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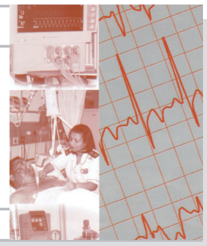
Outcome evaluation of a South African surgical ICU – a baseline study



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Objectives. To describe the baseline data of patients admitted to the surgical intensive care unit in a tertiary hospital in the Western Cape, and their outcome at discharge from the ICU.

Design. Prospective cohort observational study.

Setting. Ten-bed closed surgical unit in a university-affiliated tertiary hospital.

Sample. One hundred and sixty consecutive adult ICU admissions from 16 June to 30 September 2003.

Measurements. Demographic information, admission diagnosis, surgery classification (elective or emergency) and co-morbidities were recorded on admission to the unit. APACHE II score was calculated. The two outcomes of ICU length of stay (LOS) and mortality were recorded on discharge from the unit.

Results. Patients were 49 ± 19.95 years of age. The mean APACHE II score was 12.3 ± 7.19 and 12.3% mortality was observed. The standardised mortality ratio was 0.87. Patients stayed in the unit for 5.94 ± 6.55 days. Hypertension was the most frequent co-morbidity found in this cohort (42%), and 21% ($N = 5$) of patients tested were HIV positive. Neither age, gender nor co-morbidities had any significant association with mortality or ICU LOS ($p > 0.01$). A significant correlation was established between APACHE II scores, mortality and ICU LOS ($p < 0.001$).

Conclusions. This baseline study of a surgical ICU in a tertiary environment in the Western Cape presents a picture of a unit providing care comparable to First-World environments. It is debatable whether the current admission and discharge criteria are making optimal use of the technology available in a level 1 intensive care unit. Other cost-effective ways of managing patients who are not as ill could be investigated.

Global economic and social policies have an increasing impact on the provision of health care services, with widening in the disparity in health and wealth between nations.[1,2] Furthermore, the impact of global economic policies on the provision of health care results in service providers, policy makers and clinicians being required to make difficult decisions about the services that are provided.[3]

The political transition of South African society has been followed by the challenges of social transition and health care reform.[4] The government's drive to reform health care is based on a framework of a district-based approach to primary care, and access to a free primary health care service for all. This is resulting in resources being relocated from academic medical centres to primary levels of care.[4]

The current provision of intensive care is expensive and is increasingly being questioned in the South African context.[5,6] In a commentary on critical care in South Africa, Mathivha[5] urges critical care health workers to '... put forth strong motivations to the country's health policy-makers ...' in an effort to convince them of the importance of this service. The ways in which services are provided to critically ill patients and the resultant outcome of these interventions within South Africa therefore need ongoing evaluation.

Only one study could be identified that documented the demographics and outcome of patients admitted to an intensive care unit in southern Africa, after the successful political transition in 1994.[6] This unit performed better than predicted and was regarded as highly cost effective.

The purpose of this baseline study was to describe the demographics of patients admitted to the surgical ICU in a tertiary hospital in the Western Cape, and to report on their outcome (mortality and length of stay) at discharge from the ICU. The ventilator time, survival rate and health-related quality of life of this cohort will be reported on in subsequent publications. The data will act as a comparison for the implementation of new treatment protocols in the ICU.

Setting

Besides the economic changes affecting the provision of health care, the Western Cape population also presents with a unique health profile.[7] The impact of this health profile on ICU patient outcome is unclear.

This baseline study was completed in a 10-bed level 1 surgical ICU at a tertiary hospital in the Western Cape. This is a 1 385-bed tertiary teaching hospital for students from the Faculty of Health Sciences, Stellenbosch University, and the Faculty of Community and Health Services, University of the Western Cape. In addition to the surgical unit there are seven other independently functioning ICUs. All patients requiring intensive support or monitoring after either elective or emergency surgery or trauma are admitted to the surgical ICU.

