

See My Work: Sustaining a Data Reporting Practice by Mental Health Clinicians in Liberia

ABSTRACT

Working with the Carter Center we have developed and sustained software and training to enable data reporting at the patient level by mental health clinicians in Liberia. Over a four year time period, more than 140 clinicians have been trained in the use of the data reporting software, and more than 3000 valid reports have uploaded to the cloud. This participation has persisted despite significant technology challenges and little data feedback to clinicians. Because so many ICTD interventions fail, we were interested in the factors that contributed to sustaining the human and technology infrastructure to enable data reporting over this fairly long time period. We focus on motivations to participate and find support for positive motivations such as clinician pride. We find that being *seen* to do health work, not just *doing* the work, plays a critical role in motivation. We describe and critically analyze a novel approach to sustaining the technology, using student teams in a class. We assess project success through two lenses provided by the literature, first on characterization of project success and failure factors, and then on project champions.

Categories and Subject Descriptors. H.5.2 [Information Interfaces and Presentation (e.g., HCI)]: User Interfaces

General Terms. Design, Measurement, Human Factors

Keywords. ICTD; DEV; HCI4D; computing for development; data entry

1. INTRODUCTION

Working with the Carter Center [1] we have developed and sustained software and training to enable data reporting at the patient level by mental health clinicians in Liberia over four years. These clinicians are primarily nurses and physicians assistants, with some midwives and nurse educators. Clinicians participate in a six-month post-basic training program created and run by the Carter Center, while on leave from their current employers. They return to their place of employment with mental health diagnosis and treatment skills to add to their prior medical skills. The five-year program began in 2010.

From the outset, the Carter Center Mental Health Liberia Program committed to a culture and practice of data reporting at the patient visit level. The reasons for the commitment to data reporting are multi-fold. This was the first international mental health program for the Carter Center. Other Carter Center health programs tend to focus on disease eradication, where success is measured by well-defined and straightforward metrics. Understanding whether the mental health program makes a difference in patient outcomes, not just in access to services, was considered critical. The commitment to data reporting also enables an otherwise under-studied and under-reported picture of mental health in a country of the developing world, where issues of traditional medical health are obvious and prevalent but mental health is far less so[2].

The Carter Center partnered with Our University in four ways that contribute to enabling and sustaining data reporting. First, we consulted on the purchase of low cost laptops to be provided to each clinician upon graduation, with particular attention to issues such as reliability and battery life. Second, over the course of several offerings of an undergraduate senior and cross-listed master's level project class, we developed the Patient Encounter Form (PEF) software used by clinicians to record information from a patient visit.¹ Third, we traveled to Liberia twice a year to provide computer and PEF software training. Each trip included two training days, one with the current cohort of clinicians being trained and one as an in-service for graduates of the training program who have returned to their practice setting. Finally, we have assisted with analysis of data submitted by clinicians through the PEF software to use in annual reviews of the Carter Center Mental Health Liberia Program and, on a more limited basis, to provide data dashboards back to clinicians.

This paper focuses on the human and technology infrastructure necessary to sustain a data reporting practice by these clinicians over a multi-year time period.

In July 2014 we conducted a survey of 53 clinicians who attended the PEF in-service training. The survey asked questions about prior education and computer experience, clinical practice setting, training and learning to use the PEF, reasons for participating (or not) in the PEF data collection process, and clinical workflow. We also conducted semi-structured interviews of 12 clinicians that lasted about 30 minutes each and covered similar material to the survey in more depth. We interviewed the two in-country IT personnel who were involved in the program again using a semi-structured interview lasting about 30 minutes each. IRB approval for the research was obtained simultaneously from Our University and the University of Liberia IRB.

Based on our experience with the program and our interviews and survey results, we make the following contributions:

- A longitudinal study of data collection technology in the field and the requirements for sustaining both the technology and the participation by clinicians.
- An evaluation of motivations to participate in a largely one-way data collection effort, i.e., with little data in return. We find that individual, program and national pride play a substantial role in reported reasons to participate. We also find that the threat of negative consequences plays a lesser role than positive reasons to participate.
- Reflections on a novel method for structuring software development and maintenance work through a computer science project course taught once per year.

¹ The PEF differs from a patient health record. It does not record patient-identifying information, for example, and it does not contain notes on patient history. Clinicians maintain a paper health record for each patient in addition to the PEF.

- Lessons learned in the design of data collection software that may be useful for future systems, including those standardizing mental health data collection within Ministries of Health.

In the next section, we provide background on the Carter Center program that served as the context for our work. Section 3 describes work most closely related to our research. Section 4 discusses the design and implementation of the PEF data collection technology, starting with requirements and ending with the training approach. Section 5 contains the results of qualitative and quantitative evaluation based on interviews and surveys of clinicians. We discuss our work in larger context in Section 6 and conclude with future work in Section 7.

2. BACKGROUND

The Carter Center's Mental Health Liberia program was an early effort in the developing world [3], with an ambitious agenda comprising three pillars: mental health policy at the national level, capacity building through clinician training, and community-based education and stigma reduction. The Carter Center has worked in Liberia over many years on programs in peace and democracy. During that experience, they encountered high levels of suspected mental illness connected in part to the military overthrow of the government in 1980 and the subsequent, protracted civil war that engulfed the country for most of the time period from 1989 to the early 2000s. The Ministry of Health and Social Welfare was interested in partnering to address mental health, and the program launched in 2010.

