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Internal Medicine Section

Competency in Home Blood Pressure Monitoring and Effect of Training Program on Competency

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ABSTRACT

Introduction: Blood Pressure (BP) measurement is the basis of diagnosis and treatment of hypertension. Automatic BP monitors are available for self-measurement of BP at home and it helps in adaptation of treatment strategy. However, proper measurement procedures are of paramount importance for credible BP readings.

Aim: To ascertain the level of competency in Home Blood Pressure Monitoring (HBPM) among patients and their family members (i.e., operators) and to find the effect of a simple educational program on improvement in the competency in HBPM.

Materials and Methods: A cross-sectional survey was conducted with patients or their family members who measure BP at home. Procedure of HBPM, as practiced by the participants was observed by the surveyor physician and competency was scored on 17 item survey questionnaire. Then, an educational tool was used to educate the participants. Summative assessment was conducted after the training program by another session of HBPM. The data was tested statistically by chi-square and paired t-test with α=0.05.

Results: A total of 125 respondents of mean age 34.51±12.32 years participated in the survey. Among 17 items, overall competency score in HBPM before training program was 4.63±4.59. The competency score (16.31±2.53) significantly ($p<0.001$) increased after the training.

Conclusion: The HBPM procedure, as followed by patients or their family members is grossly deficient in accordance with standard protocol. This deficiency can be improved with simple educational program.

Keywords: Hypertension, Physicians, White coat hypertension

INTRODUCTION

The BP measurement is the basis of diagnosis of hypertension [1]. Level of measured BP helps in stratifying patients in different categories of hypertension [2]. Follow-up BP measurement helps to check the treatment response and to adopt treatment strategies accordingly. However, BP measured at hospital and clinics may show higher reading than the original BP, which is called white-coat hypertension [3]. The BP measurement at regular interval has been proved to improve BP control in hypertensive patients [4]. This necessitates the measurement of BP at home.

With advancement of BP measurement technology, especially oscillometric method, now it is possible to measure BP by patients themselves at home with little expertise [5,6]. Though, there is controversy about the accuracy of available BP monitors, it has been established that HBPM is well accepted by patients and it helps in effective management of hypertensive patients [4,7]. For this reason it is being used in many countries for better patient management [8,9]. However, the measurement should be carried out in accordance with standard protocol [10,11]. Deviation from these protocol may lead to erroneous BP report, and this may lead to patient's anxiety and unnecessary visit to physicians [12-15].

Previous study by Stryker T et al., found that HBPM is prone to error due to faulty technique of the measurer [16]. However, not only the faulty technique in measurement, pre-measurement measures are equally important for errorless BP measurement [10,11]. To the best of present knowledge, no study has been conducted in India to ascertain the competency in HBPM.

With this background, we aimed to find out the level of competency in HBPM in pre-measurement, measurement proper and post-measurement procedure in accordance with standard guidelines among BP measurers and to find out impact of a simple educational intervention on improvement in the competency.

MATERIALS AND METHODS

A cross-sectional survey was conducted from December 2016 to June 2017. This survey involved only non-invasive BP measurement by adult participants (i.e., patient or patient's family member) who consented voluntarily for participation in the study. After consultation with the institutional review board, the present study was conducted according to the guidelines by WMA Declaration of Helsinki [17].

Sampling Technique

To the best of our knowledge, no previous similar study was published from India. Hence, prevalence rate of erroneous HBPM could not be obtained. Therefore, for the present study, according to available logistics (i.e., time and manpower) a convenience sample was taken. Inclusion criteria were: written consent for participation, age above 18 years, having automatic BP monitor of their own, and accessible residence of respondents by the surveyor physician. Exclusion criteria were: Bedridden patients, respondents in any mental stress, and with any acute illness.

Recruitment Procedure

Patients and/or patient's family members were recruited from medicine outdoor of four Tertiary Care Hospitals situated in an urban area, West Bengal, India. They were enquired about availability of automatic BP measurement monitor at their home. Those who have the monitor were explained about the study and were offered a proposal of training about proper measurement of BP by automatic BP monitor. Subjects willing to participate were requested to sign the informed consent form, where the detailed address and phone numbers were recorded for future communication.

