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REVIEW

Can a Low-Resource-Use Blood Pressure Device Impact on Global Maternal Mortality?

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Background. Hypertension in pregnancy in the developing world is largely underreported, misdiagnosed, and untreated, especially in rural settings, though it contributes significantly to maternal and perinatal morbidity and mortality. To reduce general global cardiovascular and cerebrovascular morbidity and mortality, the World Health Organization aims to develop and validate low-resource-use blood pressure devices for use in developing nations. *Objective and methods.* To describe how existing antenatal care systems provide a useful and relevant model through which to evaluate the potential for this initiative to be applied in low-resource settings and to offer opportunities for much needed further research.

Keywords Hypertension, Preeclampsia, Low-resource setting, Automated blood pressure device, Blood pressure measurement.

INTRODUCTION

Hypertension in pregnancy (HiP) in the developing world is largely underreported, misdiagnosed, and untreated, especially in rural settings, despite the significant contribution it makes to perinatal and maternal morbidity and mortality (1). To reduce general global cardiovascular and cerebrovascular morbidity and mortality, the World Health Organisation aims to develop and validate low-resource-use blood pressure devices (LRU BPDs) for use in developing nations. This article evaluates the potential for this initiative to be applied to antenatal care in low-resource settings and to impact on mortality and morbidity related to HiP, and offers suggestions for further research.

PREECLAMPSIA AND GLOBAL MORTALITY

Hypertension is thought to complicate 5% of pregnancies worldwide (11% of first pregnancies) with preeclampsia and eclampsia claiming up to 40,000 womens' lives globally each year (1). Though data is scarce, conservative estimates suggest that HiP accounts for between 10% and 15% of maternal deaths

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in the developing world (2) and contributes significantly to fetal morbidity and mortality. Of concern is the startling discrepancy between obstetric outcomes in developed and developing countries, where lifetime risks of dying in pregnancy approach 1000-fold greater between best and worst (approximately 1 in 10 vs. 1000). It is estimated that although fetal case fatality is 7–25% in African countries, it is as low as 1.4% in some European countries (2). This is thought to be due to improved detection and management, with measurement of blood pressure (BP) the chief indicator for preeclampsia and eclampsia (3). Supportive indicators such as measurement of proteinuria are most useful in conjunction with measurement of BP for detecting hypertension (1).

Though it is known that antenatal care coverage is as much as 87% in some countries with the highest maternal mortality (4), prevalence of BP screening is less clear. BP measurement is an essential and cost-effective (5) screening tool at this level because interventions such as expedition of birth (caesarean section or induction of labor) or administration of magnesium sulfate (to prevent fits and reduce morbidity to the mother) (1) are feasible in low-resource settings, though remain underused in many countries (4, 5). This is largely because they rely on the detection and referral of high-risk women from antenatal care to larger hospitals offering obstetric services (1, 2).

LRU BP DEVICE IN PREGNANCY

A low-cost blood pressure device that is accurate during pregnancy is yet to be validated. Numerous problems associated with taking BP manually have been identified. Whereas the conventional sphygmomanometer is relatively cheap to provide, considerable skill is required for its use as well as training in the art of auscultation (3). Traditional mercury models are now being phased out because of environmental and health safety concerns and their aneroid replacements ideally require six-monthly re-calibration to preserve accuracy (1). Both mercury and aneroid devices are associated with considerable user bias such as terminal digit preference, threshold avoidance, error because of incorrect deflation speeds, and wrong Korrotkoff interpretation, including failure to inflate above systolic pressure (6). Initially accuracy of automated devices introduced during the 1980s was unsatisfactory; however, more recently many are passing validation by the British Hypertension Society and the International Protocol of the European Society of Hypertension. Currently there are 47 devices on the British Hypertension Society website approved for self-measurement of BP (i.e., small and portable) in adults (7). These cannot be assumed to be accurate in preeclampsia however, and many of these devices have failed when assessed in pregnant women. Only one self-measurement device has been validated in pregnancy and is suitable for detection of preeclampsia (8). These devices typically rely on batteries or electricity to operate.

