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SURVEILLANCE OF HOSPITAL ACQUIRED INFECTIONS IN A MEDICAL INTENSIVE CARE UNIT

By

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Abstract

Introduction: Hospitalized patients are at risk to develop sepsis from infections due to colonized intravenous lines, surgical wounds, and/or bedsores. Multidrug resistant Acinetobacter commonly colonizes patients in the intensive care unit (ICU) and can cause serious infections. The APACHE II severity score has shown a good calibration and discriminatory value across a wide range of disease processes, and remains the most commonly used international severity scoring system worldwide. **Aim of work:** to evaluate the patients having different types of hospital-acquired infections in the medical ICU, especially infections caused by multidrug resistant organisms (as Acinetobacter spp.), in a specific period of time, applying the APACHE II scoring system of severity. **Materials and methods:** The study included 148 patients from the medical ICU in Cairo University Hospital. Routine laboratory investigations were done together with chest X-rays, ECG, abdominal ultrasound and bacterial cultures, and APACHE II scores were calculated for all patients. **Results:** We found that the most common cause of death in ICU patients in our study was sepsis (48% of all deaths). Most frequently reported isolated organisms were Klebsiella spp. (24.4%), E-coli (21.8%), and Acinetobacter spp. (17.1%). There was a meaningful association between observed mortality rates in patients in ICU and their APACHE II score evaluation, so APACHE II score had a strong positive correlation with actual mortality rate. **Conclusion:** Sepsis was the cause of high mortality rates in medical ICU, and the most important step in the prevention and control of infection in the ICU is continuous application of effective infection control measures.

Key words: Hospital-acquired infections, ICU, APACHE II, Sepsis and Klebsiella spp.

Introduction

Hospitalized patients are at risk to develop sepsis from infections due to intravenous lines, surgical wounds, and/or bedsores (Martin et al., 2003).

Because antibiotic use has increased, many strains of bacteria have become resistant to antibiotics, making the treatment of sepsis more difficult in some cases (Dellinger et al., 2008).

Acinetobacter baumannii is a pleomorphic aerobic gram-negative bacillus (similar in appearance to Haemophilus influenzae on Gram stain). It is a water organism and preferentially colonizes in aquatic environments. This organism is often cultured from hospitalized patients' sputum or respiratory secretions, wounds, and urine. In a hospital setting, Acinetobacter commonly colonizes irrigating solutions and intravenous solutions (Pollack and Andrew, 2010).

Acinetobacter infections usually involve organ systems that have a high fluid content (eg, respiratory tract, cerebro-spinal fluid, peritoneal fluid and urinary tract), manifesting as hospital-acquired pneumonia, infections associated with continuous ambulatory peritoneal dialysis (CAPD), or catheter-associated bacteruria. The presence of Acinetobacter isolates from respiratory secretions from intubated patients nearly always represents colonization. Acinetobacter pneumonias occur in outbreaks and are usually associated with colonized respiratory-support equipments or fluids. Hospital-acquired meningitis may occur in colonized neurosurgical patients with external ventricular drainage tubes (Krol et al., 2009).

Multidrug-resistant Acinetobacter is not a new or emerging phenomenon. It has always been an organism inherently resistant to multiple antibiotics (Kramer et al., 2006).

Acinetobacter colonization is particularly common in patients who are intubated and in those who have multiple intravenous lines or monitoring devices, surgical drains, or indwelling urinary catheters. First-line treatment is with a carbapenem antibiotic such as imipenem, but carbapenem resistance is increasingly common. Other treatment options include polymyxins, tigecycline, and aminoglycosides. There are some specific treatments in

developing stage in order to overcome the resistance of this bacterium, using a specific bacteriophage against this type of bacteria. This may cause harsh pneumonia (Bassetti et al., 2011).

Scoring systems for use in ICU patients have been introduced and developed over the last 30 years. They allow an assessment of the severity of disease and provide an estimate of in-hospital mortality. A weighting is applied to each variable, and the sum of the weighted individual scores produces the severity score. Various factors have been shown to increase the risk of in-hospital mortality after admission to ICU, including increasing age and severity of acute illness, certain pre-existing medical conditions (e.g. malignancy, immune-suppression, and requirement for renal replacement therapy), and emergency admission to ICU (Lemeshow and Le Gall, 2005).

Scoring systems can be classified into:

First day scoring systems

APACHE scoring systems (Acute Physiology And Chronic Health Evaluation).

SAPS (Simplified Acute Physiology Score).

MPM (Mortality Prediction Model).

Repetitive scoring systems

OSF (Organ System Failure).

