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Evaluation of interventions to improve clinical practices for hypertension in health facilities in rural Zambia: A cross-sectional study

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Abstract: Responding to high disease burden of Hypertension (HTN), the Ministry of Health in Zambia considers improving services related to HTN a national priority. Therefore, this study evaluated the interventions for HTN pharmaceutical treatment by training of health staffs and procurement of necessary medical devices. We investigated service provision in the outpatient department (OPD) visits among patients aged 40 years and above in randomly selected health facilities in Chongwe district, between May and December 2017, before and after the interventions. The proportion of OPD visits that included standard clinical practices for HTN services significantly increased post-intervention: 45.8% to 71.9% for blood pressure screening, 26.8% to 31.8% for HTN diagnosis, and 14.2% to 20.9% for HTN medication. The proportion of OPD visits at which HTN medication was prescribed increased significantly post-intervention among patients with Grade 2 HTN or above, from 68.3% to 86.0%. The estimated district-wide monthly cost for HTN services in USD was $1,905 at baseline and increased to $2,643 post-intervention. These results suggest that improving HTN service provision is feasible and affordable at the district level. However, because a large number of individuals in need of HTN medication did not access a health facility, further investigation is required to estimate the expected effects and costs under improved access in the future.

***Keywords*:** hypertension, non-communicable diseases, Africa

Introduction

Non-communicable diseases (NCDs), including cardiovascular diseases (CVDs), are a major cause of mortality around the world; approximately 35 million people die every year from NCDs including CVDs. One of the major contributing factors to the high prevalence of CVDs is Hypertension (HTN) (*1*). In low- and middle-income countries, 80% of these deaths occur in individuals aged less than 70 years (*2,3*). Total deaths from NCDs are projected to increase by more than 17% over the next 10 years, constituting a substantial financial burden on national economies (*3,4*). In response to this situation, the World Health Organization (WHO) adopted a resolution based on the 2011 United Nations (UN) Declaration on NCDs at the 66th World Health Assembly (*5*), endorsing new health goals to enable a 25% reduction in avoidable mortality from NCDs by 2025 (*6*). In addition, NCD-related indicators were added to several targets in Goal 3 of the UN's Sustainable Development Goals (*7,8*), and the WHO published NCD related policy documents such as the Global NCD Action Plan 2013-2020 (*9*), and the Package of Essential Non-communicable Disease Interventions for primary health care in low-resource settings (*10,11*).

In African countries, there is an increased demand for quality NCD health services (*12*). In Zambia, 18% of deaths among people aged 30 to 70 years in 2017 were due to four main NCDs (cardiovascular diseases, cancers, chronic respiratory diseases and diabetes) (*13*), accounting for approximately 20,000 deaths. A sample vital registration with verbal autopsy (SAVVY) conducted in 2015 reported that cardiovascular diseases accounted for 12.1% of total causes of death (*14*). In addition, the WHO STEPwise approach to Surveillance (STEPs) in 2017 revealed a large number of people with risk factors leading to major NCDs such as HTN; 19.1% of the adult population (20.5% of men and 17.6% of women) had elevated blood pressure (BP), defined as systolic BP $\geq$ 140 mmHg and/or diastolic BP $\geq$ 90 mmHg (*15*). In this context, the Zambian Ministry of Health (MoH) has designated improved health services for HTN and other NCDs, as a priority in the National

Health Strategic Plan 2017-2021 (*16*). However, the necessary information to understand the actual capacity of health facilities and related costs for treating hypertensive patients in Zambia is lacking. Therefore, the feasibility and affordability of implementing the NCD-related services stipulated in the Basic Health Care Package, which is a set of essential health care services for everyone, were unknown.

With support from the Japanese International Cooperation Agency (JICA), the Zambian MoH has endeavored to improve HTN-related services at the primary healthcare level, in the rural Chongwe district, by increasing health staff capacity, procuring necessary medical equipment, and developing clinical guidelines for HTN. Chongwe district is located 50 km away from the Zambian capital city of Lusaka and is a middle-sized rural district with a population of 177,491, according to the Zambian National Census (*17*). To evaluate the service provision for HTN on a health facility basis, the project conducted operational research using medical record data from selected health facilities in the Chongwe district. The objective of this study is to provide useful information for the development of health policies in Zambia for HTN services by analyzing, one, the outcomes of interventions designed to improve service provision for HTN and, two, the related costs at the primary healthcare level.