This unit is run as a level 1 closed unit. The interdisciplinary team consists of an anaesthetist, a medical officer and at least one registrar from each of the departments of Orthopaedics, Neurosurgery, Neurology, Anaesthesiology and Critical Care, Surgery and Trauma. These registrars rotate through the unit on a 3-month cycle as part of their specialisation. A permanent matron is allocated to the unit and there is one senior sister in each of the 5-bed wards. On average the nurse/patient ratio is 1.7:1. Other members of the team include a part-time physiotherapist, a dietician on call, and a medical technician permanently allocated to the unit. Patients are referred to occupational therapy as indicated.

Materials and methods

Prospective cohort observational study of all patients admitted to the surgical ICU from 16 June 2003 to 30 September 2003 was undertaken. All patients were followed up until discharge from the unit.

The study was approved by the Research Ethics Committee of Stellenbosch University (2003/055/N). Proxy consent to access patients' folders was obtained from the superintendent of TBH for these patients.

Procedure

A trained research assistant and the researcher – both qualified physiotherapists – extracted the relevant data from existing documentation systems. The records of each patient were accessed daily for the previous 24-hour period (07:00 - 6:59).

Two self-designed data extraction forms were used to extract the following data:

- **Admission data:** demographic information, date and time of admission to the unit, admission diagnosis, co-morbidities and APACHE II scores. The mechanism of any trauma and the clinical course before admission to the unit as well as in the admitting area were documented.

- **Discharge data:** the time and date of discharge. When applicable the time and reason for death was also documented.

Statistical analysis

Data were analysed in consultation with a statistician using Statistica (version 6). Descriptive data were summarised and the categorical data are presented in either bar or pie charts, while the continuous data are presented in scatter plots. The central tendency is described in terms of means and the variation of the data as standard deviations (SD).

The Spearman correlation was used to examine the relationships between the APACHE II score, age and the time spent in the unit. The Kruskal-Wallis test was used to determine the differences between multiple independent groups and the chi-square test to determine if observed frequencies were related to an outcome. Values were accepted as significant at the 5% level ($p < 0.05$).

Results

One hundred and sixty-one admissions were recorded in the study period. One patient was re-admitted, and data for one patient could not be obtained, so data for 159 patients and 160 admissions were analysed (Table I).

Table I. Demographics of patients admitted to the ICU

Mean age (yrs)	49 (SD 19.95)
< 45	47% (N = 75)
45 - 70	31% (N = 50)
> 70	22% (N = 34)
Male/female ratio	92:67

Admission to the unit

The majority of patients (83%, N = 133) were admitted to the unit following emergency surgery (N = 85) or a traumatic injury (N = 48), while more than a third of the patients (37%, N = 59) were admitted following elective surgery.

Violence accounted for 67% (N = 32) of traumatic injuries, the remainder being a result of motor vehicle accidents. The majority of these patients were men. Only 6 women were admitted to the unit following a traumatic injury.

Patients admitted following elective surgery were primarily referred by the Department of Vascular Surgery (*N* = 21), while other referrals were from the departments of Obstetrics and Gynaecology (*N* = 11), Head, Neck and Breast Surgery (*N* = 10), Abdominal Surgery (*N* = 9), Orthopaedics (*N* = 4) and Urology (*N* = 4).

Patients were admitted to the unit from a variety of settings (Table II) .

Severity of illness

Patients admitted to the unit had a mean APACHE II score of 12.3 (SD 7.19). This score was signifcantly higher ($p < 0.001$) when patients were admitted from the emergency room (Table II).

Co-morbidities

Hypertension was the most frequent co-morbidity (42%, *N* = 67). Only 15% (*N* = 24) of patients were tested for HIV, of whom 21% (*N* = 5) tested positive, although the test results were still unavailable for 6 patients at the end of the study period. Only 8% (*N* = 13) of patients presented with or had a previous history of tuberculosis, and 20% (*N* = 32) had a history of smoking.

