Variability in Hypertension Management and Data Capture Capacity in Primary Health Care Centers in the Federal Capital Territory of Nigeria

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Abstract:

Background: Elevated blood pressure (BP) is a leading risk factor for cardiovascular disease (CVD) morbidity and mortality in Nigeria. The Transforming Hypertension Management in Nigeria (HTN) Program aims to adapt, implement, and evaluate the effectiveness and implementation outcomes of a 5-year system-level hypertension control program in 60 primary healthcare centers (PHCs) in Nigeria. Due to the large scale of the HTN Program, PHCs may have different access to equipment, diagnostic and treatment capacity, as well as data capture capacities. Therefore, this project aimed to 1) evaluate and compare service availability and readiness across PHCs; and 2) monitor and report on baseline data entry errors from each PHC in the hypertension registry.

Method: Site readiness and capacity was evaluated using the Service Availability and Readiness Assessment (SARA) methodology of the World Health Organization. Patient level data were extracted from the HTN Program patient registry, which is a longitudinal REDCap database. Graphical representations are used to assess the facility-based capacity and readiness for hypertension diagnosis and treatment. Tables were created to list records with various data entry errors at baseline for each site.

Results: Across six council areas within the FCT, there was variability in the presence of basic amenities, equipment, infection prevention, diagnostic capacity and essential medicines. Cardiovascular service availability was consistently high, whereas wide variability was also demonstrated in indicator scores for the presence of guidelines, equipment, and medicines. Missing data and mismatched record Ids are the most common data entry errors across all sites. Variability in the frequency and type of data entry errors exists across sites.

Discussion: While service availability and readiness was overall sufficient in the FCT, variability in the hypertension treatment cascade and data capture capabilities exists across primary healthcare centers. Consistent staff trainings and feedback on service implementation and electronic data capture is critical to effective hypertension monitoring, control and treatment.

Background:

Elevated blood pressure (BP) is a leading risk factor for cardiovascular disease (CVD) morbidity and mortality in Nigeria. Based on the definition of systolic blood pressure ≥140 mm Hg or diastolic blood pressure ≥90 mm Hg, the prevalence of hypertension among Nigerian adults ≥40 years old was 44.9% in 2013.[1] A meta-analysis of 27 studies in 2015 found a lower prevalence of 28.9% for all Nigeria adults, including 29.5% among men and 25.0% among women.[2] Although the burden is high, hypertension awareness (18.5%), treatment (<20%) and control (9%) rates in Nigeria are very low.[3] Further, geographical variation in hypertension awareness, treatment and control exists.

The National Heart, Lung, and Blood Institute-funded Transforming Hypertension Management in Nigeria (HTN) Program aims to adapt, implement, and evaluate the effectiveness and implementation outcomes of a 5-year system-level hypertension control program in 60 primary healthcare centers (PHCs) in the Federal Capital Territory of Nigeria. The HTN Program is co-led by investigators at University of Abuja Teaching Hospital and Northwestern University and is aligned with the Nigerian Federal Ministry of Health priorities and World Health Organization's HEARTS technical package and includes 5 key components: 1) registry for patients with hypertension, 2) monthly quality reports from each PHC, 3) simplified treatment guidelines, 4) use of fix-dose combinations, and 5) non-physician follow-up 2 to 4 weeks after medication change. The primary effectiveness outcomes of the program are 1) change in monthly hypertension treatment rates and 2) change in monthly hypertension control rates in all 60 participating PHC sites.

To create a culturally-and contextually-adapted intervention package and to assess the readiness and capacity for adaptation, implementation, and evaluation at the selected primary

health centers, brief surveys were administered to the selected primary health center administrators to assess "readiness and capacity" based on Service Availability and Readiness Assessment (SARA) methodology of the World Health Organization. The SARA tool was designed to assess health facilities availability of services and readiness to offer the services to inform evidence-based decision in the planning and management of the health systems.[4] The SARA tool generates a set of core indicators on key inputs and outputs of the health system, which can be used to measure progress in health system strengthening over time.