Patients and Methods

Study sites, population, and data collection

This was a repeated cross-sectional study based on medical record data from randomly selected health facilities in Chongwe District. The target population for this study was patients aged greater or equal to 40 years, who visited an outpatient department (OPD) at a targeted health facility in the Chongwe district. WHO (*9,10*) recommends routine BP screening for persons in this age group as they are a high-risk population for cardiovascular diseases, and Zambia's 2016 Standard Treatment Guideline (STG) (*18*) followed this guideline. Individuals who resided outside Chongwe district or refused to participate in the study were excluded.

Chongwe district has three types of health facilities, varying by catchment population and function: first-level hospitals, rural health centers, and health posts. The number of each type of health facility at the beginning of the study period was 1, 12, and 11, and the catchment populations were approximately 180,000, 8,000-12,000, and 2,000-4,000, respectively (*17*).

An *a priori* power analysis was conducted to determine the minimum sample and cluster sizes required to find significant differences in the proportions of HTN diagnoses, pre- and post-intervention. Power was set at 0.8, with an alpha level of 0.05, and the proportion of HTN diagnoses was assumed to be 20% before and 30% post-intervention. Based on this analysis, a minimum of 300 pre- and post-intervention visits per health facility were required to ensure adequate power. The average number of visits to rural health centers and health posts by the target population was assumed to be 50 and 100 per month, respectively, based on the data obtained from the abovementioned medical records. Therefore, two health facilities per type were selected to collect the necessary samples over four months. Thus, targeted facilities were randomly selected for each facility type using computer-generated random numbers as follows: one first-level hospital (1 of 1), one urban health center (1 of 1), two rural health centers (2 of 11), and two health posts (2 of 11).

For data collection, surveyors visited the targeted health facilities twice: just before the intervention and four months after the intervention. Using a structured data collection template developed for this research, the data were obtained retrospectively for the past four months from all medical records, that recorded OPD visits among the target population. This template covered demographic information, HTN status, and items related to standard clinical practices for HTN services, including BP screening, HTN diagnosis, and prescription of HTN medication. All data were collected over 8 months from May to December 2017, as the 2016 data from the Chongwe District Health Office indicated that the number of OPD visits for HTN did not have seasonal fluctuations. In addition, each OPD visit for HTN services was categorized as "first visit" or "revisit". Revisits were defined as multiple OPD visits for HTN treatment within the past 3 months at the targeted health facilities. Other cases were defined as first visits.

Interventions

Interventions to strengthen HTN service provision at the health facility level were implemented throughout the Chongwe district, as part of the Project for Strengthening Basic Health Care Services Management for Universal Health Coverage (the BHC for UHC Project) beginning from September 2017. These interventions consisted of HTN service training for health staff. Previously, standardized training materials for HTN services were not available in Zambia. Therefore, we spent a year developing a national training course with the MoH and experts in Zambia, by referring to Zambia's 2016 Standard Treatment Guideline (STG) (*18*) and WHO's Package of Essential Non-communicable (PEN) disease interventions for primary health care in low-resource settings (*10*). The training materials included an overview, prevention, screening, and treatment of CVDs. The risk assessment of HTN was guided only by the BP level to simplify the HTN management protocol considering the local capacity in Zambia. The training materials included lectures, case studies, demonstrations, and practicums. A two-day off-site training was provided

to 109 health staff, responsible for HTN services at primary health facilities in the Chongwe district, by nine Zambian specialists in internal medicine, who in turn had received three days of off-site training to become trainers. All essential medical equipment and medicines for HTN services were available in Chongwe district during the study period.

Analytic approach

Analysis of staff performance

The primary outcome of this study was to understand the quality of clinical practice, based on consistency with the established criteria for BP screening and prescription of HTN medications. These outcomes were calculated by analyzing data obtained from observations during set periods (pre-intervention, the first four months from May to August; and post-intervention, the second four months from September to December) and by comparing the results of the two observation periods.

BP was measured by auscultatory methods using a BP machine or sphygmomanometer, with the patient in the sitting position, with the back and the legs supported. Loss of follow-up was frequent and the diagnosis of HTN could not be re-confirmed during additional visits, as recommended by the WHO HEARTS Technical Package (*19*).

