

Factors affecting extubation outcomes after using semi-quantitative cough strength scale

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Abstract

Background: Impaired cough increases risk of reintubation in patients who pass a spontaneous breathing trial and have their endotracheal tube removed. Semi-quantitative cough strength score (SCSS) used to evaluate the patients' cough strength which was scored from 0 to 5 according to the obtained patient response. **Aim:** to evaluate factors affecting extubation outcome by using (SCSS) **Design:** descriptive design. **Setting:** intensive care units of anesthesia department at Assiut University hospital. **Subjects:** convenient sample of 80 patients who were ready for weaning off mechanical ventilator, aged from 18-65 years old, mechanically ventilated more than 24 hours and of Glasgow coma scale (GCS) of 12-15. **Tools:** **Tool I:** Assessment sheet. **Tool II:** SCSS **Tool III:** factors affecting extubation outcome assessment sheet **Method:** Before extubation, patients positioned at 30° to 45°, SCSS was measured by asking patient to cough using his full power, then disconnecting him from the ventilator. **Results:** 80% of the patients with (grade =0) reintubated in comparison with 79% of patients with (grade =5) successfully extubated. **Conclusion:** The most common factors affecting extubation were copious secretions, diminished consciousness, hypoxemia and anemia respectively.

Keywords: *Semi-Quantitative Cough Strength Score (Scss), Extubation Outcome & Mechanically Ventilated.*

Introduction

Mechanical ventilation usage in the critically ill patient has many advantages and disadvantages; while essential and life sustaining, the complications associated with unnecessarily prolonged endotracheal intubation are legion. Rapid separation from mechanical ventilation in the unprepared patient will result in extubation failure and reintubation, so the decision to extubate shouldn't be taken lightly otherwise many complications as prolonged Intensive Care Unit (ICU) stays, and increased rates of morbidity and mortality may appear (Lee et al., 2017).

Extubation failure is defined by inability to sustain spontaneous breathing after removing endotracheal tube and the need of reintubation within 48 or 72 hour of extubation which is associated with significant deterioration in patients' clinical condition. (Reis et al., 2013) It was reported in previous studies that reintubation was 15% in patients who underwent extubation. The danger of occurrence of reintubation lies in increment of complications like death rates which are much higher in reintubated patients than in successfully extubated patients, So it is important to improve extubation results by using new accurate predictors (Duan et al., 2015).

Failure of planned extubation is not without risk factors or causes as previous studies reported that excess respiratory secretions, encephalopathy, cardiac

failure, sepsis, gastrointestinal bleeding, seizures, and need for surgery were associated with extubation failure (Weinberg, 2016). Other studies reported that reintubation is varying depending on the population studied. Moreover these studies reported that anemia, disease severity, prolonged duration on mechanical ventilator before extubation, hypercapnia, fluid imbalance, large transfusion requirements, renal dysfunction and the use of continuous sedation (Kulkarni, 2008 & Thille et al., 2015).

Cough strength before extubation was taken as a predictor of critically ill patient's ability to protect his airway after extubation. (Kutchak et al., 2015). Patients who pass spontaneous breathing trial (SBT) and will be extubated are exposed to reintubation risk if they exhibited impaired cough. Patients with weak strength of cough are four times more likely to be reintubated compared to those with moderate to strong cough. (Fan et al., 2014).

It was documented that none of conventional weaning parameters were helpful in predicting extubation outcomes. Recent studies revealed that who had passed SBTs. Previous studies demonstrated that the only variable associated with extubation failure was an ineffective cough (Huang & Yu, 2013). Therefore, instead of airway parameters, namely semi-quantitative cough Strength score was highly predictive of extubation outcomes. Khamiees and his colleagues had assumed the use of a semi-

quantitative cough strength score (SCSS), graded from 0 (weak) to 5 (strong), to expect extubation failure after planned extubation. They found that the patients with a lower SCSS more likely to be reintubated than others (Duan et al., 2015)

Cough strength score is an easy and applicable method to be recorded by health providers at the bedside to evaluate cough strength. Recently it was suggested by Whitemore et al (2015) to use the cough strength score, graded from 0 to 5 where it is strong predictor in anticipating extubation outcome (Ketshat et al., 2017).

