Outcomes and Health-related Quality of Life following Intensive Care Unit Stay in Barbados

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ABSTRACT

Objectives: *To evaluate the hospital outcome and health-related quality of life (HRQOL) in adult patients admitted to intensive care units (ICUs) in Barbados.*

Methods: *A prospective observational study was done in the medical and surgical intensive care units of the Queen Elizabeth Hospital, Barbados (QEH), to evaluate the outcomes and HRQOL in adult patients. The acute physiology and chronic health evaluation (APACHE) IV score was applied on admission to one hundred and fifty patients admitted to the ICU. The HRQOL was evaluated by using Short Form 36 (SF-36) in 63 survivors, three months after ICU discharge.*

Results: *There was no significant difference between medical and surgical ICUs with respect to age, gender, APACHE IV scores, 90-day mortality, and length of stay. The mean (± SD) APACHE IV score was 42.6 (± 23.7). The observed mortality was 32.7% and the standardized mortality ratio (SMR) was 1.85. The APACHE IV scores were significantly higher in non-survivors compared to survivors (*$p < 0.001$*). Patients with APACHE IV of > 45, and who were ventilated in the first 24 hours had the highest mortality (66%). The mean ICU length of stay was 7.2 days.*

Conclusion: *In this study, the SF-36 scores in all eight dimensions indicated that the HRQOL in the majority of the survivors was average or above average. There was a significant negative correlation between APACHE IV score and the SF-36 score.*

Keywords: Acute physiology and chronic health evaluation (APACHE) IV, intensive care unit mortality, length of stay, quality of life, SF-36

Resultados Clínicos y Calidad de Vida en la Salud tras la Estadía en una Unidad de Cuidados Intensivos en Barbados

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RESUMEN

Objetivos: *Evaluar los resultados hospitalarios y la calidad de vida relacionada con la salud (CVRS) en pacientes adultos ingresados en unidades de cuidados intensivos en Barbados.*

Métodos: *Se realizó un estudio observacional prospectivo en las unidades de cuidados intensivos médicas y quirúrgicas del hospital Queen Elizabeth de Barbados (QEH), a fin de evaluar los resultados clínicos y la CVRS en pacientes adultos. El sistema de puntuación para la evaluación de la fisiología aguda y la salud crónica (APACHE IV) fue aplicada en el momento de su hospitalización a ciento cincuenta pacientes ingresados a la UCI. La CVRS fue evaluada usando el formulario breve 36 (SF-36) en 63 supervivientes, tres meses después de ser dados de alta de la UCI.*

Resultados: *No hubo ninguna diferencia significativa entre las UCI médicas y quirúrgicas con respecto a edad, género, puntuaciones APACHE IV, mortalidad de 90 días, y la duración de la estancia. La puntuación de APACHE IV media (± SD) fue 42.6 (± 23,7). La mortalidad observada fue 32.7% y la tasa de mortalidad estandarizada (SMR) 1.85. Las puntuaciones APACHE IV fueron significativamente superiores para los no sobrevivientes comparadas con las de los sobrevivientes (*$p < 0.001$*). Los*

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pacientes con puntuación APACHE IV de > 45, ventilados en las primeras 24 horas tuvieron la mortalidad más alta (66%). La longitud promedio de estancia en la UCI fue de 7.2 días.
Conclusión: *En este estudio, las puntuaciones del SF-36 en las ocho dimensiones indicaron que la CVRS en la mayoría de los sobrevivientes tuvo un nivel medio o por encima de la media. Hubo una correlación significativamente negativa entre la puntuación APACHE IV y la puntuación del SF-36.*

Palabras claves: Evaluación de la fisiología aguda y la salud crónica (APACHE) IV, mortalidad en unidades de cuidados intensivos, duración de la estancia, calidad de vida, SF-36

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INTRODUCTION

The stratification of risks, allocation of resources, evaluation of the performance of intensive care units (ICUs) and comparing the performances of different units are challenges. Several scoring systems and surveys were developed to address these challenges over the last three decades and were found to be useful in indicating the severity of illness and helping to identify patients who have poor prognosis (1). They have also been reported to be useful in predicting patient outcome, conducting cost benefit analysis and monitoring and assessing new therapies. They are utilized as audit tools to improve efficiency of an institution.