Patient outcomes

The mean overall ICU mortality was 12% (*N* = 19). Based on the APACHE II model the predicted mortality was 14.5%. The standardised mortality ratio (SMR) is the number of observed deaths/predicted deaths. In this cohort it was 0.83.

Patients with an APACHE II score of less than 19 performed consistently better than predicted, while the more severely ill patients died more often than expected (Fig. 1). There was a significant association between the APACHE II score and mortality.

While no significant association was found between the time the patient spent in the ICU and mortality, patients were more likely to die within the first 4 days in the unit. Thereafter the mortality was significantly lower, increasing again significantly after more than 14 days in the unit ($p < 0.01$) (Fig. 2). In this cohort no significant association could be established between any of the co-morbidities, age or gender and mortality.

Time in the ICU

Patients spent a mean of 5.94 (SD 6.55) days in the unit. Of the 26 patients who spent less than 24 hours in the unit, 5 died. While the mean APACHE II score of these patients was 23.8, the remaining 21 patients had a mean APACHE II score of 6.45.

Patients with increasing APACHE II scores spent significantly longer ($p < 0.001$) in the unit, even though the severity of illness only contributed 6% to the reason for spending time in the unit ($r^2 = 0.06$) (Fig. 3).

None of the co-morbidities discussed previously, patient age or patient gender had any significant effect on length of stay (LOS).

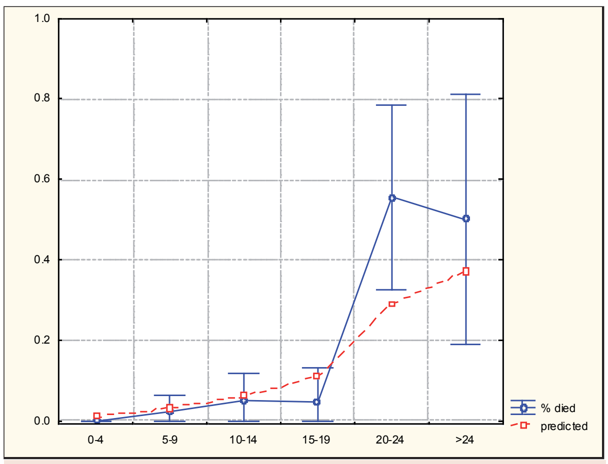

Fig. 1. Expected versus observed mortality.

Table II. Mean APACHE II scores in various subgroups

Group	*N*	Mean APACHE II	SD	Died
Emergency surgery	84	13.4	7.95	16%
Trauma	48	11.29	6.81	15%
Elective surgery	59	10.66	5.93	3%
Inpatients	11	10.82	3.45	0%
Operating rooms	76	10.62	6.06	5%
Emergency room	72	14.72 *	8.09	26%
Outside hospital	1	2	0	0%
Men	93	12.04	7.10	15%
Women	67	12.67	7.49	7%

*Significantly higher than the mean.

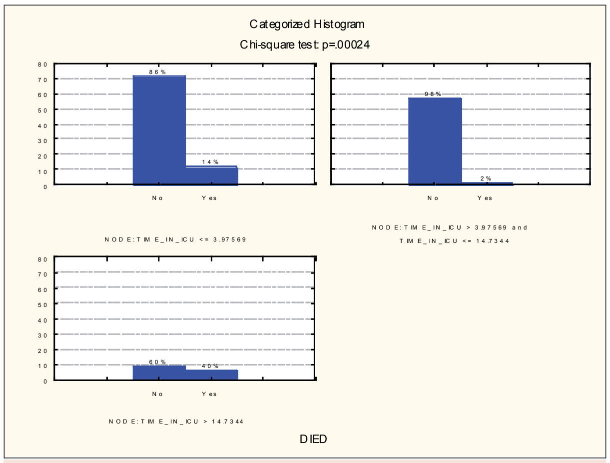

Fig. 2. CART analysis of time in the unit and mortality.