According to the STG (*18*), all adult patients aged greater or equal to 40 years who visit an OPD should undergo BP screening. Therefore, the quality of the BP screening was evaluated by dividing the number of BP screenings performed, by the total number of OPD visits by the target population. The number of visits that included BP screening was determined by the number of OPD visits during which BP was measured, as noted in the medical records. The quality of practice for HTN treatment was represented by the number of HTN medications among patients diagnosed with grade 2 (mild; systolic BP ≥ 160 mmHg or diastolic BP ≥ 100 mmHg) or grade 3 HTN (moderate; systolic BP ≥ 180 mmHg or diastolic BP ≥ 110 mmHg). HTN treatment was defined as the prescription of HTN medication in the medical records. According to STG (*18*), HTN medication should be prescribed to patients with grade 1 HTN (systolic BP ≥ 140 mmHg or diastolic BP ≥ 90 mmHg) if the HTN level persists for 3 months, even after lifestyle modification through counseling by nurses or clinical officers. Counseling addressed the four risk factors for CVDs: unhealthy diet, harmful use of alcohol, tobacco use, and insufficient physical activity. In contrast, pharmaceutical treatment should be considered immediately for all patients with grade 2 or 3 HTN. Compatibility with HTN treatment criteria was difficult to judge in patients with grade 1 HTN because many medical records had no clear history of lifestyle modifications, even when patients received relevant instructions from their clinicians during consultation. Therefore, the quality of staff performance in terms of HTN medications was investigated only for OPD visits of patients diagnosed with grade 2 HTN or above.

In addition, the proportions of other HTN practices were calculated, to evaluate the effects of the abovementioned interventions in HTN services. HTN practices included HTN diagnosis and treatment, which are the standard practice components outlined in the STG (*18*). HTN diagnoses were counted, if the BP range exceeded the criteria of grade 1 HTN according to the STG (*18*), that is, systolic BP ≥ 140 mmHg or diastolic BP ≥ 90 mmHg.

Analysis of HTN medication use

The use of HTN medications was calculated based on the data obtained from the data collection registry. The number of pills prescribed was not properly recorded in the patients' medical records, so it was assumed that patients received 30 pills per visit. This was in accordance with the STG instructions, that patients with HTN should receive pills at monthly follow-ups (*18*). To calculate costs, the unit prices for key HTN drugs were obtained from the Medical Store Limited (MSL) Catalogue 2016 (Table 1). The incremental consumption and costs of HTN medications were estimated for the post-intervention period and compared with those of the pre-intervention period. The expected monthly use and costs of these medications were estimated for Chongwe district under the assumption, that the results from one health facility would be applicable to other facilities of the same type.

Analysis of HTN service costs

The unit costs of OPD services obtained from a previous study conducted in Chongwe District (*20*), were used

Table 1. Unit costs of HTN medications

Medications	Strength	Pack size, pills	Pack cost, USD
Nifedipine	20 mg	1,000	9.25
Amiloride + hydrochlorothiazide (Moduretic)	5 mg/50 mg	1,000	3.01
Enalapril	10 mg	1,000	2.67
Atenolol	50 mg	1,000	1.78
Propranolol	40 mg	1,000	2.53
Frusemide	40 mg	1,000	3.01

Source: The Medical Store Limited (MSL) Catalogue 2016. HTN, hypertension.

Table 2. Unit costs (excluding variable costs) by health facility type

Types	OPD costs, USD	Laboratory costs, USD
First Level Hospital	14.1	3.4
Health Center (urban and rural)	2.6	1.75
Health Post	3.3	0.3

Source: Study on the Unit Costs of Health Services Provided at Hospitals and Health Centres in Lusaka and Southern Provinces, Zambia (*Ref. 20*). OPD, outpatient department.

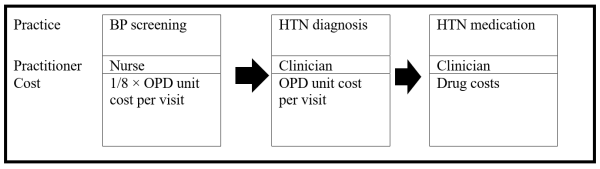

Figure 1. Practice flow for HTN service. Formula: HTN service cost = (OPD unit cost) × (number of visits with BP screening) × 0.125 + (OPD unit cost) × (number of visits with HTN diagnosis) + ∑{(unit cost of HTN medication) × (number of visits with HTN medication prescription) × (number of prescriptions for HTN medications per visit)}. BP, blood pressure; HTN, hypertension; OPD, outpatient department.

