Evaluation of Emergency Medicine Residents' Level of Knowledge of Arterial Blood Gases

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Abstract

Objective: Our purpose in this study was to determine the accuracy and reliability of interpretation of basic arterial blood gas (ABG) values and ABG values related to metabolic and respiratory disease by emergency medicine residents (EMRs). We also aimed to determine their deficiencies and create a basis for training during patient care.

Material and Methods: This study was carried out through a survey taken by EMRs in training/research and university hospitals located in Ankara. The levels of knowledge of EMRs on ABG evaluation were compared based on the institution, duration of residency, and training. A 14-question test about ABG knowledge was also applied to residents.

Results: The study was conducted with 25 EMRs in university hospitals (UH) and 88 EMRs in training/research hospitals (TRH); a total of 113 residents participated to the survey. There was no statistical significant difference between training/research and university hospitals according to the number of correct answers given. Year of residency did not affect the number of correct answers; however, residents who had training on ABG analysis in the residency period had more correct answers. Also, in a small study group (n=17), a significant improvement of the number of correct answers was observed with a short institutional course.

Conclusion: According to the results, ABG evaluation improves with personal training in the residency period independently of residency years. Based on this result, training should be given in and out of institutions, and EMRs should be encouraged to personally study ABG evaluation. *(JAEM 2014; 13: 100-3)*

Key words: Arterial blood gas, emergency medicine residents, training

Introduction

Arterial blood gas (ABG) analysis is used to measure arterial blood partial oxygen (PaO2) and partial carbon dioxide (PaCO2) pressures, oxygen saturation (SaO2), pH, and bicarbonate (HCO3) levels and determine acid-base equilibrium and respiratory stability (1). Arterial blood gas analysis is an important laboratory test that provides reliable information about the metabolic and respiratory physiology of patients (2).

Arterial blood gas analysis may be used to diagnose and follow up metabolic and respiratory events; to define the degree of decompensation developing with these events; to find the reasons of sudden and unexplained dyspnea, coma, and mental status disorders; to detect fluid and electrolyte disorders and kidney failure; and to assess requirement of dialysis and metabolic outcomes caused by intoxication (1-6).

The data obtained by arterial blood gas analysis is frequently used by emergency medicine physicians (EMPs) to evaluate these conditions. Blood gas analysis provides important data for EMPs who are responsible for planning and applying effective emergency treatment. The aim of this study is to evaluate emergency medicine residents' accuracy and reliability in the interpretation of ABG values, to identify inadequacies, and to provide a basis for training plans in clinical practice.

Materials and Methods

The study was designed as a prospective, cross-sectional study. Emergency medical resident physicians (EMRPs) training in university hospitals (UHs) and training and research hospitals (TRHs) located in Ankara were asked to fill out a standard questionnaire that aimed to evaluate the EMPRs' knowledge of arterial blood gas analysis. The study was started after approval of the Yıldırım Beyazıt University School of Medicine Non-Drug Clinical Research Ethics Committee was obtained.

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The study included EMRPs training in UHs and TRHs who volunteered to participate. EMRPs who refused to participate or did not fill the questionnaire fully as required were excluded from the study. After the features of the research were explained, the questionnaire forms were delivered by hand and collected after being filled in for 20 minutes. The data collection phase lasted approximately 6 weeks.

Survey questions included multiple-choice questions based on cases that were mainly located in textbooks or presented at conferences. The questionnaire consisted of two sections. The first section included questions about socio-demographic characteristics of the emergency medicine residents, whether they received any ABG training during their residency, and how successful they considered themselves in evaluating ABG analysis. The second section included fill-the-blank-type problems about the normal values of ABG and 14 multiple-choice questions about evaluating the ABG values of 14 cases. The multiple-choice questions about a single type of acid-base disturbance were classified as simple questions, and the ones about multiple acid-base disturbances were classified as complex questions.

After this survey an emergency medicine specialist gave a seminar on systematic interpretation of ABG to 17 emergency medicine residents in our clinic's weekly education seminar. Then, 1 month later, without notification, the EMRPs were asked to answer the same survey questions, and their answers before and after the seminar were compared.

