

# Evaluation of Various Scoring Systems in Prediction of Acute Carbon Monoxide Poisoning Outcome

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## Abstract

**Background:** Carbon monoxide (CO) poisoning is one of the most common fatal poisoning worldwide. Laboratory parameters and imaging studies have been used to predict late cardiac and neurological complications in CO poisoned patients. However, very few studies have applied scoring systems as predictors of CO poisoning outcome. **Objectives:** To evaluate various scoring systems used in emergency settings [Rapid Emergency Medicine Score (REMS), Modified Early Warning Score (MEWS) and Simple Clinical Score (SCS)] for outcome prediction in acute CO poisoned patients. **Methodology:** It was a cross-sectional study that was conducted on forty five acute CO poisoned patients. It was composed of two parts; retrospective (From 1<sup>st</sup> of January 2020 to 28<sup>th</sup> of February 2021) and prospective part (From 1<sup>st</sup> of March 2021 to 30<sup>th</sup> of June 2021). Patients with major medical conditions, pregnant females, smokers and those exposed to associated trauma and other substances in addition to CO were excluded. Using patients' data on admission, REMS, MEWS and SCS were calculated and compared for prediction of outcome. **Results:** On admission REMS, MEWS and SCS showed significant elevation in both mechanically ventilated and non-survivors when compared to non-mechanically ventilated patients and survivors. MEWS was excellent predictor for requirement of mechanical ventilation (AUC > 0.9). For mortality prediction; REMS, MEWS and SCS were all excellent (AUC = 1). **Conclusion:** REMS, MEWS and SCS are simple, rapid, reliable and applicable scoring system in predicting mechanical ventilation requirement and in-hospital mortality in acute CO poisoning.

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## Key words

Carbon monoxide (CO) poisoning, REMS score, MEWS and SCS scores, Mechanical ventilation, Mortality

## Introduction

Carbon monoxide (CO) poisoning is one of the most common fatal air born poisoning worldwide (Han et al., 2020). It is a tasteless, odorless and colorless gas, emitted by incomplete ignition of carbonaceous substances. Victims become comatose before realizing they are being poisoned (Rose et al., 2017).

Toxicity results from a combination of tissue hypoxia and direct carbon monoxide mediated damage at cellular level (Lai et al., 2016). Clinical presentation in patients with CO poisoning ranges from headache and dizziness to seizures, coma and death (Liao et al., 2019). Results of CO poisoning on humans are not always the same (Stucki and Stahl, 2020).

Laboratory parameters and imaging studies have been used to predict late cardiac and neurological complications with long term sequel (Lin et al., 2018). However, very few studies have applied scoring system to evaluate clinical features and laboratory tests as predictors of CO poisoning outcome (El-Gharbawy and Khalifa, 2019 & Wang et al., 2019).

Using scoring systems in medical practice usually support clinical decision making. They enable the physicians to diagnose diseases, assess patients' conditions and predict the outcome. In emergency situations scoring systems tend to be simple and based

mainly on clinical data with no or minimal incorporation of investigations (Oprita et al., 2014).

Many scores have been developed and validated for use in emergency department (Brabrand et al., 2010). The aim of this study was to evaluate various scoring systems used in emergency settings [Rapid Emergency Medicine Score (REMS), Modified Early Warning Score (MEWS) and Simple Clinical Score (SCS)] for outcome prediction in acute carbon monoxide poisoned patients.

## Patients and Methods

This cross-sectional study was carried out on acute carbon monoxide intoxicated patients admitted to Tanta Poison Control Center, Tanta Emergency University Hospital. It was composed of two parts; retrospective (From 1<sup>st</sup> of January 2020 to 28<sup>th</sup> of February 2021) and prospective part (from 1<sup>st</sup> of March 2021 to 30<sup>th</sup> of June 2021).

