

vented. There was some support for this in an analysis of 53 patients who died in Cardiff hospitals over 10 years.⁴ It was estimated that 28 of these might have had a better chance of survival if they had been admitted early in the attack to a specialised respiratory unit.

It is much more difficult to estimate the number of deaths from asthma outside hospital that were prevented by the emergency asthma admission service. Three patients died at home from asthma out of 360 for whom admission was requested, representing a death rate of 0.83% in a group of patients known to have a severe form of the disease. This is virtually the same as that recorded for all emergency admissions to the three Edinburgh hospitals (0.9%), and we cannot believe that the number of deaths occurring at home would not have been larger among patients on our emergency list if they had been subject to the delays inherent in conventional admission procedures. It was certainly the impression of the medical team who treated them that but for the scheme several would not have reached hospital alive and more would have needed tracheal intubation and mechanical ventilation.

In another Cardiff survey⁷ it was reported that in about one-third of 90 deaths occurring outside hospital the fatal exacerbation of asthma lasted less than two hours, and in about one-fifth less than 30 minutes. Hence it was estimated that over 10 years at least 33 deaths could have been prevented had the patients been able to admit themselves directly to hospital.

Without a controlled trial, which most doctors would regard

as unethical, it is impossible to obtain incontrovertible proof that an emergency asthma admission service saves lives, but we believe that there is now a strong *prima facie* case to support that contention. The type of service operating in Edinburgh, and now also in Melbourne, Australia, could be made available in most cities and large towns, provided that all hospitals with facilities for respiratory intensive care were prepared to co-operate with the emergency admission services, the ambulance service, and local general practitioners in its organisation.

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ABC of Blood Pressure Measurement

Reconciling the controversies: a comment on "the literature"

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In the 80 years since the sphygmomanometer was first introduced a large body of reports has developed around the subject. We comment here on some of the papers most relevant to our discussion on blood pressure measurement.

Aspects of measuring blood pressure

Observer error and the importance of training—The three major causes of observer error are: poor technique, observer bias, and terminal digit preference.¹ Proper training would probably do much to eliminate the errors arising from technique and bias,² but unfortunately the training techniques available are not widely known, and there is no standard programme for training and assessing competence.

The standard sphygmomanometer—Reports on the conventional sphygmomanometer show that as many as half the sphygmomanometers in hospital use are inaccurate³ and that hospitals usually have no policy for maintaining sphygmomanometers. The mercury sphygmomanometer is the most accurate, reliable, durable, and economical of all sphygmomanometers and must be recommended for general use in preference to aneroid and semi-automated devices. Several workers have examined the faults and problems common to sphygmomanometers.³⁻⁶

Cuff bladder dimensions—Selecting the best dimensions for the inflatable rubber bladder is one of the most controversial topics in blood pressure measurement. The best width for the bladder is generally agreed to be 12 to 14 cm, and it would seem reasonable to choose a 12-cm wide cuff for adults to allow as much room as possible for applying the stethoscope. Three independent groups of workers⁹⁻¹¹ have shown that the most accurate blood pressure measurements were obtained when the bladder completely encircled the arm and they recommended a bladder length of 40 cm. More recently, Burch and Shewey¹² challenged this recommendation, showing that a bladder encircling half the arm circumference was adequate, and pleaded for retaining the standard 23-cm long bladder. There the controversy rests for the moment, and the most reasonable compromise would be to recommend a 35-cm long bladder that would encircle most adult arms.³ We recommend that the bladder should measure 12 × 35 cm and if a bladder

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smaller than this is used the centre of the bladder must be placed over the brachial artery.

Factors affecting the patient—Environmental factors and the patient's general physiological state are major influences on blood pressure measurement.¹³ Perhaps less well known is the relevance of obesity,¹⁴ arrhythmias,⁵ the arm chosen,¹⁵ the level of the arm,¹⁶ isometric exercise in the unsupported arm,¹⁷ and venous congestion of the limb due to repeated measurements.