Survey Instrument

A survey instrument (i.e., a questionnaire to record the appropriateness of BP measurement and interview responses of the operator) was drafted for the present study by the first and second author. The instrument was composed of two parts. First part contained 17 item scale to gather information about competency in HBPM in three segments (viz., pre-measurement enquiries and instructions, measurement proper, post-measurement record keeping). Individual statement in the questionnaire was prepared in accordance with guidelines by American Heart Association, American Medical Association and the Johns Hopkins University School of Medicine [10,11]. For recording the response, there was closed option to tick "yes" or "no" against each statement.

Second part of the instrument was subdivided into two parts. Initial part was for recording demographic details of the respondents (viz., age, sex, educational qualification, duration of experience in BP measurement, total family members suffering from hypertension). Next part was for recording information about the procurement, source of information regarding monitor, training and the usage of the monitor.

After drafting the instrument, six senior colleagues were consulted for checking the face and content validity of the instrument. However, after considering the questions and response options, internal consistency was not feasible to obtain by Cronbach's alpha. After receiving comments from the experts, the final questionnaire was prepared and arranged in such a way that the whole questionnaire can be printed on a single sheet. The questionnaire was prepared in English; keeping in mind that only physician would read the questionnaire and convey the questions to the respondents in their native language.

The survey instrument was distributed among five registered medical practitioners (i.e., physician) who were briefed about the standard protocol of HBPM. The survey was aimed to conduct by interviewing the respondents by the physicians. There was no scope for self-administered method of survey. Considering scarcity of study subjects, only one subject was surveyed by each physician in the pilot study. After the experience from the pilot survey, the instrument was found to be feasible to conduct the survey further. Recorded responses of the pilot survey were not included in analysis.

Data Collection

Personal appointment was obtained prior to the home visit. The aim of the study was described in detail to the participants. They were instructed to do the whole procedure from pre-measurement, measurement and post-measurement events that they usually follow for BP measurement. Competency in HBPM was observed by the surveyor during the actual measurement by the operators (i.e., who measured the BP) on patients (i.e., whose BP was measured) or patients on themselves (i.e., operator and patient is the same person). Responses were recorded in the first part of the questionnaire. After completion of the first part, the second part was filled up by the physician by interviewing the operators. After completion of these two parts of data collection, participants were provided a self-explanatory single page educational material containing step by step correct procedure of BP measurement by automatic BP monitor. After five minutes, the whole procedure of BP measurement was repeated by the participants and observed for competency again.

STATISTICAL ANALYSIS

Collected data was tabulated in spreadsheet software OpenOffice Calc (Apache Software Foundation, Maryland, USA). Response of the participants in individual component of competency test was summed up to get total "yes" and "no" against each component and it was expressed in percentage. The ratio of responses were tested statistically by chi-square (χ^2) test (with α=0.05). Statistical significance ($p<0.05$) denotes that the response was not occurred by chance. For comparison of pre-training and post-training response in competency, responses for each component was scored as "yes=1" and "no=0". For individual respondent, the score of 17 item was added together both for before and after the training. Pre-test and post-test mean score was compared statistically by paired t-test with α=0.05.

RESULTS

Mean age of the respondents was 34.51±12.32 years. A total of 125 operators were observed and interviewed in the present study. All the respondents were attended at their homes and data was collected by physician. Hence, there was no incomplete data and responses from 125 respondents were taken for analysis (i.e., survey response rate 100%).

Correctness (i.e., "yes" response) and error (i.e., "no" response) in HBPM before the training is shown in [Table/Fig-1]. In pre-measurement precautions, only 3.2% operator asked about the consumption of coffee, alcohol, and smoking within 30 minutes. Voiding bladder before measurement was confirmed by only 4% of the operators. Keeping mobile and other electronic device away from the machine was practiced by 4.8% of the operators. In measurement proper, sitting arrangement was correct in 53.6% and hand rest was confirmed in 44.8% cases. Proper fastening of cuff was practiced by 70.4% with checking of clothing not constricting the arm in 85.6%. Proper back rest (12%) and a period of five minutes rest before measurement (8.8%) showed major deficiency. Only 5.6% of the operators measured BP for three times to calculate the average for final reading.

