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Training and assessment of observers for blood pressure measurement in hypertension research

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Summary: **Eight nurses were re-trained in the technique of measuring blood pressure firstly with an audiotape and secondly with a video and expert instruction. They were then assessed for accuracy in measurement in subjects with a range of BP.**

In the first session with the audiotape, criteria for accuracy were that the difference in readings (systolic and diastolic) between each pair of observers was to be 5 mm Hg or less in at least 85% and 10 mm Hg or less in at least 95% of the readings. Five out of the 28 observer pairs (18%) fulfilled these criteria for both systolic and diastolic pressures, six (21%) satisfied the criteria for systolic pressure and nine (32%) for diastolic pressure with eighteen pairs (64%) failing to meet the criteria for both systolic and diastolic pressure.

In the second training session seven of the original eight observers underwent further training in which the audio-tape was replaced by the British Hypertension Society video and instruction was also given by an expert. The same requirements for accuracy were used except that, in addition, the difference between the trainee observer and the expert had to be within 5 mm Hg in at least 90% and within 10 mm Hg in at least 95% of the readings. Eighteen of the 21 observer pairs (86%) achieved the accuracy criteria, with the remaining three (14%) failing on diastolic pressure only. All seven observers were within the required criteria when assessed against the expert observer.

It is concluded that training of observers is more effective with a video and expert instruction than by using audio-tapes. Recommendations for training observers in hypertension research are proposed.

Introduction

Accurate BP readings are essential in epidemiological studies, screening programmes and research studies as well as clinical practice.[1] Blood pressure measurement is subject to many potential sources of error.[1–4] Quite apart from the biological variation that may influence BP, substantial measurement errors may arise from the instrument, the observer, the subject and the interaction between the observer and the subject.[1–4] The influence of observer error, which may consist of prejudice or bias, systematic error or terminal digit preference, is often underestimated, particularly in research.[1]

Various guidelines and training programmes have been developed to minimise observer error,[5–7] most of which use either an audiotape or film sequence as the main component of training and assessment.[8–11] The problems of observer error have been demonstrated in a number of studies[5,6,9] and significant error has been shown to persist even after training.[8] The aim of this study was to determine if observer accuracy could be improved using two training programmes and to make recommendations for training requirements in hypertension research.

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Methods

First observer training

Eight nurses conversant with BP measurement were recruited and re-trained in the technique of measuring BP using an audiotape.[7] This tape consists of a series of recorded Korotkov sounds which are 'read' by the observers with the use of two stopwatches. Each sequence of Korotkov

sounds is preceded by an audible time signal at which point the observer starts both the stopwatches which are then stopped at the perceived systolic and diastolic end-points. The times recorded can then be compared with a reference standard. As the sound sequences are recorded at a cuff deflationary rate of 2 mmHg/sec, each second difference in the observer's reading and the reference standard is equivalent to 2 mmHg in the BP readings. The readings of each observer can then be compared to the standard to identify error. The tape was used repeatedly by the observers until all systolic and diastolic readings fulfilled the time score of the tape.[7]

First observer assessment

After completing the first training session the eight observers were isolated in specially constructed booths containing only the aural part of a Littmann stethoscope, a recently calibrated mercury sphygmomanometer column (PyMah) and a pencil and paper. The training supervisor, separated from the trainees by a partition, placed the cuff (bladder dimensions – 12 × 35 cm) and stethoscope head on the subject's arm and inflated and deflated the cuff which was joined by Y connectors to the mercury columns in the trainee booths as was the Littmann stethoscope. Systolic and diastolic BPs were measured on six occasions in five subjects with BP range of 100/60 to 240/120 mmHg. The subject was seated with the arm supported at the level of the heart.[12] The cuff pressure was initially inflated to 30 mmHg above the palpated BP and then deflated at a rate of 2 mmHg/second to 20 mmHg below the diastolic end-point and each observer was instructed to note the systolic and diastolic readings as the pressure fell.

Each observer measured BP in random sequence on six occasions in each of the subjects to give a total of 30 readings per observer. The criteria for passing the assessment were that the difference in readings (systolic and diastolic) between each pair of observers was 5 mmHg or less in at least 85% (i.e. 26) of the readings and 10 mmHg or less in at least 95% (i.e. 29) of the readings.

Second observer training

In this session seven of the original eight observers were trained firstly with the British Hypertension Society (BHS) video *Blood Pressure Measurement*[13] and then instructed by an expert (E O'B). The BHS video consists of two parts: in the first the technique of BP measurement according to the BHS recommendations[12] is demonstrated and in the second the observers can assess their accuracy by watching a mercury column falling against a background of recorded Korotkov sounds. Instruction by the expert observer consisted of demonstrating the different stages of BP measurement as recommended by the British Hypertension Society[12] with difficult aspects of interpretation, such as the auscultatory gap and bias, being discussed and demonstrated by example using a multiaural stethoscope.