to estimate the labor and capital costs per OPD, and the laboratory visits (Table 2). Fixed costs included capital and labor costs for HTN services, and variable costs included costs for drugs, reagents, and other necessary consumables for HTN services. The total costs for HTN clinical services (BP screening, HTN diagnosis, and medication), including variable costs, were calculated for each health facility type using Figure 1 and the formula given below. The unit cost of BP screening was estimated to be one-eighth of the OPD unit cost, as the time spent on BP screening was found to be one-eighth of the total OPD consultation, on average, in a time-motion survey conducted during this study. While the practitioners for different services in Chongwe district varied, the service providers at health facilities were generally clinical care officers, rather than medical doctors. According to previous research (*20*), the salaries of clinical care officers and nurses were similar, and it was assumed that the unit cost per BP screening depended only on the differences in the time spent for each practice. The costs of each HTN service components were summed for the pre- and post-intervention periods for each health facility type, and the unit cost per OPD visit for HTN services was calculated, as the total costs divided by the number of HTN diagnoses. The total costs for HTN services in Chongwe district were estimated from the costs for each facility type, under the assumption that the average costs for HTN services at one health facility would be applicable to other facilities, of the same type. Finally, to evaluate the cost-effectiveness of prescribing HTN medications for eligible patients, the incremental number of HTN medication prescriptions for those with HTN grade 2 or above, was estimated for the Chongwe district as a whole, and the costs per HTN treatment were calculated.

Statistics

All variables were analyzed using STATA version 14 and Microsoft Excel 2013. Statistical differences were evaluated using a multilevel regression model with restricted maximum likelihood estimation (REML) and Kenward-Roger correction for small samples (*21*). Statistical significance was set at p-values of < 0.05. Discounts and inflation were not considered in the cost estimations because the research period was less than one year. Costs were reported in USD using the currency exchange rate as of June 2016 (1 USD = 10.59 Zambian Kwacha).

Ethics

Ethics approval was obtained from the University of Zambia Biomedical Research Ethics Committee (No. 006-04-17) and the Ethics Committee of the National Center for Global Health and Medicine in Japan (No. 3288). The study used only patient information available in the medical records, hence, written consent was not obtained from individual participants. Instead, a participation information sheet explaining the study objectives and research methods was attached to the walls at all target sites during the study period. The staff measuring BP explained the information sheet verbally, allowing the patients to opt out of participation in the study. If the patients wanted to stop participation at any time during the study, they could contact the heads of the nearest target health facility or directly call the office of the principal investigator, to convey their intention.

Results

Characteristics of OPD visits

Descriptive statistics for OPD visits among the included patients during the study period are shown in Table 3. The total number of visits was 3,774 and the average patient age was 55.0 years. There were no refusal cases. These values were similar in the pre- and post-intervention periods. Men accounted for 41.3% of the sample population. The number of OPD visits by health facility type was 1,373 for the first-level hospital, 1,733 for the three targeted health centers, and 668 for the two targeted health posts.

Practices of the HTN services

Table 4 describes the key HTN services (BP screening, HTN diagnosis, and prescription of HTN medications) provided by the staff. The proportion of OPD visits at which key services were provided increased significantly

Table 3. Characteristics of OPD visits, pre- and post-intervention

Characteristics	Full study period	Pre-intervention	Post-intervention
Total visits, *n*	3,774	1,770	2,004
Average age, years (95% CI)	55.0 (54.7–55.4)	54.9 (54.3–55.4)	55.2 (54.6–55.7)
% male (95% CI)	41.3% (40.0–42.8)	42.5% (40.2–44.8)	40.1% (38.0–42.3)
Revisits for HTN, *n*	421	216	205
First Level Hospital visits, n	1,373	609	764
Health Center visits, *n*	1,733	848	904
Health Post visits, *n*	668	332	336

CI, confidence interval; HTN, hypertension.

Table 4. Visits with HTN clinical practices, pre- and post-intervention

Visits	Full study period	Pre-intervention	Post-intervention	*p* value
Total visits, *n*	3,774	1,770	2,004	N/A
BP screening visits, *n* (%)	2,250 (59.6%)	810 (45.8%)	1440 (71.9%)	< 0.05
HTN diagnosis visits, *n* (%)	1,111 (29.4%)	474 (26.8%)	637 (31.8%)	< 0.05
HTN medication visits, *n* (%)	670 (17.8%)	252 (14.2%)	418 (20.9%)	< 0.05

BP, blood pressure; HTN, hypertension.

