Staff Nurses Knowledge on Basics of Electrocardiogram Interpretation and Arterial Blood Gas Analysis Can be Significantly Improved by an Educational Intervention over a Period of 12 Weeks: An Audit Cycle-Based Quality Improvement Report

Yash Kripalani[1], Anjum Shaikh[2], Shambhavi Mishra[3], Tanvi Garude[4], Isha Budania[5], Joel Vaz[6], Hafsha Merchant[7], Shashank Mishra[8]

[1]Resident Medical Officer, Department of Critical Care Medicine, Holy Family Hospital, Bandra

[2]Consultant Intensivist, Department of Critical Care Medicine, Holy Family Hospital, Bandra

[3]Clinical Tutor, Department of Microbiology, D.Y. Patil University, School of Medicine

[4]Resident Medical Officer, P.D. Hinduja Hospital, Khar

[5]Clinical Tutor, Department of Bio-Chemistry, D.Y. Patil University, School of Medicine

[6] Medical Officer, Alva Hospital Private Limited

[7] Resident Medical Officer, Nanavati Super Speciality Hospital

[8] Intern, D.Y. Patil University, School of Medicine

Abstract: *A severe shortage of healthcare professionals was reported in 2020 as the COVID-19 pandemic surged across the country. A huge number of primary as well as tertiary healthcare centres hired inexperienced and under confident employees in order to meet the demand. This could potentially cause a decline in the overall quality of service that healthcare employees provide to their patients. In an Intensive care unit (ICU) setting, knowledge on basics of interpretation of electrocardiogram (ECG) and arterial blood gas (ABG) analysis is mandatory by not only doctors but also staff nurse practitioners, according to the guidelines set locally. Daily routine of teaching sessions has considerably reduced due to social distancing norms set out by the government [1]. This quality improvement study describes baseline knowledge on ECG and ABG interpretation of the staff nurses in a 23 bedded ICU setting of a tertiary healthcare centre and investigates whether a simple weekly teaching session as an educational intervention can improve it.*

Keywords: ECG, ABG, Education, Audit, QIP

1. Introduction

Interpretation of ECG and ABG reports are basics of day to day shifts in ICU's where a higher number of patients suffering from some form of cardiovascular disease and many who require mechanical ventilation are admitted [2][3]. The ability to accurately interpret such reports is vital. This could potentially help in division of workload pertaining to monitoring of patients in turn reducing stress on medical practitioners, thus, eventually resulting in the improvement of quality of care provided by healthcare professionals to their patients. A significant proportion of management of patients depends on assessment of such reports and appropriate intervention such as by making certain adjustments to ventilator settings and medication being given to each patient [3]. Staff nurses and junior resident doctors form the basic team in monitoring patients admitted to an ICU, hence, having adequate knowledge by staff nurses can significantly reduce pressure on doctors which can improve the outcome of admitted patients. As

many staff nurses were not exposed to daily interpretation of ECG and ABG during their undergraduate course, they lack significant experience resulting in loss of confidence when treating critically ill patients [4]. Our aim is to standardise interpretation of basic ECG and ABG reports by a simple, efficient and less time-consuming method amongst all staff nurses eventually improving quality of care provided at the ICU.

2. Methodology

A double PDSA cycle based clinical audit was conducted that involved staff nurses to answer questions specifically designed by the critical care consultant and resident doctors to assess knowledge on ECG interpretation and ABG analysis. This was approved by the critical care consultant in charge of the ICU and the quality improvement project was conducted in September 2020. The ethics committee approval was waived since it was based on education that would have been conducted as regular teaching. The staff

nurse's knowledge was assessed against guidelines set locally in the hospital and guidelines introduced by the Indian Nursing Council as well as Advanced Cardiovascular life support guidelines laid out by the American Heart Association. The Revised Standards for Quality Improvement Reporting Excellence (SQUIRE 2.0) guidelines were used in the reporting of the present quality improvement study.