Over a period of four years, the Carter Center Mental Health Liberia program has trained seven cohorts, each with 16-24 health clinicians and educators, resulting in a mental health workforce today that exceeds 140. By comparison, pre-program levels numbered in the single digits.

An in-country project lead works closely with a US-based assistant director. In Liberia, the program staff consists of a training officer who oversees the details of the cohort training and in-service sessions, a project coordinator, a logistics officer, an administrative assistant, a pool of drivers, and an IT person. For the first several years of the program, two Carter Center Liberia programs shared the same IT person; in early 2014 the Mental Health program hired its own full-time IT person. Student interns joined the in-country staff each summer and also worked in the Atlanta office supporting the program.

The mental health clinicians face many of the same challenges that any health care worker faces in Liberia or similar under-resourced setting. Clinic facilities are relatively primitive by Western standards; doctors are few; medications are not always available; power and Internet access cannot be consistently relied upon; medical records are largely paper-based; national ID and birth registrations are just beginning return the use since the war.

Mental health clinicians face some additional challenges because of their practice type. Mental health is stigmatized in Liberia [4] and the region [5] and that extends in part to clinicians. Mental health practitioners compete with traditional healers who may operate in churches or in the bush. Though the clinicians receive permission from their employer to take part in the six-month training, not all find that they are well supported when they return to their clinic. In the survey, about half of respondents reported that their supervisor was somewhat

supportive of their mental health practice while about one-fourth reported that their supervisor was not supportive.

Clinicians report that lack of supervisor support manifests in ways such as no private space to see patients or limited referrals of mental health cases from other parts of the clinic. Many clinicians are relatively isolated with respect to their mental health practice, with about half in the survey working alone in their clinical setting or with just one other mental health clinician.

Thus the context for our work on data reporting is a comprehensive program to address mental health in a developing world country that suffered from -- and is perhaps best known for -- a recent, devastating civil war. The clinicians trained in the program already have a health practice and a place of practice employment. They are aware that their work is new to the country and indeed in the developing world. They are supported by the program staff and by the community formed by identify as Carter Center trained mental health clinicians, even if their supervisor support is somewhat marginal.

3. RELATED WORK

Technology and health. The potential for technology, and especially mobile technology, to play a role in health care in the developing world is well recognized [6], [7] and a wide array of projects have used mobile technology for uses ranging from community health worker support to providing decision support at point of care. DeRenzi et al. usefully identify six health system functions that mobile technology can provide including data collection[8].

Our work shares some commonalities with prior work on data collection technology and health in the developing world. Our technology is put into the hands of front-line health workers and intended for use to record each visit, though not necessarily filled out while the patient is present. Structured data is collected. While not always sent in real-time, data is eventually uploaded and used to generate periodic reports used for program evaluation and (in limited fashion) to feedback to health workers.

Our work differs in several ways from prior work that focuses on community health workers and mobile phone platforms. Our mobile platform is not a phone, but rather a low cost laptop. Our health workers are trained clinicians who see patients in clinics, hospitals and prisons, rather than community health workers who see patients where they live. Intermittent network access and smooth off-line operation are first class concerns in our setting, while SMS-based systems often assume that connectivity will be present or they simply fail if not.

Open Data Kit (ODK) developed at the University of Washington is a (perhaps even "the") leading data collection toolkit for use in development, and it has been used by a wide variety of organizations, health and otherwise. ODK has long had a similar emphasis on smooth off-line operation [9]. A recent survey by the ODK team received responses from 73 organizations reporting on 55 different deployments in over 30 countries [10]. ODK was relatively new at the time we began our development, and focused on Android devices, whereas we were committed to Windows and laptops so that clinicians would have access to standard Microsoft productivity tools for their work.

Motivations for participation. Though the aim of this project was not to monitor or improve health worker performance per se, the literature in the area of health worker performance relates

to motivations to participate. The 2005 review by Rowe et al. asks broadly how to achieve and maintain high-quality performance of health workers in low-resource settings [11]. In their discussion of many determinants of health worker performance, they call out motivation:

A special point must be made about health worker motivation as a determinant of performance. Although it is difficult to study reliably, motivation has been considered a critical influence on performance. [p. 1027]

Psychology researchers have long been interested in the factors and mechanisms that play a role in motivation to complete tasks. Among the factors studied and found to have influence are self-efficacy and expectations of success [12], [13], self-regulation [14], [15] and form and implementation of intentions [16].

Especially relevant to our work is a 2008 study by Williams and DeSteno to investigate the role of pride in motivation to complete short-term tasks that carry some short-term cost [17]. Using two controlled studies with undergraduates, they find “support for the proposed motivational function of pride in which this emotion serves as an incentive to persevere on a task despite initial costs” [17]. Their studies differentiate the role of pride from self-efficacy and general positive affect. We return to this study in the Discussion section.

In the ICTD literature, efforts to improve health worker performance through automated reminders have been studied [18] with the conclusion that reminder systems that include escalation to the supervisor resulted in a significant increase in community health worker performance. While the reminders themselves are neither positive nor negative, the potential escalation to the supervisor acts as a negative consequence.

Anokwa et al. touch briefly on the presence of pride in ICTD project success as they bring together lessons learned by graduate students working across a variety of different ICTD project settings [19]. As they note from their experiences in deploying ICTD technologies, “the focus is on fostering a positive attitude toward process improvement, as well as creating a sense of pride and unity among users” [19], p. 110.

