

Prototype Development for an Advanced Patient Registry to Support Collaborative Care for  
Common Perinatal Mental Disorders In Low and Middle-Income Countries

Chorkin Chau

A thesis

submitted in partial fulfillment of the  
requirements for the degree of

Master of Public Health

University of Washington

2020

Committee:

Ian M. Bennett

Pamela Collins

Program Authorized to Offer Degree:

Global Health

©Copyright 2020

Chorkin Chau

University of Washington

**Abstract**

Prototype Development for an Advanced Patient Registry to Support Collaborative Care for  
Common Perinatal Mental Disorders In Low and Middle-Income Countries

Chorkin Chau

Chair of the Supervisory Committee:

Ian M. Bennett

Department of Global Health

A large portion of maternal deaths are attributed to suicide, of which are related to the high rates of women affected by common perinatal mental disorders (anxiety and depression) globally. Within low and middle income countries, there are limited resources to provide adequate care for perinatal mental health, but the collaborative care model has been seen to address this problem by integrating the expertise of psychiatric consultants within primary care settings. Though it yet to be widely implemented in low-middle income countries, this study sought to understand how to adapt an advance patient registry-an essential component to the collaborative care model within two diverse settings: Ibadan, Nigeria and Can Tho, Vietnam. The study used a user-center design framework, Discover, Design, Build, and Test (DDBT) to draw insight from potential end-users of the registry to understand key functionalities, identify obstacles and facilitators of the registry use. Data was collected through interviews, focus group discussions and surveys from both contexts and responses were thematically coded in a qualitative analysis software. The results showed the value of the DDBT model in the design of the registry tool and identified the need patient centered care that incorporates routine assessments among different staff members within the clinic. Additionally, factors such as obstetric data, the inclusion of suicide risk assessment and the implementation of a risk management plan were also found to be important to include for common perinatal mental disorder care.

## Table of Contents

Introduction.....	1
Objectives.....	3
Methods.....	3
Discover.....	4
Design.....	5
Data Management .....	5
Results.....	5
Discover.....	6
Design.....	12
Discussion.....	16
Limitations.....	17
Conclusion.....	18
Works Cited.....	19
Appendix 1.....	22
Appendix 2.....	29

## **Introduction**

Perinatal mental illnesses are defined as psychiatric disorders that are prevalent during pregnancy and one year after delivery, these include any disorders that may have existed prior to pregnancy and have continued into this period.<sup>1</sup> The types of perinatal disorders include perinatal depression, postpartum anxiety disorders, postpartum psychosis (bipolar disorder), and postpartum blues (physical discomforts and symptoms that typically occur around the first week after delivery) which can evolve into postpartum depression. Depression<sup>2</sup> and anxiety<sup>3</sup> in pregnancy and the year postpartum are the most common disorders of this period and are defined more broadly as common perinatal mental disorders (CPMD). These mental disorders, especially when left untreated, have long-term negative impacts on the mother's wellbeing and contribute to an increased risk of suicide, a leading cause of maternal mortality.<sup>4</sup> The timing of the occurrence of symptoms and their severity of depression or anxiety vary highly,<sup>1</sup> but CPMD are prevalent- affecting nearly 20% among women who recently gave birth in low and middle-income countries (LMICs).<sup>5</sup> Despite its high burden in LMICs, the amount of mental health funding is often limited, with most ministries devoting less than 1% of their health budget towards mental health care.<sup>6</sup>

Oats et. al found that 28% of maternal deaths were due to suicide and recommended routine and systematic and routine assessments of psychiatric history within all settings where maternal services are provided in order to address the major gap in care for CPMDs.<sup>5</sup> Evidence-based models of primary care-based mental health service delivery, where most mental health care is provided in high-income countries, exist but are not widely implemented in LMICs.<sup>6</sup> The collaborative care model (CoCM; Figure 1) is effective in the management and treatment<sup>7,8,9</sup> of people with common perinatal mental disorders, and has also been tested in low-resourced settings including in LMICs.<sup>10</sup> The CoCM involves integrating communication and support systems from prenatal provider staff (including midwives, obstetricians, primary care physicians, and nurses) and psychiatric consultants. An essential component of CoCM is a patient registry, in which patients are monitored and managed in a central system that can be accessed by these key providers within the team through weekly systematic case reviews. It allows proactive treatment adjustments with the input of mental health specialists. The specialists, often a psychiatric consultant, are able to review a large number of cases within a limited amount of time. The model has been shown to be particularly helpful in settings in which there are few psychiatrists available for effective management and care for patients with chronic conditions such as depression and other mental disorders.<sup>11</sup> This technology aligns with the need for health informatic systems at multiple levels of care, as outlined in the World Health Organization's report on standards for country health information.<sup>12</sup>

Vietnam and Nigeria are two LMICs with distinct health care and cultural contexts that impact the care of CPMD. Vietnam has an alarmingly high prevalence of depressive symptoms among women; in Ho Chi Minh city a study of over 500 women found that 33% had elevated depression symptom scores and 19% acknowledged suicidal ideation.<sup>13</sup> Within the country, only two percent of primary healthcare doctors receive training devoted to mental health care, and the majority (51-80%) of physicians made at least one referral per month to a mental health professional.<sup>14</sup> Similarly, in Nigeria, there are only about 200 psychiatrists for its population of 170 million, most of whom work in urban areas.<sup>15</sup> This is common in other LMICs, where the vast majority of those that are not in the larger cities have little to no access to a mental health

specialist. There is clearly a need for more mental health support as the prevalence of mental disorders continues to increase, but there are few providers that can serve their needs, among several other barriers such as insufficient funding within health budgets.<sup>16</sup>

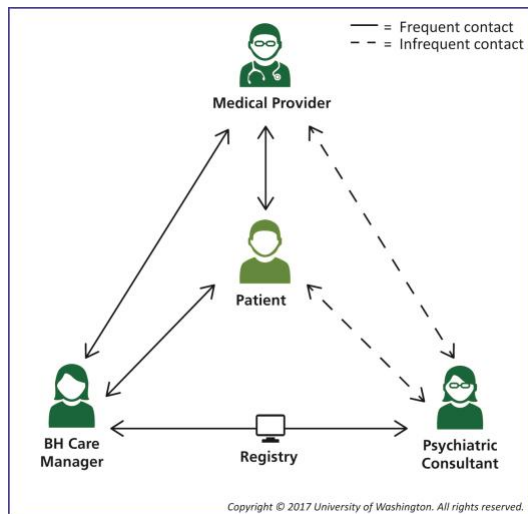


Figure 1. The collaborative care model depicting the roles and contact frequencies between the medical provider, behavioral health (BH) care manager, psychiatric consultant and registry in the care of the patient.

Figure 1 illustrates key elements of the collaborative care model (CoCM) for the management of common mental disorders.<sup>18</sup> The essential members within the CoCM include the medical provider, behavioral health (BH) care manager, psychiatric consultant, and patient. The patient registry is a central and essential component of CoCM for each team member to remain informed and engaged in the continual care and management of the patient. It is primarily used by the BH care manager and the psychiatric consultant and is used to facilitate the revision and communication about different patients who are part of the program, to

ensure they are receiving adequate attention and care. Registries and other similar forms of health information technology (HIT) have been critical in chronic care<sup>19</sup> and population-based care.<sup>20</sup> CoCM has yet to be well integrated into other LMIC settings, due to challenges such as limited health workforce and financing. However, the incorporation of tools such as a registry and collaboration among staff working at different levels of care offer opportunities for the general population to have access to a higher quality of care and also strengthen the overall health system of that setting.<sup>21</sup>

A spreadsheet-based prototype referred to as the *Patient Tracking Spreadsheet*, of an existing and well-tested registry in the U.S. (Caseload management tracking system or CMTS) developed by the AIMS center<sup>22</sup> is being used by clinicians in Ibadan, Nigeria. The prototype will be tested in Vietnam as part of an ongoing NIH funded implementation study (R21MH122345; PI Bennett), an effort to implement and adapt this tool and CoCM in diverse contexts. The study, “Happy Mom, Happy Home” (HMHH) or “Mẹ Vui Vẻ, Nhà Hạnh Phúc,” will adapt the CoCM for perinatal depression care in Can Tho, Vietnam in partnership with Can Tho University of Medicine and Pharmacy (CTUMP).<sup>23</sup> Can Tho is one of the largest cities on the Mekong Delta with approximately 2 million people and has been considered a “federally designated city” responsible for the public health of the surrounding regions (i.e., 20 million people). This thesis project is nested within HMHH and utilizes a mixed-method user-centered design (UCD)<sup>24</sup> approach to understand users, incorporate their feedback and insights from the teams in Nigeria and Vietnam will inform the building and testing of a registry tool that is being developed on a larger platform that will be piloted in both settings in a future study. Studying these contexts allows for an understanding of how both the CoCM and use of a registry could be adapted in settings that differ in health care models, workforce capacity, and technology to drive considerations and insights for implementation in other LMIC contexts.

## **Objectives**

This qualitative study sought to understand how to adapt a patient registry to provide care for CPMD in diverse LMIC settings. We recruited end-users in Ibadan, Nigeria and in Can Tho, Vietnam to identify obstacles (e.g. limited internet connection, staffing, and loss of follow up of patients) and facilitators to provide care using the *Patient Tracking Spreadsheet*. Data was collected through interviews, focus group discussions and surveys from both contexts to analyze how the CoCM and the registry component could be adapted in various settings in order to optimize its usability and acceptability of the next design and implementation of an upcoming prototype developed on the District Health Information Software 2 (DHIS2)<sup>25-27</sup> platform in an upcoming study. See Appendix 1 for a description of the selection of this technology platform. The insight from these two different contexts with diverse health systems allows for a greater understanding of different elements to be incorporated in the next iteration of the patient registry such that it can cater to the diverse needs and contexts globally. The study sought to identify the essential technical and design elements of a patient registry tool that can be used for CPMD management and treatment in LMICs.

