Cardiovascular disease (CVD) is no longer an entity of Western nations, but has become a common cause of death and disability in developing countries. It is expected that by 2020, 35% of all deaths in these nations will be due to CVD. Therefore, educational efforts to reduce exposure to risk factors for CVD and, at the same time, treat those who already are affected are imperative. The resources in developing nations are limited; consequently, implementation of health policies depends on cost and effectiveness.

Systemic arterial hypertension, a major risk factor for stroke and heart disease, causes approximately 50% of CVD morbidity and mortality worldwide. It is known that left ventricular hypertrophy (LVH) is a strong risk marker for all-cause mortality, cardiovascular death, and incidence of coronary artery disease and ventricular arrhythmia in hypertensive patients.

A BP measurement may identify hypertensive patients at one point in time, but physical examination provides little information on cardiac end-organ damage such as LVH or ventricular dysfunction. The diagnosis can easily be made by cardiac ultrasound. However, the use of standard echocardiographic equipment requires specialized personnel, technical support, as well as a reliable source of electricity. These elements are rarely available in rural areas of developing countries.

THE PROGRAM

Since 1998, a medical delegation from California annually visits countries in western Africa. Gambia is a small country on the west coast of Africa where heart disease is widespread and is becoming a leading cause of death. As part of the medical equipment, the delegation brings a battery-powered, hand-carried cardiac ultrasound (HCU) device (SononeHeart; Sonosite; Bothell, WA) that weighs 2.4 kg, and provides two-dimensional imaging, continuous, pulsed, and color-flow Doppler. Images can be frozen, and electronic calipers allow simple measurements.

EVALUATION

These results are from our experience in March 2000. During 6 days, the team examined 1,997 people. As shown in Figure 1, every day a multitude of patients waited in line to be attended at the clinic. The mean age was 25 ± 19 years (± SD) [range, 1 month to 75 years]. High BP (systolic ≥ 140 mm Hg and/or diastolic ≥ 90 mm Hg) was found in 342 patients (17%; mean age, 47 ± 18 years); the finding
was new for 92% (313 of 342 patients). The average systolic BP was $165 \pm 24$ mm Hg (maximal value measured 250 mm Hg); the diastolic BP was $98 \pm 17$ mm Hg (maximal value measured 181 mm Hg). The incidence of headache in our study was significantly more frequent in hypertensive patients (29%) than in normotensive subjects (16%) \[p < 0.0001\], and was the most common complaint in patients with newly diagnosed hypertension.

A cardiologist performed cardiac ultrasound using the HCU device with most of the patients in semi-recumbent position due to space limitations. HCU was used to identify LVH in the hypertensive population and to elucidate the etiology of dyspnea in nonasthmatic patients, as well as the cause of peripheral edema and heart murmurs. The ultrasound study was brief: \(\leq 5\) min. A two-dimensional parasternal long-axis view was used for measurement of ventricular wall thickness at end-diastole. LVH (wall thickness \(\geq 12\) mm) was found in 65% of the hypertensive population and is depicted in Figure 2. The interventricular septum measured $14 \pm 3$ mm (range, 7 to 19 mm), and the posterior wall thickness was $13 \pm 3$ mm (range, 9 to 19 mm).

Due to borderline BP values (systolic BP from 140 to 145 mm Hg, or diastolic BP from 90 to 95 mm Hg), the diagnosis of hypertension requires serial measurements not always feasible when medical personnel are scarce. Patients with borderline hypertension were evaluated with HCU. The presence of LVH was used as indicator to begin antihypertensive treatment. Specifically, LVH (\(n = 9\)) was common in those patients who had borderline hypertension and chronic headache (\(n = 35\)). Due to the nature of our study design, no serial follow-up with regard to improvement of headache symptom after treatment of hypertension was available. However, this would have been useful to ascertain if hypertension was responsible for the symptom.

**DISCUSSION**

Because of its small size, portability, and accessibility, the HCU device is an ideal tool for outpatient use. Figure 1. Queue of people outside of waiting area for clinic. The waiting area (seen through the window beyond the two large trees) held > 300 people. The clinic was located opposite the waiting area (to the left).
screening programs. HCU and standard ultrasound units have compared well in studies assessing the prevalence of heart failure in the community, LVH and aortic abdominal aneurysm in hypertensive and older patients, and hypertrophic cardiomyopathy in athletes. Our experience in Gambia demonstrates the diagnostic utility of a prototype HCU to identify LVH at the point of patient contact in unfavorable conditions of space and time. It is precisely in this underserved population that the brief physician-patient contact is a unique opportunity to identify diseases; misdiagnosis means generally that the disease will not be recognized for a long time, if ever.

Every hypertensive patient could potentially benefit from a brief cardiac ultrasound study to assess LVH, ventricular function, and complications of ischemic heart disease. However, until a cost-benefit analysis is performed and the indications for HCU in hypertensive patients are determined, we propose that these portable devices could be useful to detect cardiac damage in patients who are currently classified as low risk. HCU can identify a higher risk group of hypertensive patients by diagnosing LVH, and it is precisely this population that can derive maximal benefit from anti-hypertensive treatment. In addition, in subjects with borderline BP values, by identifying LVH, HCU could facilitate the diagnosis of hypertension at the first patient encounter.

HCU appears to have a role as a cost-effective method for screening patients at risk, as developing nations and health organizations confront the increasing burden of CVD. In countries and rural areas with limited access to physicians, as is the case of Gambia and many of the African nations, echocardiographic technicians, nurses, or health workers can operate these portable ultrasound devices with offline or remote interpretation when it is required. Qualified personnel can be adequately prepared after a brief period of echocardiographic training. It has already been demonstrated that medical residents can accurately identify ventricular dysfunction with a HCU with few hours of echocardiographic experience. Documentation of the ultrasound images should allow monitoring of both HCU quality and accuracy of the results.

**Conclusions**

LVH, a stronger marker of increased cardiovascular events than other reversible risk factors in hypertensive patients, is easily identified by HCU. The size and battery-powered characteristics of the device are cornerstone features for its high practicability in areas with limited or no access to medical diagnostic equipment. Identification and early treatment of hypertensive patients at high risk can result in a more effective use of limited health-care resources in developing nations.

![Ultrasound Image](http://journal.publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/22003/)
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