Introduction

Systemic Arterial Hypertension (SAH) is characterized by high and sustained levels of blood pressure (BP), being a multifactorial clinical condition, as well as one of the most important risk factors for the development of renal, cardiovascular and cerebrovascular diseases.\(^1\) There are about 17 million hypertensive Brazilians, 35% of the population aged 40 years or older. The number is growing and the disease manifests itself early. It is estimated that about 4% of children and adolescents are also carriers. The burden of disease represented by morbidity and mortality is very high and, for all this, it is a serious public health problem in Brazil and worldwide.\(^2\) Approximately 49% of the Brazilian population is made up of adults and deserves an effective approach to cardiovascular risk assessment and primary preventive measures. Thus, it is essential to implement continuing education for health professionals regarding the appropriate BP measurement and care for patients with SAH.

Although the indirect method for measuring BP is simple, it is subject to errors that may be related to those who perform the measurement, the equipment...
used, the sphygmomanometer and the stethoscope, the patient, the place (the doctor’s office or outside it) and the technique itself.³

To assess theoretical knowledge on BP measurement, Machado et al.,⁴ developed and validated a Theoretical Knowledge Questionnaire on Indirect Blood Pressure Measurement (Q-CTMIPA) for the population of nursing professionals in a Coronary Unit, contributing to the construction of evidence of this knowledge among different health professionals. This study evidenced the importance of training and promoting intervention on direct measurement of BP by health professionals, so that they can identify, evaluate and define assertive behaviors.

Given the above, the objective of this study was to evaluate the effects arising before and after an educational intervention on indirect BP measurement, with a single group of health professionals, in relation to their theoretical and practical knowledge.

**Methods**

This is a quasi-experimental study, developed at the Mobile Emergency Service (SAMU) located in a city in the interior of the state of São Paulo, in 2017.

The eligible population was SAMU health professionals and the sample was for convenience, regardless of gender or ethnicity. Professionals who expressed interest in participating in the pre-and post-educational intervention assessment were included.

The instrument used to assess theoretical knowledge on the steps of indirect BP measurement was the Q-CTMIPA,⁴ composed by 7 questions related to the profile of the research participants (age, sex, time elapsed from the last training on BP measurement) and 20 questions related to the steps of indirect BP measurement, based on the 7th Brazilian Hypertension Guideline,² divided into 4 stages: patient preparation and environment (9 items), patient position (8 items), measurement steps (4 items) and registration of values (8 items), totaling 31 items. The analyst (medical student) was able to identify, using the checklist, if the participant did not execute (0), performed incompletely (1), performed incorrectly (2) or performed (3) and, for each option, a value was considered using the Likert scale.

The practical evaluation was carried out in an isolated room, which became a realistic simulation of a doctor’s office. The participant, the actor, the observer, the analyst, who fed the information system, in which he detailed the entire procedure using a checklist spreadsheet and could compare the results before and after the intervention, were in the room. After the first theoretical and practical evaluation, an educational intervention was carried out. During this intervention, the students of the medical course intervened actively in the mistakes evidenced by each participant regarding the steps of BP measurement, in addition to allowing the participant to clear their doubts on semiology. In addition, immediately after the intervention, each participant was given an educational booklet with information on the semi-technique of indirect BP measurement. The educational intervention continued with safe practical experience, based on scientific evidence and critical and reflective knowledge, aware of the reasons that underlie each of these stages. During the educational activity, the following topics were addressed:

- Preparation of the patient and the environment: for the measurement, the environment must be calm and quiet,
with the patient relaxed for 5 minutes before checking the
BP, not talking during the procedure; check on bladder
emptying, not having performed physical exercises,
eating food, coffee or alcoholic beverages, and smoking.

Patient positioning: sitting position, legs uncrossed,
feet flat on the floor, relaxed. The arm is always at heart
level, free of clothes and supported, with the palm of the
hand facing up and the elbow slightly flexed.

BP measurement steps: obtaining the brachial
circumference and selecting the corresponding cuff;
cuff over the brachial artery; Osler’s maneuver to
estimate systolic pressure by palpation of the radial
artery; stethoscope positioning; insufflation of the
cuff to obtain systolic BP 20 to 30 mmHg above the
estimated; determination of systolic BP in the first
Korotkoff sound; determination of diastolic BP to the
disappearance of sounds.