The acute physiology and chronic health evaluation (APACHE) IV score encompasses three basic factors: severity of pre-existing disease, patient reserve and severity of acute illness. The original 'APACHE I' has undergone various modifications, resulting in the current APACHE IV (2). In Barbados and in the other English-speaking Caribbean countries, several studies reported the use of APACHE II to stratify ICU patients and evaluate mortality and performance (3, 4). Literature search did not reveal any reports from the Caribbean region evaluating APACHE IV. This study was designed to examine the utility of the APACHE IV scoring system in the adult ICUs at the Queen Elizabeth Hospital (QEH), Barbados.

Assessing the survival data following ICU management alone has a limited significance to patients, clinicians and administrators. The assessment of health-related quality of life (HRQOL) plays a crucial role in the evaluation of general outcome (5). The Short Form 36 (SF-36) health survey was developed in 1992 to evaluate the HRQOL using 36 questions taken from a longer instrument completed by patients participating in the Medical Outcomes Study (MOS) [6]. Review of literature regarding the use of SF-36 for HRQOL is limited and we did not find any studies from the Caribbean region evaluating this aspect of HRQOL following discharge to home after a period of ICU care. The present study utilized the SF-36 health survey to evaluate HRQOL three months following discharge from the ICU.

Hospital and ICU setting

The Queen Elizabeth Hospital is a tertiary care 650-bed institution on the island of Barbados. Barbados has a population of 281 000 with an adult literacy rate at 99.7% and a gross domestic product (GDP) of USD 3.82 million. The average life expectancy in Barbados for males is 70.8 years and for females is 74.8 years. Patients are admitted to the ICU from the Accident and Emergency Department, the wards, operating theatre and occasionally from the 15-bed private hospital which has no ICU facility. It also serves as a referral centre for all the Eastern Caribbean islands and is the only public general hospital in the island. The hospital houses two six-bed ICUs. The medical ICU is managed by two intensivists or registrars belonging to the internal medicine department. The surgical ICU is managed by consultant anaesthetists and registrars of the anaesthesia department. There is also a six-bed high dependency unit (HDU). The post anaesthesia care unit also accepts overflow from both ICUs.

SUBJECTS AND METHODS

After approval from the Institutional Review Board of The University of the West Indies, and the Queen Elizabeth Hospital Ethics Committee, a prospective observational study was conducted from January 2010 to July 2010 in the two ICUs of the Queen Elizabeth Hospital.

The following patients were excluded:

- Patients who were admitted for less than four hours
- Patients with burns
- Patients less than 16 years of age
- Patients remaining in hospital for more than 365 days
- Patients who are readmitted to ICU (only the first admission was counted)
- Patients transferred from another ICU

The following patient parameters were collected:

- Patient demographics
- ICU admission diagnoses
- Type and urgency of surgery
- Status of mechanical ventilation on the first day of admission
- The worst parameters for the APACHE IV score during the first 24 hours following admission
- Ninety-day mortality and
- Length of stay in ICU

Informed consent, to administer the SF-36 questionnaire three months following discharge from ICU, was obtained from the patients at the time of discharge from ICU to the ward, which is the point at which they were assessed to be fully coherent. Questionnaire was not administered to patients who were in a vegetative state. The SF-36 survey was administered three months after the patient was discharged from ICU *via* a telephone interview. The patients were called three times over a period of one week; they were considered lost to follow-up if, after the third telephone call, no contact was made.

