Choosing the optimal method of blood pressure measurement for limited-resource rural communities in the “Community Health Assessment Program—Philippines”

Dale Guenter MD, MPH | Ricardo Angeles MD, MPH, MHPEd, PhD
Janusz Kaczorowski BA, MA, PhD | Gina Agarwal MBBS, PhD
Fortunato L. Cristobal MD, MPH, MHPEd | Rosemarie Arciaga MD, MSc
Pattapong Kessomboon MD, PhD | John F. Smith PhD
Ricardo Angeles MD, MPH, MHPEd | Rodelin Agbulos MD, MPH
Flor Dave Arnuco MD, MPH | Jerome Barrera MD
Susan Dimitry BA | Maita Ladeza MD
Elgie Gregorio MD | Servando Halili Jr PhD
Norvie T. Jalani MD, MPH | Maita Ladeza MD
Nusaraporn Kessomboon BScPharm, MSc | Lisa Dolovich BScPhm, PharmD, MSc
Gina Agarwal MBBS, PhD | Servando Halili Jr PhD
Jerome Barrera MD | Nusaraporn Kessomboon BScPharm, MSc
Rodelin Agbulos MD, MPH | Lisa Dolovich BScPhm, PharmD, MSc

1Family Medicine, McMaster University, Hamilton, Ontario, Canada
2Universite de Montreal, Hamilton, Ontario, Canada
3Ateneo de Zamboanga University, Zamboanga City, Philippines
4Faculty of Public Health & Research and Training Center for Enhancing Quality of Life of Working Age People, Khon Kaen University, Khon Kaen, Thailand
5Community Medicine, Khon Kaen University, Khon Kaen, Thailand
6Universite de Sfax, Sfax, Tunisia
7City Health Office, City of Zamboanga, Zamboanga City, Philippines
8Khon Kaen University, Khon Kaen, Thailand

Correspondence
Dale Guenter, MD, MPH, Family Medicine, McMaster University, Hamilton, Ontario, Canada.
Email: guentd@mcmaster.ca

Funding information
Canadian Institutes of Health Research; International Development Research Centre

The Community Health Assessment Program—Philippines (CHAP-P) is an international collaboration of investigators whose aim is to adapt a previously proven Canadian community-based cardiovascular awareness and prevention intervention to the Philippines and other low-middle–income countries. Choosing a method of blood pressure measurement for the research program presents a challenge. There is increasing consensus globally that blood pressure measurement with automated devices is preferred. Recommendations from low-middle–income countries, including the Philippines, are less supportive of automated blood pressure devices. The value placed on factors including device accuracy, durability, cost, energy source, and complexity differ with local context. Our goal was to support the progress of local policy concerning blood pressure measurement while testing a comprehensive approach to community-based screening for cardiovascular risk. The authors describe the challenges in making a choice of blood pressure device and the approach to determine optimal method of measurement for our research program.

1 | BACKGROUND FOR COMMUNITY-BASED CARDIOVASCULAR PREVENTION RESEARCH IN RURAL PHILIPPINES

The Community Health Assessment Program—Philippines (CHAP-P) is in the first phase of a 5-year program of research. Its aim is to adapt the previously validated Cardiovascular Health Assessment Program (CHAP) model of population-based cardiovascular disease prevention from its original Canadian context to low-middle–income countries (LMICs). The CHAP model was found to be effective in a large community cluster randomized controlled trial in Canada. It demonstrated a statistically significant 9% reduction in annual hospital admissions at
the population level due to stroke, heart failure, and myocardial infarctions in persons 65 years and older.\(^1\)

The CHAP approach may be particularly well suited to LMICs because of its community-based, primary care–centered, volunteer-led, simple, low-cost features and its focus on population-based health promotion and disease prevention. Partner organizations in other LMICs (Thailand, Tunisia) are collaborating in order to consider customizing this process to their own settings. In the Philippines, the primary outcome of the randomized controlled trial is reduction in systolic blood pressure (BP).

The Philippines are considered an LMIC. The Human Development Index for the Philippines was 0.668 in 2014, ranking 116th of 188 countries.\(^3\) The Department of Health Philippines has reported cardiovascular diseases as the leading cause of mortality for all reporting periods since 1988.\(^4\) One billion people, or 40% of the world’s population older than 25 years, had hypertension in 2008.\(^5\) Prevalence rates are highest in LMICs, and those regions have the largest population, thus contributing to the highest burden of disease.\(^6\) About one third of deaths worldwide are caused by cardiovascular disease, and about 80% of death caused by cardiovascular disease occurs in LMICs.\(^5\) It is estimated that 45% of deaths caused by heart disease and 51% of deaths caused by stroke may be attributed to hypertension.

