

Mortality Associated Factors of Patients with Mechanical Ventilation Treated at the Intensive Care Unit of a Second Level Hospital at Piedras Negras Coahuila Mexico

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ABSTRACT

Introduction: The mechanical ventilation is the cornerstone of treatment for patients with acute respiratory failure and is one of the pivotal therapies in critical care medicine. The epidemiology of mechanical ventilation in México is scarce and usually a transpolated of the information in high specialty centers. The mechanical ventilation has the aim of assisting in the elimination of CO₂ (carbon dioxide) and / or favoring the adequate exchange of oxygen while the patient is unable to do so or due to conditions external to the respiratory system. Quality indicators of attention are a quantitative measure that are used to assess important aspects of clinical practice.

Objective: Describe the epidemiology and mortality factors in mechanically ventilated patients treated at second level ICU in Piedras Negras, Coahuila México.

Material and Methods: retrospective study from December 2016 to December 2019 all patients treated with MV. We collected general demographic characteristics, quality indicators and complications, severity of disease and mortality.

Results: 164 patients were enrolled. Female 54.8%, main diagnoses Sepsis 30.5%, and DKA 13.4%, mean age 44.1 SD ± mean SOFA 7.2 SD ± 6.2, mean SAPS3 50.6 SD ± 20.2, ICU LOS 4.5 SD ± 5.1, Hospital LOS 11.7 SD ± 10.2 p<0.0001. ICU and Hospital mortality 14 % and 23.8%. The factors associated with ICU mortality were: Age, MV hours, Respiratory SOFA, and Hepatic SOFA and with Hospital mortality: Age, Neurological SOFA, Unstable at admission, SOFA and SAPS 3.

Conclusions: MV is a primordial need of critical care patients, our mortality was reported lower than expected but quality of attention indicators must be improved in order to maintain this trend. This study has several limitations in population and applicability but contributes with primordial information about MV critical care patients treated at México.

Keywords

Mechanical ventilation, México, Mortality, Critically ill.

Introduction

The mechanical ventilation (MV) is the cornerstone of treatment for patients with acute respiratory failure and is one of the pivotal

therapies in critical care medicine [1]. The first report of mechanical ventilation was conducted by Dr. Bjorn Ibsen in Copenhagen (1953), in patients with polio, reducing mortality from 87 to 25% [2]. The epidemiology of mechanical ventilation in situations resource-limited settings is scarce and usually a transpolated from high specialty centers [3].

The aim of mechanical ventilation is assisting in the elimination of CO₂ (carbon dioxide) and promote the adequate exchange of oxygen [4,5].

The non-invasive mechanical ventilation is a therapeutic option for patients requiring breathing assistance [1]. The use of non-invasive interfaces: nasal, oronasal, facial mask and helmet had proven to be suitable in the right patient profile [6]. The success of this method of ventilation is based on tolerance and cooperation of the patient [6].

Respiratory failure is the main indication for mechanical ventilation [8]. The ventilatory failure is characterized by an increase in pressure of arterial CO₂ (PaCO₂) because hypoventilation or increased work of breathing. Failure to maintain proper oxygenation is characterized by abnormally low relation between PaO and fraction of inspired oxygen (PaO₂: FiO₂) and / or a requirement of positive pressure to maintain this relationship [9].

Acute respiratory failure is one of the most common causes of admission to the Intensive Care Unit with 330,000 patients admitted annually in the United States [13].

Complications or adverse events associated with mechanical ventilation had an incidence of 4-7 events per 100 episodes of MV and 10-15 events per 1000 days in MV [14].

Adverse events in MV are associated with increased mortality, duration of MV, and stay in the intensive care unit and increase the use of antibiotics [15].

The Ventilation Associated Pneumonia (VAP), which takes place 48 hours after mechanical assistance [16], has a prevalence of 10 to 20% worldwide [17]. The incidence in developing countries is 16.7 to 73.4 1000 days of MV [18].

Quality indicators of attention are a quantitative measurement used to monitor and assess the quality of important aspects of clinical practice [19].

All indicators have a comparator to standard defined as: [19] the desired level of performance for the indicator.

The main indicators associated with MV are: [19]

Ulcer stress prophylaxis

Critical patients often develop gastrointestinal lesions and gastrointestinal bleeding (GB) due to the alteration in gastric perfusion. It is calculated with the following formula:

(Number of patients with gastrointestinal bleeding risk with enteral nutrition and not receiving pharmacologic prophylaxis / total number of patients in the ICU with risk of gastrointestinal bleeding receiving enteral nutrition) x 100

The population at risk of GB is defined: [20]

- MV > 48 hours
- Coagulopathy INR > 1.5 Platelets < 50 / nL or TPT > 2 times upper limit of normal
- Gastrointestinal bleeding < 12 months, multiorgan failure, sepsis, shock, burns, TBI, acute renal failure, previous acid peptic disease, renal transplant, use of high - dose corticosteroids.

