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National health information systems for achieving the Sustainable Development Goals: a cross sectional survey in low- and middle-income countries

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Complete List of Authors:	<p>Suthar, Amitabh; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Khalifa, Aleya; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Joos, Olga; Centers for Disease Control and Prevention, International Statistics Program</p> <p>Manders, Eric-Jan; Centers for Disease Control and Prevention</p> <p>Abdul-Quader , Abu ; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Amoyaw , Frank; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Aoua, Camara; Ministere de la Sante et de l'Hygiene Publique</p> <p>Aynalem, Getahun; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Barradas , Danielle; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Bello , George; Ministry of Health</p> <p>Bonilla, Luis; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Cheyip , Mireille; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Dalhatu, Ibrahim Tijjani ; Centers for Disease Control and Prevention, Center for Global Health</p> <p>De Klerk , Michael ; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Dee , Jacob; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Hedje, Judith; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Jahun, Ibrahim ; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Jantaramanee , Supiya ; Ministry of Public Health</p> <p>Kamocha , Stanley ; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Lerebours , Leonel; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Lobognon, Legre Roger ; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Lote, Namarola; National Department of Health</p>

	Lubala, Léopold; Ministère de la Santé Publique Magazani, Alain; Ministère de la Santé Publique Mdodo, Rennatus ; Centers for Disease Control and Prevention, Center for Global Health Mgomella , George S. ; Centers for Disease Control and Prevention, Center for Global Health Monique , Lattah Asseka ; Ministere de la Sante et de l'Hygiene Publique Mudenda , Mphatso ; Centers for Disease Control and Prevention, Center for Global Health Mushi , Jeremiah ; Ministry of Health and Social Welfare Mutenda , Nicholus ; Ministry of Health and Social Services Nicoue , Aime ; Centers for Disease Control and Prevention, Center for Global Health Ngalamulume , Rogers Galaxy ; Centers for Disease Control and Prevention, Center for Global Health Ndjakani , Yassa ; Centers for Disease Control and Prevention, Center for Global Health Nguyen , Tuan Anh ; Centers for Disease Control and Prevention, Center for Global Health Nzelu , Charles Echezona ; Federal Ministry of Health Ofosu , Anthony Adofo ; Ghana Health Service Pinini , Zukiswa ; National Department of Health Ramírez , Edwin ; Servicio Nacional de Salud Sebastian , Victor ; Centers for Disease Control and Prevention, Center for Global Health Simanovong , Bouathong ; Ministry of Health Son , Ha Thai ; Ministry of Health Son , Vo Hai ; Ministry of Health Swaminathan , Mahesh ; Centers for Disease Control and Prevention, Center for Global Health Sivile , SuilANJI ; Ministry of Health Teeraratkul , Achara ; Centers for Disease Control and Prevention, Center for Global Health Temu , Poruan ; Centers for Disease Control and Prevention, Center for Global Health West , Christine ; Centers for Disease Control and Prevention Xaymounvong , Douangchanh ; Centers for Disease Control and Prevention, Center for Global Health Yamba, Abel ; Centers for Disease Control and Prevention, Center for Global Health Yoka , Denis ; Ministere de la Sante Publique Zhu , Hao ; Centers for Disease Control and Prevention, Center for Global Health Ransom , Ray L. ; Centers for Disease Control and Prevention, Center for Global Health Nichols, Erin; Centers for Disease Control and Prevention, International Statistics Program Murrill , Christopher S.; Centers for Disease Control and Prevention, Center for Global Health Rosen , Daniel ; Centers for Disease Control and Prevention, Center for Global Health Hladik, Wolfgang; Center for Global Health, Centers for Disease Control and Prevention
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**National health information systems for achieving the Sustainable Development Goals:
a cross sectional survey in low- and middle-income countries**

- Amitabh B. Suthar* – Center for Global Health, Centers for Disease Control and Prevention, Atlanta, U.S.A.
- Aleya Khalifa* – Center for Global Health, Centers for Disease Control and Prevention, Atlanta, U.S.A.
- Olga Joos – International Statistics Program, Centers for Disease Control and Prevention, Hyattsville, U.S.A.
- Eric-Jan Manders – Center for Global Health, Centers for Disease Control and Prevention, Atlanta, U.S.A.
- Abu Abdul-Quader – Center for Global Health, Centers for Disease Control and Prevention, Hanoi, Vietnam
- Frank Amoyaw – Center for Global Health, Centers for Disease Control and Prevention, Accra, Ghana
- Camara Aoua – Ministère de la Santé et l'Hygiène Publique, Abidjan, Côte d'Ivoire
- Getahun Aynalem – Center for Global Health, Centers for Disease Control and Prevention, Pretoria, Republic of South Africa
- Danielle Barradas – Center for Global Health, Centers for Disease Control and Prevention, Lusaka, Zambia
- George Bello – Ministry of Health, Lilongwe, Malawi
- Luis Bonilla – Center for Global Health, Centers for Disease Control and Prevention, Santo Domingo, República Dominicana
- Mireille Cheyip – Center for Global Health, Centers for Disease Control and Prevention, Pretoria, Republic of South Africa
- Ibrahim Tijjani Dalhatu – Center for Global Health, Centers for Disease Control and Prevention, Abuja, Nigeria
- Michael De Klerk – Center for Global Health, Centers for Disease Control and Prevention, Windhoek, Namibia
- Jacob Dee – Center for Global Health, Centers for Disease Control and Prevention, Kinshasa, République Démocratique du Congo
- Judith Hedje – Center for Global Health, Centers for Disease Control and Prevention, Abidjan, Côte d'Ivoire
- Ibrahim Jahun – Center for Global Health, Centers for Disease Control and Prevention, Abuja, Nigeria
- Supiya Jantaramanee – Ministry of Public Health, Bangkok, Thailand

- Stanley Kamocha – Center for Global Health, Centers for Disease Control and Prevention, Lusaka, Zambia
- Leonel Lerebours – Center for Global Health, Centers for Disease Control and Prevention, Santo Domingo, República Dominicana
- Legre Roger Lobognon – Center for Global Health, Centers for Disease Control and Prevention, Abidjan, Côte d'Ivoire
- Namarola Lote – National Department of Health, Port Moresby, Papua New Guinea
- Léopold Lubala – Ministère de la Santé Publique, Kinshasa, République Démocratique du Congo
- Alain Magazani – Ministère de la Santé Publique, Kinshasa, République Démocratique du Congo
- Rennatus Mdodo – Center for Global Health, Centers for Disease Control and Prevention, Dar es Salaam, United Republic of Tanzania
- George S. Mgomella – Center for Global Health, Centers for Disease Control and Prevention, Dar es Salaam, United Republic of Tanzania
- Lattah Asseka Monique – Ministère de la Santé et l'Hygiène Publique, Abidjan, Côte d'Ivoire
- Mphatso Mudenda – Center for Global Health, Centers for Disease Control and Prevention, Lusaka, Zambia
- Jeremiah Mushi – Ministry of Health and Social Welfare, Dar es Salaam, United Republic of Tanzania
- Nicholus Mutenda – Ministry of Health and Social Services, Windhoek, Namibia
- Aime Nicoue – Center for Global Health, Centers for Disease Control and Prevention, Abidjan, Côte d'Ivoire
- Rogers Galaxy Ngalamulume – Center for Global Health, Centers for Disease Control and Prevention, Kinshasa, République Démocratique du Congo
- Yassa Ndjakani – Center for Global Health, Centers for Disease Control and Prevention, Kinshasa, République Démocratique du Congo
- Tuan Anh Nguyen – Center for Global Health, Centers for Disease Control and Prevention, Hanoi, Vietnam
- Charles Echezona Nzelu – Federal Ministry of Health, Abuja, Nigeria
- Anthony Adofo Ofosu – Ghana Health Service, Accra, Ghana
- Zukiswa Pinini – National Department of Health, Pretoria, Republic of South Africa
- Edwin Ramírez – Servicio Nacional de Salud, Santo Domingo, República Dominicana
- Victor Sebastian – Center for Global Health, Centers for Disease Control and Prevention, Abuja, Nigeria
- Bouathong Simanovong – Ministry of Health, Lao People's Democratic Republic
- Ha Thai Son – Ministry of Health, Hanoi, Vietnam

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56 99

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58

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60

Vo Hai Son – Ministry of Health, Hanoi, Vietnam

Mahesh Swaminathan – Center for Global Health, Centers for Disease Control and Prevention, Abuja, Nigeria

Suilanji Sivile – Ministry of Health, Lusaka, Zambia

Achara Teeraratkul – Center for Global Health, Centers for Disease Control and Prevention, Bangkok, Thailand

Poruan Temu – Center for Global Health, Centers for Disease Control and Prevention, Port Moresby, Papua New Guinea

Christine West – Center for Global Health, Centers for Disease Control and Prevention, Lilongwe, Malawi

Douangchanh Xaymounvong – Center for Global Health, Centers for Disease Control and Prevention, Vientiane, Lao People's Democratic Republic

Abel Yamba – Center for Global Health, Centers for Disease Control and Prevention, Port Moresby, Papua New Guinea

Denis Yoka – Ministère de la Santé Publique, Kinshasa, République Démocratique du Congo

Hao Zhu – Center for Global Health, Centers for Disease Control and Prevention, Beijing, China

Ray L. Ransom – Center for Global Health, Centers for Disease Control and Prevention, Atlanta, U.S.A.

Erin K. Nichols – International Statistics Program, Centers for Disease Control and Prevention, Hyattsville, U.S.A.

Christopher S. Murrill – Center for Global Health, Centers for Disease Control and Prevention, Atlanta, U.S.A.

Daniel Rosen – Center for Global Health, Centers for Disease Control and Prevention, Atlanta, U.S.A.

Wolfgang Hladik – Center for Global Health, Centers for Disease Control and Prevention, Atlanta, U.S.A.

* These authors contributed equally to this work.

Corresponding author: Dr Amitabh Bipin Suthar, icf4@cdc.gov

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1
2 127 **Abstract**

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4 128 *Objectives*

5 129 Achieving the Sustainable Development Goals will require data-driven public health action. There are
6
7 130 limited publications on national health information systems that continuously generate health data. Given
8
9 131 the need to develop these systems, we summarised their current status in low- and middle-income
10 132 countries.
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14 134 *Setting*

15 135 The survey team jointly developed a questionnaire covering policy, planning, legislation, and organization
16 136 of case reporting, patient monitoring, and civil registration and vital statistics (CRVS) systems. From
17 136
18
19 137 January until May 2017, we administered the questionnaire to key informants in 51 Centers for Disease
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21 138 Control (CDC) country offices. Countries were aggregated for descriptive analyses in Microsoft Excel.
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24 140 *Results*

25
26 141 Key informants in 15 countries responded to the questionnaire. The Ministry of Health coordinated case
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28 142 reporting, patient monitoring, and CRVS systems in 93%, 93%, and 53% of responding countries,
29 143 respectively. Domestic financing supported case reporting, patient monitoring, and CRVS systems in
30 144 86%, 75%, and 92% of responding countries, respectively. The most common uses for system-generated
31 144
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33 145 data was to guide programme response in 100% of countries for case reporting, to calculate service
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35 146 coverage in 92% of countries for patient monitoring, and to estimate the national burden of disease in 83%
36 147 of countries for CRVS. Electronic systems were being used for case reporting, patient monitoring, birth
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38 148 registration, and death registration in 93%, 92%, 85%, and 73% of responding countries, respectively.
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41 150 *Conclusions*

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43 151 Most responding countries have a solid foundation for policy, planning, legislation, and organisation of
44
45 152 health information systems. Further evaluation is needed to assess the quality of data generated from
46
47 153 systems. Periodic evaluations may be useful in monitoring progress in strengthening and harmonising
48 154 these systems over time.
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52 156 *Note to BMJ Open: Since this was a global survey the participants and interventions sections of the
53 157 abstract were not applicable.
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Strengths and limitations of this study

- Health information systems generate key data to guide action in achieving the SDGs; however, the status of these systems in low- and middle-income countries is largely undocumented
- We present findings of one of the first assessments conducted in low- and middle-income countries
- Most responding countries had a solid foundation for policy, planning, legislation, and organisation of case reporting, patient monitoring, and civil registration and vital statistics systems
- Case reporting systems were commonly used to guide programme response, patient monitoring systems were most commonly used to calculate service coverage, and civil registration and vital statistics systems were most commonly used to estimate the national burden of disease
- Given that the survey represents 15 countries globally, more information from additional countries can help characterise health information systems further

1
2 172 **Introduction**

3 173 Data should guide governments as they plan, budget, and act for health. The Sustainable Development
4 174 Goal (SDG) for health, ensure healthy lives and promote well-being for all at all ages, requires data on
5 175 disease transmission, service coverage and outcomes, and causes of death (Table 1) [1]. These data can
6
7 176 come from various sources including surveys, longitudinal studies, and data systems. Given that surveys
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9 177 and longitudinal studies often are time-limited, require external resources, and take time to design and
10
11 178 administer, the role of systems in generating population disaggregated, geographically specific, and timely
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13 179 data is becoming more important [2].
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17 181 Although there are many health information systems in use, three major systems include: (1) case
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19 182 reporting, (2) patient monitoring, and (3) vital statistics derived from civil registration systems.
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21 183 Communicable disease case reporting is traditionally used to monitor trends in disease transmission across
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23 184 different geographic settings and amongst different populations as part of routine surveillance [3]. Patient
24 185 monitoring can be used to monitor health service coverage, such as treatment for HIV, tuberculosis,
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26 186 childhood immunisations, amongst others as part of universal healthcare coverage [4]. Well-functioning
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28 187 civil registration and vital statistics (CRVS) systems produce data on registered births, deaths (including
29 188 cause of death), as well as marriages, adoptions, and divorces; public health authorities primarily focus on
30
31 189 registration of births, deaths, and causes of deaths for decision making [5].
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35 191 For case reporting, many of the global norms and standards trace back to disease-specific reporting
36 192 requirements, the Integrated Disease Surveillance and Response (IDSR) framework, and to the
37
38 193 International Health Regulations [6,7]. Patient monitoring, and other health information systems, are
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40 194 transitioning from paper- to electronic-based systems [8]. The Statistical Commission of the United
41 195 Nations provides comprehensive principles and recommendations for CRVS systems to achieve universal
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43 196 coverage, continuity, confidentiality, and regular dissemination in order to be a dependable and primary
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45 197 data source for vital statistics [9]. Although WHO collates global health data in its Global Health
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47 198 Observatory [10], to our knowledge there are few publications evaluating contributing *systems* in detail
48 199 [11]. The objective of this article is to summarise the status of case reporting, patient monitoring, and
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50 200 CRVS systems amongst a sample of low- and middle-income countries.
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52 201
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54 202 **Methods**
55 203 *Design*
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The survey team jointly developed a survey covering policy, planning, legislation, and organisation of case reporting, patient monitoring, and CRVS systems. This survey was primarily designed to assess the state of information systems that could potentially be leveraged for HIV-related clinical surveillance, monitoring progress towards meeting national and global goals, and improving national responses [12]. The survey was administered through a tool developed in Excel (Microsoft Corporation, Seattle, USA). The tool consisted of multiple choice questions and text boxes through which respondents could elaborate on their selections (Appendix S1).

Definitions

For the purposes of establishing a common framework for administration of this tool, we developed definitions for case reporting, patient monitoring, and CRVS systems:

- A functioning case reporting system routinely collects information on diagnosed disease-specific cases. These cases may be reported from health facilities or providers to a central level. At subnational and national levels, these data can be used to track epidemics and quantify the burden of disease in order to inform public health programs. For example, some countries may use Integrated Disease Surveillance and Response (IDSR) to report individual and aggregated newly diagnosed cases of communicable disease.
- Patient monitoring systems collect routine data from health facilities related to clinical patient management. Patient monitoring systems are often used to measure service coverage and quality. Data are often used to assess the health sector response from the facility to the national level.
- CRVS systems register births, deaths, cause of deaths, marriages, and divorces. In public health, authorities focus on the registration of births, deaths and cause of deaths to track population demographics and patterns of disease. CRVS can generate disease specific mortality trends to inform burden and impact assessments.

Data collection

We surveyed all regional and country CDC offices with Division of Global HIV and TB staff outside of the United States. CDC country staff overseeing strategic information were selected as key informants and were contacted by email to complete the tool. One staff member was contacted per country. Respondents were encouraged to liaise with their government counterparts for questions to which they did not know the answer. Questions that the counterpart did not know, and for which they were unable to liaise with their counterpart, were left blank. We administered the questionnaire via email in January 2017.

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2 236 Up to three follow-up emails were sent to non-respondents from February to May 2017. The results were
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4 237 then reviewed with government counterparts for validity.

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7 239 *Data management and analysis*

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9 240 Country key informants entered their responses directly into the Excel tool. All country files were cleaned
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11 241 and merged into a Stata database (Statacorp, College Station, USA). The Stata database was then exported
12 242 to Excel (Microsoft, Redmond, USA) for analysis. Any response that was left blank or indicated “not
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14 243 applicable” was excluded from the denominator when percentages were calculated. Since different
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16 244 questions were left blank or indicated not applicable from key informants, most of the descriptive analyses
17 245 have different denominators. Tableau (Tableau, Seattle, USA) was used for creating maps with national
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19 246 data while Excel was used to create descriptive tables.

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22 248 *Ethical approval*

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24 249 The survey protocol was reviewed, deemed to not require CDC institutional review board approval, and
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26 250 approved by the Office of Science from the Center for Global Health at CDC.

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29 252 *Patient and Public Involvement*

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31 253 This survey included countries rather than patients as a unit of measure.

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34 255 **Results**

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36 256 Overall, 15 of 51 (29%) country key informants responded to the tool. Socioeconomic characteristics of
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38 257 responding countries, including life expectancy, mean years of schooling, gross national per capita
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40 258 income, and human development index, are found in Table 2.

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43 260 *Case reporting systems*

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45 261 Key informants from 14 of 15 (93%) countries that responded to the case reporting systems section of the
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47 262 survey indicated that the Ministry of Health was responsible for disease case reporting. Overall, there was
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49 263 legislation mandating reporting for at least one disease in 13 of 15 (87%) of responding countries.
50 264 Domestic financing contributed to funding case reporting systems in 12 of 14 (86%) responding countries.
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52 265 Some form of unique identifier was utilised for 8 of 14 (57%) of responding countries. All 14 responding
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54 266 countries indicated a physical barrier, software barrier, legal barrier, encryption, and/or unique ID being
55 267 used as a security measure. The majority of case reporting systems were linked to patient monitoring

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(80%) and laboratory information systems (70%) with a small proportion being linked to CRVS systems (10%). These findings and others are presented in Table 3. Key informants from 13 of 15 responding countries (87%) reported an electronic component in the country's case reporting system, and 8 of these 13 (62%) countries collect data on individual cases (Figure 1).

Patient monitoring systems

Key informants from 13 of 14 (93%) countries that responded to the patient monitoring systems section of the survey indicated that the Ministry of Health was responsible for patient monitoring. The primary use of patient monitoring data was to monitor service coverage (reported by 12 of 13 countries, 92%); however 8 of 13 (62%) and 10 of 13 (77%) reported using patient monitoring data for service quality improvement and commodity forecasting, respectively. Multilateral (9 of 12 countries, 75%) and bilateral (9 of 12 countries, 75%) financial support was more common for patient monitoring compared to case reporting. Five of 12 countries (42%) of patient monitoring systems used the same system for monitoring in the private and public health sector. Two of 14 (14%) countries used patient monitoring for social health insurance reimbursement. Patient monitoring systems were linked to case reporting (43%) and laboratory information systems (71%), vital statistics (43%), and health insurance systems (14%). These findings and others are presented in Table 4. Key informants from 11 of 12 (92%) responding countries reported an electronic component in the country's patient monitoring system, and 7 of these 11 (64%) countries collect data on individual patients (Figure 2).

CRVS systems

Key informants from 8 of 15 (53%) countries that responded to the CRVS systems section of the survey indicated that the Ministry of Health was responsible for CRVS, in 7 of 15 responding countries (47%) the Ministry of Interior (or similar) was responsible for CRVS, and in 4 of 15 countries (27%) the Ministry of Justice was responsible for CRVS. There were some countries in which multiple Ministries were responsible for CRVS. There was legislation mandating birth and death registration in 13 of 14 (93%) countries. Birth and death data were used to quantify service need (7 of 12 countries, 58%), analyse cost-effectiveness (6 of 12 countries, 50%), measure impact of disease programmes (7 of 12 countries, 58%), and to measure the national burden of disease (10 of 12 countries, 83%). Birth and death registration was required to access government services in all 15 responding countries (100%). These findings and others are presented in Table 5. Key informants from 10 of 13 responding countries (77%) reported an electronic component for birth registration, and 9 of these 10 (90%) countries collect data on individual births (Figure

3). Key informants from 7 of 11 responding countries (64%) reported an electronic component for death registration, and 6 of these 7 (85%) countries collect data on individual deaths (Figure 4). Key informants from 8 of 12 (67%) reported that the country used the tenth revision of the international classification of disease (ICD-10) for reporting the cause of death while 2 of 12 (17%) responding countries indicated that the vital statistics system used verbal autopsy to ascertain the cause of death (Figure 5).

Discussion

Case reporting, patient monitoring, and CRVS systems were widely implemented and used in responding countries. These systems generate critical data for public health planning, budgeting, and action. There was funding for these systems from national budgets, bi-lateral arrangements, and multi-lateral mechanisms, suggesting some level of political commitment for their development and implementation. Many countries also reported use of electronic and individual-level data, suggesting that more granular and accessible data are becoming available for end-users. Overall, these are encouraging trends which will hopefully continue in order to accelerate progress toward meeting the SDGs.

The majority of responding countries had greater than 75% geographic coverage of their case reporting system. Moreover, most countries had an electronic component to their system. Electronic systems could help store increased volumes of data over time, store more detailed data prospectively, and provide more rapid access to such data compared to paper-based systems [13]. Understanding the number of diagnosed cases of diseases can directly inform programme response to contain transmission [7]. All responding countries used case reporting data to achieve this. Future qualitative studies may help understand the ways in which case reporting data are used to contain disease transmission. For example, in Uganda a command centre was created to house an interdisciplinary rapid response team to receive, evaluate, and distribute information as the centre of communication and coordination response operations [14]. Many diseases require their own diagnostic commodities as part of national diagnostic algorithms. For example, HIV requires combinations of two or three rapid tests to diagnose each case [15]. Approximately half of responding countries used case reporting data for commodity forecasting. As observed with medicines, central procurement, informed by case reporting data, could provide cost savings and increase availability of diagnostics at service delivery sites [16].

The primary use of data from patient monitoring systems by responding countries was to monitor coverage of services. This is likely due to the importance of monitoring the coverage of key health sector

interventions for reproductive health, communicable diseases, and national immunisation schedules [4]. Many countries are embarking on the development of national health insurance schemes as part of universal healthcare coverage [17]. Given the wide geographic scale, and use of individual-level electronic data in many settings, there may be an opportunity to leverage these systems for processing claims and co-payments for services rendered [18]. Based on this survey, some countries are using the same system for social health insurance while others have linked the patient monitoring system to the health insurance system. Lessons learnt from each of these scenarios should be further examined and documented.

Overall, more countries reported systems for registering birth events relative to deaths. This is consistent with globally available data suggesting that birth registration rates are higher than death registration rates [5]. ICD-10 remains the global norm for classifying the cause of death within the health sector [19]. In this survey, the majority of responding countries reported use of ICD-10 for classifying the cause of death. Death registration, and methods to ascertain the cause of death, are more heterogeneous in communities. Verbal autopsy has shown promise as an option to incorporate within CRVS systems when medical certification of cause of death is not possible [20] and many countries reported using this approach. Vital statistics were required for a wide range of government services. The most common government service requiring birth registration was school enrolment; this requirement has been shown to be associated with higher coverage of national birth registration rates [21,22]. The most common requirement for death registration was the need for a burial permit. This requirement may also be important in improving national death registration rates [23,24].