Further, baseline data collection of the HTN study started a few months after the SARA data collection. Due to the large scale of the HTN Program, PHCs may also have variable numbers of health professionals, access to equipment and information systems, and data entry clerk capacities at baseline. It may also take time for staff to adjust to the REDCap database and electronic data capture. It is important to track and report on data entry errors and missing items at the beginning of baseline data collection to ensure data safety and quality of the hypertension registry.

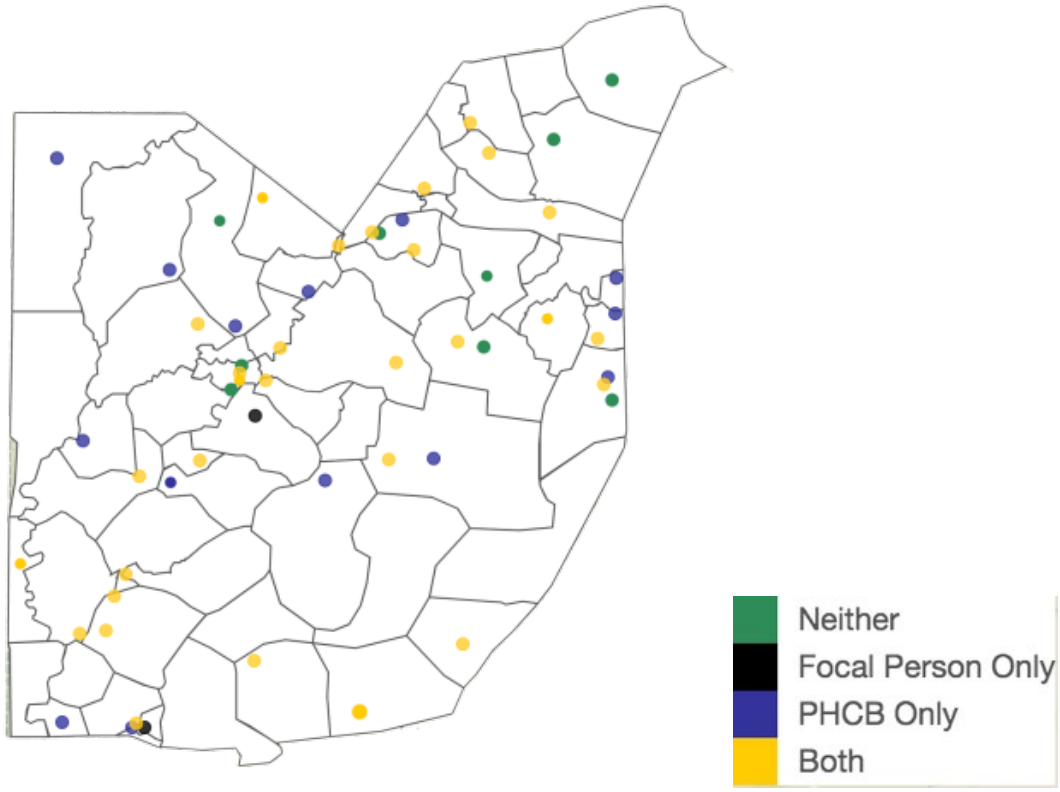
If we could identify primary healthcare centers with different levels of services availability and readiness, as well as different learning curves to electronic data capture, modified site management plans and data quality reporting systems could be developed to cater specifically to different types of sites in the HTN study. Therefore, this Culminating Experience project aimed to 1) evaluate and compare site capacity and service availability and readiness through the SARA tool; and 2) monitor and report on baseline data entry errors from each site in the hypertension registry.

Methods:

Site Selection:

A multi-stage sampling process was used to select these PHCs. The goal was to select PHCs located in different wards in the Federal Capital Territory of Nigeria so that each geographical region could be represented. Out of the 234 PHCs in 62 wards, 90 PHCs in 11 wards were excluded from the sample due to lack of road access (n=6), insufficient full-time staff (n=77), termination of business (n=1), or security concerns (n=6). A three-step sampling process was applied to the remaining 153 PHCs in 51 wards. First, 37 PHCs with a ward designated focal person were identified and 36 PHCs were randomly selected to represent 36 wards. In the remining 15 wards without a focal person, 1 site per ward (n=15 PHCs) was randomly selected to be included in the sampling frame. At this point of the sampling process, 51 out of 60 PHCs were successfully selected. The remaining 9 PHCs were randomly selected from 3 larger wards to represent geographic population density. Among 60 participating PHCs, 36 have a focal person, a healthcare worker with responsibility across the ward, and 34 are sites of interest to the Federal Capital Territory Primary Health Center Board as target facilities for investments to achieve universal health coverage.

