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The Operational Medicine Institute

The Haiti Information Technology Rescue Project: Electronic Medical Record and Patient Tracking Assessment

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EXECUTIVE SUMMARY

A coordinated tracking system of medical data for patient care does not yet exist for Haiti. Patient medical histories remain unknown and physicians continue to make vital treatment decisions with incomplete information. Haitians continue to be under-served and under-represented by this lack of medical knowledge and health services. A mobile electronic medical record could solve many of these challenges while setting the stage for improved recovery.

On January 25, 2010, the United Nations Shadow Clusters for Health and Technology in Santo Domingo tasked The Operational Medicine Institute with assessing existing information technology (IT) solutions and proposing strategies for development of improved disaster IT solutions for electronic medical record (EMR) and population tracking. Post-disaster Haiti continues to present challenges in tracking and serving a highly mobile patient population. The OMI's assessment confirms the need for a disaster-specific EMR system. A centralized, electronic database is the best solution to track and serve patients, particularly the high volume of orthopedic patients who will require on-going care for the foreseeable future.

The OMI recommends the following actions as a result of this assessment:

(1) Approval by the UN and PAHO for continued investigation and development of a universal electronic tracking system in Haiti.

(2) Confirmed UN/PAHO commitment to further the product adaptation of the iChart wireless device application (or equivalent), based on the specifications and product requirements described herein (Reference: Section III, Point 12).

(3) Designation of discrete funding to support the development, deployment and assessment of EMR and health infrastructure during Haiti's reconstruction.

An EMR system will improve patient care, reduce morbidity and mortality, and protect vulnerable populations. The OMI strongly supports this opportunity to build a high-quality, integrated data system for patient tracking and care during this critical time in Haiti's recovery.

Respectfully,

Dr. David Callaway,
Director The Operational Medicine Institute

Haiti Information Technology (HIT) Rescue Interim Report on Electronic Patient Tracking and Medical Record Systems in the Haiti Earthquake Response

SECTION I: INTRODUCTION

1. *Mission overview:* Since the earthquake of January 12, hundreds of thousands of Haitians have been displaced and have received medical attention at over 56 clinics and hospitals. In Haiti, there exists no standardized patient registration and tracking system. The consequent lack of personal identification and medical data poses further risk to victims. A standardized centralized patient tracking and medical record system would improve the quality and efficiency of the clinical care provided, decrease the likelihood of medical error and family separation and support public health efforts.

2. *Response Review:* Thousands of volunteer doctors and other medical personnel have deployed to care for the hundreds of thousands of earthquake victims in Haiti. The scale of the tragedy and the urgency of the care required, coupled with the ad hoc groups of medical teams staffing various facilities have created a serious problem with medical record keeping and patient tracking. Doctors have saved lives with rapid surgeries only to have patients suffer post operative complications related to a lack of access to critical documentation. For example, for weeks after the disaster, it was commonplace to come across a victim with a cast and have no information about the type or injury, date of surgery, or follow-up plan. Given the high frequency of orthopedic and neurological injuries following earthquakes, proper follow-on care is critical. Accordingly, the need for better record-keeping has become acute. In addition, given the significant problem of community displacement, there exists a humanitarian need to locate family members and account for displaced persons in order to efficiently direct recovery efforts and protect high risk populations.

3. *Tasking:* The United Nations Shadow Clusters for Health and Technology in Santo Domingo tasked The Operational Medicine Institute with assessing existing information technology (IT) solutions and proposing strategies for development of improved disaster IT solutions for electronic medical record (EMR) and population tracking. From our initial PAHO briefing on January 25, 2010:

   "The teams must be empowered by mandate of a recognized authority such as the Haitian or Dominican Government. The Technology Cluster should identify this authority promptly and request such a mandate."

   The Technology Cluster lead, Dr. Alejandro Baez, and the Pan American Health Organization (PAHO) provided OMI with verbal mandate to address this challenge. The OMI project, entitled "Haiti IT Rescue" was launched on 20 January 2010. The leadership team comprised of top-notch group of IT leaders, software developers, and medical and disaster response advisors promptly deployed needs assessment, implementation, and policy teams. The urgency of this initial effort cannot be emphasized enough. With each passing day after a disaster, disparate systems become increasingly ingrained and difficult to coordinate resulting in diminishing quality and efficiency of care and increased morbidity and mortality.

4. *OMI Background and Organizational Description*: The Operational Medicine Institute (OMI) is a group of Harvard affiliated professionals who provide critical mission support and training to medical personnel, humanitarians, first responders, and disaster response teams serving on humanity's frontiers. The four pillars of OMI– humanitarian intervention, disaster preparedness and response, operational medical support and unconventional diplomacy–are designed to capture the increasingly interwoven nature of complex humanitarian emergencies.

   The core values of The Operational Medicine Institute reflect:
   - A respect for human rights
   - The societal responsibility of the strong to defend the weak
   - A commitment to the advancement of the science and art of healing
   - An openness to diversity in thought and innovation in practice

   OMI responded to the devastation in Haiti with continuous operations beginning January 13th, 2010. Teams from OMI helped to establish the Incident Command Structure for Good Samaritan Hospital in Jimani, DR- a major tertiary care referral site. In addition, the initial assessment team identified several critical operational gaps and deployed specialists to initiate the Haiti IT (HIT) Rescue Project and the Comprehensive Amputee Identification and Rehabilitation (CAIR) Consortium.

5. *Partnerships/ Supporting Agencies:* The OMI is a component of Harvard Medical Faculty Physicians, based out of Beth Israel Deaconess Medical Center in Boston Massachusetts. The OMI operations have been supported by the following groups:

   5.1. Beth Israel Deaconess Medical Center
   5.2. Harvard Humanitarian Initiative
   5.3. Universidad Iberoamericana, Santo Domingo
   5.4. The Harvard Kennedy School
   5.5. The Harvard Business School
   5.6. Jordan International Aid / Enoch Choi Foundation
   5.7. CareTools, Inc.

