

Knowledge, practice, and associated factors towards Mechanical Ventilation management among adult intensive care unit Nurses at public hospitals in Addis Ababa, Ethiopia

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Abstract

Background: Mechanical ventilation (MV) is one of the commonest reasons of admission to the intensive care unit (ICU) and its management requires good knowledge and skill. There is a paucity of information on knowledge and practice of MV among nurses in the study area.

Objectives: The aim of the study was to assess knowledge, practice, and associated factors toward MV among adult ICU nurses at public hospitals in Addis Ababa, Ethiopia, in December 2021.

Methods: A cross-sectional study was conducted at public hospitals in Addis Ababa among 330 adult ICU nurses, and 10% (33) of the respondents were observed by checklist for MV practice. The collected data were cleaned, entered into EpiData version 4.4, and exported to SPSS version 25.0 software for further analysis. Both binary and multiple logistic regression analyses were used to identify associated factors with knowledge status, with adjusted odds ratio (AOR) and 95% confidence interval (CI) at p-value < 0.05.

Results: Poor knowledge level on MV management among adult ICU nurses at public hospitals in Addis Ababa was 54% (95% CI: 48.5-59.5%). The factors that increased the odds of good knowledge towards MV management were educational level: Masters of Science degree (AOR = 7.31; 95% CI: 1.73-30.89) and Bachelor of Science (AOR = 4.87; 95% CI: 1.63-14.57), on job training (AOR = 2.29, 95% CI: 1.36-3.88), and use of guidelines (AOR 1.65; 95% CI: 1.39-2.26). The study revealed that 25 out of 33 (75.8%, 95% CI: 60.6, 90.9%), of adult intensive care unit nurses demonstrated poor practice on MV management.

Conclusion: This study determined that the majority of adult ICU nurses had poor knowledge and poor practice toward MV management at public hospitals in Addis Ababa. The factors that increased the likelihood of good knowledge were educational status, training, and use of guidelines. Policymakers and health planners should strengthen the on-job training on MV management.

Keywords: Mechanical ventilation, Knowledge, Practice, Intensive Care Unit, Nurses

Background

Mechanical ventilation (MV) is a method used to artificially support respiratory function by employing a ventilator machine. It can be used to either assist or replace normal spontaneous breathing and can be undertaken invasive or non-invasively (1). This study was focused on invasive MV. Invasive MV is one of the most common interventions in intensive care; it is often lifesaving, but can have life-threatening physiological and psychological side effects (1, 2).

Studies demonstrated that inadequate MV is associated with complications such as ventilator-associated pneumonia and long-term MV dependence. Mechanical ventilation requires the simultaneous skills of many in the inter-professional healthcare team. Nurses are usually the first in identifying set issues, and understanding the physiology and management of MV is crucial (3-5). The Ethiopian federal ministry of health (FMOH) in collaboration with hospitals provides short-term training regarding MV to ICU staff to enhance the knowledge and practice of ICU nurses. In addition to this nowadays universities are giving critical care and respiratory specialty programs. But there is still a lack of adequate critical care trained nurses and most of the nurses working in ICUs have no training related with the work environment. As to the researcher's knowledge and current literature search revealed, there is no published study done regarding the knowledge and practice of MV among adult intensive care unit (AICU) nurses in Ethiopia.

The purpose of this study was to assess the knowledge and practice of nurses working in AICUs at public hospitals in Addis Ababa (AA), Ethiopia, and made a recommendations based on its findings.

As a result, as the first of its kind in Ethiopia, this study contributes to critical care nursing professional development and research by providing baseline information on the topic and related factors to the researchers, policymakers, health planners, government, and non-governmental organizations (NGOs).

Methods

Study setting and period

A facility-based cross-sectional study design was conducted on adult intensive care unit (AICU) nurses at public hospitals in Addis Ababa from December 1 to 29, 2021. Addis Ababa is the capital city of Ethiopia and is divided into 11 sub-cities. The city is located at an altitude ranging from 2,100 meters at Akaki in the south to 3,000 meters at Entoto Hill in the North. St. Paul's Hospital Millennium Medical College (SPHMMC), Tikur Ambesa Specialized Hospital (TASH), St. Petros Hospital, AaBET Hospital, Tirunesh Beijing hospital, Zewditu Hospital, Minilik II hospital, Yekatit 12 hospital, Ras Desta Damtew Memorial hospital, and Gandhi Memorial hospital were chosen. These are among the major public hospitals in AA that provide adult intensive care unit (AICU). All adult intensive care unit (AICU) Nurses at public hospitals available at the time of data collection that fulfill the selection criteria were included as study population and Nurses in positions of leadership and who were not directly involved in AICU practice were excluded from the study.