Significance of study

After successful extubation the patients may require re-intubation due to "extubation failure," which leads to high mortality and morbidity and needs to be prevented using accurate predictors before extubation using various clinical and laboratory parameters. About 1300 patients were admitted to general and trauma ICUs at Assiut university hospital in previous year and most of them often needed to be mechanically ventilated (Assiut university Hospital ICU records). In turn this reflects the importance of investigating prediction of extubation outcome by using semi-quantitative cough strength score.

Aim of Study

The Aim of the present study is to evaluate factors affecting the extubation outcomes after using semi-quantitative cough strength score (SCSS) and its accuracy on predicting extubation outcome (failure or success).

Research questions

- What are the factors affecting the extubation outcomes?
- What is the extent of accuracy of SCSS on predicting extubation outcomes?

Patients & Method

Research design

Descriptive research design was used to conduct this study.

Variables

- **Independent variable:** Application of Semi-quantitative cough strength score (SCSS) on patients.
- **Dependent variable:** Extubation outcomes (successful extubation or reintubation)

Setting

The study was conducted in (Trauma ICU, general ICU, post-operative ICU and obstetric ICU) at Assiut university hospital.

Subjects

A purposive sample included eighty patients aged from (18-65 years old) who admitted to the general, trauma, post-operative and obstetric ICUs and who were eligible for inclusion in the sample for about 6 months (from September, 2016 to March, 2017).

Inclusion criteria

The study included patients with the following criteria

- Patients who were ready to be weaned off mechanical ventilation after successful spontaneous breathing trial.
- Age : 18-65 years old
- Mechanical ventilation more than 24 hours
- GCS :12-15

Exclusion criteria

The study excluded patients with the following criteria

- Patients who had undergone tracheostomy before Extubation
- Chronically ill patients (COPD, lung cancer)

Study tools

Three tools were used in this study. The first tool developed by the researcher after reviewing the related literature (Shadvar et al., 2013), (Miu et al., 2013), (Dougherty & Lister, 2015), (Huang & Yu, 2013), (Khamiees, Raju, DeGirolamo, Amoateng-Adjepong, & Manthous, 2001)

Tool (1): Patient assessment Sheet: (Shadvar et al., 2016), (Miu et al., 2014), (Dougherty & Lister, 2015), (Huang & Yu, 2013)

This tool was developed by the researcher after reviewing the related literature. It was used to assess demographic and Clinical data of patient, it consisted of three parts:

Part I: Personal characteristics which included age and sex

Part II: Clinical data which included medical diagnosis, past history of diseases, length of stay, type of ICU, Number of days on Mechanical ventilator, APACHE II score, Arterial blood gases (PH, PaO₂ in mmHg, PaCO₂ in mm Hg and Fraction of inspired oxygen (Fio₂%) and patient's vital signs 1hr before and 1 hr. after extubation

Tool (2): Semi-quantitative cough strength score (SCSS)

This tool adopted from Khamiees et al., (2001) and used to evaluate patient's ability to generate cough for predicting reintubation after planned extubation by giving score to such cough pattern as following:

0 = no cough on command, 1 = audible movement of air through the endotracheal tube but no audible cough, 2 = weakly (barely) audible cough, 3 = clearly

audible cough, 4 = stronger cough and 5 = multiple sequential strong coughs.

Tool (3): Factors affecting successful extubation

This tool was developed by the researcher after reviewing the related literature and used to confirm presence or absence of factors that can interfere with results of extubation outcomes by using semi-quantitative cough strength score. These factors include:

Hypoxemia, hypercapnia, haemodynamic instability, Diminished consciousness, Diaphoresis, respiratory muscle fatigue, high WBCs, fever, copious secretions and anemia (**Shadvar et al., 2016**)

Method

- Permission to conduct the study was obtained from the dean of faculty of nursing at Assiut University and from hospital responsible authorities (head of the anesthesia department and head of the each ICU) after explanation of the aim and nature of the study.
- Development of the tools after reviewing the related literature.
- The tools were reviewed by 5 jury for face and content validity, this include two medical staff and three critical care nursing staff from Assiut University.
- Reliability of the tools were done by using Cronbach's Alpha test, it was 0.74 for APCHE II score and for Semi-quantitative cough strength score(SCSS)