6. *Financial Disclosures:* No member of the OMI Haiti Information Technology (HIT) Rescue Team has financial interests in any product evaluated or recommended.

SECTION II: HAITI INFORMATION TECHNOLOGY (IT) RESCUE PROJECT

1. *Consolidated HIT Rescue Mission Statement:* OMI will assess existing EMR and patient tracking technology and develop a mobile, scalable patient tracking and medical record system linked to a centralized database in order to address the growing problem of post-

disaster patient registration, care documentation and tracking and the vast inefficiencies in existing volunteer medical treatment procedures.

2. *Existing systems*: At the time of the earthquake, the main functioning electronic medical record system in Haiti was OpenMRS. OpenMRS is an open-source electronic medical record system developed by in-house programmers at Partners in Health (PIH) along with a few partner institutions. Because PIH has served Haiti for years, they had already populated a significant database of Haitian patient records in their system. To date, OpenMRS has been employed in twenty countries, primarily in Africa.

   OpenMRS is highly customizable, which makes it a powerful tool for disease tracking and scientific research; the system's principle is that "information should be stored in a way which makes it easy to summarize and analyze." Unfortunately, this level of flexibility also makes it difficult to implement in more traditional medical records environments and, in particular, in disaster situations. In addition, the complexity of the system and its implementation as a client-server application make developing a mobile version particularly challenging. The development team has been working for many months on a product but has yet to deploy one successfully.

3. *The disaster response landscape:* The HIT Rescue Project addressed four major operational characteristics in examining existing options and proposing full spectrum solutions: patients, volunteers, care sites and technology.

   3.1. Patient characteristics:
      - 3.1.1. Communication- Many patients spoke only Creole or French resulting in significant communication challenges- including registration and data collection.
      - 3.1.2. Identification- Few patients have government- issued identification cards.
      - 3.1.3. Displacement- large numbers of patients and accompanying family members were displaced 10-100km from their primary residences.
      - 3.1.4. Complex family dynamics with "aunts" and "uncles" often playing the role of parents.
      - 3.1.5. Orphans and unaccompanied minors present a unique tracking and protection challenge.
      - 3.1.6. High acuity patient population.

   3.2. Volunteer characteristics:
      - 3.2.1. Transience- The volunteers are frequently staying only 7-10 days.
      - 3.2.2. Inexperience- Volunteers-have different levels of medical and disaster expertise. Many are first time volunteers.
      - 3.2.3. Communication- Few volunteers speak Creole or French resulting in significant language barriers.
      - 3.2.4. Accountability- There is no system for volunteer registration or credentialing.
      - 3.2.5. Personal Technology- Most volunteers possess some form of cellular/digital mobile communication and/or computer.

   3.3. Care site characteristics:

3.3.1. Quantity- Estimates suggest more than 50 transient and permanent care centers exist between Haiti and Dominican Republic
3.3.2. Character- Sites vary from "tent cities", to semi- permanent structures, to fixed facilities.
3.3.3. Lack of Standardization- There are few if any standardized operating procedures at any facility
3.3.4. Logistics- Power and communication assets are variable. Few reliable resupply systems are in place.
3.3.5. Security- Security systems were variable. This is important when utilizing technology as electronic equipment can increase the risk of criminal targeting and jeopardize mission success.

3.4. Technology characteristics:

3.4.1. Internet access via satellite is unreliable and offers limited bandwidth. Generally the Internet is being accessed via computers/laptops.
3.4.2. Many volunteers have a mobile device- most common in the border region was the Apple iPhone.
3.4.3. Cellular/digital mobile access is expensive if using US-based service plan as is data and short message service (SMS) access. AT&T initially discounted cell service and texting for responding personnel.
3.4.4. Advanced wireless technology was rapidly deployed to certain regions to create local area networks.

4. *Project Specifications:* The HIT Rescue project specified that any solution must meet several minimum requirements. The following topic list was sent to the technology teams to guide their search for solutions:

4.1. Continuity of care*:* Tracking the care provided to thousands of patients by hundreds of volunteers. For example, there are patients who have obviously been previously treated based on the presence of a cast/ external fixator. However, the patient lacks documentation as to the injury/ diagnosis and the date of intervention. Also, patients may be moved from one care center to another based on a number of factors including capacity limitations.

4.2. High risk population tracking: The most obvious examples include unaccompanied minors, amputee and other post- operative victims. These populations require both immediate and ongoing treatment plans. Early identification and tracking is critical for accountability and high quality care.

4.3. Displaced population tracking: The urban epicenter of the earthquake and massive casualty numbers resulted in separation of families and displacement of victims, patients and even tangentially affected populations. Tracking of these populations is critical for public health planning, resource allocation, reconstruction efforts and family reunification. This system requires local and web based components as well as the ability to combine clinical data with other databases.

4.4. Interoperability: Recent estimates suggest there are over 3,000 NGOs operating in Haiti. In addition, local and international governmental organizations are heavily involved in aid efforts. Any IT solution must allow for interoperability with existing systems, ease of use and a facilitated training program.

5. *Implementation Challenges:*

5.1. Scale: Support across 50+ care centers, hundreds of volunteers, and thousands of patients. In order to scale a device, application, network or database solution it must be inexpensive, interoperable with existing data management systems, require little or no training or possess a built-in training module.

5.2. Patient privacy / data security: In general, health information is considered private and requires protection. In environments such as Haiti, where child trafficking is reportedly rampant and population data may be misused, proper security is critical.

5.3. Permissions: The transient nature of volunteer activity requires a tailored data access strategy. Further, volunteers may provide different levels of service resulting in a need for tiered access and permissions.

5.4. Connectivity: Data should be shared between volunteers and organizations, but mobile devices are really only "connected" when connected directly to a network, such as the Internet or tethered to an network-enabled computer. Because continuous network connectivity cannot be assured, devices must be able to function offline (potentially for up to weeks at a time) and have robust online-offline syncronization capability.