## **Methods**

Methodologies from the traditions of user-centered design (UCD),<sup>28</sup> human-centered design (HSD),<sup>29,30</sup> and participatory design (PD)<sup>31</sup> were used to evaluate the implementation and evaluation of the registry prototype (V1.0) and its usability within the CoCM in the Ibadan and Can Tho clinics. This informed the future designs of a health information technology tool that can be used in LMICs and other low resource settings broadly. Since UCD, HSD, and PD traditions are related and complementary approaches UCD will be the term used from this point on to encompass their varying elements. UCD contributes to higher usability through involving end-users not just intermittently as user testers but throughout the development process such that “technology support tasks are easy to operate, and are of value to the users” by incorporating their stated and observed needs, concerns, and suggestions.<sup>32</sup> The frameworks and design approaches are added into the modified conceptual model, (Figure 2) and support the needs of diverse communities, the innovation of new tools, and the implementation of existing evidence-based methods to manage patients with chronic conditions such as depression. This approach engages end-users in the process of developing the tool itself, to ensure their thoughts, ideas, and opinions are considered and incorporated into the product.

The Discover, Design, Build, and Test (DDBT) framework<sup>33</sup> incorporates the UCD methodology and serves as a design model to guide the development of technology solutions that have been defined by the community in which it is to be implemented. The DDBT framework is designed to help “develop scalable and efficient implementation strategies (eg, training tools), modify existing EBPIs [evidence-based psychosocial interventions] to enhance usability, and create usable and non-burdensome decision support tools for quality delivery of EBPIs.”<sup>18</sup> This framework has been modified to include the elements of PD with end-users involved throughout the development and the refining process of a technology tool in order to increase the likelihood of creating a sustainable system in caring for patients.<sup>34</sup> In the HMHH project, the incorporation of a participatory design team is composed of potential “users” of the registry, who are part of the process at every step through the different project phases and development of the registry tool. See Appendix 2 for the project timeline.

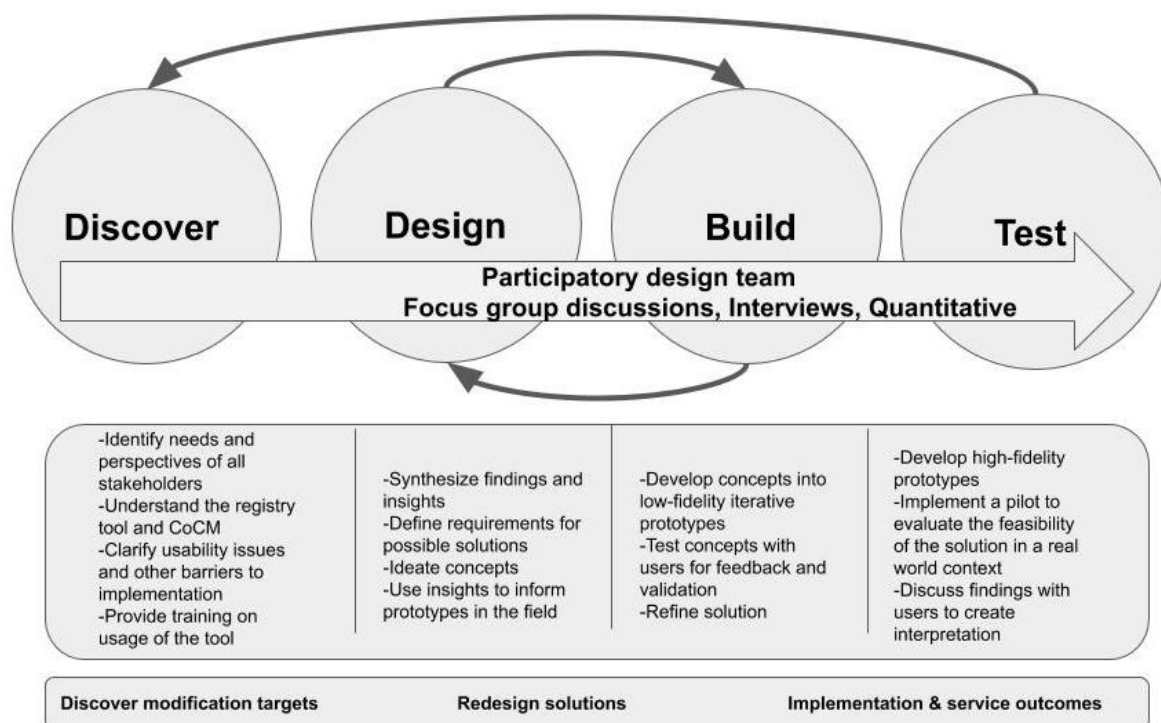


Figure 2. The model above is a modified version of the original DDBT framework to develop the registry tool and includes the component of the participatory design team who are involved throughout all the phases of development.

## Discover

In both settings, the “Discover” phase was undertaken by gathering information about the context, including staff roles and work settings. Information about the first version of the Patient Tracking Spreadsheet, a registry prototype (V1.0), and its usability was collected in the Ibadan context, where it has been used in clinical settings during the past two years. Data were collected through written structured questions that were answered by the primary users of the spreadsheet (the psychiatric consultant and the depression care manager) and virtual meetings were held to discuss their responses and ask relevant follow-up questions. In addition to the meetings and responses to the structured questionnaires, the system usability scale (SUS)<sup>35</sup> was used through an online survey to assess the usability of the spreadsheet to review the caseload of patients through in-person weekly meetings between the depression care manager (DCM) and psychiatrist consultant. The SUS scores obtained were assessed based on the standard scale of usability.

Since the prototype has yet to be implemented in the Can Tho clinics in Fall 2020, the “Discover” phase is still underway in Vietnam. In preparation for the prototype testing, information about the Vietnamese context and potential users were gathered through focus groups (FG) and individual discussions with members designated as the participatory design team. There were two semi-structured focus group discussions and two semi-structured interviews conducted by the researchers at CTUMP in a commune health center (CHC) in Can Tho. In these FGs, 6-7 health workers and 4 lay health workers (also called collaborators) were involved through selective sampling based on their roles at the health center and in the community. The first FG covered topics about each person’s role, what is currently done to manage depression, and the CoCM. In the second FG, the topics of depression and the CoCM were further elaborated and possible challenges of screening patients in the community were also

identified. All participants were assigned a number and were described by their current position to ensure the confidentiality of their identities. The interviews also included semi-structured questions and were conducted by the research staff at the university. The interviewees were the chief physician of the CHC and a collaborator. The FG discussions and interviews were recorded on a tape recorder, transcribed in Vietnamese, and translated into English by the CTUMP research team.

## Design

In taking into consideration the data gathered in the previous “Discover” phase in Ibadan, the Design phase incorporated the feedback about the prototype (V1.0) into future iterations of the patient registry (both which are based on the spreadsheet software and on the DHIS2 platform) that will be implemented in Vietnam and other LMICs. Other insights about the usability of the spreadsheet are directly informing the modifications and adjustments that are being made to the second version of the prototype (V2.0) that will be tested in Can Tho during the upcoming pilot in the next phase of the study.

## Data management

All transcriptions and responses from participants were stored in a shared cloud folder, which could be accessed by other team members on the project. They were uploaded and analyzed in the Dedoose, a qualitative analysis software. On Dedoose, codes were created, and memos were written to analyze the data and take note of follow-up questions and important ideas. The memos were then compiled into a summary document in another shared cloud folder. This document contained memos written in Dedoose and contained summaries drafted based on major themes and the analysis done up to that point. The summaries drew insights for the discussion in the final thesis.

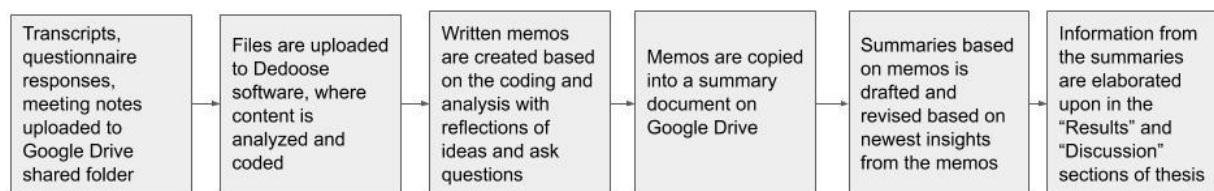


Figure 3. Flow chart of data management

Through inductive coding, several themes from the two contexts were identified. In Nigeria, the usability and challenges of using the patient tracking spreadsheet were assessed to understand the context and identify essential functionalities of the registry used during their trial. The themes of workflow and use of technology within each context gave insight about the potential users and considerations for the development of the next iteration of the registry prototype (V2.0).

## Results

Data was collected from surveys, interviews and focus groups and transcripts and memos based on such data were created in Dedoose. Information about the use of the prototype and CoCM model in Nigeria were from the discussions and surveys with the DCM and the psychiatric consultant. In Vietnam, data were derived from two focus group discussions with several members of the participatory design team and interviews with the CHC director and a

health collaborator. Summaries based on the memos created from data in the transcripts were then written and used in the analysis.

## **Discover**

### *Workflow and use of the Patient Tracking Spreadsheet in Ibadan, Nigeria*

Patient Tracking Spreadsheet prototype (V1.0) was used at 4 clinics in Ibadan during the past two years. In total, there were approximately 120 patients on the registry, with about 90 patients who have completed treatment for their perinatal depression. This number excluded those who dropped out of the study or did not give consent to participate in the study. Patients were screened using the Edinburgh Postnatal Depression Scale (EPDS),<sup>36</sup> and if they scored above 10 and experienced impairment in functioning related to symptoms for at least two weeks. They were then added into the registry by the DCM. Cases with a score of 12 or above were automatically flagged and marked in red.

The DCM primarily worked with the nurses and midwives, to manage the patient's care throughout the program by linking patients to their provider at the clinic, reminding them of appointments, sitting in on their sessions, taking notes, keeping a record of their status in the depression intervention and EPDS scores, and inputting the data onto the registry. She then traveled to the psychiatric consultant's office on a weekly basis to review these notes and cases on the registry. Together, they discussed new patients, patients who visited the clinic for intervention appointments, any cases that need specific attention, and challenges encountered by the DCM in dealing with clinic staff.

