Research

Measuring blood pressure: A call to bare arms?

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∞ See related article page 585

For over 100 years, the dominant method of blood pressure measurement in the clinic was the use of a stethoscope and sphygmomanometer. The "gold standard" mercury-filled sphygmomanometer was so ingrained in medical practice that its unit of measurement, millimetres of mercury (mm Hg), was one of relatively few in medicine that withstood the conversion to the International System of Units. Since the advent of clinical testing protocols about 20 years ago, automated blood pressure measuring devices have become more reliably accurate and common. Automated devices for measuring blood pressure are now found in pharmacies, peoples' homes and doctors' offices.

Clinical blood pressure measurement is somewhat of a misnomer. Following the deflation of a cuff that is wrapped around a patient's arm, it is not blood pressure, per se, that is measured. Rather, in the case of auscultation, when certain testing conditions are met, the onset and disappearance of Korotkoff sounds are closely associated with systolic and diastolic pressures, respectively. Many modern automated devices use oscillometric methods that detect and analyze pulse waves to determine blood pressure.[1] Both auscultation and oscillometry are indirect methods of blood pressure measurement, and the accuracy and clinical usefulness of their readings depend on personal, methodological and equipment-related factors.[2] Table 1 compares the auscultatory and oscillometric methods of blood pressure measurement.

Clinical practice guidelines outline preferred methods of blood pressure measurement. When clinical examiners follow these standardized methods, blood pressure readings predict mortality and indices of target organ damage. Casual office readings that stray from standardized methods poorly predict such outcomes. Accurate blood pressure measurement in the diagnosis and management of hypertension is important regardless of the type of device used for the reading.

Although oscillometric devices are becoming more common, the standardized methods described in clinical practice guidelines focus on the auscultation method. In this issue of *CMAJ*, Ma and colleagues[3] challenge the recommendation that blood pressure should be measured on a bare arm. Using a sample of patients from a family medicine clinic, they randomly assigned patients into 1 of 2 groups that underwent 2 blood pressure readings on the same arm. In the bare-arm group, both readings were taken on a bare arm. In the sleeved-arm group, the first reading was taken on a bare arm and the second was taken over the patient's sleeve. The authors found that readings taken over the sleeve of a shirt, blouse or light sweater were not statistically different from those taken on bare arms. These results appear to agree in magnitude and direction with findings from 3 previous studies[4–6] that investigated the accuracy of blood pressure measurement over clothing.

Key points of the article

- Blood pressure readings are indirect measurements whose accuracy depends on the control of factors related to the patient, the equipment and the methodology.
- Automated devices for measuring blood pressure, despite having passed clinical approval protocols, may be inaccurate in some individuals for reasons that are not well understood.
- Advances in the technology used in blood pressure measurement warrant a re-examination of the assumptions underlying clinical blood pressure measurement.
- Differences in patients and in the technology used by manufacturers may limit the generalizability of results related to automated devices for measuring blood pressure.

Advances in the technology behind devices that measure blood pressure require a rethinking of guidelines that were based on assumptions related to older technologies. For example, a number of hypertension practice guidelines specify the size of the blood pressure cuffs required for different upper-arm circumferences. Yet, the cuffs supplied with validated oscillometric devices do not necessarily conform to the sizes recommended for blood pressure measurement by auscultation. Whether bare arms are required for accurate blood pressure readings is another question. Surprisingly, and contrary to stated opinion, some current hypertension practice guidelines do not comment on whether arms should be bare during a reading.[7] Current Canadian Hypertension Education Program guidelines for blood pressure measurement by aus-

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Table 1: Comparison of common clinical blood pressure measurement methods

Characteristic	Auscultation	Oscillometry
Automation	Can be automated in devices that use a microphone instead of a stethoscope	Automated; some devices for clinic use can take repeat measurements in the absence of clinic staff
Blood pressure determination	Onset or disappearance of Korotkoff sounds	Analysis of pulse wave forms
Accuracy	Approved devices for manual blood pressure measurement (i.e., for use with a stethoscope) must meet standards based largely on the physical design and accuracy of pressure measurement	Approved devices must meet standards based on physical design and accuracy of pressure measurement. In addition, they must undergo a clinical testing protocol that compares readings from the device with those taken by auscultation and a mercury sphygmomanometer. Not all clinical testing protocols take into account accuracy within individual subjects
Arrhythmias	Manual methods may require many repeat measurements in patients with arrhythmias	Some devices cannot determine blood pressure in patients with arrhythmias

cultation recommend bare arms, but those guidelines recognize that not all standard measurement steps are required for automated measurements.[8]

Perhaps more importantly, the users' guide of a particular device may specify that the cuff is to be placed on a bare arm. Directives from an instruction manual of the type used by Ma and colleagues state, "Place the cuff directly against the skin, as clothing may cause a faint pulse, and result in a measurement error. Constriction of the upper arm, caused by rolling up a shirt sleeve, may prevent accurate readings."[9] Arguably, measuring blood pressure over a clothed arm constitutes an off-label use of the device. Ma and colleagues suggest that their findings, along with the results of the other studies, provide clinicians with sufficient evidence to ignore the manufacturer's recommendation. Although this may be true for relatively thin clothing and for readings made with one particular blood pressure measuring device, the results may not be generalizable. At some clothing thicknesses or combinations of thickness and material, the pulse will not be sufficiently transmitted to the cuff. At present, that combination of factors is unknown. Because many oscillometric devices, including the one used by Ma and colleagues, are marketed for home use, a clinician or person capable of making a sound judgment will not always be present to advise patients about whether measuring blood pressure over their clothing is acceptable.