5.5. Platform support: Ideal IT applications for use in a disaster relief setting will be largely platform neutral. Though many volunteers have iPhones, some have other mobile devices, and still others require computers/laptops to support specific clinical workflows. iPhones are common among volunteers but expensive, and are not common in Haiti or the Dominican Republic. Whatever device is used in the field for data entry and review should run a basic application that can feed data bi-directionally to a standardized data collection, analysis and processing system.

5.6. Budget: In the absence of governmental support, deployment will require combination of private donations, in- kind donations, and grant funding. The budget will include such costs as devices, network infrastructure and connectivity, salaries, logistics (e.g. international and local travel), training, maintenance, administration and communications.

5.7. Timeline: The need is immediate. A phased roll- out of any application could be successfully performed in less than 2 weeks with the proper financing, training officers and institutional support.

5.8. Deployment: Streamlined installation and training to get volunteers up and running quickly. System must be exceptionally easy to learn as volunteers rotate frequently and have a wide ranges of experience.

6. *Methods*: Upon receiving initial tasking from the UN/PAHO, OMI quickly assembled several technology teams, made up of volunteer industry professionals, to examine different parts of the challenge. We identified three potential courses of action:

6.1. Develop our own proprietary application*:* We developed specifications with a small team of software developers and doctors in Haiti with experience in disaster response. This project is ongoing, but we quickly determined that the development time line would be prohibitive for this to become the immediate solution Haiti required.

6.2. Adapt an existing electronic medical records software platform: Another technology team, including developers with extensive electronic medical records (EMR) experience, commenced a comprehensive survey of existing vendors and software applications to determine if there were off-the-shelf solutions that would meet the needs identified in Haiti. This has been our most active line of development.

6.3. Use existing technology, or even paper-based systems, that are not designed specifically for patient records. An example of something we examined here is using a cloud-based database like Google Docs to store patient information. The fundamental problem with most of these solutions is that they required uninterrupted, high-quality internet access; they thus failed one of our baseline requirements.

The OMI team identified option two (2) as the primary mission and immediately began parallel assessment and testing of numerous software platforms according to our criteria. Most systems failed to meet our baseline requirements as described in Section 1.4. An off the shelf application, iChart (Caretools, Inc.) met several of the predetermined requirements. The Caretools, Inc. leadership agreed to modify their existing platform based on the feedback from the HIT Rescue Team to create a more robust disaster EMR. The HIT Rescue Team decided to trial the iChart as its primary EMR. After discussion with the Caretools leadership, the OMI team began to field test this application as described below.

SECTION III: HIT RESCUE PILOT PROJECT AT FOND PARISIEN (FDP), HAITI

1. *Description of FDP Disaster Rescue Camp*: The Harvard Humanitarian Initiative (HHI) established the Disaster Recovery Center at Fond Parisien approximately 7 days after the earthquake. The OMI worked in conjunction with HHI to secure the site and begin operations. The site, located at Love a Child Orphanage, provided a discrete location with preexisting structures and a security wall. There was good infrastructure with well water, electricity (limited), and easy access to the border.

2. *The FDP Camp Characteristics were as noted*:

2.1. Patient population: Significant numbers of vulnerable populations (e.g. amputees, unaccompanied minors, patients with external fixators, elders and pregnant) with an immediate initial need for tracking these patients.

2.2. Patient Flow: Patients self presented or were transferred from Good Samaritan Hospital in Jimani, Santo Domingo, the USNS Comfort, or other facilities. Private vehicle and buses were the most common form of transportation. Patients would present to the front gate and be directed to the triage area. From triage, they would go to the medical tents or the operating room based on condition and ailment.

2.3. Patient registration: Patients were initially registered in a yellow log book. However, there existed no patient identification, tracking or medical record system.

2.4. Facilities: Major OR tents and air conditioned trucks were donated by the Dominican Ministry of Health and Operation Smile. Patients were housed in large (6-8 person) tents arranged in a grid pattern. The volunteers' section was separate with tent facilities. The LAC orphanage made available for use a warehouse and three buildings.

2.5. Power: Power for the medical and recovery facility was from a series of mobile gas-powered generators.

3. *Application Description*: iChart is a commercially available iPhone application that was specifically designed to "keep patient information organized," featuring assistance with billing, prescriptions, lab reports, and patient notes (caretools.com). Its focus is on medical assistance to a modern medical practice. iChart was not designed specifically for post-disaster application. However, given that our estimates showed that 75% of volunteer physicians at FDP had an iPhone, and that iChart was readily deployable in a limited WiFi setting (its features can be used offline as well), the HIT Rescue team used this application as part of a proof-of-concept trial before launching a home grown application specifically for post-disaster medical response.

4. *Beta Trial*: Tracking systems were first deployed to patient populations that could not readily advocate for themselves: unaccompanied minors (children under 18 without mother or father present) and amputees victims. The trial was started immediately after the HIT Rescue team partnered with Caretools who granted free access to their system while piloting this project in Haiti. During a week-long demonstration period, the HIT Rescue team registered all unaccompanied minors and amputees in the 279 person field hospital. The targeted population allowed for a proof of concept study as well as providing immediate service to the Haitian patients.

   Initially, the iChart program was used with many work-arounds. Unaccompanied minor and amputee data was gathered using the iChart demographic database, which had fields for: first and last name, social security number, medical record number, date of birth, sex, race, address, home phone, mobile phone and other. The HIT Rescue team initially used these fields to gather and track pertinent demographic information on the vulnerable populations that most needed tracking (Table 1).

OMI registration teams (1 or 2 staff + 1 Haitian- Creole interpreter) conducted a coordinated survey of the facility, visiting each tent to register patients and clear the backlog of unregistered unaccompanied minors and amputee victims. The surveys were initially conducted daily then switched to every three days once the back log was clear and all new patient data was being captured in triage or the operating theater. Average time for single patient input depended on each provider and ranged from 3min to 5min 30sec.

