Proof of Concept:
Case-Based Surveillance for HIV in Ethiopia

Federal Ministry of Health
Ethiopian Public Health Institute
NASTAD
U.S. Centers for Disease Control and Prevention

Summary Report
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*DISCLAIMER
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Finally, the staff at EPHI led the implementation of this Proof of Concept project. The result would not be achieved without their commitment and leadership.
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Acronyms

ART  Antiretroviral Therapy
CDC  Centers for Disease Control and Prevention
EMR  Electronic Medical Records
EPHI  Ethiopian Public Health Institute
FHAPCO  Federal HIV/AIDS Prevention and Control Office
FMOH  Federal Ministry of Health
HCT  HIV Counseling and Testing
HIV  Human Immunodeficiency Virus
IRB  Institutional Review Board
M  Metaphone
mPUID  Metaphone Pseudo Unique Identifier
MRN  Medical Record Number
NASTAD  National Alliance of State and Territorial AIDS Directors
PEPFAR  President’s Emergency Plan for AIDS Relief
PMTCT  Prevention of Mother to Child Transmission
PUID  Pseudo Unique Identifier
SI  Strategic Information
SNNPR  Southern Nations, Nationalities, and Peoples’ Region
UNAIDS  Joint United Nations Programme on HIV/AIDS

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Executive Summary

The Government of Ethiopia seeks to strengthen HIV surveillance in order to have more robust and timely data and routinely generate real-time information that supports HIV health decision making. Case-based surveillance captures and leverages already recorded individual-level information on those diagnosed and living with HIV via a case report form—or the electronic equivalent—and summarizes it at the regional and national level, providing public health practitioners with population specific and generalizable epidemiologic data for decision making. The Ethiopian Public Health Institute, a division of the Federal Ministry of Health, with technical assistance from the National Alliance of State and Territorial AIDS Directors, looks to assess existing HIV-related service data and the data environment—including collection, management, and reporting processes—in Ethiopia to document the readiness for case-based surveillance.

A convenience sample of health facilities in Addis Ababa were selected to participate, and electronic HIV treatment records were extracted from their electronic medical record system. A standard assessment tool quantified data quality indicators. Pseudo unique identifiers were created by abstracting combinations of patient first name, last name, birth year, and sex from existing electronic data. The identifier was applied to extracted records to identify records with matching identifiers. Double metaphone was applied to patient first and last name to account for variations in writing practices and errors. Records with matching identifiers were considered presumptive matches or health records from the same HIV patient. Data quality improvement activities and HIV case reporting were conducted in a sample of participating facilities for one month. The combined dataset of unique HIV patients was utilized to demonstrate possible analysis that can be performed when patient-level data are available. Results were summarized using SAS 9.4 and Excel.

Of 53 paper-based variables assessed in 1,500 paper-based health records, 15 (28.3%) variables were high quality (>90% average completeness and validity), 25 (47.2%) were medium-high quality (51-89%), 11 (20.8%) were medium-low quality (26-50%), and two (3.8%) were low quality (<25%). Of 82 electronic variables assessed in 52,817 electronic health records, 15 (18.3%) variables were high quality, 26 (31.7%) variables were medium-high quality, 16 (19.5%) variables were medium-low quality, and 25 (30.5%) variables were low quality. Of 108,135 electronic records available for pseudo unique identifier generation and matching, 23,807 (22.0%) health records were identified as presumptive matches, including 7,220 identified with an exact match of first and last name, birth year, and sex; 6,846 identified with the first four digits of first and last name, birth year, and sex. Application of double metaphone yielded an additional 2,688 records when matching the entire six digit metaphone-coded first and last name, and 7,053 records when matching the first three digits of the metaphone-coded first and last name. A total of 88 new HIV case reports were reported during the one-month pilot period. A total of 103,324 unique HIV patients, including 64,657 (62.6%) female and 38,677 (37.4%) male, were identified in the combined surveillance dataset. The first patient in the dataset was registered on December 21, 1996 and the last patient was registered on December 31, 2014. The majority of patients with a reported address resided in Addis Ababa, though 8.2% of patients resided in other regions. Of the 103,324 patients, 102,822 (99.5%) patients were identified as diagnosed with HIV, alive and registered at the HIV treatment clinic in the dataset. Of patients diagnosed and registered, 67,619 (65.8%) patients had evidence that they were linked to care. Of patients linked to care, 60,344 (89.2%) were eligible for ART, and of those eligible, 60,321 (100%) were started on ART.

The Proof of Concept assessment demonstrates that present conditions support implementation of HIV case-based surveillance. The assessment of existing paper-based and electronic health record data
quality found the quality of key variables sufficient to not only inform case matching algorithms, but also to identify opportunities to improve clinical data collection. By operationalizing available electronic data, four case matching algorithms were developed and applied to identify unique patients with clinical records across participating health facilities. Health facilities were engaged in quality improvement and active HIV case reporting, which yielded improvements in availability of key surveillance variables and demonstrated that surveillance data can be collected and transferred to the health system central level via manual methods. The final combined surveillance dataset generated longitudinal patient-level data and analyses were performed to describe patient outcomes by HIV cascade where several possible gaps in service delivery to key populations were identified. These findings demonstrate that opportunities exist in Ethiopia to use existing patient-level data to identify patients most in need and areas where gaps in service delivery exist, and use this information to drive response to the HIV epidemic.

Background

HIV across the Globe and in Sub-Saharan Epidemic
Across the globe, approximately 71 million people have been infected and 34 million people have died of HIV since the virus was first identified. At the end of 2014, 36.9 million [34.3–41.4 million] people were living with HIV globally (1). Recent trends indicate that new HIV infections have declined from three million in 2001 to two million in 2014. People living with HIV on antiretroviral therapy increased from one million in 2001 to 15 million in 2015, which resulted in a significant reduction in AIDS death from two million in 2004 to 1.2 million in 2014. An estimated 0.8% [0.7-0.9%] of adults aged 15–49 years worldwide are living with HIV, although the burden of the epidemic continues to vary considerably between countries and regions (2). Sub-Saharan Africa remains most severely affected, with 24.7 million people living with HIV, 71% of the global total, as well as an estimated 1.5 million new HIV infections and 1.1 million AIDS-related deaths (3).

HIV in Ethiopia
The HIV epidemic remains one of the major public health challenges in Ethiopia, causing significant morbidity and mortality since the mid-1980s. HIV was initially a localized and concentrated epidemic among specific population groups, however, within a few years the epidemic gained momentum and spread broadly across Ethiopia’s entire population. Today, Ethiopia’s HIV epidemic is highly heterogeneous, with prevalence varying markedly according to gender, from 1.0% among men to 1.9% among women; population, from 0.6% in rural areas to 4.2% in urban areas; and geography, from 0.9% in Southern Nations, Nationalities and Peoples’ Region (SNNPR) to 5.2% in Addis Ababa City and 6.5% in Gambella Region (4). The Ethiopia Federal Ministry of Health projects the prevalence of HIV is higher in urban areas (3.5%) compared to rural areas (0.5%) (5). In 2013, UNAIDS reported that Ethiopia is one of 26 countries that has reduced the number of new HIV infections by more than 50% between 2001 and 2012 (6).