Pharmacological prophylaxis includes proton pump inhibitors or H2 receptor antagonists [21].

Standard of compliance with this indicator is 80% [19]

Ventilator associated pneumonia (VAP)

It is common in the ICU, it has a direct impact in mortality and morbidity [23]. The population is all patients with invasive mechanical ventilation for more than 24 hours. It is calculated with the following formula

(Number of NAV events / Total days with MV) x 1000 days

Standard compliance is < 7 episodes per 1000 days of MV [19].

Accidental extubation

Accidental removal of endotracheal tube in patients with MV is an undesirable outcome, since it is associated with increased reintubation risk and mortality [24]. The population is all patients with invasive MV

(Number of accidental extubations / Total number of days with MV) x 1000

Standard compliance is < 3 accidental extubations for 1000 days endotracheal tube [19].

Reintubation

The reintubation by failure of elective extubation is associated with a longer hospital stay and mortality rate [25]. The elective extubation is done in scheduled basis and intentionally by a professional; the reintubation is defined as the requirement of intubation in the first 48 hrs after extubation. The population is all elective extubations except extubation for palliative care and reintubation for surgery. It is calculated with the following formula:

(number of reintubations / Number of elective extubations) x 100

Standard of compliance is < 12% [19].

In the US 180, 326 hospitalizations occurred in six states, requiring MV [13]. 52.2% of these patients were < 65 years old, these data estimate that there are 2.7 episodes of MV per 1000 residents [13].

In Mexico there is reported a trend in younger patients whom required MV, 43-48 years on average [26]. The mortality of these patients is 18-36% [26].

In our community, 55% of patients treated at ICU require MV [26]. Of this population, 61.8% had functional health status previous ICU, average age is 48.9 years [26]. The main diagnosis were Sepsis, Post-cpr and Traumatic Brain Injury [26]. The reported hospital mortality is 40.2% [26].

The impact on health, social and economy o patients with MV is important about \$ 600-1500 dollars per day [13] and subsequent morbidities imply a burden to family and society.

The aim of this study was to describe the epidemiology and mortality in patients with MV treated in the Intensive Care Unit at Hospital General de Zona 11 IMSS Piedras Negras Coahuila, identify that factors that were associated to mortality, describe the quality indicators of attention and analyze the comparison between actual and expected mortality by SAPS 3.

Material and Methods

We conducted a retrospective study from December 2016 to December 2019 all patients who were treated at the ICU of the Hospital General de Zona 11 IMSS in Piedras Negras, Coahuila, who required MV. We collected general demographic characteristics, diagnosis, origin service, previous in-hospital location, priority, admission factor, length of stay in ICU and hospital, quality indicators and complications, severity of disease, organ failure sequential assessment (SOFA), SAPS 3 and qSOFA. Using this data we calculate the quality indicators: Stress ulcer prophylaxis, Ventilator-associated pneumonia, Accidental extubation and Reintubation.

Statistical analysis was made with software version StatCalc or n 1500.1.3 © AcaStat software 2018. The quantitative variables were described in mean ± SD, qualitative in frequency and percentage, Goodness of fit test was made for significance distribution of qualitative variables with a p<0.05 T-test for quantitive variables with a p<0.05, Mid-P exact test was performed to evaluate the standardized mortality ratio of mechanical ventilated patients with p<0.05, quality of attention indicators were calculated as specified in Guías de calidad de Atención de SEMCyUC.

Results

During the 3 year timeframe 164 patients required MV in the ICU. Main characteristics were : Female 54.8% p=0.2, Health status previous ICU was Functional (no chronic disease) in 60.4% and Symtomatic (Patient had at least one chronic disease) 32.9% both p<0.0001. primary site of origin were ER 55.4% , Ward and OR 18.3% each p<0.0001, admission factor was Threat of organic failure in 32.3%, Need of Mechanical Ventilation 29.3 % and Shock 18.3 % p<0.0001, main diagnoses were Sepsis 30.5%, and DKA 13.4% p<0.0001. The mean age of the patients was 44.1 SD ± 19.6 p<0.0001, mean SOFA 7.2 SD ± 6.2 p<0.0001, mean SAPS3 50.6 SD ± 20.2 p<0.0001, ICU length of stay 4.5 days SD ± 5.1 p<0.0001, Hospital length of stay 11.7 days SD ± 10.2 p<0.0001. ICU mortality was 14 % p<0.0001, Hospital mortality was 23.8% p<0.0001 and 12.8 % p<0.0001 patients were transferred to other

hospital. Mortality calculated with SAPS3 was 35.8% SD ± 29.8% p<0.0001 (Table 1).