Unaccompanied Minors: After patient data was gathered for all unaccompanied minors in FDP, OMI helped to create a Child Protection Team which included: one pediatrician, one pediatric nurse, one physician from the field hospital administration team, and one member of the HIT Rescue team. Child Protection team members "rounded" on each unaccompanied minor twice a day, took in-depth interviews to reconnect children with family, and held nightly meetings to discuss treatment plans and placement for each child. When children were reunited with their parents, the patient was flagged with a code ("811" in the Medical Record Number field) in the iChart system to denote a resolved unaccompanied minor patient. This information was tracked by both OMI and the HHI camp administration.

Amputee victims: Amputee patient tracking data was also collected and tracked. Data was confirmed with patient interviews and review of surgical records. Effort was made to include date of surgery with general description and at least two mobile phone numbers of friends and family per patient. This data was sent through FDP Hospital Administration to the UN Subcluster in charge of dealing with providing prosthetics to amputees in Haiti (Coordinated by Handicap International).

5. *Expanding to entire field hospital*: After a weeklong roll-out of using iChart to track vulnerable populations, HIT Rescue Teams began to test the feasibility of a centralized patient tracking system for the entire field hospital. The goal was to create a real-time census and patient locator for all patients at FDP. Each patient was entered into the database as described above.

   The HIT Rescue teams added two new populations to their "vulnerable population" tracking: pregnant women and those patients with external fixation devices (these patients have limited mobility and need to eventually go back to the Operating Room to have these devices removed). These patients were tracked similarly to the unaccompanied minors and amputee patients discussed above. Pregnant women were given the code 913 and patients with external fixator devices were given the code 914 in the iChart Medical Record Number field. These groups were entered into the iChart system during the four-day period that the entire camp was entered into the iChart system. The data field was used to direct obstetrical resources and plan follow up care for orthopedic injuries.

   During the expansion process, internet access became more widely available allowing the evolution of the tracking system. With more bandwidth, communication became easier and upgrades to the system were more rapidly deployed. During this period a second, web-based system was developed by OMI and deployed in parallel with iChart to provide more robust capabilities. The system, designed by Dr. Larry Nathanson, allowed for tracking of radiographs, flagging of high risk patients, and easier generation of patient census data.

6. *Identification Bracelets*: HIT Rescue teams unveiled an identification bracelet system that was color-coded and contained identification data corresponding to the iChart Database. This allowed providers to quickly identify patients, despite many language barriers: this was especially helpful during medication distribution and Operating Room scheduling and transport. ID bracelets contained the patient's name, medical record number, and date of birth, and also a bar code.

   Bracelets were donated with a specialized printer from TPI, a group that specializes in wireless, barcode and data center solutions. This group also provided HIT Rescue with data support capabilities. Data from the iChart database was manually inputed into the TPI system.

   - Red ID Bracelets: denoted unaccompanied minors
   - Orange ID Bracelets: denoted amputee
   - Green ID Bracelets: all other patients

   The patient identification process was critical for camp operations. Initially, data transfer from the iChart to the TPI program was cumbersome and unfeasible for large scale deployment. However, as time progressed and modifications were made, the ability to export data became more streamlined.

7. *Admitting Patients:* Once the backlog of patients was entered into the iChart patient tracking software, members from the HIT Rescue teams "admitted" patients into the field hospital by collecting identifying data and printing wristbands for each patient when the patient presented at the field hospital triage. Once triaged, patients were assigned a tent number in the iChart system. If the patient was moved during their hospitalization, their location was changed in the system by their provider.

8. *Discharging Patients:* Patients were discharged from FDP to many different locations, some were transferred to higher levels of care on the *USNS Comfort* while other patients were released to the nearby refugee camp. The HIT Rescue teams developed a list of codes to denote these specific locations and input these codes into the Social Security Number field within iChart. This work-around allowed HIT Rescue teams to search for patients by their discharge location.

9. *Summary of Data:* As of March 11, 2010, when the iChart pilot project was being phased out in favor of the home-grown LAC Patient Tracker (described below), there were 490 unique patient entries in the iChart database. For each of these patients, data was collected as described in Table 1. Table 2 relays a summary of the collected patient data.

10. *Description of Success:* Overall, the iChart trial was very successful in proving that an electronic patient tracking solution can be deployed in a post-disaster setting. Patient

tracking was especially important in vulnerable populations, especially unaccompanied minors. 26 unaccompanied minor cases were resolved with the aid of the iChart system.

The following anecdote is one example of the 26 successful reunifications at FDP:

> On February 13th, a thirteen-year-old boy was transferred back to Haiti from a field hospital in Jimani, Dominican Republic. He was presumed an orphan, with very little known background. While staying in Jimani, two single mothers took him under their joint care, in addition to caring for their own toddlers. They were all transferred to our hospital, and the boy was placed into the iChart 911 category, a medical record number signifying an unaccompanied minor.
>
> The 911 code activated a child protection team to seek possibilities for reunification or placement for the children. After speaking with the team and the boy, one of the mothers realized that she was from the same neighborhood in Port-Au-Prince. With a little pocket money and some help from the staff, she left her child in the care of the other mom and set out to find this boy's family. She returned to Fond Parisien the next day, holding the birth certificate of the boy as proof that she had found his father. He had been living amidst the rubble of Port-Au-Prince, carrying his son's identification with him in hope of finding his boy somewhere. One month after the earthquake, this young man was reunited with his father.

11. *Description of challenges and constraints:* The iChart system was sufficient to prove that an electronic solution to patient tracking could be used by on-the-ground providers. However, many work-arounds were employed to make the system work (ex. using the SSN field for tracking the patient's tent number). The program was cumbersome at times and did not allow for easy export of data for analysis or census generation. The negative provider feedback included:

    11.1. Cumbersome data entry
    11.2. Inability to easily add notes, xrays, assessment and plans
    11.3. No access to response standards such as SPHERE
    11.4. Limited ability to add fields for emerging conditions such as diarrhea or measles.
    11.5. Power and battery life can be a challenge

    Overall, the iChart system made tracking and finding all patients much easier for providers during the month-long trial. In addition, it provided an important service for protecting vulnerable patients, allowing camp administrators to tailor resources and time to specific patient populations. The beta trial also prompted significant interest in electronic tracking of patients and served as a catalyst for innovation and evolution of applications in the field.