Measures		Yes n (%)	No n (%)	χ^2, p-value
Pre-measurement	Inquiry about intake of alcohol, coffee or smoking within 30 minutes	4 (3.2%)	121 (96.8%)	109.5, <0.001*
	Instruction/practice of voiding bladder before measurement	5 (4%)	120 (96%)	105.8, <0.001*
	Instruction/practice about not to talk during measurement	23 (18.4%)	102 (81.6%)	49.93, <0.001*
	Instruction/practice of not to move during measurement	44 (35.2%)	81 (64.8%)	10.95, <0.001
	Keeping mobile phones and other electronic devices away during measurement	06 (4.8%)	119 (95.2%)	102.2, <0.001*
Measurement proper	Sitting arrangement on chair or similar arrangement done	67 (53.6%)	58 (46.4%)	0.65, 0.42
	Hand rest on arm of chair or on similar structure maintained	56 (44.8%)	69 (55.2%)	1.35, 0.24
	Nearby table or similar arrangement checked	34 (27.2%)	91 (72.8%)	25.99, <0.001*
	Ensure clothes not constricting the arm	107 (85.6%)	18 (14.4%)	63.37, <0.001*
	Position of legs (not in crossed position) checked	17 (13.6%)	108 (86.4%)	66.25, <0.001*
	Position of feet (flat on the floor or on similar flat surface) checked	21 (16.8%)	104 (83.2%)	55.11, <0.001*
	Proper back rest checked	15 (12%)	110 (88%)	72.2, <0.001*
	5 minutes rest before measurement confirmed	11(8.8%)	114 (91.2%)	84.87, <0.001*
	Placement of measuring arm at level of heart	32 (25.6%)	93 (74.4%)	29.77, <0.001*
	Proper fastening of the cuff	88 (70.4%)	37 (29.6%)	20.81, <0.001*
	Measuring blood pressure 3 times at 1 (or more) minute(s) interval	07 (5.6%)	118 (94.4%)	98.57, <0.001*
Post-measurement	Recording of all readings on the log sheet	42 (33.6%)	83 (66.4%)	13.45, <0.001*

[Table/Fig-1]: Measures followed by BP measurer during HBPM by automatic BP monitor.
BP: Blood pressure; HBPM: Home blood pressure monitoring; n: Number of response
*Statistically significant p-value for chi-square test

Category of respondents, sex, educational qualification, experience in BP measurement, and total hypertensive patients present in the family on which survey was conducted is shown in [Table/Fig-2].

		Number, percentage	χ^2, p-value
BP measurer	Patient	34, 27.2	25.99, <0.001*
	Family member of patient	91, 72.8	
Sex	Male	38, 30.4	19.21, <0.001*
	Female	87, 69.6	
Educational qualification	<5th standard	0, 0	63.19, <0.001*
	5th-10th standard	21, 16.8	
	11th-12th standard	56, 44.8	
	Graduate and above	48, 38.4	
Experience in HBPM	<6 months	23, 18.4	18.35,< 0.001*
	6-12 months	40, 32	
	>12 months	62, 49.6	
Number of hypertensive patient(s) in family	1	78, 62.4	110.7, <0.001*
	2	34, 27.2	
	3	11, 8.8	
	4 and above	2, 1.6	

[Table/Fig-2]: Demographic details of the subjects (n=125) participated in the survey.
BP: Blood pressure; HBPM: Home blood pressure monitoring
*Statistically significant p-value for chi-square test

Information about the BP monitor procurement, source of information regarding monitor, learning about the measurement procedure, and usage of monitor is shown in [Table/Fig-3]. Majority of respondents (75.2%) procured the instrument with self-advice or advice from relatives, and only 10.4% bought it after consultation with the physician. Among the participants, 92% do not know how to check the authenticity of device nor the necessity of proper cuff size. Relative and friends were the source of information for measurement procedure in 67.2% participants. A significant number of participants measured BP randomly whenever they felt necessary (63.2%).

Overall score in competency test after the training (16.31±2.53) was significantly higher (p<0.001, 95% confidence interval 10.87 to 12.49) than competency test before the training (4.63±4.59) and it is shown in [Table/Fig-4].

