Inaccuracy of London School of Hygiene of Sphygmomanometer

The London School of Hygiene (LSH) sphygmomanometer is a mercury-in-glass manometer incorporating special features to reduce observer bias and digit preference. Originally intended for use by epidemiologists, it has been used in therapeutic trials, to compare direct and indirect blood pressures, and as a reference standard against which automatic devices are tested. Though validated against the standard mercury sphygmomanometer, it gave lower recordings than the standard sphygmomanometer when both were compared with intra-arterial recordings. We carried out a study to assess the accuracy of the LSH sphygmomanometer.

Methods and results

Two LSH sphygmomanometers were compared statically with a standard mercury manometer throughout the pressure range 0-250 mm Hg by connecting both devices to a single cuff wrapped around a cylinder. The internal diameters of the reservoirs and glass tubes of the LSH sphygmomanometers were measured by a micrometer. The LSH sphygmomanometers underestimated pressure, the error increasing with pressure so that at 200 mm Hg they recorded 196 mm Hg. The error was consistent with failure to calibrate for the relative diameters of the reservoir (24 mm) and glass column (3.6 mm). The scale of a mercury manometer is calibrated to compensate for the fall of mercury in the reservoir when pressure is applied. The correction factor \(h_0\), added to the recorded rise of mercury in the glass tube, is calculated as

\[
 h_0 = \frac{d_2 h}{d_1^2}
\]

where \(h\) is the rise of mercury in the glass tube and \(d_1\) and \(d_2\) the diameters of the reservoir and glass tube respectively.

The LSH sphygmomanometer was compared with the Hawksley random-zero sphygmomanometer in 20 patients with a wide range of blood pressures. Two trained observers unaware of the possible error in the LSH sphygmomanometer recorded the pressures (diasstolic phase V) at a deflation rate of 2 mm Hg per second. Both devices were connected to a single cuff through a Y connector. A two-channel stethoscope was used so that both observers auscultated the same sounds, and the observers were separated by a partition. Four paired recordings (LSH and Hawksley sphygmomanometers) were made in each patient. The LSH sphygmomanometer underestimated the Hawksley recordings (figure) by a mean of 7-1 mm Hg (p < 0.001) and 3.6 mm Hg (p < 0.001) for systolic and diastolic blood pressures respectively (Student’s t test for paired data). There was a negative correlation between the diastolic, but not systolic, error and heart rate (r = -0.27, p < 0.05).

Comment

The differences between the readings made with the LSH and Hawksley sphygmomanometers were greater than could be explained by the calibration error of the former alone. With a standard mercury manometer the observer watches a falling mercury column against a scale. If, as often happens, he is uncertain that he has heard the first sound he may delay a decision until he has confirmed the presence of sounds and then refer back to the point on the scale at which he thought sounds were first heard. Similarly, with the diastolic pressure the point of disappearance of sounds is referred to only after confirming that all the sounds have disappeared. In contrast, when the LSH sphygmomanometer is used the falling mercury column and pressure scale are not visible. Systolic pressure is indicated after the first sound when the observer is satisfied that sounds are being heard. Similarly, the diastolic pressure is indicated after the last sound, at the point where a sound is expected but fails to occur. There is therefore a tendency to underestimate blood pressure when using the LSH sphygmomanometer, and the error would be expected to increase at slower heart rates. This interpretation is supported by the finding of a negative correlation between the diastolic error and heart rate.

Our findings show that because of a calibration error and an interpretive tendency to underestimate systolic and diastolic blood pressures the LSH sphygmomanometer is not suitable for studies of blood pressure and should not be used as a reference standard.

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**Mask for continuous positive airway pressure: does it cause corneal abrasions?**

Severe pseudomonas panophthalmitis leading to the loss of an eye in an infant born at 32 weeks' gestation was recently reported from our neonatal unit. As pseudomonas conjunctivitis leads to the destruction of deeper eye tissues only in the presence of corneal damage we speculated that the facemask with which the baby was given continuous positive airway pressure for five days for treatment of hyaline membrane disease had caused such damage. We carried out a prospective study to test the hypothesis that the facemask used to give continuous positive airway pressure (Puritan-Bennet International Co-operation, Chichester) causes corneal abrasions.

**Patients, methods, and results**

We studied 79 preterm infants. Group 1 consisted of 18 infants with hyaline membrane disease who received respiratory support (continuous positive airway pressure or ventilation) by facemask. In accordance with our unit's policy the size of mask was chosen by the nursing staff so that it fitted comfortably over the infant's nose and mouth, producing minimal air leakage. The mask was held firmly in place by Netlast (Roussel Laboratories, London) and in most cases rested over the baby's eyes. Group 2 comprised 61 control infants, of whom 23 had mild hyaline membrane disease requiring treatment with only increased ambient oxygen. The remaining 38 babies had no respiratory problem.

After eight hours or more of continuous airway pressure the eyes of the infants in group 1 were stained with 1% fluorescein drops and the cornea examined under blue light. The eyes of babies in the control group were examined in the same way. All examinations were carried out in the first two days of life. When a corneal abrasion was suspected the eyes were re-examined by an ophthalmologist (PRC). Two corneal abrasions were found in the 18 infants treated with continuous positive airway pressure. The first was in the left cornea of a baby born at 28 weeks (birth weight 1280 g), who was examined after 10 hours of continuous positive airway pressure (figure). The second abrasion occurred in an infant born at 32 weeks (birth weight 1560 g), who was examined after 18 hours of continuous positive airway pressure. No corneal abrasions were found in the 61 control infants (p=0.0497, Fisher's exact test, significant at 5% level).

**Comment**

In our experience a small, well-fitting mask that does not encroach on the eyes commonly causes upper airways obstruction by pressing on the soft nose of infants. A larger mask that avoids this complication but rests on the eyes predisposes the baby to the risk of corneal abrasion. In our study the corneal abrasions caused by the facemask were transient, both healing completely within 24 hours of being detected. The potential danger of this iatrogenic hazard is that infection might establish itself and rapidly lead to panophthalmitis should the infant simultaneously develop conjunctivitis due to one of the proteus-producing organisms—for example, Pseudomonas, proteus. In a recent study 4-5% of all cases of ophthalmia neonatorum were caused by Pseudomonas in babies on postnatal wards, and it would not be unreasonable to assume that the incidence might be higher in neonatal intensive care units.

Applying respiratory support by means of a facemask is a common neonatal practice, and this study has emphasised its small but important hazards. As a result of our findings we suggest that if sticky eyes develop when a baby is receiving ventilatory support via a facemask Gram staining as well as culture of the discharge should be requested. If Gram-negative organisms are found fluorescein examination of the cornea should be undertaken by an ophthalmologist. In the event of a corneal abrasion being present, topical, parenteral, and possibly subtenon antibiotics should be administered and alternative methods of ventilatory support used.

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**Perverse T waves and chronic beta-blocker treatment**

T-wave inversion on the electrocardiogram is a non-specific abnormality that is also seen in some normal people, when its innocence may often be confirmed by its return to normal with beta-blockers. General recognition is needed that treatment with beta-blockers may itself cause T-wave inversion.

**Patients, methods, and results**

Three men, aged 44-54, were investigated for chest pain, attributed ultimately to oesophageal spasm in two (cases 1 and 2) and a musculoskeletal cause in one (case 3). At presentation all patients were receiving chronic...