM&R consultation demonstrate better outcomes. Therefore, the primary purpose of this project is to examine the differences in the trend of muscle mass and the secondary objectives are the differences in functional outcomes at hospital discharge and ICU length of stay between the PM&R consultation and no PM&R consultation and between early PM&R consultation and late PM&R consultation.

2. Method

2.1. Study design and setting

This prospective observational cohort study was conducted in 14-bed SICUs, Faculty of Medicine Siriraj Hospital, Mahidol University during June 2018 to October 2019 study period.

2.2. Sample size estimation

This sample size was estimated using results from our pilot study in 9 patients. A pilot measurement of muscle mass in these 9 patients showed an average mean (SD) of muscle mass 17.1 (4.8). Therefore, the sample size was calculated using a formula for estimating a single mean. With the mean muscle mass of 17.1, SD of 4.8, error of 1, and alpha of 0.05, a sample of 89 was required. Thus, this study included 90 patients who were then categorized into groups with or without PM&R consultation.

2.3. Participant

The study population included 65-year old or older patients who were expected to stay in SICUs for more than 24 hours. The patients who had pre-existing paralysis in any limbs or had limitations for BIVA measurement were excluded. The limitations for BIVA measurement included having an implantable cardiac defibrillator device and pacemaker, and skin impairment at the electrode placement area.

2.4. Primary and secondary outcome variables with working definition

The primary outcomes: Trend of muscle mass between the PM&R consultation and no PM&R consultation and between early PM&R consultation and late PM&R consultation

2.4.1. Muscle mass and muscle strength assessment. Muscle mass was measured by using BIVA (Maltron Bioscan-920 bioelectrical impedance analyzer, United Kingdom). Muscle strength was measured at the dominant hand with maximal strength using a handgrip dynamometer (T.K.K.-5401 Digital grip dynamometer, Japan) and by using isokinetic dynamometer for quadriceps muscle strength. In patients who could not perform handgrip strength test such as patients who were uncooperative, the muscle strength was measured by a manual muscle test scored as Medical Research Council Sum Score (MRC-SS) to test global muscle strength (MRC-SS ranges from 0 (complete paralysis) to 60 (normal strength) and scores less than 48 significantly defined as muscle weakness).[6] The level of activity will be adjusted by the SICU optimal mobilization score that describes patients' mobilization capacity on a numerical rating scale ranging from level 0 (no mobilization), level 1 (passive range of motion exercises in the bed), level 2 (sitting), level 3 (standing), or level 4 (ambulation).

2.4.2. Patients' baseline characteristics and functional status. The secondary outcomes: functional outcomes at hospital discharge between the PM&R consultation and no PM&R consultation and between early PM&R consultation and late PM&R consultation.

Patients' characteristic data included age, sex, comorbid diseases (dementia, cerebrovascular disease, diabetes mellitus, hypertension, chronic kidney disease, cardiac disease, and cirrhosis), smoking and alcohol consumption habits, medication use (statin and benzodiazepine), baseline functional status evaluated by Thai version Barthel Index of Activities of Daily Living (ADL).[9] This tool consists of 10 questions, each of which is rated from 1 to 10 by the patient. A higher score indicates a higher level of independence. Based on the total achievable score of 100 points, a score ranging from 50 to 70 indicated moderate disability, and a score within the range of 0to 20 reflected a very severe disability. The Functional Ambulation Category (FAC) is a functional walking test that evaluates ambulation ability. This 6-point scale assesses ambulation status by determining how much

human support the patient requires when walking, regardless of whether or not they use a personal assistive device.[10] SICU admission data included admission diagnosis, Acute Physiology and Chronic Health Evaluation II score, Sequential Organ Failure Assessment score. Intraoperative data was recorded including the site of surgery (abdomen, vascular, urologic, orthopedic, gynecologic, head, and neck) and type of surgery (elective, emergency).

