Sphygmomanometers

An audit in general practice

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BACKGROUND
The accuracy of sphygmomanometers used in Australian general practice is unknown but potentially important.
METHOD
We measured the accuracy of sphygmomanometers in general practice in the Hunter region of New South Wales using a gold standard. Practices were recruited by an advertisement in the division newsletter.
RESULTS
Sixty practices (35%) volunteered. A total of 404 instruments were checked. Over 95% of sphygmomanometers were within 4 mmHg of gold standard sphygmomanometer across the clinical pressure range. Mercury sphygmomanometers were more accurate than aneroid ($p<0.01$). There was no significant association between accuracy and age, calibration, or visual inspection of the instruments.
DISCUSSION
This study demonstrated a high accuracy rate of the sphygmomanometers checked, especially those sphygmomanometers that were mercury.

Hypertension is the most common problem managed in general practice (6.1% of all problems and 8.9% of all encounters).[1] It is one of the main reasons for pathology testing (6% of problem pathology combinations), and antihypertensive medications account for over half of all cardiovascular prescriptions.

Many guidelines, both Australian and international, recommend a therapeutic plan be implemented for all patients with blood pressure (BP) higher than 140 mmHg systolic and/or diastolic higher than 90 mmHg, and that patients whose BP is higher than 120/80 mmHg should receive lifestyle advice.[2–4]

Therefore, BP measurements must be accurate. Few studies have looked at the accuracy of sphygmomanometers. Those that have found significant problems: 21% of mercury and 61% of aneroid sphygmomanometers were inaccurate.[5] In general practice, the inaccuracy rates were 2.3% for mercury sphygmomanometers and nearly 15% for aneroid.[6] Aneroid instruments seem more prone to inaccuracy, something of concern as mercury sphygmomanometers are being phased out because of mercury risks.[7,8]

What constitutes 'inaccurate'? These studies used a difference of □3 mmHg[9,10] or 4 mmHg.[6,11] Aneroid sphygmomanometers can remain within the 4 mm accuracy range.[11] However, most other studies have shown more significant errors; an average deviation of 6 mmHg at 90 mmHg with 25% of devices being inaccurate overall,[9] and 30% in private practice and 50% in hospitals being inaccurate. [10]

The methods used in these studies were not always satisfactory. For example, instruments were checked at different pressures by different investigators – some were as high as 150, 200 or 250 mmHg (where errors increased at higher pressures) – levels rarely encountered in clinical practice. Inaccuracies may not have changed the management of patients.

Also, most studies were conducted in hospital or specialist practice,[9,11] few in general practice,[6] and none in Australian general practice. Hence, we saw a need to measure accuracy at levels seen in Australian general practice that affect patient treatment and management.

Method

We recruited a research nurse to visit general practices. The method used to check the accuracy of sphygmomanometers was determined following a review of the literature and was based on Australian standards which set an unacceptable level of accuracy at +/- 4 mmHg[12] and on other

research.[6,11] This used as gold standard a new mercury sphygmomanometer that read '0' at rest. This was connected to the test instrument using a Y-connector. A rigid cylindrical tube was used in place of the patient's arm. The equipment was tested at a local teaching hospital.

The Hunter Division of General Practice comprises 407 general practitioners working from 167 practices. Practices that responded to a notice in the weekly newsletter and consented to the study were visited by the nurse. The practice sphygmomanometers were checked once at each of 0, 80, 90, 100, 140, 150 and 160 mmHg against the gold standard sphygmomanometer. Automated machines were not tested. The results were rounded up to the nearest 2 mmHg.[2,13] Where the results were inaccurate by +/- 4 mmHg or more at any pressure, the practice was informed.

We also collected data on the type of sphygmomanometer used (mercury or aneroid), age of the instrument, date of the last calibration, and a subjective assessment of the sphygmomanometer's condition (cuff, tubing, visibility and legibility of the instrument, the release control valve and inflation bulb).

We tested associations using the chi-square test and the Fisher's exact test where appropriate.

Results

The research nurse visited 60 (35%) practices in the region and tested 404 sphygmomanometers (59% mercury, 41% aneroid). Details of few sphygmomanometers were known: 1/26 (4%) were less than 5 years old, 18 (69%) were 5–10 years old, seven (27%) were more than 10 years old, and 125 (31%) had been calibrated.

The conditions of the sphygmomanometers were: 84 (21%) had poor visibility, 42 (10%) poor tubing, 47 (12%) a poor cuff, 41 (10%) a poor release control valve, and 42 (10%) had a poor inflation bulb.

For all pressure levels, over 95% of the sphygmomanometers were accurate within 4 mmHg of the gold standard (*Table 1*). We compared the level of accuracy for mercury and aneroid sphygmomanometers; for all pressure levels, mercury sphygmomanometers were more accurate than aneroid ($p<0.01$) (*Table 2*).

No significant differences were found between accuracy and calibration, visibility, cuff, tubing and control valve status, or sphygmomanometer age.

Discussion

We found the majority of sphygmomanometers were accurate. There are several possible explanations: the high proportion of mercury sphygmomanometers and selection bias from volunteering practices that agreed to participate and more modern aneroid instruments may retain better calibration than older ones.

Table 1. The accuracy of sphygmomanometers at different pressures

Divergence from gold standard mmHg	Pressure at which accuracy measured, mmHg (%) 0	80	90	100	140	150	160
0–4	350 (99)	382 (96)	382 (96)	382 (96)	382 (96)	383 (96)	383 (96)
5–9	3 (1)	9 (2)	9 (2)	9 (2)	9 (2)	9 (2)	9 (2)
10+	2 (1)	8 (2)	8 (2)	8 (2)	8 (2)	7 (2)	7 (2)
Total	355	399	399	399	399	399	399

Note: Five sphygmomanometers did not have any values recorded, five sphygmomanometers had no value entered entered at '0' mmHg, and 39 sphygmomanometers had a negative value at '0' mmHg

Table 2. Accuracy of sphygmomanometers by type (mercury or aneroid) at different pressures

Pressure at which measured (mmHg)	Accuracy (mmHg)	Aneroid	Mercury	p value
0	0–4	122	228	<0.01
	≥5	5	0	
80	0–4	150	232	<0.01
	≥5	16	1	
90	0–4	150	232	<0.01
	≥5	16	1	
100	0–4	150	232	<0.01
	≥5	16	1	
140	0–4	150	232	<0.01
	≥5	16	1	
150	0–4	151	232	<0.01
	≥5	15	1	
160	0–4	151	232	<0.01
	≥5	15	1	

Note: five sphygmomanometers did not have any values recorded, five sphygmomanometers had no value entered at '0' mmHg and 39 sphygmomanometers had a negative value at '0' mmHg

Instrument accuracy is just one component of correct BP measurement. Other factors, especially operator technique (not a focus of this study) is crucial for accurate measurement. The number of accurate instruments in this study should not distract from the need for regular maintenance and calibration,[13] especially with the move away from mercury sphygmomanometers.[14] The serious consequences of over and under estimation of BP should always be considered.[15]

Implications of this study for general practice

- Accurate BP measurements may prevent under and over diagnosis of hypertension.
- Aneroid sphygmomanometers are less accurate in general practice than mercury sphygmomanometers.
- Sphygmomanometers were very accurate in the sample studied.

Conflict of interest: none declared.

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