Table 5. Visits with HTN medications by HTN grade, pre- and post-intervention

HTN grade	Pre-intervention		Post-intervention		*p* value
	Total visits, *n*	HTN medication visits, *n* (%)	Total visits, *n*	HTN medication visits, *n* (%)	
Unknown	960	27 (2.8%)	960	27 (2.8%)	< 0.05
Normal	336	21 (6.3%)	336	21 (6.3%)	0.934
Grade 1	218	55 (25.2%)	218	55 (25.2%)	0.890
Grade 2	136	68 (50.0%)	136	68 (50.0%)	< 0.05
Grade 3	120	81 (67.5%)	120	81 (67.5%)	< 0.05

HTN, hypertension.

after the interventions, from 45.8% to 71.9% for BP screening, from 26.8% to 31.8% for HTN diagnosis, and from 14.2% to 20.9% for prescription of HTN medication. The results were similar after stratification by the first visit and the revisit (Supplemental Tables S1 and S2, *https://www.ghmopen.com/site/supplementaldata.html?ID=83*).

Table 5 presents details of HTN medications prescribed at OPD visits in the pre- and post-intervention periods. The proportion of OPD visits at which HTN medication was prescribed did not differ significantly pre- and post-intervention among patients with normal BP or grade 1 HTN. In contrast, this proportion increased significantly from 68.3% to 86.0% among patients with grade 2 HTN or above after the interventions, as more health staff began following the HTN medication protocols given in the STG (*18*). As shown in Supplemental Tables S3 and S4 (*https://www.ghmopen.com/site/supplementaldata.html?ID=83*), these results were similar after stratification by first visit and revisit. However, the proportion of OPD visits at which HTN medication was prescribed without BP screening increased significantly after the interventions, even among first visits, despite being against the standard protocols (*18*).

HTN medication use

Types of HTN medication

Table 6 and Figure 2 show additional details of the HTN medications by drug type. While the proportion of OPD visits at which nifedipine or moduretic were prescribed increased significantly after the intervention, prescriptions of atenolol, propranolol, or frusemide significantly decreased. This may provide evidence for improved compliance with the standard HTN medication protocol (*18*) used in HTN training.

Estimated use of HTN medications

Supplemental Tables S5, S6, and S7 (*https://www.ghmopen.com/site/supplementaldata.html?ID=83*) describe the average monthly use and costs of HTN medications in first-level hospitals, health centers, and health posts, respectively. The l monthly average costs for HTN medications for each health facility before and after the interventions were $9.95 and $15.55 for the first level hospital, $1.06 and $4.44 for health centers, and $0.08 and $0.81 for health posts, respectively. As

Table 6. Visits with HTN drugs, pre- and post-intervention

Drugs	Pre-intervention		Post-intervention		*p* value
	n	%	*n*	%	
Nifedipine	126	50.0%	331	79.2%	< 0.05
Moduretic	73	29.0%	181	43.3%	< 0.05
Atenolol	60	23.8%	35	8.4%	< 0.05
Propranolol	24	9.5%	9	2.2%	< 0.05
Enalapril	6	2.4%	46	11.0%	< 0.05
Furosemide	57	22.6%	50	12.0%	< 0.05
Total	252		418		

HTN, hypertension.

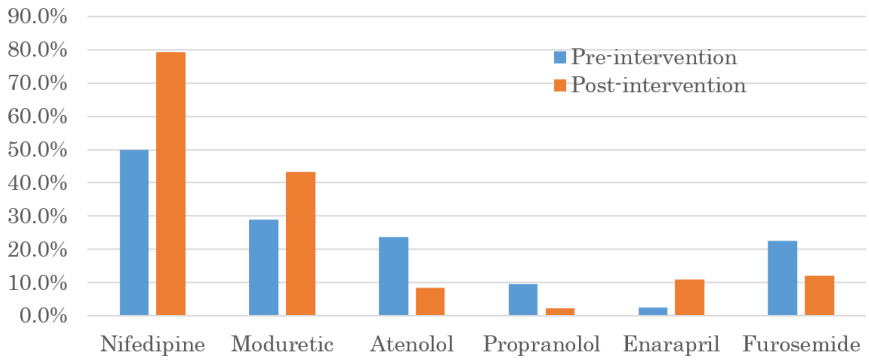

Figure 2. Percentage of outpatient department visits receiving each type of HTN medication among visits receiving any HTN medication, pre- and post-intervention.