The sample size was calculated based on the previously reported mortality of 0.16 from the surgical ICU with α of 0.05 and a power of 0.9. Data were analysed using SPSS 18.0 statistical software package. Descriptive statistics were obtained on patient's demographics, source of admission and diagnostic categories. Student's *t*-test, Pearson's Chi-squared analysis and Gabriel's test were used for multiple groups for APACHE IV data. Spearman correlations and analysis of variance (ANOVA) were used to determine relationships between SF-36 categories and APACHE IV groups.

RESULTS

The study population comprised 150 consecutive patients admitted to the medical and surgical ICUs of the QEH who met entry requirements. The distribution of age and gender of patients, APACHE IV score, 90-day mortality, and length of stay between medical and surgical ICUs are shown in Table 1. The diagnostic categories admitted are shown in Table 2.

There was no significant difference in age and gender distribution, APACHE IV score, 90-day mortality, or length of stay between surgical and medical ICUs. There was no significant difference in length of stay between survivors and non-survivors (Table 1). There was no statistically significant relationship between length of stay and mortality. Amongst 49 non-survivors, there was 20% mortality by day one, 50% within three days, and 75% of the mortality within a week following admission.

Table 1: Comparison of age, gender, acute physiology and chronic health evaluation (APACHE) IV score, 90-day mortality, and length of stay between the medical and surgical intensive care units (ICUs)

Variable	Overall n = 150	Surgical ICU n = 83	Medical ICU n = 67
Age (mean years ± SD)	54.7 ± 18	52.1 ± 19.3	57.8 ± 18.2
Male: n (%)	70 (46.7)	38 (45.8)	32 (47.8)
Female: n (%)	80 (53.3)	45 (54.2)	35 (52.2)
APACHE IV score (mean ± SD)	42.6 ± 23.7	39.9 ± 25.0	46.0 ± 21.7
Observed 90-day mortality: n (%)	49 (32.7)	27 (32.5)	22 (32.9)
Length of stay (mean days ± SD)	7.2 ± 11.51	7.5 ± 13	6.9 ±8.7
Survivors	6.2 ± 9.4	5.5 ± 9.0	7.0 ± 9.9
Non-survivors	9.3 ± 14.8	11.5 ± 19.2	6.5 ± 5.3

No significant difference was observed between the surgical intensive care unit and medical intensive care unit in any category in the table.

Table 2: The diagnostic categories admitted to the surgical and medical intensive care units (ICUs)

ICU	Diagnosis	Number of patients
Surgical ICU	Neurosurgery	20
	Laparotomy for gastrointestinal disorders	18
	General surgery	13
	Obstetrics and gynaecology	11
	Thoracic and vascular	4
	Orthopaedics	3
	Urology	2
	Polytrauma	1
	Ear nose and throat	1
Medical ICU	Cardiovascular diseases	23
	Respiratory diseases	23
	Septic shock	10
	Neurological diseases	7
	Acute renal failure	6
	Poisoning	3
	Upper gastrointestinal bleed	2
	Angioedema	1
	Acute pancreatitis	1
	Hypoglycaemia	1

There was no statistically significant difference in the APACHE IV score when compared between various diagnostic categories (Table 3). The APACHE IV scores for survivors were found to be significantly lower (36.5 ± 21.1) than those of non-survivors [55.2 ± 24.0] ($p < 0.001$). Patients who did not require mechanical ventilator support in the first 24 hours had significantly lower APACHE IV scores (34.7 ± 20.4) and lower mortality (15.6%) than those who were invasively ventilated in the first 24 hours [51.3 ± 24.2 and 49.3%, respectively] ($p < 0.001$). Predicted mortality as calculated by the APACHE IV score for the given cohort was 17.7% and the observed mortality was 32.7%. The standardized mortality ratio (SMR) was 1.85. The overall mean length of stay was 7.2 ± 11.5 (SD) days, whereas the predicted length of stay from APACHE IV was 9.0 ± 37.4 days. Pearson's correlation for predicted *versus* actual length of stay was 0.12, which was not statistically significant.