We conclude that motivations to participate are generally understudied in the ICTD literature despite the key role participation plays in the long-term success of ICTD projects. Participation is not understudied, indeed it is a common metric, the understudied element is motivation to participate. One reason for this may be the difficulty in studying motivation in the shorter-term interventions that characterize much ICTD work.

Project success and failure. The importance of attending to psychological dynamics, and especially those that contribute positively to project success, features in the study by Behrend et al. [20] of ICTD 2012 papers. As they note, “[t]his focus on breakdowns in performance related to specific tasks stands in contrast to research that has supported the importance of “positive” forms of performance, such as helping coworkers, devoting extra effort, and acting ethically.” [20], p. 11. They also call for a focus on positive factors at the team and organizational level, not just the individual level. We return to these notions of positive performance and team-level dynamics in the Discussion section.

Dodson et al. conduct a comprehensive examination of ICTD project success and failures finding that most projects fail and further that the ICTD research and practitioner community does not pay sufficient attention to the “fruits of failure”, that is,

critical evaluation and adaptation of future projects based on that evaluation [21]. In a sort of reversal of the Anna Karenina principle², they were unable to identify common features of successful projects, however they identified commonalities among failures including top-down and technology centric approaches. Interestingly, our project likely would be characterized as (mostly) top-down and technology-centric, though it avoided the third failure factor of being goal-diffuse. Indeed, commitment to a focused goal was present from conception of the project.

Without evidence, we conjecture that more project successes might yield a more complete understanding of what enables project success. The high rate of failures provides more fodder for understanding failure than for understanding success. This suggests that the research community embrace results reporting on success and critical evaluation of the contributing factors.

4. PEF DESIGN, IMPLEMENTATION AND TRAINING

We turn to the design and implementation of the PEF software and the training approach used with clinicians. We use the term “PEF” interchangeably to mean the data collection software and the unit of data entry and rely on context to disambiguate.

PEF Information. The information gathered in the PEF was designed in collaboration between mental health experts at the Carter Center, and two domain expert consultants to the Carter Center, one an MD/PhD in medical anthropology and the other a professor in disaster psychology. The PEF data entry is divided into six categories, with one entry screen per category, as illustrated in Figure 1. Fields that involve selection from a pull-down menu or from a fixed set are in *italics*. All other fields require typing. We make this distinction because it impacts data quality and ease of use as described later.

Basic information	Date of service; Location of service; Clinician ID; <i>Clinician training level</i> ; <i>Reason for visit</i> ; <i>Referral source</i>
Patient demographics	<i>Age</i> ; <i>County of residence</i> ; Distance traveled to clinic; Number of days in life role; <i>Marital status</i> ; <i>Education</i>
Functioning	PHQ-9 score; GAF score; CAGE score; WHO-DAS score; Euroqol score
Diagnosis	<i>Diagnosis (primary)</i> ; Number of seizures/month (for epilepsy); Relevant other medical conditions; Secondary diagnosis
Treatment	<i>Medication prescribed</i> ; <i>Counseling prescribed</i> ;

² The Anna Karenina principle refers to the need for all aspects of a complex endeavor to succeed for it to be successful. It derives from the quote in Tolstoy’s Anna Karenina, “Happy families are all alike; every unhappy family is unhappy in its own way.”

	Medications not available
Discharge	Need for followup care, medications; Need for followup care, counseling; Discharge location; Permission to report data

Figure 1: Patient Encounter Form Information.

PEF Implementation Requirements. Implementation requirements derive from two primary sources. The first concerns clinicians and in particular their workflow and their experience and comfort level with technology. Workflow is variable; some clinicians such as those at larger hospitals see many mental health patients a week, while others see just a few. The opportunities to gain experience with technology in Liberia are quite limited, and most clinicians have little to no experience prior to participating in the program.

The second concerns technical infrastructure in the country where electrical power is generally present in clinics and hospitals with varying reliability, but frequently not present where people live. Internet connectivity is highly variable. Over the course of the project, Internet access by individuals increased according to ITU estimates from 2.3% of the population in 2010 to 4.6% in 2013. Internet quality in the capital of Monrovia improved. However the Internet remains flakey, with regular periods of time when access is slow or entirely unresponsive.

These observations lead us to the following design decisions:

- **Design for novice users:** Reduce the amount of typing, provide paper supports (for workflow), use tabbed structure, don't put too much information per screen
- **Design for off-line operation:** Assume data entry is done off-line with uploads as much as several months later
- **Design for low bandwidth uploads.** Use concise representations to send data to the server. Support partial uploads (some stored PEFs but not all). Provide upload confirmation.

To understand whether the Carter Center program is making a difference in patient outcomes requires the ability to connect different PEFs in the database to the same individual. To achieve this while maintaining patient confidentiality, we used a mathematical hash function on select demographic data, namely patient First Name, Last Name, Date of Birth (DOB) and Gender to generate a unique patient ID. We chose this demographic information as a minimum set that we thought would avoid most collisions (i.e., two different patients with the same demographic information), based on discussions with local experts. We do not know how many collisions occurred, though an informal query to 50+ clinicians at an in-service produced just one clinician with one example of two people with the same name, DOB and gender in her practice.

One challenge with using DOB is that not all Liberians know this information. Following standard practice, clinicians were directed to use January 1 and ask for a best guess as to the year, relating it to events in the country that are well known (e.g., "before or after Tubman became president?"). Obviously this method of estimation is imperfect and could even produce two different answers from the same patient on two different visits.