Figure 1. Selected Primary Health Care Centers within the Federal Capital Territory



Data Source:

SARA:

The SARA tool has three main areas:1) service availability, 2) general service readiness, and 3) service-specific readiness.[5] More specifically, the SARA tool includes 13 domains under these 3 areas: 1) service availability, 2) patient access, 3) staffing capacity, 4) infrastructure, 5) basic client amenities, 6) infection control, 7) healthcare waste management, 8) clinical mentoring, 9) basic equipment, 10) available services with respect to non-communicable diseases and diagnostics, 11) supply chain, 12) medicines and vaccines, and 13) commodities. The HTN study adapted this SARA tool and created a REDCap database to collect and store

SARA data from each PHC. SARA assessments were completed at all (n=60) PHCs between May 2019 and October 2019. Capacity and readiness data were extracted from the database.

HTN Program Patient Registry:

Data on the 60 selected PHCs were extracted from the HTN Program patient registry, which is a REDCap database that collects longitudinal data on the following areas: PHC facility information, patient demographics, medical history, diagnosis and co-morbidities, pregnancy, hypertensive medication at baseline, blood pressure, hypertensive medication prescribed, access to counseling services (on smoking, drinking and diet), lab values, and adverse events. Blood pressure, pregnancy status, medications, counseling, medical adherence and adverse events will be collected at baseline and every time a patient comes into the clinic in the future, while other information will only be collected at baseline. For each visit, blood pressure will be measured using a blood pressure apparatus, which may be digital or manual sphygmomanometer with stethoscope. Blood pressure will be measured 2 times, and the average of the two will be taken as the final value to be evaluated for hypertension control. Patient demographics, medical history, diagnosis and co-morbidities, pregnancy status, access to counseling services (on smoking, drinking and diet), and medical adherence will be self-reported. Lab values will be measured through standard lab techniques. Data collection in this registry started in January 2020 and will continue until the end of the HTN project. Data used for this culminating experience project was extracted in April 2020.

Inclusion Criteria:

The HTN Program has 4 patient eligibility criteria for the hypertension patient registry: (1) >2 hypertension diagnoses listed in primary care visits in the past 2 years, (2) >1 primary care hypertension diagnoses and >1 hospitalizations with a primary or secondary hypertension diagnosis in the prior 2 years based on history, (3) >1 or more primary care hypertension diagnoses and >1 or more prescriptions for hypertension medication within the prior 6 months based on history, or (4) >1 primary care hypertension diagnoses and >1 or more stroke-related hospitalizations or a history of coronary heart disease, heart failure, or diabetes mellitus based on self-report.[6]

Statistical Analysis

Service Availability and Readiness:

Graphical representations are used to assess the facility-based capacity and readiness for hypertension diagnosis and treatment based on the SARA data. Readiness and capacity were assessed based on domains of interest including personnel, service delivery in the hypertension treatment cascade, equipment and supplies, information systems, and blood pressure lowering medications. Indicator scores for general and cardiovascular service readiness were each calculated as the proportion sites with available amenities, equipment, diagnostic tests, or medicines within a defined question bank. Continuous measures are summarized by mean and standard deviation, or median and interquartile range if non-parametrically distributed.

Data Safety and Quality:

Individual data entry error reports were created for each site to list errors such as patient ID mismatch, wrong registration date, missing demographic information, miss blood pressure

data, and missing pregnancy information (for female participants). The record ID, council area, site number, patient number and error message were printed out for each type of error so that data entry staffs could promptly identify and correct the mistakes. SAS version 9.4 (SAS, Cary, NC, USA) and R version 3.5.1 (R Foundation, Vienna, Austria) were used for statistical analysis.

