Original article

Survival of patients in the intensive care units of referral hospitals in Amhara Region: A prospective cohort study

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Abstract

Background: An intensive care unit (ICU) is a place where critically ill patients are managed using life-saving interventions. Evidence regarding ICUs like average days of stay, and what caused the patients to delay in the ward were scarce in resource-limited settings such as Ethiopia. The objectives of this study were to assess the survival of patients in ICUs, the incidence density for discharge with prognosis, and the determinants of ICU stay in five referral hospitals in Amhara Region.

Methods and materials: To implement the prospective cohort study design, baseline data were recorded from patients' charts at the time of admission to the ICUs of the five referral hospitals. Patients' status was followed every day for a maximum of nine days. Interviews and chart reviews were used to collect the data. A Kaplan–Meier curve was used to estimate the time of patients' discharge from the ICU. A Cox proportional hazard model (Weibull) was used to identify the predictors of ICU stay.

Results: A total of 2,789 patients were included; the incidence density of discharge with prognosis was 1,962/12,448 person days. The length of ICU stay was determined by patient-to-nurse ratio (AHR = 0.59 [95% CI: 0.56-0.64]), chronic illness (AHR = 0.93 [95% CI: 0.88-0.98]), hemoglobin concentration (AHR = 1.09 [95% CI: 1.05-1.14]), ICU area-to-bed ratio (AHR = 1.14 [95% CI: 1.06-1.22]), nosocomial infection (AHR = 0.47 [95% CI: 0.37-0.59]), tracheotomy (AHR = 1.12 [95% CI: 1.01-1.24]), time of admission (AHR = 0.83 [95% CI: 0.75-0.93]), and formal education (AHR = 0.72 [95% CI: 0.64-0.80]).

Conclusions and recommendations: Decision makers in Ethiopia should give high priority to ICU infrastructure and to increasing the number of nurses in ICU wards. [*Ethiop. J. Health Dev.* 2020; 34(1):30-34]

Key words: Critical care, Intensive care, predictors, resource-limited setting

Background

An intensive care unit (ICU) is a unit in a hospital where seriously ill patients are cared for by specially trained staff (1), It is a well resourced, isolated and self-contained area of a health facility aimed for patients with life threatening condition. 'It provides special expertise and facilities for the support of vital functions, and uses the skills of medical, nursing and other personnel experienced in the management of critical disorders' (2, 3).

Long ICU stay increases the risk of infections, complications including mental disorders, and death. Nearly 80% of patients with prolonged ICU stays show cognitive problems a year or more after their discharge, and more than half exhibit effects similar to Alzheimer's disease and traumatic brain injury(4).

ICU patients consume more resources than other hospital admission patients, and severe cases in ICUs consume a disproportionate amount of resources 7-10% of ICU patients consume 50% of ICU resources (5-7).

Shortening patients' stay in the ICU has many advantages for hospital personnel and patients, however interventions for ICU patients in Ethiopia are limited, and there is no national guideline for ICU care in the country. This study was conducted to fill these gaps. Decision makers can use the results of the study to give emphasis to critical care, and health professionals should act accordingly to avert long ICU stays.

Amhara Region has five referral hospitals, namely Gondar University Hospital, Felege Hiwot Hospital, Debre Berhan Hospital, Dessie Hospital and Debre Markos Hospital (8).

Findings from studies conducted across the globe reveal that the survival of ICU patients is determined by time of admission, development of delirium, post-operative patients, tracheotomy, gender, mechanical ventilation, nosocomial infection, age, pressure of oxygen, and sedation (9-20). In Ethiopia, there is limited data that describes the survival of ICU patients. This study, therefore, aimed to assess the survival of ICU patients, the incidence density for discharge with prognosis, and the determinants of ICU stay in referral hospitals in Amhara Region.