    Based upon the initial trial, follow on trials were initiated. The OMI initiated a collaboration with the Enoch Choi Foundation in February 2010 to expand iChart trials during the foundation's mobile clinic operations in Haiti.

SECTION IV: iCHART USE IN MOBILE CLINICS

1. *Background:* The Enoch Choi Foundation, in collaboration with Jordan International Aid (JIA), organized an initial team of 12 physicians, nurses and therapists to travel to Haiti during the fifth week after the earthquake. Two of the physicians on the initial team had substantial expertise and experience in the design, implementation and use of electronic medical records and hoped to utilize basic EMR technology to support the care provided by the group. The group made contact with OMI staff and arranged to participate in the HIT Rescue Project, piloting the use of the iChart EMR in a mobile clinic setting.

   In the days before departure for Haiti, the team obtained iPhones, loaded them with the iChart software, arranged for cellular connectivity in Haiti and learned how to use the EMR application. We were fortunate to get 10 iPhones on indefinite loan through a contact at Apple and to arrange for AT&T mobile service which was being offered for free to disaster relief workers in Haiti. While it was possible to learn the basic functionality of the iChart EMR application, it was not until we arrived in Haiti and could visit the field hospital at Font Parisien that we received specific instructions on how the OMI team had decided to enter clinical data into the iChart application.

2. *Description of Mobile Clinics:* Based on reconnaissance performed by Jordan International Aid staff appropriate clinic locations were identified in or adjacent to tent cities in and around Port Au Prince. Each day a rented bus would bring providers, translators, security staff, shelters, cots, solar power units, lights, medication, medical equipment and supplies to the designated site. After an hour of set-up the team would begin seeing patients. Initial patient identifying information was collected using local translators and triage was performed by nurses. Physicians saw patients in the order of arrival. Care included minor surgery and gynecologic care. Medication prescribed for subsequent use was supplied to patients with verbal and written instructions given by translators.

3. *Patient Population:* Mobile clinics were provided at an individual site for 1-5 days, providing care to any patients who presented on a first come first served basis. Male and female patients were represented in roughly equivalent numbers with approximately 1/3 of patients under the age of 18. While the majority of patients were ambulatory, some patients each day were moderately to severely ill requiring IV hydration and/or transfer to local hospitals. Clinics provided care for approximately 250 patients per day.

4. *EMR Use:* Our initial goal in using the EMR was to support our clinical workflows, having the triage staff enter basic demographic data, synchronize with the iChart server over the cellular connection, and then have the physician providing definitive care access the patient record and document the diagnosis, treatment, etc. As we began to see patients we found that this was not possible. Digital mobile phone service was not reliable at the clinic sites and the volume of patients to be seen did not allow for the extra time required to enter even minimal demographic and clinical data into a handheld device in real time. Paper forms were therefore utilized to capture basic demographic and clinical information for each patient. Each night, after clinic, data from these paper records was entered into the iChart application. Limited mobile phone connectivity necessitated the identification of specific locations where

sufficient signal strength was available to upload data to the server maintained by the iChart vendor.

5. *Evolving the iChart Application:* After the first JIA team returned from Haiti we had a series of calls with the Harvard OMI team to provide feedback regarding the iChart application itself as well as the challenges of utilizing a hand-held EMR in the context of disaster relief field medicine. Before the second JIA team departed for Haiti we had a chance to upgrade the iChart software on the iPhones with a version that had been modified in response to initial feedback from pilot use. Our second team was prepared with full instructions on how to use the application and had every intention to use it in real time patient care. Team Two's experience was similar to that of Team One, finding it difficult to use the EMR application in the process of care. They again documented care on paper, entering data after the fact into our growing database of patient information. JIA continues to send medical teams to Haiti for one week per month. Changes to the iChart application have facilitated more rapid entry of relevant information by clinic staff. The most recent teams have been successful in capturing limited patient data in real time but continue to record information on paper for subsequent data entry for many patients.

6. *Challenges:* Utilization of mobile information technology in a third world disaster relief situation presents many challenges. In the absence of resupply capabilities extra mobile devices must be available to manage situations of theft or damage. Power supply must be assured through access to generator and/or solar power generation. Current battery technology does not support continuous use of mobile devices, which must be augmented with auxiliary batteries and/or mobile recharging capabilities. Applications dependent on network connectivity must be supported by a robust and reliable commercial cellular infrastructure or must be supplemented by Wi-fi and/or satellite capabilities implemented to support the project. Reliance on commercial network services introduces additional variables related to account management, charges and billing.

   While handheld devices have many advantages for mobile field applications, the user interface provides challenges related to efficient data entry and viewing. A mixed installation including handheld, tablet and laptop devices would best serve clinical, operational and data collection needs. One key functionality, which the iChart application did not provide, is the ability to readily extract summary data in real time for analysis and reporting. Leaders of field relief efforts frequently need fresh data on what people-in-the-field are seeing to help them plan and supply effective interventions. It would be ideal to have some interim data available to field commanders derived directly and immediately from any data entry work that is happening in the field.

SECTION V: DISCUSSION

Disaster and health information technology are critical tools for modern responders. In 2010, basic electronic medical records and, at minimum, electronic tracking systems, should be the standard of care for disaster medicine. Though there are challenges to implementation, the HIT Rescue Project clearly demonstrates that the capabilities exist and can be deployed in a reasonable fashion.

Currently, the iChart system seems to have a reasonable capacity to achieve many of the above stated goals. Deployment in scale will require a significant commitment on the part of the company to make programmatic adaptations—including, but not limited to improved data export capabilities, broadened language capabilities, improved interoperability with data management systems and medical identification programs.