2.4.3. Other outcomes measurement. Outcome measurement included delirium defined by the fulfillment of the Confusion Assessment Method for the ICU criteria (Thai version), namely, that a patient has: 1) acute onset and fluctuating symptoms, 2) inattention and either 3) an altered level of consciousness or 4) disorganized thinking[11] after enrollment and continued for 28 days or until ICU discharge or death. The functional outcome was assessed by the Barthel Index of ADL scores and the FAC at 1 week after hospital discharge. During hospital admission, we recorded mechanical ventilator day, SICU length of stay, hospital length of stay, and mortality at ICU, and hospital discharge.

2.5. Procedure

After a patient was admitted to SICU, an attending ICU physician designed whether the patient should receive physical therapy (PT) program. The consultation to department of PM&R was performed if PT program was needed. The PM&R doctor came to assess the readiness for mobilization in ICU within 24 hours of consultation, then the PT program was commenced within 24 hours of consultation. Assessment of muscle mass and muscle strength were evaluated within 24 hours after enrollment and continued for 28 days or until ICU discharge or death. These measurements were performed daily by a single physical therapist.

2.6. Comparison

The comparison of the trend of muscle mass, muscle strength, and functional outcomes at hospital discharge was performed between the PM & R consultation and no PM&R consultation groups and between early (< 6 days) and late (> 6 days) consultation.

2.7. Ethics

The study was approved by the Siriraj Institutional Review Board of the Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand (SIRB COA no. Si 284/2018, Chairperson Prof. Chairat Shayakul, MD) on May 30, 2018. All patients or their legal guardians provided informed consent in writing before their entry into the study.

2.8. Statistical analysis

Demographic and clinical variables were summarized using descriptive statistics. Continuous variables are described as mean and standard deviation (SD) or median and interquartile range (IQRs) depending on the data distribution. Categorical variables are described as frequency and percentage. The prevalence of PM&R consultation is presented as a percentage. Comparison between the PM & R consultation and no PM&R consultation groups and between early (≤ 6 days) and late (> 6 days) consultation was performed using independent *t* test or

BIVA=bioelectrical impedance vector analysis;
PM&R=physical medicine and rehabilitation; SICU=surgical intensive care unit

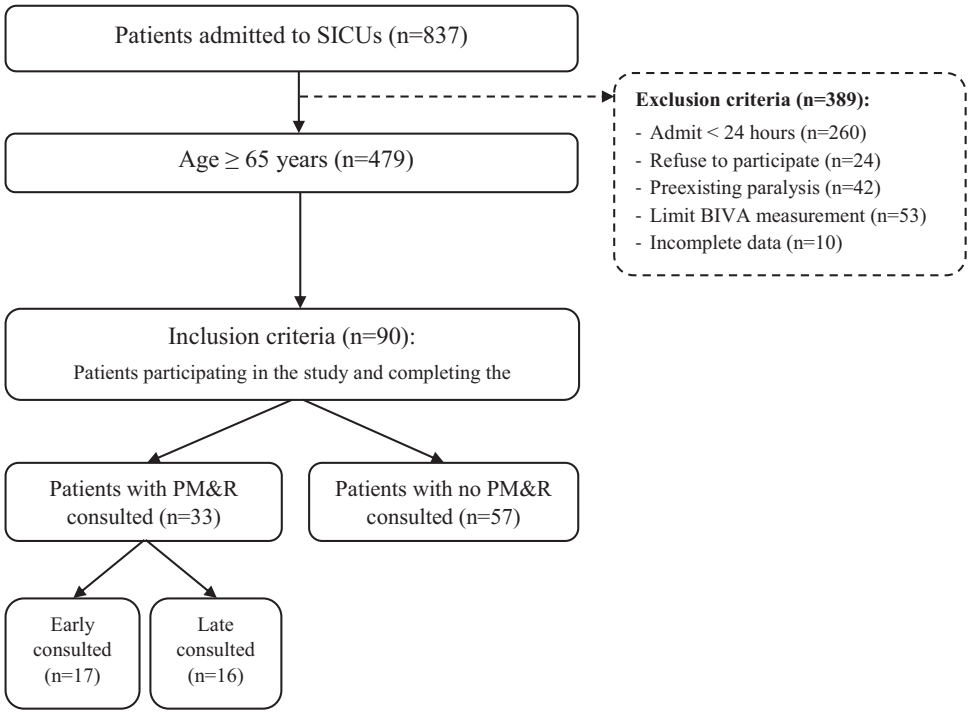

Figure 1. Flow diagram for study patient enrollment.

