

Availability and functionality of sphygmomanometers at health care institutions in Enugu, Nigeria

CP Chijioko^{1,3}, TO Okolo², KI Nwadike¹, EC Ejim³, FC Ekochin³, GN Aronu³, SI Ghasi¹, OU Chijioko⁴

¹Departments of Pharmacology and Therapeutics, ³Medicine and ⁴Medical Laboratory Science, College of Medicine, University of Nigeria, ²Department of General Outpatients, University of Nigeria Teaching Hospital, Enugu, Nigeria

Abstract

Objective: Our aim was to investigate the availability of functional blood pressure monitors at health care institutions in Enugu, Nigeria.

Methods: During repeated surveys of 15 (primary, secondary and tertiary) health care institutions in Enugu between 2007 and 2012, records were made of the availability and functional status of sphygmomanometers in the clinics and wards. We also assessed the degree of agreement between measurements by institutional staff and measurements by trained observers using the same or the standard sphygmomanometer.

Results: Apart from three institutions, there was inadequate availability of fully functional sphygmomanometers: 61 staff attending to outpatients were sharing 35 sphygmomanometers, 6 of which were faulty i.e. needing repairs. Wards invariably had only one or two functional sphygmomanometers, regardless of bed occupancy. Institutional staff ignored recommended guidelines for blood pressure measurement. The overall mean difference in blood pressure measurements between institutional staff and a trained observer (1.6 mmHg; 95% confidence interval, CI: -0.3 to 3.4; $P = 0.1$) was greater and more significant than the mean difference between the two observers (0.1 mmHg; CI: -1.5 to 1.7; $P = 0.9$) and the mean difference between institutional and standard sphygmomanometers (-0.2 mmHg; CI: -1.7 to 1.3; $P = 0.8$).

Conclusion: There has been a notable lack of reporting on the availability of blood pressure measuring devices in third world health care institutions. Our surveys have shown inadequate availability of functional sphygmomanometers in the institutions, but satisfactory agreement between measurements by institutional staff and trained observers. In view of recent guidelines and recommendations, there is need to supplement office readings with mercury devices with oscillometric home or automated office blood pressure recording.

Key words: Blood pressure measurement, healthcare quality, hospital care, mercury devices, Nigeria, sphygmomanometers

Date of Acceptance: 02-Feb-2015

Introduction

The proportion of the world population with high blood pressure (BP) has increased from about a quarter to a third, and even up to half the adult population in some African countries, within just a few years.^[1-3] The prevalence, awareness, treatment and control rates in developing countries are approaching the rates in developed countries.^[3] To tackle this waxing pandemic, there should be safe, accurate and adequate BP monitoring in health care institutions, consonant with relevant guidelines.^[4,5] Studies

of BP measurement, conducted in developed countries, suggest however that this may not be the case.^[6-12] There has been a notable lack of such studies in developing countries, including Nigeria. A frequent concern during routine clinical practice on wards and in clinics at our institution in Nigeria is that sphygmomanometers are either not available, or they are dysfunctional due to lack of repairs and maintenance. This observation motivated us to investigate

Address for correspondence:

Prof. CP Chijioko,
PMB 01129, Enugu 400001, Enugu State, Nigeria.
E-mail: chioli.chijioko@unn.edu.ng

Access this article online

Quick Response Code:



Website: www.njcponline.com

DOI: 10.4103/1119-3077.156899

PMID: 25966730

the availability of BP measuring devices in a range of health care institutions in and around Enugu, a major hub city of the south-eastern geopolitical zone of Nigeria. Our main objective was to investigate the availability of functional BP monitors at health care institutions in Enugu, Nigeria. Our specific aims were (1) To assess the availability of BP monitors on the wards and in the clinics at Enugu health care institutions, and (2) to assess the functionality of these BP monitors. A subsidiary aim was (3) to investigate the degree of agreement between institutional staff and trained observers using the institutional device and a known, reliable and functional sphygmomanometer.

