**I. Background**

EMcounter deployment at the Kumbh Mela (Allahabad 2013, Nasik 2015) demonstrated that mobile-based technology has unique public health capability. This front-facing application allowed medical officers the ability to carry out efficient and accurate documentation for a high volume of patients during mass gathering. Simultaneously, back-end interpretation of data from this process provided administrators real-time information about patient population and disease incidence in order to optimize resource allocation and government response to disease outbreak.

EMcounter’s application beyond its use in mass gathering has not been altogether established. However, expansion of this or similar technology into the primary care setting may serve an equally beneficial role. This platform has potential to replace cumbersome paper record keeping, to improve accuracy of patient/clinic data gathering, and to streamline information sharing both internally and externally to public health stakeholders. Doing so would allow for real-time disease surveillance, optimization of resource allocation, and public health intervention on large scale.

**II. Objectives**

Bhandara has been identified as a representative district to pilot study the role out of such technology in the primary health setting. To understand how best to accomplish this, we sought initially to collect general information regarding public health framework, hierarchical structure of care system, geography, and demographics. We sought to understand current mandated tracking systems and associated district-level data surveillance indicators that are important for public health officials and that ultimately dictate what records are kept at the primary level. Additionally, we aimed to visit health facilities to collect site-specific information regarding what information is currently being recorded, how it recorded, how it is shared, and for what purposes it is ultimately used. General telecom infrastructure and technology proficiency of healthcare workers at given sites was also surveyed.

**III. Methods/Schedule**

Over three days Jan 13-16, 2016, we held meetings with government officials and medical administrators knowledgeable of and responsible for district-level healthcare delivery in Bhandara. Interrogation was focused on above objectives.

5 primary sites were visited that were representative of full hierarchical structure of district healthcare system as follows: district hospital (Bhandara Civil Hospital), sub-district hospital (Tumsar), 2 primary healthcare centers (Gobarwahi, \_\_) and sub-center (Gobarwahi). Multiple healthcare providers were interviewed and recording systems were reviewed on site. Predetermined survey information was collected regarding site geography/population, staff, record keeping practices, and record reporting systems. Telecom infrastructure and provider technology capacity was also recorded. Relevant documents were photographed and archived.

**IV. Observations**

*A. Population Demographics and Healthcare Structure*

The Bhandara District occupies an area of 4087 km2 and has a population of 1.2 million (2011). Healthcare delivery functions by a tiered system as follows in order of decreasing size/specialization/centralization: district (civil) hospital, sub-district and rural hospitals, primary health centers, and sub-centers. The district hospital has 250+ bed inpatient capacity with multiple subspecialty services and a large outpatient department. Sub-district hospitals have 50+ inpatient beds with fewer subspecialty services offered and outpatient care on site. Rural hospitals have approximately 30 beds with inpatient and outpatient services, no speciality care. Throughout the district, there are approximately 40-50 primary health centers (PHC’s) that offer outpatient care on a more local scale. 5-10 sub-centers operate under each PHC to serve rural villages, offering field services and basic outpatient care to select populations. Staff varies at given sites depending on tier and size. See appendix for detail. Most PHC’s operate 24/7 with at least 1 MD on-site daily (largely allopathic, some with ayurvedic providers in addition), staff nurses, pharmacist, lab technician, auxiliary nurse midwife (ANM), lady visiting nurse, health assistant, and other attendants. Sub-centers are staffed by 1-2 ANM’s only.

Generally, patients may be referred to a higher tier facility for increasing healthcare need depending on site capabilities and patient condition. Patients requiring high-level tertiary care services are often transferred to Nagpur.

*B. Governance*

Direct government oversight of above facilities is the responsibility of two medical officials: the Civil Surgeon (1/2016 Dr. Dr. Devendra Paturkar) is in charge of district, sub-district and rural hospitals; the District Health Officer (DHO, 1/2016 Dr. V.V. Doiphode) is in charge of all PHC and sub-centers. These officials report to the Deputy Director (1/2016 Dr. Jaiswal), responsible for oversight of 5 districts, Nagpur and Bhandara two among them. Our investigation included the interrogation of these officials and others.