Results

Service Availability and Readiness:

Across six council areas within the FCT, there was variability in the presence of basic amenities, equipment, infection prevention, diagnostic capacity and essential medicines (**Table 1A**). Cardiovascular service availability (**Table 1B**) was consistently high, whereas wide variability was also demonstrated in indicator scores for the presence of guidelines, equipment, and medicines. The Bwari area council consistently had the highest indicator score across general and cardiovascular domains, ranging from 12.5% for essential medicines, to 100% for basic equipment and service availability. Essential medicines scores, based on availability of CCBs, Aspirin, Beta Blockers, ACE-Is, Statins, or Thiazides, were low on average in comparison to other domains, and extremely low for hypertension medicines only.

Table 1A. General Service Readiness Indicators

Area Council	Number of PHCs	General Service Readiness[1]				
		Basic Amenities[2]	Basic Equipment[3]	Infection Prevention[4]	Diagnostic Capacity[5]	Essential medicines[6]
Abaji	8	52.1	67.5	93.8	59.4	6.3
AMAC	15	48.9	80.0	56.7	83.3	24.4
Bwari	8	56.3	100.0	81.3	90.6	29.2
Gwagwalada	11	43.9	70.9	68.2	61.4	13.6
Kuje	8	41.7	57.5	75.0	62.5	6.3
Kwali	10	28.3	74.0	90.0	62.5	5.0

1. Each indicator is calculated as the proportion of amenities, equipment, diagnostic tests, or medicines within a defined question bank.

2.The item "Room with auditory and visual privacy for patient consultations" was not included.

3. The item “Child scale” was not included.

4. The items “Safe final disposal of infectious wastes”, “Appropriate storage of sharps waste”, “Appropriate storage of infectious waste”, “Disinfectant”, “Single use —standard disposable or auto-disable syringes”, “Soap and running water or alcohol-based hand rub” and “Latex gloves” were not included.

5. The items “Malaria diagnostic capacity”, “HIV diagnostic capacity”, “Syphilis rapid test” and “Urine test for pregnancy” were not included.