Table 1

Demographic data.

Variable	Total (n = 90)	No PM&R consults (n = 57; 63.3%)	PM&R consults (n = 33; 36.7%)	*P* value
Age	75.0 ± 7.8	74.6 ± 7.4	75.7 ± 8.4	.506
Sex: male	47 (52.2%)	28 (49.1%)	15 (45.5%)	.828
Comorbidity diseases				
Dementia	10 (11.1%)	6 (10.5%)	4 (12.1%)	1.000
Cerebrovascular disease	5 (5.6%)	4 (7.0%)	1 (3.0%)	.648
Diabetes mellitus	25 (27.8%)	16 (28.1%)	9 (27.3%)	1.000
Hypertension	59 (65.6%)	36 (63.2%)	23 (69.7%)	.647
Chronic kidney disease	19 (21.1%)	12 (21.1%)	7 (21.2%)	1.000
Cardiac disease	18 (20.0%)	11 (19.3%)	7 (21.2%)	1.000
Cirrhosis	3 (3.3%)	2 (3.5%)	1 (3.0%)	1.000
Charlson Comorbidity Index	3 (2–4)	3 (2–5)	3 (2–4)	.596
Smoking	16 (17.8%)	12 (21.1%)	4 (12.1%)	.394
Alcohol consumption	7 (7.8%)	5 (8.8%)	2 (6.1%)	1.000
Statin use	34 (37.8%)	22 (38.6%)	12 (36.4%)	1.000
Benzodiazepine use	3 (3.3%)	1 (1.8%)	2 (6.1%)	.552
APACHE-II score	16 (11–20)	14 (10–18)	16 (12–20)	.106
SOFA score	5 (3–7)	4 (3–5)	4 (3–9)	.107
Barthel index score at admission	94.4 ± 11.9	94.7 ± 12.3	94.1 ± 11.4	.831
Barthel index score $\leq$ 70 at admission	10 (11.1%)	7 (12.3%)	3 (9.1%)	.740
FAC score	5.0 ± 0.4	4.8 ± 0.5	5.0 ± 0.2	.080
Site of surgery				.625
Abdomen	41 (45.6%)	25 (43.9%)	16 (48.5%)	
Vascular	24 (26.7%)	14 (24.6%)	10 (30.3%)	
Urologic	12 (13.3%)	9 (15.8%)	3 (9.1%)	
Orthopedic	4 (4.4%)	3 (5.3%)	1 (3.0%)	
Gynecologic	1 (1.1%)	0	1 (3.0%)	
Head and neck	8 (8.9%)	6 (10.5%)	2 (6.1%)	
Type of surgery				.008
Elective	50 (55.6%)	38 (66.7%)	12 (36.4%)	
Emergency	40 (44.4%)	19 (33.3%)	21 (63.6%)	

P values for Chi-square test or Fisher exact test and independent *t* test or Mann–Whitney *U* test.

Data are presented as mean ± SD, n (%), or median (IQR).

APACHE-II score = acute physiology and chronic health evaluation ii score, FAC score = functional ambulation category score, SOFA score = sequential organ failure assessment score.

Mann–Whitney *U* test for continuous variables, and by chi-square test or Fisher exact test for categorical variables. Statistical data analyses were performed using PASW Statistics v.18 (SPSS, Inc, Chicago, IL).

3. Results

There were 837 patients admitted to SICUs during June 2018 to August 2019. Of those, 479 patients (57.2%) were aged greater than 65 years. Three hundred eighty-nine (81.2%) patients were excluded for admitting < 24 hours, refuse to participate, preexisting paralysis, limit BIVA measurement, and incomplete data. The remaining 90 surgical patients were enrolled Figure 1. Thirty-three patients (36.7%) were consulted PM&R.