Table 7. Estimated monthly average use and costs of HTN drugs in the Chongwe district

Drugs	Unit price, USD/pill	Pre-intervention		Post-intervention	
		Pills used, *n*	Cost, USD	Pills used, *n*	Cost, USD
Nifedipine 20 mg	0.00925	1,462.5	13.53	6,352.5	58.76
Moduretic	0.00301	1,256.8	3.81	4,669.3	14.15
Atenolol	0.00178	1,012.5	1.80	397.5	0.71
Propranolol	0.00253	540	1.37	247.5	0.63
Enalapril	0.00267	45	0.12	712.5	1.90
Furosemide	0.00301	832.5	2.51	465	1.40
Total			23.13		77.54

Assumptions for analysis: Unit prices for each drug were obtained from the Medical Store Limited Catalogue 2016. Material costs were calculated under the assumption, that a one month supply of drugs was prescribed (30 pills per visit). There are 12 health centers, 11 health posts and one first level (district) hospital in Chongwe. HTN, hypertension.

shown in Table 7, the estimated monthly average costs of HTN medications in Chongwe district were $23.59 pre-intervention and $77.8 post-intervention.

Estimated cost of HTN services

Supplemental Tables S8, S9, and S10 (*https://www.ghmopen.com/site/supplementaldata.html?ID=83*) describe the monthly average costs for HTN services in Chongwe district by health facility type. The monthly average costs (variable costs) for HTN services pre- and post-intervention were $1331.67 ($9.79) and $1,363.24 ($15.36) for the first-level hospital, $40.25 ($1.17) and $87.83 ($4.44) for Health Centers, and $8.29 ($0.08) and $21.41 ($0.89) for health points, respectively. Table 8 shows the fixed and variable unit costs per OPD visit with an HTN diagnosis: $16.95 and $17.51 for the first-level hospital; $3.38 and $3.91 for health centers; and $3.67 and $4.20 for health posts, respectively. As shown in Table 9, the estimated monthly average costs (variable costs) for HTN services in Chongwe District were $1,904.62 ($23.89) pre-intervention and $2,643.46 ($69.53) post-intervention. Table 8 also describes the estimated post-intervention unit cost per HTN medication prescription, among OPD visits with HTN of grade 2 or above. The incremental number of visits at which HTN medications were prescribed among patients with grade 2 or 3 HTN and the incremental post-intervention costs were 120.0 visits and $738.84, respectively. Therefore, the post-intervention unit cost required to prescribe HTN

Table 9. Estimated monthly average costs for HTN service and number of OPD visits with medication prescription in the Chongwe district

Values	Pre-intervention costs, USD	Post-intervention costs, USD	Incremental cost, USD
Total Cost	1,904.62	2,643.46	738.84
Fixed Cost	1,880.73	2,572.93	693.20
Variable Cost	23.89	69.53	45.64
No. of OPD visits with HTN treatment and HTN grade 2 or above	63.1	183.1	120.0
Medication prescription cost per visit			6.16

Assumptions for analysis: Fixed cost includes capital costs and labor costs for HTN service. Variable cost includes costs for drugs, reagents, and other necessary consumables for HTN services. There are 12 health centers, 11 health posts, and one first level (District) hospital in Chongwe. HTN, hypertension.

Table 8. Unit cost per visit with an HTN diagnosis, by health facility type

Types	Pre-intervention cost, USD	Post-intervention cost, USD
First Level Hospital	16.95	17.51
Health Center (urban and rural)	3.38	3.67
Health Post	3.91	4.20

HTN, hypertension.

medication for one person with HTN grade 2 or above was $6.16 per visit.

Discussion

We conducted training on HTN service provision for health staff in Chongwe district and evaluated the effects on the quality of clinical practices for HTN services. The results showed that proportion of eligible people who received BP screening and HTN drug therapy for secondary prevention significantly improved post-intervention. Additionally, the rates of key HTN service practices (HTN diagnosis and treatment) designated by Zambia's STG (*18*) significantly increased during the post-intervention period. While it was difficult to set the expected cutoffs of these indicators owing to the lack of any guidelines and previous data, the significant increases suggest that training led to improvements in HTN practices in terms of identifying more HTN cases and providing treatment. These indicators for evaluating staff performance in HTN service provision were selected by considering the NCD Global Monitoring Framework (*22*), which includes the target of "at least 50% of eligible people receive drug therapy and counseling to prevent heart attacks and strokes". While a population-level study was not feasible due to limited resources and because counseling history was not evaluated, HTN medications for grade 2 and grade 3 HTN patients at the facility level were assessed in this study. The key HTN practices of BP screening, HTN diagnosis, and HTN treatment were monitored as measures of health system performance, similar to the indicators referred to as the HTN care cascade in a previous study (*23*).