All participants sampled were staff nurses from a 23 bedded ICU who had less than 12 months of on-field experience. About 31 staff nurses were assessed before the educational intervention was introduced, data was collected and analysed. About 27 staff nurses were assessed on the same questions after 12 weeks, as 4 staff nurses were unavailable for the second audit cycle. Data was collected and analysed again after the educational intervention was introduced to determine the improvement of knowledge and confidence.

The intervention included a single structured educational session every week over a video conference or in-person depending on whichever method was feasible during that week, lasting for a very short duration of about 25 to 30 minutes only, for an overall period of 12 weeks. Data was collected and analysed before this intervention was introduced and after completion 12 weeks of such educational sessions. Table.1 describes the topics used as an educational session [5-10][11]. It also included two simple charts, each providing necessary concise key information to aid in ECG interpretation and ABG analysis which was attached to a wall near the nursing station to provide easy access to it for all nursing staff even while they complete their day-to-day paperwork.

Table 1: Topic included in each educational session.

Session Number	Weekly Topics
1	Einthoven's Triangle and cardiac cycle
2	Technique to perform an ECG
3	Interpreting a normal ECG
4	Acute Coronary syndrome
5	Tachyarrhythmia: An overview
6	Bradyarrhythmia: An overview
7	Management of different acute cardiac conditions
8	Basics on Arterial Blood gases
9	Technique to perform an ABG test with Allen's test
10	Interpretation of Acidosis and Alkalosis
11	Differentiating between Respiratory and Metabolic
	components of ABG with action of compensatory mechanism
12	Presentation of different types of patients and expected ABG findings in each.

Knowledge assessment involved using a questionnaire developed on google forms that consisted of ten multiple choice items equally divided between ECG and ABG related questions as a baseline audit. The same questionnaire was used after 12 weeks to assess the improvement of knowledge on the same as a re-audit in order to close the audit loop. The questionnaire also assessed confidence to answer such multiple-choice items and interpretation of ECG and ABG on a daily basis for admitted patients by simply asking about their level of confidence on a scale of 1 to 5 from being severely under-confident to very confident.

3. Results

For the analysis, the percentage of questions assessing staff nurse's knowledge answered correctly was calculated. The mean post-intervention score was significantly higher than pre-intervention as depicted in figure 1.
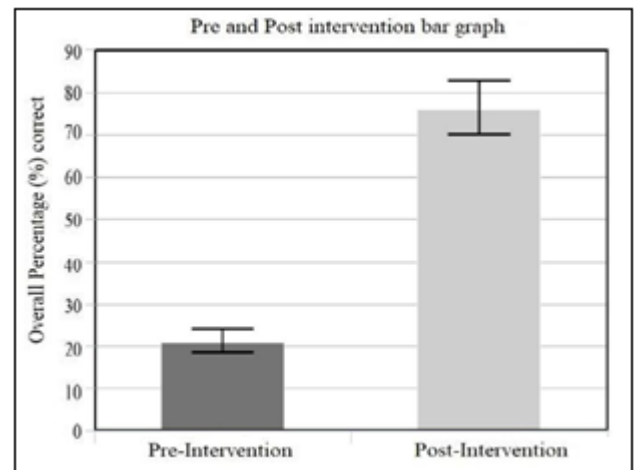

Figure 1: Bar graph illustrating the change in overall percentage score before and after educational intervention. (Mean ± SD)

