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Effectiveness of Demonstration on Knowledge Regarding Arterial Blood Gas Analysis among Second-Year B.Sc. Nursing Students at GIMS Government College of Nursing, Gadag

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Abstract: ***Background**: Arterial blood gas (ABG) analysis is one of the most important investigations for assessing ventilation, oxygenation and acid–base balance in critically ill patients, and nurses are usually the first to see and act on the results. Deficits in ABG knowledge and practice among nurses and nursing students are widely reported, and structured teaching has been shown to improve them. **Aim**: To evaluate the effectiveness of demonstration on knowledge regarding ABG analysis among second-year B.Sc. nursing students. **Methods**: A quantitative evaluative approach with a pre-experimental one-group pretest–posttest design was used. Ninety second-year B.Sc. nursing students of GIMS Government College of Nursing, Gadag, were selected by simple random sampling. Knowledge was assessed with a 30-item structured questionnaire administered as a structured interview, and practice with a 14-item observational checklist, before the demonstration and again one week afterwards. The tool was validated by ten experts and its reliability was established (split-half, Spearman–Brown r′ = 0.82). Data were analyzed with frequency, percentage, mean, SD, paired t test, Pearson's correlation and chi-square test at the 0.05 level of significance. **Results**: In the pre-test, 72.2% of students (n=65) had inadequate knowledge 75.6% (n=68) and 73.3% (n=66) had adequate knowledge. The mean knowledge score rows from 9.53±8.03 to 22.86±6.84 (paired t=18.36). Knowledge showed a significant positive correlation (r=0.682, p<0.001). Pre-test knowledge was significantly associated with attendance at workshops/seminars and previous clinical exposure to ABG, and pre-test with age, workshops/seminars and previous exposure. **Conclusion**: Demonstration was effective in improving the knowledge of ABG analysis among second-year B.Sc. nursing students. Demonstration-based teaching, supported by early clinical exposure and workshops, may be incorporated into nursing curricula to prepare students for safe care of critically ill patients.*

Keywords: Arterial blood gas analysis, demonstration, knowledge, to B.Sc. nursing students, ICU, pre-experimental study

1. Introduction

An arterial blood gas (ABG) test analyses the acid–base status of the body in terms of pH and the partial pressures of oxygen and carbon dioxide in arterial blood, and is used to assess how effectively the lungs and kidneys are maintaining gas exchange and acid–base balance. ABG testing is important in the diagnosis and management of both acute conditions such as sepsis, diabetic ketoacidosis and shock, and chronic conditions such as heart and respiratory failure[1]. Acid–base disturbances, including metabolic acidosis, are common in critically ill patients and are associated with higher mortality[2]. ABG results are used to judge the efficiency of ventilation, to determine the effect of diagnostic and therapeutic procedures and to monitor the course of disease, but their usefulness depends on correct interpretation[3].

In Indian intensive care units (ICUs), nurses play a large part in patient monitoring. Nurses are often the first health professionals to receive ABG results and must recognize their significance and decide whether the physician needs to be informed, so adequate knowledge and skill in ABG analysis are essential. Studies, however, report gaps. Among 50 critical care nurses in a Mumbai tertiary hospital, 52% had good theoretical knowledge and only 34% were confident in interpreting ABG results[4]. Among 200 nursing students in Iran, only 25% could correctly interpret all ABG parameters, with a wide gap between theoretical knowledge[5], and among 250 Saudi nursing students, difficulty was most marked with mixed acid–base disorders[6]. Teaching programmes have been reported to close these gaps. Improvements in post-test knowledge after structured programmes have been documented among nursing students and staff nurses[7–10], and a structured teaching programme improved both theoretical knowledge of ABG analysis in a quasi-experimental study of 120 nursing students[11]. Demonstration allows learners to observe and rehearse the steps of a procedure under guidance, and may therefore be particularly suited to a skill-based topic such as ABG sampling and interpretation. The present study was undertaken to evaluate the effectiveness of demonstration on knowledge regarding ABG analysis among second-year B.Sc. nursing students.

2. Conceptual Framework

The study was based on the General System Theory of Ludwig von Bertalanffy[12], in which a system consists of interconnected elements working towards a common

objective through input, throughput and output, with feedback. In this study, the **input** comprised the sociodemographic characteristics of the students (age, gender, workshops/seminars attended on ABG analysis, previous exposure to ABG in a clinical setting and sources of information) that could influence knowledge. The **throughput** comprised the pre-test using the structured knowledge questionnaire and observational checklist, the demonstration on ABG analysis (preparatory, implementation and evaluation phases) and the post-test, followed by comparison of post-test with pre-test scores. The **output** was the resulting level of knowledge (adequate, moderately adequate, inadequate) (good, average, poor). **Feedback** referred to information received at each stage of the system that guided its evaluation.