The psychiatrist provided consultations and recommendations for various treatment plans for each case reviewed. These insights suggested what course of action should be taken for the patient and were relayed by the DCM to the nurses, midwives, and doctors. In addition to these scheduled in-person meetings, the DCM will also call the psychiatrist at other times throughout the week for cases that require urgent review or if the DCM is unsure of how to proceed. In the event of a more "challenging case" such as when a patient has severe depression but was not responding to her prescribed antidepressants, the DCM encourages the doctor to directly call the psychiatrist.

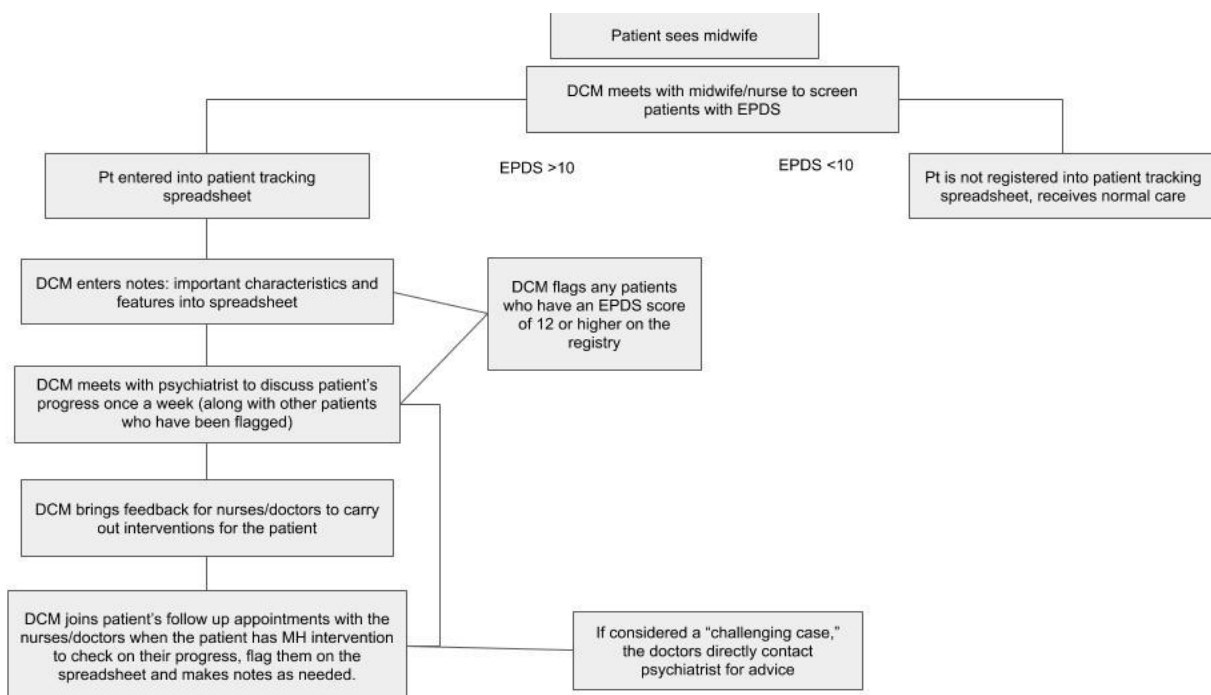


Figure 4. The workflow of how the depression care manager (DCM), primary care providers (nurses, midwives, doctors), and the psychiatric consultant care for a patient who is entered into the patient registry.

### *System Usability Scale for Prototype in Nigeria*

An online survey was conducted using the system usability scale (SUS)<sup>37</sup> questionnaire to assess the usability of the patient tracking spreadsheet by the primary users, the DCM, and the psychiatrist. The scores were calculated based on the method described in Brook's *SUS: A Quick and Dirty Usability Scale*.<sup>38</sup> The scores typically range from 0 to 100, with higher scores indicating higher usability.<sup>39</sup> The general average SUS score is 68.

The DCM's final SUS score was 75.5 and the psychiatrist's score was 75.

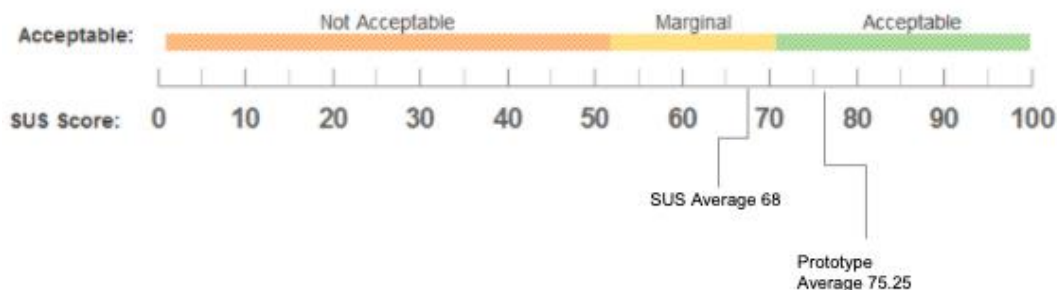


Figure 5. Range of SUS score and their associated definitions of acceptability.

This score indicates that the patient tracking spreadsheet (prototype V1.0) was found to be above average and “acceptable” in terms of its usability and acceptability. The individual scores from the DCM and the psychiatrist were similar for most questions though there was a slight difference in the last question “I needed to learn a lot of things before I could get going with [regularly use] the Patient Tracking Spreadsheet.” The DCM strongly agreed with this statement but the Psychiatrist disagreed, their contrast in responses to this question could be attributed to the DCM being the primary user for the spreadsheet and inputting data regularly

whereas the psychiatrist mainly reviewed the cases with the DCM. In addition to the SUS questionnaire, feedback regarding the spreadsheet usability was gathered through structured interview questions that were answered by the users and discussed in virtual meetings. Based on the insights from these meetings and the responses, both the DCM and psychiatrist were satisfied with the registry, as it helped with their workflow and as they felt it made their work organized to track patients and appointments. They also found the visuals to be helpful to easily identify patients who require urgent attention.

In addition, the users found the ability to take notes as a useful functionality, as it allowed for easier tracking of how the patient is responding and their progress within the counseling sessions. The registry also helped the providers keep track of follow up appointments, to ensure patients are being monitored and assessed at appropriate times throughout their treatment within the program.

### *Usability challenges*

There were a number of challenges raised by the team using the prototype, which may have impacted the overall usability of the tool. One of the challenges identified was the difficulty in creating follow-up appointment dates:

*“appointment dates are generated automatically by the registry when the patient is unable to keep that particular appointment, it is difficult to edit the registry to key in the new date, and subsequent dates are affected.”*(Lines 39-40, Discussion re Excel Use in Nigeria, Psychiatric Consultant)

The team also identified the lack of important variables about the patient’s obstetric information such as their estimated date of delivery (EDD) and date of birth (DOB):

*“We had difficulty with access to edit the registry to include other important variables for the project that the DCM needed to track such as date of birth to enable patient postnatal appointment (6 weeks after birth) be scheduled...”*(Lines 45-47, Discussion re Excel Use in Nigeria, Psychiatric Consultant)

Aside from the technical challenges of the prototype itself, there were some comments in regard to the accessibility of the tool, in which the users felt that it was inconvenient to have it only stored on the DCM’s laptop computer. This required the in-person case review meetings, which were not always kept if the psychiatrist is unavailable or traveling. The users suggested that it would be helpful to have remote access to the registry if it is available on a smaller device, such as a phone or tablet, and stored on a platform that could be accessed by users simultaneously.

### *The workflow in Can Tho, Vietnam*

In the ongoing Discovery phase, the study focused on the workflow among teams at the commune levels which are composed of staff at the CHC and the collaborators who are responsible for 150-250 households each within their community (also referred to as hamlets). The figure below shows the anticipated CoCM within this system, in which the CHC is where the PCP and care manager work together to manage cases that will be visited by collaborators in their respective hamlets. The psychiatric consultant, who will not be part of the CHC team, will be primarily communicating with the care manager to review cases in the program. This figure

can also be representative of Nigeria's context, with the exception that lay health workers (LHWs) are not part of their model.

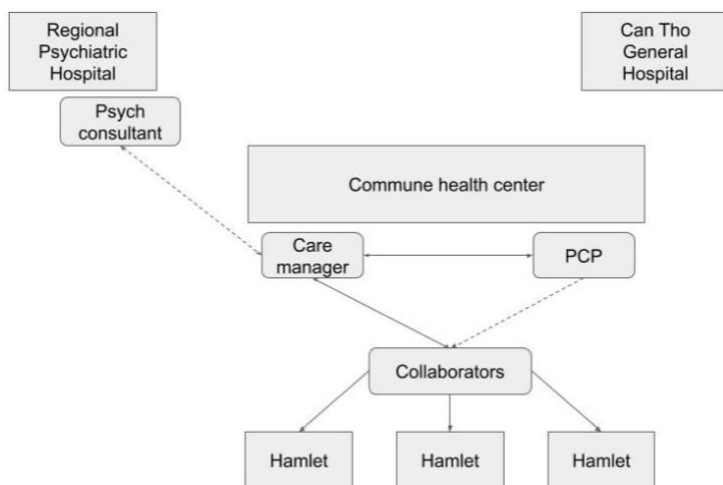


Figure 6. Overview of major healthcare infrastructures within the Vietnamese system.