HIV Surveillance
The Ethiopia Federal Ministry of Health (FMOH) and Federal HIV/AIDS Prevention and Control Office (FHAPCO) continue to examine the direction, impact, and outcomes of the HIV epidemic to target an effective response. Currently, Ethiopia’s national response to HIV is guided by prevalence estimates generated from Spectrum/Estimation and Projection Package (EPP) software (7) using a combination of demographic and health surveys and program performance data. The Ethiopian Public Health Institute (EPHI) is charged with collecting, analyzing, and presenting epidemiologic surveillance data in Ethiopia,
which the FMOH and FHAPCO use to guide their strategic planning for a coordinated response. EPHI has conducted an assessment and, based on the findings and taking into consideration the current global HIV surveillance directions, EPHI developed a national HIV-related survey and surveillance road map for the coming five years, 2016 - 2020.

**HIV Case Based Surveillance**

Case-based surveillance documents the characteristics of all people diagnosed with a disease, and monitors the trends as they progress through certain defined sentinel events. In the case of HIV, these include at a minimum: HIV diagnosis, first and subsequent CD4 test values, antiretroviral (ART) prescription, and death (8). HIV case-based surveillance captures and leverages already recorded individual-level information on those diagnosed and living with HIV via a case report form—or the electronic equivalent—and summarizes it at the regional and national level, providing public health practitioners with real-time, population-specific, and generalizable epidemiologic data for decision making. HIV case reporting involves confidential reporting of HIV infection by patient name, or other patient specific unique identifier, regardless of the stage of HIV disease (9).

With an estimated 871,334 Ethiopians living with HIV (PLHIV) ever enrolled in HIV care, 453,821 PLHIV eligible for treatment, and 375,811 PLHIV currently on ART in 2015 (10), there is a need to better understand who is becoming infected with HIV and how, the magnitude and potential reasons for gaps in treatment and care, and how to effectively improve patient outcomes. Increased utilization of patient-level clinical service data available through HIV testing, treatment, and care initiatives (11) and existing electronic patient monitoring and medical record systems (12) offers an opportunity to track patients’ movements through the health system and demonstrate patient linkage, mobility, and health outcomes (13). Other survey-based epidemiologic methods, while effective in estimating HIV prevalence at a point in time, are conducted at a high cost and cannot produce real-time information at the patient-level.

The Proof of Concept for HIV Case-Based Surveillance project, implemented by the Ethiopian Public Health Institute (EPHI) with technical assistance from NASTAD and the Ethiopia office of the Centers for Disease Control and Prevention, set out to explore cost-effective building blocks for HIV surveillance using high-quality HIV health service data. This assessment was a first step in exploring case-based surveillance as a critical addition to existing surveillance systems.

**Objective**

**Goal**

The overall goal of the Proof of Concept for HIV Case Based Surveillance project was to assess a subset of existing patient-level data and the related data collection processes to define whether conditions were in place that would enable Ethiopia to implement case-based surveillance of HIV. Where the data or environment was not in alignment, the degree of gap and the resources needed were estimated.

**Objectives**

1. To assess the quality, including completeness and validity of key HIV case surveillance-related variables within one existing electronic medical record (EMR) and standard FMOH paper-based data collection forms in order to justify the use and utility of existing data for the purpose of surveillance.
2. To identify a method to link patient data to each other using match algorithms, and a pseudo unique identifier (PUID), in order to assess patient duplication and document patient linkage and disease progression/clinical outcome.

3. To identify a method to improve availability of selected case report variables from health facilities in order to assess patient duplication and document patient linkage and disease progression/clinical outcome.

4. To demonstrate patient-level data analyses useful to document patient linkages, disease progression and clinical outcomes, and test the utility of case-based surveillance approach, including a review of the public health system and its capacity for routine case-reporting, data management and security, to generate recommendations for HIV case-based surveillance implementation design.

**Methods**

**Population to be Studied**
The population eligible to be studied during the assessment included all individuals diagnosed with HIV and receiving services at participating health facilities in Addis Ababa, including adult (aged 15 years and older) and pediatric (birth through 14 years). Data routinely collected for all patients provided with HIV-related services, collected in paper and electronic format via EMR or other electronic data systems were included.

**Site Selection**
Health facilities in Addis Ababa, the capital city of Ethiopia, were selected by convenience to participate in the assessment. A total of 48 health facilities participated overall, including 24 health facilities participated in the paper-based data quality assessment, 21 facilities participated in the electronic data quality assessment, 34 facilities contributed data to test the match algorithms to link patient data, ten facilities participated in data quality improvement and case reporting, and 34 facilities contributed data included in the descriptive analyses (Table 1). Four facilities reported no existing electronic medical record at the time of the quality assessment. Four facilities participated in all Proof of Concept activities (Appendix 1).

**Table 1: Health facilities participating in the HIV Case Based Surveillance Proof of Concept by facility type and activity, Addis Ababa, 2014-2016.**

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Health Centers</th>
<th>Hospitals</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Quality Assessment</td>
<td>Paper</td>
<td>21</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Electronic</td>
<td>21</td>
<td>0</td>
</tr>
<tr>
<td>Linking Patient Data</td>
<td></td>
<td>26</td>
<td>8</td>
</tr>
<tr>
<td>Data Quality Improvement &amp; Case Reporting</td>
<td></td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Descriptive Analysis</td>
<td></td>
<td>26</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>40</strong></td>
<td><strong>4</strong></td>
</tr>
</tbody>
</table>

**Data Collection**
For Objective 1, a standardized tool was utilized to assess paper-based and electronic health data quality. Staff from participating health facilities conducted a rapid assessment of existing paper-based clinical health record data to quantify the completeness and validity of selected variables. Health
facilities with an existing electronic medical record conducted a three-month retrospective review of existing paper-based records registered at the facility during September – December 2014. Health facilities with no electronic medical record conducted a 12-month retrospective review of existing paper-based records registered during May 2014 – May 2015. Electronic health data were extracted from the Addis Ababa City Administration Health Bureau and selected health facilities’ electronic medical record data system. Following methodology described in HIV assessment guidelines (14), the following definitions were applied: Values were considered complete if it was present and legible in the variable field. If the variable or data field was blank or illegible, the value was considered incomplete. If the variable was not contained in any register under examination, the value was also considered incomplete. Values were considered valid if it was within an expected range of values for that variable and invalid if it was not within that range. The expected range of values was determined by national health information system standards (12). Completeness was assessed for all variables contained in paper and electronic records. The validity of all variables was assessed for every fifth paper record. For electronic records, validity was assessed for selected variables only. Data quality were categorized as high, defined as >90% average completeness and validity combined (12, 14), medium-high, 51-89% average completeness and validity, medium-low, 26-50% average completeness and validity, and low, <25% average completeness and validity. During site visits to the health facilities, data flow and data security, procedures and processes were observed, using standard tools to guide observations and discussion with health facility staff. Observations were summarized to indicate the capacity for HIV case-reporting.