Sample size determination and sampling procedures

The sample size was determined by a total census of all nurses working in adult intensive care unit (AICU) of 10 public hospitals in AA. Based on the total available nurses during data collection, all 330 AICU nurses were included in the study. Naturalistic observation study conducted on 10% (33) of the total sample size a week before. Self-administered questionnaires were used to assess knowledge status of Adult ICU nurses. A total survey method was used to take all 330 AICU nurses working at public hospitals in A.A and 33 of them were selected using the convenience sampling technique for the observational checklist tool proportionally allocating to each hospital.

Data collection tools and procedures

Data was collected using pretested self-administered semi-structured questionnaires to assess the level of Nurse's knowledge on MV.

The questionnaires consists of socio-demographic and knowledge questions adapted from studies done in Turkey, Rwanda, and South Africa were used for knowledge of MV assessment (6, 7). The observational checklist was developed and used to collect the data on practice toward mechanical ventilation. A pretest was done at Adama general hospital before the study period to check for completeness, clarity and also understandability of the questionnaires.

Operational definitions

Good knowledge: A score of $\geq 75\%$ on the overall knowledge questions (8).

Poor knowledge: A score of $< 75\%$ among the knowledge questions (8).

Good practice: Those who score $\geq 75\%$ on the total observational checklist were considered to have a good practice (8).

Poor practice: A score below 75% on the observational checklist was considered poor practice towards MV (8).

Data Processing and analysis

The collected data were checked for completeness and consistency before analysis and then coded and entered into EpiData version 4.4 and transferred to (SPSS) version 26 for further analysis. The collected data were cleaned, entered into Epi data version 4.4, and exported to SPSS version 25.0 software for further analysis.

Both binary and multiple logistic regression analyses were performed to identify associated factors with knowledge status, with adjusted odds ratio (AOR) and 95% confidence interval. P-value < 0.05 was used to declare level of significance.

Results

Socio-demographic characteristics of the respondents

The study included 309 adult ICU Nurses from a total 330 adult ICU nurses, with 181 (58.6%) female participants. The study participants mean age was 27.9 years, with a minimum age of 22 and a maximum age of 39. Of total the respondents, 21.7% were

Emergency and critical Care Nurses, while 78.3% and 86.1% were clinical care nurses with first degree (see details in Table 1).

Table 1: Socio-demographic characteristics of adult ICU nurses at Public Hospitals in Addis Ababa, Ethiopia, 2021 (n = 309).

Variable	Response categories	Frequency	Percent
Sex of participants	Male	128	41.4
	Female	181	58.6
Age of participants	≤ 26	112	36.2
	27-29	99	32
	≤ 30	98	31.7
Marital status	Single	186	60.2
	Married	123	39.8
Profession of participants	Comprehensive/Clinical nurse	242	78.3
	Emergency/critical care nurse	67	21.7
The educational level of participants	Diploma	25	8.1
	Degree	266	86.1
	Masters	18	5.8
Years of AICU work experience	0-3 years	190	61.5
	4-6 years	88	28.5
	7-9 years	25	8.1
	10 years and above	6	1.9

^aICU: Intensive care unit

Facility related characteristics of the study participants

Of the total study respondents 216 (70%) had ever trained on the management mechanical ventilator, 193 (62.5%) had got supportive supervision from senior trained nurses and only 86 (27.8%) had MV management operational manual in their unit and used it as reference. Finally, very few senior nurses were allowed to adjust or manipulate MV based on patient contact (Table 2).

Table 2: Facility related characteristics of Adult ICU nurses at Public Hospitals in Addis Ababa, Ethiopia, 2021 (n = 309).

Variable	Response categories	Frequency	Percent
Ever participated in training	Yes	216	69.9
	No	93	30.1
Frequencies of training	Every year	19	6.1
	At every rotation	62	20.1
	Occasionally	228	73.8
Support and supervision	Yes	193	62.5
	No	116	35.5
Hospitals have guidelines on MV ^b management	Yes	86	27.8
	No	223	72.2
Nurses are allowed to adjust/manipulate MV ^b in hospitals	Yes	4	1.3
	No	305	98.7

^aICU stands for Intensive care unit

^bMV: Mechanical ventilation

Level of Nurses' Knowledge of Mechanical Ventilation Management

This study determined the overall poor knowledge toward mechanical ventilation management among adult intensive care unit nurses at public hospitals in Addis Ababa level of the nurses was determined that 54% (167/309) which ranges with 95% C.I. (48.5-59.5%) (Figure 1).

Factors associated with knowledge of mechanical ventilation

This study identified that MSc. degree holders were 7.3 times more likely to had good knowledge as compared to diploma Nurses (AOR = 7.31; 95% CI: 1.73-30.89) and Bachelor of Science holders were 4.87 times more likely to had good knowledge (AOR = 4.87; 95% CI: 1.63-14.57) at p-value 0.007. Adult ICU nurses who had been trained on MV management were 2.3 times more likely to had good knowledge as compared to had not trained on Mechanical ventilator management's nurses (AOR = 2.29, 95% C.I 1.362, 3.88) at p-value 0.002. Nurses who had operational manual guidelines in the ICU and utilized it as references were twice more likely to had good knowledge towards MV management as compared to counterparts to have good knowledge (p-value 0.015, AOR 2.054, 95 percent C.I 1.14, 3.67) (See Table 3).