Table 3: Acute physiology and chronic health evaluation (APACHE) IV scores for different diagnostic categories

	Diagnosis	n	Mean ± SD
SICU	Neurosurgery	20	29.36 ± 19.71
	General surgery	21	42.10 ± 21.58
MICU	Respiratory disease	23	48.34 ± 24.65
	Cardiovascular disease	23	35.20 ± 19.11

SICU = surgical intensive care unit; MICU = medical intensive care unit

A Hosmer-Lemeshow goodness-of-fit analysis was done to calibrate APACHE IV scores (Table 4). This showed a good calibration between observed and expected mortality in ten deciles of risk for mortality (HL Chi-squared 5.14; df: 8; $p = 0.743$).

Table 4: Hosmer-Lemeshow goodness-of-fit for the acute physiology and chronic health evaluation (APACHE) IV scores

Deciles of risk	Non-survivors		Survivors		Total
	Observed	Expected	Observed	Expected	
1	11	10.5	4	4.4	15
2	6	7.8	9	7.2	15
3	8	6.1	6	7.9	14
4	5	4.4	7	7.5	12
5	5	4.8	10	10.1	15
6	2	3.9	12	10.0	14
7	4	3.8	12	12.2	16
8	4	2.7	10	11.3	14
9	3	2.5	13	13.4	16
10	1	2.2	18	16.7	19

Hosmer-Lemeshow Chi-squared 5.14; df: 8; $p = 0.743$

A receiver operator characteristic (ROC) curve was obtained for discriminant analysis of APACHE IV for our case mix (Fig. 1). The area under the curve (AUC) was 0.73 with a standard error of 0.04 (95% confidence interval 0.64, 0.81). Based on the coordinates of the ROC, a cut-off level was chosen at APACHE IV score of 45. At this threshold level, the APACHE IV score of > 45 predicts mortality with a sensitivity of 0.67 and specificity of 0.70. There was a significant difference between the mortality in patients with an APACHE IV score of 45 or less (18%) compared with the mortality in patients with APACHE IV scores above 45 (52%; $p < 0.001$) [Table 5]. Patients who had APACHE IV score of > 45 and who had to be invasively ventilated in the first 24 hours following admission (n = 41) had the highest mortality of 66%.

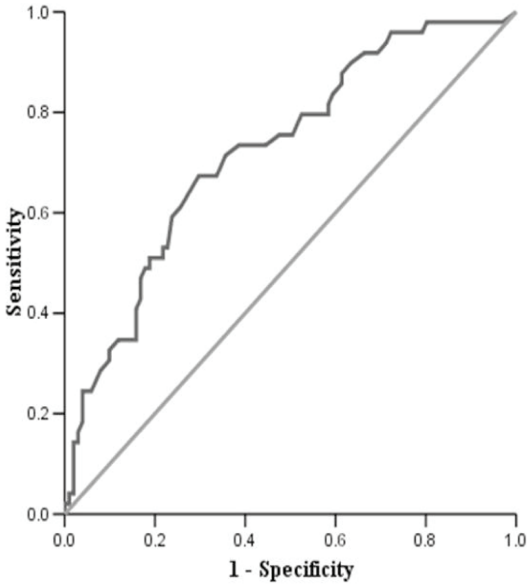

Fig. 1: Receiver operator characteristic (ROC) curve for discriminant analysis of acute physiology and chronic health evaluation (APACHE) IV for our case mix. The area under the curve (AUC) = 0.73; 95% CI = 0.64, 0.81; $p = 0.000$.

SF-36 survey

An attempt was made to administer the SF-36 questionnaire to 99 competent survivors of the sample, since 49 patients of this cohort died and two patients were in a vegetative state. Thirty-six patients were lost to follow-up and hence a total of 63 interviews were conducted at three months post-ICU discharge.