Record of values: Record of values in millimeters of
mercury (mmHg) without rounding and record of the
arm used.

One month after the educational intervention was
carried out, the same Q-CTMIPA instrument and the
same methodology for assessing practical knowledge
were reapplied in all participants, so it was possible
to compare whether there was a change in relation to
knowledge before and after the intervention.

This study was approved by the Human Research
Ethics Committee, CAAE: 41876615.5.0000.5495, and
all participants signed an informed consent form, in
accordance with Resolution 466/12.

Statistical analysis
All information obtained during data collection
was entered twice in a database using Microsoft Excel
Software. Next, they were transferred to the statistical
program STATA 9.0 for calculations of absolute and
relative frequency. Descriptive statistics were used to
synthesize the information and characterize the sample,
with measures of central tendency (mean) and variability
(standard deviation).

Results
Thirty health professionals from the Mobile Emergency
Care Service (SAMU) participated in the study, 19 (63.3%)
men and 11 (36.6%) women, with a mean age of
41 ± 9.4 and 35 ± 9.5 years, respectively. Among these
health professionals were: Doctors, Nurses, Nursing
Technicians, First Aid and Medical Regulation Assistant
Technicians (TARM).

Regarding the level of education of the participants,
only 1 (3.3%) had incomplete high school and 11
(36.6%) completed high school; 1 (3.3%) incomplete
higher education and 14 (46.6%) had complete higher
education; only 3 participants reported having a degree at
the post-graduate level, of whom 2 participants (6.6%) had
completed a lato sensu postgraduate course and 1
participant (3.3%) had a postgraduate master’s degree.

Table 1 shows the frequency distribution of the
responses referred to in relation to the last formal training
on indirect BP measurement.

The assessment of theoretical knowledge before and
after the educational intervention, in health professionals,
using the Q-CTMIPA instrument, are shown in Table 2,
with the percentage of correct answers according to each
step of the procedure.

According to the answers pointed out in each step
of the procedure, some of them expressed a lack of
theoretical knowledge of the participants, with emphasis
on "Recommended position for the upper limb",
"Calibration conditions of the device" and "Ideal clamp
size in relation to the patient’s upper limb". The other
items in question presented a remarkable improvement
in knowledge after the educational intervention.

In order to characterize the practical knowledge on
the sequential stages of the indirect measurement of
BP before and after the educational intervention, health
professionals were evaluated through a simulation exam,
using a checklist for verification. Table 3 presents the
results pointed out according to each step performed.

The results of the practical evaluation indicated gaps
in the "Steps of measurement", since "obtaining the
circumference of the patient’s arm" and "selection of the
clamp of adequate size" presented lower scores compared
to all other items, resulting in a small improvement after
educational intervention. However, the "Patient position"
stage was characterized by better performance in the
pre- and post-intervention phases.

Discussion
The study found an improvement in all evaluated
items, both in the theoretical and practical questionnaires.
However, a limitation of the intervention was observed
in the following parameters: "Recommended position
Table 1 – Distribution of the frequency of responses indicated regarding the last formal training on indirect BP measurement, by health professionals (n = 30), in 2017.

| Questions                                      | Yes | %   | No  | %   |
|------------------------------------------------|-----|-----|-----|-----|
| The training was satisfactory                  | 28  | 93.3| 2   | 6.6 |
| Received training only during the course       | 24  | 80  | 6   | 20  |
| Last training time less than 6 months          | 0   | 0   | 30  | 100 |

Source: the authors.

Table 2 – Distribution of the frequency of the number of correct answers among the health professionals on the steps of indirect BP measurement, based on the adapted Q-CTMIPA, (n = 30), in the theoretical assessment, performed in 2017.