For Objective 2, a point-in-time copy of electronic health medical record data was obtained from participating health facilities and merged into a dataset. Variables identified as high quality in Objective 1 were abstracted to test four algorithms to identify unique patients across health facilities. Applying validation and de-duplication methods, a combination of variables and/or digits of variables were used to conduct reiterative analyses to identify records as an exact match and probable match (15). Records considered an exact match were those that contained a one-to-one precise match of patient first name, last (father’s) name, year of birth, and sex (called ‘Exact’ match). Additional records were identified as an exact match if they had matching phonetic-based coded patient first name and last name (using double Metaphone[m] algorithm), year of birth and sex (called ‘[m]Exact’ match) (16). Year of birth was either extracted as contained in the record or calculated based on age contained in the record and year the patient entered chronic care. Records considered a probable match were identified using a PUID, generated from the first four digits of the patient’s first name and the patient’s last name, year of birth and sex (called ‘PUID’ match). An additional set of probable matching records were identified using first three digits of the Metaphone-coded first name and last name, year of birth and sex (called ‘mPUID’ match). A reiterative process was utilized to generate the four record sets, Exact, mExact, PUID, and mPUID, such that records contained in each set may have also been included in the remaining three sets, if they met the criteria defined in the algorithm.

Matching records identified through Exact, mExact, PUID, and mPUID match algorithms were extracted and reviewed manually to determine if they represented a unique patient. All records identified through PUID and mPUID match were reviewed. A systematic sample of Exact and mExact match records were reviewed. If 90% or more of sampled records were identified as unique patients, then all records were accepted; if less than 90% of sampled records were identified as unique patients, then the results of the first review were discarded and all records were reviewed to determine if they represent unique patients. Reviewers applied standard criteria in assessing matching records and documented the variables used to confirm or refute the identification of unique patients (Appendix 1) (15).
For Objective 3, data quality improvement and HIV case reporting activities were conducted to improve the availability of HIV case surveillance data. Specific HIV surveillance-related variables identified as low or poor quality in Objective 1 were targeted for quality improvement and health facilities were engaged to design and implement quality improvement activities. HIV case report forms were introduced to capture new HIV and Early Infant Diagnoses. Case reporting processes were adopted, with orientation and supervision support, by health facilities to test methods for capturing surveillance data. Completed case reports were securely delivered to the central office of EPHI and entered in electronic format. Completeness of key surveillance variables collected during case reporting were compared to baseline measures found during the paper-based quality assessment.

For Objective 4, data analyses were performed with the combined health facility EMR registry dataset developed in Objective 2. A second dataset that included the registry dataset with health facility EMR visit tables, laboratory tables, and pharmacy tables was utilized to test additional data analyses. Analysis was performed on the resulting datasets to describe disease progression and clinical outcomes, as depicted in the HIV Clinical Cascade (17). Standard criteria were applied to categorize unique patients in the dataset along the cascade (Table 2) (18, 19, 20). HIV clinical cascades, depicting patient engagement in HIV treatment and care, were developed for the total patient population, adults (aged >= 15 years), pediatrics (aged <15 years), pregnant females, and HIV patients with tuberculosis (TB)-positive screening at last visit.

Table 2: Operational definitions used to identify HIV patients in the HIV Clinical Cascade in the HIV Case Based Surveillance Proof of Concept, selected health facilities in Addis Ababa, 2014-2016.

<table>
<thead>
<tr>
<th>Step in Cascade</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnosed, alive, registered at HIV Treatment Clinic</td>
<td>Unique patients identified as alive</td>
</tr>
<tr>
<td>Linked to Care (18)</td>
<td>All patients diagnosed and registered at HIV Treatment Clinic AND any record of CD4 lab test or WHO stage</td>
</tr>
</tbody>
</table>
| Eligible for ART (19) | All patients Linked to care AND If Adult patient (age >=15 years):  
  • CD4<200 if chronic care start date <=Dec 31, 2012, or  
  • CD4<350 if chronic care start date >Dec 31, 2012, or  
  • WHO Stage III, or  
  • WHO Stage IV All pediatric patient (age <15 years) If Pregnant Females:  
  • CD4<200 if chronic care start date <=Dec 31, 2012, or  
  • Any pregnant female with chronic care start date >Dec 31, 2012 All HIV patients with Tuberculosis-positive screen at last visit |
| Started on ART | All patients eligible for ART AND Any ART start date |

A summary of the results was developed to describe the utility of case-based surveillance approach, including discussion of available data and the data collection tools, the extent to which they support HIV case-based surveillance, gaps in data, and possible solutions. In addition, observations from site visits related to handling of confidential patient information, reporting data, and maintenance of data security were summarized and discussed in relation to the public health system’s capacity for routine case-reporting, data management, and security.
Ethical Considerations and Data Confidentiality
Ethical clearance was obtained from Ethiopian Public Health Institute scientific and ethical committee and US Centers for Disease Control and Prevention Associate Director of Science (CGH-ADS). A waiver for informed consent was obtained from the Institutional Review Board (IRB) at the Ethiopian Public Health Institute. All data security and confidentiality measures where in places as described in the approved assessment protocol.

Findings

Objective 1. Retrospective Data Quality Assessment
A total of 24 health facilities (21 health centers and 3 hospitals) participated in the paper-based data quality assessment, including 20 (83.3%) with an existing electronic medical record, and four (16.7%) with no existing electronic medical record. A total of 1,500 paper-based health records were reviewed, including 712 (47.5%) for ART adult, 46 (3.1%) for pediatric ART, 536 (35.7%) for pre-ART adult, 17 (1.1%) for pre-ART pediatric, and 189 (12.6%) for PMTCT health services (Appendix 4). Of the 53 paper-based variables assessed, two (3.8%) variables were low quality, 11 (20.8%) were medium-low quality, 25 (47.2%) were medium-high quality, and 15 (28.3%) were high quality (Table 3).

Table 3: HIV case based surveillance-related variables from paper based records by average percent complete and valid – 24 health facilities, Addis Ababa, Ethiopia, 2015