The baseline characteristics of the participants are presented in Table 1. Patients' age, sex, comorbidity diseases, smoking, alcohol consumption, preoperative medication (statin and benzodiazepine use), Acute Physiology and Chronic Health Evaluation II, Sequential Organ Failure Assessment score, functional scores (Barthel (ADL) index and FAC score), and site of surgery were no statistically significant difference between PM&R consulted and no consulted groups; however, PM&R consulted group had a significantly higher percentage of emergency surgery (PM&R consult group, 63.6%, vs. no PM&R consult group, 33.3%; $P = .008$; Table 1).

3.1. Outcomes between PM&R consulted and no PM&R consulted groups

The performance of muscle mass and muscle strength did not significantly differ between the groups. The trend of muscle mass was not significantly different between PM&R consulted and no consulted group (17.6 ± 4.2 vs. 17.3 ± 5.0 kg; $P = .75$). Although the PM&R consulted group had MRC-SS lower than no PM&R consulted group (40.8 ± 11.9 vs. 44.3 ± 9.1; $P = .154$), there was no significant difference. Regarding the nutrition therapy, PM&R consulted group has a significantly higher the median total calories and protein received than no PM&R consulted group (Table 2).

The outcome measurement was displayed in Table 3. PM&R consulted group presented significantly higher percentage of delirious patients than no-consulted group (66.7% vs. 33.3%; $P = .004$). The PM&R consulted group demonstrated significantly lower median of FAC score at 1 week follow-up (3.5 (1.5–4.0) vs 4.0 (3.0–5.0); $P = .027$) and higher amount of moderate to severe disability assessed by Barthel index (ADL) score at the hospital discharge (92.0% vs 61.7%; $P = .006$) than no PM&R consulted group. Nevertheless, there was no significant difference of Barthel index (ADL) score at 1 week after hospital discharge between PM&R consulted group and no PM&R consulted group (68% vs 53%, $P = .317$). Although the mortality rate at ICU and

Table 2

Performance of muscle mass, muscle strength, and nutrition data.

Variable	Total (n = 90)	No PM&R consults (n = 57; 63.3%)	PM&R consults (n = 33; 36.7%)	*P* value
BIVA of muscle mass (kg)	17.4 ± 4.7	17.3 ± 5.0	17.6 ± 4.2	.753
Handgrip strength (kg)	8.9 (0–14.6)	8.3 (0–15.4)	9.3 (0–14.4)	.536
Quadriceps strength (kg)	1.7 (0–2.1)	0.8 (0–2.0)	0 (0–2.0)	.627
MRC-SS	43.0 ± 10.3	44.3 ± 9.1	40.8 ± 11.9	.154
Different trends of muscle mass (kg)	−0.4 (−1.4–0.7)	−0.3 (−1.1–0.9)	−0.7 (−3.0–0.6)	.088
Different trends of handgrip strength (kg)	−0.5 (−0.8–0.2)	0 (−1.0–0)	0 (0–0.5)	.096
Different trends of Quadriceps strength (kg)	−0.4 (0–0)	0 (−0.05–0)	0 (0–0)	.604
Difference of MRC-SS	−3.2 (−6–1)	−2.0 (−6.0–0)	−2.0 (−6.0–2.0)	.970
SOM level	1.0 ± 0.3	1.1 ± 0.2	1.1 ± 0.3	.599
Total calorie (kcal/kg)	13.4 (5.0–22.2)	8.4 (3.7–19.7)	22.1 (13.1–23.7)	.001
Total protein (g/kg)	0.6 (0–1.1)	0.3 (0–0.9)	1.0 (0.5–1.1)	.001

P values for independent *t* test or Mann–Whitney *U* test.

Data are presented as mean ± SD, or median (IQR).

BIVA = bioelectrical impedance vector analysis, MRC-SS = medical research council sum score, SOM = SICU optimal mobilization score.

hospital discharge were not significantly different between groups, the duration of mechanical ventilation, ICU length of stay, and hospital length of stay were significantly longer in PM&R consulted group as compared to no PM&R consulted group (Table 3).