There were several cross-cutting issues relevant to case reporting, patient monitoring, and vital statistics systems. For example, there were a range of approaches for identification of people in systems. These included using national identification, health identification, and system-generated identification. Across all systems national identification was used most often. Given the global momentum behind achieving SDG target 16.9, achieving free and universal legal identity by 2030, use of national identification may increase further with time [25]. Security measures to protect data from unauthorised use has emerged as a critical issue in light of the transition to electronic data systems [26]. In this survey, physical barriers, software barriers, legal barriers, encryption, and use of unique identifiers were security measures used. Software and physical barriers were most common, suggesting opportunities for using encryption, legal protection measures, and unique identifiers. Unique identifiers can offer complementary protections by limiting the number of locations, both paper and electronic, where names are used but do have additional

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2 364 risks such as re-identification of an identity from an available data source that uses the same unique
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4 365 identifier. Linking different information systems can provide improved inferences for patients
5 366 longitudinally over their life course [27]. The majority of case reporting systems were linked to patient
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7 367 monitoring and laboratory information systems with a small proportion being linked to vital statistics. The
8
9 368 majority of patient monitoring systems were linked to case reporting and laboratory information systems
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11 369 with a minority linked to vital statistics and health insurance systems. Linking systems with health
12 370 insurance may have implications on improved data quality since the data will directly affect staff
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14 371 remuneration for services rendered [28].

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16 372
17 373 One of the major limitations of this survey was the low response rate. Reducing the number of questions
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19 374 and administering the survey later in the year may help improve the number of respondents in the future.
20
21 375 Although we relied on knowledge and experience of participating staff members which may vary from
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23 376 office to office, attempts were made to extract missing information, and verify provided information from
24 377 government counterparts. Moreover, since we conducted this survey electronically, there may have been
25
26 378 differences in the way questions were interpreted across different key informants. This could have affected
27
28 379 their answer selection. The electronic format of the survey also meant that there were limited opportunities
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30 380 to qualify answers. For example, although we collected information on whether individual or aggregated
31 381 data was available in electronic systems, we did not describe pathways of data flow. In the future, use
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33 382 cases, success stories, and lessons learnt may be based on specific answers during subsequent qualitative
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35 383 interviews of stakeholders. During the implementation of this survey, CDC placed additional field staff in
36 384 countries through its Division of Global Health Protection. In the future, it may be worth reaching out to
37
38 385 key informants in CDC countries irrespective of their programme focus to have the widest reach. Some
39
40 386 important aspects of health information systems, such as interoperability, standards, and required
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42 387 workforce competencies, were not covered in this survey and may merit further exploration. Since some
43 388 countries may manage civil registration and vital statistics separately there is potential for confusion from
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45 389 key informants on how to respond to questions encompassing CRVS holistically. Finally, evaluating the
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47 390 quality of data generated from systems requires different methods that should be evaluated as part of future
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49 391 assessments.

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52 393 Most countries have a solid foundation for policy, planning, legislation, and organisation of health
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54 394 information systems. There are opportunities to link systems, strengthen security measures for electronic
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data, and use data more effectively. Periodic evaluations may help understand progress in strengthening and harmonising these systems over time.

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Table 1. Corresponding health information systems for SDG Goal 3, Ensure healthy lives and promote well-being for all at all ages

Target	SDG Indicator	Contributing Health Information System
3.1: By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births	3.1.1: Maternal mortality ratio	Civil registration and vital statistics
	3.1.2: Proportion of births attended by skilled health personnel	Patient monitoring
3.2: By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births	3.2.1: Under-five mortality rate	Civil registration and vital statistics
	3.2.2: Neonatal mortality rate	Civil registration and vital statistics
3.3: By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases	3.3.1: Number of new HIV infections per 1,000 uninfected population, by sex, age and key populations	Case reporting
	3.3.2: Tuberculosis incidence per 100,000 population	Case reporting
	3.3.3: Malaria incidence per 1,000 population	Case reporting
	3.3.4: Hepatitis B incidence per 100,000 population	Case reporting
	3.3.5: Number of people requiring interventions against neglected tropical diseases	Case reporting
3.4: By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being	3.4.1: Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease	Civil registration and vital statistics
	3.4.2: Suicide mortality rate	Civil registration and vital statistics
3.5: Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol	3.5.1: Coverage of treatment interventions (pharmacological, psychosocial and rehabilitation and aftercare services) for substance use disorders	Patient monitoring
	3.5.2: Harmful use of alcohol, defined according to the national context as alcohol per capita consumption (aged 15 years and older) within a calendar year in litres of pure alcohol	Civil registration and vital statistics (denominator)
3.6: By 2020, halve the number of global deaths and injuries from road traffic accidents	3.6.1: Death rate due to road traffic injuries	Civil registration and vital statistics
3.7: By 2030, ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programmes	3.7.1: Proportion of women of reproductive age (aged 15-49 years) who have their need for family planning satisfied with modern methods	Patient monitoring (numerator), Civil registration and vital statistics (denominator)
	3.7.2: Adolescent birth rate (aged 10-14 years; aged 15-19 years) per 1,000 women in that age group	Civil registration and vital statistics
3.8: Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all	3.8.1: Coverage of essential health services (defined as the average coverage of essential services based on tracer interventions that include reproductive, maternal, newborn and child health, infectious diseases, non-communicable diseases and service capacity and access, among the general and the most disadvantaged population)	Patient monitoring
	3.8.2: Proportion of population with large household expenditures on health as a share of total household expenditure or income	Civil registration and vital statistics (denominator)
3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination	3.9.1: Mortality rate attributed to household and ambient air pollution	Civil registration and vital statistics
	3.9.2: Mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene (exposure to unsafe Water, Sanitation and Hygiene for All (WASH) services)	Civil registration and vital statistics
	3.9.3: Mortality rate attributed to unintentional poisoning	Civil registration and vital statistics
3.a: Strengthen the implementation of the World Health Organization Framework Convention on Tobacco Control in all countries, as appropriate	3.a.1: Age-standardized prevalence of current tobacco use among persons aged 15 years and older	Civil registration and vital statistics (denominator)

3.b: Support the research and development of vaccines and medicines for the communicable and non-communicable diseases that primarily affect developing countries, provide access to affordable essential medicines and vaccines, in accordance with the Doha Declaration on the TRIPS Agreement and Public Health, which affirms the right of developing countries to use to the full the provisions in the Agreement on Trade-Related Aspects of Intellectual Property Rights regarding flexibilities to protect public health, and, in particular, provide access to medicines for all	3.b.1: Proportion of the target population covered by all vaccines included in their national programme	Patient monitoring
	3.b.2: Total net official development assistance to medical research and basic health sectors	N/A
	3.b.3: Proportion of health facilities that have a core set of relevant essential medicines available and affordable on a sustainable basis	N/A
3.c: Substantially increase health financing and the recruitment, development, training and retention of the health workforce in developing countries, especially in least developed countries and small island developing States	3.c.1: Health worker density and distribution	N/A
3.d: Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks	3.d.1: International Health Regulations (IHR) capacity and health emergency preparedness	N/A

Table 2. Human development indicators for responding countries [29]

Country	Life expectancy at birth	Mean years of schooling	Gross national income per capita (\$USD, PPP)	Composite Human Development Index
China	76	7.6	13,345	0.738
Cote D'Ivoire	51.9	5	3,163	0.474
Democratic Republic of The Congo	59.1	6.1	680	0.435
Dominican Republic	73.7	7.7	12,756	0.722
Ghana	61.5	6.9	3,839	0.579
Lao People's Democratic Republic	66.6	5.2	5,049	0.586
Malawi	63.9	4.4	1,073	0.476
Namibia	65.1	6.7	9,770	0.64
Nigeria	53.1	6	5,443	0.527
Papua New Guinea	62.8	4.3	2,712	0.516
South Africa	57.7	10.3	12,087	0.666
Thailand	74.6	7.9	14,519	0.74
United Republic of Tanzania	65.5	5.8	2,467	0.531
Vietnam	75.9	8	5,335	0.683
Zambia	60.8	6.9	3,464	0.579

*PPP, purchasing power parity

Table 3. Characteristics of case reporting systems by region

	Number	Number of responses	Percentage of countries that responded (%)
Entity is responsible for case reporting	15	15	100
Ministry of Health	14	15	93
National Public Health Institute	1	15	7
Law exists that mandates case reporting for at least one disease	13	15	87
Case reporting data is used in country	15	15	100
Program response	15	15	100
Diagnostics forecasting	8	15	53
Burden of disease estimates	12	15	80
Case reporting system is currently funded	14	15	93
Domestic	12	14	86
Multilateral	10	14	71
Bilateral ¹	9	14	64
Private sector reports newly diagnosed cases of disease using the same system	11	13	85
Case reporting system is linked to other systems	10	14	71
Patient monitoring	8	10	80
Laboratory information system	7	10	70
Vital statistics	1	10	10
Unique identifiers are used for case reporting	8	14	57
National ID	4	7	57
Health ID	1	7	14
System-specific ID	1	7	14
Client demographics	4	7	57
Biometric data	0	7	0
Security measures used for <i>electronic</i> case reporting systems	14	14	100
Physical barrier	8	14	57
Software barrier	13	14	93
Legal barrier	5	14	36
Encryption	4	14	29
Unique ID	3	14	21

Note: Missing or "N/A" responses are excluded from the denominator number of responses. ¹ Bilateral organizations include both government agencies and non-government agencies

Table 4. Characteristics of patient monitoring systems by region

	Number	Number of responses	Percentage of countries that responded (%)
Entity is responsible for patient monitoring	14	15	93
Ministry of Health	13	14	93
National Public Health Institute	1	14	7
Other	1	14	7
Patient monitoring data is used in country	13	14	93
Service coverage calculation	12	13	92
Service quality improvement	8	13	62
Commodity forecasting	10	13	77
Patient monitoring system is currently funded	12	14	86
Domestic	9	12	75
Multilateral	9	12	75
Bilateral ¹	9	12	75
Private	1	12	8
Private sector monitors patients using the same system	5	12	42
Patient monitoring system is used for social health insurance reimbursement	2	14	14
Patient monitoring system is linked to other systems	7	13	54
Case reporting	3	7	43
Laboratory information system	5	7	71
Vital statistics	3	7	43
Health insurance system	1	7	14
Unique identifiers are used for patient monitoring	7	12	58
National ID	1	6	17
Health ID	1	6	17
System-specific ID	2	6	33
Client demographics	3	6	50
Biometric data	0	6	0
Security measures used for electronic patient monitoring systems	11	11	100
Physical barrier	7	11	64

Software barrier	9	11	82
Legal barrier	3	11	27
Encryption	5	11	45
Unique ID	3	11	27

Note: Missing or "N/A" responses are excluded from the denominator number of responses. ¹ Bilateral organizations include both government agencies and non-government agencies

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1
2 412 **Table 5.** Characteristics of CRVS systems by region

	Number	Number of responses	Percentage of countries that responded (%)
An entity is responsible for CRVS	15	15	100
Ministry of Health or similar	8	15	53
Ministry of Interior or similar	7	15	47
Ministry of Justice or similar	4	15	27
Law exists that mandates birth and death registration	13	14	93
Vital statistics data is used in country	13	15	87
To quantify health service need	7	12	58
To analyze cost-effectiveness	6	12	50
To measure impact of disease programs	7	12	58
National burden of disease estimates	10	12	83
Vital statistics system is currently funded	13	14	93
Domestic	11	12	92
Multilateral	2	12	17
Bilateral ¹	6	12	50
Private sector reports birth events using same electronic system	6	9	67
Private sector reports death events using same electronic system	5	10	50
Birth or death registration is required to access government services	15	15	100
Immunizations	9	15	60
Health insurance	10	14	71
School enrollment	14	15	93
Welfare	10	15	67
Legal services	11	15	73
Burials	11	15	73
Inheritance	8	15	53
Life insurance	10	15	67
Unique identifiers are used for vital statistics	5	14	36
National ID	4	5	80
Health ID	0	5	0
System-specific ID	1	5	20

Client demographics	1	5	20
Biometric data	0	5	0
Security measures used for electronic vital statistics system	8	11	73
Physical barrier	6	8	75
Software barrier	6	8	75
Legal barrier	4	8	50
Encryption	1	8	13
Unique ID	2	8	25

Note: Missing or "N/A" responses are excluded from the denominator number of responses. ¹ Bilateral organizations include both government agencies and non-government agencies

- 1
2 416 **Figure 1.** Case reporting systems by system type and geographic coverage
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5 418 **Figure 2.** Patient monitoring systems by system type and geographic coverage
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9 420 **Figure 3.** Vital statistics systems for registering births by system type and geographic coverage
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12 422 **Figure 4.** Vital statistics systems for registering deaths by system type and geographic coverage
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16 424 **Figure 5.** Cause of death classifications in death registration and mortality surveillance

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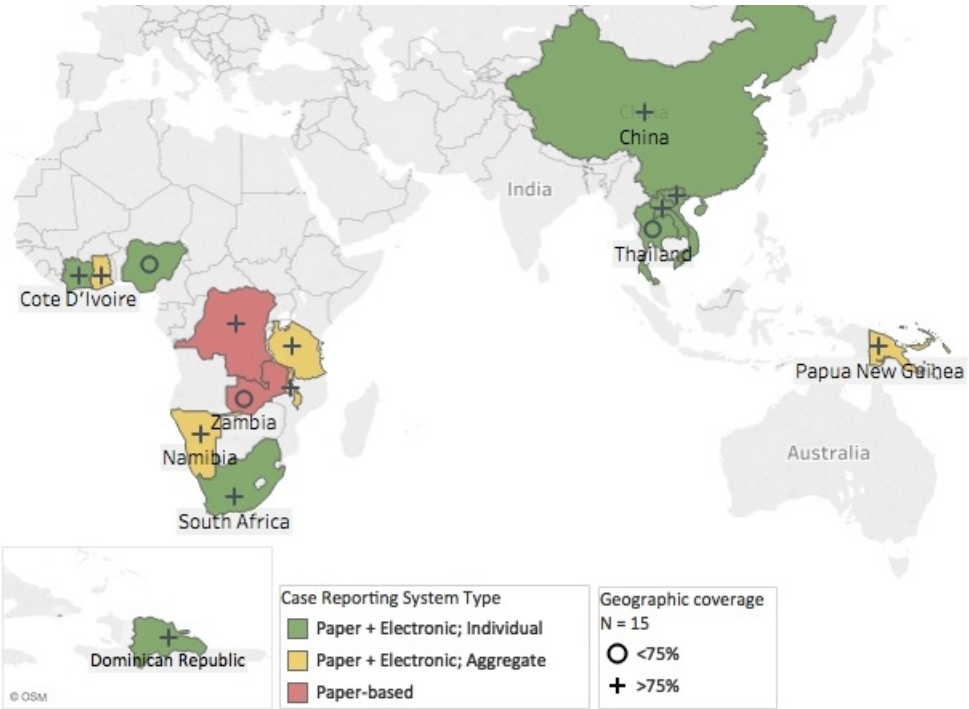
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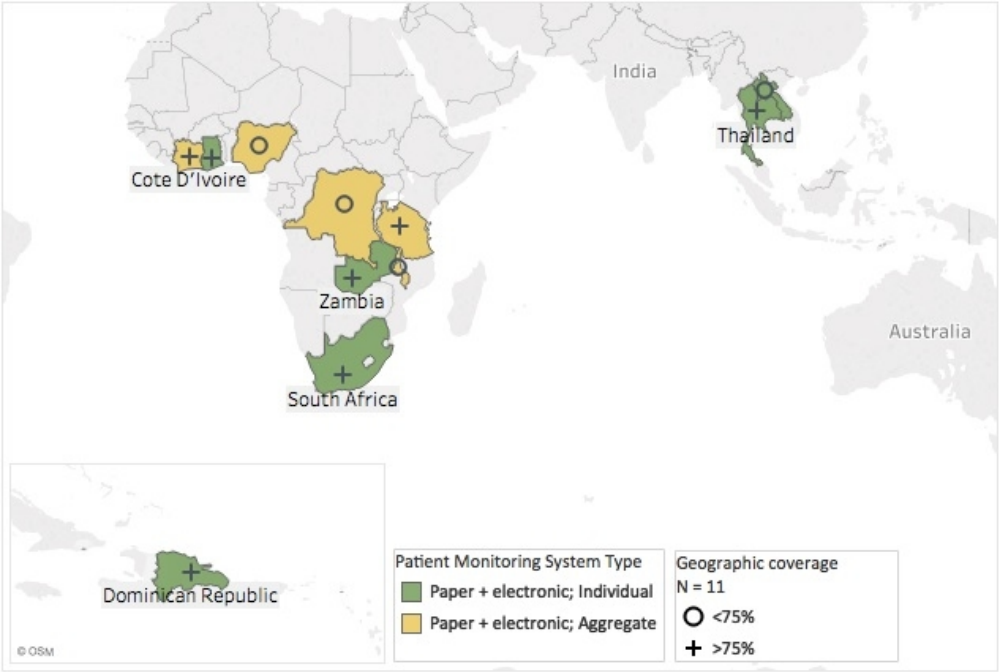
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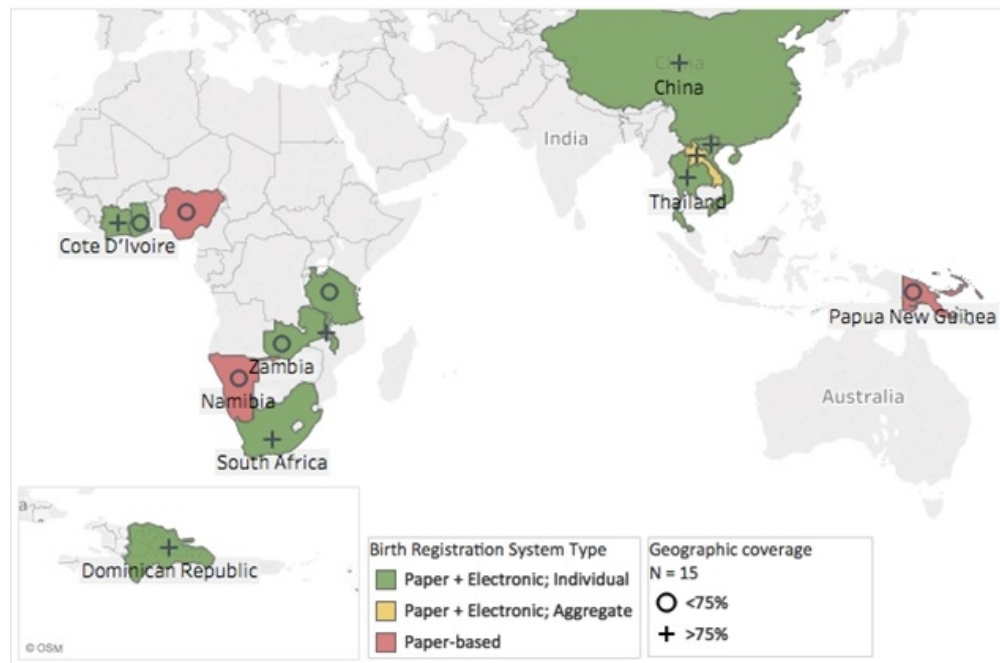
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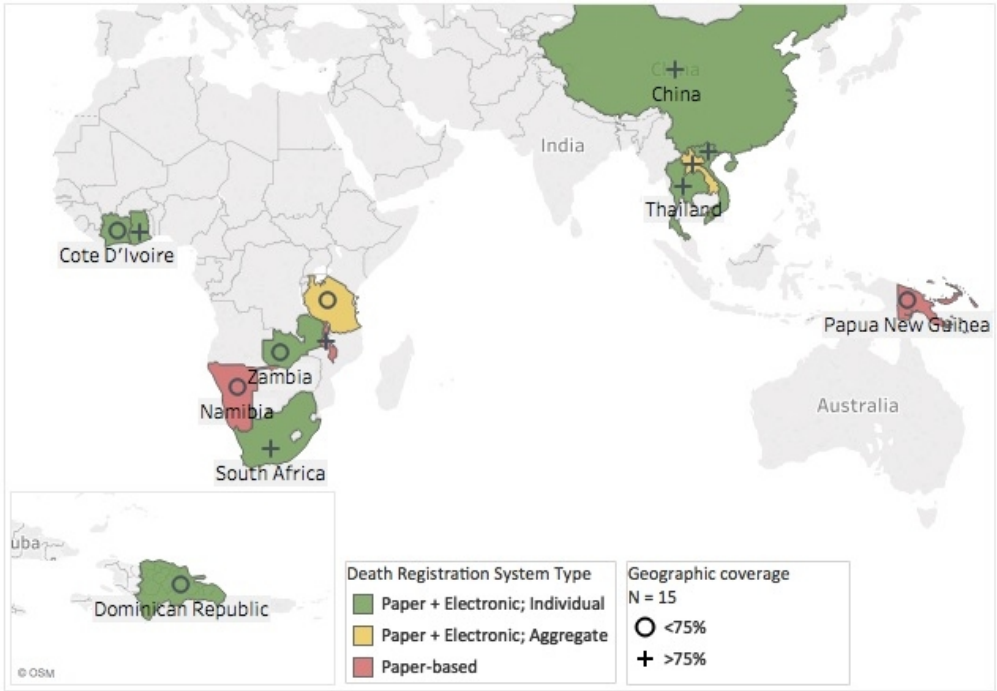
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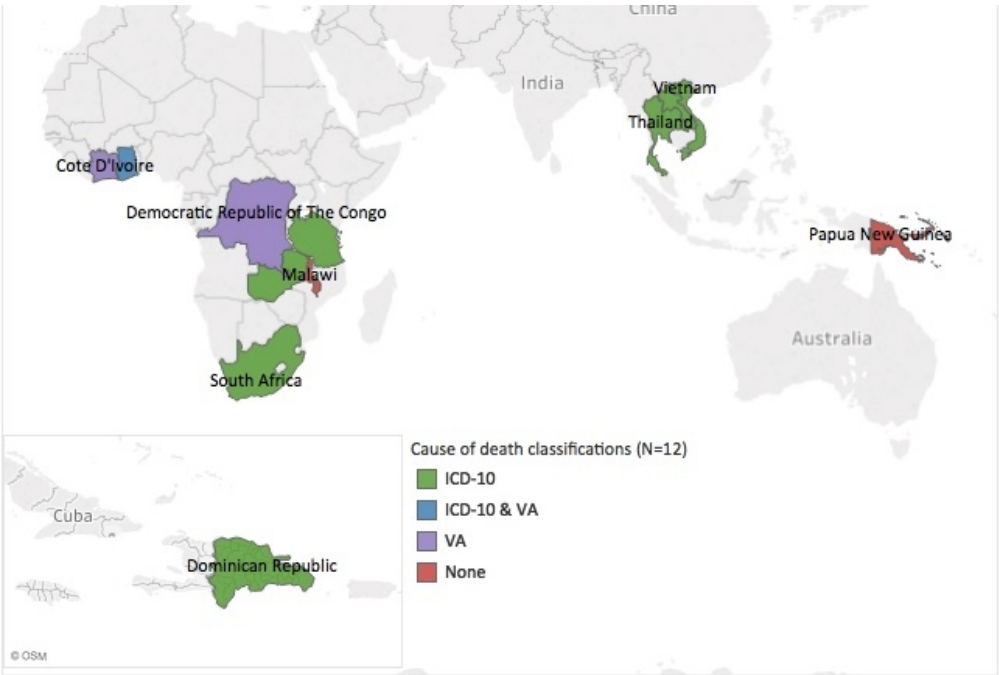
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System A. Case Reporting

Select your country -->

Definition: A functioning case reporting system routinely collects information on diagnosed disease-specific cases. This system can be used to measure the first ninety; number of people living with HIV with known status. These cases may be reported from health facilities or providers to a central level. At subnational and national levels, these data can be used to track epidemics and quantify the burden of disease in order to inform public health programs. For example, some countries may use Integrated Disease Surveillance and Response (IDSR) to track individual and aggregated newly diagnosed cases of disease.