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Average Percent Complete &amp; Valid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year of death</td>
<td>23.3%</td>
</tr>
<tr>
<td>Month of death</td>
<td>23.3%</td>
</tr>
<tr>
<td>Year of ART regime change</td>
<td>26.1%</td>
</tr>
<tr>
<td>Patient expected delivery month (if pregnant)</td>
<td>29.5%</td>
</tr>
<tr>
<td>Patient expected delivery year (if pregnant)</td>
<td>30.5%</td>
</tr>
<tr>
<td>Year of infant PCR</td>
<td>36.8%</td>
</tr>
<tr>
<td>Day postnatal ART prophylaxis given</td>
<td>37.3%</td>
</tr>
<tr>
<td>Month of infant PCR</td>
<td>37.4%</td>
</tr>
<tr>
<td>Month postnatal ART prophylaxis given</td>
<td>38.2%</td>
</tr>
<tr>
<td>Year postnatal ART prophylaxis given</td>
<td>38.4%</td>
</tr>
<tr>
<td>Mother treated at delivery</td>
<td>38.8%</td>
</tr>
<tr>
<td>Month of ART regime change</td>
<td>41.4%</td>
</tr>
<tr>
<td>Day of infant PCR</td>
<td>41.5%</td>
</tr>
<tr>
<td>Patient mother's name (for exposed infant)</td>
<td>50.8%</td>
</tr>
<tr>
<td>Patient pregnancy status (if female)</td>
<td>57.9%</td>
</tr>
<tr>
<td>Year of delivery</td>
<td>58.6%</td>
</tr>
<tr>
<td>Infant treated at delivery</td>
<td>58.7%</td>
</tr>
<tr>
<td>Month of delivery</td>
<td>65.5%</td>
</tr>
<tr>
<td>Day of delivery</td>
<td>67.2%</td>
</tr>
<tr>
<td>Partner tested</td>
<td>68.8%</td>
</tr>
<tr>
<td>Unique ART number</td>
<td>71.6%</td>
</tr>
<tr>
<td>Patient mother's code (for exposed infant)</td>
<td>72.2%</td>
</tr>
<tr>
<td>Year cotrimoxazole prescribed</td>
<td>79.1%</td>
</tr>
<tr>
<td>Year of first ART prescription</td>
<td>79.2%</td>
</tr>
<tr>
<td>Month of first ART prescription</td>
<td>79.8%</td>
</tr>
<tr>
<td>Month cotrimoxazole prescribed</td>
<td>79.9%</td>
</tr>
<tr>
<td>Patient Woreda of residence</td>
<td>80.9%</td>
</tr>
<tr>
<td>Name of institution referred to</td>
<td>83.0%</td>
</tr>
<tr>
<td>Patient grandfather name</td>
<td>86.2%</td>
</tr>
<tr>
<td>Syphilis test result</td>
<td>86.4%</td>
</tr>
</tbody>
</table>
Electronic medical record data were available from 21 health facilities (all health centers) for inclusion in the electronic data quality assessment. A total of 52,817 health records were available for analysis, including 66% female patients and 34% male patients. Pregnant women represented five percent of the health records, while one percent of the records belonged to children aged less than five years. Of 82 electronic variables assessed, 25 (30.5%) variables were categorized as low quality, 16 (19.5%) were medium-low quality, 26 (31.7%) were medium-high quality, and 15 (18.3%) were high quality (Table 4).

**Table 4: HIV surveillance related variables from electronic medical records by percentage complete and valid – 21 health facilities, Addis Ababa, Ethiopia, 2015**
<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Percent Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHO stage 2 month Ethiopian Calendar</td>
<td>22.9%</td>
</tr>
<tr>
<td>WHO stage 2 day Ethiopian Calendar</td>
<td>22.9%</td>
</tr>
<tr>
<td>WHO stage 1 date Western Calendar</td>
<td>25.0%</td>
</tr>
<tr>
<td>WHO stage 1 year Ethiopian Calendar</td>
<td>25.0%</td>
</tr>
<tr>
<td>WHO stage 1 month Ethiopian Calendar</td>
<td>25.0%</td>
</tr>
<tr>
<td>WHO stage 1 day Ethiopian Calendar</td>
<td>25.0%</td>
</tr>
<tr>
<td>Patient Follow Up Status</td>
<td>27.8%</td>
</tr>
<tr>
<td>CD4 Lab Test Result Percent Children</td>
<td>30.7%</td>
</tr>
<tr>
<td>Last Visit Tuberculosis (TB) Screen</td>
<td>34.2%</td>
</tr>
<tr>
<td>WHO stage 3 date Western Calendar</td>
<td>34.7%</td>
</tr>
<tr>
<td>WHO stage 3 month Ethiopian Calendar</td>
<td>34.7%</td>
</tr>
<tr>
<td>WHO stage 3 day Ethiopian Calendar</td>
<td>34.7%</td>
</tr>
<tr>
<td>WHO stage 3 year Ethiopian Calendar</td>
<td>34.8%</td>
</tr>
<tr>
<td>Appointment Date Western Calendar</td>
<td>41.2%</td>
</tr>
<tr>
<td>Appointment Month Ethiopian Calendar</td>
<td>41.2%</td>
</tr>
<tr>
<td>Appointment Day Ethiopian Calendar</td>
<td>41.2%</td>
</tr>
<tr>
<td>Appointment Year Ethiopian Calendar</td>
<td>41.2%</td>
</tr>
<tr>
<td>Last Visit Weight</td>
<td>44.6%</td>
</tr>
<tr>
<td>Weight</td>
<td>52.1%</td>
</tr>
<tr>
<td>CD4 Lab Test Result Count Adults</td>
<td>53.0%</td>
</tr>
<tr>
<td>Functional Status at start ART</td>
<td>53.6%</td>
</tr>
<tr>
<td>WHO Stage</td>
<td>54.5%</td>
</tr>
<tr>
<td>Eligible &amp; Ready to start ART Date Western Calendar</td>
<td>54.6%</td>
</tr>
<tr>
<td>Eligible &amp; Ready to start ART Month Ethiopian Calendar</td>
<td>54.6%</td>
</tr>
<tr>
<td>Medically Eligible for ART Date Ethiopian Calendar</td>
<td>54.6%</td>
</tr>
<tr>
<td>Medically Eligible for ART Month Ethiopian Calendar</td>
<td>54.6%</td>
</tr>
<tr>
<td>Original ART Regimen</td>
<td>54.8%</td>
</tr>
<tr>
<td>ART Start Date Ethiopian Calendar</td>
<td>54.8%</td>
</tr>
<tr>
<td>ART Start Year Ethiopian Calendar</td>
<td>54.8%</td>
</tr>
<tr>
<td>ART Start Day Ethiopian Calendar</td>
<td>54.8%</td>
</tr>
<tr>
<td>ART Start Month Ethiopian Calendar</td>
<td>54.8%</td>
</tr>
<tr>
<td>ART Start Year Ethiopian Calendar</td>
<td>54.8%</td>
</tr>
<tr>
<td>Estimated delivery date Western Calendar</td>
<td>59.2%</td>
</tr>
<tr>
<td>Estimated delivery Day Ethiopian Calendar</td>
<td>59.4%</td>
</tr>
<tr>
<td>Estimated delivery Year Ethiopian Calendar</td>
<td>59.4%</td>
</tr>
<tr>
<td>Estimated delivery Month Ethiopian Calendar</td>
<td>59.4%</td>
</tr>
<tr>
<td>Last Visit Date Western Calendar</td>
<td>60.0%</td>
</tr>
<tr>
<td>Last Visit Day Ethiopian Calendar</td>
<td>60.1%</td>
</tr>
<tr>
<td>Last Visit Month Ethiopian Calendar</td>
<td>60.1%</td>
</tr>
<tr>
<td>Last Visit Year Ethiopian Calendar</td>
<td>60.1%</td>
</tr>
<tr>
<td>Referral Site Information</td>
<td>84.1%</td>
</tr>
<tr>
<td>Address Kilfe Ketema</td>
<td>93.9%</td>
</tr>
<tr>
<td>Patient Pregnancy Status at Enrollment</td>
<td>94.9%</td>
</tr>
<tr>
<td>Chronic Care Entry Date Western Calendar</td>
<td>98.1%</td>
</tr>
<tr>
<td>HIV Test Day Western Calendar</td>
<td>99.6%</td>
</tr>
<tr>
<td>HIV Treatment History Day Ethiopian Calendar</td>
<td>99.7%</td>
</tr>
<tr>
<td>HIV Treatment History Month Ethiopian Calendar</td>
<td>99.7%</td>
</tr>
<tr>
<td>HIV Treatment History Year Ethiopian Calendar</td>
<td>99.7%</td>
</tr>
<tr>
<td>Chronic Care Entry Day Ethiopia Calendar</td>
<td>100.0%</td>
</tr>
<tr>
<td>Chronic Care Entry Month Ethiopia Calendar</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
HIV service data flow processes were observed during health facility visits conducted during the paper assessment. Patient flow and data collection processes appeared to be consistent across facilities and conformed with standards set by the Ministry of Health (13). Patients entered the facility and first report to the registrar office, where they were identified as a new patient (e.g., patient is assigned medical registration number [MRN] and card number) or as a returning patient (e.g., patient presents MRN or card number). The patient was then seen at triage, where the reason for visit was determined. The patient was assigned to a service unit based on the reason, and the patient chart was carried to the service unit by a facility runner. The clinical service unit office provided service to the patient and documented the services delivered and laboratory and pharmacy services ordered in the patient chart, abstract register, and if available electronic system. At the end of the day, patients’ charts were returned to the registrar office for archiving. The facilities’ HMIS coordinator was responsible to tally service data from each unit’s abstract register for the purposes of reporting; similarly, if an electronic system was operational, the system administrator extracted clinical service data for reporting.

