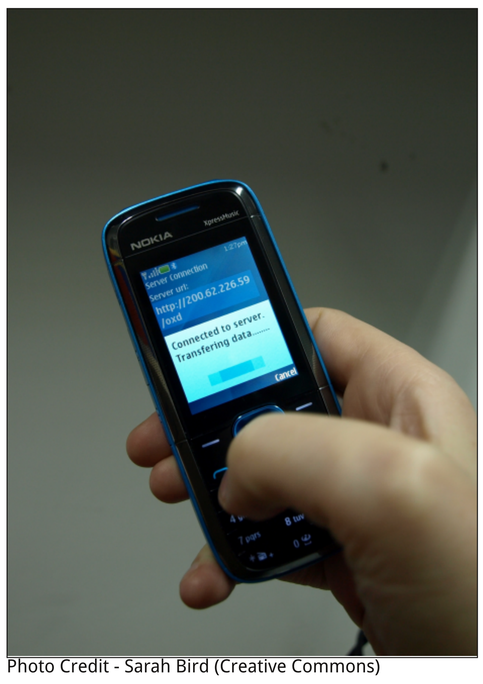
Implementing mobile phone-based data collection in a large cohort longitudinal study in Lima, Peru

S Bird,[1,2] J Galea,[3] O Ahmed,[1] N Garcia,[4] J Tomaylla,[4] L Lecca,[3] M Becerra,[3,5,6] M Murray[3,5,6]

Photo Credit - Jeff Werner (Creative Commons)



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Problem In conducting a large-cohort longitudinal study with ~24,000 participants in Lima, Peru, a paper-based system was being used to collect data. Data was collected by study workers, and then entered using standard double-entry procedures into OpenMRS where the study records were then maintained electronically. Paper was then warehoused and stored. **Figure 1 depicts the complete process previously required to get one form into the electronic record.** With large volumes of data being collected, there was a significant opportunity to save time and money associated with paper management and data entry. These savings have been realized through a mobile-phone based data collection system. In addition, near-real-time data access offers secondary benefits to researchers and study managers.