DISCUSSION

Results of the present study showed several important aspects of HBPM as practiced by patients or their family members in the state of West Bengal, India. The automatic BP monitor is designed conveniently so that the patient themselves can measure the BP and keep track of their BP level [18]. However, from the present study, it was found that only 27.2% patient themselves measure their own BP. The family members of the patients measured BP of patients in majority of the cases (72.8%). Hence, when any physician thinks about demonstrating the procedure of BP measurement by automatic BP monitor; they should include patient's family members too.

In most of the families (62.4%), there was only one patient suffering from hypertension and they bought automatic BP machine for tracking the BP. However, surprisingly, the decision of buying BP monitor was self-influenced. Only 10.4% of the patients bought BP monitor by the advice of their physician. Majority of the instruments were bought with the help of friends or relatives. The underlying potential reasons may be less information about the price, brand or quality of the device, for which they refer relatively expert friend or relative. Lack of awareness about the device was also evident from the finding that 92% of the respondents do not know what to check for the authenticity of the device. Validity of the automatic BP monitor is of paramount importance

			Number, percentage	χ^2, p-value
BP monitor related information	Bought BP monitor after consultation with	Physician	13, 10.4	171.5, <0.001*
		Relative/Friend	16, 12.8	
		Pharmacist	2, 1.6	
		Self/family members	94, 75.2	
	BP monitor purchased from	Medical shops	44, 35.2	39.18, <0.001*
		E-commerce websites	12, 9.6	
		Don't know (someone else bought it for me/us)	69, 55.2	
	Checking authenticity	Checked	8, 6.4	194, <0.001*
		Not checked	2, 1.6	
		Don't know what to check	115, 92	
	Cuff size appropriateness	Checked	6, 4.8	193.7, <0.001*
		Not checked; know how to check	4, 3.2	
		Not checked; do not know how to check	115, 92	
Learning and usage of BP monitor	Learning measurement procedure	From physician	9, 7.2	120.8, <0.001*
		By reading manual	20, 16	
		From relative/ friends	84, 67.2	
		From shop-keeper who sold the device	12, 9.6	
	Keeping log of all measured values	Yes	57, 45.6	0.97, 0.33
		No	68, 54.4	
	Time of measurement	Morning	18, 14.4	110.2, <0.001*
		Afternoon	0, 0	
		Evening	28, 22.4	
		Randomly, whenever feel necessary	79, 63.2	
	Measurement at regular interval	Maintained	40, 32	16.20, <0.001*
		Not maintained	85, 68	
	Showing BP record to physician	Yes	48, 38.4	6.73, 0.009*
		No	77, 61.6	

[Table/Fig-3]: Information regarding BP monitor procuring, learning about measurement and its usage by respondents (n=125) expressed in percentage.
BP: Blood pressure
*Statistically significant p-value for chi-square test

Measures	Before training (Mean±SD)	After training (Mean±SD)	t, p-value
Pre-measurement (sum of 5 items)	0.66±1.14	4.63±1.19	29.85, <0.001*
Measurement (sum of 11 items)	3.64±3.16	10.73±1.29	25.50, <0.001*
Post-measurement (1 item)	0.34±0.47	0.95±0.21	14.10, <0.001*
Overall (sum of 17 item)	4.63±4.59	16.31±2.53	28.47, <0.001*

[Table/Fig-4]: Competency score in HBPM before and after training program.
HBMP: Home blood pressure monitoring; SD: Standard deviation
*Statistically significant p-value of paired t-test

for choosing a BP monitor as substandard machine may provide erroneous BP readings [19].

After buying the BP instrument, majority of the patients (92.8%) did not take it to physician for learning proper measurement procedure, rather they learned the procedure from friends or relatives (67.2%).

In some of the cases (9.6%), respondents learned measurement from the shop keeper from where they bought the monitor. Learning BP measurement procedure from these sources may contribute in improper technique adopted by respondents as evident from [Table/Fig-3].