We don't have a method for determining how often this type of error occurred.

Clinicians need a basic level of understanding about how the patient ID is generated so that (1) they believe patient confidentiality is preserved and (2) they can provide some explanation to patients if asked about confidentiality preservation. Since patients are asked for clearly identifying information (name, DOB, gender), and clinicians must enter this information in the form to generate the Patient ID, belief in what happens after that, inside the machine, is critical. We settled on an analogy to cooking a common Liberian dish (soup). In the analogy, the name, DOB and gender are ingredients in the soup. Once the soup is made, you cannot tell exactly how much of each ingredient went in, but if you make it again with the exact same ingredients, it will taste the same. Clinicians reported that this made sense to them. An early effort to use an analogy to making rice was scrapped when we learned that rice dishes in Liberia have only one ingredient (rice).

PEF Implementation Effort. The PEF implementation was largely built by teams of undergraduate and MS-level students enrolled in a capstone, project-based course in computer science. Two implementations were completed and deployed: the first was built in Fall 2010 and deployed for use starting in January 2011. This first implementation was web-based and required the installation of an apache web server on each clinician laptop and a cumbersome method for generating the Patient ID in a separate application with cut-and-paste into the PEF. The second implementation was built in Fall 2011 and deployed for use starting in June 2012. The second implementation was application-based and written in Java. It did not require apache web server installation, and it had a more robust, built-in facility to generate the Patient ID. All of the data reported in this paper comes from use of the second version, starting in June 2012. Figure 2 illustrates a screen shot from the second implementation.

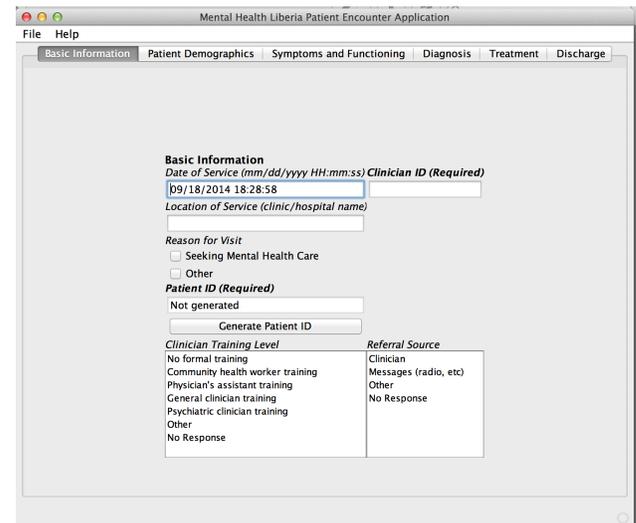


Figure 2. PEF Screenshot.

An MS student in Computer Science worked on the second implementation during the spring term of 2012. At that point he graduated and took a job at Google. Somewhat remarkably, he has continued to support the implementation, fitting the work into evenings and weekends as his day job allows.

A third implementation was developed in Fall 2013 but never deployed. The student team that implemented it did not complete the handover of code to the Carter Center and did not respond to email inquires after the term ended.

Both deployed implementations supported off-line data entry with a web server in the cloud to be used to upload PEFs when Internet access was available.

PEF Training. Training on use of the PEF took place initially in a half-day session during the six-month training of each cohort. During this session, use of the PEF was demonstrated, and then the clinicians practiced using it under supervision. We chose locations for the PEF training that had wifi and Internet access; sometimes it worked and sometimes it didn't, a faithful reproduction of what clinicians encountered in the field. A one-page sheet of instructions was provided that covered the basics and emphasized areas of common problems based on past experiences. For example, for consistent generation of the Patient ID, names had to be entered in standard format, e.g., Peter Flomo. Likely due to inexperience with typing and with forms, small errors were common, e.g., peter Flomo, Peter J. Flomo. Because small errors produce completely different patient IDs, it is crucial to avoid them.

Follow up training was provided via one-day (Saturday) in-service training every six months. In-service trainings were a standard part of clinician practice; they were held on a variety of topics throughout the year. Clinicians were reimbursed for their travel costs and provided with breakfast and lunch during trainings. As in the initial training, follow up training was held in locations with wifi access.

Our survey indicates that nearly all clinicians attended the PEF training day during their six-month mental health training. At the in-service in July 2014 about half of all respondents had attended one PEF in-service training previously and about half had not attended any previously. Many who had not attended previously came from the most recent cohort, and thus this in-service was their first opportunity to participate.

PEFs in Practice. Submitting a PEF was not an easy task. It required the successful completion of many steps, each subject to possible disruption. The clinician needed to see a mental health patient, take notes during the patient visit, have a laptop without viruses or other operational issues, have a sufficiently charged laptop battery or connection to a power source, correctly use the PEF software to enter the patient information, store the PEF locally, get access to the Internet with an edge that had credit and was in a location with wifi coverage, and upload the PEF. A key goal of our evaluation efforts was to understand what motivated clinicians to persist in completing this challenging process.

5. EVALUATION

We surveyed 53 mental health clinicians, all of whom attended an in-service training in July 2014. One attendee declined to participate in the survey. The survey had five sections: prior education and computer experience, clinical practice setting, training and learning to use the PEF, reasons for participating (or not) in the PEF data collection program, and workflow. The survey was not anonymous; clinicians were asked for their name and cohort number. We did this primarily to allow for the possibility of selecting interview candidates based on survey responses, however we ended up choosing interview candidates by other means and could have made the surveys anonymous.