Second observer assessment

This was similar to the first assessment except that the expert observer was included in place of Observer 8 so that the trainee observers could be assessed against an 'expert' standard. The criteria for passing the assessment were as in the first assessment together with the added criteria that the difference between the trainee observer and the expert should be less than 5 mmHg in at least 90% (i.e. 27) of the readings and less than 10 mmHg in at least 95% (i.e. 29) of the readings.

Results

First observer assessment

The table shows the results of the assessment for systolic and diastolic readings following the first training session. Only five (18%) out of the 28 observer pairs (comprising paired readings of each observer against the remaining observers), fulfilled the accuracy criteria for both systolic and diastolic pressures. Six (21%) fulfilled the accuracy criteria for systolic pressure and 9 (32%) for diastolic pressure. Eighteen pairs (64%) failed to meet the criteria for both systolic and diastolic pressure. One observer (No.8) left the study after the first session for personal reasons.

Second observer assessment

Eighteen out of the 21 observer pairs (from the seven trainee observers) achieved the accuracy criteria (86%) for both systolic and diastolic pressures; all seven observers achieved the accuracy criteria for systolic pressure, with the remaining three (14%) failing on diastolic pressure only (Table). All observers were within the required criteria when assessed against the expert observer.

Table Comparison of observers against each other in the first and second assessments

First assessment		*Second assessment*	
Observer pairs	*SBP/DBP*	*Observer pairs**	*SBP/DBP*
1 v 2	P/F	1 v 4	P/F
1 v 3	F/F	1 v 3	P/P
1 v 4	F/F	1 v 4	P/P
1 v 5	P/P	1 v 5	P/P
1 v 6	F/F	1 v 6	P/F
1 v 7	P/P	1 v 7	P/P
1 v 8	F/F	1 v E	P/P
2 v 3	F/F	2 v 3	P/P
2 v 4	F/F	2 v 4	P/P
2 v 5	P/P	2 v 5	P/P
2 v 6	F/P	2 v 6	P/P
2 v 7	P/P	2 v 7	P/P
2 v 8	F/F	2 v E	P/P
3 v 4	F/F	3 v 4	P/F
3 v 5	F/F	3 v 5	P/P
3 v 6	F/F	3 v 6	P/P
3 v 7	F/F	3 v 7	P/P
3 v 8	F/F	3 v E	P/P
4 v 5	F/F	4 v 5	P/P
4 v 6	F/F	4 v 6	P/P
4 v 7	F/F	4 v 7	P/P
4 v 8	F/P	4 v E	P/P
5 v 6	P/P	5 v 6	P/P
5 v 7	F/P	5 v 7	P/P
5 v 8	F/F	5 v E	P/P
6 v 7	F/P	6 v 7	P/P
6 v 8	F/F	6 v E	P/P
7 v 8	F/F	7 v E	P/P
Totals			
28	6P/10P	21	21P/19P
Percent 100	21P/32P	100	100P/90P

* In the second assessment observer 8 is replaced by the expert
P = pass; F = fail; E = expert

Discussion

This study demonstrates that the accuracy of observers, which was unacceptable after training with an audiotape, could be improved greatly by using a training video together with expert instruction. In the Minneapolis Children's Blood Pressure Study, it was shown that despite careful training with tapes, measurement bias remained an important source of error.[8] Similar measurement bias was seen in observers following tape training and assessment in other studies.[9,10]

Our study might be criticised on the grounds that the first audio-tape session could have influenced the second session with the video but this is unlikely as the training sessions were separated by more than three months. It might further be argued that Observer 8 who withdrew after the first session might have done so because she was experiencing difficulty with the technique and that the inclusion of her measurements might have biased the comparative results of the two studies. However, exclusion of her measurements from the first session only results in a small improvement in the percentage accuracy from 21 to 28% for systolic pressure and from 32 to 38% for diastolic pressure.

Whereas the recommendations for the measurement of BP in clinical practice have been stated by a number of authorities,[2,13,14] the problem of assessing trained observers has not been addressed. In hypertension research it is desirable not only to train observers to a high level of accuracy but it is also necessary to show that they have achieved this goal. An intensive observer training programme with the application of stringent accuracy criteria should be a prerequisite to all research studies using conventional sphygmomanometry. On the basis of this study we put forward the following recommendations for the training and assessment of observers for the measurement of BP in hypertension research:

1. An initial training session of one hour using the BHS video *Blood Pressure Measurement*.
2. A subsequent training session of one hour with instruction by an expert using a multiaural stethoscope.
3. An assessment session with 10 subjects as described and the application of the following accuracy criteria:
   (a) systolic and diastolic readings between each pair of observers to be within 5 mmHg in at least 85% and 10 mmHg in at least 95% of the readings.
   (b) systolic and diastolic readings between each observer and the expert to be within 5 mmHg in at least 90% and 10 mmHg or less in at least 95% of the readings.

Failure to achieve this degree of accuracy necessitates repeat training and assessment for the failed observer. Allowing for recruitment of subjects, training by video and expert, assessment and analysis of results, the above programme requires the participation of an experienced research nurse for seven hours and of an expert observer for two

hours in the assessment phase. It is recommended that this programme be undertaken before each research study using conventional sphygmomanometry.

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