Within the CHCs there are several different services provided such as administration of vaccines, medications, and routine care provided by the PCPs:

*“In general, people here have organized vaccination, obstetric gynecological examination as a routine care... We only manage... immunization for pregnant women and their children after that.”* (Lines 156-157, 160-

161 Field notes and transcriptions 1st FGD, CHC Director)

Midwives spend the most amount of time interacting with pregnant women at the clinics performing these different tasks;

*“that is only one person to talk with them in the center, other people do not have much time...”* (Line 424 Field notes and transcriptions 1st FGD, CHC Director)

The collaborators are an essential component of how care is delivered at the commune level, in that they are able to spend more time with the patients after they receive care at the center. They follow up with these patients regularly and are able to provide insight into the community as a whole

*“...Because the collaborator is a local, is also a key officer and has a good understanding of the local population and people...manages a population of fewer people. compared to the health station that manages an entire commune with many people...”* (Lines 530-534 Field notes and transcriptions 1st FGD, Doctor's Assistant)

Though not part of the original CoCM, the role that the collaborators have is a central part of the public health system at the commune level in Vietnam. They act as liaisons between the providers and patients and can serve the population of people who may not regularly access services at the health center.

When discussing the possible workflow and methods of screening and monitoring patients who would be part of the perinatal depression program, there were suggestions that initial screening for CPMDs would be conducted by the midwife (who would be considered as a potential care manager in CoCM) as part of their routine care. She would possibly serve as the care manager in this setting, and the collaborators would be following up with the patient in their communities.

*“Contacting households will be for collaborators. So, we contact periodically, by week by month... Collaborators will report to [the midwife], then...report to [the head physician of the CHC].” (Lines 803-805, Field notes and transcriptions 1st FGD, Doctor’s Assistant)*

Figure 7. The potential workflow of patients being assessed at the commune health center and followed up by collaborators from their respective community.

This workflow indicates that screening would be primarily done in the CHC as the patient is accessing their care, but the number of patients coming into the CHC may not be truly reflective of what the needs of the community are, therefore having screening done at the hamlet level by collaborators is an important consideration being made for this model.

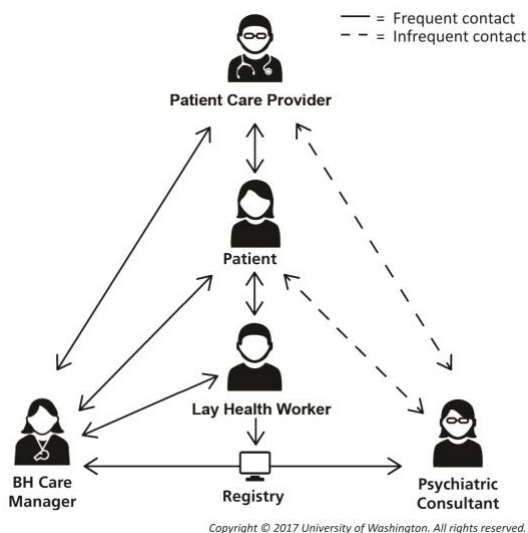
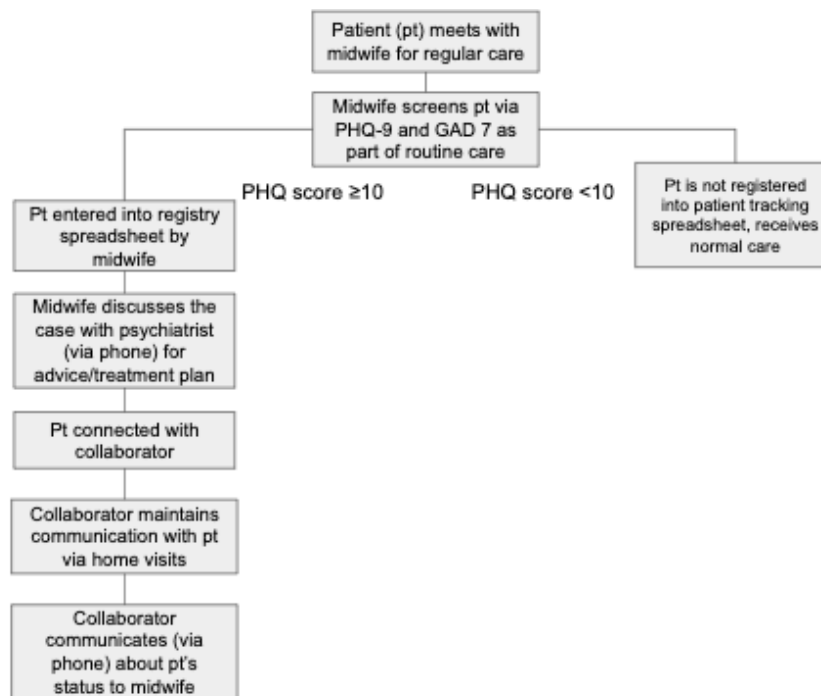


Figure 8. A modified version of the CoCM developed by AIMS Center at UW (see Figure 1) that includes the role of lay health workers (LHWs).

Figure 8 describes the potential way in which the CoCM could be adapted in contexts with lay health workers (LHWs) like Can Tho. They would be in frequent contact with the patient and their care manager and could contribute to the registry by inputting data from their screening of patients within their communities. Their inputs would then be reviewed by the care manager and the psychiatric consultant.

As a caveat regarding the current work in both Nigeria and Vietnam, the psychiatric consultant has been contracted from the partnered research university. The long-term goal dissemination will

require the use of psychiatrists that are part of primary care services within the existing public health model within each context. An ongoing exploration of how to support the staff fiscally and through training is still being conducted in these settings.

*Use of technology in Nigeria and Vietnam*

How technology is being used within these settings was an important aspect to explore within the Discover phase, as it determines ways in which the registry tool would be designed and implemented. In Nigeria, a smartphone video communication app (WhatsApp) was used by the primary users of the registry to maintain discussion and communication about the patients if the psychiatric consultant was traveling or unavailable for their typical in-person meetings. Phone calls were also made to patients by the DCM to remind them of their upcoming appointments, and in some cases, appointments with their providers were conducted over the phone. These phone discussions made it easier for both patients and providers and reduced missed appointments.

The main challenges of using phones were the limitation in network connectivity and electricity to charge devices that affected the patient's ability to be reached by their providers. This could be attributed to Nigeria's current broadband penetration being only at a rate of 37.8% within the population. Moreover, these connections are primarily through mobile broadband connections, which account for approximately 99.8% of the broadband base.<sup>40</sup>

These rates are much lower in comparison to Vietnam, where 70% of the population in 2020 had access to the internet.<sup>41</sup> However, these contexts are similar such that most users are using the internet with their mobile devices, only 5.63% of users in Vietnam were fixed broadband subscribers.<sup>42</sup> The Vietnamese CHC staff and collaborators often communicated to each other via phone to discuss about patients in the communities. There is regular dialogue and communication throughout the weeks because collaborators typically only meet once a month at the center to discuss progress on their programs with their supervisors. When there are more urgent cases, the collaborators are asked to accompany the patient to the CHC outside of those scheduled meetings.

The use of phones to communicate with patients themselves varied among the collaborators, as some already have been using this tool to contact patients; for example, participant #4, a nurse, described their process in which they identify a married woman in their community and take a record of her phone number and wedding date. They maintain contact with her by calling her two months after her wedding to check on her health and ask about her pregnancy status. If the woman is pregnant, the collaborator offers her advice to get an ultrasound screening and creates in-person follow up meetings. Through maintaining a written record of the different women they are managing and have anticipated time frames of when follow-up communications need to be made, this collaborator does not conduct as many house visits as compared to others.

Other barriers to the use of phones within their work included the concerns regarding cost, Participant #4 indicated that the cost of paying for phone usage is deemed as expensive. Another challenge is the limited knowledge of using smartphones, Participant #13, a doctor's assistant, mentioned these devices are more difficult for older collaborators who are only able to pick up calls, not to surf the web, etc. The director of the CHC further supported this perspective as he described most collaborators owned cell phones and cannot use applications or have internet access on their devices. However, he suggested they would be interested in receiving training and support on how to use smartphones and the apps. The rates of data packages being more affordable due to its wide availability also suggested that using internet-based apps to communicate would be more cost-effective than calling through a mobile carrier. Further exploration of this matter will be conducted to understand how to best incorporate these factors into the training and implementation of using smartphones and apps to communicate information.

Within this Discover phase, insight was gained about the teams, their level of collaboration, and the methods of communication amongst themselves and to their patients. The registry is a central piece to the CoCM, and serves to facilitate the coordination and communication between the team members within the model. The understanding the similarities and differences between these two settings contribute to the ideation of the adjustments that need to be made to the current registry prototype (V2.0) based on the spreadsheet as well as the design of its next iterations.

Context	Ibadan, Nigeria	Can Tho, Vietnam
Use of lay health workers in the study	No	Yes (called collaborators)
Care manager	Hired during the study period, not part of the clinic team	The primary care provider will take this role
Home visits	No	Yes, made by collaborators
Referral system	Psychiatric consultant available via phone to doctors and DCM	Difficult patients are referred to an outside psychiatrist at regional hospitals
Broadband penetration in the population	37.8%	70%
Mobile broadband connection	99.8%	94.4%
Fixed broadband connection	1.2%	5.6%
Mobile phone usage between team members	Yes	Yes
Mobile phone usage to contact patients	Yes, frequently	Yes, limited
Use of internet-based apps for communication among team members	Yes, Whatsapp	No
Psychiatric consultant	Hired from the university during trial	Hired from the university during trial

Table 1. Overview of the differences in context between Nigeria and Vietnam relevant to the use of the registry and CoCM.

## Design

The project continues into the Design phase, as the Discover phase insights from both contexts contribute to the modification of the existing spreadsheet-based prototype and the design of its future iteration, which will be developed on the DHIS2 platform. The noted differences in the context of Ibadan and Can Tho, such as the use of lay health workers, mobile phones to contact patients, and mobile applications for communication, allow for an understanding of the variability of future potential sites in which the registry could be used. The feedback from the different teams offered perspective on challenges, needs, and suggested functionalities of the registry to fit within their respective workflows.

### *Obstetric data*

Changes made to the prototype (V2.0) to be used in Can Tho addressed the concerns and difficulties raised by the users of the V1.0 prototype in Ibadan. This includes adding information regarding the patient's delivery timeline such as their estimated and final dates of delivery, current week of pregnancy, and current month of postpartum. Another functionality added was the flagging of a patient's status on the registry if the patient is 43 weeks in their current pregnancy to alert their providers to assess her for potential health risks.