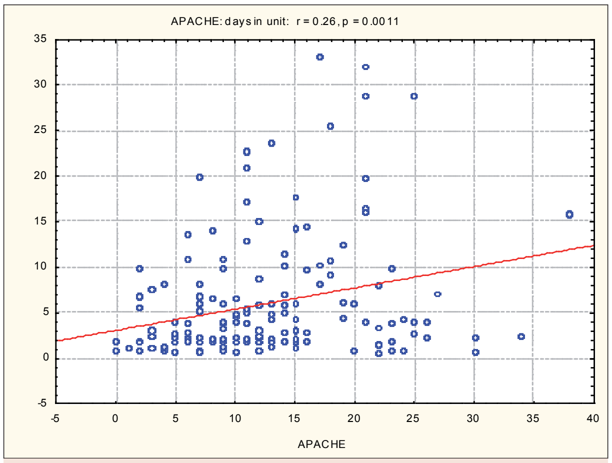

Fig. 3. Correlation between APACHE II scores and time in the unit.

Discussion

The SMR of this unit compares well to the SMR of units reported from the USA, the UK and Barbados.[8-11] It is also similar to other South African units.[5,12] The relatively high SMR (1.67) previously observed in other developing countries has been attributed to a variety of factors such as the increased time before admission to a unit (the so-called lead time bias), possible less technical sophistication of the units, or the case-mix admitted to the unit.[13,14]

Despite the fact that this unit in a developing country is performing similarly to units in First-World countries, significantly more patients died in the higher APACHE II categories than predicted. A probable explanation for this could be the small number of patients ($N = 8$) admitted to the unit with an APACHE II 20 - 24 category score. In such a small population there are not sufficient data to reliably distinguish between high- and low-risk patients.[15] However, similar discrepancies in these higher APACHE II groups have been reported in other units, suggesting a possible under-prediction of mortality in more severely ill patients and over-prediction in lower APACHE II ranges.[16] Another possible reason for this observation could be that active treatment might be discontinued in the very sick patients who are not likely to benefit from further intervention.

Despite the current controversy regarding the APACHE II scoring system, this system has provided researchers with the tools to compare the performance of their units.[11] In this study the system was used to adjust for risk in comparing the outcomes of the same unit over time.

The significant association between APACHE II and mortality observed in this study has also been confirmed in numerous international studies.[10,11,17,18] However, the relatively low observed mortality (12%) found in this cohort is numerically lower than reported from both First-World and developing countries.[5,9,14,17,18] The mean APACHE II score of this cohort is lower than found in both First-World and developing countries.[5,10,11] A possible reason for this could be the relatively high percentage of elective surgery patients admitted to this unit.[19] Units from other developing countries have reported relatively low percentages of elective surgery patients[5,11,14] when compared with other First-World environments.[18,20]

A second possible reason could be that only a third of the admissions resulted from a traumatic injury. This percentage is almost half the 53% reported at Baragwanath[5] and raises some questions, especially in the face of the high violence statistics previously reported in South Africa.[21] This relatively low statistic is however not a true reflection of the percentage of trauma patients admitted to the hospital, as all patients admitted here are first admitted to the emergency room, where emergency care is provided and patients are kept until stable. An audit of the emergency room statistics for the same period could provide some answers to the statistics, and specifically the outcome of trauma-related admissions.

Even though severity of illness has been linked to an increased LOS,[22] in this cohort the correlation was not strong. ICU LOS is increasingly being used to assess the economic performance of an ICU.[23] Considering the fact that the first ICU day is reported to be four times as expensive as other ICU days, which in turn are 2.5 times as expensive as non-ICU days,[23] a shorter ICU stay potentially has huge financial benefits.

The less ill patient population in this unit stayed in the ICU 2 days longer than patients in the UK. Two possible reasons for this could be lack of a step-down facility and the continued medical care of patients not likely to benefit from intensive care.