The overall median scores calculated for the 63 patients interviewed showed scores of 50 or above in all the eight categories. These data represent average or above average level of functioning in 50% or more of the responders (Table 6). Patients with an age of 45 years or less had consistently better scores in all categories. However, only in the category of emotional well-being was there a statistically significant difference ($p = 0.02$; Gabriel's test for multiple comparisons) between the age groups of 45 or less (78.8 ± 17.7) years, and age group of 46−65 (58.2 ± 30.2) years. No statistically significant difference was observed in any of the eight categories of SF-36 scores between males and females.

Table 5: Mortality in relation to the acute physiology and chronic health evaluation (APACHE) IV score and ventilation status in first 24 hours

Mortality	APACHE ≤ 45 and not ventilated*	APACHE ≤ 45 and ventilated*	APACHE > 45 and not ventilated*	APACHE > 45 and ventilated*	Total
Survivors	49 (86%)	22 (73%)	16 (73%)	14 (34%)	101
Non-survivors	8 (14%)	8 (27%)	6 (27%)	27 (66%)	49
Total	**57 (100%)**	**30 (100%)**	**22 (100%)**	**41 (100%)**	**150**

* Ventilated or not ventilated in the first 24 hours of admission
Pearson's Chi-squared: 30.38; degree of freedom: 3; $p < 0.001$

Table 6: Short Form 36 scores in eight health/function categories

Quality of life (QOL) category	Mean ± SD	Floor* %	Score†† ≥ 50%	Ceiling† %
Physical health/functioning	62.4 ± 36.0	12.7	73.0%	31.7
Role limitation due to physical health	51.6 ± 47.7	41.3	52.4%	46.0
Bodily pain	74.1 ± 32.0	7.9	77.8%	47.6
General health	63.3 ± 26.6	6.3	79.4%	12.7
Energy/fatigue	62.4 ± 27.0	6.3	77.8%	17.5
Social health/functioning	67.4 ± 34.9	11.1	81.0%	39.7
Role limitation due to emotional health	57.0 ± 46.7	36.5	57.1%	49.2
Emotional well-being	70.2 ± 27.3	6.3	79.4%	22.2

*proportion of patients with the lowest score, †† proportion of patients with scores > 50%, †proportion of patients with the highest score

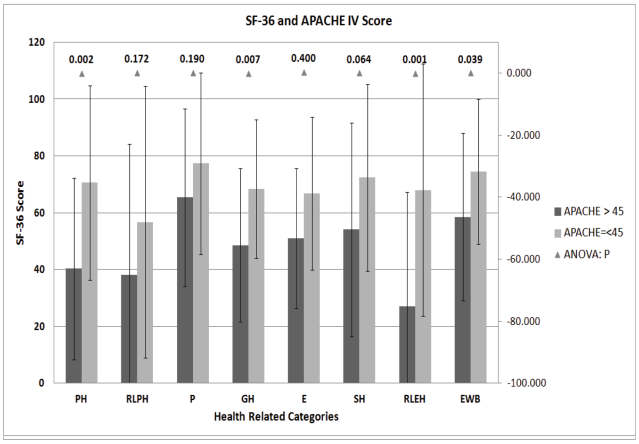

Fig. 2: Short Form 36 (SF-36) scores in patients with acute physiology and chronic health evaluation (APACHE) IV scores ≤ 45 and > 45.

The SF-36 scores were slightly better in patients discharged from the surgical ICU. In the categories of social functioning and general health, there were significantly lower scores in patients discharged from the medical ICU compared to those from the surgical ICU (Table 7). There was no significant correlation in the SF-36 scores and the length of stay in ICUs.

The total SF-36 in all categories was analysed for association with APACHE IV scores. There was a significant negative correlation between APACHE IV scores and total SF-36 scores. The higher the admitting APACHE IV scores, the poorer the post discharge HRQOL. Similar correlations were observed in all the categories (Table 8). The SF-36 scores in all categories were higher in patients admitted with APACHE IV scores of 45 or less; statistically significant difference was observed in four categories: physical functioning, role limitation due to emotional health, emotional well-being and general health (Fig. 2). There was no significant difference in the HRQOL between the patients who received mechanical ventilation in the first 24 hours and those who did not.