A.1 Policy, Planning, and Legislation: case reporting of all diseases		Complete	Notes/Comments:
A.1.1 Is there an entity responsible for managing the case reporting system for all newly diagnosed cases of disease?	<input type="radio"/> No	X	
	<input type="radio"/> Yes, check all that apply:		
	<input type="checkbox"/> Ministry of Health		
	<input type="checkbox"/> National Public Health Institute		
	<input type="checkbox"/> Another entity, specify:		
A.1.2 Are there laws (or similar policies) in place mandating the reporting of newly diagnosed cases of disease? <i>If yes, please provide a soft copy.</i>	<input type="radio"/> No	X	
	<input type="radio"/> Yes		
	<input type="radio"/> Partially		
A.1.3 Has a strategic plan or other strategic document been developed? <i>If yes, please provide a soft copy.</i>	<input type="radio"/> No	X	
	<input type="radio"/> Yes		
A.1.4 Are data on newly diagnosed cases of disease being used in the country?	<input type="radio"/> No	X	
	<input type="radio"/> Yes, check all that apply:		
	<input type="checkbox"/> National program response		
	<input type="checkbox"/> Subnational program response		
	<input type="checkbox"/> National diagnostics forecasting		
	<input type="checkbox"/> Subnational diagnostics forecasting		
	<input type="checkbox"/> National burden of disease estimation		
	<input type="checkbox"/> Subnational burden of disease estimation		
<input type="checkbox"/> Other use, specify:			
	<input type="radio"/> No		
	<input type="radio"/> Yes, specify below:		
	<input type="checkbox"/> Domestic		

A.1.5 Is there a funding source for the case reporting system?

- ☐ Global Fund
- ☐ PEPFAR
- ☐ Other bilateral, specify
- ☐ Other multilateral, specify
- ☐ Other private, specify

X

A.2 Policy, Planning, and Legislation: HIV case reporting

Complete

Notes/Comments:

A.2.1 Is there an entity responsible for managing the case reporting system for HIV/AIDS?

- ☐ No
- ☐ Yes, check all that apply:
- ☐ Ministry of Health
- ☐ National Public Health Institute
- ☐ Another entity, specify:

X

A.2.2 Are there laws (or similar policies) in place mandating the reporting of diagnosed cases of HIV/AIDS? *If yes, please provide a soft copy.*

- ☐ No
- ☐ Yes, check all that apply:
- ☐ The HIV-specific law/policy exists within the general communicable disease reporting policy
- ☐ The HIV-specific law/policy exists independently of the general communicable

X

A.2.3 Has a strategic plan or other strategic document been developed for the reporting of diagnosed cases of HIV/AIDS? *If yes, please provide a soft copy.*

- ☐ No
- ☐ Yes, check all that apply:
- ☐ The HIV case reporting strategic plan exists within the strategic plan for general case reporting of communicable diseases
- ☐ The HIV case reporting strategic plan exists independently of the strategic plan for

X

A.2.4 Are HIV case reporting data being used in the country?

- ☐ No
- ☐ Yes, check all that apply:
- ☐ National HIV program response
- ☐ Subnational HIV program response
- ☐ National HIV diagnostics forecasting

X

country?	<div><input type="checkbox"/> Subnational HIV diagnostics forecasting</div> <div><input type="checkbox"/> National burden of HIV estimation</div> <div><input type="checkbox"/> Subnational burden of HIV estimation</div> <div><input type="checkbox"/> Other use, specify:</div>		
A.2.5 Is there a funding source for the HIV case reporting system?	<div><input type="radio"/> No</div> <div><input type="radio"/> Yes, specify below:</div> <div><input type="checkbox"/> Domestic</div> <div><input type="checkbox"/> Global Fund</div> <div><input type="checkbox"/> PEPFAR</div> <div><input type="checkbox"/> Other bilateral, specify</div> <div><input type="checkbox"/> Other multilateral, specify</div> <div><input type="checkbox"/> Other private, specify</div>		
A.3 System Organization: General case reporting for all diseases		Complete	Notes/Comments:
A.3.1 What is the approximate geographic coverage of the case reporting system	<div><input type="radio"/> N/A</div> <div><input type="radio"/> 1% - 25%</div> <div><input type="radio"/> 26% - 50%</div> <div><input type="radio"/> 51% - 75%</div> <div><input type="radio"/> 76% - 100%</div> <div>If geographic coverage is above 0%, specify if:</div> <div><input type="checkbox"/> Reporting is in urban areas</div> <div><input type="checkbox"/> Reporting is in rural areas</div> <div><input type="checkbox"/> Reporting is in both urban and rural</div>		
A.3.2 What is the lowest level at which data are collected on newly diagnosed cases of disease?	<div><input type="radio"/> N/A</div> <div><input type="radio"/> National</div> <div><input type="radio"/> Subnational level 1</div> <div><input type="radio"/> Subnational level 2</div> <div><input type="radio"/> Subnational level 3</div>		
	<div><input type="radio"/> N/A</div>		

A.3.3 Are data on newly diagnosed cases of disease linked to other systems?

- ☐ No
- ☐ Yes, check all systems that are linked:
- ☐ Patient monitoring system
- ☐ Laboratory information system
- ☐ Vital statistics system
- ☐ Other, specify:

X

A.3.4 Does the private sector report newly diagnosed cases of disease using the same system?

- ☐ N/A
- ☐ No
- ☐ Yes
- ☐ Partially
- If yes or partially, check all that apply:
- ☐ Private sector reports through the same
- ☐ Private sector reports through the same electronic system

X

A.3.5 Does the case reporting system use a unique identifier?

- ☐ N/A
- ☐ No
- ☐ Yes, check all that apply:
- ☐ The unique identifier is the National ID
- ☐ The unique identifier is the Health ID
- ☐ The unique identifier is system-specific
- ☐ The unique identifier is created from
- ☐ The unique identifier is linked to biometric

X

A.3.6 Is an electronic system used for case reporting in any area of the country?

- ☐ N/A
- ☐ No
- ☐ Yes, check all that apply:
- ☐ Electronic system is in urban areas
- ☐ Electronic system is in rural areas

X

A.3.7 What is the lowest level at which data on new cases of disease are collected through electronic systems?	<div><div><input type="radio"/> N/A</div><div><input type="radio"/> National</div><div><input type="radio"/> Subnational level 1</div><div><input type="radio"/> Subnational level 2</div><div><input type="radio"/> Subnational level 3</div></div>	X	
A.3.8 What is the approximate electronic coverage of the case reporting system across all health facilities?	<div><div><input type="radio"/> N/A</div><div><input type="radio"/> 1% - 25%</div><div><input type="radio"/> 26% - 50%</div><div><input type="radio"/> 51% - 75%</div><div><input type="radio"/> 76% - 100%</div></div>	X	
A.3.9 Does the electronic system capture data at the individual or aggregate level?	<div><div><input type="radio"/> N/A</div><div><input type="radio"/> Individual</div><div><input type="radio"/> Aggregate</div><div><input type="radio"/> Both individual and aggregate</div></div>	X	
A.3.10 Are security measures in place for the electronic case reporting system?	<div><div><input type="radio"/> N/A</div><div><input type="radio"/> No</div><div><div><input type="radio"/> Yes, check all security measures that apply:<div><div><input type="checkbox"/> Physical barrier</div><div><input type="checkbox"/> Software barrier</div><div><input type="checkbox"/> Legal barrier</div><div><input type="checkbox"/> Encryption</div><div><input type="checkbox"/> Unique identifier</div></div></div></div></div>	X	
A.4 System Organization: HIV case reporting		Complete	Notes/Comments:
A.4.1 What is the approximate geographic coverage of the case reporting system?	<div><div><input type="radio"/> N/A</div><div><input type="radio"/> 1% - 25%</div><div><input type="radio"/> 26% - 50%</div><div><input type="radio"/> 51% - 75%</div></div>		

A.4.1 What is the approximate geographic coverage of the HIV case reporting system

☐ 76% - 100%

X

If geographic coverage is above 0%, specify if:

☐ HIV case reporting is in urban areas

☐ HIV case reporting is in rural areas

☐ HIV case reporting is in urban and rural

A.4.2 What is the **lowest** level at which data are collected on newly diagnosed HIV cases?

☐ N/A

☐ National

☐ Subnational level 1

☐ Subnational level 2

☐ Subnational level 3

X

A.4.3 Are data on newly diagnosed HIV cases linked to other systems?

☐ N/A

☐ No

☐ Yes, check all linked systems that apply:

☐ Patient monitoring system

☐ Laboratory information system

☐ Vital statistics system

☐ Other, specify:

X

A.4.4 Does the private sector report on newly diagnosed HIV cases through this system?

☐ N/A

☐ No

☐ Yes

☐ Partially

X

If yes or partially, check all that apply:

☐ Any portion of the private sector reports

☐ Any portion of the private sector reports

☐ N/A

☐ No

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2	A.4.5 Is an electronic system used for HIV case reporting	<input type="radio"/> Yes, check all that apply:	X
3	in any area of the country?	<input type="checkbox"/> Electronic system is in urban areas only	
4		<input type="checkbox"/> Electronic system is in rural areas only	
5		<input type="checkbox"/> Electronic system is in urban and rural areas	
6			
7			
8	A.4.6 What is the lowest level at which data on new HIV	<input type="radio"/> N/A	X
9	cases are collected through electronic systems?	<input type="radio"/> National	
10		<input type="radio"/> Subnational level 1	
11		<input type="radio"/> Subnational level 2	
12		<input type="radio"/> Subnational level 3	
13			
14			
15	A.4.7 What is the approximate electronic coverage of	<input type="radio"/> N/A	X
16	the HIV case reporting system across all health facilities?	<input type="radio"/> 1% - 25%	
17		<input type="radio"/> 26% - 50%	
18		<input type="radio"/> 51% - 75%	
19		<input type="radio"/> 75% - 100%	
20			
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22			
23	A.4.8 Does the electronic HIV case reporting system	<input type="radio"/> N/A	X
24	capture data at the individual or aggregate level?	<input type="radio"/> Individual	
25		<input type="radio"/> Aggregate	
26		<input type="radio"/> Both individual and aggregate	
27			
28			
29	A.4.9 Are security measures in place for the electronic	<input type="radio"/> N/A	X
30	HIV case reporting system?	<input type="radio"/> No	
31		<input type="radio"/> Yes, check all security measures that apply:	
32		<input type="checkbox"/> Physical barrier	
33		<input type="checkbox"/> Software barrier	
34		<input type="checkbox"/> Legal barrier	
35		<input type="checkbox"/> Encryption	
36		<input type="checkbox"/> Unique identifier	
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System B. Patient Monitoring

Definition: Patient monitoring systems collect routine data from health facilities related to clinical patient management. In HIV programming, patient monitoring systems are useful in measuring the second and third nineties as they capture program indicators such as service use, patient retention and treatment outcomes. Patient monitoring systems are often used to improve quality of services across various service areas. Data are often used to assess the health sector response from the facility to the national level.

B.1 Policy, Planning, and Legislation: Patient monitoring system for all diseases

Complete

Notes/Comments:

B.1.1 Is there an entity responsible for managing the patient monitoring system for all diseases?

☐ No

☐ Yes, check all entities that apply:

☐ Ministry of Health

☐ National Public Health Institute

☐ Another entity, specify:

X

B.1.2 Has a strategic plan or other strategic document been developed? *If yes, please provide a soft copy.*

☐ No

☐ Yes

X

B.1.3 Are patient monitoring data being used in the country?

☐ No

☐ Yes, check all that apply:

☐ National service coverage calculation

☐ Subnational service coverage calculation

☐ National quality of services improvement

☐ Subnational quality of services improvement

☐ National commodity forecasting

☐ Subnational commodity forecasting

☐ Other use, specify:

X

B.1.4 Is there a funding source for the patient monitoring system?

☐ No

☐ Yes, specify below:

☐ Domestic

☐ Global Fund

☐ PEPFAR

☐ Other bilateral, specify

X

	<input type="checkbox"/> Other multilateral, specify		
	<input type="checkbox"/> Other private, specify		
B.1.5 Is the patient monitoring system used for social health insurance reimbursement?	<input type="radio"/> No	X	
	<input type="radio"/> Yes		
	<input type="radio"/> No, but other system is used (specify:)		
B.2 Policy, Planning, and Legislation: HIV Patient monitoring system		Complete	Notes/Comments:
B.2.1 Is there an entity responsible for managing the patient monitoring system for HIV/AIDS?	<input type="radio"/> No	X	
	<input type="radio"/> Yes, check all that apply:		
	<input type="checkbox"/> Ministry of Health		
	<input type="checkbox"/> National Public Health Institute		
	<input type="checkbox"/> Another entity, specify:		
B.2.2 Has a strategic plan or other strategic document been developed for HIV patient monitoring? If yes, please provide a soft copy.	<input type="radio"/> No	X	
	<input type="radio"/> Yes, check all that apply:		
	<input type="checkbox"/> The HIV patient monitoring plan exists within larger patient monitoring system		
	<input type="checkbox"/> The HIV patient monitoring plan exists independent of the larger patient		
B.2.3 Are HIV patient monitoring data being used in the country?	<input type="radio"/> No	X	
	<input type="radio"/> Yes, check all that apply:		
	<input type="checkbox"/> National HIV service coverage calculation		
	<input type="checkbox"/> Subnational HIV service coverage calculation		
	<input type="checkbox"/> National quality of service improvement		
	<input type="checkbox"/> Subnational quality of service improvement		
	<input type="checkbox"/> National HIV commodity forecasting		
	<input type="checkbox"/> Subnational HIV commodity forecasting		
	<input type="checkbox"/> Other use, specify:		

1		<input type="radio"/> No		
2		<input type="radio"/> Yes, specify below:		
3		<input type="checkbox"/> Domestic		
4		<input type="checkbox"/> Global Fund		
5		<input type="checkbox"/> PEPFAR		
6	B.2.4 Is there a funding source for the HIV patient monitoring system?	<input type="checkbox"/> Other bilateral, specify below		
7		<input type="checkbox"/> Other multilateral, specify below		
8		<input type="checkbox"/> Other private, specify below		
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13	B.3 System Organization: Patient monitoring system for all diseases		Complete	Notes/Comments:
14		<input type="radio"/> N/A		
15		<input type="radio"/> 1% - 25%		
16		<input type="radio"/> 26% - 50%		
17		<input type="radio"/> 51% - 75%		
18		<input type="radio"/> 76% - 100%		
19	B.3.1 What is the approximate geographic coverage of the patient monitoring system?	If geographic coverage is > 0%, specify if:		
20		<input type="checkbox"/> Patient monitoring is in urban areas		
21		<input type="checkbox"/> Patient monitoring is in rural areas		
22		<input type="checkbox"/> Patient monitoring is in urban and rural		
23				
24				
25				
26				
27		<input type="radio"/> N/A		
28		<input type="radio"/> National		
29	B.3.2 What is the lowest level at which patient data are collected?	<input type="radio"/> Subnational level 1		
30		<input type="radio"/> Subnational level 2		
31		<input type="radio"/> Subnational level 3		
32				
33				
34				
35		<input type="radio"/> N/A		
36		<input type="radio"/> No		
37		<input type="radio"/> Yes, check all linked systems that		
38		<input type="checkbox"/> Case reporting system		
39	B.3.3 Are patient data linked to other systems?	<input type="checkbox"/> Laboratory information system		
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	<input type="checkbox"/> Vital statistics system	
	<input type="checkbox"/> Health insurance system(s)	
	<input type="checkbox"/> Other, specify:	
	<input type="radio"/> N/A	X
	<input type="radio"/> No	
	<input type="radio"/> Yes	
	<input type="radio"/> Partially	
	If yes or partially, check all that apply:	
	<input type="checkbox"/> Any portion of the private sector monitors patients through the same paper-based	
	<input type="checkbox"/> Any portion of the private sector monitors patients through the same electronic system	X
	<input type="radio"/> N/A	
	<input type="radio"/> No	
	<input type="radio"/> Yes, check all that apply:	
	<input type="checkbox"/> The unique identifier is the National ID	
	<input type="checkbox"/> The unique identifier is the Health ID	
	<input type="checkbox"/> The unique identifier is system-specific	X
	<input type="checkbox"/> The unique identifier is created from	
	<input type="checkbox"/> The unique identifier is linked to biometric	
	<input type="radio"/> N/A	X
	<input type="radio"/> No	
	<input type="radio"/> Yes	
	<input type="checkbox"/> Electronic system is in urban areas only	
	<input type="checkbox"/> Electronic system is in rural areas only	
	<input type="checkbox"/> Electronic system is in urban and rural areas	
	<input type="radio"/> N/A	

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2		<input type="radio"/> National		
3	B.3.7 What is the lowest level at which patient data are	<input type="radio"/> Subnational level 1	X	
4	collected through electronic systems?	<input type="radio"/> Subnational level 2		
5		<input type="radio"/> Subnational level 3		
6				
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8		<input type="radio"/> N/A	X	
9		<input type="radio"/> 1% - 25%		
10	B.3.8 What is the approximate electronic coverage of the	<input type="radio"/> 26% - 50%		
11	patient monitoring system across all health facilities?	<input type="radio"/> 51% - 75%		
12		<input type="radio"/> 76% - 100%		
13				
14		<input type="radio"/> N/A	X	
15		<input type="radio"/> Individual		
16	B.3.9 Does the electronic system capture patient data at	<input type="radio"/> Aggregate		
17	the individual or aggregate level?	<input type="radio"/> Both individual and aggregate		
18				
19		<input type="radio"/> N/A	X	
20		<input type="radio"/> No		
21		<input type="radio"/> Yes, check all security measures that		
22	B.3.10 Are security measures in place for the electronic	<input type="checkbox"/> Physical barrier		
23	patient monitoring system?	<input type="checkbox"/> Software barrier		
24		<input type="checkbox"/> Legal barrier		
25		<input type="checkbox"/> Encryption		
26		<input type="checkbox"/> Unique identifier		
27				
28				
29				
30				
31				
32	B.4 System Organization: HIV Patient monitoring system		Complete	Notes/Comments:
33		<input type="radio"/> N/A	X	
34		<input type="radio"/> 1% - 25%		
35		<input type="radio"/> 26% - 50%		
36		<input type="radio"/> 51% - 75%		
37		<input type="radio"/> 76% - 100%		
38				
39	B.4.1 What is the approximate geographic coverage of the			
40	HIV patient monitoring system?			
41				
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43				
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	<div>If geographic coverage is > 0%, specify if:</div> <div><div><input type="checkbox"/> HIV patient monitoring is in urban areas</div><div><input type="checkbox"/> HIV patient monitoring is in rural areas</div><div><input type="checkbox"/> HIV patient monitoring is in urban and rural</div></div>	
B.4.2 What is the lowest level at which HIV patient data are collected?	<div><div><input type="radio"/> N/A</div><div><input type="radio"/> National</div><div><input type="radio"/> Subnational level 1</div><div><input type="radio"/> Subnational level 2</div><div><input type="radio"/> Subnational level 3</div></div>	X
B.4.3 Are HIV patient data linked to other systems?	<div><div><input type="radio"/> N/A</div><div><input type="radio"/> No</div><div><div><input type="radio"/> Yes, check all linked systems:</div><div><div><input type="checkbox"/> Case reporting system</div><div><input type="checkbox"/> Laboratory information system</div><div><input type="checkbox"/> Vital statistics system</div><div><input type="checkbox"/> Health insurance system(s)</div><div><input type="checkbox"/> Other, specify:</div></div></div></div>	X
B.4.4 Does the private sector monitor HIV patients using the same system?	<div><div><input type="radio"/> N/A</div><div><input type="radio"/> No</div><div><input type="radio"/> Yes</div><div><input type="radio"/> Partially</div></div> <div><div>If yes or partially, check all that apply:</div><div><div><input type="checkbox"/> Any portion of the private sector monitors HIV</div><div><input type="checkbox"/> Any portion of the private sector monitors HIV</div></div></div>	X
	<div><div><input type="radio"/> N/A</div><div><input type="radio"/> No</div></div>	

B.4.5 Is an electronic system used for HIV patient monitoring in any area of the country?

- ☐ Yes, check all that apply:
- ☐ Electronic system is in urban areas
- ☐ Electronic system is in rural areas
- ☐ Electronic system is in urban and rural

X

B.4.6 What is the **lowest** level at which HIV patient data are collected through electronic systems?

- ☐ N/A
- ☐ National
- ☐ Subnational level 1
- ☐ Subnational level 2
- ☐ Subnational level 3

X

B.4.7 What is the approximate electronic coverage of the HIV patient monitoring system across all health facilities?

- ☐ N/A
- ☐ 1% - 25%
- ☐ 26% - 50%
- ☐ 51% - 75%
- ☐ 76% - 100%

X

B.4.8 Does the electronic system capture HIV patient data at the individual or aggregate level?

- ☐ N/A
- ☐ Individual
- ☐ Aggregate
- ☐ Both individual and aggregate

X

B.4.9 Are security measures in place for the electronic HIV patient monitoring system?

- ☐ N/A
- ☐ No
- ☐ Yes, check all security measures that apply:
- ☐ Physical barrier
- ☐ Software barrier
- ☐ Legal barrier
- ☐ Encryption
- ☐ Unique identifier

X

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System C. Civil Registration and Vital Statistics			
Definition: Civil registration and vital statistics (CRVS) systems register births, deaths, cause of deaths, marriages, and divorces. In public health, authorities focus on the registration of births, deaths and cause of deaths to track population demographics and patterns of disease. When interlinked with other information systems, CRVS could generate HIV-related mortality trends to inform burden and impact assessments.			
C.1 Policy, Planning, and Legislation	Complete	Notes/Comments:	
C.1.1 Is there an entity responsible for managing the CRVS system?	<input type="radio"/> No	X	
	<input type="radio"/> Yes, check all that apply:		
	<input type="checkbox"/> Ministry of Health, or similar		
	<input type="checkbox"/> Ministry of Interior, or similar		
	<input type="checkbox"/> Ministry of Justice, or similar		
	<input type="checkbox"/> Other entity, specify:		
C.1.2 Are there laws (or similar policies) in place mandating the registration of births and deaths? <i>If yes, please provide a soft copy.</i>	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Partially	X	
C.1.3 Has a strategic plan or other strategic document been developed? <i>If yes, please provide a soft copy.</i>	<input type="radio"/> No <input type="radio"/> Yes	X	
C.1.4 Are birth and death data being used in the country?	<input type="radio"/> No	X	
	<input type="radio"/> Yes, check all that apply:		
	<input type="checkbox"/> Quantify health service need/coverage		
	<input type="checkbox"/> Cost-effectiveness analysis of disease		
	<input type="checkbox"/> Measure impact of disease programs		
	<input type="checkbox"/> National burden of disease estimation		
	<input type="checkbox"/> Subnational burden of disease estimation		
	<input type="checkbox"/> Other use, specify:		
	<input type="radio"/> No		
	<input type="radio"/> Yes, check all that apply:		
	<input type="checkbox"/> Quantify HIV service need/coverage		

C.1.5 Are birth and death data being used specifically for HIV?

- ☐ Cost-effectiveness analysis of
- ☐ Measure impact of HIV programs
- ☐ National burden of HIV estimation
- ☐ Subnational burden of HIV estimation
- ☐ Other use, specify:

X

C.1.6 Is there a funding source for CRVS system development?