Although our team mandate was to survey the field without bias or precedent to find the best, currently-available EMR system, we quickly realized that trying to compete with OpenMRS was a non-starter, in Haiti especially. Thus, we determined that some level of inter-operability was a new requirement. The OpenMRS developers, while wedded to their proprietary system, have been helpful with assistance to address this issue. Our conversations have suggested that two-way compatibility is a significant technical challenge, so instead we have focused on ensuring that data from our mobile system can be downloaded into OpenMRS as required for proper follow-on treatment and study. Most likely this would take place as a one-time event, either as a large-scale transition of data or when a particular patient enters settles at a more permanent facility that uses OpenMRS.

The reconstruction efforts and improved communication infrastructure may allow for the deployment of a purely web-based application. The HIT Rescue Project deployed such a system with great success at FDP after donors delivered material for satellite connections and wireless systems development. The web based OMI system was more user-friendly and provided improved tracking capabilities, but was not functional without internet access. This restriction limits widespread adoption of the application as it currently exists. Most of the usability issues were addressed in the iChart update. Importantly, any web-based systems that requires regular connectivity and cannot operate affectively offline may be valuable as conditions in Haiti improve but will be less useful in the early phases of other disaster situations.
Future capabilities: The OMI HIT Rescue team reviewed field after-action reports from affiliated user groups and its own teams to create a prioritized modification list for the iChart application in order to improve capabilities in the field. The promise of a disaster relief EMR is compelling. If we are able to collect and manage clinical data in real time it would support continuity of care for individual patients, provide critical data to direct the distribution of scarce human and material resources, and allow for the early identification of disease trends.

The ideal disaster relief EMR would also provide real time decision support, which is sorely needed by clinicians working in a foreign country, with unfamiliar diseases and severely limited access to diagnostic testing, medications, supplies and other therapies. An international standard, specifying a minimum data set, decision support functionality and back end database characteristics would allow developers to provide various hardware and software solutions that might be deployed immediately after a disaster as well as a community of relief organizations and individuals prepared to operationalize these tools quickly and effectively when the need arises.

Specifically, a field EMR requires the following capabilities:

1.1. General

1.1.1. Improved tracking of specific injuries:

1.1.1.1. For fractures:
- Date of cast removal
- Date of ex-fix, ex-fix across a joint
- X-Ray

1.1.1.2. Amputees
- Date of surgery

1.1.1.3. For infections:
- Days on antibiotics

1.1.2. Improved integration with other EMR systems such as OpenMRS;

1.1.3. Capability to take multiple pictures (face, injury, etc)

1.2. **Integration with patient tagging system**

1.3. **Voice Transcription**

1.4. **Robust Data base mining and Patient Search Capabilities:** There exists a need to be able to search by the following fields, alone or in combination:

1.4.1. Last Name (as designated)
1.4.2. MRN
1.4.3. SSN/ID
1.4.4. DOB
1.4.5. Tent/Unit
1.4.6. Sex
1.4.7. Address (contains) (access to all fields)
1.4.8. Phone

1.5. **Discrete data collection modalities**: The application must be able to capture and search by discrete data fields for ease of entry and data retrieval. Fields should include:

1.5.1. Unaccompanied Minor, Pregnant Female, Amputee, Vulnerable adult/elderly (default: none selected)
1.5.2. Checkbox for: Discharged (default: not selected) (default: none selected)
1.5.3. Checkbox for Flags: Requires Transfer, Discharge, OR, etc.
1.5.4. Primary Diagnosis (searches all primary diagnosis fields)
1.5.5. Accompanying Individuals

1.6. **Barcode scanner:** Allows for rapid registration, tracking and to identification

1.7. **Census Data**

1.7.1. Continual census statistics, easily accessible
1.7.2. Flag system for designated "at risk" patient populations
1.7.3. A screen that displays basic lists of numbers from the database
1.7.4. Accessible via the web interface to easily produce summary reports

1.8. **Adaptability**

1.8.1. Fields are adjustable to allow for flexibility depending on the site and situation (eg tents vs huts, tracking infections, amputations, etc.)
1.8.2. Likely most effectively completed through the web interface

1.9. **Multi-lingual capability**
1.9.1. Select a language in settings
1.9.2. Automatically affects all fields
1.9.3. Prioritized language list: English, Spanish, French, Portuguese

1.10. **Location tracking and tagging system**: This capability is critical for situational awareness, crisis mapping, resource allocation, etc.

SECTION VI: FINANCIAL SUMMARY

The deployment of an electronic tracking and medical record system in disaster is cost effective and certainly improves patient care.

1. *Overview*: The Operational Medicine Institute (OMI) managed on-the-ground operations from Fond Parisien hospital for six-weeks starting on February 1, 2010.

   OMI's work was made possible as a result of funds raised to cover on-the-ground operating costs as well as significant in-kind volunteer time dedicated to the development of a successful technology solution.

   The total cost of the six-week on-the-ground OMI operations that led to the development of the HIT Rescue application cost $37,286 and reflects on-the-ground field team expenses, HIT Rescue product development and design, and pilot testing. Additionally, with an estimated total of 2,051 volunteer hours by the OMI team and product development partners, the total OMI volunteer effort represents an additional $108,685 of valued resources dedicated to the Haiti disaster. (See Table 3).

   In summary, the HIT Rescue project is **valued** at **$145,971,** while it **actually cost $37,268 for development,** indicating that the OMI team and partners provided nearly **four times the value of the project relative to actual costs.**

   Details of the OMI HIT Rescue budget and volunteer hours are provided below and in Table 3 and Table 4.

2. *Cost Components*: The OMI operation was conducted primarily with volunteers and in- kind donations (Table 3).

   2.1. Labor and Personnel: OMI staff members and volunteers did not receive paid compensation for their time. OMI maintained its standard use of a lean, four-person team, rotating members in week- or multi-week shifts and overseen by Drs David Callaway and Alejandro Baez. The OMI team on the ground was comprised of medical personnel and volunteer support from Beth Israel Deaconess Medical Center, Harvard University and the University of California, San Francisco. Additional volunteer support was remotely was provided by Harvard Business School students, freelance technology programmer consultants, and several private sector technology firms such as CareTools (Table 3). CareTools has continued to provide in-kind programming services to make adjustments to its existing iChart product to meet the needs of OMI's HIT Rescue application design.