6. Only the items "CCB", "Aspirin", "Beta Blockers", "ACE", "Statin" and "Thiazide" were included.

Table 1B. Cardiovascular Disease Service Availability and Readiness Indicators

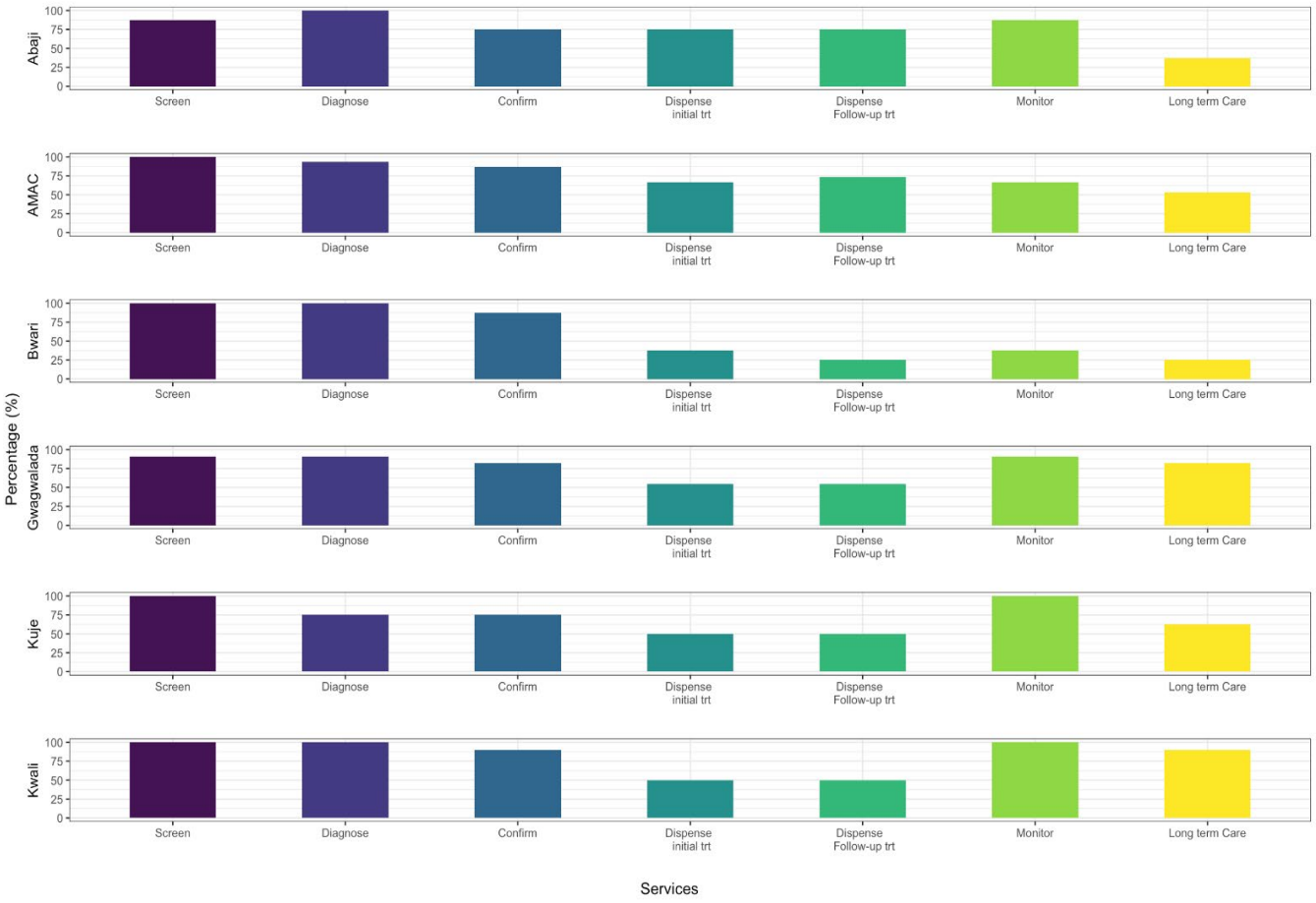
Area Council	Number of PHCs	Service Availability[1]	Service Readiness[2]		
			Guidelines[3]	Equipment[4]	Medicines[5]
Abaji	8	100.0	12.5	70.9	7.5
AMAC	15	100.0	6.7	84.4	28.0
Bwari	8	100.0	0.0	100.0	30.0
Gwagwalada	11	100.0	0.0	69.7	16.4
Kuje	8	87.5	0.0	66.7	7.5
Kwali	10	90.0	20.0	73.4	6.0

1. Percentage of facilities offering cardiovascular disease diagnosis and/or management.
2. Each indicator is calculated as the proportion of amenities, equipment, diagnostic tests, or medicines within a defined question bank.
3. Only the item “guidelines for diagnosis and treatment of chronic cardiovascular conditions” was included.
4. Only the items “Stethoscope”, “Blood pressure apparatus” and “Adult scale” were included.
5. Only the items "CCB", "Aspirin", "Beta Blockers", "ACE" and "Thiazide” were included.

Across six council areas within the FCT, there was also variability in the hypertension treatment cascade, which includes hypertension screening, diagnosis, confirmation, dispense of initial treatment, dispense of follow-up treatment, monitoring and long term care. Most PHCs in all council areas provide hypertension screening and diagnosis services and are able to confirm a hypertension case. However, while around 75% of PHCs in the Abaji and AMAC council area are able to dispense initial treatment, around 50% do so in the Gwagwalada, Kuje, and Kwali council area, and only 25% the do so in the Bwari council area. The Abaji council area also has the highest proportion of PHCs that dispense follow-up treatment, and the Bwari council area also has the lowest proportion. The Kuje council area has the highest proportion of PHCs

monitoring hypertensive patients, while Bwari council area has the lowest proportion. The Gwagwalada council area has the highest proportion of PHCs that provide long term hypertension care, while the Bwari council area continues to have the lowest proportion.