- ☐ No
- ☐ Yes, specify below:
- ☐ Domestic
- ☐ Global Financing Fund
- ☐ PEPFAR
- ☐ Gates Foundation
- ☐ Bloomberg Data for Health
- ☐ Other bilateral, specify
- ☐ Other multilateral, specify

X

C.1.7 Is proof of birth or death registration required for any government services? (e.g. birth or death certificate)

- ☐ No
- ☐ Yes, specify below:
- ☐ Immunization
- ☐ Health insurance
- ☐ School enrollment
- ☐ Welfare
- ☐ Legal services
- ☐ Burial
- ☐ Inheritance
- ☐ Life insurance
- ☐ Other service, specify:

X

C.2 System organization

Complete Notes/Comments:

C.2.1 Which vital events are registered?

- ☐ N/A
- ☐ Births

Y

C.2.1 Which vital events are registered?	<div><input type="radio"/> Deaths</div> <div><input type="radio"/> Both births and deaths</div>	^	
C.2.2 Does the CRVS system use a unique identifier?	<div><input type="radio"/> N/A</div> <div><input type="radio"/> No</div> <div><input type="radio"/> Yes, check all that apply:<div><input type="checkbox"/> The unique identifier is the National ID</div><div><input type="checkbox"/> The unique identifier is the Health ID</div><div><input type="checkbox"/> The unique identifier is system-specific</div><div><input type="checkbox"/> The unique identifier is created from</div><div><input type="checkbox"/> The unique identifier is linked to biometric</div></div>		

1			
2		<input type="radio"/> N/A	
3		<input type="radio"/> National	
4	C.3.2 What is the lowest level at which birth events are	<input type="radio"/> Subnational level 1	X
5	registered?	<input type="radio"/> Subnational level 2	
6		<input type="radio"/> Subnational level 3	
7			
8			
9		<input type="radio"/> N/A	
10		<input type="radio"/> No	
11		<input type="radio"/> Yes, check all linked systems:	X
12		<input type="checkbox"/> Case reporting system	
13		<input type="checkbox"/> Patient monitoring system	
14	C.3.3 Are data on birth events linked to other systems?	<input type="checkbox"/> Health insurance system	
15		<input type="checkbox"/> Legal system/policing	
16		<input type="checkbox"/> Voter registration system	
17		<input type="checkbox"/> National ID	
18		<input type="checkbox"/> Other, specify:	
19			
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23			
24		<input type="radio"/> N/A	
25		<input type="radio"/> No	
26	C.3.4 Is an electronic system used for registering births in	<input type="radio"/> Yes, check all that apply:	X
27	any area of the country?	<input type="checkbox"/> Electronic system is in urban areas	
28		<input type="checkbox"/> Electronic system is in rural areas	
29		<input type="checkbox"/> Electronic system is in urban and rural	
30			
31			
32		<input type="radio"/> N/A	
33		<input type="radio"/> National	
34	C.3.5 What is the lowest level at which birth events are	<input type="radio"/> Subnational level 1	X
35	registered through electronic systems?	<input type="radio"/> Subnational level 2	
36		<input type="radio"/> Subnational level 3	
37			
38			
39		<input type="radio"/> N/A	
40		<input type="radio"/> 1% - 25%	
41	C.3.6 What is the approximate electronic coverage of the		
42			

1				
2	birth registration system across all health facilities and/or registrar offices?	<input type="radio"/> 26% - 50%	X	
3		<input type="radio"/> 51% - 75%		
4		<input type="radio"/> 76% - 100%		
5				
6	C.3.7 Does the electronic system capture birth events at the individual or aggregate level?	<input type="radio"/> N/A	X	
7		<input type="radio"/> Individual		
8		<input type="radio"/> Aggregate		
9		<input type="radio"/> Both individual and aggregate		
10				
11	C.3.8 Does the private sector report birth events using the same electronic system?	<input type="radio"/> N/A	X	
12		<input type="radio"/> No		
13		<input type="radio"/> Yes		
14		<input type="radio"/> Some		
15				
16	C.4 System Organization for <u>death</u> registration		Complete	Notes/Comments:
17				
18	C.4.1 What is the approximate geographic coverage of death registration?	<input type="radio"/> N/A	X	
19		<input type="radio"/> 1% - 25%		
20		<input type="radio"/> 26% - 50%		
21		<input type="radio"/> 51% - 75%		
22		<input type="radio"/> 76% - 100%		
23		If geographic coverage is > 0%, specify if:		
24		<input type="checkbox"/> Death registration is in urban areas		
25		<input type="checkbox"/> Death registration is in rural areas		
26		<input type="checkbox"/> Death registration is in urban and rural		
27				
28	C.4.2 What is the lowest level at which death events are collected?	<input type="radio"/> N/A	X	
29		<input type="radio"/> National		
30		<input type="radio"/> Subnational level 1		
31		<input type="radio"/> Subnational level 2		
32		<input type="radio"/> Subnational level 3		
33		<input type="radio"/> N/A		
34				

C.4.3 Are data on death events linked to other systems?	<input type="radio"/> No	X
	<input type="radio"/> Yes, check all linked systems:	
	<input type="checkbox"/> Case reporting system	
	<input type="checkbox"/> Patient monitoring system	
	<input type="checkbox"/> Health insurance system	
	<input type="checkbox"/> Legal system/policing	
	<input type="checkbox"/> Voter registration	
	<input type="checkbox"/> National ID	
	<input type="checkbox"/> Other, specify:	
C.4.4 Is an electronic system used for registering deaths in any area of the country?	<input type="radio"/> N/A	X
	<input type="radio"/> No	
	<input type="radio"/> Yes	
	<input type="checkbox"/> Electronic system is in urban areas	
	<input type="checkbox"/> Electronic system is in rural areas	
	<input type="checkbox"/> Electronic system is in urban and rural	
C.4.5 What is the lowest level at which deaths are registered through electronic systems?	<input type="radio"/> N/A	X
	<input type="radio"/> National	
	<input type="radio"/> Subnational level 1	
	<input type="radio"/> Subnational level 2	
	<input type="radio"/> Subnational level 3	
C.4.6 What is the approximate electronic coverage of the death registration system across all health facilities or registrar offices?	<input type="radio"/> N/A	X
	<input type="radio"/> 1% - 25%	
	<input type="radio"/> 26% - 50%	
	<input type="radio"/> 51% - 75%	
	<input type="radio"/> 76% - 100%	
C.4.7 Does the electronic system capture death events at the individual or aggregate level?	<input type="radio"/> N/A	X
	<input type="radio"/> Individual	
	<input type="radio"/> Aggregate	

	<input type="radio"/> Both individual and aggregate		
	<input type="radio"/> N/A		
C.4.8 Does the private sector report death events using the same electronic system?	<input type="radio"/> No	X	
	<input type="radio"/> Yes		
	<input type="radio"/> Some		
C.5 Cause of death information		Complete	Notes/Comments:
	<input type="radio"/> N/A	X	
	<input type="radio"/> No		
C.5.1 Are sentinel surveillance approaches used to measure cause of death? (e.g. alternative methods for cause-specific mortality surveillance)	<input type="radio"/> Yes, check all methods used to ascertain		
	<input type="checkbox"/> Verbal autopsy		
	<input type="checkbox"/> Minimally invasive autopsy		
	<input type="checkbox"/> Full autopsy		
	<input type="checkbox"/> Hospital-based system		
	<input type="checkbox"/> Other ascertainment method, specify:		
	<input type="radio"/> N/A	X	
	<input type="radio"/> No		
C.5.2 Do these sentinel surveillance approaches utilize a method of classification to report cause of death?	<input type="radio"/> Yes, check all methods that apply:		
	<input type="checkbox"/> ICD-10		
	<input type="checkbox"/> Verbal autopsy - InterVA		
	<input type="checkbox"/> Verbal autopsy - Tariff2		
	<input type="checkbox"/> Verbal autopsy - SmartVA		
	<input type="checkbox"/> Other classification method, specify:		
	<input type="radio"/> N/A	X	
	<input type="radio"/> No		
C.5.3 Does the vital statistics system collate cause of death?	<input type="radio"/> Yes, check all methods used to ascertain		
	<input type="checkbox"/> Verbal autopsy		

1 death information?

- 2 ☐ Minimally invasive autopsy
- 3 ☐ Full autopsy
- 4 ☐ Hospital-based system
- 5 ☐ Other ascertainment method, specify:
- 6

8 C.5.4 Does the vital statistics **system** utilize a method of
9 classification to report cause of death?

- 10 ☐ N/A
- 11 ☐ No
- 12 ☐ Yes, select all methods that apply:
- 13 ☐ ICD-10
- 14 ☐ Verbal autopsy - InterVA
- 15 ☐ Verbal autopsy - Tarrif2
- 16 ☐ Verbal autopsy - SmartVA
- 17 ☐ Other classification method, specify:
- 18

19 C.5.5 What is the **lowest** level at which cause of death is
20 collated in the system?

- 21 ☐ N/A
- 22 ☐ National
- 23 ☐ Subnational level 1
- 24 ☐ Subnational level 2
- 25 ☐ Subnational level 3
- 26

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National health information systems for achieving the Sustainable Development Goals: a cross sectional survey in low- and middle-income countries

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Complete List of Authors:	<p>Suthar, Amitabh; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Khalifa, Aleya; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Joos, Olga; Centers for Disease Control and Prevention, International Statistics Program</p> <p>Manders, Eric-Jan; Centers for Disease Control and Prevention</p> <p>Abdul-Quader , Abu ; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Amoyaw , Frank; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Aoua, Camara; Ministere de la Sante et de l'Hygiene Publique</p> <p>Aynalem, Getahun; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Barradas , Danielle; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Bello , George; Ministry of Health</p> <p>Bonilla, Luis; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Cheyip , Mireille; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Dalhatu, Ibrahim Tijjani ; Centers for Disease Control and Prevention, Center for Global Health</p> <p>De Klerk , Michael ; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Dee , Jacob; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Hedje, Judith; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Jahun, Ibrahim ; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Jantaramanee , Supiya ; Ministry of Public Health</p> <p>Kamocha , Stanley ; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Lerebours , Leonel; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Lobognon, Legre Roger ; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Lote, Namarola; National Department of Health</p>

	Lubala, Léopold; Ministère de la Santé Publique Magazani, Alain; Ministère de la Santé Publique Mdodo, Rennatus ; Centers for Disease Control and Prevention, Center for Global Health Mgomella , George S. ; Centers for Disease Control and Prevention, Center for Global Health Monique , Lattah Asseka ; Ministere de la Sante et de l'Hygiene Publique Mudenda , Mphatso ; Centers for Disease Control and Prevention, Center for Global Health Mushi , Jeremiah ; Ministry of Health and Social Welfare Mutenda , Nicholus ; Ministry of Health and Social Services Nicoue , Aime ; Centers for Disease Control and Prevention, Center for Global Health Ngalamulume , Rogers Galaxy ; Centers for Disease Control and Prevention, Center for Global Health Ndjakani , Yassa ; Centers for Disease Control and Prevention, Center for Global Health Nguyen , Tuan Anh ; Centers for Disease Control and Prevention, Center for Global Health Nzelu , Charles Echezona ; Federal Ministry of Health Ofosu , Anthony Adofo ; Ghana Health Service Pinini , Zukiswa ; National Department of Health Ramírez , Edwin ; Servicio Nacional de Salud Sebastian , Victor ; Centers for Disease Control and Prevention, Center for Global Health Simanovong , Bouathong ; Ministry of Health Son , Ha Thai ; Ministry of Health Son , Vo Hai ; Ministry of Health Swaminathan , Mahesh ; Centers for Disease Control and Prevention, Center for Global Health Sivile , SuilANJI ; Ministry of Health Teeraratkul , Achara ; Centers for Disease Control and Prevention, Center for Global Health Temu , Poruan ; Centers for Disease Control and Prevention, Center for Global Health West , Christine ; Centers for Disease Control and Prevention Xaymounvong , Douangchanh ; Centers for Disease Control and Prevention, Center for Global Health Yamba, Abel ; Centers for Disease Control and Prevention, Center for Global Health Yoka , Denis ; Ministere de la Sante Publique Zhu , Hao ; Centers for Disease Control and Prevention, Center for Global Health Ransom , Ray L. ; Centers for Disease Control and Prevention, Center for Global Health Nichols, Erin; Centers for Disease Control and Prevention, International Statistics Program Murrill , Christopher S.; Centers for Disease Control and Prevention, Center for Global Health Rosen , Daniel ; Centers for Disease Control and Prevention, Center for Global Health Hladik, Wolfgang; Center for Global Health, Centers for Disease Control and Prevention
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7

84Amitabh B. Suthar* – Center for Global Health, Centers for Disease Control and Prevention, Atlanta,

95U.S.A.

10

116Aleya Khalifa* – Center for Global Health, Centers for Disease Control and Prevention, Atlanta, U.S.A.

12

137Olga Joos – International Statistics Program, Centers for Disease Control and Prevention, Hyattsville,

148U.S.A.

15

169Eric-Jan Manders – Center for Global Health, Centers for Disease Control and Prevention, Atlanta,

1710U.S.A.

18

1911Abu Abdul-Quader – Center for Global Health, Centers for Disease Control and Prevention, Hanoi,

2012Vietnam

21

2213Frank Amoyaw – Center for Global Health, Centers for Disease Control and Prevention, Accra, Ghana

23

2414Camara Aoua – Ministère de la Santé et l'Hygiène Publique, Abidjan, Côte d'Ivoire

25

2615Getahun Aynalem – Center for Global Health, Centers for Disease Control and Prevention, Pretoria,

2716Republic of South Africa

28

2917Danielle Barradas – Center for Global Health, Centers for Disease Control and Prevention, Lusaka,

3018Zambia

31

3219George Bello – Ministry of Health, Lilongwe, Malawi

33

3420Luis Bonilla – Center for Global Health, Centers for Disease Control and Prevention, Santo Domingo,

3521República Dominicana

36

3722Mireille Cheyip – Center for Global Health, Centers for Disease Control and Prevention, Pretoria,

3823Republic of South Africa

39

4024Ibrahim Tijjani Dalhatu – Center for Global Health, Centers for Disease Control and Prevention, Abuja,

4125Nigeria

42

4326Michael De Klerk – Center for Global Health, Centers for Disease Control and Prevention, Windhoek,

4427Namibia

45

46

4728Jacob Dee – Center for Global Health, Centers for Disease Control and Prevention, Kinshasa,

4829République Démocratique du Congo

49

5030Judith Hedje – Center for Global Health, Centers for Disease Control and Prevention, Abidjan, Côte

5131d'Ivoire

52

5332Ibrahim Jahun – Center for Global Health, Centers for Disease Control and Prevention, Abuja, Nigeria

54

5533Supiya Jantaramanee – Ministry of Public Health, Bangkok, Thailand

56

57

58

59

60

- Stanley Kamocha – Center for Global Health, Centers for Disease Control and Prevention, Lusaka, Zambia
- Leonel Lerebours – Center for Global Health, Centers for Disease Control and Prevention, Santo Domingo, República Dominicana
- Legre Roger Lobognon – Center for Global Health, Centers for Disease Control and Prevention, Abidjan, Côte d'Ivoire
- Namarola Lote – National Department of Health, Port Moresby, Papua New Guinea
- Léopold Lubala – Ministère de la Santé Publique, Kinshasa, République Démocratique du Congo
- Alain Magazani – Ministère de la Santé Publique, Kinshasa, République Démocratique du Congo
- Rennatus Mdodo – Center for Global Health, Centers for Disease Control and Prevention, Dar es Salaam, United Republic of Tanzania
- George S. Mgomella – Center for Global Health, Centers for Disease Control and Prevention, Dar es Salaam, United Republic of Tanzania
- Lattah Asseka Monique – Ministère de la Santé et l'Hygiène Publique, Abidjan, Côte d'Ivoire
- Mphatso Mudenda – Center for Global Health, Centers for Disease Control and Prevention, Lusaka, Zambia
- Jeremiah Mushi – Ministry of Health and Social Welfare, Dar es Salaam, United Republic of Tanzania
- Nicholus Mutenda – Ministry of Health and Social Services, Windhoek, Namibia
- Aime Nicoue – Center for Global Health, Centers for Disease Control and Prevention, Abidjan, Côte d'Ivoire
- Rogers Galaxy Ngalamulume – Center for Global Health, Centers for Disease Control and Prevention, Kinshasa, République Démocratique du Congo
- Yassa Ndjakani – Center for Global Health, Centers for Disease Control and Prevention, Kinshasa, République Démocratique du Congo
- Tuan Anh Nguyen – Center for Global Health, Centers for Disease Control and Prevention, Hanoi, Vietnam
- Charles Echezona Nzelu – Federal Ministry of Health, Abuja, Nigeria
- Anthony Adofo Ofosu – Ghana Health Service, Accra, Ghana
- Zukiswa Pinini – National Department of Health, Pretoria, Republic of South Africa
- Edwin Ramírez – Servicio Nacional de Salud, Santo Domingo, República Dominicana
- Victor Sebastian – Center for Global Health, Centers for Disease Control and Prevention, Abuja, Nigeria
- Bouathong Simanovong – Ministry of Health, Lao People's Democratic Republic

- 1
- 2
- 3 66 Ha Thai Son – Ministry of Health, Hanoi, Vietnam
- 4
- 5 67 Vo Hai Son – Ministry of Health, Hanoi, Vietnam
- 6
- 7 68 Mahesh Swaminathan – Center for Global Health, Centers for Disease Control and Prevention, Abuja,
- 8 69 Nigeria
- 9
- 10 70 SuilANJI Sivile – Ministry of Health, Lusaka, Zambia
- 11
- 12 71 Achara Teeraratkul – Center for Global Health, Centers for Disease Control and Prevention, Bangkok,
- 13 72 Thailand
- 14
- 15 73 Poruan Temu – Center for Global Health, Centers for Disease Control and Prevention, Port Moresby,
- 16 74 Papua New Guinea
- 17
- 18 75 Christine West – Center for Global Health, Centers for Disease Control and Prevention, Lilongwe,
- 19 76 Malawi
- 20
- 21 77 Douangchanh Xaymounvong – Center for Global Health, Centers for Disease Control and Prevention,
- 22 78 Vientiane, Lao People's Democratic Republic
- 23
- 24 79 Abel Yamba – Center for Global Health, Centers for Disease Control and Prevention, Port Moresby,
- 25 80 Papua New Guinea
- 26
- 27 81 Denis Yoka – Ministère de la Santé Publique, Kinshasa, République Démocratique du Congo
- 28
- 29 82 Hao Zhu – Center for Global Health, Centers for Disease Control and Prevention, Beijing, China
- 30
- 31 83 Ray L. Ransom – Center for Global Health, Centers for Disease Control and Prevention, Atlanta, U.S.A.
- 32
- 33 84 Erin K. Nichols – International Statistics Program, Centers for Disease Control and Prevention,
- 34 85 Hyattsville, U.S.A.
- 35
- 36 86 Christopher S. Murrill – Center for Global Health, Centers for Disease Control and Prevention, Atlanta,
- 37 87 U.S.A.
- 38
- 39 88 Daniel Rosen – Center for Global Health, Centers for Disease Control and Prevention, Atlanta, U.S.A.
- 40
- 41 89 Wolfgang Hladik – Center for Global Health, Centers for Disease Control and Prevention, Atlanta,
- 42 90 U.S.A.
- 43
- 44

45 91 * These authors contributed equally to this work.

46

47 92

48 93 **Corresponding author:** Dr Amitabh Bipin Suthar, icf4@cdc.gov

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3 129 **Abstract**

4 130 *Objectives*

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6 131 Achieving the Sustainable Development Goals will require data-driven public health action. There are

7

8 132 limited publications on national health information systems that continuously generate health data. Given

9

10 133 the need to develop these systems, we summarised their current status in low- and middle-income

11 134 countries.

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13 135

14

15 136 *Setting*

16 137 The survey team jointly developed a questionnaire covering policy, planning, legislation, and organization

17

18 138 of case reporting, patient monitoring, and civil registration and vital statistics (CRVS) systems. From

19

20 139 January until May 2017, we administered the questionnaire to key informants in 51 Centers for Disease

21

22 140 Control (CDC) country offices. Countries were aggregated for descriptive analyses in Microsoft Excel.

23 141

24

25 142 *Results*

26

27 143 Key informants in 15 countries responded to the questionnaire. The Ministry of Health coordinated case

28

29 144 reporting, patient monitoring, and CRVS systems in 93%, 93%, and 53% of responding countries,

30 145 respectively. Domestic financing supported case reporting, patient monitoring, and CRVS systems in

31

32 146 86%, 75%, and 92% of responding countries, respectively. The most common uses for system-generated

33

34 147 data was to guide programme response in 100% of countries for case reporting, to calculate service

35 148 coverage in 92% of countries for patient monitoring, and to estimate the national burden of disease in 83%

36

37 149 of countries for CRVS. Electronic systems were being used for case reporting, patient monitoring, birth

38

39 150 registration, and death registration in 93%, 92%, 85%, and 73% of responding countries, respectively.

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41 151

42 152 *Conclusions*

43

44 153 Most responding countries have a solid foundation for policy, planning, legislation, and organisation of

45

46 154 health information systems. Further evaluation is needed to assess the quality of data generated from

47 155 systems. Periodic evaluations may be useful in monitoring progress in strengthening and harmonising

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49 156 these systems over time.

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53 158 *Note to BMJ Open: Since this was a global survey the participants and interventions sections of the

54 159 abstract were not applicable.

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Strengths and limitations of this study

- All respondents had national case reporting, patient monitoring, and civil registration and vital statistics systems in place to assess
- Given that this survey was administered electronically, there may have been differences in how respondents interpreted question and answer choices
- Knowledge and experience of respondents may have varied from office to office
- Given that the survey represents 15 countries globally, more information from additional countries can help characterise health information systems further
- To our knowledge this is the first detailed multi-country assessment of national case reporting, patient monitoring, and vital statistics systems

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Introduction

Data should guide governments as they plan, budget, and act for health. The Sustainable Development Goal (SDG) for health, ensure healthy lives and promote well-being for all at all ages, requires data on disease transmission, service coverage and outcomes, and causes of death (Table 1) [1]. These data can come from various sources including surveys, longitudinal studies, and data systems. Given that surveys and longitudinal studies often are time-limited, require external resources, and take time to design and administer, the role of systems in generating population disaggregated, geographically specific, and timely data is becoming more important [2].

The World Health Organization has specified that key data sources for health information systems include individual records (such as case reports and disease registries), service records from health providers, civil registration and vital statistics, amongst others [3]. For the purposes of this survey we honed in on three core systems used for disease identification, service provision, and vital status monitoring. These include: (1) communicable disease case reporting from individual records, (2) patient monitoring from service records, and (3) vital statistics derived from civil registration systems. Communicable disease case reporting is traditionally used to monitor trends in disease transmission across different geographic settings and amongst different populations as part of routine surveillance [4]. Patient monitoring can be used to monitor health service coverage, such as treatment for HIV, tuberculosis, childhood immunisations, amongst others as part of universal healthcare coverage [5]. Well-functioning civil registration and vital statistics (CRVS) systems produce data on registered births, deaths (including cause of death), as well as marriages, adoptions, and divorces; public health authorities primarily focus on registration of births, deaths, and causes of deaths for decision making [6].

For case reporting, many of the global norms and standards trace back to disease-specific reporting requirements, the Integrated Disease Surveillance and Response (IDSR) framework, and to the International Health Regulations [7,8]. Patient monitoring, and other health information systems, are transitioning from paper- to electronic-based systems [9]. The Statistical Commission of the United Nations provides comprehensive principles and recommendations for CRVS systems to achieve universal coverage, continuity, confidentiality, and regular dissemination in order to be a dependable and primary data source for vital statistics [10]. Although WHO collates global health data in its Global Health Observatory [11], to our knowledge there are few publications evaluating contributing *systems* in detail

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[12]. The objective of this article is to summarise the status of case reporting, patient monitoring, and CRVS systems amongst a sample of low- and middle-income countries.