Statistical Analysis

Statistical Package for Social Sciences 16.0 (SPSS Inc., Chicago, IL, USA) was used for the statistical evaluation of the data. Normal distribution of data was assessed by Kolmogorov-Smirnov and Shapiro-Wilk tests. Continuous variables were assessed by student t-test and Mann-Whitney U-test. Dependent group comparisons were performed by using paired t-test. One-way analysis of variance and Kruskal-Wallis tests were used in triple-group comparisons. Pearson chi-square test was used for the evaluation of categorical variables. A value of $p<0.05$ was considered statistically significant.

Results

One hundred twenty-one emergency medicine residents participated in the study; 8 emergency medicine residents who did not complete the questionnaire were excluded from the study. As a result, a total of 113 emergency medicine residents (25 from UHs and 88 from TRHs) were included in the statistical analysis. Seventy of the participants (61.9%) had received training on assessment of ABG, and 43 (38.1%) participants had no previous training. The distribution of the duration of residency and the numbers of trainings they had are presented in Table 1.

The medians of the correct answers were found to be 8.00 among the EMRPs training in training and research hospitals and 7.00 among the EMRPs training in university hospitals. Accordingly, there was no statistically significant difference between the two groups (p=0.344). Regarding the duration of residency, the medians of the correct answers were 7.15±2.10 among the junior residents, 8.10±2.40 among the mid-senior residents, and 7.14±2.07 among the senior residents, respectively. There was no statistically significant difference among the three groups (p=0.886). The median of correct answers among those who had received ABG training was 8.00 and 7.00 among who had not received ABG training. There was a statistically significant difference between the two groups (p=0.006). Regarding the number of trainings and average of correct answers, there was no statistically significant difference (p=0.069).

Table 1. Whether participants received training on the ABG and the number and duration of training

	TRH n (%)	UH n (%)	Total n (%)
Have received training?	88 (100.0%)	25 (100.0%)	113 (100.0%)
Yes	55 (62.5%)	15 (60.0%)	70 (61.9%)
No	33 (37.5%)	10 (40.0%)	43 (38.1%)
Number of training	55 (100.0%)	15 (100.0%)	70 (100.0%)
1	19 (34.5%)	5 (33.3%)	24 (34.2%)
2	15 (27.3%)	6 (40.0%)	21 (30.0%)
≥3	21 (38.2%)	4 (26.7%)	25 (35.7%)
Duration of residency	88 (100.0%)	25 (100.0%)	113 (100.0%)
0-12 months	43 (48.9%)	12 (48.0%)	55 (48.6%)
13-36 months	24 (27.2%)	5 (20.0%)	29 (25.7%)
>36 months	21 (23.9%)	8 (32.0%)	29 (25.7%)

TRH: Training and research hospitals, UH: University hospitals

Regarding the question about how sufficient they considered themselves in interpreting ABG, 8 (7.1%) EMRPs considered themselves insufficient, 58 (51.3%) considered themselves moderate, and 47 (41.6%) considered themselves fairly sufficient. The median total of correct answers between the groups was 7.00, 8.00, and 8.00, respectively. Accordingly, no statistically significant difference was found between the three groups (p=0.241).

Thirty-six participants (32.0%) gave correct answers to all of the items on the question about the normal range of arterial blood gas parameters. The ratio of participants who received ABG training during residency gave the correct answer to this question when compared with those who did not receive ABG training (p=0.049). We found that 30 of these 36 participants who gave correct answers to this problem had received ABG training previously.

Four of the questions were simple questions about blood gas samples, while the other four were complex questions involving acid-base disorders. The rate of the correct answers to the questions about simple blood gases was 76.75% (question 1; 84%, question 2; 58%, question 3; 87%, question 4; 85%), whereas the rate of correct answers to the questions about complex blood gases was 44% (question 1; 29%, question 2; 0.35%, question 3; 76%, question 4; 70%). Simple blood gases were referred to as Group 1, and complex blood gases were referred to as Group 2. According to seniority in residency, there was no statistically significant difference between the ratio of correct answers in Groups 1 and 2 (Group 1: p=0.357, Group 2: p=0.955). There was no statistically significant difference between the ratio of correct answers given to simple blood gas questions and complex gas questions when the participants were compared in terms of being trained previously; the percentage of correct answers was higher in Group 1 (p=0.690) than in Group 2 (p=0.034).