Data flow processes observed at health facilities contribute to the security of patient level clinical service data. The MRN and card number were used to identify a patient, rather than names, at the registrar office. Facility runners were responsible for carrying patient’s paper charts to the service units, limiting the movement of confidential information. Electronic data were stored securely with only one staff person accessing password protected data. However, gaps were observed in data security standards at the visited health facilities. Health facilities reported that data security training is provided to staff in the ART service unit only at the time of employment. No training on data security and confidentiality was provided to registrar office, runner, and triage staff who handle confidential data, so these staff were unaware of their responsibilities while handling confidential patient information. Paper records were observed to be stored in an insecure manner, suggesting physical security of data was weak. No health facilities reported having a standard operating procedure in place to guide data security and patient confidentiality practices at the facility.

**Objective 2. Linking Patient Data through Match Algorithms**

A total of 34 health facilities’ (26 health centers and 8 hospitals) electronic medical record data were available for analysis to test the utility of four match algorithms, including the pseudo unique identifier. A total of 108,138 health records originating from the patient register were available, with a range of three to 14,445 records per facility. Among the 108,138 health records, a total of 7,220 (6.7%) matching records were identified through an exact match of patient first name, patient last [father’s] name, year of birth, and gender (Exact match). An additional 2,688 matching records (2.5%) were identified by incorporating the use of Metaphone (m) (mExact match) to control for variations in patient first name and patient last name. Subsequently, the PUID and mPUID match identified an additional 6,846 (6.3%) and 7,053 (6.5%) potential matching records, respectively. A total of 23,807 (22.0%) potential matching records were identified.
Of the 7,220 Exact match records, 1,449 (20.1%) were sampled and reviewed manually, and 1,387 (95.7%) were confirmed to represent duplicate records from unique patients. The manual review of 561 (20.9%) sampled mExact records resulted in 178 (31.7%) confirmed as a match, a lower yield than the target 90%, and as a result a second review of all 2,688 mExact records was conducted. The second review of mExact records resulted in 1,561 (58.1%) records confirmed to represent duplicate records from unique patients. Manual review of all matching PUID and mPUID records confirmed 1,882 (27.5%) and 703 (10.0%) respectively, as duplicate records from unique patients (Table 5). Patient name and address variables were most often used to confirm or refute the match.

### Table 5: Application of Match Algorithms, Pseudo Unique Identifier (PUID) and Metaphone (m) PUID, to identify unique HIV patients in electronic medical records – 34 health facilities, Addis Ababa, Ethiopia, 2015

<table>
<thead>
<tr>
<th>Match Algorithm</th>
<th>Electronic match</th>
<th>Manual review</th>
<th>Manual match</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>Exact</td>
<td>7,220</td>
<td>6.7</td>
<td>1,449</td>
</tr>
<tr>
<td>mExact</td>
<td>2,688</td>
<td>2.5</td>
<td>2,688</td>
</tr>
<tr>
<td>PUID</td>
<td>6,846</td>
<td>6.3</td>
<td>6,846</td>
</tr>
<tr>
<td>mPUID</td>
<td>7,053</td>
<td>6.5</td>
<td>7,053</td>
</tr>
</tbody>
</table>

A total of 103,324 (95.5%) unique patients were identified among the 108,138 records in the dataset, after the application of four match algorithms and manual review results were integrated (Figure 1). Of the 103,324 unique patients, 956 (0.9%) had records that documented they had received HIV care and treatment in two or more health facilities (range two - six health facilities).

**Figure 1: Identification of unique HIV patients in electronic medical records via application of four match algorithms – 34 health facilities, Addis Ababa, Ethiopia, June 2015 – March 2016**

**Objective 3. Data Quality Improvement and HIV Case Reporting**

For Objective 3, as a result of health facility-based data quality improvement activities conducted during February – March 2016, a total of 96 HIV case reports were received by EPHI, of which 88 represented unique patients and seven represented duplicate reports on the same patient. One health center, Gotera Health Center, reported 18 HIV cases identified during the preceding year which were included in the total. Zewditu Hospital reported new cases identified mostly through the hospital’s voluntary testing and counselling services. HIV cases reported appear to have age distribution consistent with that of Addis Ababa city, with the majority of patients’ reports among persons aged 35-39 years (29.2%) and a range of 11 – 60 years of age.

Several data quality improvements in HIV surveillance variables were observed through HIV case reporting, when compared to the retrospective quality assessment of HIV cases in paper-based health
records (Figure 2). These include completeness of patient first name, father’s name, grandfather’s name; sex; HIV diagnosis month and year; and reporting institution. Seven variables, unavailable in the retrospective quality assessment performed in Objective 1, became available through HIV case reporting, and were found to have medium – high quality. These include: birth year, month, and day; birth kebele, woreda, and sub city; and HIV diagnosis day.

Figure 2: Percentage of HIV case patients (n=96) with complete data by variable -- 10 health facilities, Addis Ababa, February – March, 2016.

Objective 4. Patient-level Descriptive Analyses
A total of 103,324 unique HIV patients, including 64,657 (62.6%) female and 38,677 (37.4%) male patients, were identified in the combined surveillance dataset. The first patient in the dataset was registered on December 21, 1996 and the last patient was registered on December 31, 2014. The majority of patients with a reported address resided in Addis Ababa, though 8.2% of patients resided in other regions. Of the 103,324 patients, 102,822 (99.5%) patients were identified as diagnosed with HIV, alive, and registered at the HIV treatment clinic in the dataset. Of patients diagnosed, alive, and registered, 67,619 (65.8%) patients had evidence that they were linked to care. Of patients linked to care, 60,344 (89.2%) were eligible for ART, and of those eligible, 60,321 (100%) were started on ART (Figure 3).
Among the 64,657 female patients in the dataset, 64,404 (99.6%) were identified as diagnosed with HIV, alive, and registered at the HIV treatment clinic. Of females diagnosed and registered, 40,684 (63.2%) had evidence that they were linked to care. Of females linked to care, 35,304 (86.8%) were eligible for ART, and of those eligible, 35,288 (100%) were started on ART. Among the 38,677 male patients in the dataset, 38,418 (99.4%) were identified as diagnosed with HIV, alive, and registered at the HIV treatment clinic. Of males diagnosed and registered, 26,935 (70.1%) had evidence that they were linked to care. Of males linked to care, 25,040 (93.0%) were eligible for ART, and of those eligible, 25,033 (100%) were started on ART. A total of 4,143 (4.0%) pediatric patients aged less than 15 years were identified among all patients in the dataset. Of those, 4,095 (99.8%) pediatric patients were diagnosed with HIV, identified as alive and registered at the HIV treatment clinic. Of pediatrics diagnosed and registered, 2,372 (57.9%) had evidence that they were linked to care. All pediatric patients linked to care were eligible for ART and started on ART (Table 6).