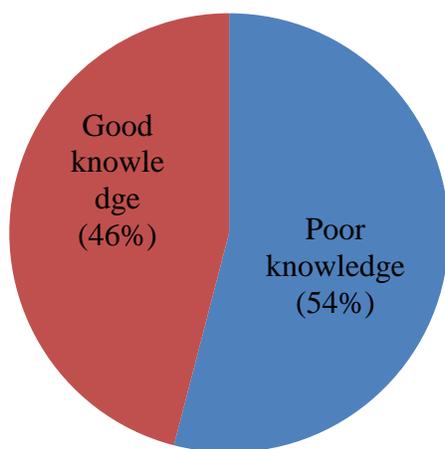


Figure 1: Showing the level of knowledge towards mechanical ventilation among adult intensive care unit nurses at public hospitals in AA, 2021 (n = 309).

Observational findings on practice of Nurses towards mechanical ventilation Management (n = 33)

An observational study result revealed that 25 out of 33 (75.8%) of adult intensive care unit nurses were demonstrated poor practice of mechanical ventilation management (95% CI: 60.6%- 90.9%). The proportion of good practice was observed only among 24% of adult ICU nurses (95% CI: 9.1%-39.4%), and only 7 (21.2%) of the study participants performed ventilator settings correctly. One in three nurses failed to check the inspiratory time during high-pressure alarms and rate and trigger sensitivity settings during high respiratory alarms.

Discussion

It is highly important that nurses caring for mechanically ventilated patients must possess good knowledge and practice levels to prevent complications associated with mechanical ventilation and improve patient care quality. The knowledge and practice level of the ICU nurses were found to be low in the current study area. The proportion of good knowledge, and practice was determined to be 24% and 46 % respectively. This study also identified factors that increasing the likelihood of good knowledge were educational status, training, and guidelines. These findings are consistent with the findings of an Indian study on MV knowledge, which found that 66%of the subjects had poor mechanical ventilation knowledge (9). ICU nurses' lack of knowledge and practice may be due to a lack of education/training on this topic.

Nurses are usually the first in identifying set issues, and understanding the physiology and management of mechanical ventilation is crucial for clinicians managing patients in the ICU. These caregivers must alert the clinician managing the case immediately if there are any issues with ventilator use. Inappropriate setting changes, failure to change alarms, changing settings without appropriate orders, and failure to communicate changes to the medical team can result in poor patient outcomes(10). The findings of this study are consistent with a study done in Rwanda which stated that all nurses in the study (100%) had unsatisfactory practice

MV and studies done in Egypt and Saudi Arabia reported that 68.3% of nurses had poor MV knowledge (9, 11, 12).

Table 3: Factors associated with mechanical ventilation management knowledge on multivariable logistic regression among Adult ICU Nurses at Public Hospitals in Addis Ababa, Ethiopia, 2021.

Variable	Response	Knowledge level		P-value	AOR (95% C.I.)
		Good knowledge	Poor knowledge		
Professional qualification	Diploma	4(1.29%)	21(6.79%)		1:00
	Degree	128(41.42%)	138(44.66%)	0.006	4.714(1.553, 14.309)
	Masters	10(3.23%)	8(2.58%)	0.007	7.316(1.733, 30.895)
Participated on training related to mechanical ventilation	Yes	62(20.06%)	31(10.03%)	0.002	2.299(1.362, 3.881)
	No	105(33.98%)	31(10.03%)		1:00
Availability of guideline/Operational manual in ICU	Yes	33(10.67%)	53(17.15%)	0.015	2.054(1.149-3.671)
	No	109(35.27%)	114(36.89%)		1:00

This indicates that knowledge and practice towards MV is an issue that must be investigated deeply in order to map strategies to improve it this finding is consistent with a study done in Saudi Arabia which reported that common PVAs detection assessed using observational analysis as low in critical care settings, with about 25% of PVAs going undetected by critical care practitioners (9). This may be due to lack of training and awareness of the nurses working in the ICUs especially in our country.

Ventilator wave form analysis helps early identification of ventilator complications that may not be visible with other assessments and take appropriate action early. Therefore, nurses must be trained and be aware of ventilator graphics to pick the problem in the making. This study the identified factors that increasing the likelihood of good knowledge were professional qualification/educational level, training, and availability of operational manual or guidelines in ICU and MV knowledge of ICU nurses. This finding is incongruent with the findings of another study which reported no significant association between demographic variables and MV knowledge of the nurses (13). This difference may be due time and study setting difference. But this finding is consistent with a Baghdad study that discovered statistical associations between nurses' educational levels, years of experience in critical units, training sessions, and nurses' knowledge of MV. Educational level, training, and guidelines improve mechanical ventilation knowledge from a scientific standpoint (14).