Table 1: Main Characteristics of critical care patients with MV at ICU Hospital General Zona 11 IMSS, Piedras Negras Coahuila 2016-2019.

	TOTAL n = 164	p
Female n (%)	90 (54.8%)	0.2
Age, years (SD)	44.1 (± 19.6)	<0.0001
ICU LOS (SD)	4.5 (± 5.1)	<0.0001
Hospital LOS (SD)	11.7 (± 10.2)	<0.0001
SOFA (SD)	7.2 (± 6.2)	<0.0001
SAPS 3 (SD)	50.6 (± 20.2)	<0.0001
SAPS 3 Mortality (SD)	35.8% (± 29.8)	<0.0001
qSOFA (SD)	1.6 (± 0.9)	<0.0001
	Outcomes	
ICU mortality n (%)	23 (14%)	<0.0001
Hosp mortality n (%)	39 (23.8%)	<0.0001
Transferred n (%)	21 (12.8%)	<0.0001
	Previous Activity and Health Status	
Functional (%)	99 (60.4%)	<0.0001
Symptomatic n (%)	54 (32.9%)	<0.0001
	Site of origin	
ER n (%)	99 (55.4%)	<0.0001
Ward n (%)	30 (18.3%)	<0.0001
OR n (%)	30 (18.3%)	<0.0001
	Admission factor	
Threat to organic failure n (%)	53 (32.3%)	<0.0001
Mechanical Ventilation n (%)	48 (29.3%)	<0.0001
Shock n (%)	30 (18.3%)	<0.0001
Other n (%)	33 (20.1%)	<0.0001
	Diagnosis	
Sepsis n (%)	56 (31.5%)	<0.0001
DKA n (%)	22 (13.4%)	<0.0001
TBI n (%)	11 (6.7%)	<0.0001
Otros n (%)	75 (48.4%)	<0.0001

ICU: Intensive Care Unit; ER: Emergency Room; OR: Operating Room; SAPS 3: Simplified Acute Physiology Score 3; qSOFA: quickSOFA; SOFA: Sequential Organ Failure Assessment; SD: Standard Deviation; TBI: Traumatic Brain Injury; DKA: Diabetic Ketoacidosis.

The complications reported in this cohort are described in Table 2

Table 2: Complications of critical care patients with MV at ICU Hospital General Zona 11 IMSS, Piedras Negras Coahuila 2016-2019.

	TOTAL n = 164	p
VAP n (%)	22 (13.4%)	<0.001
Accidental extubation n (%)	6 (3.6%)	<0.0001
Pneumothorax n (%)	2 (1.2%)	<0.0001
Reintubation < 24 hrs n (%)	5 (3%)	<0.0001
Unexpected Cardiac Arrest n (%)	11 (6.7%)	<0.0001
ICU Acquired Weakness n (%)	16 (9.8%)	<0.0001

VAP: Ventilator Associated Pneumonia; ICU: Intensive Care Unit.

The factors associated with ICU mortality with a p < 0.05 were:

Age, MV hours, Respiratory SOFA, and Hepatic SOFA. The factors associated with Hospital mortality with $p < 0.05$ were: Age, Neurological SOFA, Unstable at admission, SOFA and SAPS 3 (Table 3).

Table 3: Factors associated with mortality of critical care patients with MV at ICU Hospital General Zona 11 IMSS, Piedras Negras Coahuila 2016-2019.