Table 6: Patients engaged in HIV treatment and care by selected characteristics -- 34 health facilities, Addis Ababa, Ethiopia, 1996 - 2014

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Diagnosed, alive, registered</th>
<th>Linked to Care</th>
<th>Eligible for ART</th>
<th>Started ART</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>No.</td>
</tr>
<tr>
<td>All patients</td>
<td>103,324</td>
<td>102,822</td>
<td>99.5</td>
<td>67,619</td>
<td>65.8</td>
</tr>
<tr>
<td>Females</td>
<td>64,657</td>
<td>64,404</td>
<td>99.6</td>
<td>40,684</td>
<td>63.2</td>
</tr>
<tr>
<td>Males</td>
<td>38,667</td>
<td>38,418</td>
<td>99.4</td>
<td>26,935</td>
<td>70.1</td>
</tr>
<tr>
<td>Pediatrics</td>
<td>4,143</td>
<td>4,095</td>
<td>98.8</td>
<td>2,372</td>
<td>57.9</td>
</tr>
</tbody>
</table>
Variations were observed when looking at the treatment cascade by age group. Of the 103,324 patients in the dataset, 191 patients were aged < one year, 1,270 aged one-four years, 1,574 aged five-nine, 1,108 aged ten-14 years, 2,017 aged 15-19 years, 10,471 aged 20-24 years, 78,800 aged 25-49 years, and 7,893 aged 50 years and greater. Of patients diagnosed with HIV, identified as alive and registered at the HIV treatment clinic, 109 (58.9%) patients < one year, 620 (49.6%) patients aged one-four years, 914 (58.6%) aged five-nine years, 729 (66.2%) aged ten-14 years, 959 (47.8%) aged 15-19 years, 5,102 (48.9%) aged 20-24 years, 53,340 (68.0%) aged 25-49 years, and 5,846 (74.5%) aged 50 years and greater had evidence that they were linked to care. Of patients linked to care, all patients aged < one year, one-four years, five-nine years, and ten-14 years were eligible for ART; 83.2%, 82.6%, 89.3%, and 90.9% of patients aged 15-19 years, 20-24 years, 25-49 years, and 50 years and greater, respectively, were linked to care. Of patients eligible, 100% started ART (Table 7). Variations were also observed in the treatment cascade by sex, pregnancy status, age group, and among patient with tuberculosis-positive screening (Appendix 7).

### Table 7: Patients engaged in HIV treatment and care by age group -- 34 health facilities, Addis Ababa, Ethiopia, 1996 - 2014

<table>
<thead>
<tr>
<th>Age Groups</th>
<th>Total</th>
<th>Diagnosed, alive, registered</th>
<th>Linked to Care</th>
<th>Eligible for ART</th>
<th>Started ART</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>&lt;1 year</td>
<td>191</td>
<td>185</td>
<td>96.9</td>
<td>109</td>
<td>58.9</td>
</tr>
<tr>
<td>1-4 years</td>
<td>1,270</td>
<td>1,249</td>
<td>98.3</td>
<td>620</td>
<td>49.6</td>
</tr>
<tr>
<td>5-9 years</td>
<td>1,574</td>
<td>1,560</td>
<td>99.1</td>
<td>914</td>
<td>58.6</td>
</tr>
<tr>
<td>10-14 years</td>
<td>1,108</td>
<td>1,101</td>
<td>99.4</td>
<td>729</td>
<td>66.2</td>
</tr>
<tr>
<td>15-19 years</td>
<td>2,017</td>
<td>2,006</td>
<td>99.5</td>
<td>959</td>
<td>47.8</td>
</tr>
<tr>
<td>20-24 years</td>
<td>10,471</td>
<td>10,433</td>
<td>99.6</td>
<td>5,102</td>
<td>48.9</td>
</tr>
<tr>
<td>25-49 years</td>
<td>78,800</td>
<td>78,445</td>
<td>99.5</td>
<td>53,340</td>
<td>68.0</td>
</tr>
<tr>
<td>50+ years</td>
<td>7,893</td>
<td>7,843</td>
<td>99.4</td>
<td>5,846</td>
<td>74.5</td>
</tr>
<tr>
<td>Total</td>
<td>103,324</td>
<td>102,822</td>
<td>99.5</td>
<td>67,619</td>
<td>65.8</td>
</tr>
</tbody>
</table>

### Discussion

The Proof of Concept assessment demonstrates that present conditions support implementation of HIV case-based surveillance in Ethiopia. The assessment of existing paper-based and electronic record data found the quality of key variables was in line with national data quality standards (12) and was sufficient to inform case matching algorithms and identify opportunities to improve clinical data collection. By operationalizing available electronic data, four case matching algorithms and standard case matching procedures were successfully applied to identify unique patients with clinical records across participating health facilities, replicating validation procedures used in other national HIV case based surveillance systems (15). The engagement of health facilities in quality improvement activities through HIV case reporting yielded improvements in availability of key surveillance variables needed for case matching and demonstrated that surveillance data can be collected and transferred to the health system central level via manual methods. Though limited to ten health facilities, these findings suggest that data quality improvement and HIV case reporting activities contributes to on-going improvements in quality of key surveillance variables, which in turn strengthens systematic matching of case and identification of unique patients. The final combined surveillance dataset generated longitudinal patient-level data, which were used to describe patient outcomes by the HIV Clinical Cascade, where several possible gaps in service delivery to key populations were identified. These findings demonstrate that opportunities
exist to use existing patient-level data to identify patients most in need and areas where gaps in service delivery exist, and use this information to drive response to the HIV epidemic in Ethiopia.

Lessons learned through implementation are also worth noting. Differences were observed in the quality of key variables between paper and electronic health service data, which suggests an opportunity to improve facility processes that support gathering data from patients and entering data in electronic systems. Improvements in data quality, most notably increasing the availability of patient first and last name, day, month, and year of birth, mother’s name, and residence at birth, will improve the identification of unique patients through the match algorithms. Reporting of new HIV infections through paper forms and manual processes identified challenges to collecting selected data, such as HIV risk behaviors. Analysis of the surveillance dataset revealed that data on patients diagnosed through HIV voluntary counseling and testing sites were not available, and therefore not included in the HIV cascade. Similarly, we were unable to describe patients currently on ART and virally suppressed, due to lack of available data. Finally, additional analyses need to be developed to further describe patient outcomes along the HIV Clinical Cascade, particularly to understand the differences observed between patients diagnosed with HIV, alive, and registered at treatment clinic and patients linked to care.