In this report, we discuss the challenge faced by the CHAP-P research team in one specific aspect of our work: selecting the optimal measurement method for screening and diagnosis of hypertension. Rural communities such as those in the southern Philippines, with limited financial and personnel resources, present unique considerations. Our challenge is to adapt current evidence, guidance, and policy, most of which has been produced in high-income countries, for application in these communities. We briefly review relevant evidence, guidance, and policy; describe the principles of our research program that are shaping our decision process; and outline the strategic approach we are taking for choosing a method of BP measurement for the research program and beyond.

### 2 | CHARACTERISTICS OF COMMON METHODS OF BP MEASUREMENT

The standard method for BP measurement for most of history has made use of either mercury or aneroid sphygmomanometers, using manual cuff inflation and auscultation.\(^7\)\(^9\) This method has a high risk of inaccuracy, primarily with overdiagnosis of hypertension known as white-coat effect (WCE) but also underdiagnosis (masked hypertension). The most accurate and dependable devices use mercury. Mercury presents a risk to health and the environment, and many countries, including the Philippines, have phased out these devices. Sphygmomanometers require calibration every 6 months and use of a standardized technique, the practice of which is widely recognized as being rare anywhere in the world.\(^10\)\(^\text{–}13\)

There are several types of automated devices. They all include the feature of detecting pulse through oscillometric sensor rather than the human ear, eliminating one type of variability that limits the utility of manual devices. Some (fully automatic) devices also inflate and deflate an arm cuff, eliminating the variability of cuff deflation. Some are designed to take multiple measurements on their own, without an observer present. All automated devices require a source of electricity.

Ambulatory BP monitoring (ABPM) is recognized as the gold standard, eliminating WCE and permitting averaging of continuous measurements. It is also the most complex and expensive. It requires specialized setup for the patient, 24 to 48 hours of measurement at home (thus eliminating WCE), and a second visit for retrieving data and computer analysis.\(^7\)\(^8\) It has been shown to be predictive of end-organ damage.\(^14\)\(^15\)

Home BP monitoring with a fully automated device has similar advantages. It performs best when the patient prepares themselves appropriately and takes readings twice daily for up to a week, then calculates an average. It has been shown to be less prone to WCE and to be predictive of end-organ damage.\(^16\)\(^18\)

Automated office BP measurement (AOBP) has been proven to correlate well with ABPM.\(^19\)\(^21\) There is also some evidence of a correlation with end-organ damage.\(^22\)\(^24\) Observer error is eliminated and WCE is greatly reduced if measurement is performed with an observer absent, in an uninterrupted private space. Measurement is completed with 3 to 6 preprogrammed readings over 4 to 7 minutes. The cost associated with AOPB is less than that for ABPM and is decreasing as new devices are developed. CHAP and the recent Systolic Blood Pressure Intervention Trial (SPRINT) are two large research applications of ABPM.\(^12\)\(^25\)\(^26\) AOBP was the method used for both screening and diagnosis, although it was not compared with any other method.

Automated methods of BP measurement come with several concerns in addition to cost and energy source. As with manual devices, an appropriately sized cuff should be used. Attention must be given to a relaxed and appropriately positioned arm, and an uninterrupted private environment must be used. Measurement in the setting of arrhythmia can be unreliable. Finally, evidence on automated devices is of low quality at best (level C or D), and is derived almost entirely from high-resource countries.

### 3 | GUIDANCE AND POLICY RECOMMENDATIONS FOR THE METHOD OF BP MEASUREMENT

The Table summarizes relevant consensus statements regarding the method of BP measurement. The following highlights are evident:

- Mercury, although accurate and reliable, is no longer an option in any jurisdiction.
- A two-step process of screening, followed by confirmation, is generally recommended to diagnose hypertension.
- Screening: Manual clinic-based sphygmomanometry, conducted with appropriate calibration and technique, is the most widely recommended method for screening. Canadian recommendations have recently changed to promote AOBP for screening.
### TABLE International recommendations for method of BP measurement