Ethical considerations

- Research proposal was approved from ethical committee in the faculty of nursing.
- There was no risk for study subjects during application of the research.
- The study followed common ethical principles in clinical research
- Informed consent was obtained from the responsible person for the unconscious patients or guidance that was willing to participate in the study, after explaining the nature and purpose of the study.
- Confidentiality of the data and anonymity and privacy of patients were assured
- Study subjects privacy was considered during collection of data.
- A pilot study was conducted on 8 patients who met the determined selection criteria to test the feasibility and applicability of the tool and necessary modification was done, the eight patients of the pilot study were excluded from the study.

Data collection

- During period of Spontaneous breathing trial before extubation , ventilator parameters were recorded

- One hour before extubation , the vital signs of the patient were assessed and the arterial blood gases were drawn.
- After the patient weaned off mechanical ventilation and before extubation patient was positioned at 30° to 45°, asked to cough using his full power, SCSS was measured then he was disconnected from the ventilator.
- The cough strength was scored from 0 to 5 as follows: 0 = no cough on command, 1 = audible movement of air through the endotracheal tube but no audible cough, 2 = weakly (barely) audible cough, 3 = clearly audible cough, 4 = stronger cough and 5 = multiple sequential strong coughs.
- One hour after Extubation the vital signs were assessed and the arterial blood gases were drawn.
- factors that can affect the extubation success were assessed to extubated patients and recorded
- After extubation each patient was followed up for 72hrs to check for extubation success or failure (reintubation)

Statistical analysis

- Data were coded and transformed into specially designed form so as to be suitable for computer process.
- Statistical analysis was performed using the software package spss, version 20.
- Data of obtained result were tabulated in the form of frequency using mean \pm SD, number and percentage.
- Using t-test to determine statistical significance between two variables.
- Using chi-square test to determine significance between variables.
- Using paired T-test to determine significance in change with time

Results

The main results yielded by the present study were

Table (1): personal characteristics and clinical data among the studied group (Total N of patients =80).

Items	No (n=80)	%
Age		
18-35	39	48.8
35-50	19	23.8
50-65	22	27.5
Age M ±SD	40.56±16.14	
Sex		
Male	53	66.3
Female	27	33.8
Medical diagnosis		
Traumatic causes		
Head trauma	28	35
Chest trauma	6	7.5
Other trauma	12	15
Non traumatic causes	34	42.5
Medical diagnoses	22	64.7
Surgical diagnoses	8	23.5
obstetric diagnoses	4	11.8
Past history of diseases		
Hypertension	15	18.8
Diabetes	6	7.5
Respiratory failure	2	2.5
Hypertension+ Diabetes	4	5
Congestive heart failure	2	2.5
Hypertension+ Diabetes+	1	1.25
Non	50	62.5
Length of stay		
M ±SD	11.9 ± 6.7	
Days on MV		
M ±SD	6.46± 3.96	

* Significant at ($P < 0.05$)

Table (2): Comparison between reintubated and successfully extubated patients in relation to Ventilator parameters during Spontaneous breathing trial (SBT).

Parameters	Successful extubation M±SD	Reintubation M±SD	P value
Tidal volume (VT)	454.3±134.1	404.3±130	0.095
Minute ventilation (Ve)	8.4±2.1	8.2±3	0.78
Pressure support (Psupp)	10.6±2.1	10.5±1.8	0.88
Rapid shallow breath index (RSBI)	62.8±23.6	53.8±20.14	0.07

*Statistical significant difference ($P \leq 0.05$)

Table (3): Comparison between successfully extubated and reintubated patients in relation to arterial blood gases one hour before and after extubation.