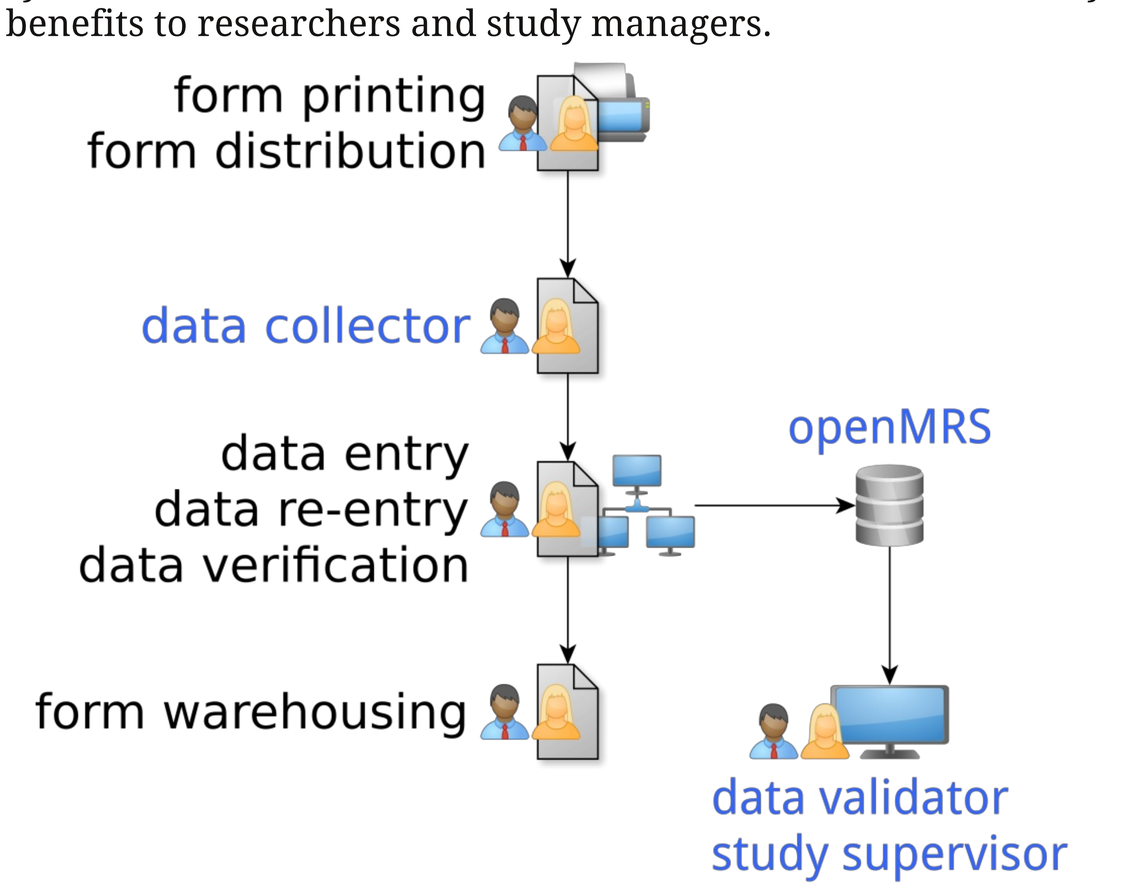


Fig. 1 Paper-based data collection system

Benefits realized In just 2.5 months **over 3,000 man-hours have been saved** - an average of 40 hours per day - in data entry tasks alone. The new digital process is depicted in Figure 2. The blue elements have remained the same, but the new system has eliminated all tasks associated with paper handling, including double data entry. A conservative estimate for the double data entry and validation process in a paper system is 10 minutes per form. Since the system launched on August 1st, 2011, 91 data collectors have collected nearly 19,000 forms.

Implementing an electronic data collection system required careful planning and took many months to set-up and test. However, these upfront costs are significantly outweighed by the ongoing savings, reduced paperwork, and faster access to data.

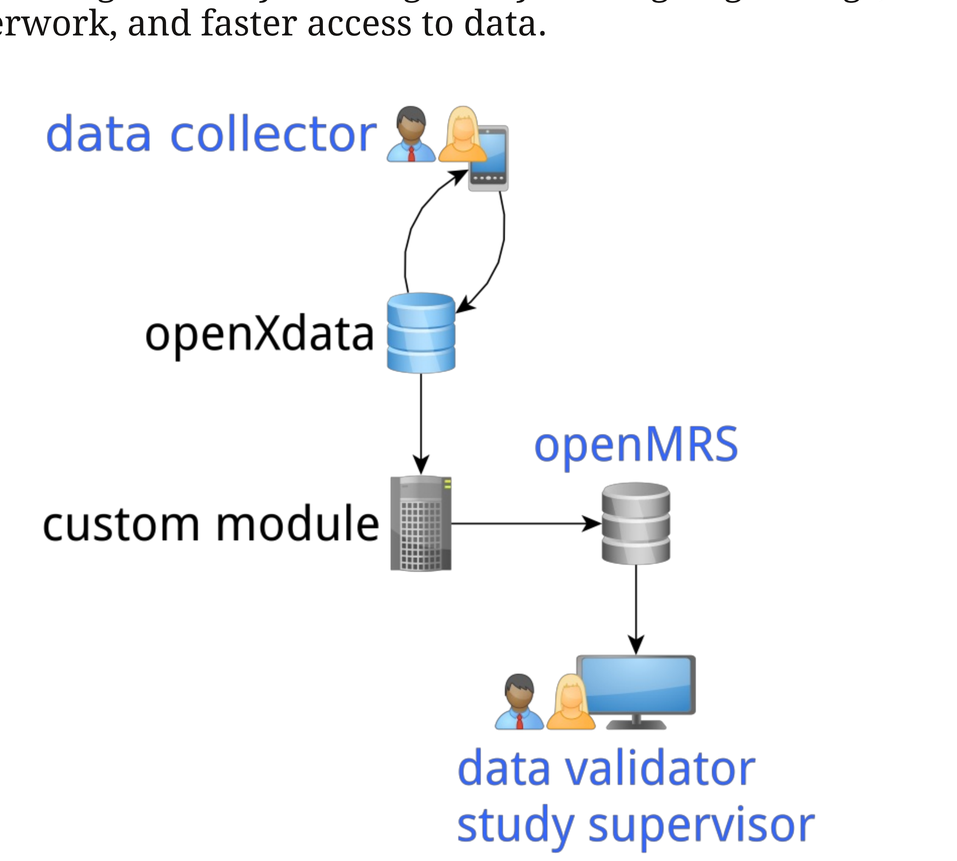


Fig. 2 Mobile phone-based data collection

Implementation As shown in Figure 2, data now enters the study record through a two-step process using openXdata and OpenMRS. Each data collector was issued a Nokia phone, model 5130c-2. That phone runs the openXdata mobile client, which was translated into Spanish through use of a simple text file translation. The study forms are downloaded onto the phone and are then available to be completed by data collectors. The openXdata phone application can store multiple completed forms on the phone if there is no phone connectivity to upload the data. Whenever convenient, the data collector initiates an upload, and the filled-in forms are uploaded to the server over a data connection on the mobile phone network. The forms arrive at the openXdata server. We are running openXdata v1.2.

The study was already running OpenMRS v1.6 to collect all study data and maintain the study record. OpenMRS has a modular architecture that enabled us to build a custom module, written in Java, that runs on a schedule. Each time it runs, the module asks the openXdata server for any new data. It takes this new data and adds it to OpenMRS using mappings of openXdata fields to OpenMRS fields that are specified manually on initial setup. The authors hope to make this module open-source. To obtain further information on the module, please contact Sarah Bird.