The diastolic dilemma—The choice of Korotkoff phase 4 (muffling of sounds) or phase 5 (disappearance of sounds) as the true diastolic pressure has been a major controversy and source of confusion in several reviews on the technique of blood pressure measurement.^{2, 3, 6, 19, 20} The matter is more than an academic quibble: the difference between phases may average as much as 10 mm Hg.²¹ General opinion now favours the fifth phase, because it is closer to the intra-arterial diastolic pressure and there is better agreement between observers in determining disappearance of sounds. Occasionally, however, the sounds disappear at a pressure considerably below that of muffling, and we support the recommendation of the expert committee of the World Health Organisation²² to record both phases.

Infancy and childhood—The principles of blood pressure measurement are the same for all ages, but in small children and infants it takes more time to obtain an accurate measurement. Selection of the appropriate cuff size is important,²³ and although phase 4 (muffling) is generally recommended for the diastolic pressure, the best practice would be to record both phases.

New devices—The number of reports on new developments in techniques for measuring blood pressure^{1, 4, 8, 24-28} is surprisingly small, and the reports are often lacking in detail, possibly reflecting the gap between medical and engineering interests. Indeed it is surprising that there has been so little development in techniques of measurement. None of the newer devices, no matter how advanced or costly, appear to be better than the simple (and cheap) conventional mercury sphygmomanometers; it is worrying that blood pressure measuring devices can be sold to the public (and medical profession) on the basis of claims that have not been adequately assessed. A few independent surveys of semi-automated devices have shown that the standard of engineering and quality control is often poor; and many of these devices are very expensive: gadgetry may raise the cost of a standard mercury sphygmomanometer above £100 without increasing its accuracy; ultrasound machines generally cost over £2000, and the Remler Company's Portometer²⁸ for ambulatory recording costs £6000. The random zero sphygmomanometer²⁷ is an accurate instrument that eliminates a major source of error—namely, observer bias—and the principle might be developed further and incorporated in many standard sphygmomanometers.

Ambulatory recording—Two of the most important decisions for the hypertensive patient are the reaching of a diagnosis, and starting treatment. Neither decision should be made (except in extreme cases) on the basis of casual readings. The folly of relying on casual surgery or hospital blood pressure readings in artificial circumstances has been clearly shown,²⁸ and it is well recognised that blood pressure falls between successive visits. The striking variation in blood pressure during normal daily activity has been clearly shown by continuous recording of blood pressure,^{8, 28} and many studies have confirmed that the average ambulatory blood pressure is generally lower than the average values shown by casual measurements. Furthermore, there is some evidence that the cardiovascular complications of hypertension are more closely related to mean pressure over 24 hours than to casual readings.²⁸ Unfortunately, techniques for continuous blood pressure measurement are invasive, and although they provide much-needed information on blood pressure behaviour they are not applicable in routine practice. (Direct intra-arterial measurement is, of course, very valuable in patients with obesity or in those in whom the blood pressure

is difficult to measure with a conventional sphygmomanometer.) Non-invasive techniques for recording ambulatory blood pressure depend on cuff occlusion and therefore record intermittent rather than continuous pressure.^{28, 29} Clinical experience with the few devices available is limited, mainly because they are very expensive, but development of a cheap and accurate means of ambulatory recording would have a considerable impact on the diagnosis of borderline hypertension and the assessment of the efficacy of treatment.

Home recording—We have found home recording of blood pressure by the patient, a relative, or a friend to be practicable and a useful guide to management, and see the technique serving as a compromise between casual and continuous recording. Home recording has never been popular, probably because guidelines for training subjects have not been stated adequately, but several workers have found the practice valuable.²⁹

Conclusion

In this series we have examined the many sources of error in blood pressure measurement and suggested ways of improving technique. In particular, we have emphasised the importance of training, eliminating observer bias, using a bladder of adequate size, maintaining equipment, and accepting 5th-phase diastolic pressure. The mercury sphygmomanometer is the most accurate device for indirect measurement of blood pressure, and newer, more expensive, and often less accurate pieces of equipment should be viewed critically unless they have been independently assessed by a reputable laboratory. Ambulatory recording is important but the lack of cheap non-invasive techniques makes home-recording the most satisfactory means of obtaining a profile of blood pressure response to daily activities.

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