Five sections of the survey were common to all clinicians. In the section on PEF use, clinicians were asked to self-identify as “light”, “medium” or “heavy” PEF users, with guidance that light means “you have submitted none or few PEFs (0-10%)”, medium means “you have submitted PEFs on some patients (10-50%)”, and heavy means “you have submitted PEFs on many patients (50-100%)”. The survey branched so that light and medium users responded to questions about barriers to use while medium and heavy users responded to questions about motivations to participate. Most clinicians identified as light users (48%) or medium users (38%), with 14% self-identifying as heavy users. This is not entirely surprising since those who are heavy users have less reason to attend the in-service about how to use the PEF. (They are still encouraged to come, and the in-service provides additional value such as a chance to connect and reconnect with other clinicians.)

In addition to surveys we conducted 12 interviews, most lasting about 30 minutes, also in the mid July time period. The interview participants were chosen to get coverage across all of the cohorts except the most recent, to get a gender balance, and to achieve some geographic coverage across counties of the country. Clinician availability at the in-service or in the local area was also a consideration. The interview participant demographics are provided in Figure 3. In the quotes that follow, clinicians are identified as C1-C12 corresponding to participant 1 through 12.

Participant	Age	Sex	County	Cohort
1		M	Nimba	6
2	37	F	Montserrado	5
3	32	F	Lofah	3
4	32	F	Grand Gedeh	2
5	41	F	Montserrado	2
6	40	M	Gbarpolu	5
7	42	M	Gbarpolu	4
8	30	M	Maryland	4
9	26	M	Bomi	5
10	36	F	Grand Gedeh	1
11	36	F	Sinoe	4
12	28	M	Sinoe	6

Figure 3. Interview Participant Details

Except for the first, the clinician interviews were conducted by a research assistant who had not been involved in the PEF implementation or training. The names of the clinicians interviewed were not included in the transcripts, though the demographic information above could have been used to connect the interview to the person. These steps reduce, but are not guaranteed to remove, expectancy bias.

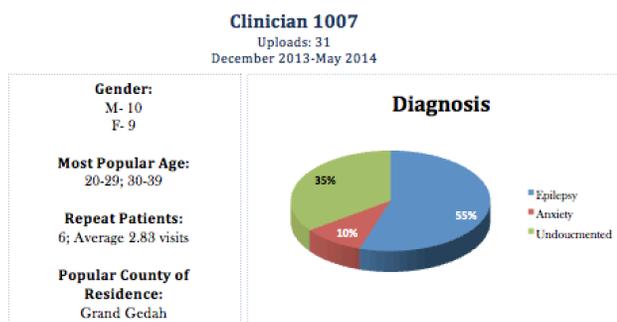
We also interviewed the prior IT support person who worked half-time for the Mental Health program and the current IT support person who works full-time for Mental Health. These interviews also lasted about 30 minutes and were conducted by the faculty member who led the PEF development and training, thus they had greater potential for expectancy bias. We chose this interviewer because the IT interviews touched on technology issues that were not familiar to other available interviewers.

Because the interviews probed similar content to the surveys, we interleave quantitative results from the surveys with qualitative results from the interviews.

Motivation to participate. We were interested in what motivated clinicians to participate in the PEF data collection. The importance of doing so was extolled regularly by the in-country program director, and the clinicians were well aware that one primary reason for providing them with laptops was for PEF completion. They were also taught and encouraged to use the laptops for research and for preparing educational materials.

During in-service trainings in the summer, the clinicians were shown presentations of aggregate data that had been used in the spring program reviews back in Atlanta, illustrating that their work was showcased to others. On the “stick” side of the carrot-stick equation, clinicians were regularly threatened that their edge devices for accessing the Internet would be taken away or not re-filled with credit if they did not submit PEFs. That threat was not acted upon until late in the program when a new, full-time IT person was hired with time to devote to accounting for monthly submissions.

While the original intent was to close the loop and provide the clinicians with dashboards illustrating their practice, that only came to fruition in very limited fashion. In July 2014 clinicians were provided with a half sheet of data, a pie chart of diagnosis, counts of male/female patients, most common age ranges, most common county of residence, number of repeat patients. (See Figure 2.)



When asked about motivation to participate, many who were medium to heavy users rated the reason “Important for the Carter Center MH³ Program” as Very Important (87%) and the reason “Important for MH in Liberia to have data collection” as also Very Important (94%). Most medium and heavy users also reported that being “Proud of my practice and want to share information about it” was a Very Important reason for completing the PEF (77%).

Sharing information with those in a position of responsibility for the program was a theme in the comments on motivation to participate:

“[O]ne of the motivating things is that, it helps we the clinicians...to let Carter Center know that we are working – we are on the field, implementing what they have taught us.” [C1]

³ MH is an abbreviation for Mental Health well understood to the clinicians.

“Well, it’s very very very important to fill out the PEF to report to the program manager, whosoever is supporting the program to know the level of work we are providing in Liberia, that makes him or her know how the program happens and they will continue to do even more.” “[I]t is very very important for us to get online to share reports with our bosses so they can support us in the program.” [C3]

And

“It is important because you people will get to know the patients we are seeing, the improvement, the number of cases and the breakdown, too....so people will support the program.” [C4]

Positive reasons to participate, such as those above, were rated as more important than negative consequences. “Afraid the edge might be taken away” was rated “Not Important” by 83% of regular users. Respondents were relatively split in their responses to the prompt “Don’t want to disappoint program director”; 48% of respondents stated that this was a “Very Important” reason to complete the PEF, while 37% stated that this was “Not Important.” Similarly, survey respondents were evenly split in their response to the prompt “Don’t want to disappoint technology person” with 44% stating that this was “Not Important” and 41% stating that it was “Very Important.”