Methods and materials

A prospective cohort study design was implemented for the study. Representative numbers of post-operative patients and other patients (non-post-operative patients) were prospectively followed. Patients were followed until they were discharged from the ICU. The study was implemented in the referral hospitals in Amhara Region, with data collected from June 2015 to August 2017. The study population consisted of patients in the ICUs in Amhara Region referral hospitals. ICU patients with incomplete baseline

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medical records were excluded. The sample size was calculated using Epi Info software version 7 with the assumptions of 95% confidence interval, 85% power, ratio of post-operative ICU patients (exposed) to non-post-operative ICU patients (unexposed) 1:2, and 10% loss to follow-up rate, resulting in 956 post-operative patients and 1,912 non-post-operative patients in the ICUs. A stratified sampling technique was used to select the study participants. In the study region, there were a total of five referral hospitals. A stratified sampling proportional to size allocation method was used to include the study subjects from each hospital. Both post-operative and non-post-operative patients were study participants. Interviews and chart reviews were used to collect the data. The data were collected using 30 nurse professionals, supervised by 10 medical doctors. Initially, baseline information was recorded from patients' charts at the time of admission to the ICUs. Patients' status was followed each day until they were discharged from the ICU ward, up to a maximum of nine days. A pre-test was conducted on 50 patients, after which necessary corrections were made to the interview tool. The entire data collection procedure was closely supervised by supervisors and investigators.

The event of this study was the discharge of patients from ICU wards with prognosis. A patient who was not discharged from the ICU ward at the end of the study or was lost from the study was considered as censured (missed outcome at the time of data collection). Data were entered into a computer using Epi Info software and transferred to Stata version 12 for analysis. A Kaplan–Meier curve was used to estimate time to discharge from the ICU. A Cox proportional hazard model (Weibull) was used to identify the predictors of ICU stay. The adjusted hazard ratio (AHR) at 95% CI was used to identify the predictors of ICU stay.

This research was approved by the ethical committee of the College of Medicine and Health Sciences, Bahir Dar University. A letter of support was obtained from Amhara Regional State Health Bureau. Legal permission was obtained from the respective authorities. Written informed consent was obtained from each patient who took part in the study.

Results

A total of 2,789 patients were included. The response rate of the study subjects was at 97.25%. The mean age of the respondents was 33.07 years [SD (standard deviation) = 6.9 years]. Females constituted 51.42% of the study participants.

Profile of non-post-operative patients: A total of 1,870 non-post-operative patients were included in the study, with a response rate of 97.8%. The mean age of non-post-operative patients was 32.63 years [SD = 6.27 years]. The incidence density for discharge with good prognosis was 1,358/9,011 person days (see Table 1).

Table 1: **Life table for the survival of non-post-operative patients in the ICU**

Interval in days	Beginning total	Discharged	Lost	Survived	95% CI
1-2	1,870	102	4	0.9454	0.9341-0.9548
2-3	1,764	322	17	0.7720	0.7522-0.7904
3-4	1,425	154	37	0.6875	0.6658-0.7081
4-5	1,234	177	91	0.5851	0.5620-0.6074
5-6	966	224	54	0.4455	0.4218-0.4689
6-7	688	63	105	0.4013	0.3777-0.4249
7-8	520	110	32	0.3137	0.2904-0.3373
8-9	378	170	42	0.1643	0.1446-0.1853
9-10	166	36	130	0.1058	0.0867-0.1270

Profile of post-operative patients: A total of 919 post-operative patients were included in the study, with a response rate of 96.13%. The mean age of the patients was 33.97 years [SD = 7.95 years]. The incidence density for discharge with good prognosis was 604/3,437 person days (see Table 2).

Table 2: **Life table for the survival of post-operative patients in the ICU**

Interval in days	Beginning total	Discharged	Lost	Survived	95% CI
1-2	919	29	13	0.9682	0.9546-0.9778
2-3	877	104	57	0.8495	0.8242-0.8715
3-4	716	136	13	0.6867	0.6544-0.7167
4-5	567	255	12	0.3746	0.3416-0.4075
5-6	300	56	186	0.2732	0.2407-0.3067
6-7	58	24	34	0.1133	0.0745-0.1610

Survival of both post-operative and non-post-operative patients in the ICUs: The incidence density for the discharge with prognosis was 1,962/12,448 person days; 25%, 50% and 75% of the patients were discharged on the 3rd, 4th and 6th days of the IUC stay, respectively. Proportional hazard assumption was checked using a Kaplan–Meier survival curve, which proved that both non-post-operative patients and post-operative patients' survival fulfilled the assumptions (see Figure 1).