### *Suicide risk assessment*

Information regarding suicide risk assessment and management plan were also added to the prototype V2.0. The inquiries were based on the MhGAP guidelines<sup>43</sup> to prompt users to identify whether the patient may be considered at risk for suicide and to take note of whether a safety plan had been made for her, if appropriate. The registry also flags and prioritizes cases with a safety risk or requires further discussion with the psychiatric consultant. Though these features were not directly requested by the team in either setting, they serve an important role in ensuring that suicide risk is properly assessed when patients are enrolled in the program and to support providers in their care by prompting them to create a safety plan for the patient when needed. The total number of patients at risk or imminent risk (those who have a score of 1 or above on the 9th question of the Patient Health Questionnaire-9 (PHQ-9)<sup>44</sup>) and the number of patients with a safety plan were the metrics added to the prototype V2.0 to assess and monitor suicide risk.

### *Caseload statistics*

Table 2. Descriptions of caseload statistic metrics that were included in prototype V2.0 to support management and overview of all active and inactive cases on the registry.

Caseload Statistics - Active and Inactive Cases	
Category	Metric
Patient Count	Total Number of Pts. on Caseload (Active + Relapse Prevention)
	Number of Active Pts. in Relapse Prevention
Contacts	Number of Pts. w/ 1+ Follow-up Contacts
	Mean Number of Follow-up Contacts
	Percent of Follow-up Contacts Labeled "In Person at Clinic"
	Percent of Follow-up Contacts Labeled "Phone"
	Percent of All Contacts w/ a PHQ-9 Score Recorded
Psychiatric Consultation	Number of Pts. Flagged for Discussion w/ Psychiatric Consultant
	Number of Pts. w/ at least 1 Psychiatric Case Review Note
	Number of Pts. Not Improving and w/o a Psychiatric Case Review Date Recorded
PHQ-9	Mean Initial PHQ-9 Score
	Mean Last Available PHQ-9 Score
	Number of Pts. w/ an Initial PHQ-9 Score Recorded
	Number of Pts. w/ 1+ Follow-up PHQ-9 Scores Recorded
	Number of Pts. w/ No PHQ-9 Score Recorded in Last 30 Days
GAD-7	Number of Pts. w/ PHQ-9 Score <5 or ≥50% Improvement from Initial Score
	Mean Initial GAD-7 Score
	Mean Last Available GAD-7 Score
	Number of Pts. w/ an Initial GAD-7 Score Recorded
	Number of Pts. w/ 1+ Follow-up GAD-7 Scores Recorded
	Number of Pts. w/ No GAD-7 Score Recorded in Last 30 Days
Number of Pts. w/ GAD-7 Score <10 or Improved by ≥5 points from Initial Score	

In addition to the inclusion of suicide risk assessments, prototype V2.0 of the registry also has metrics to support the workflow of the team members within the CoCM.

Information regarding both active and inactive cases are recorded for care managers and the psychiatric consultant to monitor the overall status of all patients ever included in the registry. Other specific metrics such as the patient's scores on the Generalized Anxiety Disorder scale (GAD-7),<sup>45</sup> the number of flagged patients, the types of follow up

contacts are among other several data that is included in the newest iteration of the registry. See Table 2 for the descriptions of the metrics that were added to prototype V2.0.

### *Screening*

The newest iteration of the registry prototype V2.0 includes a page in the spreadsheet that allows users to input information about every patient that is screened. Those who meet the

criteria for the perinatal depression program are then transferred into the caseload page of the registry where more specifics about their status and treatment plan are entered. This is primarily for the users of the registry in clinical settings. This tab includes details of the type of screening tool used (PHQ-2, PHQ-9, or EPDS) when during the antenatal or postpartum period it was conducted, and the patient's date of enrollment into the perinatal depression care program. The number of people who are eligible for screening and the number of people with a screener due in less than 30 days was added metrics to better monitor screenings conducted and needed throughout the caseload. See Table 2 for summary of metrics of screening added to prototype V2.0.

Screenings	Metric
Screenings are conducted during Antenatal and Postnatal Periods	Total PHQ-9 Positive
	Total PHQ-2 or EPDS Positive Not Screened with PHQ-9
	Patients Added to Registry with Positive Depression Screening
	Total Patients Added to Registry
	Total Missed Screeners
	Total Screened with PHQ-2, EPDS, PHQ-9
	Currently Active and Eligible for Screening

For the Vietnam context, details of the patient's assigned collaborator are also collected in V2.0 of the prototype. The research team continues to make considerations regarding how data from screenings conducted in the community by the collaborators or LHWs will be incorporated into the larger registry.

Possible ideas discussed

thus far include creating a simple data entry form that can be accessed via smartphone. This form would have to be accessible in settings with limited to no internet access.

### *Remote access*

Creating a registry tool that can be accessed remotely is a vital factor when aiming to implement it in LMICs. There may be high variability in where data collection occurs, in some instances, data about may be collected from the field by lay health workers or in other locations within the clinic without access to the computer where the registry is stored. Having remote access is also helpful for the psychiatric consultant to conduct proper systematic case reviews as they often not working onsite at the clinics or locations where the data is collected. It would also be helpful to allow for multiple users to view and edit the registry simultaneously if it were stored on a remote cloud server or on a web portal.

There are ongoing considerations of which server platform to use to store the spreadsheet-based registry, because of the sensitivity of the data. Furthermore, these platforms require adequate network capacity, a concern raised by users in Nigeria, because of limited connectivity in primary care settings. The respondents felt that it may be difficult for multiple users to access the registry simultaneously if doing so would require more bandwidth.

The next iteration of the prototype is currently being developed on the DHIS2 software platform based on this feedback. This platform was chosen based on its ability to store and collect data on the DHIS2 web portal, mobile Android app, and direct import to the desktop application.<sup>46</sup> The use of the web portal and mobile application would allow for multiple users to access the registry remotely. More assessments regarding the bandwidth needed to access the data is required, however because it has been implemented in several other LMICs with similar

ranges of internet connectivity as Nigeria and Vietnam, it is expected that the users within these settings would not be limited by this factor using this system.

### *Mobile functionalities*

Considerations based on the feedback from the users in Nigeria and Vietnam in their use of mobile devices have contributed to efforts to develop a registry onto a mobile platform. This has been done primarily through the DHIS2 software, which has a mobile Android app, DHIS 2 Capture, as part of their existing system. Users are able to collect data about patients, track their progress, and access other cases through their smartphones. The app also has full offline functionality with intelligent synchronization such that a “local database in the mobile device keeps a synchronized copy of the programs and datasets available to the user.”<sup>46</sup> This function also allows users to collect and input data without internet access; once the network connection is reestablished, the app will automatically push the information collected into the server.

The development of the registry on the DHIS2 platform incorporates the respondents’ suggestions of having the registry on a phone or tablet device with internet access rather than a computer because they felt that it would be more accessible and usable when accompanying patients at the clinics. Incorporating the registry onto a mobile platform would also ensure that the internet connectivity would be via the mobile data from the phone or tablet’s SIM card. This would ensure that the use of the registry would not be limited or affected by the network connectivity of the clinics. DHIS2 Capture’s offline and sync functionalities would also support the work of the collaborators in Vietnam as they conduct screenings in the field and have limited internet connectivity.<sup>47</sup>

<b>Discover</b>	<b>Design</b>
Appointment dates were difficult to modify because they were automatically generated	Appointment dates are automatically generated on the spreadsheet, but there has been a column added to include actual date of contact with the patient which resets the next appointment scheduled
Important dates about patient’s antenatal and postpartum status were not included in data collected	New obstetric data about the patient have been included: EDD, DOB, current month postpartum, and the current week in pregnancy
Mobile functionality desired (remote access)	DHIS2 allows access to the registry and data collection via mobile phone
Limitations in wifi and internet connections	DHIS2 platform allows users to input new data without internet access and can sync into larger data systems once the user connects to a network.

Table 4. Overview of feedback identified in the Discover phase and ways in which it was addressed in the Design phase of DDBT.

### *DHIS2 Configurations*

The development of the registry on the DHIS2 platform is still ongoing, however no fundamental changes to its existing structure will be needed in order to address the concerns raised by the teams in Nigeria and Vietnam. Features such as the ability to monitor and track the patient’s treatment, take notes during each visit made, and generate reports about multiple cases

within a treatment program are components that already exist within the system. Insights from users of the prototype have informed specific modifications for CPMD care such as the inclusion of different data input inquiries regarding suicide and screening. Additional functionalities of an advanced patient registry as outlined by the AIMS center need to be further assessed and incorporated by the DHIS2 developers and research team as part of the next DDBT phases of the prototype in an upcoming study.

## **Discussion**

### *Principal Findings*

This study sought to use the DDBT framework to understand and identify essential technical and design elements of a registry tool that can be used for CPMD management and treatment in LMICs. The results indicated the need to understand the existing workflows among team members within the CoCM in order to find ways that the registry can support their systems of collaboration and communication. Within Nigeria, the use of the Patient Tracking Spreadsheet facilitated the relationships between patients and their providers, as well as between the care manager and the psychiatric consultant. In Vietnam, the lay health workers and the staff at the commune health centers gave important perspectives on what different roles they play in the managing of patients within their communities. In both settings, how technology has been implemented into the work environment was also assessed. Several lessons were learned in this early assessment of the contexts to further ideate the design, build, and testing of the patient registry for CPMD in low-middle income countries.

### **Key findings compared to previous work**

The method of using DDBT to frame the systematic assessment of usability and involve stakeholders and potential users of the tool gave a greater insight into ways that the registry has been beneficial to the Nigerian team and features that should be considered for its adaptation in Vietnam. This is advantageous in offering opportunities for the development of the tool, identify challenges, and offer potential solutions. The results also demonstrated the advantages of having a registry include being able to flag patients based on their status to prioritize and quickly address any gaps in their care.