*C. Government Programs, Mandated Reporting*

In an effort to track health outcomes and combat selected diseases, the government mandates data reporting from all levels of the healthcare system. Some data collection occurs via online tracking systems (3 total); most data reporting for government surveillance is accomplished by other means (paper, sms text, email). All programs are independent and do not communicate with each other. The scope of these programs is broad, and the details of each are beyond the scope of this report. Briefly, here is an overview of major programs (3 online systems first):

* District Health Information Software (DHIS2)
  + District-level, online open source software
  + Aggregate data collection with no individual tracking or intervention
  + Tracks reproductive/child health, communicable and non-communicable disease programs, health facility services, and deaths
  + Reported monthly
  + No offline data entry capability
  + Input at each facility/tier independently
* Mother and Child Tracking System (MCTS)
  + National program, online
  + Individual data collection for actionable intervention (mother and child given unique ID at registration)
  + Tracks all antenatal care, birth outcomes, child immunization and childhood disease <16yrs old
  + Reported daily
  + No offline entry capability
  + Input at each facility/tier independently
* Revised National Tuberculosis Control Program (RNTCP)
  + State-run program reported online via “Nikshay” system
  + Individual data collection, actionable
  + Reported monthly
  + No offline data entry capability
  + Input at each facility/tier independently
* Integrated Disease Surveillance Program (IDSP)
  + National program
  + Active surveillance, passive surveillance, laboratory investigation mechanisms
  + Reported weekly
  + Offline report submitted to appointed Thaluka health officer, who then reports data to DHO via email
  + Report submitted at PHC level (after sub-center collection)
* Malaria (MF – 7)
  + Submitted offline fortnightly to District Malaria Officer
  + Report submitted at PHC level
* Leprosy
  + Submitted offline monthly to Assistant Director of Leprosy
  + Report submitted at PHC level
* HIV/AIDS
  + Submitted offline monthly to district AIDS control society (NGO); SMS text sent daily to government
  + Report submitted at PHC level
* Other data reporting:
  + Non-communicable diseases, eg. diabetes and hypertension – technically rolled out but consistent reporting not yet realized
  + Pharmacy inventory (Al
  + Facility reports
  + Financial reports

*D. Data recording and reporting at facility level*

Recording and reporting specifics vary by facility tier, as patient flow, complexity of workup, and available services are institution-dependent. At the primary level (PHC and sub-center), there is considerable uniformity. Mandated reporting systems are identical for all centers, and structure dictated by DHO is largely cohesive at the sites we visited.

To contextualize data record at the PHC level, it is necessary to understand patient movement through the outpatient department (OPD). Typically, a patient is seen initially and registered at entrance. Date, name and identifying information (age, sex, address) are solicited and the patient is assigned a new registration number. This information is documented into a register by a class worker, and the patient is given an OPD form with the above information copied onto it. The patient is eventually seen by an MD, where he/she presents the OPD card received at entry. After evaluation, the MD will record a given symptom, diagnosis, and investigation or treatment onto the OPD card. He will also record the same information into an OPD register at his desk. The patient will then take the OPD card to the necessary location within the PHC depending on the doctor’s orders.

If an investigation is ordered, the patient will present his/her OPD card to the lab technician. The lab technician will perform the ordered lab test and record the patient’s registration number, identifying information, and the lab test ordered into a lab register. If treatment is ordered, the patient will take his/her OPD card to the pharmacy and medication is dispensed. The pharmacist will record patient ID, identifying information, and medication dispensed into a pharmacy register. A separate register with common medications in stock and number dispensed will be filled (for formulary stock tallying).

If the patient is due for follow up within the week, he/she will take the OPD away from the PHC and return with it at next visit. If the patient is not due for immediate follow up, the pharmacist will keep the OPD card. OPD cards are bundled daily and kept in a stock room. They are rarely referred to thereafter, but they are technically searchable if a patient knows the date of last visit. Generally speaking, patients are given new registration numbers for repeat OPD visits, so no unique record is ever stored for reference or chart update.