Methods

The protocol for this study was approved by the University of Nigeria Teaching Hospital Ethics Committee. The settings are tertiary level and major primary and secondary level health care institutions in and around Enugu, Nigeria (which were visited between 2007 and 2012). Some of the institutions, as indicated in the tables, were visited twice or thrice during this period. Observers were medical doctors who were further trained by performing triplicate BP measurements on consenting subjects, using mercury column, aneroid and oscillometric devices respectively, with careful observation of measurement technique, and correction of errors in technique. Normotensive or hypertensive nonpregnant adults (at least 16 years old, arm circumference 22–32 cm), without concurrent illness or complications of hypertension, were recruited for the study. They gave informed consent to four sequential BP measurements. A recently purchased mercury column sphygmomanometer (Accoson®, UK) was used as a “standard sphygmomanometer.” The number of sphygmomanometers available in the clinics and wards at the health institution was recorded, and their functional status classified as GOOD (functional, in good working order), POOR (dysfunctional, usable but technical problems requiring repairs) or BAD (nonfunctional, not usable). A trained observer conducted a “blind” comparison of the standard sphygmomanometer with the sphygmomanometers in the wards and clinics. The observer and a member of the institution’s nursing or medical staff measured the BP of a consenting patient using the sphygmomanometer available on the ward or in the clinic. Finally, the observer measured the BP using the standard sphygmomanometer. Although the same observer undertook most of the measurements, a second trained observer duplicated the measurement with the institutional device; the aim was to ascertain and maintain between-observer consistency, bearing in mind the inherent variability of BP. Blinding meant that the observers and the institutional staff did not know each other’s measurements. For “GOOD” devices, the degree of agreement for mean BP between the observers and the institutional staff, and between test and standard sphygmomanometers, was

assessed using the method of Bland and Altman.^[13] All data were computerized and analyzed using SPSS software, version 17.0.(Accoson UK).

Results

Tables 1 and 2 portray the availability of sphygmomanometers at the tertiary, secondary and primary health care institutions, compared to the number of doctors working in the clinics and to the bed occupancy of the wards. Table 3 reflects the degree of agreement between BP measurements at the institutions by comparing the trained observers and standard sphygmomanometer with the institutional staff and BP device.

For dysfunctional or nonfunctional devices, the problems included bladder stiffness (difficult or impossible to inflate), air leakage from cuff or bladder with constant or uncontrollable falling of the mercury column, leakage of

Table 1: Sphygmomanometer availability and functional status (outpatient clinics)

Date/healthcare setting	Number doctors	Good	Number doctors/ good device	Poor	Bad
2007-2009					
Tertiary	82	23	3.6	6	17
Secondary	12	12	1	0	0
Primary/rural	13	9	1.4	1	7
Overall	107	44	2.4	7	24
2010-2012					
Tertiary	44	15	2.9	3	15
Secondary	4	2	2	1	0
Overall	48	17	2.8	4	15

These data show combined data for the availability of sphygmomanometers at 2 tertiary referral, 3 secondary care and 7 primary care (1A-1G) institutions, and their functional status, compared with the number of doctors usually working in the clinics that were surveyed. All sphygmomanometers were of the mercury column type except for one aneroid monitor at a tertiary center. Data collected in the earlier surveys (2007-2009) are compared with later observations in repeat surveys (2010-2012)

Table 2: Sphygmomanometer availability and functional status (wards)

Date/healthcare setting	Patients	Good	Number patients per “good” device	Poor	Bad
2007-2009					
Tertiary	148	6	24.7	5	2
Secondary	70	7	10	4	3
Primary/rural	15	4	5	1	3
Overall	233	17	13.7	10	8
2012-2014					
Tertiary	85	5	17	1	2