3.2. Outcomes between early and late PM&R consultation groups

We determined the threshold of early vs late PM&R consultation by the median time of PM&R consultation after SICU admission. The median time of PM&R consultation was at day 6th after admission. 51.5% of PM&R consulted patients were categorized as early PM&R consultation with the median time of consultation was at day 3 after SICU admission while the median time of late PM&R consultation was at day 12 after SICU admission ($P < .001$, Table 4). However, there were no significant difference in terms of baseline characteristics, the assessment of muscle mass and muscle strength and other outcome measurements between early and late PM&R consulted patients except a significantly higher number of chronic kidney disease patients in late PM&R consulted group than in early PM&R consulted group ($P = .003$) (Table 4).

4. Discussion

The current study demonstrated nearly 40% of critically ill patients who admitted in SICU received rehabilitation consultation. However, there was no significant difference in muscle mass and function between consulted and no consulted groups. In addition, consulted group showed worse in other clinical outcomes including higher amount of moderate to severe disability at hospital discharge, higher delirium, longer duration of mechanical ventilation, ICU, and hospital LOS. The median time of rehabilitation consultation was 6 days and, in consulted group, there were no significant differences in clinical outcomes between early ($\leq$ 6 days) and late ($>$ 6 days) consultation.

These results contradicted findings from other studies as mentioned earlier demonstrated that early mobilization protocol improved clinical outcomes.[6,7] However, a randomized con-

Table 3

Outcome data.

Variable	Total (n = 90)	No PM&R consults (n = 57; 63.3%)	PM&R consults (n = 33; 36.7%)	*P* value
Delirium	41 (45.6%)	19 (33.3%)	22 (66.7%)	.004
Subtype of delirium (n = 41)				.090
Hypoactive	11 (26.8%)	2 (10.5%)	9 (40.9%)	
Hyperactive	11 (26.8%)	6 (31.6%)	5 (22.7%)	
Mixed	19 (46.3%)	11 (57.9%)	8 (36.4%)	
Duration of mechanical ventilation (days)	7.1 (2.0–10.0)	3.0 (1.0–4.0)	10.0 (4.0–18.0)	<.001
ICU length of stay (days)	9.4 (3.0–14.0)	4.0 (3.0–6.0)	11.0 (6.0–20.0)	<.001
Mortality at ICU discharge	4 (4.4%)	2 (3.5%)	2 (6.1%)	.622
Hospital length of stay (days)	19.0 (14.7–34.3)	18.0 (13.0–27.0)	26.0 (15.0–40.0)	.006
Mortality at hospital discharge	18 (20.0%)	10 (17.5%)	8 (24.2%)	.585
FAC score at 1 wk follow-up	4.0 (2.0–5.0)	4.0 (3.0–5.0)	3.5 (1.5–4.0)	.027
Barthel index ADL score at hospital discharge	40 (5–75)	50 (5–90)	18 (5–48)	.036
Barthel index ADL score $\leq$ 70 (n = 72)	52 (72.2%)	29 (61.7%)	23 (92.0%)	.006
Barthel index score $\leq$ 70 at 1 wk follow-up	50 (25–90)	55 (25–90)	40 (20–78)	.125
Barthel index score $\leq$ 70 (n = 69)	40 (58.0%)	24 (53.3%)	16 (66.7%)	.317

P values for Chi-square test or Fisher test and Mann–Whitney *U* test.

Data are n (%) or median (IQR).

Barthel index ADL = barthel index of activities of daily living, FAC score = functional ambulation category score, ICU = intensive care unit.

Table 4

Comparison of baseline characteristics and outcomes between early and with late PM&R consult patients.

