

Research Article

Instrumental Insights: Evaluating Anesthesia Equipment Proficiency among Himachal Pradesh's Resident Anesthetists

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Abstract: *Background:* Anesthesia is a pivotal component of modern healthcare, ensuring patient safety during surgical interventions. Proficiency in managing anesthesia equipment is essential for Resident Anesthetists, as it underpins the delivery of safe and effective anesthesia. This study assesses the knowledge of essential anesthesia equipment among Resident Anesthetists in Himachal Pradesh, India. *Materials and Methods:* A cross-sectional survey was conducted among Junior and Senior Residents of Anesthesia in Himachal Pradesh. A structured questionnaire assessed their knowledge of anesthesia machines, ventilators, and monitoring devices. Data from 100 participants were analyzed using descriptive statistics. *Results:* Participants exhibited varying levels of knowledge. While many had a good understanding of anesthesia machines' primary function and components, there was room for improvement in comprehending safety features and calibration procedures. Proficiency in mechanical ventilation concepts was notable, though some areas, such as troubleshooting ventilator issues, could be enhanced. Resident Anesthetists demonstrated commendable knowledge of monitoring devices, including capnography and pulse oximetry. Knowledge gaps existed in normal vital sign ranges and alarm response. *Conclusion:* This study highlights the importance of ongoing education and training for Resident Anesthetists in Himachal Pradesh, focusing on anesthesia equipment management. Addressing knowledge gaps can contribute to improved patient safety and healthcare quality.

Keywords: Anesthesia equipment, Resident Anesthetists, knowledge assessment, patient safety, healthcare quality.

INTRODUCTION

The field of anesthesia is a critical cornerstone of modern medicine, ensuring the safety and well-being of patients undergoing surgical procedures. Within this intricate medical landscape, Resident Anesthetists are entrusted with the pivotal responsibility of administering anesthesia, meticulously overseeing anesthesia equipment, and safeguarding patients throughout their perioperative journey. In the picturesque landscapes of Himachal Pradesh, where the grandeur of the Himalayas meets the serenity of valleys, the healthcare system relies heavily on the expertise of Resident Anesthetists to deliver safe and effective anesthesia services.¹⁻³

Anesthesia, at its core, comprises not only the administration of anesthetic agents but also the management of intricate and technologically advanced equipment that plays an indispensable role in patient care. Anesthesia equipment, including anesthesia machines, ventilators, and monitoring devices, constitutes the life-supporting infrastructure that ensures patients receive the right balance of anesthetic agents, oxygen, and mechanical ventilation, tailored to their unique physiological needs.^{3,4}

The anesthesia machine, a complex apparatus in itself, serves as the conduit through which anesthetic gases and oxygen are delivered to the patient's airway. Ventilators, on the other hand, facilitate the rhythmic exchange of air, ensuring the patient receives adequate oxygen and carbon dioxide removal during surgery. The monitoring devices, ranging from electrocardiograms (ECGs) to pulse oximeters, continuously assess the patient's vital signs, providing real-time feedback that is crucial for the anesthetist to make precise adjustments and maintain the patient's physiological stability.^{5,6}

Competence in managing anesthesia equipment is an essential aspect of an anesthetist's role. Proficiency in understanding, operating, and troubleshooting these devices is paramount to ensure the safe delivery of anesthesia, minimize risks, and respond effectively to unforeseen challenges.

This study embarks on a mission to comprehensively evaluate the levels of awareness and knowledge among Resident Anesthetists in Himachal Pradesh concerning essential anesthesia equipment and their proper usage. By delving into their proficiency in handling anesthesia machines, ventilators, and monitoring devices, and by scrutinizing their understanding of the intricate mechanisms and safety protocols associated with these instruments, we aim to illuminate areas that may require further education and training.

The significance of this research lies in its potential to enhance the competency of Resident Anesthetists, ultimately contributing to the delivery of safer anesthesia services, optimized patient care, and elevated healthcare standards in the captivating terrain of Himachal Pradesh. As we journey through this exploration of anesthesia equipment knowledge, we recognize the instrumental role that these devices play in preserving life and ensuring the success of surgical interventions, all within the embrace of the Himalayas.

OBJECTIVES OF THE STUDY:

The primary objective of this study is to gauge the levels of awareness and knowledge about Assess knowledge regarding essential anesthesia equipment, like anesthesia machines, ventilators, and monitoring devices, and their proper usage among the Residents of Anesthesia in Himachal Pradesh.

RESEARCH METHODOLOGY

- Research Approach -Descriptive
- Research Design- Cross-sectional survey design
- Study area: Himachal Pradesh
- Study duration- between April 2023 to June 2023
- Study population: The study's target population encompassed all Junior and Senior Residents of Anesthesia working in Medical Colleges in Himachal Pradesh.
- Sample size- A robust sample size of 100 was determined using a 95% confidence level, an estimated knowledge level of 50% regarding Anesthesia Equipment , a precise 10% absolute error margin, and a conservative 5% non-response rate.
- Study tool: A google form questionnaire consisting of questions regarding socio-demography and knowledge regarding Anesthesia Equipment was created. The questionnaire was initially pre-tested on a small number of participants to identify any difficulty in understanding by the respondents.
- Description of Tool-
 - a) Demographic data survey instrument: The demographic form elicited information on participants' background: age, gender, marital status, religion etc.
 - b) Questionnaire: The questionnaire contains 20 structured knowledge related questions regarding Anesthesia Equipment. One mark was given for each correct answer and zero for incorrect answer. The maximum score was 20 and minimum score was zero. Scoring was done on the basis of marks as >80%(16-20)=very good,60-79%(12-15) =Good,41-59% (8-11)=Fair,<40% (< 8)=poor
- Validity of tool - by the experts in this field
- Data collection- Data was collected under the guidance of supervisors. The google form questionnaire was circulated among all the Junior and Senior Residents of Anesthesia working in Medical Colleges in Himachal Pradesh for responses using online modes like e-mail and social media platforms like Whatsapp groups, Facebook, Instagram and LinkedIn till the 100 responses were collected.
- Data analysis- Data was collected and entered in Microsoft excel spread sheet, cleaned for errors and analyzed with Epi Info V7 Software with appropriate statistical test in terms of frequencies and percentage.
- Ethical Considerations- Participants confidentiality and anonymity was maintained.