All patients above 12 years old, acutely intoxicated by CO were included in this study. Diagnosis of acute carbon monoxide intoxication was done depending on history of CO exposure, clinical findings (such as alteration in consciousness level, syncope, seizures, shortness of breath, chest pain and

palpitation) and/or carboxyhaemoglobin (COHb %) level >5% in non-smokers or >10% in smokers (*Hampson et al., 2012 & Rose et al., 2017*).

Patients with major medical conditions (e.g. cardiovascular disease, chronic obstructive pulmonary disease, renal or hepatic failure), pregnant females and smokers were excluded. Furthermore, patients who received any medications before admission and those exposed to associated trauma and other substances in addition to carbon monoxide were excluded. Retrospective patients with essential missed data were also excluded.

Sociodemographic data (including age, gender and residence) and toxicological data (including mode of exposure and time elapsed before hospital admission) were collected. Vital signs (Pulse, blood pressure, respiratory rate and temperature) and consciousness level were assessed and reported on admission. Investigations included; Electrocardiogram (ECG), blood oxygen saturation (using pulse oximeter) and blood carboxyhaemoglobin (using Rad.57 Signal Extraction Pulse CO-Oximeter device) (Masimo Rainbow SET ©, USA).

The following scoring systems were compared for outcome prediction in acute carbon monoxide poisoned patients:

1. Rapid emergency medicine score (REMS) using pulse rate, mean arterial pressure, respiratory rate, GCS, age and oxygen saturation. The minimum score is zero, while the maximum score is 26 by (*Olsson et al., 2004a*)
2. Modified Early Warning Score (MEWS) using respiratory rate, oxygen saturations, temperature, systolic blood pressure, pulse rate, level of consciousness (using AVPU scale) with a minimum score of zero and a maximum score of 14 (*Kelly et al., 2004*).
3. Simple clinical score (SCS) using the age, airway condition, breathing, circulation, disability, ECG, and temperature. The minimum score is zero and the maximum score is 21 (*Subbe et al., 2010*).

The previous scoring systems were compared for prediction of short-term outcome of all included patients. Primary outcome was in-hospital mortality; secondary outcome was need for mechanical ventilation (MV).

This study was conducted following approval from medical research ethical committee in Tanta Faculty of Medicine. All prospective patients (or their guardians) were asked to provide informed written consent for participation after receiving detailed information about the study. File records of retrospective patients were revived after administration approval. Patients' privacy, data confidentiality and the investigations results were maintained by using coding number.

Statistical analysis: MedCalc Statistical Software version 15.8 was used to analyze the collected data. The distribution of numerical data was determined according to the Shapiro-Wilk test for normality. Numerical data were summarized as mean  $\pm$  standard deviation (SD) for normally distributed variables or as the median and interquartile range

(IQR: 25th – 75th percentiles) for abnormally distributed variables. The comparison of the studied scores between two independent groups was done using the Mann-Whitney test. Spearman's rank-order correlation was performed to assess the relationship between the scores and relevant numerical variables. The categorical variables were summarized as frequencies. Receiver operating characteristics (ROC) curve was performed to identify the optimal cut-off point, sensitivity, specificity, positive and negative predictive values (PPV and NPV) for the studied scores. The area under the curve (AUC) was graded excellent (0.90-1.00), good (0.80-0.90), fair (0.70-0.80) and poor (0.60- 0.70).

## Results

During the period of the study, 45 acute CO poisoned patients have fulfilled inclusion criteria. Table (1) illustrates socio-demographic and toxicological data of studied patients. The age of patients ranged between 12 and 78 years old, with a median age of 26 years. All patients were accidentally exposed to CO, with a median delay of 2 hours before arrival.

Table (2) shows results of scoring systems used for clinical evaluation of patients. REMS, MEWS and SCS registered median values of 5, 4 and 4 respectively. Patients' oxygen blood saturation ranged from 40% to 100% with a mean value of  $88.8 \pm 14.3$ . On admission, carboxyhemoglobin (COHb) level ranged from 8% to 63% with a median value of 20%. Figure (1) demonstrates that 53.3% of patients stayed at hospital less than 24 hours. Mechanical ventilation was required in 15.6% of patients; death was reported in 8.9%.