Participant's knowledge increased over every single question related to both ECG and ABG interpretation. The shift of scores from pre- and post-intervention are shown in figure 2.
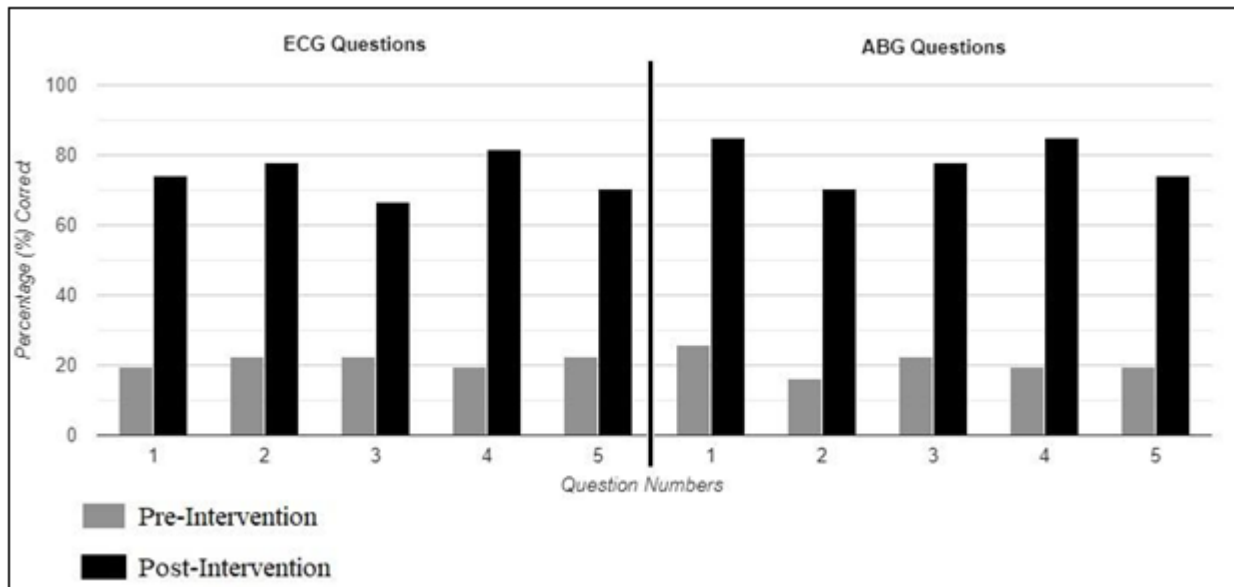
Figure 2: Graph demonstrating the improvement pre- and post-intervention for each question

The confidence to interpret ECG and ABG significantly improved after 12 weeks of intervention. It rose from 90.4% participants feeling under-confident to 74% participants feeling confident in using the knowledge they gained for patient care.

Table 2: Breakdown of questions and participants performance both pre- and post-intervention

Question Number	Pre-intervention (n = 31)		Post-intervention (n = 27)		% Improvement
	Actual Correct	% Correct	Actual Correct	% Correct	
1	6	19.4	20	74.1	281.96%
2	7	22.6	21	77.8	244.24%
3	7	22.6	18	66.7	195.13%
4	6	19.4	22	81.5	320.10%
5	7	22.6	24	70.4	230.23%
6	8	25.8	23	85.2	230.23%
7	5	16.1	19	70.4	337.26%
8	7	22.6	21	77.8	244.24%
9	6	19.4	23	85.2	339.17%
10	6	19.4	20	74.1	281.95%
All Questions	20.99%		76.32%		263.60%

4. Discussion

This study demonstrates the feasibility and efficacy of deploying a simple educational session every week and a couple of charts that share concise information to improve staff nurse knowledge of ECG and ABG interpretation. Overall, this achieved a significant improvement in the ability of staff nurses to correctly identify different pathologies and disorders that could potentially show early on during their management and an early intervention could be made possible. The intervention was structured in such a way that it remained limited to a single weekly session, making it possible to fit in along with the routine day-to-day work of staff nurses. Furthermore, the format of a concise chart providing key information as a guide was cheap and reproducible. Such interventions can facilitate implementations of guidelines set out locally and nationally. This also improved the confidence that staff nurses lacked before the educational sessions were conducted but regular

teaching and assessment may be required to keep their confidence level intact. A continuous exposure and experience in ECG interpretation and ABG analysis is required for development of practical knowledge.

Postgraduate education is limited and has taken a drastic setback due to the current ongoing pandemic. The feasibility and efficacy of mandatory teaching sessions despite being online can improve knowledge and confidence. Limited awareness of local and national guidelines and difficulties in learning due to increase in workload can lead to decrease in the quality of services healthcare professionals provide leading to a poor outcome of a patient admitted to the ICU. The burden of monitoring a patient round the clock falls on the shoulders of junior residents and staff nurses forming a team together.