In 2005 a working group drew up a set of recommendations for the design of BP measuring devices for use in low-resource settings (9). Specifications of design include appropriate cuff size, manual pump, suitable power supply, and resistance to shock and temperature change.

BARRIERS TO IMPLEMENTATION

Several limitations prevent accurate, affordable BP measurement. Though US $20 per unit is a target, devices are currently relatively expensive to provide and replace, whereas their durability in the environment remains to be established. Devices powered by battery risk batteries being stolen or drained by frequent use and misuse. Batteries are also often unavailable in low-resource-use settings and disposal thereof is a concern. Locked or secured casings would deter thieves, as would specially sized and shaped batteries; however, these would need to be rechargeable as they would be difficult to replace. Solar powered devices escape many of these limitations altogether. Introduction of such devices also needs to be accompanied by education, as effective use depends on staff understanding of BP and the concept of disease existing in asymptomatic women. Staff capabilities and their trust in and motivation to use and care for the devices are also important factors in device utility.

INTERVENTIONS TO REDUCE MORTALITY IN THE DEVELOPING WORLD

Confidential enquiries into maternal deaths suggest that women who die from HiP in developed countries have received substandard care, with delayed identification of raised BP or delayed action. It is recognized that timely administration of anti-hypertensive medication both reduces the risk of women developing severe hypertension and lessens the need for further management (3), thus saving lives. As serious disease is often not associated with symptoms, and the common causes of death in HiP (i.e., cerebrovascular accident and pulmonary edema) can be avoided by treatment of blood pressure or delivery, BP devices have the potential to save lives. Cost–benefit analyses have shown that the treatment of severe preeclampsia and eclampsia, including transport, support, anti-hypertensives, and magnesium sulfate, both antenatally and intrapartum, is cost-effective and feasible in low-resource settings (5). However, implementation of such interventions relies on timely referral from the community and reliable supply of the relevant medications. There is less available literature regarding feasibility and availability of caesarean section or induction of labor in developing countries. Whereas delivery is known to be the only effective cure for preeclampsia, these interventions are dependent on the presence of sufficient expertise, facilities, and resources. Induction of labor for instance, a relatively cheap intervention that may prevent maternal death, may also lead to miscarriage or neonatal mortality in this setting because of lack of neonatal intensive care facilities. Similarly, although caesarean section is carried out in some low-resource hospitals for presentation in obstructed labor, further evidence is required regarding it having a widespread, preemptive role in the management of preeclampsia in such settings.

SUGGESTIONS FOR FIELD TRIALS PROTOCOL

Field trials should include a short-term analysis of the feasibility of implementing LRU BPDs in low-resource environments (Table 1). Any area that is

Table 1: Suggested areas for research in low-resource settings.

Context (epidemiology)	Analysis of maternal and fetal morbidity and mortality
	Incidence and prevalence of HiP and associated morbidity and mortality in area
	Referral patterns from rural clinics to hospital obstetric care in area
Field trials (suggested methodologies)	Device durability in the environment, including long-term follow-up: observational survey
	Staff knowledge and acceptability of devices: interview survey
	Comparison of referral rates for HiP between equipped and control clinics: randomized intervention-control study (RICS)
	Change in incidence and prevalence of HiP-associated morbidity and mortality in the intervention area as compared to control area: RICS

to introduce these devices needs confirmation of the epidemiological data and retrospective analysis of morbidity and mortality to confirm its potential impact and allow analysis of implementation. Incidence and prevalence of significant morbidity associated with HiP should be investigated, as well as referral data from rural clinics to hospital obstetric care for patients with these conditions, if such data exists. An endpoint might be a comparison of intervention and control clinic referral rates. These field trials should include teaching rural staff BP knowledge and measurement with trial devices. Trials should survey responses of staff to new devices. Long-term follow-up should be carried out, particularly regarding power supply, durability, and use by staff.

CONCLUSION

In the developing world, HiP-related morbidity and mortality is substantial. There is potential to implement strategies to reduce morbidity and mortality through LRU BPD development and implementation. Much research is required, especially in terms of prototype field trials investigating the reality of the need for, and sustainability of, such an effort. In particular, relevant barriers to implementing these devices need to be identified and challenged.

Declaration of Interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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