SOFA (Sequential Organ Failure Assessment).

MODS (Multiple Organ Dysfunction Score).

(Mourouga et al., 2006)

The ideal scoring system would have the following characteristics:

1. On the basis of easily/routinely recordable variables
2. Well calibrated
3. A high level of discrimination
4. Applicable to all patient populations
5. Can be used in different countries
6. The ability to predict functional status or quality of life after ICU discharge (Lemeshow et al., 2004).

The Acute Physiology and Chronic Health Evaluation (APACHE) score is probably the best-known and most widely used score. The APACHE II scoring system was released in 1985 and

incorporated a number of changes from the original APACHE. The APACHE II severity score has shown a good calibration and discriminatory value across a range of disease processes, and remains the most commonly used international severity scoring system worldwide (Knaus et al., 1985).

Aim of work

To evaluate patients having different types of hospital-acquired infections in the medical ICU, especially infections caused by multidrug resistant organisms (as Acinetobacter spp.), in a specific period of time, in order to determine the prognosis of those patients, and how the hospital-acquired infection can affect the outcome of patients in the medical ICU.

Materials and methods

- **Study design:** Prospective (follow-up) study.
- **Place and duration of the study:** The study was conducted in medical ICU of Kasr El-Ainy hospital during six months from 1st May 2011 to 30 October 2011.
- **Study sample:** It included all patients admitted in the medical ICU starting from 1st May 2011 and discharged or died before 30 October 2011. The number was 148 patients.

Study methods:

- Blood sample for complete blood count, liver functions, renal functions, electrolytes, and arterial blood gases, were collected and sent soon after the patient was admitted to the ICU.
- Chest X Ray, ECG, Abdominal ultrasound, and bacterial culture / sensitivity and other relevant investigations were done according the individual requirements.
- APACHE II scores were calculated manually and using web based calculators, assessed in the first 24 hrs after ICU admission.

The APACHE II Severity of Disease Classification System

(Knaus et al., 1985)

Physiologic Variable	High Abnormal Range					Low Abnormal Range				
	+4	+3	+2	+1	0	+1	+2	+3	+4	Points
Temperature - rectal (°C)	≥41°	39 to 40.9°		38.5 to 38.9°	36 to 38.4°	34 to 35.9°	32 to 33.9°	30 to 31.9°	≤29.9°	
Mean Arterial Pressure - mm Hg	≥160	130 to 159	110 to 129		70 to 109		50 to 69		≤49	
Heart Rate (ventricular response)	≥180	140 to 179	110 to 139		70 to 109		55 to 69	40 to 54	≤39	
Respiratory Rate (non-ventilated or ventilated)	≥50	35 to 49		25 to 34	12 to 24	10 to 11	6 to 9		≤5	
Oxygenation: A-aDO2 **or** PaO2 (mm Hg) a. FIO2 ≥0.5 record A-aDO2 b. FIO2 <0.5 record PaO2	≥500	350 to 499	200 to 349		<200 PO2>70	 PO2 61 to 70		 PO2 55 to 60	 PO2<55	
Arterial pH (preferred) Serum HCO3 (venous mEq/l) (not preferred, but may use if no ABGs)	≥7.7 ≥52	7.6 to 7.69 41 to 51.9		7.5 to 7.59 32 to 40.9	7.33 to 7.49 22 to 31.9		7.25 to 7.32 18 to 21.9	7.15 to 7.24 15 to 17.9	<7.15 <15	
Serum Sodium (mEq/l)	≥180	160 to 179	155 to 159	150 to 154	130 to 149		120 to 129	111 to 119	≤110	
Serum Potassium (mEq/l)	≥7	6 to 6.9		5.5 to 5.9	3.5 to 5.4	3 to 3.4	2.5 to 2.9		<2.5	
Serum Creatinine (mg/dl) Double point score for acute renal failure	≥3.5	2 to 3.4	1.5 to 1.9		0.6 to 1.4		<0.6			
Hematocrit (%)	≥60		50 to 59.9	46 to 49.9	30 to 45.9		20 to 29.9		<20	
White Blood Count (total/mm3) (in 1000s)	≥40		20 to 39.9	15 to 19.9	3 to 14.9		1 to 2.9		<1	
Glasgow Coma Score (GCS) Score = 15 minus actual GCS										
A. Total Acute Physiology Score (sum of 12 above points)										
B. Age points (years) ≤44=0; 45 to 54=2; 55 to 64=3; 65 to 74=5; ≥75=6										
C. Chronic Health Points (see below)										
Total APACHE II Score (add together the points from A+B+C)										

N.B: Chronic Health Points: If the patient has a history of severe organ system insufficiency or is immune-compromised as defined below, assign points as follows:

5 points for non operative or emergency postoperative patients

2 points for elective postoperative patients (Knaus et al., 1985)

Interpretation of APACHE II Score (Knaus et al., 1985):

Score	Death rate (%)
0-4	4
5-9	8
10-14	15
15-19	25
20-24	40
25-29	55
30-34	75
>34	85

Consent

An informed verbal consent of study subjects (or their families in unconscious patients) to participate in the study was obtained before the start of work, with assurance of confidentiality and anonymity of the data.