In interviews, most interview participants reported that their primary motivation for filling out the PEF was to gather and report information about mental health and about their work as mental health clinicians in Liberia. Many participants were motivated to complete the PEF because they felt that the information gathered from the PEF could help raise awareness about mental health. Many participants also felt that the PEF was an important tool to report the results of the mental health program to stakeholders, including the program director, The Carter Center, and the Ministry of Health and Social Welfare. Some participants reported that they felt the information collected from the PEF could help gather support for the mental health program. Some participants also felt motivated that the data collected from the PEF could be used provide clinicians with feedback about their practice. Some interview participants reported that they were motivated to complete the PEF because they felt that it was part of their duty, personal commitment, or responsibility. For example:

“Well, the first thing is: I’ve made a commitment. I have made a commitment to do this mental health work.” (C6) And from the same clinician, *“if I took my ordinary work...and I did treat the client and did not record anything at all regarding the malaria treatment...though the client went home well, I have not done anything because I did not record it.” (C6)*

A few participants reported that completing the PEF helped improve their clinical practice by guiding them to make more specific diagnoses or by supporting them in following patients over time.

Most interviewees reported that the threat to not recharge the edge if they failed to upload a sufficient number of PEFs did not serve as a significant motivator; several clinicians reported that they could obtain internet access otherwise with relative ease even without the edge, and some reported that the network for the edge was poor at their clinical site anyway. A few participants expressed that they supported the “threat” because they felt that access to the edge served as a reward for contributing to the program.

Paper supports. Early in the program we asked clinicians who were regularly completing the PEF to talk to us and other

clinicians about their workflow practices. We heard that they typically took notes in a notebook during the patient encounter and then completed the PEF later, at the end of the day or week. To assist with this workflow practice, we developed two related paper supports. We created a half-sheet version of the most important PEF information and laminated it into a reference card that clinicians could keep to guide the information they recorded into a notebook. Some clinicians were able to make paper copies of the reference sheet, but most did not have reliable access to copying. We later produced booklets that had tear-off copies of this half sheet version so that clinicians could record information directly onto the sheet.

Most interview participants reported that they used the paper version of the PEF, with many of these reporting that they recorded additional notes or information that is not included in the paper copy elsewhere for entry in the PEF software. Many of these participants reported filling out the PEF for every patient with mental health issues that they encountered. A few interview participants reported that they preferred to enter the patient's information directly into the PEF software. A few participants reported that they did not have any paper copies of the PEF form, one because they had never received them, the other because they reported that the hardcopies were in short supply. Some participants reported that they had never received a copy of the laminated hardcopy of the PEF. A few additional participants reported that they did not use the laminated form even though they had it. Only one participant reported using the laminated form in order to make photocopies.

Many respondents reported that the one page sheet of instructions was helpful when initially learning the PEF, although no respondents reported continuing to use this sheet of instructions.

Informal learning. We were interested in who clinicians turned to for assistance when they had difficulty with the laptops or with the PEF. Most survey respondents reported that they had sought help from Carter Center staff for help with their laptop (89%), with the majority of those reporting that the experience was either "Very Satisfactory" (66%) or "Somewhat Satisfactory" (28%). Most survey respondents had also asked another clinician for help with their laptop (61%) and had also received a "Very Satisfactory" (30%) or "Somewhat Satisfactory" (55%) experience. Similarly, most respondents reported having asked staff for assistance with the PEF (75%), with most reporting a "Very Satisfactory" (63%) or "Somewhat Satisfactory" (29%) experience. Most had also asked another clinician for assistance with the PEF (75%), with most of those reporting a "Somewhat Satisfactory" experience (66%) but a higher percentage reported that their experience was "Not Satisfactory" (18%).

In interviews, many interviewees mentioned that the initial PEF training was helpful, most reported that it was only somewhat helpful. A few participants specifically mentioned that the first orientation to the PEF was too brief. The majority of interviewees reported that the first PEF in-service training that they attended was especially helpful. Many of participants mentioned that they found talking to other clinicians about the PEF helpful for learning and trouble-shooting purposes. Nearly all interview participants reported that the IT service-specialist (either the first or second) was particularly helpful for both learning and trouble-shooting.

The IT personnel also reported that they spent considerable time on informal learning, much of it around viruses. From the first IT support person:

That was a common problem with their computer operating software and viruses on the clinicians. A lot of the clinicians were kind of limited [in their experience with the computer]. Any advertisement, flashing, that they saw, free shareware and free software [was attractive to them], all brought a lot of spyware and viruses, so I spent a lot of time trying to get it straight, clean the computers, get it working.

And on how he attempted to educate the clinicians about viruses:

I told them, on the Internet you have to be careful. It is one of the most common places to attract viruses, especially free software, some of them love music, they always try to get that, I told them you have to be careful...sometimes you see flashes on-line it tells you maybe you won \$50,000 and you know knowing to yourself you did not play any lottery and then you click and you download a virus. If you see it just pass by it. Do not click.