There are several challenges in achieving high-quality HTN services. First, BP screening rates were suboptimal, even after the interventions. Although Zambian guidelines indicate that BP screening should be conducted for all OPD patients aged greater or equal to 40 years (*18*), the prevalence of these practices was still as low as 71.9%. Second, pharmacological HTN treatment was received by 80% of patients with grade 2 HTN and 94.3% of those with grade 3 HTN. Moreover, the proportion of HTN medications among patients with normal BP did not significantly change, and 4.2% of patients with normal BP received HTN drugs even after intervention. We observed that some healthcare staff prescribed medications only for HTN-related symptoms. Even in first-visit cases, this proportion did not significantly change (Supplemental Table S3, *https://www.ghmopen.com/site/supplementaldata.html?ID=83*). These results suggest that there is scope for improvement in the HTN service quality. Third, the number of Revisits was similar throughout the study period, despite the fact that the number of patients receiving HTN medications significantly increased. This finding indirectly suggests a high follow-up dropout rate because the number of revisits should accumulate if all patients taking HTN medications receive follow-up, as recommended. Therefore, the capacity of health staff should be increased, and the health system should be strengthened to allow such patients to regularly visit health facilities. Finally, our results suggest that health facilities were not accessed by a large proportion of the population who required HTN medication. Considering that 19.1% of the adult population in Zambia has elevated BP[13] and 15% of the total population in the Chongwe district was greater or equal to 40 years during the study period (*24*), approximately 6,000 adults requiring HTN medication and monthly follow-up was expected in the sampled district. However, there were only an estimated 418 monthly OPD visits by patients with elevated BP in Chongwe district post-intervention, suggesting that many people in need of HTN medication did not access the health facilities. Therefore, community awareness of HTN should be improved to encourage the extensive use of HTN services.

There have been concerns about the incremental costs of HTN treatment owing to the increased number

of patients with HTN visiting health facilities as a result of improved awareness. The budget impact of these interventions could be substantial given that NCDs are generally chronic diseases that require long-term treatment. Our analysis showed that the estimated monthly costs required for Chongwe District were $1,905 ($23.90, variable costs) pre-intervention and $2,643 ($69.50, variable costs) post-intervention. As all fixed costs and most variable costs are covered by the Zambian government, Chongwe District is responsible for only a portion of the variable costs. Therefore, the estimated costs of HTN services appear affordable based on this research, even after the interventions, considering that the provisions in the 2018 Chongwe District Health Office budget was approximately $270,000 (*25*). Post-intervention incremental costs per visit, excluding intervention costs, were estimated at $6.16. These figures should still be fairly affordable, given that the Zambian gross domestic product was $1,509.80 per capita in 2017 (*26*). Therefore, policymakers should secure the necessary budget to cover the costs of HTN services according to these estimates for interventions to improve the performance of HTN clinical practices.

This study has several limitations. First, the BP data in the medical records may not be reliable due to various reasons discussed below. There may be concerns regarding the skills of health workers in measuring BP using sphygmomanometers, especially before the intervention. However, most health staff already knew how to manually screen for BP because they had been trained to use a stethoscope and sphygmomanometer in other programs, including those for HIV/AIDS and maternity services. Therefore, an increase in BP screening and HTN diagnosis may reflect an improvement in the knowledge of HTN management. In addition, the appropriateness of the BP measurement procedure could not be monitored during each patient visit. The training course covered the methods of BP measurement by the BP monitoring machine as well as the sphygmomanometer, including practices to make sure that patients wait at least five minutes after sitting, that BP is measured twice in one-two minute intervals, and that the average BP is calculated. However, we could not monitor the details of the procedure, even post-intervention, owing to the limited resources available for this research. Therefore, we could not ensure that accurate BPs measurements were obtained and recorded in medical records. However, patients usually needed to wait for a minimum of 30 minutes before receiving consultation in Zambian health facilities, and almost all health staff members were familiar with the sphygmomanometer during training. Therefore, we surmise that the BP data is reliable.