3. Objectives of the Study

- To assess the knowledge and regarding among second-year B.Sc. nursing students before the demonstration.
- To evaluate the effectiveness of demonstration by comparing pre-test and post-test knowledge scores and scores.
- To determine the relationship between knowledge scores.

4. Materials and Methods

A quantitative research approach (evaluative) with a pre-experimental one-group pretest–posttest design (O1 – X – O2) was adopted. The study was conducted at GIMS Government College of Nursing, Gadag, Karnataka. The target population was all second-year B.Sc. nursing students of the college, and the accessible population was those available during data collection. Students who were willing to participate and available at the time of data collection were included; those who were sick at the time of data collection were excluded.

The sample size was calculated using $n = Z^2pq/d^2$, with Z = 1.96 (95% confidence), p = 0.5, q = 0.5 and a margin of error d of 9.8%, giving 101 students. Data were obtained from 90 students selected by simple random sampling.

The tool had two sections. Section I collected sociodemographic data (age, gender, workshop/seminar on ABG analysis attended, previous exposure to ABG in a clinical setting and source of information). Section II had two components: (a) a structured knowledge questionnaire of 30 multiple-choice questions on ABG analysis administered by structured interview (one mark per correct answer; score 0–30), and (b) an observational checklist of 14 items assessing practice (one mark per correct step; score 0–14). Knowledge was graded as inadequate (0–10), moderately adequate (11–20) or adequate (21–30).

The tool was prepared from an extensive literature review and the suggestions of the guide and experts. Content validity was established by ten experts from the departments of Medical Surgical Nursing and NPCC, and the tool was revised accordingly. Reliability was assessed by the split-half method on nine students from Guramma College of Nursing, Gadag (odd versus even items, Karl Pearson's correlation, corrected by the Spearman–Brown prophecy formula), giving $r' = 0.82$, indicating a highly reliable tool. The same nine students took part in a pilot study, which found the 45-minute programme feasible.

The intervention was a demonstration on ABG analysis (the procedure of ABG sampling and interpretation of results) following a script prepared from the literature and expert suggestions. The pre-test (questionnaire and checklist) was conducted and the demonstration was given on the same day; the post-test was conducted one week later using the same questionnaire and checklist. The study period was four to six weeks.

Permission was obtained from the Principal of GIMS Government College of Nursing, Gadag, and informed consent was obtained from all participants. Data were analysed using descriptive statistics (frequency, percentage, mean and standard deviation) and inferential statistics: the paired t test to compare pre-test and post-test scores, Pearson's correlation coefficient to examine the relationship between knowledge and the chi-square test to examine association with sociodemographic variables, at the 0.05 level of significance. The hypotheses tested were: H1, a significant difference between pre-test and post-test knowledge scores; H2, a significant correlation between knowledge H3, a significant association of knowledge of respectively, with selected sociodemographic variables.

5. Results

Sociodemographic Characteristics

Of the 90 students, most (73.3%, n=66) were aged 18–19 years and 74.4% (n=67) were female. Only 20% (n=18) had attended a workshop/seminar on ABG analysis. Previous exposure to ABG in a clinical setting was most often in the ICU (70%, n=63), and clinical guidelines were the commonest source of information (65.6%, n=59) (Table 1).

Table 1: Distribution of students by sociodemographic characteristics (N=90)

Characteristic	Category	n	%
Age (years)	18–19	66	73.3
	20–21	16	17.8
	22 and above	8	8.9
Gender	Male	23	25.6
	Female	67	74.4
Workshop/seminar on ABG attended	Yes	18	20
	No	72	80
Previous exposure to ABG in clinical setting	Emergency department	12	13.3
	Intensive care unit	63	70
	Operation theatre	9	10
	Others	6	6.7
Source of information	Clinical guidelines	59	65.6
	Training programme	11	12.2
	Mass media	12	13.3
	Others	8	8.9

Knowledge and Practice Levels before and after Demonstration

In the pre-test, 72.2% (n=65) of students had inadequate knowledge and only 14.4% (n=13) had adequate knowledge; after the demonstration, 73.3% (n=66) had adequate knowledge and 5.6% (n=5) inadequate knowledge (Table 2, Fig 1). Similarly, 75.6% (n=68) had poor practice in the pre-

test and only 10% (n=9) had good practice, whereas in the post-test 73.3% (n=66) had good practice and 5.6% (n=5) poor practice (Table 3, Fig 2).