Ethical approval

Approval of the administration authority of Kasr Al-Aini hospital and medical ICU was obtained.

Data management

SPSS version 11 was used for data analysis, including the causes of admission in the medical ICU, causes of mortality in the medical ICU, mortality rate in most of admission diagnoses, organisms isolated from bacterial culture / sensitivity of cases died with sepsis, APACHE II score and duration of stay. Chi- square test was used to examine the association of categorical variables such as APACHE II score with mortality. Pearson Chi-square test was used to determine the association between APACHE II score and the mortality rates of different groups of APACHE II score. Results were considered statistically significant when $p<0.05$.

Results

Table (1): Mortality rate and causes of death among the studied group

Mortality rate	**Frequency**	**%**
Total number of patients	148	100
Number of deaths	52	35.1
Number of survived patients	96	64.9
Cause of Death	**Frequency**	%
Septic shock	25	48.2
Cardiogenic shock	10	19.2
Malignancy (late stage)	5	9.6
Hepatorenal syndrome	4	7.7
Hypovolemic shock (hemorrhage)	4	7.7
Respiratory failure	2	3.8
Cerebral hemorrhage	2	3.8

Table (1) showed that the mortality rate of the studied group was 35.1%. The most common cause of death was septic shock (48.2%).

Table (2): Causative organisms isolated from cases died with sepsis.

Organism	**Acinetobacter**	**Klebsiella**	**MRSA**	**E-coli**	**Pseudomonas**	**No growth**	**Total**
Frequency	6	5	4	1	1	8	25
Percent	24%	20%	16%	4%	4%	32%	100

Table (2) showed that the most commonly isolated organism from patients died with septic shock in the studied group was Acinetobacter (24%), followed by Klebsiella (20%). No growth means failure to detect the pathogen in the blood.

Table (3): Number and percent of patients in different groups of APACHE II score and association between APACHE II and outcome.

APACHE II	Number and percent	Survived	Died
		No %	No %
0-4	4 (2.7)	4 (100)	0
5-9	19 (12.8)	18 (94.7)	1 (5.35)
10-14	45 (30.4)	37 (82.2)	8 (17.8)
15-19	36 (24.3)	24 (66.7)	12 (33.3)
20-24	14 (9.5)	4 (28.6)	10 (71.4)
25-29	19 (12.8)	7 (36.8)	12 (63.2)
30-34	9 (6.1)	2 (22.2)	7 (77.8)
>35	2 (1.4)	0	2 (100)
Mean±SD	16.7±7.8	**Value**	**Asymp. Sig. (2-sided)**
	Pearson Chi-Square	41.811	0.001

Table (3) showed that the mean APACHE II score of the studied group was 16.7 ranging from 3 to 46 and that there was a strong positive association between APACHE II score of the patients and percentage of deaths.

Table (4): Comparison between observed mortality rate and expected mortality rate among the studied group according to APACHE II.

APACHE II	Observed mortality rate	Expected mortality rate according to APACHE II	p
0-4	0.0%	4%	>0.05
5-9	5.3%	8%	>0.05
10-14	17.8%	15%	>0.05
15-19	33.3%	25%	<0.05*
20-24	71.4%	40%	<0.05*
25-29	63.2%	55%	<0.05*
30-34	77.8%	75%	>0.05
>35	100.0%	85%	<0.05*

*: Statistically significant.

Table (4) showed that the difference between the observed mortality rate and the expected mortality rate according to APACHE II score was not significant in APACHE II score from 0 to 14 in the studied group. In APACHE II scores from 15 to 29 the observed mortality rate was significantly higher than the expected in the studied group. In APACHE II score 30-34 the difference was not significant, but in APACHE II scores >35 the observed mortality rate returned to be significantly higher again.

Discussion

Sepsis is a common condition in the ICU and is associated with high mortality, morbidity and cost.