Figure 2. Hypertension Treatment Cascade by Council Area



Data Safety and Quality:

Figure 3 shows a few examples of data entry errors in facility and patient identifiers. The registry ID for each patient consists information on the council area, site number, and patient number. The error message "ID does not equal registry information" is returned when there is a mismatch between the ID and council area number, site number, or patient number. The format

and length of the registry ID are also checked. The error message “Error in ID” is returned when the length of registry ID does not equal to 14 characters.

Figure 3. Sample Data Entry Errors in Facility and Patient Identifiers

Data Entry Error in Facility and Patient Identifiers

id	unique_id	council_area	site_id	patient_number	patient_id	error
FCT/03/08/0006	FCT/03/08/0006	3	8	6		ID does not equal registry information;
FCT/03/08/0008	FCT/03/08/0008	3	8	8		ID does not equal registry information;
FCT/03/08/0010	FCT/03/08/0010	3	8	10		ID does not equal registry information;
FCT/03/08/0014	FCT/03/08/0014	3	8	14		ID does not equal registry information;

id	unique_id	council_area	site_id	patient_number	patient_id	error
01060095	01060095	1	6	01060095	FCT/01/06/0095	Error in ID; ID does not equal registry information;

Errors in facility in facility and patient identifiers are quite frequent across all sites. The most common error is the mismatch between registry ID and registry information.

Figure 4. shows a few examples of errors in registration dates. The most common error is missing registration date. In this case, the error message “Registration Date Missing” is returned. Further, registration date is also compared with current date and date of baseline data collection initiation to identify potential errors in date entry. For instance, the error message “Registration date is in the future” is returned when the registration date is ahead of the date the data safety and quality report is updated.

Figure 4. Sample Data Entry Errors in Registration Date

id	registration_date	dateError
01060090	2020-05-21	Registration date is in the future

Data Entry Error in Registration Date

id	registration_date	dateError
FCT/02/02/0015	NA	Registration Date Missing

Figure 5 shows a sample of errors in data access groups. Each site was assigned to a unique data access group number, so that staff from each site could only access information on the respective site. This data access group number is essential to data safety. Results show that many sites have not been assigned a data access group number at baseline. Data entry staff should go back to the database and assign a number to the record. Further, the error message "Access Group Does not Match Facility Information" is returned when the data access group number does not match council area number or site number. For instance, the data access group number may indicate the record belongs to site 01, but the site id of the record is 05. This mismatch is tabulated so that data entry staff could go back to the database and investigate what happened.

Figure 5. Sample Data Entry Errors in Data Access Groups

Data Entry Errors in Data Access Groups

id	unique_id	redcap_data_access_group	council_area	site_id	patient_number	dagerror
01060085	FCT/01/06/0085		1	6	0085	Not Assigned to A Data Access Group
01060087	FCT/01/06/0087		1	6	0087	Not Assigned to A Data Access Group
01060090	FCT/01/06/0090		1	6	FCT/01/06/0090	Not Assigned to A Data Access Group
01060095	01060095		1	6	01060095	Not Assigned to A Data Access Group
02010001	FCT/02/01/0001		2	1	0001	Not Assigned to A Data Access Group
02010006	FCT/02/01/0006		2	1	0006	Not Assigned to A Data Access Group
02030072	FCT/02/03/0072		2	3	0072	Not Assigned to A Data Access Group
02030097	FCT/02/03/0097		2	3	0097	Not Assigned to A Data Access Group
FCT/06/01/0005	FCT/06/01/0005	fct0601_ashara_phc	6	5	5	Data Access Group Does not Match Facility Information
FCT/06/01/0006	FCT/06/01/0006	fct0601_ashara_phc	6	5	6	Data Access Group Does not Match Facility Information
FCT/06/01/0007	FCT/06/01/0007	fct0601_ashara_phc	6	5	7	Data Access Group Does not Match Facility Information

Figure 6 shows a sample of data entry errors in demographic data, including gender, education level, height, smoking, and alcohol use. Records missing any one of these data points are listed. Many records have missing height and education information.