Factors	Total (n = 33)	Early Consult at ≤ 6 days (n = 17; 51.5%)	Late Consult at > 6 days (n = 16; 48.5%)	*P* value
Age (yrs)	75.7 ± 8.4	77.0 ± 6.9	74.3 ± 9.8	.369
Sex: male	18 (54.5%)	11 (64.7%)	7 (43.8%)	.303
Date of rehabilitation consultation (days)	6 (3–12)	3 (3–5)	12 (9–15)	<.001
Comorbid diseases				
Dementia	4 (12.1%)	3 (17.6%)	1 (6.3%)	.601
Cerebrovascular disease	1 (3.0%)	0	1 (6.3%)	.485
Diabetes mellitus	9 (27.3%)	5 (29.4%)	4 (25.0%)	1.000
Hypertension	23 (69.7%)	13 (76.5%)	10 (62.5%)	.465
Chronic kidney disease	7 (21.2%)	0	7 (43.8%)	.003
Cardiac disease	7 (21.2%)	4 (23.5%)	3 (18.8%)	1.000
Cirrhosis	1 (3.0%)	1 (5.9%)	0	1.000
Charlson comorbidity index	3 (2–4)	3 (2–4)	3 (2–4)	.557
APACHE-II score	17.6 ± 8.2	17.7 ± 8.1	17.6 ± 8.5	.994
Barthel index score ≤ 70 at admission	3 (9.1%)	1 (5.9%)	2 (12.5%)	.601
FAC score	5.0 ± 0.2	5.0 ± 0	4.9 ± 0.3	.333
Site of surgery				.707
Abdomen	16 (48.5%)	9 (52.9%)	7 (43.8%)	
Vascular	10 (30.3%)	4 (23.5%)	6 (37.5%)	
Urologic	3 (9.1%)	2 (11.8%)	1 (6.3%)	
Orthopedic	1 (3.0%)	1 (5.9%)	0	
Gynecologic	1 (3.0%)	0	1 (6.3%)	
Head and neck	2 (6.1%)	1 (5.9%)	1 (6.3%)	
Type of surgery				.721
Elective	12 (36.4%)	7 (41.2%)	5 (31.3%)	
Emergency	21 (63.6%)	10 (58.8%)	11 (68.8%)	
Difference of MRC-SS	−2.0 (−8.5–2.0)	−2.0 (−12.0–1.0)	−1.5 (−6.0–4.0)	.557
Different trends of muscle mass (kg)	−0.7 (−3.0–0.6)	−0.1 (−3.0–0.7)	0.7 (−2.7–−0.2)	.488
Different trends of handgrip strength (kg)	0 (−0.1–0)	0 (−0.2–0.1)	0 (0–1.1)	.402
Different trends of quadriceps strength (kg)	0 (0–0)	0 (0–0)	0 (0–0.3)	.204
SOM level	1.1 ± 0.3	1.1 ± 0.2	1.1 ± 0.3	.524
ICU length of stay (days)	11 (6–20)	11 (5–20)	12 (7–24)	.763
Mortality at ICU discharge	2 (6.1%)	1 (5.9%)	1 (6.3%)	1.000
Hospital length of stay (days)	26 (15–41)	21 (15–39)	30 (19–41)	.683
Mortality at hospital discharge	8 (24.2%)	5 (29.4%)	3 (18.8%)	.688
FAC score at 1 wk follow-up (n = 29)	3.5 (1.3–4.0)	4.0 (2.0–5.0)	3.0 (1.0–4.0)	.219
Barthel index score ≤ 70 at hospital discharge (n = 25)	23 (92.0%)	10 (83.3%)	13 (100%)	.220
Barthel index score ≤ 70 at 1 week follow-up (n = 24)	16 (66.7%)	6 (50.0%)	10 (83.3%)	.193

P values for Chi-square test or Fisher exact test and independent *t* test or Mann–Whitney *U* test.

Data are presented as mean ± SD, n (%) or median (IQR).