ICU Mortality n= 142	OR IC 95%	p
Age	1.03 (1.02-1.03)	0.04
Gender Female	1.4 (1.3-1.5)	0.43
Functional Status previous ICU	0.62 (0.55-0.69)	0.27
Unstable at admission	1.8 (1.69-1.90)	0.30
MV hours	0.99 (0.98-0.99)	0.03
NIVMV hours	1.1 (1.09-1.11)	0.23
SOFA	1.08 (1.06-1.09)	0.34
SOFA Respiratory	1.66 (1.61-1.70)	0.04
SOFA Renal	1.06 (1.01-1.10)	0.80
SOFA Hepatic	0.53 (0.47-0.58)	0.04
SOFA Cardiovascular	1.30 (1.26-1.33)	0.22
SOFA Hematologic	1.21 (1.17-1.24)	0.36
SOFA Neurologic	1.29 (1.18-1.25)	0.17
SAPS 3	1.03 (1.02-1.033)	0.09
qSOFA	2.02 (1.95-2.08)	0.07
Hospital Mortality n=142	OR IC 95%	p
Age	1.07 (1.06-1.073)	0.0009
Gender Female	0.71 (0.61-0.80)	0.57
Symptomatic Status previous ICU	1.55 (1.46-1.63)	0.40
Unstable at admission	6.3 (6.10-6.40)	0.002
MV hours	0.99 (0.98-0.99)	0.65
NIVMV hours	0.64 (0.53-0.74)	0.51
SOFA	1.32 (1.30-1.33)	0.008
SOFA Respiratory	1.12 (1.07-1.17)	0.68
SOFA Renal	0.70 (0.65-0.74)	0.22
SOFA Hepatic	0.66 (0.61-0.71)	0.17
SOFA Cardiovascular	0.83 (0.79-0.86)	0.37
SOFA Hematologic	1.56 (1.51-1.60)	0.07
SOFA Neurologic	1.76 (1.72-1.79)	0.004
SAPS 3	1.12 (1.11-1.12)	0.0001
qSOFA	1.22 (1.16-1.27)	0.57

ICU: Intensive Care Unit; ER: Emergency Room; OR: Operating Room; SAPS 3: Simplified Acute Physiology Score 3; qSOFA: quickSOFA; SOFA: Sequential Organ Failure Assessment; SD: Standard Deviation; TBI: Traumatic Brain Injury; DKA: Diabetic Ketoacidosis.

The quality of attention indicators were: Ulcer Stress Prophylaxis 97%, DVT Prophylaxis 91.4%, VAP 37.8 per 1000 days of MV, Accidental extubation 12.1 per 1000 days of MV, Reintubation rate 7.6% and ICU weakness 46.7%.

The Standardized Mortality Ratio was 0.78 IC 95% 0.56-1.05 $p=0.1$

Discussion

In Mexico there is lack of information of critically ill patients treated with MV. General population characteristics had a predominance of Female 54.9% $p < 0.2$, this is different from reported in literature, Ming-Jang et al. [13] in Taiwan reported

male 61%, Esteban, et al [2] reported male 59.6%, nevertheless this was the only demographic characteristic that didn't reach statistical significance. The median age was 44.1 years $SD \pm 19.6$ it was younger as compared with European data that reported a mean age of 56 years $SD \pm 17$ [9] but the trend is to report younger patients and sometimes healthier in allocations similar to ours [1] in this issue we reported 60.4 % $p < 0.0001$ of patients had a activity and health status defined as functional, previous admission.

Recently Marin et al. [14] reported in epidemiological study of 959 patients in Mexico with MV in ICU a Male predominance with 66%. The mean age of this MV patients was 48.9 $SD \pm 19.4$, this was similar in mexican patients; 48 years $SD \pm 20.5$ [13]. The primary diagnosis in this population was Sepsis 31.5% $p < 0.0001$; Carrillo, et al [10] reported 27.1% of septic patients in 135 ICU at Mexico; International data reports 6%-30% ICU admissions with this diagnosis [11-12]. The mortality in ICU and hospital was 14% and 23.8% $p < 0.0001$, international data reports [9] higher ICU and hospital mortality 38.5% and 48% [9]. We reported a 21 patients (20.8%) were transferred to other hospital.

The majority of patients were reported as functional 50.3% and 40.2% were symptomatic ($p < 0.0001$), Balasubramanian, K et al [16] reported 237 adult patients treated at low-resource setting in India a 50% comorbidity illness (Diabetes Mellitus, Hypertension, COPD).

The quality of attention indicators we reported met international standard in ulcer stress prophylaxis and DVT prophylaxis, the ones that were above international standard were VAP, reintubation, ICU acquired weakness and accidental extubation [19]. To our knowledge there is no data available with this specific indicators in México, but it is reported that 30-56% of patients had a complication associated with MV [3,4,7].

The limitations of our study were: we only assessed one ICU of the three ICU available at site. We only admitted patients that were treated for the only intensive care physician at IMSS this could represent gap in patients admitted and discharged during weekends, all data was recorded, and the statistical analysis was made for the author, that was also the only intensive care physician in the city.

Despite this limitations we believe that the epidemiological data reported in this study contributes to better profiling of patients treated in Mexico and worldwide. The clinical outcomes (mortality) were better than expected, this reflects a committed team work (nurses and physician) in charge of MV patients and show the path for improvement.

In conclusion MV is a primordial need of critical care patients, our mortality was reported lower than expected but quality of attention indicators most be improved in order to maintain this trend. This study has several limitations in population and applicability but contributes with primordial information about MV critical care patients treated at México.

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