These data show the combined availability of sphygmomanometers at 3 tertiary referral, 3 secondary care and 5 primary care institutions, and their functional status, compared with the number of patients on the wards at the time of the survey. All sphygmomanometers were of the mercury column type except for one aneroid monitor at a primary healthcare center. Data from earlier surveys (2007-2009) are compared with more recent update surveys at 2 of the tertiary referral centers (2012-2014)

Table 3: Between-observer and between-sphygmomanometer agreement of blood pressure measurements (Bland-Altman analysis^[12])

Health centre	n	Staff Difference	Staff 95% CI	Observer Difference	Observer 95% CI	Machine Difference	Machine 95% CI
Tertiary	71	2.0	-0.3-4.4 (0.1)	0.2	-1.6-2.1 (0.8)	0.1	-1.8-2.1 (0.9)
Second	25	-0.5	-4.6-3.6 (0.8)	0.1	-4.0-4.1 (0.97)	-0.6	-3.8-2.6 (0.7)
PriRural	10	3.4	-1.9-8.8 (0.17)	-1.3	-6.9-4.3 (0.6)	-1.6	-5.8-2.6 (0.4)
Overall	106	1.6	-0.3-3.4 (0.1)	0.1	-1.5-1.7 (0.95)	-0.2	-1.7-1.3 (0.8)

The four rows show respectively the results of combined analyses for tertiary care, secondary care, primary care/rural (PriRural), and all (Overall) institutions, conducted between 2007 and 2012. 'n' indicates the number of sphygmomanometers that were assessed at the institution (s) concerned. "Staff Difference" refers to the mean difference between measurements (in mmHg) made with the institution's sphygmomanometer (test device) by the ward or clinic staff and those made by the first observer; "Observer Difference" refers to the mean difference between the second and first observers using the test device; "Machine Difference" refers to the mean difference between measurements by the first observer using the test and standard devices. "95% CI" refers to the 95% confidence interval of the mean differences, followed by the statistical *P* value in between brackets

mercury (empty column), unequal double mercury column, baseline reading up to 4–7 mmHg above zero.

On three occasions, we observed with alarm, "BAD," unusable sphygmomanometers from which there was neglected leakage and spillage of mercury from its usual confine, obviously contaminating the environment. We noticed that in the routine use of mercury sphygmomanometers in the wards and clinics that the institutional staffs invariably do not bother to return the mercury to its storage compartment below the inflation column and close the safety lock. More attention to this safety maneuver would help in the prevention of leakage: There is clearly a need for education and training in this regard.

Common human errors (committed invariably by institutional staff) included unduly tight application of the cuff to the arm and failure to cross-check the systolic pressure by palpation before auscultation. None of the staff adhered to guidelines such as comparing the BP in the two arms, ensuring 5 min' rest before BP measurement or measuring arm circumference. Almost all the staff (over 90%) only paid cursory attention to other guidelines such as avoiding noise and distractions, correct positioning and support for the back and arm, asking about recent smoking, caffeine intake, exercise, and anxiety.

Discussion

During the period covered by this report (2007–2012), studies in developed countries were demonstrating the superiority of ambulatory, home and automated office BP measurements to manual office BP monitoring for the prediction of long-term risk from hypertension.^[14-20] Although there is increasing uptake of home BP monitoring by patients who can afford it (<5% of hypertensives), manual office BP monitoring with conventional mercury column sphygmomanometers remains the widespread usual practice in our setting. As shown in the tables, there were only two aneroid devices seen in all our surveys and no oscillometric devices.

Although the risk to the environment has encouraged the move away from mercury devices in developed countries,^[16,21]

there are reminders that automated oscillometric devices may not be accurate in some circumstances, for example marked hypertension or hypotension, arrhythmias.^[18,22] Furthermore, specific populations would need separate validation of the oscillometric method (e.g., elderly, diabetics, pregnancy, renal failure, obese, children).^[18]

Apart from such circumstances, in which the conventional mercury sphygmomanometer is necessary, another reason for retaining the use of these devices in our environment would be the issue of cost. With the progressive reduction of cost of validated oscillometric monitors, however (some of which are now comparable in cost to a conventional mercury sphygmomanometer), they are becoming more affordable in our setting.