On admission REMS, MEWS and SCS showed significant elevation in both mechanically ventilated and non-survivors when compared to non-mechanically ventilated patients and survivors as noticed in Table (3). Spearman's rank-order correlation revealed positive significant correlation between the studied scores on admission and patients' blood COHb level. On the other hand, duration of hospital stay had no significant correlation with any of the studied scores (Table 4).

Table (5) and figure (2) analyzed MEWS as excellent predictor for requirement of mechanical ventilation in receiver operating characteristics (ROC) curve, (AUC > 0.9) with 100% sensitivity at cut off value > 4 (specificity 65.8%). Good negative and positive predictive values were found in REMS and SCS (AUC > 0.8) with 100% and 57.1% sensitivity at cut off levels > 4 and 9 respectively (specificity 57.9% and 100% respectively). For mortality prediction; REMS, MEWS and SCS were all excellent (AUC = 1) with 100% sensitivity and specificity at cut off levels > 11, 7 and 9 respectively.

**Table (1): Age, Gender, residence and delay hours of acutely poisoned patients with carbon monoxide (N=45).**

<b>Age (years)</b>	Median [IQR] (Min-Max)	26 [20 - 44] (12 - 78)	
<b>Gender</b>	Male	27	60%
	Female	18	40%
<b>Residence</b>	Rural	34	75%
	Urban	11	24.4%
<b>Delay (hours)</b>	Median [IQR] (Min-Max)	2 [1 - 4] (1 - 10)	

*IQR: interquartile range; Max: maximum; Min: minimum; SD: standard deviation*

**Table (2): Scoring systems, O<sub>2</sub> saturation, Co level on admission of acutely poisoned patients with carbon monoxide (N=45).**

<b>REMS</b>	Median [IQR] (Min-Max)	5 [2 - 8] (0 - 20)
<b>MEWS</b>	Median [IQR] (Min-Max)	4 [2 - 6] (0 - 10)
<b>SCS</b>	Median [IQR] (Min-Max)	4 [2 - 8] (0 - 10)
<b>O<sub>2</sub> saturation (%)</b>	Mean ± SD (Min-Max)	88.8 ± 14.3 (40 - 100)
<b>CO level (%)</b>	Median [IQR] (Min-Max)	20 [12 - 28] (8 - 63)

*REMS: Rapid Emergency Medicine Score, MEWS: Modified Early Warning Score, SCS: Simple Clinical Score, O<sub>2</sub>: Oxygen, CO: carbon monoxide. IQR: interquartile range, Max: maximum; Min: minimum; SD: standard deviation.*

**Table (3): Comparison of scoring systems on admission between patients categorized according to the need of mechanical ventilation and mortality in acute carbon monoxide poisoning (N=45) using Mann-Whitney test.**

		Mechanical ventilation		Mann-Whitney test		Mortality		Mann-Whitney test	
		Yes	No	Z	p	yes	No	Z	P
<b>REMS</b>	Median [IQR] (Min-Max)	17.0 [7 - 18] (5 - 20)	4.0 [2 - 7] (0 - 11)	3.139	0.001*	18 [17 - 19] (17 - 20)	4 [2 - 7] (0 - 11)	3.294	<0.001*
<b>MEWS</b>	Median [IQR] (Min-Max)	8 [6 - 10] (5 - 10)	3 [2 - 5] (0 - 7)	3.549	<0.001*	10 [9 - 10] (8 - 10)	4 [2 - 6] (0 - 7)	3.294	<0.001*
<b>SCS</b>	Median [IQR] (Min-Max)	10 [5 - 10] (4 - 10)	3 [1 - 7] (0 - 9)	2.851	0.003*	10 [10 - 10] (10 - 10)	3 [1 - 6] (0 - 9)	3.290	<0.001*

