Results of different studies examining accuracy of Hawksley random zero sphygmomanometer compared with standard mercury sphygmomanometer. Three groups presented results as the mean differences between the two instruments; the two others reported the range of difference

Study	Measurement given	Systolic pressure (mm Hg)	Diastolic pressure (mm Hg)		No of subjects
			Phase IV	Phase V	
Evans and Prior[2]	Mean difference	−1·2	−2·2		906
Labarthe *et al*[3]	Mean difference	−1·6	−2·6	−2·7	24 subjects, multiple readings
Gaudemaris *et al*[4]	Range of difference	−0·77 to −3·06		−1·04 to 2·7	40-500 readings, six protocols
Parker *et al*[5]	Range of difference	−2·5 to −3·3		−1·9 to −2·7	66
O'Brien *et al*[6]	Mean difference	−3·5		−7·5	86

systematic tendency to underread both systolic and diastolic pressures with the Hawksley random zero sphygmomanometer compared with the conventional mercury manometer. Only O'Brien *et al*,[6] however, have found large differences in the measurement of diastolic pressure. Labarthe *et al* commented that a modified type of mercury sphygmomanometer (the Hawksley random zero sphygmomanometer) "compared well" with the standard device,[3] and after their examination Parker *et al* commented that the data did not indicate that one instrument was clearly superior to the other and, in fact, the Hawksley random zero sphygmomanometer may be more appropriate where appreciable observer bias might invalidate clinical findings.[5]

All instruments, including the Hawksley random zero sphygmomanometer, require correct use; for the Hawksley random zero sphygmomanometer this means pumping the mercury column to over 240 mm Hg and waiting for five seconds to allow the reservoir to fill with mercury before deflating the cuff with the special control valve, which regulates this to 2 mm Hg/s. The Hawksley instrument, like all other machinery, requires careful maintenance to retain its accuracy. Conroy and colleagues rightly draw attention to the need for accuracy in medical instruments, particularly when the results obtained with a particular instrument are widely applied. The findings of O'Brien *et al*[6] are indeed worrying, but in the light of the evidence from other workers we would like to see further studies of the Hawksley random zero sphygmomanometer before it is consigned to the dustbin. It has several advantages over the standard mercury sphygmomanometer, although we recognise that it has problems—for example, we have found that its zero is not truly random, but this problem does not invalidate its use.

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Measuring instruments are never perfect

EDITOR,—We welcome the recognition that measurement errors occur when the Hawksley random zero sphygmomanometer is used.[1] We question, however, whether a comparison with a mercury sphygmomanometer is valid as any machine will have systematic errors. Should methods of estimating blood pressure be evaluated against intra-arterial measurement or will such measurements themselves accurately reflect true blood pressure? Surely such purist aspirations will be thwarted by the medical equivalent of the uncertainty principle.

As has been recognised,[1] comparison studies are not compromised by measurement bias as long as the same machine is used, so that relatively true readings are given. Far more important, however, are the effects of the different circumstances in trials and in clinical practice. Measurements in trials are usually preceded by 10 minutes' rest and are taken by a research nurse. A pressor effect resulting from the presence of a doctor is well documented.[2] For laborious and expensive trials to provide clinically useful data some scientific accuracy has to be sacrificed in an attempt to retain clinical relevance.[3] This imperative of retaining a link with the real world of clinical practice is the principle of ecological validity.

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Instrument is accurate if used properly

EDITOR,—Rónán M Conroy and colleagues cast doubt on the validity of a large number of blood pressure studies and therapeutic trials by questioning the accuracy of the Hawksley random zero sphygmomanometer.[1] They report that in their hands the Hawksley instrument gave readings that on average were 3·5 mm Hg lower for systolic pressure and 7·5 mm lower for diastolic pressure than readings given by a standard orthodox mercury manometer. These discrepancies between the instruments differ (by a factor of about three for diastolic pressure) from those reported previously.

Under static conditions the random zero sphygmomanometer gives readings identical with those of the orthodox manometer, as can be shown by linking both instruments to a single cuff and comparing measurements after correcting for the zero error in the research instrument. In clinical use the observer can influence the zero error mechanism in two ways: if insufficient time is allowed for the reserve mercury chamber to fill before deflation is started the range of observed zero errors will be restricted; and if insufficient care is taken to ensure that complete deflation has occurred the zero error to be subtracted will be falsely high. This is the only known mechanism that can account for falsely low readings.

The main virtue of the Hawksley instrument, which was developed by Wright and Dore[2] from Garrow's "zero-muddler for unprejudiced sphygmomanometry,"[3] is that it allows multiple consecutive but independent measurements to be made without bias. This gives it great advantages over the standard manometer and made it the instrument of choice for use in epidemiological and therapeutic trials. There was no commercially available alternative at the time of the large national and international trials.

Unless it is possible to show a convincing alternative explanation of the mechanism of their findings the authors should not be allowed to undermine the authority of the many important cardiovascular studies that have used a random zero sphygmomanometer. Adequate training and testing of observers, as occurred in the Medical Research Council's trials,[4,5] for example, are critical to the use of either instrument.

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Used in epidemiology, not individual people

EDITOR,—Rónán M Conroy and colleagues comment that the Hawksley random zero sphygmomanometer underestimates both systolic and diastolic blood pressures when compared with the standard mercury sphygmomanometer.[1]

Other studies have shown that on average both systolic and diastolic blood pressures are higher when they are measured directly than when they are measured by the cuff method.[2,3] The two methods, however, have a high correlation. The mean difference between intra-arterial and cuff blood pressures was 24·6 mm Hg for systolic pressure, 5·3 mm Hg for diastolic pressure (muffling), and 13·1 mm Hg for diastolic pressure (disappearance).[3] The difference between the two methods could not be explained by the intra-arterial pressure or age. Thus the differences that Conroy and colleagues found were relatively small compared with the differences between cuff and intra-arterial pressures.

Both the London School of Hygiene sphygmomanometer[4] and the "zero muddler" were designed for epidemiological use and were subsequently adopted for use in trials of treatment of blood pressure. The originators of the instruments never suggested that they should be used to measure blood pressure in individual patients.

Criteria for treatment are based on various premises—for example, the results of randomised controlled trials of treatment in patients with a given blood pressure. The fact that the Hawksley sphygmomanometer underestimates blood pressure would be of consequence if the criteria for treatment were based on results obtained, for example, by intra-arterial measurement of blood pressure.

In view of the known sources of variation of blood pressure the criteria for treatment must be clearly defined and these definitions must be adhered to. Thus criteria based on measurements made with a standard sphygmomanometer must be appropriately corrected if a random zero instrument is used.

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