After most technical implementation was complete and as testing began, data collectors were trained on the use of openXdata. A copy of training material used is available separately.

Results Figures 3 to 5 show data on the performance of the system. The data was obtained from analysis of the forms stored in the openXdata database for 77 days starting on August 1st, 2011, the launch of the production system.

Fig. 3 Forms uploaded per day through openXdata

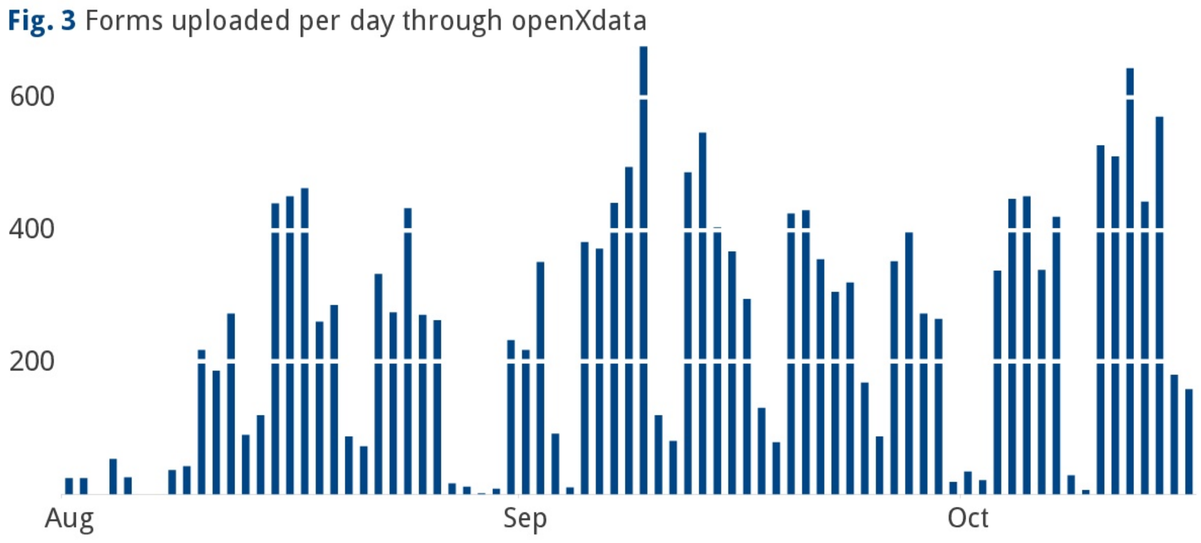


Fig. 4 Total forms uploaded per user

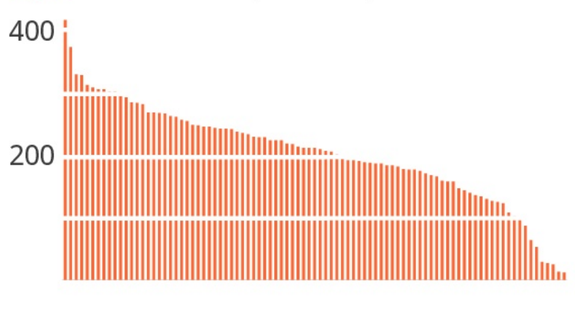
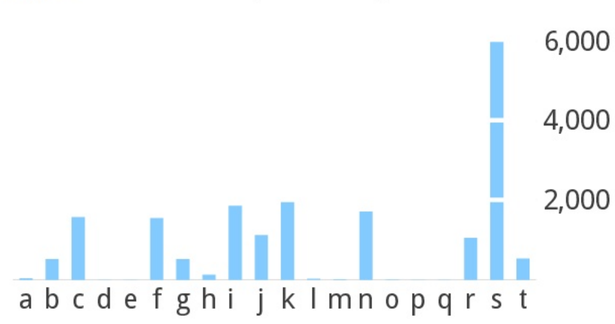


Fig. 5 Total forms uploaded by form



Number of days	77	Number of data collectors	91
Total forms collected	18,989	Number of participants	5,582
Average forms collected / day	247	Number of form versions	53

Free & open-source technologies

OPENXDATA

Mobile phone- and web-based data collection
www.openxdata.org

OpenMRS

Enterprise electronic medical record system
www.openmrs.org

Contact
Sarah Bird - sarah@bonvaya.com
Jerome Galea - Jgalea_SES@pih.org
Omar Ahmed - omar.ahmed@irdinformatics.org

Affiliations
1 - Center for Health Informatics, Interactive Research and Development, Karachi, Pakistan
2 - Bonvaya, Emeryville, CA, USA
3 - Partners in Health, Boston, MA, USA
4 - Socios en Salud Sucursal, Lima, Peru
5 - Department of Global Health & Social Medicine, Harvard Medical School, Boston, MA, USA
6 - Division of Global Health Equity, Brigham and Womens Hospital, Boston, MA, USA