Methods

Survey design

The survey team, comprised of global experts in informatics, surveillance, and programme, jointly developed a survey covering policy, planning, legislation, and organisation of case reporting, patient monitoring, and CRVS systems. This survey was primarily designed to assess the state of information systems that could potentially be leveraged for HIV-related clinical surveillance, monitoring progress towards meeting national and global goals, and improving national responses [13]. The survey was piloted prior to full implementation. The survey was administered through a tool developed in Excel (Microsoft Corporation, Seattle, USA). The tool consisted of multiple choice questions and text boxes through which respondents could elaborate on their selections (Table S1-S3).

Definitions

For the purposes of establishing a common framework for administration of this tool, we developed definitions for case reporting, patient monitoring, and CRVS systems:

- A functioning case reporting system routinely collects information on diagnosed disease-specific cases. These cases may be reported from health facilities or providers to a central level. At subnational and national levels, these data can be used to track epidemics and quantify the burden of disease in order to inform public health programs. For example, some countries may use Integrated Disease Surveillance and Response (IDSR) to report individual and aggregated newly diagnosed cases of communicable disease.
- Patient monitoring systems collect routine data from health facilities related to clinical patient management. Patient monitoring systems are often used to measure service coverage and quality. Data are often used to assess the health sector response from the facility to the national level.
- CRVS systems register births, deaths, cause of deaths, marriages, and divorces. In public health, authorities focus on the registration of births, deaths and cause of deaths to track population demographics and patterns of disease. CRVS can generate disease specific mortality trends to inform burden and impact assessments.

Data collection

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2
3 233 We surveyed all regional and country CDC offices with Division of Global HIV and TB staff outside of
4 234 the United States (Table S4). CDC country staff overseeing strategic information (encompassing health
5
6 235 information systems, surveillance, and monitoring and evaluation) were selected as key informants and
7
8 236 were contacted by email to complete the tool. One staff member was contacted per country. Respondents
9
10 237 were encouraged to liaise with their national government counterparts for questions to which they did not
11 238 know the answer. Questions that the counterpart did not know, and for which they were unable to liaise
12
13 239 with their counterpart, were left blank. We administered the questionnaire via email in January 2017. Up
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15 240 to three follow-up emails were sent to non-respondents from February to May 2017. The results were then
16 241 reviewed with government counterparts for validity.
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18 242

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20 243 *Data management and analysis*

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22 244 Country key informants entered their responses directly into the Excel tool. All country files were cleaned
23 245 and merged into a Stata database (Statacorp, College Station, USA). The Stata database was then exported
24
25 246 to Excel (Microsoft, Redmond, USA) for analysis. Any response that was left blank or indicated “not
26
27 247 applicable” was excluded from the denominator when percentages were calculated. Since different
28
29 248 questions were left blank or indicated not applicable from key informants, most of the descriptive analyses
30 249 have different denominators. Tableau (Tableau, Seattle, USA) was used for creating maps with
31
32 250 OpenStreetMap images while Excel was used to create descriptive tables.
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34 251

35 252 *Ethical approval*

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37 253 The survey protocol was reviewed, deemed to not require CDC institutional review board approval, and
38
39 254 approved by the Office of Science from the Center for Global Health at CDC.
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41 255

42 256 *Patient and Public Involvement*

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44 257 This survey included countries rather than patients as a unit of measure.
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46 258

47 259 **Results**

48
49 260 Overall, 15 of 51 (29%) country key informants responded to the tool (Table S4). Socioeconomic
50
51 261 characteristics of responding countries, including life expectancy, mean years of schooling, gross national
52
53 262 per capita income, and human development index, are found in Table 2 [14,15].
54 263

55
56 264 *Case reporting systems*

Key informants from 14 of 15 (93%) countries that responded to the case reporting systems section of the survey indicated that the Ministry of Health was responsible for disease case reporting. Overall, there was legislation mandating reporting for at least one disease in 13 of 15 (87%) of responding countries. Domestic financing contributed to funding case reporting systems in 12 of 14 (86%) responding countries. Some form of unique identifier was utilised for 8 of 14 (57%) of responding countries. All 14 responding countries indicated a physical barrier, software barrier, legal barrier, encryption, and/or unique ID being used as a security measure. The majority of case reporting systems were linked to patient monitoring (80%) and laboratory information systems (70%) with a small proportion being linked to CRVS systems (10%). These findings and others are presented in Table 3. Key informants from 13 of 15 responding countries (87%) reported an electronic component in the country's case reporting system, and 8 of these 13 (62%) countries collect data on individual cases (Figure 1). Eleven of the 13 (85%) responding countries reported that the coverage of the case reporting system exceeded 75% (Figure 1).

Patient monitoring systems

Key informants from 13 of 14 (93%) countries that responded to the patient monitoring systems section of the survey indicated that the Ministry of Health was responsible for patient monitoring. The primary use of patient monitoring data was to monitor service coverage (reported by 12 of 13 countries, 92%); however 8 of 13 (62%) and 10 of 13 (77%) reported using patient monitoring data for service quality improvement and commodity forecasting, respectively. Multilateral (9 of 12 countries, 75%) and bilateral (9 of 12 countries, 75%) financial support was more common for patient monitoring compared to case reporting. Five of 12 countries (42%) of patient monitoring systems used the same system for monitoring in the private and public health sector. Two of 14 (14%) countries used patient monitoring for social health insurance reimbursement. Patient monitoring systems were linked to case reporting (43%) and laboratory information systems (71%), vital statistics (43%), and health insurance systems (14%). These findings and others are presented in Table 4. Key informants from 11 of 12 (92%) responding countries reported an electronic component in the country's patient monitoring system, and 7 of these 11 (64%) countries collect data on individual patients (Figure 2). Seven of the 11 (64%) responding countries reported that the coverage of the patient monitoring system exceeded 75% (Figure 1).

CRVS systems

Key informants from 8 of 15 (53%) countries that responded to the CRVS systems section of the survey indicated that the Ministry of Health was responsible for CRVS, in 7 of 15 responding countries (47%)

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2
3 297 the Ministry of Interior (or similar) was responsible for CRVS, and in 4 of 15 countries (27%) the Ministry
4 298 of Justice was responsible for CRVS. There were some countries in which multiple Ministries were
5
6 299 responsible for CRVS. There was legislation mandating birth and death registration in 13 of 14 (93%)
7
8 300 countries. Birth and death data were used to quantify service need (7 of 12 countries, 58%), analyse cost-
9
10 301 effectiveness (6 of 12 countries, 50%), measure impact of disease programmes (7 of 12 countries, 58%),
11 302 and to measure the national burden of disease (10 of 12 countries, 83%). Birth and death registration was
12
13 303 required to access government services in all 15 responding countries (100%). These findings and others
14
15 304 are presented in Table 5. Key informants from 10 of 13 responding countries (77%) reported an electronic
16 305 component for birth registration, and 9 of these 10 (90%) countries collect data on individual births (Figure
17
18 306 3). Key informants from 7 of 11 responding countries (64%) reported an electronic component for death
19
20 307 registration, and 6 of these 7 (85%) countries collect data on individual deaths (Figure 4). Key informants
21
22 308 from 8 of 12 (67%) reported that the country used the tenth revision of the international classification of
23 309 disease (ICD-10) for reporting the cause of death while 2 of 12 (17%) responding countries indicated that
24
25 310 the vital statistics system used verbal autopsy to ascertain the cause of death (Figure 5). Eight of 15 (53%)
26
27 311 and seven of 15 (47%) responding countries reported that the coverage of the vital statistics system
28
29 312 registering births and deaths, respectively, exceeded 75% (Figures 4 and 5, respectively).

30 313
31
32 314 **Discussion**

33
34 315 Case reporting, patient monitoring, and CRVS systems were widely implemented and used in responding
35 316 countries. These systems generate critical data for public health planning, budgeting, and action. There
36
37 317 was funding for these systems from national budgets, bi-lateral arrangements, and multi-lateral
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39 318 mechanisms, suggesting some level of political commitment for their development and implementation.
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41 319 Many countries also reported use of electronic and individual-level data, suggesting that more granular
42 320 and accessible data may be available for end-users. Overall, these are encouraging trends which will
43
44 321 hopefully continue in order to accelerate progress toward meeting the SDGs.

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46 322
47 323 The majority of responding countries had greater than 75% geographic coverage of their case reporting
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49 324 system. Moreover, most responding countries had an electronic component to their system. Electronic
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51 325 systems could help store increased volumes of data over time, store more detailed data prospectively, and
52
53 326 provide more rapid access to such data compared to paper-based systems [16]. Understanding the number
54 327 of diagnosed cases of diseases can directly inform programme response to contain transmission [8]. All
55
56 328 responding countries used case reporting data to achieve this. Future qualitative studies may help

understand the ways in which case reporting data are used to contain disease transmission. For example, in Uganda a command centre was created to house an interdisciplinary rapid response team to receive, evaluate, and distribute information as the centre of communication and coordination response operations [17]. Many diseases require their own diagnostic commodities as part of national diagnostic algorithms. For example, HIV requires combinations of two or three rapid tests to diagnose each case [18]. Approximately half of responding countries used case reporting data for commodity forecasting. As observed with medicines, central procurement, informed by case reporting data, could provide cost savings and increase availability of diagnostics at service delivery sites [19].

The primary use of data from patient monitoring systems by responding countries was to monitor coverage of services. This is likely due to the importance of monitoring the coverage of key health sector interventions for reproductive health, communicable diseases, and national immunisation schedules [5]. Countries may also have disease-specific patient monitoring systems. Many countries are embarking on the development of national health insurance schemes as part of universal healthcare coverage [20]. Given the wide geographic scale, and use of individual-level electronic data in many settings, there may be an opportunity to leverage these systems for processing claims and co-payments for services rendered [21]. Based on this survey, some countries are using the same system for social health insurance while others have linked the patient monitoring system to the health insurance system. Lessons learnt from each of these scenarios should be further examined and documented.

Overall, more countries reported systems for registering birth events relative to deaths. This is consistent with globally available data suggesting that birth registration rates are higher than death registration rates [6]. ICD-10 remains the global norm for classifying the cause of death within the health sector [22]. In this survey, the majority of responding countries reported use of ICD-10 for classifying the cause of death. Death registration, and methods to ascertain the cause of death, are more heterogeneous in communities. Verbal autopsy has shown promise as an option to incorporate within CRVS systems when medical certification of cause of death is not possible [23] and many countries reported using this approach. Vital statistics were required for a wide range of government services. The most common government service requiring birth registration was school enrolment; this requirement has been shown to be associated with higher coverage of national birth registration rates [24,25]. The most common requirement for death registration was the need for a burial permit. This requirement may also be important in improving national death registration rates [26,27].

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There were several cross-cutting issues relevant to case reporting, patient monitoring, and vital statistics systems. For example, there were a range of approaches for identification of people in systems. These included using national identification, health identification, and system-generated identification. Across all systems national identification was used most often. Given the global momentum behind achieving SDG target 16.9, achieving free and universal legal identity by 2030, use of national identification may increase further with time [28]. Security measures to protect data from unauthorised use has emerged as a critical issue in light of the transition to electronic data systems [29]. In this survey, physical barriers, software barriers, legal barriers, encryption, and use of unique identifiers were security measures used. Software and physical barriers were most common, suggesting opportunities for using encryption, legal protection measures, and unique identifiers. Unique identifiers can offer complementary protections by limiting the number of locations, both paper and electronic, where names are used but do have additional risks such as re-identification of an identity from an available data source that uses the same unique identifier. Linking different information systems can provide improved inferences for patients longitudinally over their life course [30]. The majority of case reporting systems were linked to patient monitoring and laboratory information systems with a small proportion being linked to vital statistics. The majority of patient monitoring systems were linked to case reporting and laboratory information systems with a minority linked to vital statistics and health insurance systems. Linking systems with health insurance may have implications on improved data quality since the data will directly affect staff remuneration for services rendered [31].

One of the major limitations of this survey was the low response rate. Specifically, there were limited responses from the Americas, Central Asia, and Eastern Europe. These regions are comprised of middle-income countries that may have a different health information system context. Reducing the number of questions and administering the survey later in the year may help improve the number of respondents in the future. We relied on knowledge and experience of participating staff members which may vary from office to office. Although attempts were made to extract missing information, and verify provided information from government counterparts, there were still questions without answers from some respondents. This may have been because they had less developed systems or because they did not know the answer at the time they filled the survey. Requiring all questions to be answered could improve our confidence in the final estimates. Moreover, since we conducted this survey electronically, there may have been differences in the way questions were interpreted across different key informants. This could have

affected their answer selection. For example, linkage could be interpreted as interoperability across different systems or producing summary information for the same location and time. The electronic format of the survey also meant that there were limited opportunities to qualify answers. For example, although we collected information on whether individual or aggregated data was available in electronic systems, we did not describe pathways of data flow. In the future, use cases, success stories, and lessons learnt may be based on specific answers during subsequent qualitative interviews of stakeholders. During the implementation of this survey, CDC placed additional field staff in countries through its Division of Global Health Protection. In the future, it may be worth reaching out to key informants in CDC countries irrespective of their programme focus to have the widest reach. Some important aspects of health information systems, such as interoperability, standards, and required workforce competencies, were not covered in this survey and may merit further exploration. Since some countries may manage civil registration and vital statistics separately there is potential for confusion from key informants on how to respond to questions encompassing CRVS holistically. Finally, evaluating the quality of data generated from systems requires different methods that should be evaluated as part of future assessments.

To our knowledge this is the first detailed assessment of national case reporting, patient monitoring, and vital statistics systems. Most responding countries have a solid foundation for policy, planning, legislation, and organisation of health information systems. There are opportunities to link systems, strengthen security measures for electronic data, and use data more effectively. Periodic evaluations may help understand progress in strengthening and harmonising these systems over time to achieve the SDGs.

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Table 1. Corresponding health information systems for SDG Goal 3, Ensure healthy lives and promote well-being for all at all ages

Target	SDG Indicator	Contributing Health Information System
3.1: By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births	3.1.1: Maternal mortality ratio	Civil registration and vital statistics
	3.1.2: Proportion of births attended by skilled health personnel	Patient monitoring
3.2: By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births	3.2.1: Under-five mortality rate	Civil registration and vital statistics
	3.2.2: Neonatal mortality rate	Civil registration and vital statistics
3.3: By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases	3.3.1: Number of new HIV infections per 1,000 uninfected population, by sex, age and key populations	Case reporting
	3.3.2: Tuberculosis incidence per 100,000 population	Case reporting
	3.3.3: Malaria incidence per 1,000 population	Case reporting
	3.3.4: Hepatitis B incidence per 100,000 population	Case reporting
	3.3.5: Number of people requiring interventions against neglected tropical diseases	Case reporting
3.4: By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being	3.4.1: Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease	Civil registration and vital statistics
	3.4.2: Suicide mortality rate	Civil registration and vital statistics
3.5: Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol	3.5.1: Coverage of treatment interventions (pharmacological, psychosocial and rehabilitation and aftercare services) for substance use disorders	Patient monitoring
	3.5.2: Harmful use of alcohol, defined according to the national context as alcohol per capita consumption (aged 15 years and older) within a calendar year in litres of pure alcohol	Civil registration and vital statistics (denominator)
3.6: By 2020, halve the number of global deaths and injuries from road traffic accidents	3.6.1: Death rate due to road traffic injuries	Civil registration and vital statistics
3.7: By 2030, ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programmes	3.7.1: Proportion of women of reproductive age (aged 15-49 years) who have their need for family planning satisfied with modern methods	Patient monitoring (numerator), Civil registration and vital statistics (denominator)
	3.7.2: Adolescent birth rate (aged 10-14 years; aged 15-19 years) per 1,000 women in that age group	Civil registration and vital statistics
3.8: Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all	3.8.1: Coverage of essential health services (defined as the average coverage of essential services based on tracer interventions that include reproductive, maternal, newborn and child health, infectious diseases, non-communicable diseases and service capacity and access, among the general and the most disadvantaged population)	Patient monitoring
	3.8.2: Proportion of population with large household expenditures on health as a share of total household expenditure or income	Civil registration and vital statistics (denominator)
3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination	3.9.1: Mortality rate attributed to household and ambient air pollution	Civil registration and vital statistics
	3.9.2: Mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene (exposure to unsafe Water, Sanitation and Hygiene for All (WASH) services)	Civil registration and vital statistics
	3.9.3: Mortality rate attributed to unintentional poisoning	Civil registration and vital statistics
3.a: Strengthen the implementation of the World Health Organization Framework Convention on Tobacco Control in all countries, as appropriate	3.a.1: Age-standardized prevalence of current tobacco use among persons aged 15 years and older	Civil registration and vital statistics (denominator)

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3.b: Support the research and development of vaccines and medicines for the communicable and non-communicable diseases that primarily affect developing countries, provide access to affordable essential medicines and vaccines, in accordance with the Doha Declaration on the TRIPS Agreement and Public Health, which affirms the right of developing countries to use to the full the provisions in the Agreement on Trade-Related Aspects of Intellectual Property Rights regarding flexibilities to protect public health, and, in particular, provide access to medicines for all	3.b.1: Proportion of the target population covered by all vaccines included in their national programme	Patient monitoring
	3.b.2: Total net official development assistance to medical research and basic health sectors	N/A
	3.b.3: Proportion of health facilities that have a core set of relevant essential medicines available and affordable on a sustainable basis	N/A
3.c: Substantially increase health financing and the recruitment, development, training and retention of the health workforce in developing countries, especially in least developed countries and small island developing States	3.c.1: Health worker density and distribution	N/A
3.d: Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks	3.d.1: International Health Regulations (IHR) capacity and health emergency preparedness	N/A

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Table 2. Human development indicators and World Bank economy classification for responding countries

Country	Life expectancy at birth	Mean years of schooling	Gross national income per capita (\$USD, PPP)	Composite Human Development Index
China	76	7.6	13,345 (Upper-middle income)	0.738
Cote D'Ivoire	51.9	5	3,163 (Lower-middle income)	0.474
Democratic Republic of The Congo	59.1	6.1	680 (Low-income)	0.435
Dominican Republic	73.7	7.7	12,756 (Upper-middle income)	0.722
Ghana	61.5	6.9	3,839 (Lower-middle income)	0.579
Lao People's Democratic Republic	66.6	5.2	5,049 (Lower-middle income)	0.586
Malawi	63.9	4.4	1,073 (Low-income)	0.476
Namibia	65.1	6.7	9,770 (Upper-middle income)	0.64
Nigeria	53.1	6	5,443 (Lower-middle income)	0.527
Papua New Guinea	62.8	4.3	2,712 (Lower-middle income)	0.516
South Africa	57.7	10.3	12,087 (Upper-middle income)	0.666
Thailand	74.6	7.9	14,519 (Upper-middle income)	0.74
United Republic of Tanzania	65.5	5.8	2,467 (Low-income)	0.531
Vietnam	75.9	8	5,335 (Lower-middle income)	0.683
Zambia	60.8	6.9	3,464 (Lower-middle income)	0.579

*PPP, purchasing power parity

Table 3. Characteristics of case reporting systems by region

	Number	Number of responses	Percentage of countries that responded (%)
Entity is responsible for case reporting	15	15	100
Ministry of Health	14	15	93
National Public Health Institute	1	15	7
Law exists that mandates case reporting for at least one disease	13	15	87
Case reporting data is used in country	15	15	100
Program response	15	15	100
Diagnostics forecasting	8	15	53
Burden of disease estimates	12	15	80
Case reporting system is currently funded	14	15	93
Domestic	12	14	86
Multilateral	10	14	71
Bilateral ¹	9	14	64
Private sector reports newly diagnosed cases of disease using the same system	11	13	85
Case reporting system is linked to other systems	10	14	71
Patient monitoring	8	10	80
Laboratory information system	7	10	70
Vital statistics	1	10	10
Unique identifiers are used for case reporting	8	14	57
National ID	4	7	57
Health ID	1	7	14
System-specific ID	1	7	14
Client demographics	4	7	57
Biometric data	0	7	0
Security measures used for <i>electronic</i> case reporting systems	14	14	100
Physical barrier	8	14	57
Software barrier	13	14	93
Legal barrier	5	14	36
Encryption	4	14	29
Unique ID	3	14	21

Note: Missing or "N/A" responses are excluded from the denominator number of responses. ¹ Bilateral organizations include both government agencies and non-government agencies

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Table 4. Characteristics of patient monitoring systems by region

	Number	Number of responses	Percentage of countries that responded (%)
Entity is responsible for patient monitoring	14	15	93
Ministry of Health	13	14	93
National Public Health Institute	1	14	7
Other	1	14	7
Patient monitoring data is used in country	13	14	93
Service coverage calculation	12	13	92
Service quality improvement	8	13	62
Commodity forecasting	10	13	77
Patient monitoring system is currently funded	12	14	86
Domestic	9	12	75
Multilateral	9	12	75
Bilateral ¹	9	12	75
Private	1	12	8
Private sector monitors patients using the same system	5	12	42
Patient monitoring system is used for social health insurance reimbursement	2	14	14
Patient monitoring system is linked to other systems	7	13	54
Case reporting	3	7	43
Laboratory information system	5	7	71
Vital statistics	3	7	43
Health insurance system	1	7	14
Unique identifiers are used for patient monitoring	7	12	58
National ID	1	6	17
Health ID	1	6	17
System-specific ID	2	6	33
Client demographics	3	6	50
Biometric data	0	6	0
Security measures used for electronic patient monitoring systems	11	11	100
Physical barrier	7	11	64

Software barrier	9	11	82
Legal barrier	3	11	27
Encryption	5	11	45
Unique ID	3	11	27

Note: Missing or "N/A" responses are excluded from the denominator number of responses. ¹ Bilateral organizations include both government agencies and non-government agencies

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Table 5. Characteristics of CRVS systems by region

	Number	Number of responses	Percentage of countries that responded (%)
An entity is responsible for CRVS	15	15	100
Ministry of Health or similar	8	15	53
Ministry of Interior or similar	7	15	47
Ministry of Justice or similar	4	15	27
Law exists that mandates birth and death registration	13	14	93
Vital statistics data is used in country	13	15	87
To quantify health service need	7	12	58
To analyze cost-effectiveness	6	12	50
To measure impact of disease programs	7	12	58
National burden of disease estimates	10	12	83
Vital statistics system is currently funded	13	14	93
Domestic	11	12	92
Multilateral	2	12	17
Bilateral ¹	6	12	50
Private sector reports birth events using same electronic system	6	9	67
Private sector reports death events using same electronic system	5	10	50
Birth or death registration is required to access government services	15	15	100
Immunizations	9	15	60
Health insurance	10	14	71
School enrollment	14	15	93
Welfare	10	15	67
Legal services	11	15	73
Burials	11	15	73
Inheritance	8	15	53
Life insurance	10	15	67
Unique identifiers are used for vital statistics	5	14	36
National ID	4	5	80
Health ID	0	5	0

System-specific ID	1	5	20
Client demographics	1	5	20
Biometric data	0	5	0
Security measures used for electronic vital statistics system	8	11	73
Physical barrier	6	8	75
Software barrier	6	8	75
Legal barrier	4	8	50
Encryption	1	8	13
Unique ID	2	8	25

Note: Missing or "N/A" responses are excluded from the denominator number of responses. ¹ Bilateral organizations include both government agencies and non-government agencies

Figure 1. Case reporting systems by system type and geographic coverage. Map created with OpenStreetMap images