Table 2: Levels of knowledge in pre-test and post-test (N=90)

Level of knowledge (score)	Pre-test n (%)	Post-test n (%)
Inadequate (0–10)	65 (72.2)	5 (5.6)
Moderately adequate (11–20)	12 (13.3)	19 (21.1)
Adequate (21–30)	13 (14.4)	66 (73.3)
Total	90 (100)	90 (100)

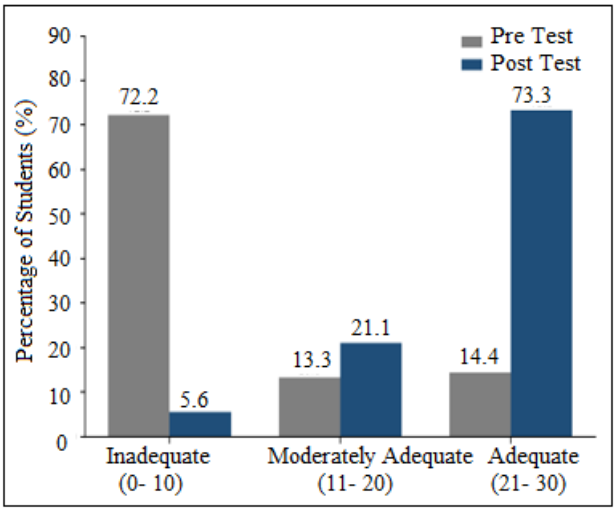


Figure 1: Percentage distribution of students by level of knowledge in pre-test and post-test.

Effectiveness of Demonstration

The mean knowledge score increased from 9.53±8.03 (31.8%) in the pre-test to 22.86±6.84 (76.2%) in the post-test, a mean gain of 13.33 points. The mean practice score increased from 3.34±3.57 (23.9%) to 9.54±3.28 (68.1%), a mean gain of 6.20 points (Table 4, Fig 3). The calculated paired t values for knowledge (18.36) and practice (15.33) were greater than the table value (1.98, df=89, $p<0.05$). Hypotheses H1 and H2 were therefore accepted: the demonstration was effective in improving both knowledge and practice.

Table 4: Comparison of pre-test and post-test knowledge (N=90)

Variable (max score)	Pre-test Mean±SD (%)	Post-test Mean±SD (%)	Mean gain	Paired t (df=89)	Table value
Knowledge (30)	9.53±8.03 (31.8)	22.86±6.84 (76.2)	13.33	18.36*	1.98

**Significant at p<0.05.*

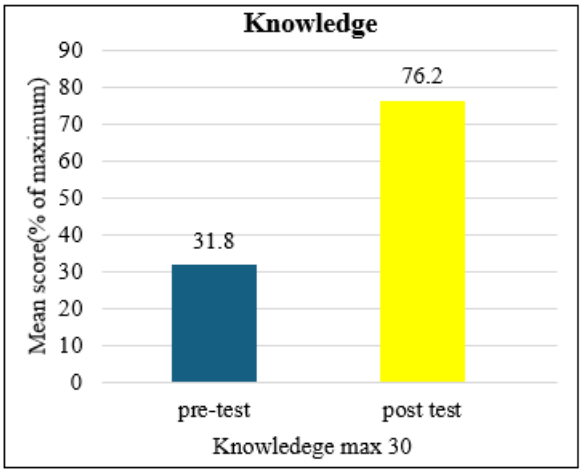


Figure 3: Mean knowledge in pre-test and post-test as percentage of maximum score

Association with Sociodemographic Variables

Pre-test knowledge was significantly associated with attendance at workshops/seminars on ABG analysis (χ^2=12.54, df=2, p=0.002) and previous exposure to ABG in a clinical setting (χ^2=21.61, df=6, p=0.001), but not with age, gender or source of information. Pre-test practice was significantly associated with age (χ^2=12.80, df=4, p=0.012), workshops/seminars (χ^2=6.45, df=2, p=0.040) and previous clinical exposure (χ^2=15.72, df=6, p=0.015), but not with gender or source of information (Table 5). H4 and H5 were therefore partially accepted.