The current study showed that the mortality rate of the studied group was 35.1% (Table 1), average APACHE II score of admitted cases was 16.7, ranging from 3 to 46. While Abdelbaset et al. (2015) who studied comparison of the mortality prediction of different ICU scoring systems (APACHE II and III, SAPS II, and SOFA), found that the APACHE II score ranged from 5 to 34 with a median of 10. Goldhill and Sumner (2008) studied the outcome of ICU and found that the mortality rate was 18.9% within one year with average APACHE II of 12.6. Wunsch H et al. (2004) studied the mortality rate in ICU, which was 28.2% within one year and the average APACHE II was 14.3. The higher mortality rate in our study may be attributed to higher average APACHE II score of the study group.

The most common cause of death in ICU in our study was sepsis, as 25 patients out of 55 patients died from sepsis, which represented 48.2 % (Table 1). This was slightly higher than that reported by Vincent et al. (2005) in his study about infection in ICU, which revealed that sepsis was the cause of death of 38.3% of patients. It was also higher than the results obtained by Garrouste-Orgeas et al. (2008) who studied the ICU organization and found that sepsis represented 33.3% of dead patients. The study done by Iapichino et al. (2008) about mortality in ICU, also revealed that respiratory failure representing 31.2% of dead patients, followed by sepsis representing 23.3%.

Out of a total of 148 patients admitted into the ICU during the study period, 25 cases were admitted with sepsis, and 32 cases with ICU acquired infections were recorded. This gives an infection rate of 21.6%, which compares favorably with other hospitals, which had reported infection rates of up to18.4% in Vincent et al. (2006) study of infection rate in ICUs in Europe.

The most frequently reported isolated organisms from patients died with sepsis were Acinetobacter spp. (24%), followed by Klebsiella spp. (20%) and MRSA (16%) (Table 2) . There were no detectable pathogens in 8% of patients died with sepsis (no

growth), which may be explained by too small volume of blood in the collected sample, poor handling of the blood sample, unfavorable incubation environment for microbial growth, starting antibiotics before the blood sample is collected or a slow-growing bacteria.

In Hosein et al. (2002) study on infection in ICU, isolated organisms were E-coli (27.2 %), and Klebsiella spp. (19.1%), followed by MRSA (17.2%), Acinetobacter spp. (13.2%), and Pseudomonas aeruginosa (13.2%). Brown et al. (2005) who studied sepsis in ICU, detected that the main isolated organisms were Klebsiella spp. (21.7%), and Pseudomonas aeruginosa (18.5%), followed by MRSA (16.9%), Acinetobacter spp. (9.2%), and E-coli (7.7%). In comparison with previous studies, our ICU had a higher infection rate of Acinetobacter. This can be explained by the fact that most of our patients were on assisted ventilation, which is a favorable environment for Acinetobacter.

This study confirmed a meaningful association between observed mortality rates in patients in ICU and their APACHE II score evaluation (Tables 3), as mortality rate had been increased in patients by increase in their APACHE II score, so APACHE II score had a strong positive correlation with actual mortality rate ($p<0.001$). This was consistent with the study done by Abdelbaset et al., 2015 who compared the mortality prediction of different ICU scoring systems. They found that APACHE II score was a significant predictor of mortality.

Livingston et al., 2006 study of scoring models in ICU, Hantke et al., 2009 study of APACHE II score, and Stevens et al., 2012 study of prediction of mortality in ICU – detected significant correlation between the APACHE II score and the current mortality of the patients.

In comparison with death rate expected according to APACHE II score system (Table 4), observed mortality rate in patients with APACHE II score 0-4, and 5-9 was better than expected mortality rate. Observed mortality rate in patients with APACHE II score 10-14, and 30-34, was with no significant difference than expected mortality rate. Observed mortality rate in patients with

APACHE II score >35 was 100%, as 2 cases only admitted with APACHE II score above 35. Observed mortality rate in patients with APACHE II score 15-19, 20-24, and 25-29, was more than expected mortality rate according to APACHE II score.

This was partly consistent with the results obtained by Naved et al., 2011, in which the observed mortality rates were non-significantly better than the expected mortality rates in patients with APACHE II scores from 3 to 40, while in patients with APACHE II scores >40, observed mortality rate was 100% compared to 92% expected mortality rate.

Conclusion and recommendations

Sepsis was the main cause of high mortality in ICU. Meanwhile, the use of a good scoring system (as APACHE II) in evaluation and follow up of patients in the ICU helps in figuring out the most important causes of death in ICU. The prevention and control of infection in the ICU will improve outcome and decrease mortality. Specific surveillance for the most prevalent infections helps in determining the causative organisms, helps in early treatment with the suitable antibiotics to prevent spread of infection and decrease mortality due to sepsis.

Conflict of Interest

There is no conflict of interest.

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