Figure 2. Patient monitoring systems by system type and geographic coverage. Map created with OpenStreetMap images

Figure 3. Vital statistics systems for registering births by system type and geographic coverage. Map created with OpenStreetMap images

Figure 4. Vital statistics systems for registering deaths by system type and geographic coverage. Map created with OpenStreetMap images

Figure 5. Cause of death classifications in death registration and mortality surveillance. Map created with OpenStreetMap images

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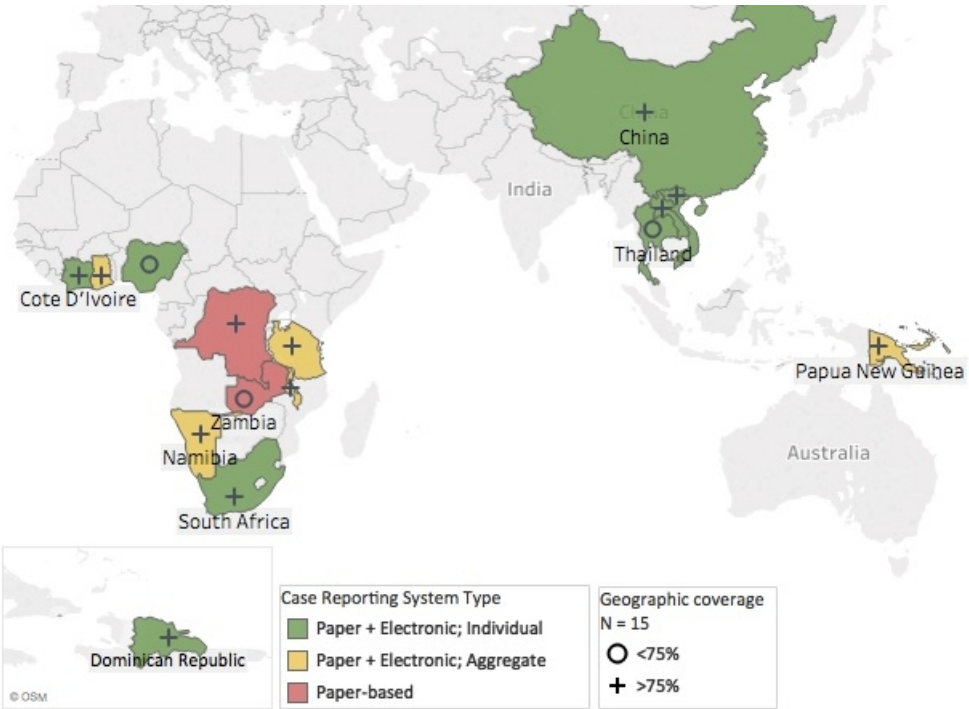
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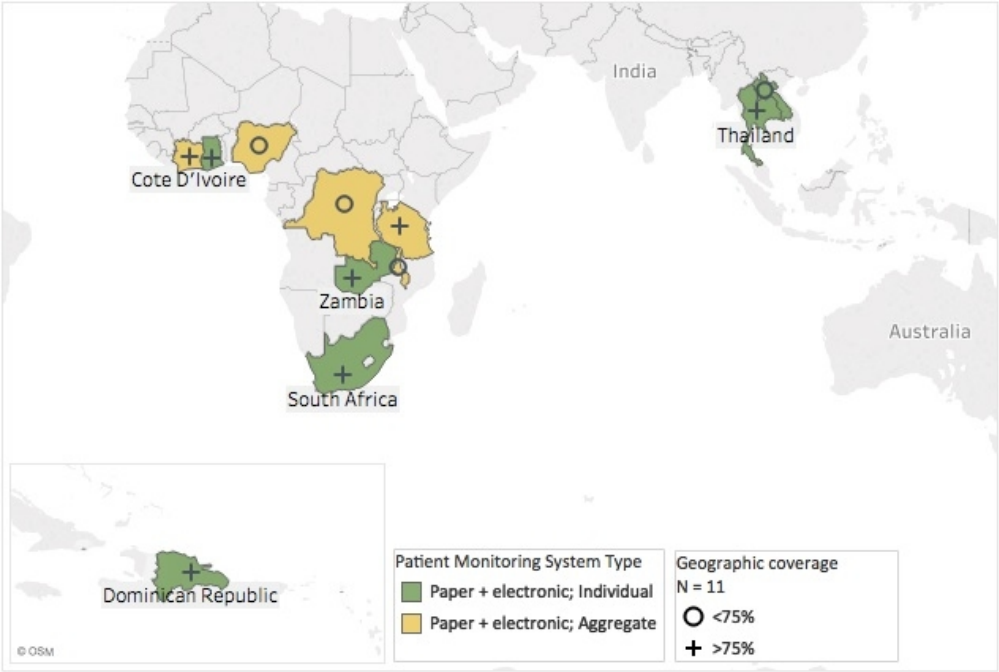
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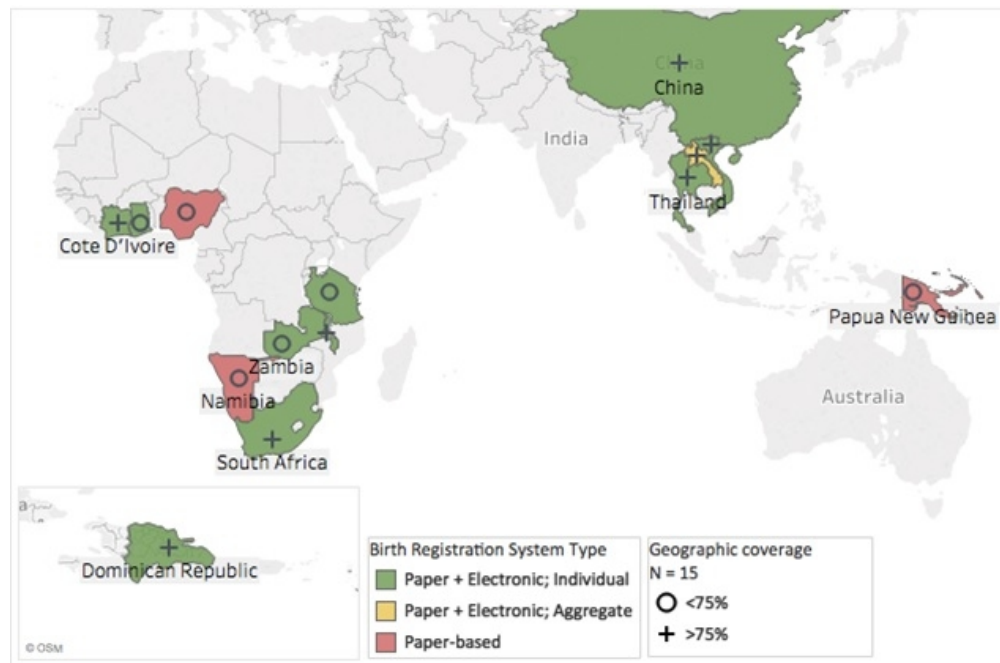
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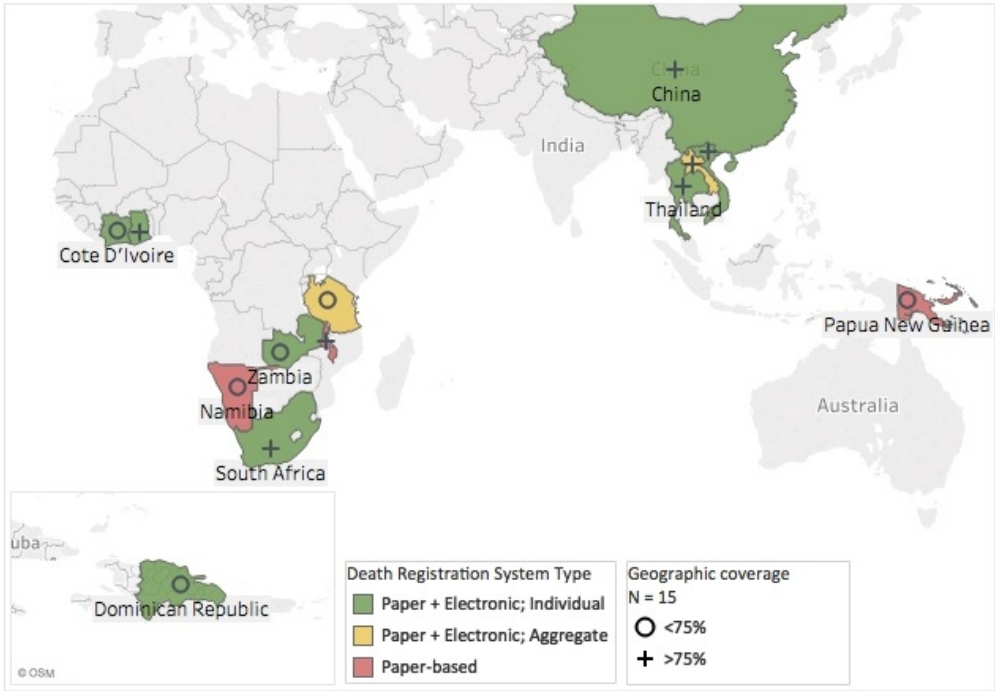
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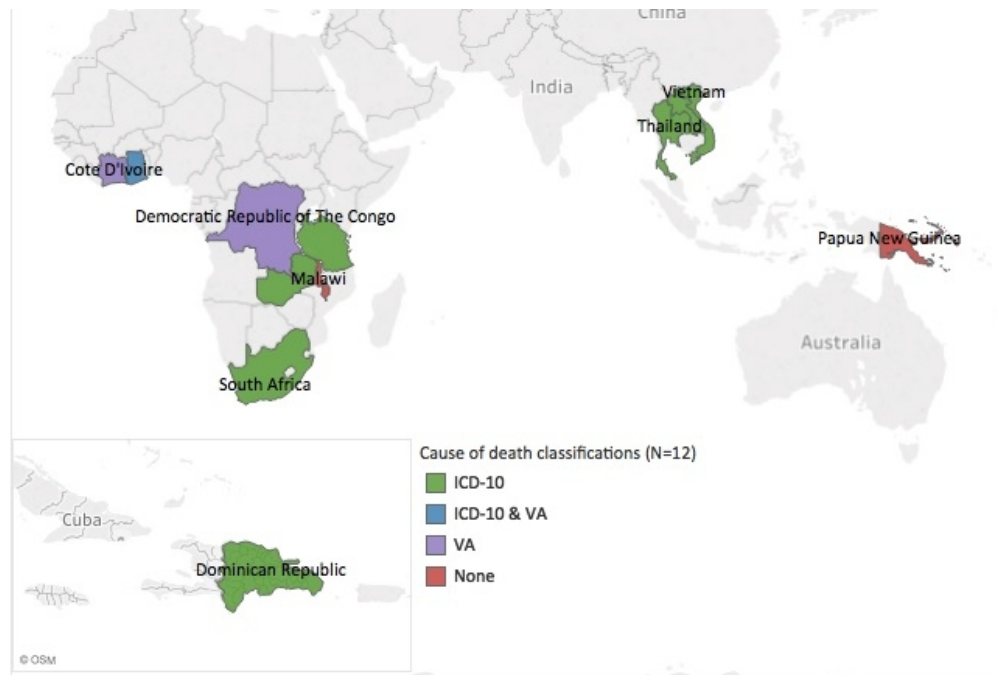
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System A. Case Reporting

Select your country -->

Definition: A functioning case reporting system routinely collects information on diagnosed disease-specific cases. This system can be used to measure the first ninety; number of people living with HIV with known status. These cases may be reported from health facilities or providers to a central level. At subnational and national levels, these data can be used to track epidemics and quantify the burden of disease in order to inform public health programs. For example, some countries may use Integrated Disease Surveillance and Response (IDSR) to track individual and aggregated newly diagnosed cases of disease.

A.1 Policy, Planning, and Legislation: case reporting of all diseases		Complete	Notes/Comments:
A.1.1 Is there an entity responsible for managing the case reporting system for all newly diagnosed cases of disease?	<input type="radio"/> No	X	
	<input type="radio"/> Yes, check all that apply:		
	<input type="checkbox"/> Ministry of Health		
	<input type="checkbox"/> National Public Health Institute		
	<input type="checkbox"/> Another entity, specify:		
A.1.2 Are there laws (or similar policies) in place mandating the reporting of newly diagnosed cases of disease? <i>If yes, please provide a soft copy.</i>	<input type="radio"/> No	X	
	<input type="radio"/> Yes		
	<input type="radio"/> Partially		
A.1.3 Has a strategic plan or other strategic document been developed? <i>If yes, please provide a soft copy.</i>	<input type="radio"/> No	X	
	<input type="radio"/> Yes		
A.1.4 Are data on newly diagnosed cases of disease being used in the country?	<input type="radio"/> No	X	
	<input type="radio"/> Yes, check all that apply:		
	<input type="checkbox"/> National program response		
	<input type="checkbox"/> Subnational program response		
	<input type="checkbox"/> National diagnostics forecasting		
	<input type="checkbox"/> Subnational diagnostics forecasting		
	<input type="checkbox"/> National burden of disease estimation		
	<input type="checkbox"/> Subnational burden of disease estimation		
<input type="checkbox"/> Other use, specify:			
A.1.5 Is there a funding source for the case reporting	<input type="radio"/> No		
	<input type="radio"/> Yes, specify below:		
	<input type="checkbox"/> Domestic		
	<input type="checkbox"/> Global Fund		

system?

☐ PEPFAR☐ Other bilateral, specify☐ Other multilateral, specify☐ Other private, specify

X

A.2 Policy, Planning, and Legislation: HIV case reporting**Complete****Notes/Comments:**

A.2.1 Is there an entity responsible for managing the case reporting system for HIV/AIDS?

☐ No☐ Yes, check all that apply:☐ Ministry of Health☐ National Public Health Institute☐ Another entity, specify:

X

A.2.2 Are there laws (or similar policies) in place mandating the reporting of diagnosed cases of HIV/AIDS? *If yes, please provide a soft copy.*☐ No☐ Yes, check all that apply:☐ The HIV-specific law/policy exists within the general communicable disease reporting policy☐ The HIV-specific law/policy exists independently of the general communicable disease reporting policy

X

A.2.3 Has a strategic plan or other strategic document been developed for the reporting of diagnosed cases of HIV/AIDS? *If yes, please provide a soft copy.*☐ No☐ Yes, check all that apply:☐ The HIV case reporting strategic plan exists within the strategic plan for general case reporting of communicable diseases☐ The HIV case reporting strategic plan exists independently of the strategic plan for general case reporting of communicable diseases

X

A.2.4 Are HIV case reporting data being used in the country?

☐ No☐ Yes, check all that apply:☐ National HIV program response☐ Subnational HIV program response☐ National HIV diagnostics forecasting☐ Subnational HIV diagnostics forecasting

X

	<input type="checkbox"/> National burden of HIV estimation		
	<input type="checkbox"/> Subnational burden of HIV estimation		
	<input type="checkbox"/> Other use, specify:		
	<input type="radio"/> No		
	<input type="radio"/> Yes, specify below:		
	<input type="checkbox"/> Domestic		
A.2.5 Is there a funding source for the HIV case reporting system?	<input type="checkbox"/> Global Fund	X	
	<input type="checkbox"/> PEPFAR		
	<input type="checkbox"/> Other bilateral, specify		
	<input type="checkbox"/> Other multilateral, specify		
	<input type="checkbox"/> Other private, specify		
A.3 System Organization: General case reporting for all diseases		Complete	Notes/Comments:
	<input type="radio"/> N/A		
	<input type="radio"/> 1% - 25%		
	<input type="radio"/> 26% - 50%		
A.3.1 What is the approximate geographic coverage of the case reporting system	<input type="radio"/> 51% - 75%	X	
	<input type="radio"/> 76% - 100%		
	If geographic coverage is above 0%, specify if:		
	<input type="checkbox"/> Reporting is in urban areas		
	<input type="checkbox"/> Reporting is in rural areas		
	<input type="checkbox"/> Reporting is in both urban and rural areas		
	<input type="radio"/> N/A		
A.3.2 What is the lowest level at which data are collected on newly diagnosed cases of disease?	<input type="radio"/> National	X	
	<input type="radio"/> Subnational level 1		
	<input type="radio"/> Subnational level 2		
	<input type="radio"/> Subnational level 3		
	<input type="radio"/> N/A		
	<input type="radio"/> No		

A.3.3 Are data on newly diagnosed cases of disease linked to other systems?

☐ Yes, check all systems that are linked:

☐ Patient monitoring system

☐ Laboratory information system

☐ Vital statistics system

☐ Other, specify:

X

A.3.4 Does the private sector report newly diagnosed cases of disease using the same system?

☐ N/A

☐ No

☐ Yes

☐ Partially

X

If yes or partially, check all that apply:

☐ Private sector reports through the same paper-based system

☐ Private sector reports through the same electronic system

A.3.5 Does the case reporting system use a unique identifier?

☐ N/A

☐ No

☐ Yes, check all that apply:

☐ The unique identifier is the National ID

☐ The unique identifier is the Health ID

☐ The unique identifier is system-specific

☐ The unique identifier is created from client demographics (e.g. algorithm)

☐ The unique identifier is linked to biometric data

X

A.3.6 Is an electronic system used for case reporting in any area of the country?

☐ N/A

☐ No

☐ Yes, check all that apply:

☐ Electronic system is in urban areas

☐ Electronic system is in rural areas

☐ Electronic system is in urban and rural areas

X

A.3.7 What is the lowest level at which data on new cases of disease are collected through electronic systems?	<input type="radio"/> N/A	X	
	<input type="radio"/> National		
	<input type="radio"/> Subnational level 1		
	<input type="radio"/> Subnational level 2		
	<input type="radio"/> Subnational level 3		
A.3.8 What is the approximate electronic coverage of the case reporting system across all health facilities?	<input type="radio"/> N/A	X	
	<input type="radio"/> 1% - 25%		
	<input type="radio"/> 26% - 50%		
	<input type="radio"/> 51% - 75%		
	<input type="radio"/> 76% - 100%		
A.3.9 Does the electronic system capture data at the individual or aggregate level?	<input type="radio"/> N/A	X	
	<input type="radio"/> Individual		
	<input type="radio"/> Aggregate		
	<input type="radio"/> Both individual and aggregate		
A.3.10 Are security measures in place for the electronic case reporting system?	<input type="radio"/> N/A	X	
	<input type="radio"/> No		
	<input type="radio"/> Yes, check all security measures that apply:		
	<input type="checkbox"/> Physical barrier		
	<input type="checkbox"/> Software barrier		
	<input type="checkbox"/> Legal barrier		
	<input type="checkbox"/> Encryption		
	<input type="checkbox"/> Unique identifier		
A.4 System Organization: HIV case reporting		Complete	Notes/Comments:
A.4.1 What is the approximate geographic coverage of the HIV case reporting system	<input type="radio"/> N/A	X	
	<input type="radio"/> 1% - 25%		
	<input type="radio"/> 26% - 50%		
	<input type="radio"/> 51% - 75%		
	<input type="radio"/> 76% - 100%		

1			
2		If geographic coverage is above 0%, specify if:	
3		<input type="checkbox"/> HIV case reporting is in urban areas	
4		<input type="checkbox"/> HIV case reporting is in rural areas	
5		<input type="checkbox"/> HIV case reporting is in urban and rural areas	
6			
7			
8		<input type="radio"/> N/A	
9		<input type="radio"/> National	
10	A.4.2 What is the lowest level at which data are collected	<input type="radio"/> Subnational level 1	X
11	on newly diagnosed HIV cases?	<input type="radio"/> Subnational level 2	
12		<input type="radio"/> Subnational level 3	
13			
14			
15		<input type="radio"/> N/A	
16		<input type="radio"/> No	
17		<input type="radio"/> Yes, check all linked systems that apply:	
18	A.4.3 Are data on newly diagnosed HIV cases linked to	<input type="checkbox"/> Patient monitoring system	X
19	other systems?	<input type="checkbox"/> Laboratory information system	
20		<input type="checkbox"/> Vital statistics system	
21		<input type="checkbox"/> Other, specify:	
22			
23			
24			
25			
26		<input type="radio"/> N/A	
27		<input type="radio"/> No	
28		<input type="radio"/> Yes	
29		<input type="radio"/> Partially	
30	A.4.4 Does the private sector report on newly diagnosed		X
31	HIV cases through this system?	If yes or partially, check all that apply:	
32		<input type="checkbox"/> Any portion of the private sector reports through the paper-based system	
33		<input type="checkbox"/> Any portion of the private sector reports through the electronic system	
34			
35			
36			
37			
38		<input type="radio"/> N/A	
39		<input type="radio"/> No	
40		<input type="radio"/> Yes, check all that apply:	
41	A.4.5 Is an electronic system used for HIV case reporting	<input type="checkbox"/> Electronic system is in urban areas only	X
42	in any area of the country?		
43			
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2		<input type="checkbox"/> Electronic system is in rural areas only	
3		<input type="checkbox"/> Electronic system is in urban and rural areas	
4			
5	A.4.6 What is the lowest level at which data on new HIV cases are collected through electronic systems?	<input type="radio"/> N/A	X
6		<input type="radio"/> National	
7		<input type="radio"/> Subnational level 1	
8		<input type="radio"/> Subnational level 2	
9		<input type="radio"/> Subnational level 3	
10			
11			
12	A.4.7 What is the approximate electronic coverage of the HIV case reporting system across all health facilities?	<input type="radio"/> N/A	X
13		<input type="radio"/> 1% - 25%	
14		<input type="radio"/> 26% - 50%	
15		<input type="radio"/> 51% - 75%	
16		<input type="radio"/> 75% - 100%	
17			
18			
19			
20	A.4.8 Does the electronic HIV case reporting system capture data at the individual or aggregate level?	<input type="radio"/> N/A	X
21		<input type="radio"/> Individual	
22		<input type="radio"/> Aggregate	
23		<input type="radio"/> Both individual and aggregate	
24			
25			
26	A.4.9 Are security measures in place for the electronic HIV case reporting system?	<input type="radio"/> N/A	X
27		<input type="radio"/> No	
28		<input type="radio"/> Yes, check all security measures that apply:	
29		<input type="checkbox"/> Physical barrier	
30		<input type="checkbox"/> Software barrier	
31		<input type="checkbox"/> Legal barrier	
32		<input type="checkbox"/> Encryption	
33		<input type="checkbox"/> Unique identifier	
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System B. Patient Monitoring

Definition: Patient monitoring systems collect routine data from health facilities related to clinical patient management. In HIV programming, patient monitoring systems are useful in measuring the second and third nineties as they capture program indicators such as service use, patient retention and treatment outcomes. Patient monitoring systems are often used to improve quality of services across various service areas. Data are often used to assess the health sector response from the facility to the national level.

B.1 Policy, Planning, and Legislation: Patient monitoring system for all diseases

Complete

Notes/Comments:

B.1.1 Is there an entity responsible for managing the patient monitoring system for all diseases?

☐ No

☐ Yes, check all entities that apply:

☐ Ministry of Health

☐ National Public Health Institute

☐ Another entity, specify:

X

B.1.2 Has a strategic plan or other strategic document been developed? *If yes, please provide a soft copy.*

☐ No

☐ Yes

X

B.1.3 Are patient monitoring data being used in the country?

☐ No

☐ Yes, check all that apply:

☐ National service coverage calculation

☐ Subnational service coverage calculation

☐ National quality of services improvement

☐ Subnational quality of services improvement

☐ National commodity forecasting

☐ Subnational commodity forecasting

☐ Other use, specify:

X

B.1.4 Is there a funding source for the patient monitoring system?