Limitations

There are several limitations to consider when interpreting these findings. First, data sources utilized to assess the quality in paper and electronic records were different, in that patient follow-up cards were most often used during the paper assessment and an electronic copy of the facility’s ART registry database was utilized in the electronic assessment. As such, the results of the quality assessment are not directly comparable and instead provide information on two primary sources of HIV surveillance data. Second, the quality of key surveillance variables, including patient name, father’s name, grandfather’s name, and birth year, may have impacted the effectiveness of case matching algorithms which may have resulted in a higher count of unique patients in the dataset. This may be particularly true for those records included in the PUID and mPUID algorithm, where only 27.5% and ten percent, respectively, were confirmed via manual review. Third, electronic data utilized in linking patients through case matching and in the patient-level descriptive analyses were obtained from HIV Treatment Clinic databases at a point in time and were not part of an on-going transfer of data. As a result, descriptive analyses on longitudinal patient outcomes, particularly related to HIV counseling and testing diagnoses, patients current on ART, and patients virally suppressed, was limited. Finally, data were obtained from a convenience sample of health facilities in Addis Ababa and was inclusive of public health facilities only, which likely under estimates patient duplication and mobility across the entire Addis Ababa health system. Despite these limitations, analyses performed were useful to demonstrate the methods by which dynamic surveillance data can be used to describe disease progression and clinical outcomes, as depicted in the HIV Clinical Cascade.

Recommendations

Based on these findings, there is a need to move forward with implementation of HIV case surveillance in Ethiopia. This requires initiation of national planning including defining the scope, requirements, and resource implications for a phased approach to HIV case-based surveillance scale up and implementation. The following are the major recommendations:

- Data quality of key surveillance variables contained in paper and electronic records should be improved, including:
Socio-demographic variables: Patient day, month, and year of birth; patient address region, woreda, and kifle ketema; patient name and father’s name; and patient mobile phone number.

Clinical variables: Referral Site Information for the referring health facility; CD4 lab test count for adults and percentage for children; patient’s HIV test day, month, and year; ART start day, month, and year; and viral load test count.

- Data collected via HIV case reporting should include variables that will support case matching and are not currently included in the National HMIS standard reporting forms. These include:
  - Patient’s mother’s name and birth kebele, woreda, and sub-city.

HIV case-based surveillance implementation requires development and consistent implementation of standards to assure the safety and security of reportable cases.

Convey the importance of HIV case surveillance, through training, supportive supervision, and data feedback, will improve the commitment of health facility staff as critical contributors to the system.

Improvements and maintenance of clinical data entered at health facilities’ database systems is critical. A data cleaning manual should be developed and used at the health facility level.

When envisioning a way forward, the following next steps are recommended:

- Development of case reporting requirements, including case report forms, standard data elements, and standard formats;
- Development of standard operating procedures, user guides, and trainings for both central-, regional-, and facility-level users of the case based surveillance system;
- Implementation of routine data transfer processes for both electronic and paper data that ensure reliable and secure transfer, extraction, and validation;
- Development of a central data repository, including plan to integrate and optimize utilization of existing data systems at all levels, with appropriate data security requirements integrated in the system design;
- A phased approach for implementing HIV reporting at health facilities, considering criteria such as facilities with high HIV disease burden, in prioritized geographic areas, and factoring in the presence of motivated staff, and facilities’ capacity to generate electronic data including HIV counseling and testing data; and
- Creation of a robust data analysis plan to ensure that the critical information gathered during case surveillance activities can be fully utilized for epidemic tracking, prevention, and treatment activities.
References


Appendices

Appendix 1: Standard Criteria Applied During HIV Case Matching Manual Review

Standard Operating Procedure

Subject: HIV Case Matching

Purpose: To identify health records that represent unique patients, using the Pseudo Unique Patient Identifier (PUID) and patient demographic and clinical information.

Background: This HIV Case Matching SOP will guide the manual review of patient records to identify which represent unique patients. By consistently applying the HIV Case Matching SOP, decision making about whether records identified as matching represent the same patient will be standardized across reviewers and time.

Procedure:

1. Perform manual review of the matching records to decide whether records are a true match and represent unique patients.
2. Decision making is based on patient demographic and clinic information available in the record.
3. Reviewers will consistently apply inclusion/exclusion criteria to make decisions.
4. Records will be determined to represent a unique patient if data contained in specific variables across records are deemed to be the same or alike.
5. When determining if data elements are a true match or logical match, the following standard criteria will be applied:
   a. For Exact match, a true match (meaning precise, one-to-one match of all digits) of data in the following variables:
      i. Patient first name,
      ii. Patient last [father’s] name,
      iii. Birth year, and
      iv. Gender
   b. For mExact, PUID, and mPUID match, a true match (defined above) or logical match (meaning best judgement says information is the same patient, accounting for variation in spelling and use of abbreviations) of data in the following variables:
      i. Patient first name,
      ii. Patient last [father’s] name,
      iii. Birth year, and
      iv. Gender
   c. For Exact, mExact, PUID, and mPUID, there is a logical match (meaning best judgment indicates records represent same patient, accounting for variation in spelling, use of abbreviations, and distance between locations) of data in the following variables:
      i. Patient address,
      ii. Patient mobile phone number,
      iii. Facility where tested for HIV (Testing facility),
      iv. Facility where patient transferred from (Transfer in Facility),
      v. Patient Card Number, and
      vi. Date Patient Entered in Chronic Care.

Appendix 2: Participating Health Facilities

Table 1: Health facilities participating in the HIV Case Based Surveillance Proof of Concept, Addis Ababa, 2015-2016.

<table>
<thead>
<tr>
<th>Facility Name</th>
<th>Facility Type</th>
<th>Quality Assessment</th>
<th>PUID Testing</th>
<th>Case Reporting</th>
<th>Descriptive Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Paper</td>
<td>Electronic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Addis Hiwot (Bole)</td>
<td>Hospital</td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>AfenchoBer</td>
<td>Health Center</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Akaki Health</td>
<td>Health Center</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Arada Health</td>
<td>Health Center</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Be’ata Health</td>
<td>Health Center</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Beletshachew</td>
<td>Health Center</td>
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<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
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<td>Health Center</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Bole No 2</td>
<td>Health Center</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Efoyta*</td>
<td>Health Center</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Entotofana</td>
<td>Health Center</td>
<td>1</td>
<td>1</td>
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* Health facilities (n=4) with no existing electronic medical record at the time of the assessment
Appendix 3: Paper-based Data Quality Assessment Count of Records by Facility

Table 2: Participating health facilities (n=24) by count of health records included in paper data quality assessment by health service area – Addis Ababa, Ethiopia, 2015.