The mathematical algorithms that manufacturers of automated devices use are proprietary and kept as trade secrets.[1] Some algorithms may weight one characteristic of the pulse envelope more heavily than others. Until many different devices are tested to determine the robustness of their readings when taken on bare versus clothed arms, we probably will not know whether deviance from manufacturers' instructions is warranted.

The type of device used by Ma and colleagues was clinically validated according to the Association for the Advancement of Medical Instrumentation standard and a modification of the British Hypertension Society protocol. Neither of these 2 clinical validation protocols take into account "person-effects" on the accuracy of the device. These associations test the devices against validation criteria, and the devices pass based on their performance over a total number of readings rather than on their performance on individual people. Investigators have shown that some devices may have margins of error of 5 mm Hg or more in half of the people, despite having met validation criteria.[10] For example, Although Ma and colleagues did not report significant variation in readings between hypertensive and nonhypertensive patients, one of the earlier studies[5] that examined blood pressure measurement on a bare versus a clothed arm did show variation. Reasons for the inaccuracy of devices with some individuals but not others are not fully known. Likely, the transmission of the pulse wave from the subject's arm to the cuff is part of the issue. If so, a bare versus a clothed arm may be more important in some individuals than others.

The use of automated blood pressure measuring devices in the clinic provides some real benefits. Well-working fully automated devices are free of terminal digit bias, deflate at the correct rate, operate consistently over time, record the results, do not require good hearing and generally require less training to operate properly. Despite these benefits, if the patient is not prepared for the blood pressure measurement in advance (e.g., avoids consuming caffeine and food, empties his or her bladder), the reading taken may not be of much clinical use.[2] Until more is known about interactions between devices and clothing, perhaps the best advice is to prepare the patient in advance so that clothing removal is not an issue.

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Should physicians warn patients' relatives of genetic risks?

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When a patient refuses to disclose genetic risk information to relatives, whether the patient's physician should or may disclose such information without the patient's consent will depend on the seriousness, the imminence and the preventability of the risk. The legal landscape around the duty to warn of genetic risk is unclear in Canada, but in some cases the benefits of disclosure may be so great as to outweigh the obligation to maintain confidentiality. In this article we use a case-based approach to address the ethical and legal issues surrounding physicians' duty to warn family members of genetic risk.

Key points of the article

- Protecting confidentiality and preventing harm to family members may create a dilemma for physicians.
- Requiring patients to agree to disclosure before genetic testing can lead to coercion and consequent reluctance to seek testing, which would effectively deprive patients and their relatives of genetic information.
- Physicians should make every effort to inform patients of the relevance of the information to relatives, persuade the patient of the need for intrafamilial disclosure and offer to inform relatives on behalf of patients.
- If patients refuse to have information disclosed, nonconsensual disclosure is not legally compelled and may in fact be punishable. However, if the risks are associated with a serious, imminent genetic condition that is preventable or treatable, the benefits of disclosure may be so great as to justify it on ethical grounds.

The case

Mrs. B has a family history of breast cancer and has become worried about getting cancer herself. Her family physician, Dr. T, refers her for genetic testing. Her results show that she has the *BRCA1* mutation.

Mrs. B attends post-test genetic counselling and clearly understands the implications of the results for herself and her daughter (aged 29), who is also Dr. T's patient. Dr. T receives a copy of the test results and strongly recommends that Mrs. B inform her daughter of her own risk, but Mrs. B declines to do so immediately. Dr. T offers to inform the daughter on Mrs. B's behalf, but Mrs. B declines the offer. The daughter is getting married in 6 months, and Mrs. B does not want to worry her. She says that she may tell her daughter herself after the wedding.

The daughter finds a pamphlet about a familial breast cancer program in her mother's study. During a visit with Dr. T, the daughter asks if she should be concerned.

A conflict of duties

Mrs. B's refusal to share her test results with her daughter places Dr. T in a dilemma. On one hand, the physician has a legal and ethical duty to Mrs. B to maintain confidentiality. On the other hand, the physician has a duty to take reasonable steps to prevent harm to her patients, to give them the information they need to make informed decisions about their care and to answer their questions to the best of her ability.[1,2] Dr. T also has a general ethical duty to act for the benefit of others. Do these latter duties amount to a duty to warn the daughter of her genetic risk? How can Dr. T square this duty with the confidentiality she owes to Mrs. B?

Benefits and harms of nonconsensual disclosure

The principal benefit of disclosing genetic risk information to family members is the avoidance of harm. If Dr. T informs Mrs. B's daughter of her risk of carrying the *BRCA1* mutation, the daughter will be able to decide whether to undergo testing

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