Figure 6. Sample Data Entry Errors in Demographic Data

id	sex	education	height
02010001	2	NA	NA
02010006	1	7	NA
02030072	2	NA	152.0
03010049	2	NA	160.0
03010052	2	5	NA
FCT/01/01/0001	1	7	NA
FCT/01/01/0007	1	5	NA
FCT/01/01/0008	1	1	NA
FCT/01/01/0014	2	NA	178.0

Figure 7 shows a sample of data entry errors in pregnancy data. The error message "Male gender selected in baseline form" is returned if the sex variable equals "1" but pregnancy information is provided. If the sex variable equals "2" but no pregnancy information is provided, the error message "Missing pregnancy at Registration" is returned. Date mismatches are also listed if the delivery date is before registration date.

Figure 7. Sample Data Entry Errors in Pregnancy Data

Errors in Pregnancy Data

	id	sex	registration_date	pregnant_reg	delivery_date	pregnanterror
15	05050014	1	2020-03-23	NA	NA	Male gender selected in baseline form
31	FCT/01/03/0001	1	2020-02-21	NA	NA	Male gender selected in baseline form
34	FCT/01/03/0005	1	2020-01-24	NA	NA	Male gender selected in baseline form
66	FCT/01/06/0074	1	2020-03-11	NA	NA	Male gender selected in baseline form
70	FCT/01/08/0010	2	2020-02-12	NA	NA	Missing Pregnancy at Registration Data
73	FCT/01/08/0015	2	2020-02-21	NA	NA	Missing Pregnancy at Registration Data
75	FCT/01/08/0016	2	2020-02-28	NA	NA	Missing Pregnancy at Registration Data
78	FCT/02/02/0005	NA	2020-03-11	NA	NA	Gender Missing
79	FCT/02/02/0006	1	2020-03-12	0	NA	Male gender selected in baseline form
101	FCT/02/05/0012	2	2020-03-11	1	2020-02-22	Date Mismatch
106	FCT/02/08/0002	2	2020-02-13	1	2020-01-29	Date Mismatch

Discussion

While service availability and readiness was overall sufficient in the FCT, variability in the hypertension treatment cascade and data capture capabilities exists across primary healthcare centers. This project identified the need to provide treatment guideline, health worker training, hypertension medication supply, and consistent data entry feedback to the participating sites to improve hypertension control as well as data safety and quality. Across all council areas, more than half of the sites have general readiness in the domain of basic equipment, infection prevention, and diagnostic capacities. However, many sites do not have general readiness in the domain of basic amenities and essential medicine. Most sites provide hypertension screening and diagnosis services and are able to confirm a hypertension case. However, the ability to dispense initial treatment and provide long term care varies by council area. Service implementation trainings and sustained supply of hypertension medications will be needed for the successful implementation of the HTN study.

On the data safety and quality side, the number of data entry errors in registration id, registration date, and missing variables is high. This relatively high frequency of data entry errors is expected at the start of baseline data collection, as data entry staff are still adjusting to electronic data capture and the REDCap online database overall. Effective monitoring and identification of these errors are needed so that the staff could get prompt feedback on what errors to pay attention to and avoid similar mistakes in the future. There is variability in the number of data entry errors across sites. It is necessary to identify sites with the highest number of data entry errors and assess reasons behind these errors. Additional data capture trainings could be provided to these sites in order to avoid more errors in longitudinal data collection.

This project does have important limitation. First, only 60 sites with at least 2 full time staff were selected to participate in the study. This sampling frame may not accurately represent service readiness in the FCT as many sites in remote locations and limited staff were excluded. Second, the data entry error reports may not fully capture all errors in the database. Data entry staff may not be aware of these unreported errors and make more mistakes in the future. However, these reports are updated and examined on a weekly basis. It is easy and flexible to make changes to the reports to include more types of errors.

For future directions, more site-level audit and feedback reports will be created to summarize site operation, patient characteristics and primary outcomes. These reports will be emailed to each site on a regular basis to effectively monitor site performance and identify potential operational problems. These steps will be critical for the sustained implementation of the HTN study and effective hypertension control and management.

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