Table 8: Correlation between the acute physiology and chronic health evaluation (APACHE) IV scores and Short Form 36 scores in different categories

Category	Spearman's correlations	*p*
Physical health/functioning	-0.427	0.000
Role limitation due to physical health	-0.348	0.005
Bodily pain	-0.382	0.002
General health	-0.449	0.000
Energy/fatigue	-0.358	0.004
Social health/functioning	-0.297	0.018
Role limitation due to emotional health	-0.518	0.000
Emotional well-being	-0.357	0.004
Total Short Form 36 score	-0.467	0.000

Table 7: Short Form 36 scores comparison between surgical and medical intensive care units (ICUs)

Category	N	PH	RLPH	P	GH	E	SH	RLEH	EWB
Surgical ICU	35	67.9 (34.0)	59.3 (45.4)	76.6 (29.7)	70.3 (24.3)	66.9 (24.9)	75.6 (30.8)	60.8 (46.0)	75.3 (25.5)
Medical ICU	28	55.5 (37.8)	41.9 (49.6)	70.9 (34.9)	54.0 (26.8)	56.9 (29.0)	57.2 (37.5)	52.1 (48.0)	63.7 (28.6)
***p*-value**		**0.18**	**0.15**	**0.49**	**0.01***	**0.14**	**0.03***	**0.47**	**0.09**

PH = physical health, RLPH = role limitations due to physical health, P = pain, GH = general health, E = energy, SH = social health, RLEH = role limitations due to emotional health, EWB = emotional well-being

*Statistically significant by ANOVA tests

DISCUSSION

The present study is the first report from the Caribbean region validating APACHE IV in medical and surgical ICU patients, as well as assessing the HRQOL of patients 90 days after discharge from the ICUs. The largest diagnostic groups on the surgical ICU were for general surgery and neuro-surgery, while in medical ICU, they were for cardiovascular and respiratory diseases. The surgical ICU case mix in this study varies from the previous study conducted in Barbados

between 1999 and 2001, which included more trauma patients, indicating the dynamics of surgical ICU (3). The diagnostic categories (Table 2) and mean APACHE IV sores (Table 1) in our study were similar to the report by Zimmerman *et al* (2). However, higher mean APACHE IV scores (73.1) were reported from a Saudi Arabian ICU, and their patients were admitted with severe sepsis and septic shock (7). Hence it is apparent that caution must be applied when making decisions based on APACHE IV scores (8).

The mean APACHE IV score in survivors in this study was significantly lower than that of the non-survivors. This finding is similar to the previously published study from Barbados which used the APACHE II scores (3). The overall mortality in this cohort is 32.7% which is higher than the previously reported mortality (15.9%) during 1999−2001 from the surgical ICU of the same hospital (3). The ICU mortality in this study is higher than those reported from the developed countries [United States of America 10%, United Kingdom 18% and Spain 21%] (9). It is also higher compared with the mortality of 19.8% reported from Trinidad in 2007 (10). The estimated mortality in a study from France was 20–30%, with substantial variations across studies in France (11). The mortality rate is similar to the figures from Jamaica (34%) reported during 2005 (4).

The predicted mortality, from the APACHE IV data, was 17.7%, whereas the observed mortality was 32.7%. The SMR in this study was 1.85, whereas it was 0.97 in an earlier study for our SICU using APACHE II (3). This apparent deterioration in SMR may be related to the use of different tools or inability of the unit to cope with the increasing number of sicker patients. Studies comparing the validity of APACHE II and APACHE IV have reported higher SMR when using APACHE IV. Dahhan *et al* reported an SMR of 0.83 using APACHE II and 0.99 using APACHE IV on the same cohort of patients in Saudi Arabia (7). Bhattacharyya and Todi reported a significantly lower SMR of 0.87 using APACHE II in comparison with 2.85 using APACHE IV in an Indian ICU (12). The APACHE IV appears to give a better idea of the performance of the ICUs, whereas the APACHE II under-estimated the performance of ICU.