☐ No

☐ Yes, specify below:

☐ Domestic

☐ Global Fund

☐ PEPFAR

☐ Other bilateral, specify

☐ Other multilateral, specify

X

	<input type="checkbox"/> Other private, specify		
	<input type="radio"/> No		
	<input type="radio"/> Yes		
B.1.5 Is the patient monitoring system used for social health insurance reimbursement?	<input type="radio"/> No, but other system is used (specify:)	X	
B.2 Policy, Planning, and Legislation: HIV Patient monitoring system		Complete	Notes/Comments:
	<input type="radio"/> No		
	<input type="radio"/> Yes, check all that apply:		
B.2.1 Is there an entity responsible for managing the patient monitoring system for HIV/AIDS?	<input type="checkbox"/> Ministry of Health	X	
	<input type="checkbox"/> National Public Health Institute		
	<input type="checkbox"/> Another entity, specify:		
	<input type="radio"/> No		
	<input type="radio"/> Yes, check all that apply:		
B.2.2 Has a strategic plan or other strategic document been developed for HIV patient monitoring? <i>If yes, please provide a soft copy.</i>	<input type="checkbox"/> The HIV patient monitoring plan exists within larger patient monitoring system strategy document	X	
	<input type="checkbox"/> The HIV patient monitoring plan exists independent of the larger patient monitoring system strategy document		
	<input type="radio"/> No		
	<input type="radio"/> Yes, check all that apply:		
B.2.3 Are HIV patient monitoring data being used in the country?	<input type="checkbox"/> National HIV service coverage calculation	X	
	<input type="checkbox"/> Subnational HIV service coverage calculation		
	<input type="checkbox"/> National quality of service improvement		
	<input type="checkbox"/> Subnational quality of service improvement		
	<input type="checkbox"/> National HIV commodity forecasting		
	<input type="checkbox"/> Subnational HIV commodity forecasting		
	<input type="checkbox"/> Other use, specify:		
	<input type="radio"/> No		

B.2.4 Is there a funding source for the HIV patient monitoring system?

- ☐ Yes, specify below:
- ☐ Domestic
- ☐ Global Fund
- ☐ PEPFAR
- ☐ Other bilateral, specify below
- ☐ Other multilateral, specify below
- ☐ Other private, specify below

X

B.3 System Organization: Patient monitoring system for all diseases

Complete

Notes/Comments:

B.3.1 What is the approximate geographic coverage of the patient monitoring system?

- ☐ N/A
- ☐ 1% - 25%
- ☐ 26% - 50%
- ☐ 51% - 75%
- ☐ 76% - 100%
- If geographic coverage is > 0%, specify if:
- ☐ Patient monitoring is in urban areas
- ☐ Patient monitoring is in rural areas
- ☐ Patient monitoring is in urban and rural areas

X

B.3.2 What is the lowest level at which patient data are collected?

- ☐ N/A
- ☐ National
- ☐ Subnational level 1
- ☐ Subnational level 2
- ☐ Subnational level 3

X

B.3.3 Are patient data linked to other systems?

- ☐ N/A
- ☐ No
- ☐ Yes, check all linked systems that
- ☐ Case reporting system
- ☐ Laboratory information system
- ☐ Vital statistics system
- ☐ Health insurance system(s)

X

	<input type="checkbox"/> Other, specify:	
B.3.4 Does the private sector monitor patients using the same system?	<div><input type="radio"/> N/A</div> <div><input type="radio"/> No</div> <div><input type="radio"/> Yes</div> <div><input type="radio"/> Partially</div> <div>If yes or partially, check all that apply:</div> <div><input type="checkbox"/> Any portion of the private sector monitors patients through the same paper-based system</div> <div><input type="checkbox"/> Any portion of the private sector monitors patients through the same electronic system</div>	X
B.3.5 Does the patient monitoring system use a unique identifier?	<div><input type="radio"/> N/A</div> <div><input type="radio"/> No</div> <div><input type="radio"/> Yes, check all that apply:</div> <div><input type="checkbox"/> The unique identifier is the National ID</div> <div><input type="checkbox"/> The unique identifier is the Health ID</div> <div><input type="checkbox"/> The unique identifier is system-specific</div> <div><input type="checkbox"/> The unique identifier is created from client demographics (e.g. algorithm)</div> <div><input type="checkbox"/> The unique identifier is linked to biometric data</div>	X
B.3.6 Is an electronic system used for patient monitoring in any area of the country?	<div><input type="radio"/> N/A</div> <div><input type="radio"/> No</div> <div><input type="radio"/> Yes</div> <div><input type="checkbox"/> Electronic system is in urban areas only</div> <div><input type="checkbox"/> Electronic system is in rural areas only</div> <div><input type="checkbox"/> Electronic system is in urban and rural areas</div>	X
B.3.7 What is the lowest level at which patient data are collected through electronic systems?	<div><input type="radio"/> N/A</div> <div><input type="radio"/> National</div> <div><input type="radio"/> Subnational level 1</div> <div><input type="radio"/> Subnational level 2</div>	X

	<input type="radio"/> Subnational level 3		
B.3.8 What is the approximate electronic coverage of the patient monitoring system across all health facilities?	<input type="radio"/> N/A	X	
	<input type="radio"/> 1% - 25%		
	<input type="radio"/> 26% - 50%		
	<input type="radio"/> 51% - 75%		
	<input type="radio"/> 76% - 100%		
B.3.9 Does the electronic system capture patient data at the individual or aggregate level?	<input type="radio"/> N/A	X	
	<input type="radio"/> Individual		
	<input type="radio"/> Aggregate		
	<input type="radio"/> Both individual and aggregate		
B.3.10 Are security measures in place for the electronic patient monitoring system?	<input type="radio"/> N/A	X	
	<input type="radio"/> No		
	<input type="radio"/> Yes, check all security measures that apply:		
	<input type="checkbox"/> Physical barrier		
	<input type="checkbox"/> Software barrier		
	<input type="checkbox"/> Legal barrier		
	<input type="checkbox"/> Encryption		
	<input type="checkbox"/> Unique identifier		
B.4 System Organization: HIV Patient monitoring system		Complete	Notes/Comments:
B.4.1 What is the approximate geographic coverage of the HIV patient monitoring system?	<input type="radio"/> N/A	X	
	<input type="radio"/> 1% - 25%		
	<input type="radio"/> 26% - 50%		
	<input type="radio"/> 51% - 75%		
	<input type="radio"/> 76% - 100%		
	If geographic coverage is > 0%, specify if:		
	<input type="checkbox"/> HIV patient monitoring is in urban areas		
	<input type="checkbox"/> HIV patient monitoring is in rural areas		
	<input type="checkbox"/> HIV patient monitoring is in urban and rural areas		

B.4.2 What is the lowest level at which HIV patient data are collected?	<input type="radio"/> N/A	X		
	<input type="radio"/> National			
	<input type="radio"/> Subnational level 1			
	<input type="radio"/> Subnational level 2			
	<input type="radio"/> Subnational level 3			
B.4.3 Are HIV patient data linked to other systems?	<input type="radio"/> N/A	X		
	<input type="radio"/> No			
	<input type="radio"/> Yes, check all linked systems:			
	<input type="checkbox"/> Case reporting system			
	<input type="checkbox"/> Laboratory information system			
	<input type="checkbox"/> Vital statistics system			
	<input type="checkbox"/> Health insurance system(s)			
<input type="checkbox"/> Other, specify:				
B.4.4 Does the private sector monitor HIV patients using the same system?	<input type="radio"/> N/A	X		
	<input type="radio"/> No			
	<input type="radio"/> Yes			
	<input type="radio"/> Partially			
	If yes or partially, check all that apply:			
	<input type="checkbox"/> Any portion of the private sector monitors HIV patients using the same paper-based system			
	<input type="checkbox"/> Any portion of the private sector monitors HIV patients using the same electronic system			
B.4.5 Is an electronic system used for HIV patient monitoring in any area of the country?	<input type="radio"/> N/A	X		
	<input type="radio"/> No			
	<input type="radio"/> Yes, check all that apply:			
	<input type="checkbox"/> Electronic system is in urban areas			
	<input type="checkbox"/> Electronic system is in rural areas			
	<input type="checkbox"/> Electronic system is in urban and rural areas			

B.4.6 What is the lowest level at which HIV patient data are collected through electronic systems?	<input type="radio"/> N/A	X	
	<input type="radio"/> National		
	<input type="radio"/> Subnational level 1		
	<input type="radio"/> Subnational level 2		
	<input type="radio"/> Subnational level 3		
B.4.7 What is the approximate electronic coverage of the HIV patient monitoring system across all health facilities?	<input type="radio"/> N/A	X	
	<input type="radio"/> 1% - 25%		
	<input type="radio"/> 26% - 50%		
	<input type="radio"/> 51% - 75%		
	<input type="radio"/> 76% - 100%		
B.4.8 Does the electronic system capture HIV patient data at the individual or aggregate level?	<input type="radio"/> N/A	X	
	<input type="radio"/> Individual		
	<input type="radio"/> Aggregate		
	<input type="radio"/> Both individual and aggregate		
B.4.9 Are security measures in place for the electronic HIV patient monitoring system?	<input type="radio"/> N/A	X	
	<input type="radio"/> No		
	<input type="radio"/> Yes, check all security measures that apply:		
	<input type="checkbox"/> Physical barrier		
	<input type="checkbox"/> Software barrier		
	<input type="checkbox"/> Legal barrier		
	<input type="checkbox"/> Encryption		
	<input type="checkbox"/> Unique identifier		

1	HIV?	<input type="checkbox"/> Measure impact of HIV programs	^	
2		<input type="checkbox"/> National burden of HIV estimation		
3		<input type="checkbox"/> Subnational burden of HIV estimation		
4		<input type="checkbox"/> Other use, specify:		
5				
6				
7				
8	C.1.6 Is there a funding source for CRVS system development?	<input type="radio"/> No	X	
9		<input type="radio"/> Yes, specify below:		
10		<input type="checkbox"/> Domestic		
11		<input type="checkbox"/> Global Financing Fund		
12		<input type="checkbox"/> PEPFAR		
13		<input type="checkbox"/> Gates Foundation		
14		<input type="checkbox"/> Bloomberg Data for Health		
15		<input type="checkbox"/> Other bilateral, specify		
16		<input type="checkbox"/> Other multilateral, specify		
17				
18				
19				
20				
21	C.1.7 Is proof of birth or death registration required for any government services? (e.g. birth or death certificate)	<input type="radio"/> No	X	
22		<input type="radio"/> Yes, specify below:		
23		<input type="checkbox"/> Immunization		
24		<input type="checkbox"/> Health insurance		
25		<input type="checkbox"/> School enrollment		
26		<input type="checkbox"/> Welfare		
27		<input type="checkbox"/> Legal services		
28		<input type="checkbox"/> Burial		
29		<input type="checkbox"/> Inheritance		
30		<input type="checkbox"/> Life insurance		
31		<input type="checkbox"/> Other service, specify:		
32				
33				
34				
35				
36	C.2 System organization		Complete	Notes/Comments:
37	C.2.1 Which vital events are registered?	<input type="radio"/> N/A	X	
38		<input type="radio"/> Births		
39		<input type="radio"/> Deaths		
40		<input type="radio"/> Both births and deaths		
41				
42				
43				
44				
45				
46				
47				

C.2.2 Does the CRVS system use a unique identifier?	<div><div><input type="radio"/> N/A</div><div><input type="radio"/> No</div><div><input type="radio"/> Yes, check all that apply:<div><div><input type="checkbox"/> The unique identifier is the National ID</div><div><input type="checkbox"/> The unique identifier is the Health ID</div><div><input type="checkbox"/> The unique identifier is system-specific</div><div><input type="checkbox"/> The unique identifier is created from client demographics (e.g. algorithm)</div><div><input type="checkbox"/> The unique identifier is linked to biometric data</div></div></div></div>	X	
C.2.3 Are security measures in place for the CRVS system?	<div><div><input type="radio"/> N/A</div><div><input type="radio"/> No</div><div><input type="radio"/> Yes, check all that apply:<div><div><input type="checkbox"/> Physical barrier</div><div><input type="checkbox"/> Software barrier</div><div><input type="checkbox"/> Legal barrier</div><div><input type="checkbox"/> Encryption</div><div><input type="checkbox"/> Unique identifier</div></div></div></div>	X	
C.3 System organization for <u>birth</u> registration		Complete	Notes/Comments:
C.3.1 What is the approximate geographic coverage of birth registration?	<div><div><input type="radio"/> N/A</div><div><input type="radio"/> 1% - 25%</div><div><input type="radio"/> 26% - 50%</div><div><input type="radio"/> 51% - 75%</div><div><input type="radio"/> 76% - 100%</div><div>If geographic coverage is > 0%, specify if:<div><div><input type="checkbox"/> Birth registration is in urban areas</div><div><input type="checkbox"/> Birth registration is in rural areas</div><div><input type="checkbox"/> Birth registration is in urban and rural areas</div></div></div></div>	X	
C.3.2 What is the approximate population coverage of birth registration?	<div><div><input type="radio"/> N/A</div><div><input type="radio"/> National</div></div>		

C.3.2 What is the **lowest** level at which birth events are registered?

☐ Subnational level 1

☐ Subnational level 2

☐ Subnational level 3

X

C.3.3 Are data on birth events linked to other systems?

☐ N/A

☐ No

☐ Yes, check all linked systems:

☐ Case reporting system

☐ Patient monitoring system

☐ Health insurance system

☐ Legal system/policing

☐ Voter registration system

☐ National ID

☐ Other, specify:

X

C.3.4 Is an electronic system used for registering births in any area of the country?

☐ N/A

☐ No

☐ Yes, check all that apply:

☐ Electronic system is in urban areas

☐ Electronic system is in rural areas

☐ Electronic system is in urban and rural areas

X

C.3.5 What is the **lowest** level at which birth events are registered through electronic systems?

☐ N/A

☐ National

☐ Subnational level 1

☐ Subnational level 2

☐ Subnational level 3

X

C.3.6 What is the approximate electronic coverage of the birth registration system across all health facilities and/or registrar offices?

☐ N/A

☐ 1% - 25%

☐ 26% - 50%

☐ 51% - 75%

X

	<input type="radio"/> 76% - 100%			
C.3.7 Does the electronic system capture birth events at the individual or aggregate level?	<input type="radio"/> N/A	X		
	<input type="radio"/> Individual			
	<input type="radio"/> Aggregate			
	<input type="radio"/> Both individual and aggregate			
C.3.8 Does the private sector report birth events using the same electronic system?	<input type="radio"/> N/A	X		
	<input type="radio"/> No			
	<input type="radio"/> Yes			
	<input type="radio"/> Some			
C.4 System Organization for <u>death</u> registration		Complete	Notes/Comments:	
C.4.1 What is the approximate geographic coverage of death registration?	<input type="radio"/> N/A	X		
	<input type="radio"/> 1% - 25%			
	<input type="radio"/> 26% - 50%			
	<input type="radio"/> 51% - 75%			
	<input type="radio"/> 76% - 100%			
	If geographic coverage is > 0%, specify if:			
	<input type="checkbox"/> Death registration is in urban areas			
	<input type="checkbox"/> Death registration is in rural areas			
C.4.2 What is the lowest level at which death events are collected?	<input type="checkbox"/> Death registration is in urban and rural areas	X		
	<input type="radio"/> N/A			
	<input type="radio"/> National			
	<input type="radio"/> Subnational level 1			
	<input type="radio"/> Subnational level 2			
	<input type="radio"/> Subnational level 3			
	<input type="radio"/> N/A			
	<input type="radio"/> No			
	<input type="radio"/> Yes, check all linked systems:			
	<input type="checkbox"/> Case reporting system			

C.4.3 Are data on death events linked to other systems?

- ☐ Patient monitoring system
- ☐ Health insurance system
- ☐ Legal system/policing
- ☐ Voter registration
- ☐ National ID
- ☐ Other, specify:

X

C.4.4 Is an electronic system used for registering deaths in any area of the country?

- ☐ N/A
- ☐ No
- ☐ Yes
- ☐ Electronic system is in urban areas
- ☐ Electronic system is in rural areas
- ☐ Electronic system is in urban and rural areas

X

C.4.5 What is the **lowest** level at which deaths are registered through electronic systems?

- ☐ N/A
- ☐ National
- ☐ Subnational level 1
- ☐ Subnational level 2
- ☐ Subnational level 3

X

C.4.6 What is the approximate electronic coverage of the death registration system across all health facilities or registrar offices?

- ☐ N/A
- ☐ 1% - 25%
- ☐ 26% - 50%
- ☐ 51% - 75%
- ☐ 76% - 100%

X

C.4.7 Does the electronic system capture death events at the individual or aggregate level?

- ☐ N/A
- ☐ Individual
- ☐ Aggregate
- ☐ Both individual and aggregate

X

C.4.8 Does the private sector report death events using

- ☐ N/A
- ☐ No

y

1				
2	the same electronic system?	<input type="radio"/> Yes		
3		<input type="radio"/> Some		
4				
5	C.5 Cause of death information		Complete	Notes/Comments:
6		<input type="radio"/> N/A	X	
7		<input type="radio"/> No		
8		<input type="radio"/> Yes, check all methods used to ascertain cause of death		
9		<input type="checkbox"/> Verbal autopsy		
10	C.5.1 Are sentinel surveillance approaches used to measure cause of death? (e.g. alternative methods for cause-specific mortality surveillance)	<input type="checkbox"/> Minimally invasive autopsy		
11		<input type="checkbox"/> Full autopsy		
12		<input type="checkbox"/> Hospital-based system		
13		<input type="checkbox"/> Other ascertainment method, specify:		
14				
15		<input type="radio"/> N/A	X	
16		<input type="radio"/> No		
17		<input type="radio"/> Yes, check all methods that apply:		
18		<input type="checkbox"/> ICD-10		
19	C.5.2 Do these sentinel surveillance approaches utilize a method of classification to report cause of death?	<input type="checkbox"/> Verbal autopsy - InterVA		
20		<input type="checkbox"/> Verbal autopsy - Tarrif2		
21		<input type="checkbox"/> Verbal autopsy - SmartVA		
22		<input type="checkbox"/> Other classification method, specify:		
23				
24		<input type="radio"/> N/A	X	
25		<input type="radio"/> No		
26		<input type="radio"/> Yes, check all methods used to ascertain cause of		
27	C.5.3 Does the vital statistics system collate cause of death information?	<input type="checkbox"/> Verbal autopsy		
28		<input type="checkbox"/> Minimally invasive autopsy		
29		<input type="checkbox"/> Full autopsy		
30		<input type="checkbox"/> Hospital-based system		
31		<input type="checkbox"/> Other ascertainment method, specify:		
32				

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C.5.4 Does the vital statistics **system** utilize a method of classification to report cause of death?

- ☐ N/A
- ☐ No
- ☐ Yes, select all methods that apply:
- ☐ ICD-10
- ☐ Verbal autopsy - InterVA
- ☐ Verbal autopsy - Tarrif2
- ☐ Verbal autopsy - SmartVA
- ☐ Other classification method, specify:

X

C.5.5 What is the **lowest** level at which cause of death is collated in the system?

- ☐ N/A
- ☐ National
- ☐ Subnational level 1
- ☐ Subnational level 2
- ☐ Subnational level 3

X

Country	Contacted	Provided response with government concurrence
Brazil	Yes	
Angola	Yes	
Barbados	Yes	
Botswana	Yes	
Burundi	Yes	
Cambodia	Yes	
Cameroon	Yes	
China	Yes	Yes
Cote d'Ivoire	Yes	Yes
Dem Rep of the Congo	Yes	Yes
Dominican Republic	Yes	Yes
El Salvador	Yes	
Ethiopia	Yes	
Ghana	Yes	Yes
Guatemala	Yes	
Guyana	Yes	
Haiti	Yes	
Honduras	Yes	
India	Yes	
Indonesia	Yes	
Jamaica	Yes	
Kazakhstan	Yes	
Kenya	Yes	
Krygyzstan	Yes	
Laos	Yes	Yes
Lesotho	Yes	
Malawi	Yes	Yes
Mali	Yes	
Mozambique	Yes	
Myanmar	Yes	
Namibia	Yes	Yes
Nicaragua	Yes	
Nigeria	Yes	Yes
Panama	Yes	
Papua New Guinea	Yes	Yes
Rwanda	Yes	
Senegal	Yes	
Sierra Leone	Yes	
South Africa	Yes	Yes
South Sudan	Yes	
Suriname	Yes	
Swaziland	Yes	
Tajikstan	Yes	
Tanzania	Yes	Yes
Thailand	Yes	Yes
Trinidad and Tobago	Yes	
Uganda	Yes	
Ukraine	Yes	
Vietnam	Yes	Yes
Zambia	Yes	Yes
Zimbabwe	Yes	

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (Line 2)
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found (Lines 134-138)
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported (lines 203-212)
Objectives	3	State specific objectives, including any prespecified hypotheses (lines 211-212)
Methods		
Study design	4	Present key elements of study design early in the paper (lines 216-223)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection (lines 243-251)
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants (lines 244-248)
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable (lines 226-240 and annex)
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group (Full survey provided in annex)
Bias	9	Describe any efforts to address potential sources of bias (Lines 256-259)
Study size	10	Explain how the study size was arrived at (Lines 243-244)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why (Lines 254-260 and annex)
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding
		(b) Describe any methods used to examine subgroups and interactions
		(c) Explain how missing data were addressed
		(d) If applicable, describe analytical methods taking account of sampling strategy
		(e) Describe any sensitivity analyses
		Analytical methods described in lines 254-260. Since our unit of measure was a country, there were limited formal statistical analyses possible.
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (Table 1)
		(b) Give reasons for non-participation at each stage (Annex includes non-respondents)
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (Table 2)
		(b) Indicate number of participants with missing data for each variable of interest (Tables 3-5)
Outcome data	15*	Report numbers of outcome events or summary measures (Tables 3-5)
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were

		adjusted for and why they were included
		(b) Report category boundaries when continuous variables were categorized
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
		Results described fully in lines 274-322)
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives (Lines 325-390)
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias (Lines 392-416)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence (Lines 418-419)
Generalisability	21	Discuss the generalisability (external validity) of the study results (Lines 419-420)
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based (Lines 100-103)

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

National health information systems for achieving the Sustainable Development Goals: a cross sectional survey in low- and middle-income countries

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Date Submitted by the Author:	20-Mar-2019
Complete List of Authors:	<p>Suthar, Amitabh; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Khalifa, Aleya; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Joos, Olga; Centers for Disease Control and Prevention, International Statistics Program</p> <p>Manders, Eric-Jan; Centers for Disease Control and Prevention</p> <p>Abdul-Quader , Abu ; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Amoyaw , Frank; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Aoua, Camara; Ministere de la Sante et de l'Hygiene Publique</p> <p>Aynalem, Getahun; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Barradas , Danielle; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Bello , George; Ministry of Health</p> <p>Bonilla, Luis; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Cheyip , Mireille; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Dalhatu, Ibrahim Tijjani ; Centers for Disease Control and Prevention, Center for Global Health</p> <p>De Klerk , Michael ; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Dee , Jacob; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Hedje, Judith; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Jahun, Ibrahim ; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Jantaramanee , Supiya ; Ministry of Public Health</p> <p>Kamocha , Stanley ; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Lerebours , Leonel; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Lobognon, Legre Roger ; Centers for Disease Control and Prevention, Center for Global Health</p> <p>Lote, Namarola; National Department of Health</p>

	Lubala, Léopold; Ministère de la Santé Publique Magazani, Alain; Ministère de la Santé Publique Mdodo, Rennatus ; Centers for Disease Control and Prevention, Center for Global Health Mgomella , George S. ; Centers for Disease Control and Prevention, Center for Global Health Monique , Lattah Asseka ; Ministere de la Sante et de l'Hygiene Publique Mudenda , Mphatso ; Centers for Disease Control and Prevention, Center for Global Health Mushi , Jeremiah ; Ministry of Health and Social Welfare Mutenda , Nicholus ; Ministry of Health and Social Services Nicoue , Aime ; Centers for Disease Control and Prevention, Center for Global Health Ngalamulume , Rogers Galaxy ; Centers for Disease Control and Prevention, Center for Global Health Ndjakani , Yassa ; Centers for Disease Control and Prevention, Center for Global Health Nguyen , Tuan Anh ; Centers for Disease Control and Prevention, Center for Global Health Nzelu , Charles Echezona ; Federal Ministry of Health Ofosu , Anthony Adofo ; Ghana Health Service Pinini , Zukiswa ; National Department of Health Ramírez , Edwin ; Servicio Nacional de Salud Sebastian , Victor ; Centers for Disease Control and Prevention, Center for Global Health Simanovong , Bouathong ; Ministry of Health Son , Ha Thai ; Ministry of Health Son , Vo Hai ; Ministry of Health Swaminathan , Mahesh ; Centers for Disease Control and Prevention, Center for Global Health Sivile , SuilANJI ; Ministry of Health Teeraratkul , Achara ; Centers for Disease Control and Prevention, Center for Global Health Temu , Poruan ; Centers for Disease Control and Prevention, Center for Global Health West , Christine ; Centers for Disease Control and Prevention Xaymounvong , Douangchanh ; Centers for Disease Control and Prevention, Center for Global Health Yamba, Abel ; Centers for Disease Control and Prevention, Center for Global Health Yoka , Denis ; Ministere de la Sante Publique Zhu , Hao ; Centers for Disease Control and Prevention, Center for Global Health Ransom , Ray L. ; Centers for Disease Control and Prevention, Center for Global Health Nichols, Erin; Centers for Disease Control and Prevention, International Statistics Program Murrill , Christopher S.; Centers for Disease Control and Prevention, Center for Global Health Rosen , Daniel ; Centers for Disease Control and Prevention, Center for Global Health Hladik, Wolfgang; Center for Global Health, Centers for Disease Control and Prevention
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42a cross sectional survey in low- and middle-income countries

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7

84Amitabh B. Suthar* – Center for Global Health, Centers for Disease Control and Prevention, Atlanta,

95U.S.A.