The data in Tables 1 and 2 show inadequate availability of "GOOD," functional sphygmomanometers for BP monitoring in the wards and clinics. For example, up to 15 doctors would share one "GOOD" device in tertiary institution surgical outpatients. In one primary care institution, the only available functional device could not be used because it was locked up for security reasons. The key was not available to the staff on duty. In 7 out of 26 wards surveyed, there was no functional device available.

The results of manual office BP measurement may be quite variable for several reasons, apart from the human and machine error factors we observed, as listed above. The reasons include inherent biological variability, the presence of a clinician (white coat effect, masked hypertension), casual/sub-optimal technique and the use of unreliable (unvalidated) devices.^[6-9,19] This protean variability would explain the wide 95% confidence intervals of the mean differences in Table 3, implying lack of a statistically significant difference between the observers and between the institutional and standard sphygmomanometers. The data in Table 3 however, show that the mean differences between the institutional staff and the first observer were on the whole greater than the mean differences between the two trained observers, perhaps reflecting the additional human error factor, even though statistically significant in only two

instances (at the conventional level of $P < 0.05$). The magnitude of differences between test (institutional) and standard sphygmomanometers was similar to the differences between the two trained observers using the same device. These mean differences were on the whole relatively small, again without statistical significance, suggesting that the degree of agreement of "GOOD" sphygmomanometers at the institutions visited (with the standard device) was adequate.

Other limitations of this report include the limited number of institutions included in the survey. Being unfunded, this research relied on the good will and spare time of volunteer observers. Hence, although the three main tertiary referral centers were covered, only five secondary care and five primary care centers were included. Limitation of time and resources also stretched out the overall time-span of the surveys. Although this may suggest that some of the earlier data are outdated, similar observations and results were obtained with later repeat visits to the same institutions. Our current ongoing experience during practice on the wards and in the clinics also suggests that the earlier data are still applicable and worth reporting.

Conclusion

These institutional sphygmomanometer surveys at Enugu have shown general poor availability of BP measurement devices in the wards and clinics, errors of technique which are readily correctable with appropriate training, and satisfactory agreement between functional devices and the standard sphygmomanometer. There was neglect of mercury spillage from some dysfunctional devices and failure to handle sphygmomanometers with the necessary care to minimize the risks of environmental contamination. The use of manual office BP monitoring with mercury devices remains the widespread norm in our setting, in spite of recommendations,^[16,21] albeit controversial,^[23] to use nonmercury devices instead.

Thus the main priority is the adequate provision of functional BP monitoring devices on the wards (say at least one device for ten inpatients) and in the clinics (at least one per doctor). Education should encourage the need to supplement manual office measurements with more prognostic methods such as home and automated office BP monitoring.

Acknowledgment

We do hereby acknowledge the effort of Dr. C. Uzoke who helped to provide some recent update data on the availability and functionality of sphygmomanometers at one of the tertiary healthcare institutions.