2.2. Technology / Equipment ($6,730 - 18% of total expenditures): OMI incurred several costs for operations out of Fond Parisien, namely in communication fees, hardware, and software. Cell phone use and data fees enabled for communications on-the-ground and in the development of HIT Rescue. Hardware and software costs are represented by laptops (2 units) purchased for use in patient tracking at Fond Parisien hospital, as well as in the in-kind donation of Apple iTouch (15 units) products to pilot test the iChart-based application in partnership with CareTools.

2.3. Supplies and Support at Fond Parisien ($16,150 - 43% of total cost): OMI incurred additional expenses in supporting on-the-ground OMI team members engaged in testing the technology pilot designs to allow for product enhancements via the programmers at CareTools. Costs include the purchase of tents for OMI staff sleeping and work quarters, food allowance, local transportation rental costs, evacuation insurance, and additional lodging costs when traveling to and from the Domincan Republic and Haiti.

2.4. OMI Team Travel Expenses ($14,400 - 39% of total cost): While OMI team members, primarily physicians and care givers, donated their time voluntarily, each member paid his or her flight and transport to fly into the Dominican Republic.

2.5. Partnerships, Fundraising, and In-kind Donations: As previously mentioned, OMI's efforts to fulfill its mission and expand into developing the HIT Rescue product would not have been possible without efforts by donors who provided both financial and in-kind product resources.

Table 3 reflects the estimated salary averages and volunteer time. Using industry salary averages and a volunteer hour tally, an allocated portion of time spent on OMI efforts was estimated per participant and totaled. OMI is grateful to its team of OMI staff and volunteers who donated $108,685 of volunteer time to develop HIT Rescue solutions.

3. *Financial Budget Summary*: A detailed financial summary with actual costs is attached in Table 4.

SECTION VII: RECOMMENDATIONS

The Operational Medicine Institute Haiti IT (HIT) Rescue Project identified a critical gap in patient care and relief hospital operations. HIT Rescue Project teams provided data to support the need for an electronic tracking system, beta tested an existing work-around system and made recommendations for application future development. Despite being tasked to "investigate", the

HIT Rescue Team provided critical data for decision makers throughout the study period. This data was utilized on an individual patient level by physicians, at a camp level by administrators and at a national level by groups such as Handicap International, UNICEF and the ICRC.

To date, there still exists no theater wide tracking system in Haiti. The OMI HIT Rescue Project demonstrated that mobile devices can be used in a cost effective manner, especially if developed pre incident and deployed immediately. The development of this capability will require the commitment of international organizations, private groups and the United Nations.

The HIT Rescue Project Team recommends that the United Nations and PAHO investigate the deployment of a universal electronic tracking system in Haiti for the ongoing humanitarian crisis. Despite its limitations, the iChart demonstrated significant potential. With continued support from Caretools, Inc. the iChart could rapidly evolve to a highly functional solution.

We suggest further evaluation of the iChart application and designation of a discrete funding stream for the development, deployment and assessment of a more robust application. In addition, the UN/PAHO should more broadly support the development and deployment of disaster information technology tools in Haiti and in future responses.

Specific actions should include:

1. **Short Term** (Week 1-2; Complete by 01 August 2010)
   - 1.1. Creation of UN/ PAHO tasking order to develop and deploy interoperable electronic tracking system in Haiti
   - 1.2. Designation of UN funding stream for creation of EMR system
   - 1.3. Stream lined funding approval process for EMR deployment
   - 1.4. Designation of lead agency for management of EMR deployment and integration in Haiti
   - 1.5. Designation of Haiti Ministry of Health (MOH) liaison team for EMR development and deployment
   - 1.6. Support for continued development and deployment of the iChart system to 3-5 additional clinical sites

2. **Medium Term** (Week 2-10; Complete by 15 September 2010)
   - 2.1. Process for integration of EMR into Haiti MOH through electronic records or paper print outs of patient data
   - 2.2. Consolidation of data into secure database for aggregation and analysis
   - 2.3. Development of application that is ready for next major international disaster response
   - 2.4. Creation of unified patient population, resources and deficiency mapping program

Table 1: iChart inputs and HIT Rescue patient tracking use

iChart input	HIT Rescue patient tracking use
First and Last Name	First and Last Name
Medical Record Number	Code to flag vulnerable population (i.e. 911= unaccompanied minor, 811 = resolved unaccompanied minor, 912 = amputee)
Social Security Number	Field Hospital Tent location
Date of Birth	Date of Birth
Race	Used to indicate if patient had a color-coded wristband with patient name and DOB: red=unaccompanied minor, orange=amputee.
Sex	Sex
Address	Pre-earthquake residence / location
Home phone	Description of injury
Mobile phone	Mobile phone number if available
Other	Name of attendant if present at field hospital (each patient could have one attendant)

Table 2: Summary of Vulnerable Populations Tracked using iChart as of March 11, 2010

Unaccompanied Minors	12
Resoloved Unacompanied Minor Cases*	26
Amputees	42
Pregnant	6
External fixation	35

*Cases were considered resolved when the patient's parents were found or when placement was obtained via collaboration with UN sanctioned agencies in consultation with the Child Protection Team.