Second, we randomly selected six health facilities of different types to ensure generalizability within the Chongwe district. However, our results may not be fully applicable to other regions of Zambia, such as urban areas or districts further away from the capital city. Further research is required to investigate the generalizability of the present results to other regions of Zambia.

Third, because the follow-up of individual patients with HTN was difficult owing to the poor quality of medical records, health staff performance was evaluated based on OPD visits. Individual patient records should be analyzed to fully evaluate the quality of HTN service provision, as appropriate practices for HTN patients vary between the first and subsequent visits. In addition, BP screening should be conducted for all OPD patients, and HTN medications should be prescribed for all patients diagnosed with grade 2 HTN or higher according to the Zambian treatment guidelines. Therefore, the staff performance of these practices could be evaluated by the OPD visit history, regardless of the first visit or revisit status. In addition, only visits by patients diagnosed with grade 2 or 3 HTN were evaluated for the provision of HTN medications, as the unavailability of individual histories made it difficult to judge compatibility with treatment criteria among patients with grade 1 HTN.

Fourth, the duration of the study was only eight months. While the samples of OPD visits were sufficient for the analysis of staff performance to assess the short-term effects of training on the capacity to manage HTN, the study was not long enough to observe follow-ups for patients diagnosed with HTN, and to evaluate the durability of training effects. A longer study period is necessary to develop more effective strategies to strengthen HTN services from a long-term perspective. However, we found that the improvement of HTN practice was not sufficient even four months after pre-intervention, including the prescription of medications for grade 2 & 3 HTN and unnecessary medication for people with normal BP. We believe that these findings could be useful when considering the points of emphasis during the training for HTN. In addition, cost analysis, including intervention costs, was not considered because the intervention effects were evaluated only for the first four months post-intervention. Post-intervention incremental costs could be lower, if the follow-up period is longer.

Fifth, the unit-cost data obtained from previous research had several limitations, including missing data and small sample sizes. We found that the MSL Catalogue prices were lower than the market prices. A unit cost survey should be conducted using larger samples in Zambia to improve generalizability, and the results of the present analysis may require adjustment if the unit cost data change in the future.

Finally, this study did not evaluate the effectiveness of HTN treatment on patients' clinical presentations, such as BP level, complications, and mortality. Geldsetzer *et al.* (2019) evaluated health system management performance for HTN in 44 low- and middle-income countries using an HTN care cascade, including HTN

diagnosis and HTN treatment, and the final indicator for evaluating performance was the outcome of treatment to control HTN. The clinical effects need to be scrutinized for different HTN risks. To truly evaluate the cost-effectiveness of HTN interventions, further studies should utilize data on clinical effects together with the costs and utility values for mathematical modeling (*e.g.*, a Markov model). The aim should be to project HTN management costs and secure utility values in the Zambian setting to arrive at policy implications for NCD strategies at the primary level, similar to Robberstad *et al.*'s study on the cost-effectiveness of HTN in Tanzania (*27*). Furthermore, although there are evidence-based clinical guidelines for HTN in Zambia, the sustainability of local-level applications is challenging due to limited resources to ensure quality services. Therefore, cost-effective health system modifications, such as integration with other chronic diseases, such as HIV, should also be addressed, similar to those introduced by Gimbel in Mozambique (*28*).

Conclusion

This study used medical records to investigate the staff performance in delivering HTN services at health facilities in rural Zambia. The rate of adherence to standard clinical practices among health staff at the target sites increased after the implementation of interventions, that included training and procurement of necessary medical devices. However, the quality of HTN services, including risk screening and pharmacological treatment, can be improved. To improve and sustain the quality of their performance, program managers should consider additional interventions, such as periodical training, mentorship, and online education.

The estimated monthly cost of HTN services was $2,643 for the target district, post-intervention. As most of the expenditures were fixed costs covered at the national level, the district-level costs amounted to $69.53. Therefore, when implementing interventions, policymakers should secure a budget to cover the costs of HTN services based on the results of research to improve the performance of clinical practices for HTN at the facility level. However, a large proportion of the population in need of HTN medication did not access any health facilities during the study period, indicating that, outreach to improve community awareness of HTN is necessary to increase access to HTN services among eligible individuals. Further investigation is necessary to examine the expected effects and costs for providing HTN services.

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