References

- Kaplan NM, Opie LH. Controversies in hypertension. *Lancet* 2006;367:168-76.
- World Health Organization. *World Health Statistics 2012*. Geneva: World Health Organization; 2012.
- Pereira M, Lunet N, Azevedo A, Barros H. Differences in prevalence, awareness, treatment and control of hypertension between developing and developed countries. *J Hypertens* 2009;27:963-75.
- Beevers G, Lip GY, O'Brien E. ABC of hypertension: Blood pressure measurement. Part II-conventional sphygmomanometry: Technique of auscultatory blood pressure measurement. *BMJ* 2001;322:1043-7.
- Pickering TG, Hall JE, Appel LJ, Falkner BE, Graves J, Hill MN, et al. Recommendations for blood pressure measurement in humans and experimental animals: Part I: Blood pressure measurement in humans: A statement for professionals from the Subcommittee of Professional and Public Education of the American Heart Association Council on High Blood Pressure Research. *Hypertension* 2005;45:142-61.
- Coleman AJ, Steel SD, Ashworth M, Vowler SL, Shennan A. Accuracy of the pressure scale of sphygmomanometers in clinical use within primary care. *Blood Press Monit* 2005;10:181-8.
- Kim JW, Bosworth HB, Voils CI, Olsen M, Dudley T, Gribbin M, et al. How well do clinic-based blood pressure measurements agree with the mercury standard? *J Gen Intern Med* 2005;20:647-9.
- Manzoli L, Simonetti V, D'Errico MM, De Vito C, Flacco ME, Forni C, et al. (In) accuracy of blood pressure measurement in 14 Italian hospitals. *J Hypertens* 2012;30:1955-60.
- Rayner B, Blockman M, Baines D, Trinder Y. A survey of hypertensive practices at two community health centres in Cape Town. *S Afr Med J* 2007;97:280-4.
- Myers MG, Godwin M, Dawes M, Kiss A, Tobe SW, Kaczorowski J. The conventional versus automated measurement of blood pressure in the office (CAMBO) trial: Masked hypertension sub-study. *J Hypertens* 2012;30:1937-41.
- Myers MG, Godwin M. Automated office blood pressure. *Can J Cardiol* 2012;28:341-6.
- Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet* 1986;1:307-10.
- Hodgkinson J, Mant J, Martin U, Guo B, Hobbs FD, Deeks JJ, et al. Relative effectiveness of clinic and home blood pressure monitoring compared with ambulatory blood pressure monitoring in diagnosis of hypertension: Systematic review. *BMJ* 2011;342:d3621.
- Sheikh S, Sinha AD, Agarwal R. Home blood pressure monitoring: How good a predictor of long-term risk? *Curr Hypertens Rep* 2011;13:192-9.
- Skirton H, Chamberlain W, Lawson C, Ryan H, Young E. A systematic review of variability and reliability of manual and automated blood pressure readings. *J Clin Nurs* 2011;20:602-14.
- Myers MG. The great myth of office blood pressure measurement. *J Hypertens* 2012;30:1894-8.
- Stergiou GS, Parati G. Should the measurement of blood pressure in the office be redefined? *J Hypertens* 2012;30:1906-8.
- O'Brien E. Has conventional sphygmomanometry ended with the banning of mercury? *Blood Press Monit* 2002;7:37-40.
- Myers MG, Godwin M, Dawes M, Kiss A, Tobe SW, Grant FC, et al. Conventional versus automated measurement of blood pressure in primary care patients with systolic hypertension: Randomised parallel design controlled trial. *BMJ* 2011;342:d286.
- McVicker JT. Blood pressure measurement – Does anyone do it right? An assessment of the reliability of equipment in use and the measurement techniques of clinicians. *J Fam Plann Reprod Health Care* 2001;27:163-4.
- Villegas I, Arias IC, Botero A, Escobar A. Evaluation of the technique used by health-care workers for taking blood pressure. *Hypertension* 1995;26:1204-6.
- Buchanan S, Orris P, Karliner J. Alternatives to the mercury sphygmomanometer. *J Public Health Policy* 2011;32:107-20.
- Jones DW, Frohlich ED, Grim CM, Grim CE, Taubert KA. Mercury sphygmomanometers should not be abandoned: An advisory statement from the Council for High Blood Pressure Research, American Heart Association. *Hypertension* 2001;37:185-6.

How to cite this article: Chijioke CP, Okolo TO, Nwadike KI, Ejim EC, Ekochin FC, Aronu GN, et al. Availability and functionality of sphygmomanometers at health care institutions in Enugu, Nigeria. *Niger J Clin Pract* 2015;18:544-7.

Source of Support: Nil, **Conflict of Interest:** None declared.