Table 3: Estimated volunteer hours in support of OMI HIT Rescue Project

OMI Volunteer Hours					
On the Ground	Hours	Days	Total Hours	_	
Dave Callaway	17	12	204		
Jenny Callaway	17	6	102		
Elizabeth Cote	17	15	255		
Seth Moulton	17	6	102		
Toff Peabody	17	6	102		
Ari Hoffman	17	6	102		
Larry Nathanson	17	6	102		
Total On the Ground Hours			***969***		
From Boston/ San Francisco			Total Hours	_	Main Task
CareTools Team			100		System modification, technical support, programming
Beth Israel Online Donor Admin Support			5		Transition to BIDMC donor system
Dave Callaway			100		Project management; ongoing funder conversations
Elizabeth Cote			30		Project summary; ongoing email communication with PAHO contacts
Seth Moulton			100		Tech development management
Toff Peabody			50		Public relations and fundraising
Ari Hoffman			30		Support of public relations and fundraising
Katie Laidlaw			50		Coordination of communication materials and budget
Larry Nathanson			40		Pre- and post- on the ground tech development and communication
Matt McKnight			20		Support of public relations and DC contacts
Brett Gibson			10		Support of public relations at HBS
Kat Hebert			15		Support of public relations at HBS
Total Hours from Boston/ Elsewhere			***550***		
TOTAL VOLUNTEER HOURS			**1519**		

Table 4: OMI HIT Rescue Expenses

Table 4: OMI HIT Rescue Expenses Operations Expense Summary													
	Actuals							Forecast					
	Week 0	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
OMI Haiti Mission													
Number of people on ground		4	4	4	4	4	4	4	4	4	4	4	4
Average No Nights on Ground		6	6	6	6	6	6	6	6	6	6	6	6
Flights Total		$2,400	$2,400	$2,400	$2,400	$2,400	$2,400	$2,400	$2,400	$2,400	$2,400	$2,400	$2,400
Number of flights		4	4	4	4	4	4	4	4	4	4	4	4
Average cost per flight		$600	$600	$600	$600	$600	$600	$600	$600	$600	$600	$600	$600
Food Total		$146	$146	$146	$146	$146	$146	$146	$146	$146	$146	$146	$146
Avg Cost per Meal		$8	$8	$8	$8	$8	$8	$8	$8	$8	$8	$8	$8
Water		$50	$50	$50	$50	$50	$50	$50	$50	$50	$50	$50	$50
Lodging Total		$480	$480	$480	$480	$480	$480	$480	$480	$480	$480	$480	$480
Cost per night		$20	$20	$20	$20	$20	$20	$20	$20	$20	$20	$20	$20
Transportation Total		$600	$600	$600	$600	$600	$600	$600	$600	$600	$600	$600	$600
Rental truck cost per week		$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500
Gasoline cost per week		$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100
Communication Total		$125	$125	$125	$125	$125	$125	$125	$125	$125	$125	$125	$125
Cell phone est. cost		$50	$50	$50	$50	$50	$50	$50	$50	$50	$50	$50	$50
Other data/ comm costs		$75	$75	$75	$75	$75	$75	$75	$75	$75	$75	$75	$75
Evac Insurance Total		$250	$250	$250	$250	$250	$250	$250	$250	$250	$250	$250	$250
Average cost per person		$250	$250	$250	$250	$250	$250	$250	$250	$250	$250	$250	$250
Supplies Total	$1,300	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
Tents	$300												
Number of tents	2												
Cost per sleeping tent	$150												
Medical Supplies purchased and brought ea	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
OMI Haiti On-Ground Mission Sub-Total	**$1,300**	**$5,001**	**$5,001**	**$5,001**	**$5,001**	**$5,001**	**$5,001**	**$5,001**	**$5,001**	**$5,001**	**$5,001**	**$5,001**	**$5,001**
HIT Rescue													
Hardware													
Laptops, Total	$2,500								$1,250				
Number of laptops	2								1				
Average Cost per laptop	$1,250								$1,250				
iPhones, Total	$0								$4,500				
Number of iPhones	0								15				
Average Cost per iPhone	$300								$300				
Satellite Link	$0												
Mobile Storage Devices	$400												
Number of ext harddrives	4												
Average Cost per Harddrive	$100												
Hardware Subtotal	*$2,900*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*	*$5,750*	*$0*	*$0*	*$0*	*$0*
Software													
iChart Total		$520	$520	$520	$520								
Development Costs		$0	$0	$0	$0								
Cost per user		$130	$130	$130	$130								
Number of users		4	4	4	4								
New Tracking Program						$500	$500	$500	$500	$500	$500	$500	$500
Development Costs						$0	$0	$0	$0	$0	$0	$0	$0
Cost per user						$50	$50	$50	$50	$50	$50	$50	$50
Number of users						10	10	10	10	10	10	10	10
Software Subtotal	*$0*	*$520*	*$520*	*$520*	*$520*	*$500*	*$500*	*$500*	*$500*	*$500*	*$500*	*$500*	
HIT Rescue Subtotal	**$2,900**	**$520**	**$520**	**$520**	**$520**	**$500**	**$500**	**$500**	**$6,250**	**$500**	**$500**	**$500**	**$0**
Ongoing Operating Costs (Boston)													
Staffing Costs Total								$270	$270	$270	$270	$270	$270
Part-Time Data Mgmt/Oversight								1	1	1	1	1	1
Cost per Hour								$15	$15	$15	$15	$15	$15
Hours per week								18	18	18	18	18	18
Institutional Department Fees Total													
Assumption: 1%													
Legal Costs Total		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Retainer Fees		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
BIMDC Admin Total													
Assumption: 0%		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Webpage Total		$0	$0	$0	$0	$0	$0	$45	$45	$45	$45	$45	$45
PT Maintenance		1	1	1	1	1	1	1	1	1	1	1	1
Cost per Hour		$0	$0	$0	$0	$0	$0	$15	$15	$15	$15	$15	$15
Est. Hours per Week		3	3	3	3	3	3	3	3	3	3	3	3
Ongoing Operating Costs Subtotal	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$315**	**$315**	**$315**	**$315**	**$315**	**$315**
TOTAL OPERATING EXPENSES	*$4,200*	*$5,521*	*$5,521*	*$5,521*	*$5,521*	*$5,501*	*$5,501*	$5,816	$11,566	$5,816	$5,816	$5,816	$5,316
		$37,286 Total Cost of OMI & HIT Rescue expenses											