We found significant value in using the DDBT framework to understand the context (conducted in the Discover phase) and use this information to inform the design of the tool itself to ideate its next iteration (conducted in the Design phase). This is seen in the ways that the input from the primary users of the registry prototype (V1.0) in Nigeria directly informed the different modifications and additions to the next iteration of the prototype (V2.0). The functionalities identified as essential to the patient registry include the ability to create and modify follow-up appointments, assess the patient's risk of suicide, record important obstetric dates, and remotely access the tool through mobile devices in settings with and without an adequate internet connection. The insights from the participatory design team in Vietnam were also critical within the Discover phase as they provided important information regarding the context and potential challenges in implementing the registry and CoCM. This framework also provides a clear picture of the various phases of the research project and communicates clearly the next steps for further development of the tool. In the upcoming Build and Test phases of the study, the spreadsheet-based prototype with the new modifications based on insights from Nigerian users will be

adapted in the Vietnam context and feedback from the participatory design team will continue to inform and influence the ongoing iterations of the prototype, returning to the Design phase as more adjustments are made. The insights from the DDBT of the Patient Tracking Spreadsheet will ultimately contribute to the Discover phase of the next prototype based on the DHIS2 platform. This iterative process will continue as it is tested among a wider range of users in both Nigeria and Vietnam.

#### *Implications for informatics*

These findings support the need for informatics to be patient-centered, routinely assessed, and population-based care management.<sup>18</sup> The metrics collected via the registry support providers to have easy access to patients who may not be responding to treatment, are at risk of suicide or have not been assessed after an extended period of time. The challenge of having inadequate internet access to use the registry was raised in this study, which furthers the importance of having ways to collect and input data offline. These concerns from local end-users directed which platforms were considered for the next iteration of the registry prototype. In gathering their feedback, the adjustments and modifications made will likely lead to higher acceptability and usability of the tool designed for their contexts.

#### *Implications for perinatal mental health*

One of the major modifications made to the registry prototype (V2.0) was the inclusion of input for obstetric data such as the EDD and DOB. The adjustments from users in Nigeria raised insights about the need for specific metrics in perinatal mental health care that benefits both patients and their providers by giving a framework of the patient's status within the antenatal and postpartum period. Another modification within the spreadsheet and DHIS2 prototypes was the inclusion of suicide risk assessment which will be piloted in both sites in the next phase of the study. Patients who are registered in the treatment program are regularly screened for suicide risk and are expected to have a safety management plan if they have any level of risk. This work addresses the concerns raised in previous literature regarding the high rates of suicide attributed to CPMD by ensuring that the patient is properly assessed through this inquiry.<sup>4,5</sup> The additional metrics included in the prototype V2.0 also provide support for caseload management of members within the CoCM and have the potential to contribute to a more effective workflow in low-resource settings.<sup>8-13</sup>

#### **Limitations**

Due to the small sample size of the study, other relevant issues to CoCM and CMPD treatment were not fully assessed within this study. Furthermore, the registry prototype (V1.0) has only been tested in the Ibadan clinics, and users were hired from the partner research university. Since the roles of the psychiatrist and depression care manager were not truly reflective of the public health system, there may have been other existing challenges or concerns that were not raised by the respondents. This is to be addressed as training and interviews of potential psychiatric consultants and DCMs within the healthcare workforce of both Vietnam and Nigeria will be conducted in the near future.

## **Conclusion**

Collaborative care supports the healthcare workforce in low and middle income countries and their patients with chronic conditions such as perinatal depression through tools such as advanced patient registries to streamline communication and workflow among team members within the model. This project sought to provide insight into ways in which a registry could be designed and implemented in a way that would fit the needs and contexts of users in diverse settings by drawing insights from users in Nigeria and Vietnam. Through user-centered design, essential functionalities such as the inclusion of obstetric data, having remote access, and the use of phone applications were identified and have contributed to the modifications of an existing prototype and its upcoming iteration on an open-source platform.

### Works Cited

1. O'Hara MW, Wisner KL. Perinatal mental illness: Definition, description and aetiology. *Best Pract Res Clin Obstet Gynaecol*. 2014 Jan 1;28(1):3–12.
2. Gelaye B, Rondon M, Araya R, Williams MA. Epidemiology of maternal depression, risk factors, and child outcomes in low-income and middle-income countries. *Lancet Psychiatry*. 2016 Oct;3(10):973–82.
3. Fairbrother N, Young AH, Janssen P, Antony MM, Tucker E. Depression and anxiety during the perinatal period. *BMC Psychiatry*. 2015 Aug 25;15(1):206.
4. Lindahl V, Pearson JL, Colpe L. Prevalence of suicidality during pregnancy and the postpartum. *Arch Women's Ment Health*. 2005 Jun 1;8(2):77–87.
5. Oates M. Perinatal psychiatric disorders: a leading cause of maternal morbidity and mortality. *Br Med Bull*. 2003 Dec 1;67(1):219–29.
6. Saxena S, Thornicroft G, Knapp M, Whiteford H. Resources for mental health: scarcity, inequity, and inefficiency. *The Lancet*. 2007 Sep 8;370(9590):878–89.
7. Siskind D, Araya R, Kim J. Cost-effectiveness of improved primary care treatment of depression in women in Chile. *Br J Psychiatry J Ment Sci*. 2010 Oct;197(4):291–6.
8. Grote Nk, Katon Wj, Russo J, Lohr Mj, Curran M, Galvin E, Et Al. Collaborative Care For Perinatal Depression In Socioeconomically Disadvantaged Women: A Randomized Trial. *Depress Anxiety*. 2015 Nov;32(11):821–34.
9. Melville JL, Reed SD, Russo J, Croicu CA, Ludman E, LaRocco-Cockburn A, et al. Improving care for depression in obstetrics and gynecology: a randomized controlled trial. *Obstet Gynecol*. 2014 Jun;123(6):1237–46.
10. Katon W, Unützer J, Wells K, Jones L. Collaborative depression care: history, evolution and ways to enhance dissemination and sustainability. *Gen Hosp Psychiatry*. 2010 Oct;32(5):456–64.
11. Gilbody S, Bower P, Fletcher J, Richards D, Sutton AJ. Collaborative care for depression: a cumulative meta-analysis and review of longer-term outcomes. *Arch Intern Med*. 2006 Nov 27;166(21):2314–21.
12. Health Metrics Network. (2008). *Framework and standards for country health information systems*.
13. Fisher JRW, Morrow MM, Ngoc NTN, Anh LTH. Prevalence, nature, severity and correlates of postpartum depressive symptoms in Vietnam. *BJOG Int J Obstet Gynaecol*. 2004;111(12):1353–60.
14. WHO-AIMS Report on Mental Health System in Vietnam, WHO and Ministry of Health, Hanoi, Viet Nam, 2006.
15. Gureje O, Abdulmalik J, Kola L, Musa E, Yasamy MT, Adebayo K. Integrating mental health into primary care in Nigeria: report of a demonstration project using the mental health gap action programme intervention guide. *BMC Health Serv Res*. 2015 Jun 21;15(1):242.
16. Esponda GM, Hartman S, Qureshi O, Sadler E, Cohen A, Kakuma R. Barriers and facilitators of mental health programmes in primary care in low-income and middle-income countries. *Lancet Psychiatry*. 2020 Jan 1;7(1):78–92.
17. Hallgren KA, Bauer AM, Atkins DC. Digital technology and clinical decision making in depression treatment: Current findings and future opportunities. *Depress Anxiety*. 2017;34(6):494–501.

18. Team Structure | University of Washington AIMS Center [Internet]. [cited 2020 Sep 17]. Available from: <http://aims.uw.edu/collaborative-care/team-structure>
19. Young AS, Chaney E, Shoai R, Bonner L, Cohen AN, Doebbeling B, et al. Information Technology to Support Improved Care For Chronic Illness. *J Gen Intern Med*. 2007 Dec 1;22(3):425–30.
20. Mendu ML, Ahmed S, Maron JK, Rao SK, Chaguturu SK, May MF, et al. Development of an electronic health record-based chronic kidney disease registry to promote population health management. *BMC Nephrol*. 2019 Dec;20(1):1–11.
21. Acharya B, Ekstrand M, Rimal P, Ali MK, Swar S, Srinivasan K, et al. Collaborative Care for Mental Health in Low- and Middle-Income Countries: A WHO Health Systems Framework Assessment of Three Programs. *Psychiatr Serv Wash DC*. 2017 Sep 1;68(9):870–2.
22. Care Management Tracking System (CMTS) | University of Washington AIMS Center [Internet]. [cited 2020 Sep 17]. Available from: <https://aims.uw.edu/resource-library/care-management-tracking-system-cmts>
23. Project Information - NIH RePORTER - NIH Research Portfolio Online Reporting Tools Expenditures and Results [Internet]. [cited 2020 Mar 2]. Available from: [https://projectreporter.nih.gov/project\\_info\\_description.cfm?aid=9689106&icde=49058216](https://projectreporter.nih.gov/project_info_description.cfm?aid=9689106&icde=49058216)
24. Lyon AR, Koerner K. User-Centered Design for Psychosocial Intervention Development and Implementation. *Clin Psychol Sci Pract*. 2016;23(2):180–200.
25. Collect, Manage, Visualize and Explore your Data | DHIS2 [Internet]. [cited 2020 Jun 5]. Available from: <https://www.dhis2.org/>
26. Sahay, S., Rashidian, A., & Doctor, H. V. (2020). Challenges and opportunities of using DHIS2 to strengthen health information systems in the Eastern Mediterranean Region: A regional approach. *The Electronic Journal of Information Systems in Developing Countries*, 86(1), e12108. <https://doi.org/10.1002/isd2.12108>
27. Global Goods Guidebook. (n.d.). Digital Square. Retrieved September 21, 2020, from <https://digitalsquare.org/global-goods-guidebook>
28. Atkinson NL, Massett HA, Mylks C, McCormack LA, Kish-Doto J, Hesse BW, et al. Assessing the impact of user-centered research on a clinical trial eHealth tool via counterbalanced research design. *J Am Med Inform Assoc*. 2011 Jan 1;18(1):24–31.
29. Beres LK, Simbeza S, Holmes CB, Mwamba C, Mukamba N, Sharma A, et al. Human-Centered Design Lessons for Implementation Science: Improving the Implementation of a Patient-Centered Care Intervention. *J Acquir Immune Defic Syndr* 1999. 2019;82 Suppl 3:S230–43.
30. Bazzano AN, Martin J, Hicks E, Faughnan M, Murphy L. Human-centred design in global health: A scoping review of applications and contexts. *PLOS ONE*. 2017 Nov 1;12(11):e0186744.
31. Gordon M, Henderson R, Holmes JH, Wolters MK, Bennett IM. Participatory design of ehealth solutions for women from vulnerable populations with perinatal depression. *J Am Med Inform Assoc*. 2016 Jan 1;23(1):105–9.
32. De Vito Dabbs A, Myers BA, Mc Curry KR, Dunbar-Jacob J, Hawkins RP, Begey A, et al. User-Centered Design and Interactive Health Technologies for Patients. *Comput Inform Nurs CIN*. 2009;27(3):175.
33. Lyon AR, Munson SA, Renn BN, Atkins DC, Pullmann MD, Friedman E, et al. Use of