Table 5: Association of pre-test knowledge with sociodemographic variables (N=90)

Variable	df	Table value	Knowledge χ^2 (p)
Age	4	9.49	8.83 (0.066)
Gender	2	5.99	1.35 (0.509)
Workshop/seminar attended	2	5.99	12.54* (0.002)
Previous exposure to ABG	6	12.59	21.61* (0.001)
Source of information	6	12.59	10.18 (0.117)

**Significant at p<0.05.*

6. Discussion

Before the demonstration, knowledge of ABG analysis were low: 72.2% of the students had inadequate knowledge. This agrees with reports of limited ABG competence among nursing students and nurses, including a large gap between theoretical knowledge[5], difficulty in applying knowledge to clinical situations[6] and low confidence in interpretation among critical care nurses[4]. Because ABG analysis is rarely part of routine undergraduate knowledge, the finding that only 20% of students had attended any workshop or seminar on the topic is also unsurprising. In a quasi-experimental study of undergraduate nursing students, Manoj reported that 29.6% had poor, 65.6% average and only 4.8% good knowledge before teaching[10]; the higher proportion with inadequate knowledge in the present study may partly reflect different scoring categories.

After the demonstration, the proportion of students with adequate knowledge rose from 14.4% to 73.3% and the mean knowledge score from 31.8% to 76.2% of the maximum (paired t=18.36). Comparable improvements have been

reported after teaching programmes: in Manoj's study the proportion with good knowledge rose from 4.8% to 54.4%[10]; Karpukkarasi and Arasumani found adequate knowledge in 80% of ICU nurses after a structured teaching programme, with none in the pre-test[15]; Anita et al. reported good knowledge in 75% of staff nurses after teaching[14]; Kaur and Yadav reported a 30–45% gain in knowledge[11]; and Kaur and Singh reported a significant mean difference with a paired t of 20.631 for knowledge[9].

Divya and Rakhi observed that after teaching most staff nurses had good or very good practice[8]. Singh et al. reported significant gains in both theoretical knowledge skills of ABG analysis among nursing students[12]. A demonstration lets students watch each step of sample collection and interpretation, ask questions and relate theory to the procedure, which may explain why gains in knowledge. Students and nurses with low confidence in interpretation make more errors[16], and several authors recommend knowledge -oriented methods such as simulation and demonstration to address this[5,6,16].

Knowledge scores were positively correlated (r=0.682), indicating that students who knew more about ABG analysis tended also to perform the procedure better. This supports teaching knowledge and skill together, and is consistent with the theory–described among nursing students[5]. Attendance at workshops/seminars and previous clinical exposure to ABG were associated with both pre-test knowledge, whereas gender and source of information were not; age was associated with knowledge only. Previous formal and clinical exposure thus appears to be an important determinant of baseline competence, which supports offering early workshops and supervised clinical exposure. Some categories of these variables contained few students (for example, six students with exposure in other departments and eight in the 22-years-and-above group), so these associations should be interpreted cautiously.

7. Conclusion

Second-year B.Sc. nursing students had low levels of knowledge of ABG analysis before the intervention. Demonstration significantly improved both: the proportion with adequate knowledge rose from 14.4% to 73.3%, and effective method of teaching ABG analysis to nursing students.

8. Implications

1) **Nursing knowledge:** Better knowledge skill in ABG analysis will help nurses detect acid–base imbalance and respiratory problems early and reduce errors in arterial sample collection and interpretation in ICU patients.
2) **Nursing education:** Demonstration and simulation strategies on ABG collection and interpretation may be incorporated into the nursing curriculum, supported by audio-visual aids such as videos, models and pamphlets and by early supervised clinical exposure.
3) **Nursing administration:** Regular in-service education and demonstration sessions may be arranged for ICU nurses, hospital guidelines on ABG collection and analysis developed, and availability of ABG analysers ensured.
4) **Nursing research:** Studies with larger, randomly selected samples and a control group, and comparative studies of demonstration against video-assisted teaching or simulation, may be undertaken among students, staff nurses and postgraduate students.

9. Limitations

1) The study was limited to second-year B.Sc. nursing students of one college (GIMS Government College of Nursing, Gadag) and to 90 students, which limits generalisability.
2) A pre-experimental one-group design without a control group was used, so changes cannot be attributed to the demonstration with certainty; use of the same instruments at pre-test and post-test may also have produced a testing effect.
3) The demonstration was restricted to about 45 minutes and the post-test was conducted only one week later, so long-term retention was not assessed.
4) The investigator had little control over environmental factors that could influence knowledge of the participants

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