RESULTS

The primary objective of this study was to gauge the understanding regarding essential anesthesia equipment, like anesthesia machines, ventilators, and monitoring devices, and their proper usage among the Residents of Anesthesia in Himachal Pradesh. A total of 100 participants took part in the study.

S.No.	Statements	Frequency of Correct Responses
1.	What is the primary function of an anesthesia machine in surgical procedures?	80
2.	Describe the components of a standard anesthesia machine, including the breathing circuit.	72
3.	How is the proper functioning of an anesthesia machine ensured before each use?	70
4.	Explain the importance of the anesthesia vaporizer and how it delivers specific anesthetic agents.	61
5.	What safety features should be checked on an anesthesia machine, and why are	58

	they essential?	
6.	How do you recognize and respond to common issues or alarms on an anesthesia machine?	53
7.	Describe the procedures for calibrating and maintaining an anesthesia machine.	50
8.	Why is mechanical ventilation necessary during general anesthesia, and what are its goals?	61
9.	Differentiate between controlled and assisted ventilation modes in anesthesia.	68
10.	What parameters should be monitored when setting up a mechanical ventilator for a patient?	82
11.	Explain the significance of tidal volume, respiratory rate, and positive end-expiratory pressure (PEEP) in ventilation.	67
12.	What safety measures should be in place to prevent complications during mechanical ventilation?	72
13.	How do you troubleshoot common ventilator-related issues during surgery?	61
14.	Name essential monitoring devices used during anesthesia and their functions.	75
15.	What vital signs should be continuously monitored during surgery, and why?	82
16.	Explain the role of capnography in assessing a patient's respiratory status during anesthesia.	63
17.	How is the depth of anesthesia typically monitored, and what is the significance?	78
18.	Describe the use of pulse oximetry in assessing oxygenation levels during surgery.	92
19.	What are the normal ranges for vital signs during anesthesia, and when should interventions be initiated?	72
20.	How do you respond to alarm notifications from monitoring devices to ensure patient safety?	54

Table-1: Knowledge regarding essential anesthesia equipment among study participants

In the present study 27 participants had very good knowledge (16-20 marks) towards essential anesthesia equipment, 36 had good knowledge (12-15 marks), 19 had fair knowledge (8-11 marks) and 18 having poor knowledge (<8 marks).

Category (Marks)	Frequency (n=100)
V. Good (16-20)	27
Good (12-15)	36
Fair(8-11)	19
Poor(<8)	18

Table-2: Knowledge scores towards essential anesthesia equipment among study participants

DISCUSSION:

In this study, we aimed to evaluate the proficiency of Resident Anesthetists in Himachal Pradesh in managing essential anesthesia equipment, including anesthesia machines, ventilators, and monitoring devices, as well as their understanding of the proper usage of these critical components in the anesthesia delivery system.

A significant proportion of participants demonstrated a good understanding of anesthesia machines. They recognized the primary function of these machines in surgical procedures, the components of a standard anesthesia machine, and the importance of pre-use checks to ensure proper functioning. However, there is room for improvement in comprehending the anesthesia vaporizer's role and the necessity of checking safety features and responding to common issues or alarms promptly. Furthermore, knowledge regarding the calibration and maintenance procedures of anesthesia machines could be enhanced.³⁻⁶

The participants exhibited a commendable grasp of mechanical ventilation, understanding its necessity and goals during general anesthesia. They could differentiate between controlled and assisted ventilation modes and recognized the vital parameters to monitor while setting up a mechanical ventilator. However, further education may be beneficial in explaining the significance of tidal volume, respiratory rate, and positive end-expiratory pressure (PEEP) in ventilation. While they demonstrated an understanding of safety measures to prevent complications during mechanical ventilation, there's room for improvement in troubleshooting common ventilator-related issues.²⁻⁵

Residents displayed good knowledge of essential monitoring devices used during anesthesia and their functions. They recognized the importance of continuous monitoring of vital signs during surgery and understood the significance of capnography, depth of anesthesia monitoring, and pulse oximetry. Knowledge of normal vital sign ranges and when interventions should be initiated was also commendable. However, further education may be beneficial in improving responses to alarm notifications from monitoring devices to ensure patient safety.³⁻⁶

These findings are consistent with similar studies conducted in various regions, highlighting varying levels of knowledge among anesthesia practitioners. It underscores the importance of ongoing education and training programs for Resident Anesthetists to maintain and enhance their proficiency in managing anesthesia equipment.

CONCLUSION

In conclusion, while a significant proportion of Resident Anesthetists in Himachal Pradesh demonstrated good knowledge in various aspects of anesthesia equipment management, there are specific areas where further training and education are warranted. These findings emphasize the need for regular anesthesia equipment training programs to enhance the proficiency of Resident Anesthetists, ultimately contributing to improved patient safety and the quality of healthcare in the region.

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