The same test was applied to the group limited by 17 participants who received training on systematic evaluation of ABG by emergency medicine specialists, a month later; a statistically signifi-

cant difference was observed between the ratio of correct answers before and after training (p<0.001). The average number of correct answers to all questions was 8.47±1.51 before the training and 11.76±1.68 after the training.

There was no statistically significant difference between the correct answers given to questions on normal levels of ABG (p=1.000) and simple blood gases (p=0.389) before and after the training. On the other hand, a statistically significant difference was found between the answers given to the questions about complex blood gases (p=0.013). The distributions of correct answers of the group of 17 people before and after training are presented in Table 2.

Discussion

In our study, we found that 15 of the 25 residents in UHs (60.0%) and 55 of the 88 residents (62.5%) in TRHs had received approximately the same ABG training during their residency. The similar rates of correct answers given by EMRPs training in university hospitals and training and research hospitals may be attributed to the similar levels of training received.

There are few studies on the evaluation of ABG in the literature. Austin and friends, in their study, investigated the sufficiency of EMPs in ABG interpretation with a sample of 43 emergency medicine residents and 37 emergency medicine specialists. They found that the success of EMPs increased gradually over the years and that emergency medicine specialists and 4-year residents had shown the highest success (7). In our study, we observed an increase in the average of correct answers among the junior and mid-senior residents, whereas this upward trend was not observed in the senior residents. We found no significant differences between the three groups. Considering that the EMRPs who had received ABG training gave more correct answers, independent of the number of trainings, we suggest that sufficiency in the interpretation of ABG is related with training rather than the duration of residency.

Powles and his friends found that 24% of participants interpreted ABG analysis incorrectly and 41% of them interpreted them insufficiently in a study including 42 interns and trainee doctors (8). Schreck and colleagues, in their 35-item questionnaire study that they conducted with 21 physicians, found that the rate of correct answers was 86% to simple blood gas questions, and the rate was lower for complex blood gas questions (9). In our study, the rate of correct answers was 76.75% for simple blood gases and 44% for complex blood gases. Given the diversity of the study population, the rates of correct answers of emergency medicine residents to the questions about simple blood may be considered sufficient, whereas the rate of correct answers was relatively low for complex acid-base disorders. We think that evaluation of uniform metabolic or respiratory events is easier, but when the table is extended by compensation or addition of a disorder, interpretation of blood gas analysis becomes more difficult.

Table 2. The distributions of correct answers in the group of 17 people before and after training was presented

	All questions (The medians of correct answers)	**Simple blood gas questions** (The medians of correct answers)	**Complex blood gas questions** (The medians of correct answers)
The average number of correct answers before training	8.47	3.058	2.117
The average number of correct answers after training	11.76	3.352	2.705

There are few studies investigating the correct assessment of the normal range of arterial blood gas parameters in the literature. Sullivan and his colleagues, in their study including 66 physicians (13 of them emergency physicians), found that 54% of the participants (n=36) correctly stated the normal values of ABG (10). In our study, 32% of participants (n=36) answered all items of the question about the normal values of blood gas correctly. The lower rate of success in our study is because we accepted only the ones who answered all of the items of the question correctly. Considering that 30 of the 36 residents who answered all of the items of the question had received previous training, we suggest that the training given during the residency increases success.

There are very few studies investigating the evaluation and training of ABG in the literature. In our study, training on the systematic assessment of ABG was given by an emergency medicine specialist to a limited group of 17 people, and the test was repeated after the training. The significant differences in the rates of correct answers to questions about both simple and complex blood gases suggest the importance of repeated training during residency in the understanding of acid-base disturbances.

Study Limitations

Our study reflects the results of a survey including nonstandardized questions asked to a limited group of emergency medicine residents. With different questions and populations of participants, the results may be different. Studies including a larger group of participants are needed.

Conclusion

The results of our study suggest that the development of EMRPs in the interpretation of arterial blood gases depends largely on training rather than duration of residency, and more success can be provided by frequent repetition of relevant practical training.

Ethics Committee Approval: The study was started after approval of Yıldırım Beyazıt University School of Medicine Non-Drug Clinical Research Ethics Committee was obtained.

Informed Consent: All participants were informed verbally before they were given the survey.

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