But in support of the current finding, a study done in Pakistan indicated that nursing knowledge regarding ventilator mechanics improved after the implementation of teaching module (13, 15). The difference in the previous study's association of ICU work experience with knowledge of mechanical ventilation may be explained by the nurses' lack of ICU work experience in the current study area. Critical care providers need to adopt the newly emerging MV related evidence and incorporate them into daily practice. Engaging critical care providers in periodic educational activities and clinical training is advisable. Enhancing knowledge and sharpening MV related skills will likely reduce MV related adverse events and improve outcomes.

Regarding wave form identification and analysis only 2(6.1%) among 33 study subjects identified wave forms that indicate air trapping and secretion while all of them failed to troubleshoot auto triggering and identify wave forms showing PVAs. This finding is consistent with a study done in Saudi Arabia which reported that common PVAs detection assessed using observational analysis as low in critical care settings, with about 25% of PVAs going undetected by critical care practitioners (9, 13). This may be due to lack of training and awareness of the nurses working in the ICUs especially in our country. Ventilator wave form analysis helps early identification of ventilator complications that may not be visible with other assessments and take appropriate action early. Therefore, nurses must be trained and be aware of ventilator graphics to pick the problem in the making.

Only 86 (27.8 percent) of current study participants reported having guidelines in their unit, which is similar to a study done in Turkey, which found that 71 percent of nurses working in ICUs did not have access to an MV operating manual. However, in a separate study conducted in New Zealand, two-thirds (66.5 percent, n=204) of the nurses work in ICUs with guidelines, policies, or protocols to guide staff in ventilation management (7, 16). This inconsistency could be attributed to setting differences and a lack of ICU organization in our country. This could be due to nurses' limited scope of practice and a lack of adequate training.

Limitations of the study

- This study used a cross-sectional study design which cannot identify cause and effect relationships.
- Due to time and resource constraints, an inadequate sample size was used for the observational study.

Conclusions

This study determined that the majority of adult ICU nurses had poor knowledge and poor practice toward mechanical ventilation management at public hospitals in Addis Ababa with identified factors that increasing the likelihood of good knowledge were educational status, training, and guidelines. Therefore, policymakers and health planners would be better strengthen adult ICU nurses on job training on mechanical ventilation management by using standardized and provide guidelines mechanical ventilation management and protocols to improve Adult ICU nurses' knowledge and practice in the study area were strongly recommended.

Nurses shall use available manuals properly and read different materials related to mechanical ventilation to in order to be up to date and improve their knowledge and practice towards mechanical ventilator/ventilation.

The ministry of health shall develop guidelines and organize trainings in collaboration with hospitals on how to manage mechanical ventilation and ventilators in order make improve ICU nurses' knowledge and practice.

Abbreviations

AA: Addis Ababa; AC: Assist Control; AICU: Adult Intensive care Unit; AOR: Adjusted Odd Ratio; ARDS: Acute Respiratory Distress Syndrome; CCNPs: Critical Care, Nursing Practitioners; cmH₂O: Centimeter of Water; CO₂: Carbon Dioxide; COPD: Chronic Obstructive pulmonary disease; COR: Crude Odd Ratio; ECCN: Emergency and Critical Care Nurse; ETTs: Endotracheal Tubes; FIO₂: Fraction of Inspired Oxygen; FRC: Functional Residual Volume; ICU: Intensive Care Unit; IBW: Idea Body Weight; IRB: Institutional Review Board; MV: Mechanical Ventilator; NGOs: Non-Governmental Organizations; O₂: Oxygen; PCO₂: Partial Pressure of Carbon Dioxide; PEEP: Peak End Expiratory Pressure; PH: The potential of Hydrogen; PIP: Pick Inspiratory Pressure; PO₂: Partial Pressure of Oxygen; PVA: Patient Ventilator Asynchrony; RR: Respiratory Rate; SPHMMC: Saint Paul's Hospital Millennium Medical College; SD: Standard Deviation; VE: Minute Ventilation; and TV: Tidal Volume

Declarations

Ethics approval and consent to participate

Ethical approval for this study was obtained from St. Paul hospital millennium medical college Institutional Review Board prior to the study with approval number (*Ref. No: PM1239/2021*). Written informed consent from the legally authorized representatives of the patient prior to study.

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Authors' contributions

KA designed the study, developed the proposal, participated in the data collection, performed analysis and drafted the manuscript. EH, DBD, and TD approved the proposal with revisions, participated in data analysis, and revised subsequent drafts of the manuscript. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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