The fact that this hospital does not have a step-down facility could force the team to keep patients in the unit longer, as early discharge from an ICU has been linked to high re-admission rates and increased hospital mortality.[23] This is in part substantiated by the fact that only one patient was re-admitted to the unit in the study period. However, again this is not a true reflection of the status in this hospital, as unstable inpatients are initially admitted to the emergency room, where cardiopulmonary resuscitation and other necessary interventions are performed. Once stabilised, patients are then transferred to the ICU. An analysis of the emergency room admissions and hospital mortality will present a more accurate reflection of the standard of care.

Secondly, the relatively long ICU stay in this cohort could be because the often difficult decision to discontinue active treatment of very sick patients not likely to benefit from further intervention is not made early enough. The survival time of this cohort will only be reported in a follow-up study, but almost half of the patients receiving intensive care for longer than 14 days died in the ICU. In a study that compared the outcomes of patients managed in a French and a Tunisian ICU, a significantly shorter stay was observed in the Tunisian cohort (6.6 days compared with 8.1 days) after adjusting for severity of illness.[24] These authors stated that the higher demand for ICU beds in Tunisia – a developing country – led to earlier termination of active treatment.

Demographics

This study confirms the observation that a significantly younger population is admitted to units in developing countries[14,26] when compared with First-World countries.[9,17] More convincing statistics of a younger ICU population are the percentages of patients younger than 45 admitted to ICU. Almost half of this cohort was younger than 45, compared with 27% in the UK,[25] while in the original APACHE II cohort only 16% of patients were younger than 45.[26] In contrast, 70% of patients in India and in the Baragwanath unit in South Africa were reported to be younger than 45.[12,13]

This trend towards a younger ICU patient population, especially noted in the developing countries, could be related to decreasing funds available for intensive care therapy, specifically in the public sector, and the strict inclusion criteria set up by developing countries.[13,24] These criteria are necessary to ensure that this very costly service is only provided to those patients who are most likely to benefit from treatment.[5] However, it is not clear whether age should be regarded as one of these criteria.[27]

Age has not been associated with prolonged time on the ventilator or increased LOS in the ICU.[28] Increased mortality was observed in older patients when complications such as acute renal failure or shock were diagnosed.[27,28] This observation was confirmed in our cohort, where no significant association could be found between age and mortality or age and the length of stay in the unit.

Gender

A worldwide discrepancy is reported in gender-related admission ratios to intensive care. The 3:2 ratio (men/women) admitted to our unit is comparable to both developing and First-World countries.[14,18,24] Population demographics have been cited as a possible explanation.[18] However, currently both international and national demographic data indicate a more equal ratio of the sexes.[29]

The possibility of a referral bias in the critical care environment, in that women are usually 'sicker' when admitted to a unit, has been mentioned previously.[30] This could not be substantiated in our study, in which similar APACHE II scores were found in the male and female patients. Kollef *et al.*[30] also suggested that active aggressive medical treatment was discontinued earlier in women than in men because less emergency surgery was being performed in female patients.

Gender has been independently associated with increased hospital mortality in ventilated patients,[30] but the impact of gender on other outcomes is still unclear. In this study no association was found between gender and mortality or time in the unit. Future research could focus on admission rates of female patients and not only on outcome.

Co-morbidities

None of the co-morbidities evaluated in this cohort significantly affected the time patients spent in the unit. Former studies have indicated that the effect is greater when the co-morbidity is the primary reason for admission to a unit. For example, in a study to examine the effect of HIV on the outcome of patients admitted to an ICU in Natal, South Africa, Bhagwanjee *et al.*[31] tested all patients for HIV. Only 13% of those patients tested positive. Although HIV-positive patients were more prone to septic shock and organ failure in the Natal study, these researchers could not find a significant effect on mortality or LOS.[33] In contrast, De Palo *et al.*[32] reported a significantly increased LOS and mortality when patients were admitted to an ICU with HIV infection or an AIDS-defining disorder.

In our study unit it is not routine practice for all patients to be tested for HIV, and only patients who are considered for dialysis because of acute renal failure are tested. Only one-fifth of the cohort tested were positive for HIV. No conclusions could be made from this owing to the small sample.