*REMS: Rapid Emergency Medicine Score, MEWS: Modified Early Warning Score, SCS: Simple Clinical Score, IQR: interquartile range; Max: maximum; Min: minimum; \* significant at p<0.05\**

**Table (4): Spearman's rank-order correlation between scoring systems on admission and the duration of hospital stay of acutely poisoned patients with carbon monoxide (N=45)**

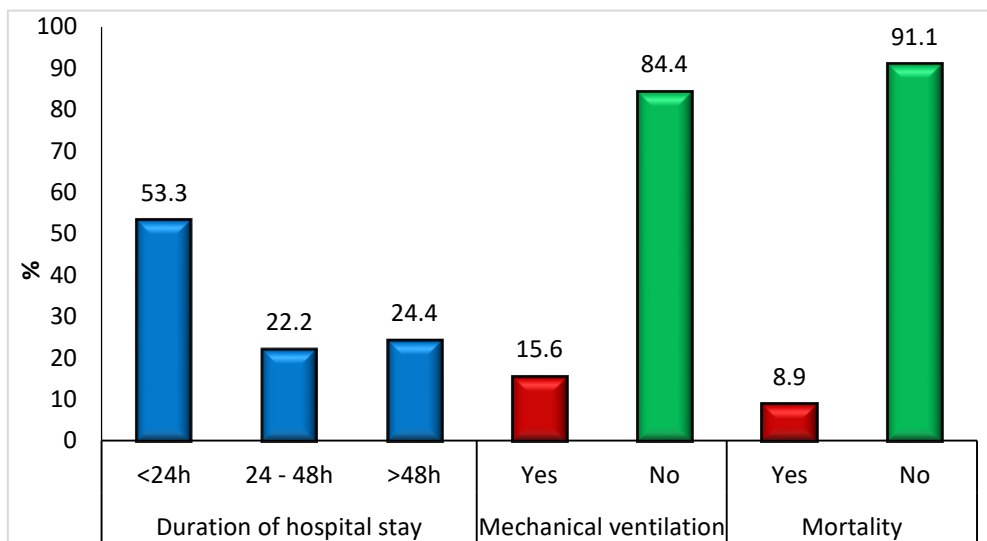
		Duration of hospital stay	CO level (%)
		<b>REMS</b>	r <sub>s</sub>
	p	0.076	0.001*
<b>MEWS</b>	r <sub>s</sub>	0.109	0.340
	p	0.477	0.022*
<b>SCS</b>	r <sub>s</sub>	0.235	0.415
	p	0.120	0.005*

*REMS: Rapid Emergency Medicine Score, MEWS: Modified Early Warning Score, SCS: Simple Clinical Score, rs: coefficient of Spearman's rank-order correlation; \* significant at p < 0.05.*