The intervention used here can be deployed quickly, effectively and with a very low cost. A limitation to this study is use of only two formal data collection periods. Many sessions had to be repeated for some staff nurses as they were unable to attend the webinar due to work rota. This led to an increase in the amount of time required to re-audit to 12 weeks. This work was conducted at a single 23 bedded ICU with a limited number of staff nurses who had an experience of less than 12 months. The utilisation of the same questionnaire could've led to such a drastic improvement in performance due to prior exposure to specific questions. However, the staff nurses were not given the correct answers and a period of 12 weeks is sufficient time for washout of information. Despite this, the nature of the study is such that it cannot confirm that true change in clinical practice was achieved, or whether any such changes was sustained. Further work to include ECG and ABG interpretation as a formal workshop, mandatory to attend would ensure that improved access is maintained amongst all staff nurses. The Questionnaire was designed as a multiple-choice pattern with five options that could have led to a 20% probability of answering the question correctly without appropriate knowledge. This could result in a minor incorrect interpretation and analysis of the data but would

not alter the improvement observed in the second audit cycle.

5. Conclusion

This quality-improvement study supports a role for a simple and easily reproducible educational intervention to improve ECG and ABG interpretation by newly qualified staff nurses who lack on-field experience. It also improves their confidence to apply their knowledge to routine practice in an ICU. Such educational intervention should be introduced all over the country where post-graduate education lacks and is necessary to provide good patient care.

References

[1] "COVID-19 Educational Disruption and Response". UNESCO. 4 March 2020. Retrieved 24 May 2020.

[2] ECGNOW, http://ecgnow.com.br.

[3] Alfano G, Fontana F, Mori G, et al. Acid base disorders in patients with COVID-19 [published online ahead of print, 2021 Jun 11]. Int Urol Nephrol. 2021;10.1007/s11255-021-02855-1. doi:10.1007/s11255-021-02855-1

[4] Zhang H, Hsu LL. The effectiveness of an education program on nurses' knowledge of electrocardiogram interpretation. Int EmergNurs. 2013 Oct;21(4):247-51. doi: 10.1016/j.ienj.2012.11.001. Epub 2012 Dec 21. PMID: 23266113.

[5] Bogun F, Anh D, Kalahasty G, Wissner E, BouSerhal C, Bazzi R, et al. Misdiagnosis of atrial fibrillation and its clinical consequences. Am J Med. 2004;117(9):636–642. doi: 10.1016/j.amjmed.2004.06.024.

[6] Masoudi FA, Magid DJ, Vinson DR, Tricomi AJ, Lyons EE, Crounse L, et al. Implications of the failure to identify high-risk electrocardiogram findings for the quality of care of patients with acute myocardial infarction: results of the emergency department quality in myocardial infarction (EDQMI) study. Circulation. 2006;114(15):1565–1571. doi: 10.1161/CIRCULATIONAHA.106.623652.

[7] Schlapfer J, Wellens HJ. Computer-interpreted electrocardiograms: benefits and limitations. J Am Coll Cardiol. 2017;70(9):1183–1192. doi: 10.1016/j.jacc.2017.07.723.

[8] Salerno S, Alguire P, Waxman H. Competency in interpretation of 12 lead electrocardiograms: A summary and appraisal of published evidence. Ann Intern Med. 2003;138(9):751–760. doi: 10.7326/0003-4819-138-9-200305060-00013.

[9] Little B, Ho KJ, Scott L. Electrocardiogram and rhythm strip interpretation by final year medical students. Ulster Med J. 2001;70(2):108–110.

[10] Kellum JA. Making Strong Ion Difference the "Euro" for Bedside Acid-Base Analysis. Yearbook of Intensive Care and Emergency Medicine. Spr Ber Heid Publ. 2005; 5: 675.

[11] Fent G., Gosai J., Purva M. Teaching the interpretation of electrocardiograms: which method is best. Journal of Electrocardiology. 2015;48(2):190–193. doi: 10.1016/j.jelectrocard.2014.12.014.