| Steps of the BP measure                                      | Pre-intervention | Post-intervention |
|--------------------------------------------------------------|------------------|-------------------|
|                                                              | n    | %    | n    | %    |
| Preparation of patient                                       |      |      |      |      |
| Mentioned asking questions to the patient before measuring their BP | 4    | 13.3 | 14   | 46.6 |
| Mentioned resting of at least 5 minutes                      | 4    | 13.3 | 14   | 46.6 |
| Mentioned recommended position for upper limb                | 0    | 0    | 2    | 6.6  |
| Mentioned recommended position for lower limbs               | 2    | 6.6  | 16   | 53.3 |
| Preparation of the environment                               |      |      |      |      |
| Reported the ideal environment to carry out the BP measurement| 1    | 3.3  | 7    | 23.3 |
| Care with the device                                         |      |      |      |      |
| Referred to the calibration conditions of the automatic device| 0    | 0    | 0    | 0    |
| Agreed that clamp of inappropriate size can influence values | 29   | 96.6 | 30   | 100  |
| Considered removing from use armband structure and extensions with any problems/damage | 2    | 6.6  | 7    | 23.3 |
| Referred to the calibration period of the automatic device   | 7    | 23.3 | 13   | 43.3 |
| Values obtaining and recording                               |      |      |      |      |
| Referred to the ideal size of the cuff according to the patient’s upper limb | 0    | 0    | 1    | 3.3  |
| Agreed that it is possible to obtain different BP values between the patient’s right and left upper limb | 28   | 93.3 | 29   | 96.6 |
| Considered different BP values between the right and left upper limbs | 9    | 30   | 10   | 33.3 |
| Considered the position of the cuff on the patient’s upper limb | 1    | 3.3  | 6    | 20   |
| Agreed that it is important to record the limb used to measure BP | 28   | 93.3 | 28   | 93.3 |
| Allowed 1 minute interval between two measurements            | 6    | 20   | 16   | 53.3 |
| Considered the recording of BP values in millimeters of mercury | 29   | 96.6 | 30   | 100  |
| Considered the recording of BP values without rounding       | 13   | 43.3 | 20   | 66.6 |

n = number of correct answers.
Source: authors.
### Table 3 – Distribution of the number of correct answers on the steps of BP indirect measurements, based on the role-play, among health professionals (n = 30), in the practical evaluation, performed in 2017.

| Steps of the BP measure                                                                 | Pre-intervention | Post-intervention |
|-----------------------------------------------------------------------------------------|------------------|------------------|
| **Patient preparation and environment**                                                  |                  |                  |
| Explained the procedure to the patient                                                  | 25               | 30               |
| Allowed the patient to rest for at least 5 minutes in a calm environment                 | 8                | 16               |
| Provided a calm and quiet environment                                                    | 29               | 30               |
| Oriented the patient not to talk during the measurement                                  | 6                | 20               |
| Made sure that the patient was not with full bladder                                     | 4                | 13               |
| Certified that the patient did NOT exercise in the previous 60 minutes                   | 13               | 27               |
| Certified that the patient did NOT drink alcohol in the previous 30 minutes              | 8                | 26               |
| Certified that the patient did NOT drink coffee in the previous 30 minutes               | 4                | 16               |
| Certified that the patient did NOT smoke in the previous 30 minutes                      | 9                | 21               |
| **Patient position**                                                                    |                  |                  |
| Kept sitting in a relaxed position                                                      | 30               | 30               |
| Kept his/her back on the chair                                                         | 18               | 30               |
| Kept legs uncrossed                                                                     | 16               | 29               |
| Kept feet flat on the floor                                                            | 15               | 28               |
| Removed clothes from the arm to put the cuff on                                         | 20               | 29               |
| Positioned arm at heart level                                                           | 26               | 30               |
| Kept his/her arm supported                                                              | 26               | 30               |
| Kept his/her palm upside down                                                           | 26               | 30               |
| Kept his/her elbow slightly bent                                                        | 26               | 30               |
| **Measuring steps**                                                                     |                  |                  |
| Obtained the circumference of the patient’s arm                                         | 0                | 1                |
| Selected the right size arm cuff                                                        | 0                | 5                |
| Placed the cuff without leaving clearances 2 to 3 cm above the cubital fossa            | 28               | 30               |
| Centered the middle of the compressive part of the armband over the brachial artery     | 29               | 30               |
| **Registration of securities**                                                           |                  |                  |
| Recorded systolic / diastolic values                                                    | 24               | 30               |
| Waited 1 to 2 minutes for new measurements                                               | 9                | 27               |
| Reported the BP values obtained for the patient                                          | 29               | 30               |
| Noted the BP values obtained without rounding                                            | 4                | 16               |
| Recorded member on which BP was checked                                                 | 6                | 20               |
| Checked whether the time between the recordings was less than 5 min                     | 30               | 30               |
| Recorded values in mmHg                                                                  | 18               | 24               |
| Kept silent during the procedure                                                       | 7                | 29               |

*n = number of correct runs.
Source: authors.
for the upper limb", "Instrument calibration conditions", "Ideal clamp size in relation to the patient’s upper limb", being the greatest deficiencies observed in the "obtaining of the circumference of the arm of the patient" and the "selection of the clamp of suitable size" results.