ABG items	1hr Before Extubation			1hr After Extubation		
	Extubation success (n=43) 53.7%	Reintubation (n=37) 46.3%	Pvalue	Extubation success (n=43) 53.7%	Reintubation (n=37) 46.3%	P value
PH	7.43 (0.09)	7.42 (0.07)	0.51	7.44(0.07)	7.43 (0.08)	0.71
PCO ₂ ,mm Hg	39.6 (7)	40.65 (12.9)	0.64	40.3 (9)	38 (13.7)	0.39
PaO ₂ ,mm Hg	130.3 (50.2)	130.5 (51.9)	0.98	129.3 (43)	104.9 (45)	0.02*
PaO ₂ /FIO ₂	300.9(128.6)	306.3(140.8)	0.85	431.(647.3)	255.3(130.8)	0.11
SaO ₂ (%)	98.1 (1.8)	97.6 (3.3)	0.65	97.8 (2.8)	95.7 (4.2)	0.01*

*Statistical significant difference ($p \leq 0.05$) - T-test

PH: acidity or power of hydrogen -PaO₂: partial pressure of oxygen -PaCO₂ partial pressure of carbon Dioxide - SaO₂: oxygen saturation - Fio₂: fraction of inspired oxygen

Table (4): Comparison between successfully extubated and reintubated groups in relation to vital signs before and after extubation.

Items of Vital signs	1hr Before extubation			1hr After extubation		
	Extubation success (n=43) M±SD	Reintubation (n=37) M±SD	P value	Extubation success (n=43) M±SD	Reintubation (n=37) M±SD	P value
Body Temperature	37.3±(0.47)	37.7±(0.49)	0.001**	37.5762±(0.46)	37.59±(0.55)	0.87
Heart rate	96.7±(16.4)	108±(14.8)	0.24	95.3±(20.6)	100.7±(12.7)	0.16
Respiratory rate	18.7±(3.6)	19.5±(3.6)	0.34	23.2±(12.7)	22.2±(4.4)	0.62
Mean arterial Blood pressure	89.9±(14.1)	88.7±(10.9)	0.64	86.8±(15.3)	85.4±(10.5)	0.64

Table (5): frequency and percentage distribution of the patients in the successfully extubated and reintubated by Semi-quantitative cough strength score.

Score items	Successful extubation N=43		Reintubation N=37	
	N	%	N	%
no cough on command	1	20	4	80
audible movement of air through the endotracheal tube but no audible cough	1	14.3	6	85.7
weakly (barely) audible cough	1	11.1	8	88.8
clearly audible cough	5	50	5	50
stronger cough	1	16.7	5	83.3
multiple sequential strong coughs	34	79.1	9	20.9
SCSS (M±SD)	4.5±1.13		2.74±1.7 P value =0.0001***	