APACHE-II score = acute physiology and chronic health evaluation ii score, Barthel index ADL = barthel index of activities of daily living, BIVA = bioelectrical impedance vector analysis, FAC score = functional ambulation category score, ICU = intensive care unit, MRC-SS = medical research council sum score, SOFA score = sequential organ failure assessment score, SOM = SICU optimal mobilization score.

trolled trial showed that even intensified physical therapy commenced at a median 8 days after ICU admission was unable to improve ICU hospital-free days or physical function in patients who had received mechanical ventilation for at least 4 days for acute respiratory failure.[12] Similarly, Morris et al reported that the ICU rehabilitation did not decrease the ICU and hospital LOS or improved functional status at 6 months. Although the patients in Morris's study were received mobilization intervention early (day 1 for passive range of motion and day 4 for progressive resistance exercise), the process of progressing patients' physical activities was less standardized.[13] The key to success might include both intensified physical therapy and early start of mobilization or the rigid mobilization protocol.

The current study was a pilot study; the rehabilitation consultation depended on the attending physicians' discretion and lack of a standard protocol for physical therapy. The consulted patients demonstrated longer ICU LOS, ventilator days and received higher nutrition therapy. Basically, physician had a trend to consult physiotherapist or occupational therapist when the patients' acute conditions were stabilized and he or she was closer to discharge that might take a period of time. In addition, in some different scenario, some geriatric patients who turned to be chronically ill and develop persistent inflammation, immunosuppression and catabolism syndrome (PICS) lingering in ICU for a long time would be another type of patients for a rehabilitation consultation.[14] Consequently, the rehabilitation consultation without the rigorous rehabilitation protocol might result in ineffective outcomes as shown in our results including higher delirium, longer duration of mechanical ventilation, ICU, and hospital LOS in rehabilitation consultation group and no significantly difference in muscle mass and function. Moreover, our study did not demonstrate the significant difference in clinical outcomes between early (the median days was 3) and late rehabilitation (the median day was 12) consultation. Not only the

SICU = surgical intensive care unit, PM&R = physical medicine and rehabilitation, MAP = mean arterial pressure, HR = heart rate, SBP = systolic blood pressure, SpO2 = pulse oximetry, PEEP = positive end expiratory pressure, ICP = intracranial pressure, PROM = passive range of motion, AROM = active range of motion.