The position of the upper limb during BP measurement is of great value for the veracity and accuracy of the measurement obtained. When the arm is hyperinduced along the axis of the body, the pressure is lower than the intra-arterial pressure measured directly, and that decreases with abduction of the arm. In addition, the same study states that, depending on the type of chair, armchair or patient's own posture, muscle tension can cause changes in BP measurements. F, the patient should be relaxed with his/her back supported on the back of the chair. It is evident, therefore, that the patient's position and the arm supported at the height of the heart with the palm facing upwards are indispensable for a good evaluation of BP by indirect measurement. Thus, it is clear that the approach used for this issue needs to be modified so that more reliable indirect BP measurements can be obtained in the future.

The reference to adequate calibration time of the BP measurement device was correctly made by only 23.3% of the professionals in the pre-intervention stage and, in the post-intervention stage, by 43.3%. These evidences are based on a study on the evaluation of the conditions of the use of sphygmomanometers in health services, which revealed that most respondents (76.6%) did not know how often the aneroid apparatus should be calibrated. It is also worth noting that 0% of the participants knew how to evaluate the calibration of the automatic devices because they were not available in the institution. Therefore, since there is a current tendency to replace aneroid devices by automatic devices, it would be extremely important that trainings are carried out in order to prepare professionals to deal with this novelty.

Inadequately sized sleeves result in incorrect BP measurements. Tiny cuffs used to measure BP in people with a larger than expected waist circumference overestimate the diagnosis of hypertension, whereas larger cuffs underestimate BP readings. One study showed that approximately 97% of practitioners do not check the appropriate measures given by the formula "Correct width cuff = 0.40 x Arm Circumference / Sleeve Width". This same situation was observed in 83.8% of the participants, who did not measure the brachial circumference, and were completely unaware of the purpose of the measurement. Thus, it can be inferred that providing adequate cuffs is essential to achieve BP measurements closer to the theoretical ideal.

Despite the gaps identified during the theoretical and practical evaluation of the BP measurement steps, the number of correct answers was lower during the pre-intervention stage, with a significant improvement in the post-intervention period. A survey conducted at the University of Mississippi compared the measurements acquired by current medical professionals with professionals trained by the American Heart Association and found a difference in SBP of 5.66 mmHg and a decrease in DBP of -2.96 mmHg. The study reinforces our data and suggests that periodic training favors the adequate measurement of BP even though all of these professionals have already been trained.

In Minas Gerais, researchers applied a simulation training strategy for health professionals on the management of patients with acute coronary syndrome and observed an impact on the acquisition of knowledge and confidence of the learners using the training model. This study reinforces evidences of a positive impact of realistic simulations on performance.

In fact, with the educational intervention, we noticed an improvement in the BP measurement technique. Providing specific training after the training of professionals is required for their updating and for the proper functioning of the institution.

The study carried out presented limitations regarding the small sample size, which allows for considering the results found only for the population in question.

**Conclusion**

Based on the results of this study, it is possible to note that both theoretical and practical knowledge of health professionals on the stages of BP measurement was insufficient. In general, the professionals presented gaps regarding the accomplishment of the "Measurement steps", especially when "obtaining the circumference of the patient’s arm" and "selecting the appropriate size cuff" in the pre-intervention assessment. However, the educational intervention had a positive influence and brought improvements in relation to the knowledge gaps presented. Educational strategy plans should be carried out, with institutional actions aimed at the permanent training of all professionals, with an emphasis on detailing the correct and effective performance of each procedure performed in the process of patient care.
Author contributions

Conception and design of the research: Bachur CK. Acquisition of data: Silveira GB, Sousa SGO, Hercos Neto J. Analysis and interpretation of the data: Candido SS. Critical revision of the manuscript for intellectual content: Veiga EV.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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