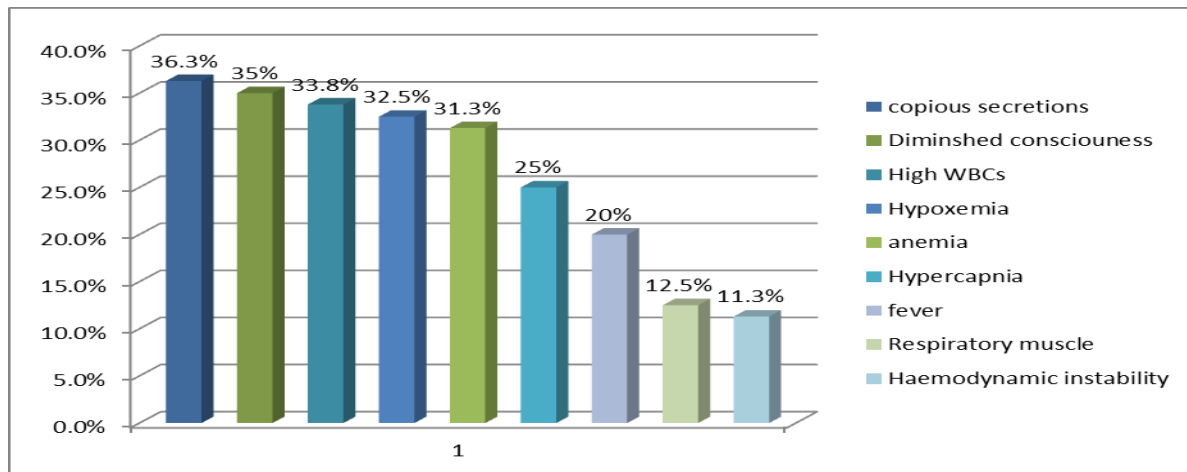


Figure (1): Percentage distribution of factors affecting extubation outcome

Table (1): Reveals personal characteristics and clinical data among the studied group. It shows that about 49% of the studied group was in the age group of (18-35) years old and the mean age of them was 40.56 ± 16.14 , in relation to sex, about 66% were males and about 34% females. Regarding medical diagnosis, about 57.5% diagnosed as traumatic patients. Most patients (62.5%) had no past history of diseases, the mean days of stay in intensive care unit were 11.9 ± 6.7 and for days on mechanical ventilation was (6.46 ± 3.96)

Table (2): Shows Ventilator parameters of the studied group, it shows that there is no statistical significant difference between reintubated and successfully extubated patients in relation to the ventilator parameters during SBT :(VT) , (RSBI), (Psupp)or (Ve) $P > 0.05$

Table (3): Shows that, regarding ABG before extubation, there was no statistical significant difference between extubation or reintubation groups $P < 0.05$. In relation to the arterial blood gases after extubation there was no significant difference between both groups regarding PH,PCO₂ and Po₂/Fio₂ but there was significant difference within normal range in relation to Po₂ and So₂. $P < 0.05$

Table (4): Shows statistical significant difference between groups in relation to body temperature one hour before extubation ($P < 0.05$), however no statistical significant difference between them regarding vital signs one after extubation ($P > 0.05$)

Table (5): Shows frequency and percentage distribution of the patients in the successfully extubated and reintubated by the Semi-quantitative cough strength score. It shows that 20% of patients who had no cough on command successfully extubated versus 80% of them reintubated, in comparison with 79% of the patients who developed multiple sequential strong coughs successfully

extubated versus 21% of them reintubated, with statistical significance difference ($P < 0.001$)

Figure (1): Shows the most common factors among the studied group which lead to Extubation failure that included presence of copious secretions ($P = 0.02$), diminished consciousness ($P = 0.001$) and hypoxemia ($P = 0.001$)

Discussion

Although mechanical ventilation is responsible for beneficial effects by giving positive pressure ventilation, it is also responsible for many complications .One of these complications is extubation failure (Hess & Kacmarek, 2014)

An ineffective cough, duration of mechanical ventilation more than 7 days and severe systolic left ventricular dysfunction were stronger predictors of extubation failure (Thille et al., 2015) Whitmore and Mahambray ,2015 suggested using the cough strength score, graded from 0-5 for predicting extubation outcome ,So this study aimed to evaluate factors affecting extubation outcome by using (SCSS) (Kteshat et al., 2017)

In present study, the mean age in the studied group was 40.5 ± 16.2 years old. More than half of the studied group were traumatic and most of them were males which can be attributed to the occurrence of traumatic accidents among men more than women in our country and the major entrance cause in the ICUs was trauma. Taking extubation outcome in consideration. Menon et al., (2012) studied the occurrence and complications of extubation failure in critically ill patients as they reported that male gender is more affected with extubation failure due to respiratory failure which was dominant on men than women in his study group.

The present study demonstrated that no statistical significant difference between successfully extubated

group and reintubated group in relation to RSBI, Vt and Ve ($P=0.07$, 0.095 and 0.78 respectively), this is can be attributed to diagnoses type as most of the studied group weren't respiratory diseased . This is in agreement with **Daun et al., (2015)** who used semi-quantitative cough strength score (SCSS) in predicting reintubation after planned extubation as they found that RSBI and Ve had no statistical significance difference between both groups, but he was in contrast with the finding of the present study in relation to Vt, this was attributed to implementing this study on respiratory diseased patients except COPD. Moreover **Lai et al., (2016)** found that there were significance difference between successfully extubated and reintubated groups concerning RSBI and Vt when they wanted to set indicators for successfully planned extubation. Furthermore **Phillip & Abouzgheib, (2012)** mentioned that higher f/VT ratio at the end of an SBT was associated with extubation failure

Oxygenation was an important component for predicting early extubation failure whereas lowering oxygenation was considered as risk factor for reintubation within 24hour of extubation **Miu et al., 2014, Cheng et al., (2011)** studied the outcomes and predictors of reintubation in intensive care patients and showed that oxygenation failure after extubation was one of causes leading to reintubation. **Nugent, (2016)** studied extubation management among high risk patients and reported that extubated patients should show satisfactory oxygenation before extubation.