If the patient needs referral – for investigation not available at facility, or for higher level of care – a referral form is filled out by the MD at the time of patient visit. The patient will take this with him/her upon leaving. The doctor will also record ID, demographic information, diagnosis, and reason for referral into a referral register.

If the patient is a mother or child, or known to have a communicable or non-communicable condition that requires mandated reporting (see section above), relevant information is separately recorded by a variable healthcare worker: nurse, mid-level provider, lab technician, or pharmacist. Separate registers are kept for all reportable indicators. These registers are then referred to for manual tallying and eventual reporting (online or offline) at the appropriate interval specified by requirements as previously mentioned. Each PHC has a protocol for collecting this information from appropriate sub-centers and reporting all mandated information upwards to appropriate personnel.

Sub-centers function in a similar fashion, keeping registers for all visits and recording all mandated data. At the sub-center we visited, two ANMs on staff rotated daily, one doing field visits and the other staffing the sub-center on site. They record into 13 registers total. Daily, they walk 0.5km to enter relevant MCTS information into a computer with landline connection (unless internet connectivity poor and unable to access website). They similarly enter online data for DHIS2 and RNTCP monthly. Other information is summed and reported up to PHC at required intervals.

It should be noted that digital literacy of all healthcare providers encountered was largely sufficient. Current online software already used requires moderate technical savvy. Many have smart phones. Connectivity was 2-3G at PHCs visited, with limited connectivity at sub-center.

**V. Reflections/Discussion**

Many conclusions were drawn after complete investigation. Inefficiencies exist both at government and primary site level.

At the government level, there is clearly demand for aggregate data as a way of tracking district disease burden and potentially intervening where necessary for designated diseases. Most of the programs and associated systems have been rolled out vertically over time and exist in independent silos. They do not crosstalk and there is significant redundancy in data contained within each. Data is most often reported to different health officials who operate autonomously to manage specific programs. Accuracy of data is ultimately unknown, and data takes variable time to receive.

As a result of the complexity of data reporting, primary health providers consistently relayed frustration regarding the current system. While most of those responsible strived for compliance, they admitted difficulties with reliable tallying and reporting. Especially at sub-center level, where staffing is minimal and workload heavy, consistent data entry - sometimes away from facility and not possible if internet connectivity low - was not possible. Total data collection currently requires cumbersome documentation and multiple register upkeep, and manual counting of that information adds to healthcare provider workload. Data entry therefore limits time spent performing patient care activities, which are often many in busy settings. Moreover, although patient record keeping is often meticulous, it does not currently allow for future patient reference, updated charting, or internal data sharing.

The above inefficiencies may feasibly be mitigated with a software system that allows easy front-facing data input and simultaneous back-end data interpretation. EMcounter in its current form has this basic capability, but would need to be developed further to satisfy necessary components of data tracking. One could envision a digital system that replaces all current handwritten PHC/sub-center forms and registers. At the primary level, this would minimize time spent on manual data recording, minimize duplication, and eliminate cumbersome tallying. It would also have potential capability of internal crosstalk and subsequent patient reference. Data collected through this system would likely be more accurate than what is currently being reported. All important data indicators for mandating reporting upwards could be included and potentially interface with current government systems. If done, this would allow for real-time surveillance and quicker public health intervention than is currently possible. If data inputs converge through one system, the possibility for communication between programs may also be possible.

**VI. Next steps**

Further investigation and development will require government support. Not only is government financial backing integral, but also government insight is needed to ensure proper interface with current government data systems. All required data points from current systems must be known. Sustainability of this system is only possible if future programs also communicate with developed technology.

Immediate next steps should include further site visits and interviews of primary providers to obtain recommendations for technology development and current needs. Software will need to be user friendly and minimally invasive to current OPD procedures. Specific data contained in all forms and registers will need to be recorded to know all required data inputs.

If software is developed after above steps, deployment should then happen on small scale and be rigorously studied for impact.

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