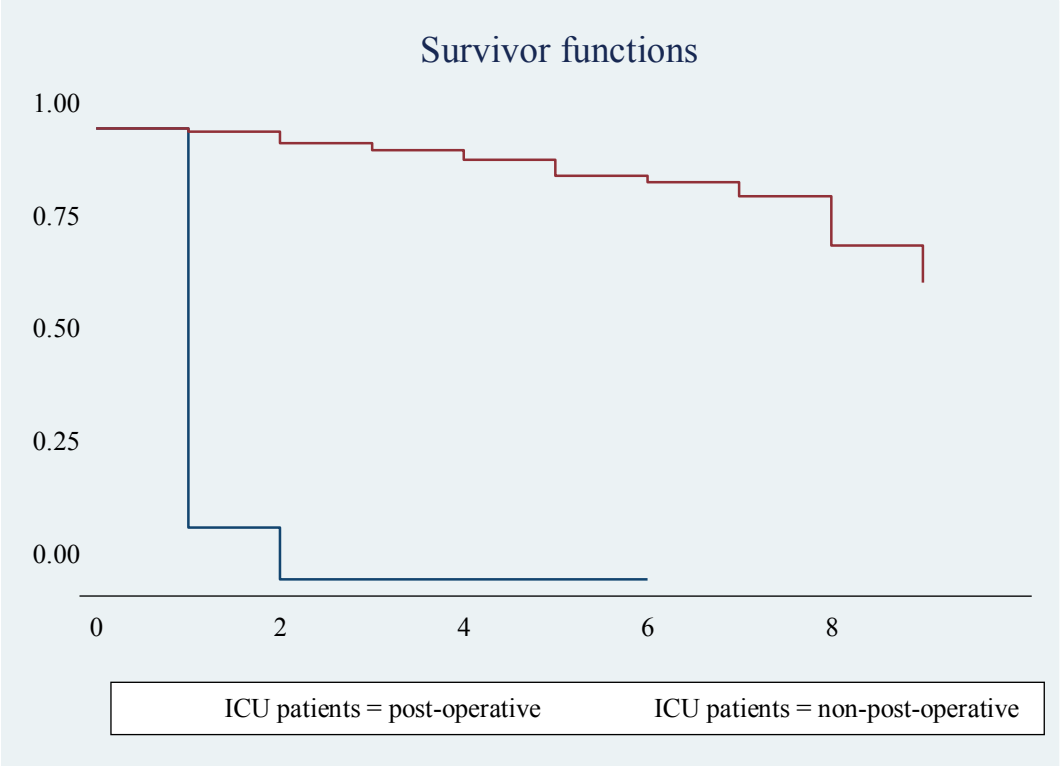

Figure 1: Kaplan Meier survival curve for post-operative and non-post-operative patients in the ICU

Patients' stay in the ICU was determined by type of patients, patient-to-nurse ratio, the presence of chronic illness, age, hemoglobin concentration, ICU area-to-bed ratio, nosocomial infection, tracheotomy, time of admission, and educational status (see Table 3).

Table 3: **Predictors of discharge from the ICU with good prognosis**

Variable	CHR	AHR	95% CI	P-value
Type of patients	0.59	0.44	0.39-0.49	0.000
Patient-to-nurse ratio	0.52	0.59	0.56-0.64	0.000
Chronic illness	0.66	0.93	0.88-0.98	0.005
Age	1.00	1.00	1.00-1.01	0.005
Hemoglobin	1.41	1.09	1.05-1.14	0.000
ICU area-to-bed ratio	1.78	1.14	1.06-1.22	0.000
Nosocomial infection	0.15	0.47	0.37-0.59	0.000
Tracheotomy	1.05	1.12	1.01-1.24	0.030
Mechanical ventilation	1.11	0.99	0.89-1.11	0.998
Delirium	0.41	1.03	0.79-1.35	0.811
Time of admission	0.66	0.83	0.75-0.93	0.001
Sex	1.04	0.97	0.89-1.07	0.571
Educational status	0.61	0.72	0.64-0.80	0.000

CHR = crude hazard ratio, AHR = adjusted hazard ratio

In this study, the mean length of ICU stay for the post-operative patients was 56% lower than for non-post-operative patients. One unit increase in the patient-to-nurse ratio increased the length of ICU stay by 59%. The presence of chronic illness increased the length of ICU stay by 7%. One unit increase in the patient hemoglobin concentration decreased the length of ICU stay by 9%. A $1m^2$ increase in the ICU area-to-bed ratio decreased the length of ICU stay by 14%. Nosocomial infection increased the length of ICU stay by 53%. Tracheotomy decreased the length of ICU stay by 12%. Length of ICU stay was 17% higher among patients admitted in the day time. Length of ICU stay was 28% higher among patients with a formal education (see Tables 3 and 4).