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* Health facilities (n=4) with no existing electronic medical record at the time of the assessment
### Table 3: ART service area variables from paper based health records by percentage complete and valid – 24 health facilities, Addis Ababa, Ethiopia, June 2015

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Table 4: ART Pediatrics service area variables from paper based health records by percentage complete and valid – 24 health facilities, Addis Ababa, Ethiopia, June 2015
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Table 5: Pre-ART service area variables from paper based health records by percentage complete and valid – 24 health facilities, Addis Ababa, Ethiopia, June 2015
Table 6: Pre-ART Pediatric service area variables from paper based health records by percentage complete and valid – 24 health facilities, Addis Ababa, Ethiopia, June 2015

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Appendix 5: Electronic Data Quality Assessment Findings by Facility

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Appendix 6: Health Facilities Participating in Case Matching Algorithm Testing

Table 8: Participating health facilities (n=33) by count of records in HIV case matching algorithm testing – Addis Ababa, Ethiopia, June 2015.

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<td><strong>Total</strong></td>
<td><strong>108135</strong></td>
</tr>
</tbody>
</table>

* Datasets represent the same health facility; each dataset contains unique patient medical records.

^ Datasets represent the same health facility; each dataset contains unique patient medical records.
Appendix 7: HIV Clinical Cascades

**Adult patients (n=99181) engaged in HIV treatment and care, Proof of Concept for HIV Case Based Surveillance, 34 health facilities, Addis Ababa, Ethiopia, 1996 - 2014**

<table>
<thead>
<tr>
<th>Count</th>
<th>Diagnosed, registered at HIV Treatment Clinic</th>
<th>Linked to Care</th>
<th>Eligible for ART</th>
<th>Started ART</th>
</tr>
</thead>
<tbody>
<tr>
<td>98727</td>
<td></td>
<td>65247</td>
<td>57972</td>
<td>57949</td>
</tr>
</tbody>
</table>

**Pediatric patients (n=4143) engaged in HIV treatment and care, Proof of Concept for HIV Case Based Surveillance, 34 health facilities, Addis Ababa, Ethiopia, 1996 - 2014**

<table>
<thead>
<tr>
<th>Count</th>
<th>Diagnosed, registered at HIV Treatment Clinic</th>
<th>Linked to Care</th>
<th>Eligible for ART</th>
<th>Started ART</th>
</tr>
</thead>
<tbody>
<tr>
<td>4095</td>
<td></td>
<td>2372</td>
<td>2372</td>
<td>2372</td>
</tr>
</tbody>
</table>
Pregnant female patients (n=4576) engaged in HIV treatment and care, Proof of Concept for HIV Case Based Surveillance, 34 health facilities, Addis Ababa, Ethiopia, 1996 - 2014

<table>
<thead>
<tr>
<th>Count</th>
<th>Diagnosed, registered at HIV Treatment Clinic</th>
<th>Linked to Care</th>
<th>Eligible for ART</th>
<th>Started ART</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>4568</td>
<td>2291</td>
<td>1662</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>50.2%</td>
<td></td>
</tr>
</tbody>
</table>

Tuberculosis co-infected patients (n=4818) engaged in HIV treatment and care, Proof of Concept for HIV Case Based Surveillance, 34 health facilities, Addis Ababa, Ethiopia, 1996 - 2014

<table>
<thead>
<tr>
<th>Count</th>
<th>Diagnosed, registered at HIV Treatment Clinic</th>
<th>Linked to Care</th>
<th>Eligible for ART</th>
<th>Started ART</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>4752</td>
<td>2741</td>
<td>2739</td>
</tr>
</tbody>
</table>

Diagnosed, registered at HIV Treatment Clinic, Linked to Care, Eligible for ART, Started ART.
Female adult patients (n=62577) engaged in HIV treatment and care by age group, Proof of Concept for HIV Case Based Surveillance, 34 health facilities, Addis Ababa, Ethiopia, 1996 - 2014

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Diagnosed, registered at HIV Treatment Clinic</th>
<th>Linked to Care</th>
<th>Eligible for ART</th>
<th>Started ART</th>
</tr>
</thead>
<tbody>
<tr>
<td>50+ years</td>
<td>3599</td>
<td>2679</td>
<td>2394</td>
<td>2393</td>
</tr>
<tr>
<td>25-49 years</td>
<td>48101</td>
<td>31745</td>
<td>27581</td>
<td>27567</td>
</tr>
<tr>
<td>20-24 years</td>
<td>9066</td>
<td>4420</td>
<td>3611</td>
<td>3610</td>
</tr>
<tr>
<td>15-19 years</td>
<td>1573</td>
<td>672</td>
<td>550</td>
<td>550</td>
</tr>
</tbody>
</table>

Count

Male adult patients (n=36604) engaged in HIV treatment and care by age group, Proof of Concept for HIV Case Based Surveillance, 34 health facilities, Addis Ababa, Ethiopia, 1996 - 2014

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Diagnosed, registered at HIV Treatment Clinic</th>
<th>Linked to Care</th>
<th>Eligible for ART</th>
<th>Started ART</th>
</tr>
</thead>
<tbody>
<tr>
<td>50+ years</td>
<td>4244</td>
<td>3167</td>
<td>2921</td>
<td>2921</td>
</tr>
<tr>
<td>25-49 years</td>
<td>30344</td>
<td>21595</td>
<td>20064</td>
<td>20058</td>
</tr>
<tr>
<td>20-24 years</td>
<td>1367</td>
<td>682</td>
<td>603</td>
<td>602</td>
</tr>
<tr>
<td>15-19 years</td>
<td>433</td>
<td>287</td>
<td>248</td>
<td>248</td>
</tr>
</tbody>
</table>
### Female Pediatric Patients

**Female pediatric patients (n=2080) engaged in HIV treatment and care by age group,**

*Proof of Concept for HIV Case Based Surveillance, 34 health facilities, Addis Ababa, Ethiopia, 1996 - 2014*

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Diagnosed, registered at HIV Treatment Clinic</th>
<th>Linked to Care</th>
<th>Eligible for ART</th>
<th>Started ART</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-14 years</td>
<td>567</td>
<td>378</td>
<td>378</td>
<td>378</td>
</tr>
<tr>
<td>5-9 years</td>
<td>801</td>
<td>441</td>
<td>441</td>
<td>441</td>
</tr>
<tr>
<td>1-4 years</td>
<td>605</td>
<td>293</td>
<td>293</td>
<td>293</td>
</tr>
<tr>
<td>&lt;1 year</td>
<td>92</td>
<td>56</td>
<td>56</td>
<td>56</td>
</tr>
</tbody>
</table>

### Male Pediatric Patients

**Male pediatric patients (n=2063) engaged in HIV treatment and care by age group,**

*Proof of Concept for HIV Case Based Surveillance, 34 health facilities, Addis Ababa, Ethiopia, 1996 - 2014*

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Diagnosed, registered at HIV Treatment Clinic</th>
<th>Linked to Care</th>
<th>Eligible for ART</th>
<th>Started ART</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-14 years</td>
<td>534</td>
<td>351</td>
<td>351</td>
<td>351</td>
</tr>
<tr>
<td>5-9 years</td>
<td>759</td>
<td>473</td>
<td>473</td>
<td>473</td>
</tr>
<tr>
<td>1-4 years</td>
<td>644</td>
<td>327</td>
<td>327</td>
<td>327</td>
</tr>
<tr>
<td>&lt;1 year</td>
<td>93</td>
<td>53</td>
<td>53</td>
<td>53</td>
</tr>
</tbody>
</table>