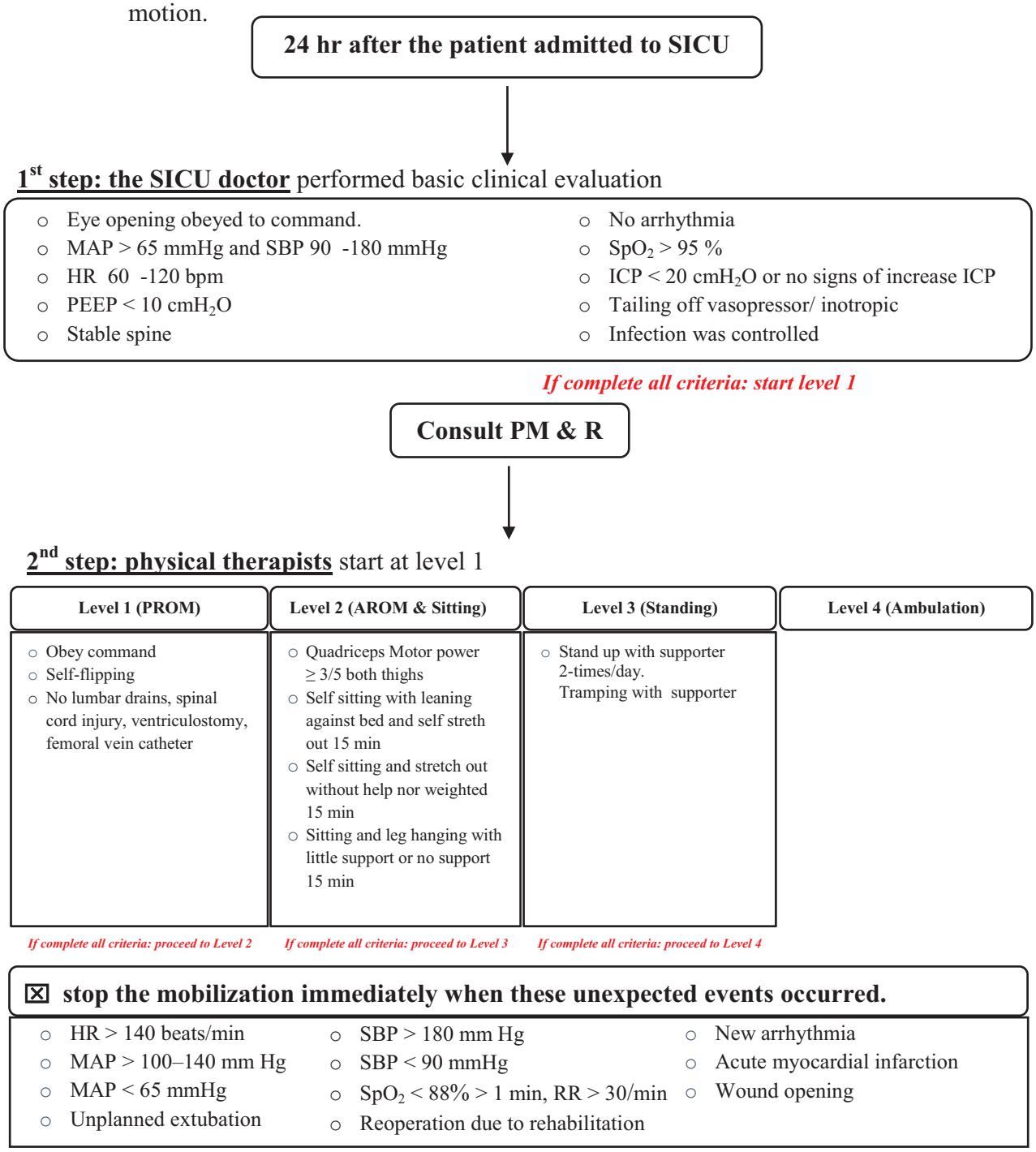

Figure 2. Protocol for early mobilization in general surgical ICU; Siriraj hospital.

standardization of the protocol but the sample size might not be enough to make the interpretation.

Although there has been a mobilization protocol for SICU patients, a goal-directed mobilization using inter-professional approach of close loop communication which is still lacking in our hospital might help improve the outcomes of our SICU patients. From this pilot study, our SICU team cooperation with the department of PM&R created a mobilization protocol for

SICU patients Figure 2. The protocol started whenever the patients (age > 65 years) admitted to SICU longer than 24 hours, the attending staff will assess the criteria for commencing the mobilization protocol and then consult the PM&R if the patients meet all of the lists. The physical therapist will start performing the physical activity according to the SICU optimal mobilization score level. The protocol created the interdisciplinary evaluation; increase communication between related healthcare worker and bringing continuation of care after discharging from SICU. Our teams are further doing the study regarding the effectiveness of this protocol (Thai clinical trial No. TCTR20210203006).

Several limitations should be considered. First, this study was a pilot study; we did not control the intervention or control group. Our aim would focus on the impact of current problem regarding the mobilization in SICU so the sample size might not be appropriate. Second, there could be other important differences between groups that were not accounted for these analyses. Third, although previous study[8] reported the feasibility of BIVA as a measure of muscle mass in ICU patient, there have been no gold standard or consensus regarding the muscle mass or muscle strength measurement in critically ill patients. Finally, this study looked specifically at the SICU patients in a tertiary care hospital, the results would not be similar to other type of patients or other hospitals that might have different magnitude or service system especially for the rehabilitation consultation.

5. Conclusion

This pilot study demonstrated that PM&R consultation did not improve clinical outcomes including muscle mass, functional outcomes at hospital discharge, and ICU length of stay in critically ill surgical patients. In addition, there was also no difference in clinical outcomes between early (≤ 6 days) and late (> 6 days) rehabilitation consultation. The rehabilitation consultation without the rigorous rehabilitation protocol might result in ineffective outcomes. The key to success might include both intensified physical therapy and early start of mobilization or the rigid mobilization protocol.

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