- Human-Centered Design to Improve Implementation of Evidence-Based Psychotherapies in Low-Resource Communities: Protocol for Studies Applying a Framework to Assess Usability. *JMIR Res Protoc*. 2019 Oct 9;8(10):e14990.
34. Agarwal S, Labrique A. Newborn Health on the Line: The Potential mHealth Applications. *JAMA*. 2014 Jul 16;312(3):229–30.
  35. Lewis JR, Sauro J. The Factor Structure of the System Usability Scale. In: Kurosu M, editor. *Human Centered Design* [Internet]. Berlin, Heidelberg: Springer Berlin Heidelberg; 2009 [cited 2020 Aug 17]. p. 94–103. (Lecture Notes in Computer Science; vol. 5619). Available from: [http://link.springer.com/10.1007/978-3-642-02806-9\\_12](http://link.springer.com/10.1007/978-3-642-02806-9_12)
  36. Buist A, Condon J, Brooks J, Speelman C, Milgrom J, Hayes B, et al. Acceptability of routine screening for perinatal depression. *J Affect Disord*. 2006 Jul 1;93(1):233–7.
  37. Affairs AS for P. System Usability Scale (SUS) [Internet]. Department of Health and Human Services; 2013 [cited 2020 Aug 17]. Available from: [system-usability-scale.html](http://www.asia.gov/system-usability-scale.html)
  38. Brooke, J. (1996). SUS: A "quick and dirty" usability scale. In P. W. Jordan, B. Thomas, B. A. Weerdmeester, & A. L. McClelland (Eds.), *Usability Evaluation in Industry*. London: Taylor and Francis. 1996.
  39. Kortum P, Peres SC. The Relationship Between System Effectiveness and Subjective Usability Scores Using the System Usability Scale. *Int J Human–Computer Interact*. 2014 Jul 3;30(7):575–84.
  40. Nigeria National Broadband Plan 2020-2025.pdf [Internet]. [cited 2020 Sep 16]. Available from: <https://www.ncc.gov.ng/documents/880-nigerian-national-broadband-plan-2020-2025/file>
  41. Vietnam Internet Statistics 2020 [Internet]. [cited 2020 Sep 16]. Available from: <https://vnetwork.vn/en/news/thong-ke-internet-viet-nam-2020>
  42. Point Topic - Vietnam broadband overview [Internet]. Point Topic. [cited 2020 Sep 16]. Available from: <http://point-topic.com/free-analysis/vietnam-broadband-overview/>
  43. Organization WH. MhGAP Humanitarian Intervention Guide (mhGAP-HIG): Clinical Management of Mental Neurological and Substance Use Conditions in Humanitarian Emergencies. World Health Organization; 2015. 68 p.
  44. Kroenke K, Spitzer RL, Williams JBW. The PHQ-9. *J Gen Intern Med*. 2001 Sep;16(9):606–13.
  45. Jordan P, Shedden-Mora MC, Löwe B. Psychometric analysis of the Generalized Anxiety Disorder scale (GAD-7) in primary care using modern item response theory. *PLoS ONE* [Internet]. 2017 Aug 3 [cited 2020 Oct 2];12(8). Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5542568/>
  46. DHIS2 Overview | DHIS2 [Internet]. [cited 2020 Sep 17]. Available from: <https://www.dhis2.org/overview>
  47. Mobile Data Capture with DHIS2 Android App | DHIS2 [Internet]. [cited 2020 Sep 17]. Available from: <https://www.dhis2.org/Android>

## Appendix 1

### Registry Platform Considerations for Happy Mom Happy Home Project

The collaborative care model (CoCM) for treatment of common mental disorders requires patient registries to support key functions of the clinical team. A registry with functionality tailored to CoCM has key functions listed in Table 1. These functionalities have been defined and refined over 2 decades of tool development and trial and error. A patient registry for common perinatal mental disorders (CMPD) contains key clinical indicators of their condition such as clinical symptom scores (PHQ-9, GAD-7) and embedded decision support to aid the delivery of guideline based care. These registries facilitate team review of patient status and allow indication of priority cases, and streamlined communications between providers to create follow up reminders and appointments. Monitoring patients at this level has the potential to help with adherence to treatment and be used for preventative interventions. (1)

#### Platform Requirements

When looking for a platform to develop the advanced patient registry for perinatal depression for the Happy Mom, Happy Home (HMHH) project, we had a number of requirements to consider. As a patient registry for use in low-middle income countries and in contexts in which there is limited bandwidth, we needed to find a tool that can function asynchronously such that an internet connection is not needed in order to access the registry and collect patient data - since it can be linked to a shared database as connectivity is established. We wished to identify platforms with existing apps native to mobile devices that also had asynchronous capabilities.

We also looked for an existing platform in which any registry work created could later be further developed, either as a separate module, or something that would be integrated with existing modules. We identified platforms already in use in LMICs in order to maximize the rapid dissemination of any tool we create and increase retention and sustainability. The platform should also be able to have functionalities that allow for tailored patient management for chronic diseases.

Additional registry-specific criteria were based on the AIMS Center Case Management Tracker System (CMTS) developed at the UW and have been used across various clinical settings within the US but is not available in a form generally functional in the LMIC setting. A list of the specific registry requirements from the AIMS Center is found below:

<b>Table 1. AIMS Center Collaborative Care Registry Requirements</b>
<p><b>Track clinical outcomes across a target population</b> The care team is accountable for clinical outcomes across the target patient population. Population-level reports allow providers to evaluate current values and trends in validated behavioral health measures, such as the PHQ-9. It can also be used by supervisors to monitor workloads and progress.</p>
<p><b>Track patient engagement across a caseload</b> The behavioral health provider is responsible for ensuring patients stay engaged in treatment. Reminders or alerts can help the provider easily see patients that are due for an appointment or who may require more intensive efforts to engage them in care. These functions can help focus outreach efforts to ensure patients don't fall through the cracks.</p>

**Prompt treatment-to-target**

The care team must be able to adjust a patient's treatment plan based on clinical outcome measures, such as the PHQ-9 score. Measurement of outcomes over time makes trends visible and aids the team in evaluating treatment response. Recent values and dates of measurement should be available in real-time.

**Facilitate efficient, systematic psychiatric caseload review**

Behavioral health providers and psychiatric consultants track patient progress at the caseload-level in order to prioritize patients who are not improving as expected and may need a treatment adjustment. A caseload-level report allows the behavioral health team to sort or filter patients by specific screening results and is critical for efficient caseload review. Tracking previous case review dates is also important for prioritizing patients for discussion. The ability for providers to manually flag patients for psychiatric consultation and review can also be helpful.

**Monitor individual patient progress**

The behavioral health provider is responsible for monitoring the individual patients on their assigned caseload. Patient-level reports should display a summary of treatment history over time, including baseline and most recent symptom scores, and visually graph outcomes, such as the PHQ-9 score.

In addition to these key requirements, there were other essential functionalities that the registry should have, such as

- (1) defined inclusion rules of what criteria patients must meet to be enrolled into the registry (such as a certain PHQ-9 score, etc.),
- (2) clear markings of the patient's treatment status within the program (such as active, relapse, discharged or graduated),
- (3) referral and appointment reminders for healthcare providers and
- (4) the number of the patient's episode of care. (2)

Additional desired functions for the registry include:

1. The platform has been used successfully in LMICs,
2. The platform is open-sourced,
3. The data is accessible with limited and intermittent internet connectivity,
4. The software is on a mobile platform or has the potential to be developed on it,
5. The data can be stored on a server that is accessible by multiple users simultaneously and remotely.

**Platforms Considered**

We had several meetings with Joel Myers, co-principal at FuseIQ, a technical consultant who we initially partnered with to create the registry (he later was unable to continue with the project), to discuss these requirements. He shared with us the Digital Square Global Goods Guidebook which listed various existing open-sourced digital software, services, and tools that "are adaptable to different countries and contexts to help address key health system challenges." (3) Among the several tools and platforms listed, we had identified and considered Community Health Toolkit (CHT), Open Medical Record System (OpenMRS), OpenData Kit (ODK), and District Health Information Software (DHIS2) for this project. Each was selected based on their capabilities for registry functionality and had met other criteria considered.

*Community Health Toolkit-CHT*

CHT was one of the initial platforms assessed, it was created to support community health workers and other healthcare workers by creating an open-source platform that could be accessible to store and share important information about patients, disease outbreaks, essential medicine stocks, and emergencies. The application which can be accessed on mobile devices has

five “highly configurable areas of functionality: messaging, task and schedule management, decision support workflows, longitudinal person profiles, and analytics.” Users can access patient information with details about their demographics, treatment status, any upcoming tasks relevant to their care, and their health history. Data input and communication between health care workers and patients are accessible via basic phones through text messages and through an Android app for smartphones. The tool has been used across thirteen countries within Asia and Africa and supports users with limited network connections through “offline-first” in which data is stored locally on the user’s device such that their workflows can be completed without syncing to the server but will be automatically synced once the connection is established. (4)

The structure of the CHT hierarchical in manner, such that roles could be clearly established and users with different roles had different types of permissions in using the tool. This was deemed as a potential benefit due to the different roles within the CoCM, however there were other essential functionalities that the tool lacked such as the ability to conduct systematic case reviews of all patients enrolled in a program.