In the present study there was statistical significant difference within normal range in relation to PO₂ and SO₂ (oxygenation) one hour after extubation. Lowering oxygenation within normal rang can be attributed to the fact that extubation was on true basis so the deceleration of PaO₂ and SaO₂ in reintubated patients wasn't deep.

In recent study there is no statistical significant difference between successfully extubated patients and reintubated patients regarding vital signs except for body temperature one hour before extubation ($P=0.001$) (**Weinberg et al., 2016**) studied risk factors for extubation failure among traumatic patients and reported that high body temperature at the time of extubation is associated with extubation failure, they attributed extubation failure because of fever due to presence of infectious or Inflammatory process. In Current study higher body temperature among reintubated patients can be attributed to prevalence of infection among them in the ICUs, small number of nurses /patients and mixing contagious diseased patients with non

Esquinas, (2016) stressed on the fact that Poor cough and inability of the patient to protect his airway

increase the risk of extubation failure. Moreover **Hughes & Black, (2011)** considered poor cough with secretion retention the most causes of extubation failure.

The current study presented that most (80%) of the patients who cannot no cough on command (grade =0) reintubated in comparison to more four fifth(79%) of patients who developed multiple sequential strong coughs (grade =5) successfully extubated. This mean that the higher SCSS the lower reintubation rate .This affirms that patients with high cough strength score more often to be successfully extubated.

It had been shown that patients with low cough strength score (CSS) were more likely to be reintubated and reintubation rate among patients cough strength score grade=0 were four times compared to that of patients with (grade=5) of SCSS, This is in an agreement with **Duan et al., (2015)** who reported that patients with SCSSs from 4 to 0 were 3.2 to 7.2 times more likely exposed to extubation failure in comparison to patient of SCSS with 5 degree and reintubation rate can reach 29% in patients with SCSS of 0 degree, they attributed this to many factors as lowering oxygen saturation in blood, hypercapnia, hemodynamic instability, diminished consciousness, diaphoresis, or clinical signs of respiratory muscle fatigue which precipitate to reintubation quickly. Moreover, it was in the line with **Kteshat et al., (2017)** who used semi-quantitative cough strength score in their studies and reported that reintubation incidence increased as semi-quantitative cough strength score reduced attributing reintubation to the association with cough strength **Whitmore & Mahambray, (2015)**, also suggested using cough strength score and reported that the degree of five is the strongest predictor of extubation success. (**Kteshat, et al., 2017**)

Many studies have addressed factors that were associated with extubation failure as Impaired neurological status, poor cough, Increased secretion, high APACHE score at the time of weaning, positive fluid balance ,age > 65 years ,Chronic respiratory disease and chronic cardiac disease (**Thille, et al., 2015**)

In current study the most common factors affecting extubation were copious secretions, diminished consciousness, hypoxemia and anemia respectively **Weinberg et al., (2016)** considered excessive respiratory secretions and low Glasgow coma scale (GCS) at extubation were some of factors associated with extubation failure. The current study was in the line with **Shadvar et al., (2013)** who studied risk factors of reintubation and addressed hypoxemia, decreased level of consciousness and copious secretions as factors can lead to extubation failure. Furthermore, **Parotto & Cooper, (2015)** reported

that number of factors contributes to extubation failure as hypoxemia, altered secretion production and others which attributed to reduced respiratory and hemodynamic reserve which may diminish tolerance to apnea Lee et al., (2017) studied factors associated with reintubation in an Intensive Care Unit and documented that anemia was associated with reintubation risk.

Conclusion

The most common factors affecting extubation were copious secretions, diminished consciousness, hypoxemia and anemia respectively. The higher SCSS the lower reintubation rate.

Recommendations

- The current study recommended reapplying this research adding Chest-physiotherapy for low cough strength score patients.
- Improve documentation of reintubation complications and its rates to measure the size of this problem accurately.

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