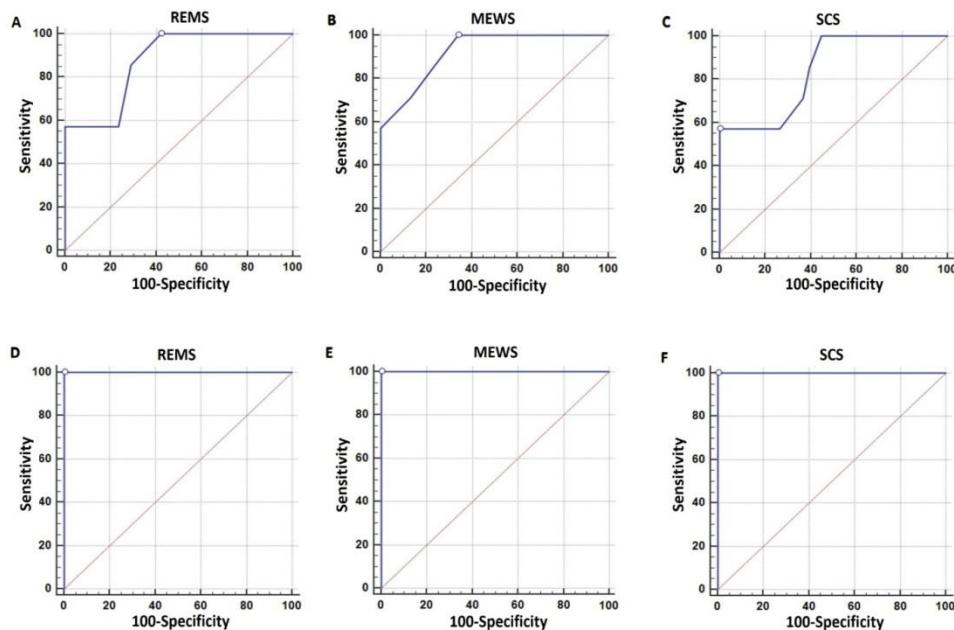
**Table (5): Diagnostic performance of REMS, MEWS & SCS in prediction the need for mechanical ventilation and mortality by receiver operating characteristic (ROC) curve analysis.**

	AUC	(95% CI)	p	Cut-off value	Sensitivity(%)	Specificity(%)	PPV(%)	NPV(%)
<b>Mechanical ventilation</b>								
<b>REMS</b>	0.874	0.741 - 0.954	<0.001*	>4	100.0	57.9	30.4	100
<b>MEWS</b>	0.923	0.803 - 0.981	<0.001*	>4	100.0	65.8	35.0	100
<b>SCS</b>	0.840	0.700 - 0.932	<0.001*	>9	57.1	100	100	92.7
<b>Mortality</b>								
<b>REMS</b>	1	0.921 - 1	<0.001*	>11	100	100	100	100
<b>MEWS</b>	1	0.921 - 1	<0.001*	>7	100	100	100	100
<b>SCS</b>	1	0.921 - 1	<0.001*	>9	100	100	100	100

REMS: Rapid Emergency Medicine Score, MEWS: Modified Early Warning Score, SCS: Simple Clinical Score, AUC: area under ROC curve; CI: confidence interval; \*significant at  $p < 0.05$



**Fig. (1): Outcome of acutely poisoned patients with carbon monoxide (N=45).**



**Fig. (2): Receiver Operating Characteristic (ROC) curve analysis for Rapid Emergency Medicine Score (REMS), Modified Early Warning Score (MEWS), and Simple Clinical Score (SCS) as predictors of mechanical ventilation (A, B, & C, respectively) and mortality (D, E, & F, respectively).**

## Discussion

CO poisoning is known to have several complications and high fatality rate. However, they are potentially preventable if they are early recognized and adequately treated (Tabrizian *et al.*, 2018). Prediction of complications in CO poisoned patients is believed to be a challenging task. Hence, this study was designed to evaluate different scoring systems as predictors of severity, course and prognosis of carbon monoxide poisoning.

The present study revealed that, socio-demographic & toxicological data, clinical presentation and COHb level in the studied patients were more or less in agreement with data gathered by comparable researches in Egypt and worldwide (Ghosh *et al.*, 2016; Sikary *et al.*, 2017; Huang *et al.*, 2017; El-Gharbawy and Khalifa, 2019 & Roca-Barceló *et al.*, 2020).

In the current study, REMS has recorded a median value of 5. The REMS was introduced by (Olsson *et al.*, 2004<sub>a</sub>), for mortality rate prediction among nonsurgical patients. It incorporates age, heart & respiratory rate, blood pressure, Glasgow Coma Scale (GCS) and oxygen saturation. According to (Hu *et al.*, 2020). In emergency situations, REMS was effective in risk stratification for critically ill patients, which was attributed to its high negative predictive value.