For correct BP measurement, it is advised that the measurement should be taken on the morning and evening at the same time of the day for consecutive days. This is advised to avoid the morning-evening difference in HBPM [20,21]. However, this was not followed by the respondents participated in present study. They measured BP whenever they felt the necessity. This random measurement may contribute to erroneous record of BP. In addition, the necessity of measurement is fainted by the fact that only 45.6% of respondents were keeping record of the measured BP. Lack of proper guidance may be the underlying factor. Among the participants, only 38.4% shows the recorded blood pressure to the physician. There may be multiple factors behind this practice. The obvious one is that 54.4% patients do not keep log. Majority of the respondents bought BP instrument with the instruction of friends or with self-advice. Hence, may be the attending physician does not want the record; even the physician may be unaware about the availability of the BP monitor with the patient. Furthermore, physicians may not rely on the patient-recorded blood pressure at all [22].

Among the participants, 95.2% did not ever check whether the cuff size was appropriate for the patient or not. Choosing a wrong cuff size may provide erroneous result. Smaller than the required cuff may show increased BP and larger than the required cuff may show decreased BP [23].

From the competency survey, it is evident that there is gross deficit in procedure of HBPM. Not only had the measurement itself, majority of the participant failed to follow pre-measurement and post-measurement guidelines [Table/Fig-1]. In pre-measurement protocol, information about intake of alcohol, coffee or smoking within 30 minutes was enquired by only 3.2% of participants. Intake of those substance within 30 minutes before the measurement may provide inaccurate BP [24]. Talking and body movement can also affect the BP readings [25]. Before BP measurement, voiding bladder is suggested as distention of bladder may increase blood pressure [26]. All these factors showed different level of deficiencies in the present study [Table/Fig-1]. For credible BP reading in HBPM, sitting position on a chair, maintenance of proper resting of arm and placement of legs are important and any deviations from standard protocol may provide wrong reading [27-30].

The BP measured by automatic BP machine has several disadvantages and it has been found to be inferior to the aneroid BP monitor [31]. However, its suitability has been established in clinical practice [15]. Contribution of ambulatory blood pressure monitoring and HBPM have been found to be effective measures for prevention of cardiovascular disease and mortality rate [32]. For HBPM, authentic automatic BP monitors are being suggested and it has no accessibility barriers for visually impaired patients also [33]. A single measurement of BP by automatic machine is not sufficient. Hence, three measurements at an interval of one minute are suggested. In the present study, 5.6% followed it [11,34]. Hence, these factors should be taken into consideration during instructions to patients.

Majority of the respondents (66.4%) did not record the BP reading on log sheet during competency test. However, in second part of the survey, when they were asked about recording of reading on log sheet, 54.4% participants informed that they do not keep record. The 12% (66.4-54.4) of the respondents may be influenced by social desirability bias.

With an aim to reduce these errors in HBPM, we designed a simple educational tool in vernacular language (i.e., Bengali) and considering cultural diversity of the survey area, we also made the same tool in Hindi and English. However, 100% participants were native Bengali speaker. When we evaluated the effect of the training, we found significant improvement in technique in HBPM [Table/Fig-4]. This result is corroborative to the result reported by Stryker T et al., [16].

The result of the present study established the applicability of a simple educational tool on improvement in HBPM. A similar tool may be used effectively in educating population for proper HBPM. This does not eliminate the need of full demonstration of BP measurement by a physician. However, from Indian perspective of health care system, in many settings, it is not possible for the physician to provide a live demonstration. In those cases, similar tool would be an effective alternative.

LIMITATION

The present study has several limitations. The participants were thoroughly briefed about the aim of the study; however, participant's response bias, if any, was beyond our control. During recruitment of the participants, it was informed that they would get training on how to measure blood pressure appropriately. The consent for participation in the survey may be influenced by this factor. The sample was a convenience sample. A systemic random sample in future study would reflect more precise result. According to residence of physicians and logistics, all participants were recruited from urban and semi-urban area. Hence, scenario in rural area is not reflected from the survey. For assimilation of information from the educational material, on an average only five minutes were allowed because of time constraint of the surveyor physician. The effectiveness of the educational program was assessed only by summative method only.

CONCLUSION

Procedure in HBPM by automatic BP monitors followed by patients and patient's family members is incorrect in majority of the cases. Pre-measurement enquiries and instructions are grossly deficit. These factors should be considered by physicians during instruction to their patients. A single page educational material about proper BP measurement would provide an effective way to educate patients or their family members about errorless BP measurement. Busy physicians may adopt this for educating their patients.

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