Even though the Western Cape has the highest reported incidence of tuberculosis in the world, in this cohort the diagnosis was confirmed in only a small number of patients and did not appear to influence patient outcome significantly. This is in contrast to a study by Lee *et al.*[33] who found a 65.9% in-hospital mortality rate among patients with active pulmonary tuberculosis suffering acute respiratory failure and requiring mechanical ventilation. However, these patients were admitted to the ICU with a mean APACHE II score > 16 and the presence of two failed organs. In contrast, in our cohort the presence of active tuberculosis was not the primary reason for admission to the unit or for mechanical ventilation.

Conclusion and recommendations

This baseline study of a surgical ICU in a tertiary environment in the Western Cape presents a picture of a unit providing care comparable to First-World environments. When comparing this cohort of patients with published data it is evident that the patients admitted to our unit were younger than First-World populations but older than patients in developing countries, and that the gender distribution was similar. Patients were admitted to the unit with lower APACHE II scores than in either First-World or developing countries, but they remained in the unit for a longer period. The observed mortality was lower than in either First-World or developing countries, while the SMR was similar to First-World countries but better than in developing countries.

The specific health profile of patients in the Western Cape does not appear to have had a significant effect on ICU outcome. However, it is debatable whether the current admission and discharge criteria are making optimal use of the technology available in a level 1 intensive care unit. Other cost-effective ways of managing patients who are not as ill could be investigated. These could include:

- Implementation of a high-care unit (level 4)[19] for elective surgery patients who require limited postoperative monitoring. This could potentially increase the resources available for sicker patients.
- Implementation of a step-down facility[34] for patients to be discharged to once they are no longer in need of support but still require minimal monitoring. This could potentially decrease ICU LOS without increasing hospital mortality.