Significant elevation was detected in REMS parameters in both mechanically ventilated and died patients when compared to non-mechanically ventilated patients and survivors. A result that agrees with (Olsson *et al.*, 2004<sub>b</sub>), (Abd Elghany *et al.*, 2018) & (El-Gharbawy and Khalifa, 2019) who recorded significantly higher REMS values in non-survivors in comparison with survivors. Furthermore, (Cattermole *et al.*, 2009) recorded significant increase of REMS in patients who needed ICU or died when compared to those who had better prognosis.

In the current study, REMS was good predictor for requirement of mechanical ventilation at cut off value > 4. This matches with (Olsson and Lind, 2003), (Goodacre, Turner and Nicholl, 2006), (El-Sarnagawy and Hafez, 2017) & (Abd Elghany *et al.*, 2018) who supposed REMS as a valuable scoring system that tends to be a good predictor of morbidity and duration of hospitalization in patients admitted to the Emergency department (ED).

Furthermore, El-Sarnagawy and Hafez (2017) reported that REMS was a good predictor for mechanical ventilation in drug-overdosed patients with disturbed conscious level. Such finding comes in line with results obtained in the current study where REMS registered 100% sensitivity i.e. REMS was able to predict all patients who needed mechanical ventilation.

REMS registered excellent mortality prediction at cut off level > 11 in this study. However, at the same cut off level it was found to be good predictor for mortality in non-surgical patients admitted to ED according to (Olsson *et al.* 2004<sub>b</sub>, & Chang *et al.* 2018 & El-Gharbawy and Khalifa 2019).

In the present study MEWS has recorded a median value of 4. Xie *et al.* (2018) supposed MEWS as a simple tool, designed for bedside assessment of

critically ill patients by nursing staff in a busy clinical area. It is a defined judgment based on routinely recorded physiological parameters including systolic blood pressure, respiratory rate, pulse rate, temperature and AVPU score. It is able to identify patients at risk of deterioration and in need of further medical intervention.

Subbe *et al.*, (2003), Reini *et al.* (2012) & Kirsch *et al.* (2020); Identified MEWS components with strong correlation to the need for ICU admission. These components include lower systolic blood pressure and increased both heart rate and respiratory rate. Considering these data, it was expected to find significant elevation in MEWS parameters in both mechanically ventilated and non-survivors when compared to non-mechanically ventilated patients and survivors.

In the current study, MEWS was excellent predictor for requirement of mechanical ventilation at cut off value > 4 with 100% sensitivity i.e. MEWS was able to predict all patients who needed mechanical ventilation. A result coincides with Subbe *et al.*, (2003) & Salottolo *et al.* (2017) who supposed 4 as a critical score that indicate increased risk of catastrophic deterioration of patients.

According to Subbe *et al.*, (2003) & Kirsch *et al.* (2020), MEWS cut off value of 5 was modified to 7 to be more sensitive and specific record when considering ICU admission. MEWS of at least six was considered by Reini *et al.* (2012) as a predictor of both longer stay at ICU and mortality. Hence, several authors considered MEWS as a helpful screening tool to classify patients for further treatment on ward or ICU.

In the current study, for mortality prediction; MEWS was excellent at cut off levels > 7. According to Xie *et al.* (2018) the MEWS was a good tool for in-hospital mortality prediction. With higher ratio of in-hospital mortality at high scores, indicating that MEWS was significantly correlated with patient mortality. This comes in line with data gathered by Kirsch *et al.* (2020), who found that > 7 MEWS carried a nearly 3-fold increased risk of mortality.

In the present study, SCS has recorded a median value of 4. It includes age, airway condition, breathing, circulation, disability, ECG, and temperature. SCS represents a useful algorithm to assist clinical judgment to prognosticate critically ill patients. It could quickly and accurately identify high risk patients who might benefit from enhanced care to avoid adverse outcomes without waiting for further investigations (Subbe *et al.*, 2010 & Stræde and Brabrand, 2014).