Barriers to participation. We explored barriers to participation with those who self identified as light or medium users, as well as with all interviewees. Overwhelmingly the barriers concerned use of technology, especially the Internet, rather than technology-neutral barriers such as a belief that filling out the PEF was not important. In interviews, the most commonly reported challenge in working with the PEF was problems with Internet connectivity, particularly if the edge network was down or there was no network available in their area. Many respondents mentioned that they had difficulty uploading the PEF, an issue that could come from problems using the PEF software, but perhaps more likely comes from Internet access. Some clinicians reported that they had difficulty when their edge was not recharged; some respondents reported that they had problems with damage to their laptops, which may have included viruses, not just physical damage.

Interview respondents also reported some problems using the PEF software. Some participants reported that they had difficulty with "null files", a bug in the software that caused PEFs to save locally in incorrect format, blocking further uploads. The in-country IT director discovered this problem and developed a fix, which was shared with mental health clinicians at in-service sessions and in one-on-one tech support interactions. Some respondents mentioned that they had difficulty saving their PEF forms.

One workflow issue emerged in interviews. Some clinicians reported that they had difficulty completing the PEF when their patient load was very heavy. All interview participants who were asked how much time it took them to fill out the PEF reported 5 minutes or less. In the survey, 25% of light and medium users reported that the time to fill out the PEF was "Somewhat Important" as a contributing factor when they did not fill it out, while 63% reported the time was "Not Important" as a contributing factor. It appears the heavy patient load is a barrier because it leaves less time in the workday for extra work such as completing the PEF, not because the PEF itself is overly time consuming.

6. DISCUSSION

Individual, Collective and National Pride.

Our interviews suggest that pride is felt by clinicians as individuals, as a collective (mental health clinicians trained by the Carter Center) and as citizens of Liberia. Being proud of one's own practice is a significant factor in reporting, as indicated by our survey, but in our interviews, collective and national pride both are mentioned as key reasons to fill out the PEF.

"[A]ctually when I received the call that I have not been sending forms, it also motivated me because it made me know that people are actually following me after training, not just training and let me go, so they had interests in what we do." C5

"So that is the motivation so that our country will have the record of how many mentally ill clients we have in our country so we can use this information to look at the world around us. To know even though others are having mentally ill people, what about Liberia?" C6

Williams and DeSteno's work on pride and perseverance cites several definitions of pride that all have in common that pride is a positive emotion connected to accomplishment that involves "public evaluations of the self" [17] p. 1007. That is, pride is most strongly felt when the accomplishment is visible and valued in public. Despite the fact we did not close the feedback loop by giving clinicians regular dashboards of their practice, the evidence indicates that they were acutely aware that their reporting was visible to others and potentially used to make important decisions. It was less important that their accomplishments were documented back to themselves, and more important that they were visible to others.

In other work in Liberia, teaching computer programming at the iLab technology hub, we have heard similar notions of individual and national pride. The desire to create something and have others outside Liberia use it is mentioned by class participants as a reason to be interested in learning to program.

This suggests that ICTD projects that rely on participation might productively work to increase the sense of pride by participants. Because pride involves public visibility, ICTD projects should pay additional attention to the ways that participants understand who is seeing their information and how their information is being used. More generally, individual and collective motivation appears to be a fruitful direction for more ICTD research.

ICT Project Success. On the criteria of longitudinal data collection, this project has been a success. The project has operated over more than four years; more than 140 clinicians have received training in the use of the software; PEF uploads currently number more than 4000, with around 3000 valid uploads (not duplicates or from training days or with obvious errors). The project included significant changes in the software, in the software development "staff" (students, discussed below) and a change in the local IT support personnel.

The literature identifies a key role in ICT4D project success for project champions [22] defined as "any individual who makes a decisive contribution to the ICT4D project by actively and enthusiastically promoting its progress through critical stages in order to mobilize resources and/or active support and cooperation from project stakeholders." The so-called 3Rs of results, relationships and resources are three constructs associated in the literature, and by Renken and Heeks, with champions [22].

In our context we identify a constellation of project champions, each instrumental yet none serving as "the" singular champion. The in-country lead for the Mental Health Liberia project was a champion of relationships and results. For this project, her relationship with the clinicians and enthusiasm to press upon them the importance of the PEF were critical. The C4G professor was skilled at focusing on results and assembling resources in the form of student groups and even post-graduation student effort. Other individuals played important roles, including the Director of Mental Health for the Carter Center who advocated for and supported the inclusion of laptops in the program budget, the IT support personnel who were on the front lines in keeping the laptops operational and in providing informal PEF training, and the graduated student who remained connected to the project far beyond expectations.

The literature on project success and failures identifies three common features in failed projects, namely top-down, technology centric and goal diffuse [21]. Our project was largely top-down, though we made changes based on clinician input, including simplifying the patient ID generation process, adding a section for clinicians to mention drugs that were prescribed but not available, and providing paper supports. Our project was data collection centric; whether that counts as technology centric or not may be debatable. The data collection was largely an addition to regular clinician practice, rather than an integral part of practice so in that sense it was technology centric. Our project was definitely not goal diffuse. The clinicians heard the same message consistently over many years and from multiple sources: it was important to fill out the PEF to provide a picture of mental health in Liberia to guide the program and to show to program supporters. These observations suggest that success for long-term efforts may depend more on consistency of purpose and adaptability of methods rather than initial disposition.