1. Benatar S. Health care reform and the crisis of HIV and AIDS in South Africa. *N Engl J Med* 2004; **351:** 81-92.
2. Benatar SR, Daar AS, Singer PA. Global health ethics: the rationale for mutual caring. *International Affairs* 2003; **79:** 107-138.
3. Povar G, Blumen H, Daniel J, *et al.* Ethics in practice: managed care and the changing health care environment: medicine as a profession managed care ethics working group statement. *Ann Intern Med* 2004; **141:** 131-136.
4. Benatar S. Health care reform in the new South Africa. *N Engl J Med* 1997; **336:** 891-895.
5. Mathivha LR. ICU's worldwide: An overview of critical care medicine in South Africa. *Crit Care* 2002; **6:** 22-23.
6. Potgieter P, Hammill L, Gough A, Hammond J. Cost of critical care in South Africa. *S Afr Med J* 1995; **85:** 425-443.
7. Strategic and Service Delivery Improvement Plan (SSDIP) Provincial Government of the Western Cape Department of Health Draft Paper, 2000. **http://www.westerncape.gov.za/health_social_services/policy_planning** (accessed 27 March 2003).
8. Becker R, Zimmerman J. ICU scoring systems allow prediction of patient outcomes or comparison of ICU performance. *Crit Care Clin* 1996; **12:** 503-514.
9. Goldhill D, Sumner A. Outcome of intensive care patients in a group of British Intensive care units. *Crit Care Med* 1998; **26:** 1337-1345.
10. Beck D, Taylor B, Millar B, Smith G. Prediction of outcome from intensive care: A prospective cohort study comparing APACHE II and III prognostic systems in a United Kingdom intensive care unit. *Crit Care Med* 1997; **25:** 9-15.
11. Hariharan S, Moseley S, Kumar A. Outcome evaluation in a surgical intensive care unit in Barbados. *Anaesthesia* 2002; **57:** 434-441.
12. Marik P, Kraus P, Lipman J. Intensive care utilization: the Baragwanath Experience. *Anaesth Intensive Care* 1993; **21:** 396-399.
13. Parikh C, Karnard D. Quality, cost and outcome of intensive care in a public hospital in Bombay, India. *Crit Care Med* 1999; **27:** 1754-1759.
14. Bastos P, Sun X, Wagner D, Knaus W, Zimmerman J. Application of the APACHE III prognostic system in Brazilian ICU: a prospective multicenter study. *Intensive Care Med* 1996; **22:** 564-570.
15. Randolph A, Guyatt G, Carlet J. Understanding articles comparing the outcomes among intensive care units to rate quality of care. *Crit Care Med* 1998; **26:** 773-781.
16. Armaganidis A. Intensive care in developed and developing countries: are comparisons of ICU performance meaningful? *Intensive Care Med* 1998; **24:** 1126-1128.
17. Wong D, Crofts S, Gomez M. Evaluation of predictive abaility of APACHE II system and hospital outcome in Canadian ICU patients. *Crit Care Med* 1995; **23:** 1177-1183.
18. Sirio C, Tajimi K, Tase C, Knauss W, Wagner D. An initial comparison of intensive care in Japan and the USA. *Crit Care Med* 1992; **20:** 1207-1215.
19. Kilpatrick A, Ridley S, Plenderleith L. A changing role for intensive therapy: is there a case for high dependancy care? *Anaesthesia* 1994; **49:** 666-670.
20. Berger M, Marazzi A, Freeman J, Chiolero R. Evaluation of the consistency of APACHE II scoring in a surgical intensive care unit. *Crit Care Med* 1992; **20:** 1681-1687.
21. Linton D. The impact of trauma on ICU facilities in South Africa. *S Afr Med J* 1992; **81:** 118-119.
22. Rapoport J, Teres D, Lameshow S. Timing of ICU admission in relation to ICU outcome. *Crit Care Med* 1990; **18:** 1231-1235.
23. Rapoport J, Teres D, Zhao Y, Lemeshow S. Length of stay data as a guide to hospital economic performance for ICU patients. *Med Care* 2003; **41:** 386-397.
24. Nouira S, Roupie E, El Atrouss S, *et al.* Intensive care use in a developing country: a comparison between a Tunisian and a French unit. *Intensive Care Med* 1998; **24:** 1144-1151.
25. Rowan K, Kerr J, McPherson K, Short A, Vessey M. Intensive care societies in Britian and Ireland. *BMJ* 1993; **307:** 977-981.
26. Knauss WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II. A severity of disease classification system. *Crit Care Med* 1985; **13:** 818-829.
27. Stephan F, Cheffi A, Bonnet F. Nosocomial infection and outcome of critically ill elderly patients after surgery. *Anesthesiology* 2001; **94:** 407-414.
28. Estaban A, Anzueto A, Frutos-Vivar F, *et al.* Outcome of older patients receiving mechanical ventilation. *Intensive Care Med* 2004; **30:** 639-646.
29. United Nations Statistics Division, 2002 **http://unstats.un.org/unsd/demographic/ww2000/table3b.htm** (accessed 23 July 2004).
30. Kollef MH, O'Brien JD, Silver P. The impact of gender on outcome from mechanical ventilation. *Chest* 1997; **111:** 434-441.
31. Bhagwanjee S, Muckart DJ, Jeena P, Moodley P. Does HIV status influence the outcome of patients admitted to a surgical ICU? *BMJ* 1997; **314:** 1077-1081.
32. De Palo V, Millstein BH, Mayo PH, Salzman SH, Rosen MJ. Outcome of intensive care in patients with HIV infection. *Chest* 1995; **107:** 506-510.
33. Lee PL, Jerng JS, Chang YL, *et al.* Patient mortality of active pulmonary tuberculosis requiring mechanical ventilation. *Eur Respir J* 2003; **22:** 141-147.
34. Rosenberg A, Zimmerman J, Alzola C, Draper E, Knauss W. ICU length of stay: Recent changes and future challenges. *Crit Care Med* 2000; **28**(10): 3465-3473.