Significant elevation was detected in SCS parameters in both mechanically ventilated and died patients when compared to non-mechanically ventilated patients and survivors. This finding correlates to data gathered by Shahin and Hafez (2020) who believed that SCS was significantly different between mechanically ventilated patients and non-mechanically ventilated as well as between survivors and non-survivors.

According to Li et al. (2012) SCS predicts mortality with acceptable accuracy and excellent discrimination. It is very accurate and predicts 30-day mortality that could be difficult to predict clinically. Nevertheless, it is more difficult to use in daily practice. In general, most fatalities are preceded by abnormalities in vital signs, that would raise the score (Stræde and Brabrand, 2014).

In the current study, SCS was good predictor for requirement of mechanical ventilation at cut off value > 9 with 100% specificity i.e. SCS was able to predict all patients who did not need mechanical ventilation. Moreover, SCS had a positive predictive value (PPV) of 100% i.e. (the probability that a patient with SCS >9 will need mechanical ventilation is 100%).

SCS was utilized by Li et al. (2012) as a risk stratification tool. It might help to indicate timeframe and to decide management plan for ICU admission. In the same time, Shahin and Hafez (2020). Registered >3 as a cut off value for prediction of mechanical ventilation. However, they recorded a specificity of 76% compared to 100% specificity at cut off value > 9 in this study.

At cut off level > 9, SCS was excellent predictor of mortality with 100% specificity and sensitivity in the current study. Stræde and Brabrand (2014). have found that, SCS was excellent in identification of patients at high risk of mortality with good accuracy. Recently, a cut off value of SCS > 4 was registered as good mortality predictor with specificity 85% and sensitivity 86% (Shahin and Hafez, 2020).

On admission, positive significant correlation was found between REMS, MEWS and SCS and patients' blood COHb level. *Gozubuyuk et al. (2017)* supposed that, symptoms of poisoning are linked to carboxyhaemoglobin level. However, Köthe and Radke (2010) considered initial COHb level as an inaccurate reflection of a patients' exposure because COHb levels decrease with time and with oxygen treatment. On the other hand, duration of hospital stay had no significant correlation with REMS, MEWS and SCS.

Toxicology researches lack a well-accepted method for assessing severity of CO poisoning in emergency department (Roca-Barceló et al. 2020 & Han et al., 2021). The current study is unique to investigate REMS, MEWS & SCS as a predictor of the need for ventilation and mortality in acute CO poisoned patients in Egypt. However, Aksu et al. (2012) have concluded that using admission vital signs alone for outcome prediction could be misleading, as patients may present very early with quite stable vital signs.

According to data gathered in the current study, MEWS was found to be an excellent predictor of both need for mechanical ventilation and mortality. In the same time, both REMS & SCS were found to be good predictor of need for mechanical ventilation and excellent predictor of mortality. Hence, the authors believe that MEWS will be a suitable score to help doctors to predict both need for mechanical ventilation and mortality. It would be beneficial for emergency and toxicology resident doctors to apply MEWS score in acute CO intoxicated patients so as to control need for mechanical ventilation subsequently saving hospital resources.

## Conclusion

In conclusion, REMS, MEWS and SCS are simple, easy, rapid, reliable and applicable scoring system that does not consume time, require several laboratory variables which could be unavailable at admission or highly qualified personnel. Hence, they seem to be helpful in predicting mechanical ventilation requirement and in-hospital mortality in acute CO poisoning.

## Study Limitation

Being a single center study with limited number of patients in a specific local setting is a major limitation of the current study. For technical reasons, we were unable to collect data about use of hyperbaric oxygen in treatment of included patients.

## Recommendations

Further multicenter researches on larger scales with ability to follow up hyperbaric oxygen treatment are needed to confirm the results of the current study.