The Hosmer-Lemeshow goodness-of-fit test showed that the score was well calibrated in this case mix (Table 4). The ROC curve analysis enables one to discriminate between patients who die from those who survive. Typically, a model discriminates well if the AUC of the ROC curve is > 0.70 (13). In the present study, the area under the ROC curve is 0.73. Zimmerman *et al* reported an area under the ROC of 0.88 in their model, implying that the APACHE IV model had excellent discrimination (2). The previous study from the surgical ICU of the Queen Elizabeth Hospital, which applied APACHE II, reported an area under the ROC curve to be 0.76 (3), similar to the present study. Based on the coordinates of the ROC curve, we hypothesized that an APACHE IV score of greater than 45 may be used as a predictor of mortality in our ICUs. However, the use of this cut-off value has not been reported in the literature and needs to be further evaluated in a larger sample and in different units with different case mix.

The mean length of stay for non-survivors (9.3 days) was lower than that reported (14 days) from the previous study (3). The length of stay in the present study is lower than that predicted using APACHE IV. This may be attributed to aggressive attempts to improve turnover due to increasing demands, and most importantly, the establishment of a high dependency unit during this period.

The SF-36 survey was completed by 63 of the eligible 99 persons, which is a 64% response rate. The response rates reported in the literature varied from 39% to 96% (6, 14, 15). In six categories, 73% to 81% of the survivors reported average or above average health or functional status. Only in the categories of role limitation either due to physical health or emotional health did a little over 50% had average or above average functioning. Though this distribution indicates reasonable outcome in terms of HRQOL, interpretation may be biased in the absence of control from the matched population, or scores prior to getting ill or admitted to ICU (5, 14). Hofhuis *et al* reported that the SF-36 distribution gets worse prior to ICU admission, and by about six months, they return back to the healthy population values. However, the recovery is incomplete in physical health, social functioning and general health categories (16). Myhren *et al* reported significantly lower scores at three months when compared to pre-ICU estimates. However, the scores were stable from three months to one year in six categories. Only physical functioning and role limitation due to physical health seemed to improve from three months to one year (14).

The SF-36 score distribution in the current study is similar to those reported by Khoudri *et al* who evaluated the Arabic version at three months post-ICU discharge (17). They described that the discriminant validity was good and concluded that the Arabic version of SF-36 was a robust tool in ICU.

The SF-36 scores for surgical ICU patients were higher than those from medical ICU in all categories. This may be partly due to the fact that the APACHE scores were slightly higher in medical ICU patients. In the medical ICU, the SF-36 scores in patients with respiratory disease were below average for all categories except pain. This reinforces the view that the long-term quality of life depends largely on diagnostic category. Patients with severe acute respiratory distress syndrome, severe trauma and severe sepsis appear to have the worst and long-term reductions in quality of life (5).

The limitation of the present study is the absence of the incidence of pre-morbid illnesses which should have been factored when evaluating the SF-36 scores. If scores are known before ICU admission, it would have allowed for better assessment of post illness scores. The report by Oeyen *et al* reiterates the need for baseline values (5). Full evaluation of patients' level of functioning post ICU care,

following discharge, is difficult and SF-36 may be limited in its use, even though it is well validated and widely used in ICUs worldwide.

CONCLUSION

The overall mortality of ICU patients in this study was higher than expected when evaluated by the APACHE IV. Patients with APACHE IV score over 45 not only had higher mortality but also had a poorer health-related quality of life. Patients with APACHE IV score of over 45 and who had to be ventilated in the first 24 hours following admission had the highest mortality of 66%. There is an inverse correlation between SF-36 scores and APACHE IV score. The HRQOL, 90 days after the patients were discharged from ICU, showed scores of 50 or above in all categories, which means average or above average in the majority of the patients.

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