Efforts to communicate with the developers of the tool through email exchange were made, but there was no virtual meeting between the researchers and the development team to further discuss the potential of using this platform due to schedule conflicts and loss of follow up.

#### *OpenMRS- Open Medical Record System*

OpenMRS was also considered for this project, it is a web-based electronic medical record initially created to support HIV/AIDs care in Kenya and Rwanda. (5) It is an open-source program that has been used across several LMICs to support healthcare delivery across diverse contexts. At its core is its Concept Dictionary, in which terms and definitions of data to be inputted are organized as questions and answers. Information about a patient’s single visit is defined as an Encounter, and is later composed into the patient’s records, defined as the Workflow. The program also has a functionality to view multiple patients who are created as a Cohort in the Reporting Capability module, as specific characteristics and criteria are defined and filtered in the search. Patients can also be enrolled into a specific program, which can also lead to the creation of reports that are based on different defined indicators. The core framework of OpenMRS also has been developed into an app that can be accessed on support Android devices and covers most functionalities that are on the web-based version of the software. This app supports working offline, but only within a chosen subset of patients registered. (6)

In considering these functionalities, we were able to discuss with one of the main contributors to OpenMRS the details of our project and the desired functionalities for the registry tool. During the discussion, it was clear that though the functionalities of the platform itself were not very specific, it was designed to be so for a purpose in which developers could change and adapt the tool as needed for their context. Subsequent follow-up meetings were conducted with the staff and insight of the tool’s role in chronic disease management within clinical settings were further given. After careful consideration among the research team, we decided not to work within this platform due to the fact that it was more catered to individual patient-level data within a single clinic. The key functionality of caseload overview was not a critical component of this platform therefore more effort and resources would have been needed to develop the tool to fit the framework of CoCM.

#### *Open Data Kit-ODK*

ODK was among the platforms considered, as it is a free and open-source platform that was created to collect data offline. Users are able to create forms that can be accessed without any internet connection. This could be done on ODK's mobile or web-based apps and the data could be easily synched and analyzed in different software or stored on the platform's cloud server. ODK has been used by several types of agencies on a global scale and has been used across several sectors such as global health, agriculture, humanitarian aid, and more. (7) Due to the limitations of the software and the fact that its main purpose is to only collect data, rather than to create a registry in which patients can be tracked over a period of time, we quickly decided to disregard this platform for our project. However, our team briefly discussed the possibility of using ODK to collect screening data in the field for the HMHH project. This is still being considered and would need to be further discussed with the collaborators in Vietnam.

#### *District Health Information Software-DHIS2*

DHIS2 is another open-source platform that supports “both aggregate and individual-level data-including features for monitoring and following up with individual people or entities over time--and data entry via the DHIS2 web portal, mobile Android app, or direct import.” (8) It has been used and adapted in over 60 countries and supports a number of health ministries and organizations. Its core functionalities integrate data management and analytics and case-based records to offer quick reviews of patients within a defined program through its feature, “Tracker Capture.” All data could be accessed and shared across multiple healthcare facilities at various levels (regional hospitals to local clinics). The platform also has offline-first functionality in which data can be accessed and inputted without internet and will sync into the server once internet connection is established. The status of a patient can be easily viewed as information from their previous visits within the program they are enrolled in are easily accessible. There are also options to flag cases and send messages across different users within the system. It also has the capacity to be highly scalable as it is currently being used by several countries as part of their national health information system. Moreover there are several teams of developers internationally, and we were able to discuss the specifics of the project with the team based in Vietnam.

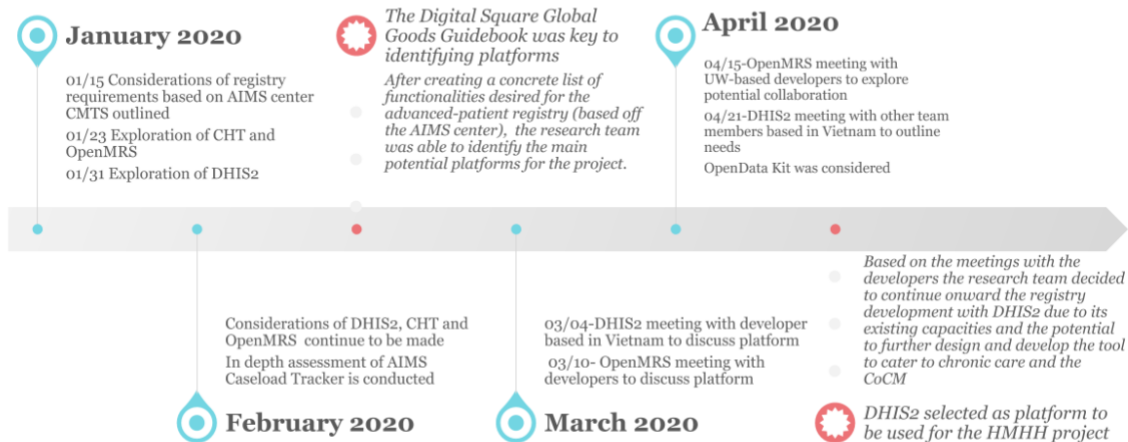
Within the call, there was discussion about the core functionalities on DHIS2 and how it compares with the AIMS Center requirements. It became clear that all the needs of the project could be met with making some modifications to the DHIS2 platform without structurally changing the software itself. The developers were enthusiastic about the creation of a new “package” that could be used and downloaded onto the DHIS2 platform for other users globally who may also have programs to care for patients with common perinatal mental disorders (CMPD). After this initial meeting, several more were conducted with other team members in Vietnam to discuss more specific details about the requirements, indicators, and functionalities. The DHIS2 developers also described ongoing efforts with the World Health Organization (WHO) and United Nations Children's Fund (UNICEF) to develop antenatal and well-childcare modules within the platform which was deemed highly beneficial and relevant to the HMHH project. This further supported the research team's decision to partner with DHIS2 because of the potential that the development of a module for CMPD could be implemented as part of the antenatal and well-childcare modules which could possibly be adapted and used by other LMICs.

<b>AIMS Registry Requirements</b>	<b>DHIS2</b>	<b>OpenMRS</b>	<b>CHT</b>	<b>ODK</b>
Track clinical outcomes across a target population	Yes	No	No	No
Track patient engagement across a caseload	Yes	Yes	Yes	No
Prompt treatment-to-target	Yes	No	Yes	No
Facilitate efficient, systematic psychiatric caseload review	Yes	No	No	No
Monitor individual patient progress	Yes	No	Yes	No
<b>Other Requirements</b>				
Used in LMICs	Yes	Yes	Yes	Yes
Offline data accessible	Yes	Yes	Yes	Yes
Has an existing mobile platform	Yes	Yes	Yes	Yes
Hosted on a server	Yes	Yes	Yes	Yes
Open-sourced	Yes	Yes	Yes	Yes

## Choosing DHIS2

After considerations were made about the four diverse platforms that have been used in multiple contexts for several types of programs, we decided to continue our partnership with DHIS2 due to the ways in which the platform was highly compatible with the requirements of the advanced patient registry for the CoCM. The platform also had features and benefits that were regarded as “bonuses” to the requirements of the research team. This included the manner in which any modules created on the platform could be accessed and implemented into the software of any user of DHIS2 globally, which increased the accessibility and usability of the registry and met the goal in future dissemination of the tool. Other platforms were also open-sourced but the ability to share and integrate development of modules such as these were not as well integrated into their software. In addition, among the others explored DHIS2 was the most widely used platform within LMICs and had developers based in Vietnam who were able to give contextual feedback and had experiences in implementing the software at different levels of the healthcare system. This serves a great purpose in the overall efforts within this project which is to create a registry for chronic care and eventually integrate the tool into the healthcare infrastructure of the country at systemic level to support their workflows and care for patients. Overall, the DHIS2 platform was chosen due to the requirements that it met, the additional desired capabilities, and its potential to be integrated into other healthcare systems on a global scale.

# Registry Platform Identification Timeline



### Works Cited

1. Using a Simple Patient Registry to Improve Your Chronic Disease Care -- FPM [Internet]. [cited 2020 Jun 26]. Available from: <https://www-aafp-org.offcampus.lib.washington.edu/fpm/2006/0400/p47.html>
2. Collaborative Care Registry Requirements Guide\_2019\_0.pdf [Internet]. [cited 2020 Sep 21]. Available from: [https://aims.uw.edu/sites/default/files/Collaborative%20Care%20Registry%20Requirements%20Guide\\_2019\\_0.pdf](https://aims.uw.edu/sites/default/files/Collaborative%20Care%20Registry%20Requirements%20Guide_2019_0.pdf)
3. Global Goods Guidebook [Internet]. Digital Square. [cited 2020 Sep 21]. Available from: <https://digitalsquare.org/global-goods-guidebook>
4. Why the Community Health Toolkit? [Internet]. Community Health Toolkit. [cited 2020 Sep 21]. Available from: <https://docs.communityhealthtoolkit.org/why-the-cht/>
5. OpenMRS Around the World · GitBook [Internet]. [cited 2020 Sep 21]. Available from: <http://guide.openmrs.org/en/>
6. OpenMRS 2.x Android Client - Projects - OpenMRS Wiki [Internet]. [cited 2020 Sep 21]. Available from: <https://wiki.openmrs.org/display/projects/OpenMRS+2.x+Android+Client>
7. ODK - Collect data anywhere [Internet]. [cited 2020 Sep 24]. Available from: <https://getodk.org>
8. DHIS2 Overview | DHIS2 [Internet]. [cited 2020 Sep 21]. Available from: <https://www.dhis2.org/overview>

## Appendix 2

### Timeline of registry prototype development