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## تقييم أنظمة قياسية مختلفة للتنبؤ بنتائج التسمم الحاد بأول أكسيد الكربون

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### الملخص العربي

**المقدمة:** يعد غاز أول أكسيد الكربون واحدا من أكثر الغازات المسببة للتسمم الحاد في جميع أنحاء العالم. وتتراوح الأعراض المرضية في حالات التسمم الحاد به من أعراض بسيطة كالغثيان وضيق التنفس إلى أعراض خطيرة كالشنجات والغيوبه وإضرابات في عضلة القلب. كما أن المضاعفات الناتجة عنه من الصعب التنبؤ بها، حيث تختلف نتائج التسمم الحاد به من شخص إلى آخر. وعلي الرغم من إجراء العديد من الدراسات للتنبؤ بالمضاعفات الناتجة عن التسمم الحاد بأول أكسيد الكربون إلا أن هذه الدراسات اعتمدت على نتائج التحاليل المعملية والأشعة التصويرية التي قد يتعذر توفرها في جميع الأحيان.

**الهدف من الدراسة:** كان الهدف من هذه الدراسة هو تقييم أنظمة التسجيل المختلفة المستخدمة في حالات الطوارئ (نظام طب الطوارئ السريع، ونظام الإنذار المبكر المعدل ونظام النتائج السريرية البسيطة) للتنبؤ بالنتائج في المرضى المصابين بالتسمم الحاد بأول أكسيد الكربون. **طريقة البحث:** تعد الدراسة الحالية دراسة مقطعية أجريت على خمسة وأربعين مريضاً يعانون من التسمم الحاد بأول أكسيد الكربون. وقد تمت هذه الدراسة على جزئين: الأول بأثر رجعي (من بداية يناير ٢٠٢٠ إلى نهاية فبراير ٢٠٢١) والثاني جزء مرتقب (من بداية مارس ٢٠٢١ حتى نهاية يونيو ٢٠٢١). وقد تم استبعاد المرضى الذين يعانون من حالات طبية خطيرة والذين تعرضوا لأي إصابات مصاحبه للتسمم كما تم استبعاد المرضى المصابين بتسمم من أي سموم أخرى مصاحبه لغاز أول أكسيد الكربون. وقد تم استخدام بيانات المرضى المسجله وقت دخول المستشفى؛ لحساب النقاط الخاصه بأنظمة التسجيل الطبيه المستخدمه بالدراسه (نظام طب الطوارئ السريع، ونظام الإنذار المبكر المعدل ونظام النتائج السريرية البسيطة) ومن ثم مقارنة هذه الأنظمة من حيث دورها في التنبؤ بنتائج التسمم الحاد بأول أكسيد الكربون في الحالات محل الدراسه. **النتائج:** أظهرت نتائج تقييم المرضى وقت دخول المستشفى ارتفاعاً كبيراً في مجموع النقاط لأنظمة التسجيل الثلاثة في الحالات التي تم وضعها على أجهزة تنفس صناعي وحالات الوفاة مقارنة بالحالات التي تعافت دون الإحتياج لأجهزة التنفس الصناعي. وقد أظهرت أنظمة القياس الثلاثة نتائج ممتازة من حيث قدرتها على التنبؤ بحدوث الوفاة في حالات التسمم الحاد بأول أكسيد الكربون. **الخلاصة:** يمكن الإعتماد على أنظمة القياس الثلاثة في تقييم حالات التسمم الحاد بأول أكسيد الكربون وقت دخول المستشفى كوسيلة سريعة وسهلة للتنبؤ بتطورات الحالات من حيث إحتياجها لأجهزة التنفس الصناعي أو حدوث مضاعفات خطيره أثناء علاجها بالمستشفى قد تؤدي إلى الوفاة. **التوصيات:** نوصي بمزيد من الأبحاث في مراكز السموم المختلفه مع متابعه الحالات التي تم علاجها بالاكسجين عالي الضغط وذلك لتأكيد نتائج الدراسه الحالية.