Table 4: **Life table for the survival of ICU patients**

Interval in days	Beginning total	Discharged	Lost		
				Survived	95% CI
1-2	2,789	131	17	0.9529	0.9443-0.9602
2-3	2,641	426	74	0.7970	0.7815-0.8116
3-4	2,141	290	50	0.6878	0.6699-0.7049
4-5	1,801	432	103	0.5179	0.4986-0.5369
5-6	1,266	280	240	0.3914	0.3720-0.4107
6-7	746	87	139	0.3411	0.3216-0.3606
7-8	520	110	32	0.2666	0.2472-0.2864
8-9	378	170	42	0.1397	0.1230-0.1574
9-10	166	36	130	0.0899	0.0737-0.1079

Discussion

For non post operative patients, the incidence density for discharge from the ICU with good prognosis was 1,358/9,011 person days, i.e., if we were to follow 9,011 ICU patients for one day, 1,358 patients would be discharged with good prognosis per day from the ICU. The mean time of ICU stay for non-post-operative patients was 2.43 days, and the mean duration of ICU stay for post-operative patients was 1.31 days. Non-post-operative patients stayed 1.22 extra days in the ICU. The median ICU stay was four days.

The mean length of ICU stay for post-operative patients was 56%, which was lower than for non-post-operative patients (AHR = 0.44 [95% CI: 0.39-0.49]). This finding, which agrees with the finding of a study conducted in Great Britain (2) , might be due to the good pre-operative care and pre-operative exercise given to this group of patients (1). One unit increase in the patient-to-nurse ratio increased the length of ICU stay by 59% (AHR = 0.59 [95% CI: 0.56-0.64]). This finding, which is in line with a study conducted in Iran (21), might be due to the impact of nurses' heavy workload on the quality of care (22).

We observed a 7% increment in the ICU stay in the presence of chronic illness (AHR = 0.93 [95% CI: 0.88-0.98]). This finding is consistent with the finding of a study conducted in the USA (23), indicating that chronic illness depresses the immune system and decreases the response to interventions (5).

In this study, a single unit increase in the patient hemoglobin concentration decreased the length of ICU stay by 9% (AHR = 1.09 [95% CI: 1.05-1.14]). This finding, which agrees with the finding of a study conducted in Germany (6), might be due to the high probability of multiple vital organ failures in anemic ICU patients (7).

In our study, a $1m^2$ increase in the ICU area-to-bed ratio decreased the length of ICU stay by 14% (AHR = 1.14 [95% CI: 1.06-1.22]). This finding, which is comparable to the finding from a study conducted in Iran (3), might be due to the good infrastructure planning of the ICU ward (2).

Nosocomial infection increased the length of ICU stay by 53% (AHR = 0.47 [95% CI: 0.37-0.59]), which was found to be inconsistent with a study conducted in France by Cavallazzi *et al.* in 2010 (9). Bercault & Boulain suggest that nosocomial infections increase the severity of existing illness (16).

Tracheotomy decreased the length of ICU stay by 12% (AHR = 1.12 [95% CI: 1.01-1.24]). This finding agrees with the finding of a comparable study conducted in the USA (11). A study by Goldhill & Sumner indicates that tracheotomy has a positive impact on improving respiratory muscle functions (12).

In our study, the length of ICU stay was 17% higher among patients admitted during the day time (AHR = 0.83 [95% CI: 0.75-0.93]). This finding, which disagrees with the finding of a study conducted in Iran (11), might be due to the high workload in the day time, resulting in the patient not getting all inclusive quality services (24).

The length of ICU stay was also found to be 28% higher among patients with formal education (AHR = 0.72 [95% CI: 0.64-0.80]). This might be due to educated people being more prone to substance abuse, and their addiction might be a complicating factor in their treatment, resulting in an increased stay in the ICU(25, 26).

Conclusions and recommendations

The mean length of stay in the ICU was higher than the expected. The length of ICU stay was determined by the patient-to-nurse ratio, chronic illness, hemoglobin concentration, ICU area-to-bed ratio, nosocomial infection, tracheotomy, time of admission and educational status.

Decision makers should give priority to allocating resources for ICU infrastructure. In addition, hospital managers should to increase the nurse-to-patient ratio.

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Disclosure

The authors declare that they have no competing interests.

Authors' contributions

BEF and TEF conceived the study; BEF, MD, DA, FB and TEF performed the study, planned the data collection process, and analyzed and interpreted the data. BEF, MD, DA, FB and TEF wrote the manuscript and approved the final draft for publication.

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