Project Development Sustainability. The software for this project has been sustained over more than four years. Student teams comprised of undergraduates and MS students worked on versions of the PEF software in Fall 2010, Fall 2011 and Fall 2013. An MS student on the Fall 2011 team did an independent study to further develop the software in Spring 2012, and he has continued to support the software since then. The same professor taught the project-based Computing for Good class each of these fall terms and supervised all teams, providing project continuity. Student teams were relatively effective as a mechanism for software development under the supervision of a single professor responsible for the relationship with the Carter Center and for training. The student teams were not viable for software maintenance, and instead the graduated student was the only source of maintenance, a risky arrangement but one that worked for this project.

To the open-ended question of why he continues to support the PEF, the graduated student replied:

There are several reasons I stayed involved with the program. In the order of importance:

The first is that it feels good to be able to use my talents to help other people.

The second is that I like that it enables me to stay in touch with Our University, which I credit for giving me the opportunity to learn and advance on the path that I follow today.

The third is that it's nice to know something I helped create is continuing to serve a useful purpose, and I like maintaining it and improving it so that it can continue to serve its purpose.

Using a changing team of students was not without issues. Students in the Fall 2011 team deployed the server with a third-party hosting service, using a name and credit card of one of the generous students as the method for recurring payment. The responsibility for payment was not transferred to the Carter Center, as we realized only when the credit card expired in June 2013, and the hosting service was unable to reach the student by the email address left as the contact. After a month without response, the hosting service took down the server and deleted the data. We had a local copy of the data up until April 2013, which we restored. Ironically, after the server was taken down, the PEFs could not be uploaded and thus were stored on clinician laptops, just as if the Internet was not working. There was some data loss in the May-July time period, after our last download to local storage and while the server was still up and accepting PEF uploads.

This problem is, of course, easy to avoid, however it is symptomatic of a bigger issue, namely a mismatch between faculty-led and student-constructed software development and long-term software maintenance practices. We have used the expired credit card story in every subsequent offering of Computing for Good to highlight the importance of a *complete* handoff of a project to the partner organization. More generally, we have increasingly emphasized project sustainability from the outset of the course, requiring sustainability considerations at each phase, from design to implementation to deliverables.

Lessons Learned about Design of Data Collection Software.

The lessons learned about data collection are not surprising in retrospect, and perhaps should have been anticipated. Because they were not, we offer these as guidance to future research and implementation projects. They largely stem from assumptions about what would be “easy” or “obvious” for clinicians in the field based on Western imagination. These were made despite inclusion in the project of those with expertise working in international health.

The first lesson concerns the amount of data collected. In short, more is not better. During design of the PEF it was not entirely clear what data would be most useful later, and thus there was a natural tendency towards including more. This increased the time to fill out the PEF, but in addition, led to an unnecessary cognitive load. Certain fields, such as the distance traveled to the clinic, were difficult to explain to clinicians while also receiving little or no attention in post analysis. (Distance is difficult to estimate when most travel is by walking or riding in shared taxis.) We eventually mapped distance to walking time as we explained how to fill out the field, e.g., “1 hour walk is 5 km”, but better would have been to leave this out or to ask for distance in walk time rather than kilometers.

We offset the too-long form somewhat by creating the short paper form that asked the clinicians to record only what we later decided was most important to record in the PEF. But far better if the PEF had asked for exactly this information rather than asking the clinicians to partially fill out what was there.

A second lesson learned was that standards for information representation essentially embed assumptions. It takes experience and exposure to develop the notion, for example, that names should always be expressed as First Last. This is confounded by the challenges of learning to type in a setting where there are very few opportunities and resources to do so. Thus mistakes can arise from the challenge of typing and also from a not-yet-ingrained representation standard. The obvious implication for technology is to include format checks in the

data entry software, with useful feedback to allow correction. The latter of these may require local context.

A third lesson learned was that the effort to maintain a working set of 140 laptops distributed throughout a developing world country is a near full-time job. Some of the effort was connected to the PEF software, but a substantial additional issue was the presence of viruses. Our contacts at the iLab technology hub report surmise that nearly every thumb drive in the country is infected. New users are more vulnerable to enticements arriving via email or on the web that contain viruses. Keeping virus software up to date is nearly impossible with intermittent connectivity. This suggests a need for a different model for virus protection software suitable for low resource environments, combined with additional user education efforts.

7. FUTURE WORK AND CONCLUSION

Our survey data may allow higher-order statistical analysis to investigate correlations between clinician participation and other factors such as practice location, prior technology training, current technology use, and clinician support or isolation. This would be helpful for understanding how to reinforce clinician participation for those who are not regular participants as well as to develop a more complete picture of the role of pride as a motivator in comparison to other factors correlated with participation.

Our lessons learned about data collection and mental health data collection in particular have been shared with the Ministry of Health and Social Welfare. They have the potential to inform the design of future data collection systems, such as the integration of mental health patient data into DHIS2.0, a health information system in wide use in the developing world [23].

At the end of July 2014, the Carter Center removed all American personnel from Liberia due to the Ebola outbreak. A minimal staff of Liberians continues to work at the Mental Health Liberia program office, but training has been suspended. Remarkably, clinicians continue to upload PEFs, with more than 200 uploads in the six week period from mid July to early September. The data contained therein and subsequently may eventually allow an analysis of the effect of the outbreak on mental health in the region, pre-outbreak, as the outbreak evolves, and hopefully post-outbreak.

8. ACKNOWLEDGEMENTS

Omitted to maintain anonymity.

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