<table>
<thead>
<tr>
<th>Source</th>
<th>Manual (auscultatory, aneroid)</th>
<th>Automated (oscillometric, electronic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Philippine Society of Hypertension (2012)</td>
<td>Mercury preferred (although banned in 2009), otherwise aneroid, digital, or other automated devices provide reasonable alternatives, as long as they satisfy technical requirements for accuracy and are calibrated and tested on a regular basis</td>
<td>Use validated and affordable devices; solar energy preferred; battery not recommended; ease of calibration every 6 mo; accurate for 10 to 20,000 cycles, to a temperature of 50°C and humidity 85%; cost &lt; 20 Euros</td>
</tr>
<tr>
<td>World Health Organization (2005)</td>
<td>Phase out mercury; use aneroid only when automated not possible and if calibrated every 6 mo</td>
<td>Semi-automated or fully automated oscillometric BP device, where resources allow. Governmental and nongovernmental organizations work to ensure worldwide BP screening programs that use semi-automated or fully automated oscillometric BP devices</td>
</tr>
<tr>
<td>World Hypertension League (2014)</td>
<td>Only where automated measures not feasible, with recently calibrated device and trained observer; not endorsed as standard</td>
<td>Precautionary measures, such as calibration and maintenance, are recommended to maintain accuracy.</td>
</tr>
<tr>
<td>ISH and ASH (2013)</td>
<td>Accepted for diagnosis if automated device not available</td>
<td>Good alternative to manual office BP, 5 to 7 d</td>
</tr>
<tr>
<td>NICE (2011)</td>
<td>Office screening</td>
<td>To confirm elevated office BP, Twice daily 4 to 7 d</td>
</tr>
<tr>
<td>USPSTF (2014)</td>
<td>Office screening</td>
<td>To confirm elevated office BP, Twice daily 4 to 7 d</td>
</tr>
<tr>
<td>CHEP (2016)</td>
<td>Only where automated measures not feasible, with recently calibrated device and trained observer</td>
<td>Preferred method for office screening; follow with ambulatory measurement</td>
</tr>
</tbody>
</table>

Abbreviations: ABPM, ambulatory blood pressure monitoring; ASH, American Society of Hypertension; AOBP, automated office blood pressure; BP, blood pressure; CHEP, Canadian Hypertension Education Program; HBPM, home blood pressure monitoring; ISH, International Society of Hypertension; NICE, National Institute for Health and Care Excellence; US Preventive Services Task Force.

- **Diagnosis**: Ambulatory measurement (home BP monitoring or ABPM) is broadly recommended to confirm hypertension that is suspected in screening.
- **Resource constraints**: Cost, durability, and reliability of energy source must be taken into account and may limit introduction of automated devices.
- **The Philippines**: have taken a pragmatic approach, recommending use of any available method with proper calibration and technique, without promoting automated devices.

### 4 | Navigating the Evidence, Guidelines, and Practical Considerations

Our criteria for the optimal method of BP measurement in our research context include the following: low risk of observer error, mechanical failure, and WCE; affordability; ease of use; not dependent on reliability of energy supply; culturally acceptable; and nonintrusive to workflow. It will not be possible to meet all of these criteria.

Evidence and guidelines concerning BP measurement have evolved in the past 20 years as research on new technologies has emerged. Evidence is generally of low quality and from high-resource settings, yet automation is widely promoted due, in part, to the significant limitations of manual measurement and to the hope of decreasing unnecessary and costly treatment. Unfortunately, most high-income settings, including Canada, have been able to achieve only partial compliance with any form of recommended automation. The Philippines, like most LMICs, struggle to screen for hypertension, regardless of device.

The CHAP-P research group is convinced that manual BP measurement for either screening or diagnosis is on a slow path to obsolescence. It is also our impression that the conditions for accurate manual measurement in rural communities are rarely satisfied. Finally, we suspect the complexity of both ABPM and home BP monitoring (with repeated measures) is prohibitive for rural communities where transportation, language skills, personnel training, and opportunities for repeat visits exist. The cost of most validated and durable automated devices is too high, but we predict that this will not always be the case. Reliable electricity is a concern, but solar charging solutions are within reach in most instances.

This research program presents an opportunity to introduce some degree of automation, develop local capacity with these devices, collect data on acceptability and reliability of the devices to health human resources, and collaborate with local experts involved in research and policy on hypertension. Introducing automated devices now could begin to pave the way for adopting better and less expensive technology in the future.

To this end, our plan to move forward is the following:
• Select an AOBP device that best fulfills criteria of validation, accuracy, durability, cost, availability, and appropriate energy source.
• Perform a series of pilot studies in rural communities to test the acceptability and reliability of the AOBP device in comparison with manual devices with which personnel are familiar. Use this for both screening and diagnosis (through repeat visits for confirmation).
• Collaborate with the Philippine Department of Health and the Philippine Society of Hypertension to ensure that data gathered from our research will be appropriate for informing progressive local guidelines and policy to improve cardiovascular risk assessment and prevention.

5 | CONCLUSIONS

We hope to work collaboratively with local experts and policy makers in the Philippines to develop a progressive, reasonable, and sustainable approach to the screening and diagnosis of hypertension. The CHAP-P research process will improve capacity, quality, and locally relevant evidence related to automated BP measurement so that improvement on a national level might eventually be achieved.

ACKNOWLEDGMENTS

We would like to acknowledge the support of Dr Arwin Alpha and Celina Gorre through their participation in the discussion leading up to this publication. Our project is funded by the Canadian Institutes of Health Research (CIHR) and the International Development Research Centre (IDRC). We would also like to acknowledge the support of the Global Alliance for Chronic Diseases (GACD).

STATEMENT OF FINANCIAL DISCLOSURE

The authors report no specific funding in relation to this research and have no specific conflicts to disclose.

REFERENCES