10

116Aleya Khalifa* – Center for Global Health, Centers for Disease Control and Prevention, Atlanta, U.S.A.

12

137Olga Joos – International Statistics Program, Centers for Disease Control and Prevention, Hyattsville,

148U.S.A.

15

169Eric-Jan Manders – Center for Global Health, Centers for Disease Control and Prevention, Atlanta,

1710U.S.A.

18

1911Abu Abdul-Quader – Center for Global Health, Centers for Disease Control and Prevention, Hanoi,

2012Vietnam

21

2213Frank Amoyaw – Center for Global Health, Centers for Disease Control and Prevention, Accra, Ghana

23

2414Camara Aoua – Ministère de la Santé et l'Hygiène Publique, Abidjan, Côte d'Ivoire

25

2615Getahun Aynalem – Center for Global Health, Centers for Disease Control and Prevention, Pretoria,

2716Republic of South Africa

28

2917Danielle Barradas – Center for Global Health, Centers for Disease Control and Prevention, Lusaka,

3018Zambia

31

3219George Bello – Ministry of Health, Lilongwe, Malawi

33

3420Luis Bonilla – Center for Global Health, Centers for Disease Control and Prevention, Santo Domingo,

3521República Dominicana

36

3722Mireille Cheyip – Center for Global Health, Centers for Disease Control and Prevention, Pretoria,

3823Republic of South Africa

39

4024Ibrahim Tijjani Dalhatu – Center for Global Health, Centers for Disease Control and Prevention, Abuja,

4125Nigeria

42

4326Michael De Klerk – Center for Global Health, Centers for Disease Control and Prevention, Windhoek,

4427Namibia

45

46

4728Jacob Dee – Center for Global Health, Centers for Disease Control and Prevention, Kinshasa,

4829République Démocratique du Congo

49

5030Judith Hedje – Center for Global Health, Centers for Disease Control and Prevention, Abidjan, Côte

5131d'Ivoire

52

5332Ibrahim Jahun – Center for Global Health, Centers for Disease Control and Prevention, Abuja, Nigeria

54

5533Supiya Jantaramanee – Ministry of Public Health, Bangkok, Thailand

56

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58Page 1 of 27

59

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- Stanley Kamocha – Center for Global Health, Centers for Disease Control and Prevention, Lusaka, Zambia
- Leonel Lerebours – Center for Global Health, Centers for Disease Control and Prevention, Santo Domingo, República Dominicana
- Legre Roger Lobognon – Center for Global Health, Centers for Disease Control and Prevention, Abidjan, Côte d'Ivoire
- Namarola Lote – National Department of Health, Port Moresby, Papua New Guinea
- Léopold Lubala – Ministère de la Santé Publique, Kinshasa, République Démocratique du Congo
- Alain Magazani – Ministère de la Santé Publique, Kinshasa, République Démocratique du Congo
- Rennatus Mdodo – Center for Global Health, Centers for Disease Control and Prevention, Dar es Salaam, United Republic of Tanzania
- George S. Mgomella – Center for Global Health, Centers for Disease Control and Prevention, Dar es Salaam, United Republic of Tanzania
- Lattah Asseka Monique – Ministère de la Santé et l'Hygiène Publique, Abidjan, Côte d'Ivoire
- Mphatso Mudenda – Center for Global Health, Centers for Disease Control and Prevention, Lusaka, Zambia
- Jeremiah Mushi – Ministry of Health and Social Welfare, Dar es Salaam, United Republic of Tanzania
- Nicholus Mutenda – Ministry of Health and Social Services, Windhoek, Namibia
- Aime Nicoue – Center for Global Health, Centers for Disease Control and Prevention, Abidjan, Côte d'Ivoire
- Rogers Galaxy Ngalamulume – Center for Global Health, Centers for Disease Control and Prevention, Kinshasa, République Démocratique du Congo
- Yassa Ndjakani – Center for Global Health, Centers for Disease Control and Prevention, Kinshasa, République Démocratique du Congo
- Tuan Anh Nguyen – Center for Global Health, Centers for Disease Control and Prevention, Hanoi, Vietnam
- Charles Echezona Nzelu – Federal Ministry of Health, Abuja, Nigeria
- Anthony Adofo Ofosu – Ghana Health Service, Accra, Ghana
- Zukiswa Pinini – National Department of Health, Pretoria, Republic of South Africa
- Edwin Ramírez – Servicio Nacional de Salud, Santo Domingo, República Dominicana
- Victor Sebastian – Center for Global Health, Centers for Disease Control and Prevention, Abuja, Nigeria
- Bouathong Simanovong – Ministry of Health, Lao People's Democratic Republic

- 1
- 2
- 3 66 Ha Thai Son – Ministry of Health, Hanoi, Vietnam
- 4
- 5 67 Vo Hai Son – Ministry of Health, Hanoi, Vietnam
- 6
- 7 68 Mahesh Swaminathan – Center for Global Health, Centers for Disease Control and Prevention, Abuja,
- 8 69 Nigeria
- 9
- 10 70 Suilanjji Sivile – Ministry of Health, Lusaka, Zambia
- 11
- 12 71 Achara Teeraratkul – Center for Global Health, Centers for Disease Control and Prevention, Bangkok,
- 13 72 Thailand
- 14
- 15 73 Poruan Temu – Center for Global Health, Centers for Disease Control and Prevention, Port Moresby,
- 16 74 Papua New Guinea
- 17
- 18 75 Christine West – Center for Global Health, Centers for Disease Control and Prevention, Lilongwe,
- 19 76 Malawi
- 20
- 21 77 Douangchanh Xaymounvong – Center for Global Health, Centers for Disease Control and Prevention,
- 22 78 Vientiane, Lao People's Democratic Republic
- 23
- 24 79 Abel Yamba – Center for Global Health, Centers for Disease Control and Prevention, Port Moresby,
- 25 80 Papua New Guinea
- 26
- 27 81 Denis Yoka – Ministère de la Santé Publique, Kinshasa, République Démocratique du Congo
- 28
- 29 82 Hao Zhu – Center for Global Health, Centers for Disease Control and Prevention, Beijing, China
- 30
- 31 83 Ray L. Ransom – Center for Global Health, Centers for Disease Control and Prevention, Atlanta, U.S.A.
- 32
- 33 84 Erin K. Nichols – International Statistics Program, Centers for Disease Control and Prevention,
- 34 85 Hyattsville, U.S.A.
- 35
- 36 86 Christopher S. Murrill – Center for Global Health, Centers for Disease Control and Prevention, Atlanta,
- 37 87 U.S.A.
- 38
- 39 88 Daniel Rosen – Center for Global Health, Centers for Disease Control and Prevention, Atlanta, U.S.A.
- 40
- 41 89 Wolfgang Hladik – Center for Global Health, Centers for Disease Control and Prevention, Atlanta,
- 42 90 U.S.A.
- 43
- 44

45 91 * These authors contributed equally to this work.

46

47 92

48 93 **Corresponding author:** Dr Amitabh Bipin Suthar, icf4@cdc.gov

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52 95 **Disclaimer:** The findings and conclusions in this article are those of the authors and do not necessarily

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54 96 represent the official position of their governments or funding agencies.

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56 97

57 98 **Competing interests:** We have read the journal's policy and have no competing interests to declare.

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Abstract: 266

Word count: 2,778

References: 29

Figures: 5

Tables: 5

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3 129 **Abstract**

4 130 *Objectives*

5

6 131 Achieving the Sustainable Development Goals will require data-driven public health action. There are

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8 132 limited publications on national health information systems that continuously generate health data. Given

9

10 133 the need to develop these systems, we summarised their current status in low- and middle-income

11 134 countries.

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15 136 *Setting*

16 137 The survey team jointly developed a questionnaire covering policy, planning, legislation, and organization

17

18 138 of case reporting, patient monitoring, and civil registration and vital statistics (CRVS) systems. From

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20 139 January until May 2017, we administered the questionnaire to key informants in 51 Centers for Disease

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22 140 Control (CDC) country offices. Countries were aggregated for descriptive analyses in Microsoft Excel.

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25 142 *Results*

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27 143 Key informants in 15 countries responded to the questionnaire. Several key informants did not answer all

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29 144 questions, leading to different denominators across questions. The Ministry of Health coordinated case

30 145 reporting, patient monitoring, and CRVS systems in 93% (14/15), 93% (13/14), and 53% (8/15) of

31

32 146 responding countries, respectively. Domestic financing supported case reporting, patient monitoring, and

33

34 147 CRVS systems in 86% (12/14), 75% (9/12), and 92% (11/12) of responding countries, respectively. The

35 148 most common uses for system-generated data was to guide programme response in 100% (15/15) of

36

37 149 countries for case reporting, to calculate service coverage in 92% (12/13) of countries for patient

38

39 150 monitoring, and to estimate the national burden of disease in 83% (10/12) of countries for CRVS. Systems

40

41 151 with an electronic component were being used for case reporting, patient monitoring, birth registration,

42 152 and death registration in 87% (13/15), 92% (11/12), 77% (10/13), and 64% (7/11) of responding countries,

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44 153 respectively.

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46 154

47 155 *Conclusions*

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49 156 Most responding countries have a solid foundation for policy, planning, legislation, and organisation of

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51 157 health information systems. Further evaluation is needed to assess the quality of data generated from

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53 158 systems. Periodic evaluations may be useful in monitoring progress in strengthening and harmonising

54 159 these systems over time.

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BMJOPEN-2018-027689R2

*Note to BMJ Open: Since this was a global survey the participants and interventions sections of the abstract were not applicable.

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Strengths and limitations of this study

- To our knowledge this is the first detailed multi-country assessment of national case reporting, patient monitoring, and vital statistics systems
- Given that this survey was administered electronically, there may have been differences in how respondents interpreted question and answer choices
- Knowledge and experience of respondents may have varied from office to office
- Given that the survey represents 15 countries globally the results may not be globally representative
- Given that survey respondents did not answer all questions, there are differences in the denominator across questions

Introduction

Data should guide governments as they plan, budget, and act for health. The Sustainable Development Goal (SDG) for health, ensure healthy lives and promote well-being for all at all ages, requires data on disease transmission, service coverage and outcomes, and causes of death (Table 1) [1]. These data can come from various sources including surveys, longitudinal studies, and data systems. Given that surveys and longitudinal studies often are time-limited, require external resources, and take time to design and administer, the role of systems in generating population disaggregated, geographically specific, and timely data is becoming more important [2].

The World Health Organization has specified that key data sources for health information systems include individual records (such as case reports and disease registries), service records from health providers, civil registration and vital statistics, amongst others [3]. For the purposes of this survey we honed in on three core systems used for disease identification, service provision, and vital status monitoring. These include: (1) communicable disease case reporting from individual records, (2) patient monitoring from service records, and (3) vital statistics derived from civil registration systems. Communicable disease case reporting is traditionally used to monitor trends in disease transmission across different geographic settings and amongst different populations as part of routine surveillance [4]. Patient monitoring can be used to monitor health service coverage, such as treatment for HIV, tuberculosis, childhood immunisations, amongst others as part of universal healthcare coverage [5]. Well-functioning civil registration and vital statistics (CRVS) systems produce data on registered births, deaths (including cause of death), as well as marriages, adoptions, and divorces; public health authorities primarily focus on registration of births, deaths, and causes of deaths for decision making [6].

For case reporting, many of the global norms and standards trace back to disease-specific reporting requirements, the Integrated Disease Surveillance and Response (IDSR) framework, and to the International Health Regulations [7,8]. Patient monitoring, and other health information systems, are transitioning from paper- to electronic-based systems [9]. The Statistical Commission of the United Nations provides comprehensive principles and recommendations for CRVS systems to achieve universal coverage, continuity, confidentiality, and regular dissemination in order to be a dependable and primary data source for vital statistics [10]. Although WHO collates global health data in its Global Health Observatory [11], to our knowledge there are few publications evaluating contributing *systems* in detail

[12]. The objective of this article is to summarise the status of case reporting, patient monitoring, and CRVS systems amongst a sample of low- and middle-income countries.

Methods

Survey design

The survey team, comprised of global experts in informatics, surveillance, and programme, jointly developed a survey covering policy, planning, legislation, and organisation of case reporting, patient monitoring, and CRVS systems. This survey was primarily designed to assess the state of information systems that could potentially be leveraged for HIV-related clinical surveillance, monitoring progress towards meeting national and global goals, and improving national responses [13]. The survey was piloted prior to full implementation by review from system-specific experts and staff working in country offices for content and usability of the survey tool. The survey was administered through a tool developed in Excel (Microsoft Corporation, Seattle, USA). The tool consisted of multiple choice questions and text boxes through which respondents could elaborate on their selections (Table S1-S3).

Definitions

For the purposes of establishing a common framework for administration of this tool, we developed definitions for case reporting, patient monitoring, and CRVS systems:

- A functioning case reporting system routinely collects information on diagnosed disease-specific cases. These cases may be reported from health facilities or providers to a central level. At subnational and national levels, these data can be used to track epidemics and quantify the burden of disease in order to inform public health programs. For example, some countries may use Integrated Disease Surveillance and Response (IDSR) to report individual and aggregated newly diagnosed cases of communicable disease.
- Patient monitoring systems collect routine data from health facilities related to clinical patient management. Patient monitoring systems are often used to measure service coverage and quality. Data are often used to assess the health sector response from the facility to the national level.
- CRVS systems register births, deaths, cause of deaths, marriages, and divorces. In public health, authorities focus on the registration of births, deaths and cause of deaths to track population demographics and patterns of disease. CRVS can generate disease specific mortality trends to inform burden and impact assessments.

Data collection

We surveyed all regional and country CDC offices with Division of Global HIV and TB staff outside of the United States (Table S4). CDC country staff overseeing strategic information (encompassing health information systems, surveillance, and monitoring and evaluation) were selected as key informants and were contacted by email to complete the tool. One staff member was contacted per country. Respondents were encouraged to liaise with their national government counterparts for questions to which they did not know the answer. Questions that the counterpart did not know, and for which they were unable to liaise with their counterpart, were left blank. We administered the questionnaire via email in January 2017. Up to three follow-up emails were sent to non-respondents from February to May 2017. The results were then reviewed with government counterparts for validity.

Data management and analysis

Country key informants entered their responses directly into the Excel tool. All country files were cleaned and merged into a Stata database (Statacorp, College Station, USA). The Stata database was then exported to Excel (Microsoft, Redmond, USA) for analysis. Any response that was left blank or indicated “not applicable” was excluded from the denominator when percentages were calculated. With countries acting as our unit of measure we had limited statistical power and chose not to conduct statistical tests but rather describe the results of the survey using proportions. Since different questions were left blank or indicated not applicable from key informants, most of the descriptive analyses have different denominators. Tableau (Tableau, Seattle, USA) was used for creating maps with OpenStreetMap images while Excel was used to create descriptive tables. The United Nations Human Development Index was used to summarise life expectancy, mean years of schooling, and gross national income per capita [14]. World Bank thresholds were used to classify countries as low, lower-middle, or upper-middle income [15].

Ethical approval

The Office of Science from the Center for Global Health at CDC deemed this survey to not require CDC Institutional Review Board review and approved the survey protocol for implementation.

Patient and Public Involvement

This survey included countries rather than patients as a unit of measure. Patients and the public were not involved in the design or planning of the study.

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Results

Overall, 15 of 51 (29%) country key informants responded to the tool (Table S4). Socioeconomic characteristics of responding countries, including life expectancy, mean years of schooling, gross national per capita income, and human development index, are found in Table 2 [14,15].

Case reporting systems

Key informants from 14 of 15 (93%) countries that responded to the case reporting systems section of the survey indicated that the Ministry of Health was responsible for disease case reporting. Overall, there was legislation mandating reporting for at least one disease in 13 of 15 (87%) of responding countries. Domestic financing contributed to funding case reporting systems in 12 of 14 (86%) responding countries. Some form of unique identifier was utilised for 8 of 14 (57%) of responding countries. All 14 responding countries indicated a physical barrier, software barrier, legal barrier, encryption, and/or unique ID being used as a security measure. The majority of case reporting systems were linked to patient monitoring (80%) and laboratory information systems (70%) with a small proportion being linked to CRVS systems (10%). These findings and others are presented in Table 3. Key informants from 13 of 15 responding countries (87%) reported an electronic component in the country’s case reporting system, and 8 of these 13 (62%) countries collect data on individual cases (Figure 1). Eleven of the 13 (85%) responding countries reported that the coverage of the case reporting system exceeded 75% (Figure 1).

Patient monitoring systems

Key informants from 13 of 14 (93%) countries that responded to the patient monitoring systems section of the survey indicated that the Ministry of Health was responsible for patient monitoring. The primary use of patient monitoring data was to monitor service coverage (reported by 12 of 13 countries, 92%); however 8 of 13 (62%) and 10 of 13 (77%) reported using patient monitoring data for service quality improvement and commodity forecasting, respectively. Multilateral (9 of 12 countries, 75%) and bilateral (9 of 12 countries, 75%) financial support was more common for patient monitoring compared to case reporting. Five of 12 countries (42%) of patient monitoring systems used the same system for monitoring in the private and public health sector. Two of 14 (14%) countries used patient monitoring for social health insurance reimbursement. Patient monitoring systems were linked to case reporting (43%) and laboratory information systems (71%), vital statistics (43%), and health insurance systems (14%). These findings and others are presented in Table 4. Key informants from 11 of 12 (92%) responding countries reported an electronic component in the country’s patient monitoring system, and 7 of these 11 (64%) countries

collect data on individual patients (Figure 2). Seven of the 11 (64%) responding countries reported that the coverage of the patient monitoring system exceeded 75% (Figure 1).

CRVS systems

Key informants from 8 of 15 (53%) countries that responded to the CRVS systems section of the survey indicated that the Ministry of Health was responsible for CRVS, in 7 of 15 responding countries (47%) the Ministry of Interior (or similar) was responsible for CRVS, and in 4 of 15 countries (27%) the Ministry of Justice was responsible for CRVS. There were some countries in which multiple Ministries were responsible for CRVS. There was legislation mandating birth and death registration in 13 of 14 (93%) countries. Birth and death data were used to quantify service need (7 of 12 countries, 58%), analyse cost-effectiveness (6 of 12 countries, 50%), measure impact of disease programmes (7 of 12 countries, 58%), and to measure the national burden of disease (10 of 12 countries, 83%). Birth and death registration was required to access government services in all 15 responding countries (100%). These findings and others are presented in Table 5. Key informants from 10 of 13 responding countries (77%) reported an electronic component for birth registration, and 9 of these 10 (90%) countries collect data on individual births (Figure 3). Key informants from 7 of 11 responding countries (64%) reported an electronic component for death registration, and 6 of these 7 (85%) countries collect data on individual deaths (Figure 4). Key informants from 8 of 12 (67%) reported that the country used the tenth revision of the international classification of disease (ICD-10) for reporting the cause of death while 2 of 12 (17%) responding countries indicated that the vital statistics system used verbal autopsy to ascertain the cause of death (Figure 5). Eight of 15 (53%) and seven of 15 (47%) responding countries reported that the coverage of the vital statistics system registering births and deaths, respectively, exceeded 75% (Figures 4 and 5, respectively).

Discussion

Case reporting, patient monitoring, and CRVS systems were widely implemented and used in responding countries. These systems generate critical data for public health planning, budgeting, and action. There was funding for these systems from national budgets, bi-lateral arrangements, and multi-lateral mechanisms, suggesting some level of political commitment for their development and implementation. Many countries also reported use of electronic and individual-level data, suggesting that more granular and accessible data may be available for end-users. Overall, these are encouraging trends which will hopefully continue in order to accelerate progress toward meeting the SDGs. Importantly, these results

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2 331 are indicative of systems interpreted by key informants as meeting the survey definitions and do not speak
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4 332 to the breadth of coverage relative to specific diseases or interoperability.
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8 334 The majority of responding countries had greater than 75% geographic coverage of their case reporting
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10 335 system. Moreover, most responding countries had an electronic component to their system. Electronic
11 336 systems could help store increased volumes of data over time, store more detailed data prospectively, and
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13 337 provide more rapid access to such data compared to paper-based systems [16]. Understanding the number
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15 338 of diagnosed cases of diseases can directly inform programme response to contain transmission [8]. All
16 339 responding countries used case reporting data to achieve this. Future qualitative studies may help
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18 340 understand the ways in which case reporting data are used to contain disease transmission. For example,
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20 341 in Uganda a command centre was created to house an interdisciplinary rapid response team to receive,
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22 342 evaluate, and distribute information as the centre of communication and coordination response operations
23 343 [17]. Many diseases require their own diagnostic commodities as part of national diagnostic algorithms.
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25 344 For example, HIV requires combinations of two or three rapid tests to diagnose each case [18].
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27 345 Approximately half of responding countries used case reporting data for commodity forecasting. As
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29 346 observed with medicines, central procurement, informed by case reporting data, could provide cost
30 347 savings and increase availability of diagnostics at service delivery sites [19].
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34 349 The primary use of data from patient monitoring systems by responding countries was to monitor coverage
35 350 of services. This is likely due to the importance of monitoring the coverage of key health sector
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37 351 interventions for reproductive health, communicable diseases, and national immunisation schedules [5].
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39 352 Countries may also have disease-specific patient monitoring systems. Many countries are embarking on
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41 353 the development of national health insurance schemes as part of universal healthcare coverage [20]. Given
42 354 the wide geographic scale, and use of individual-level electronic data in many settings, there may be an
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44 355 opportunity to leverage these systems for processing claims and co-payments for services rendered [21].
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46 356 Based on this survey, some countries are using the same system for social health insurance while others
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48 357 have linked the patient monitoring system to the health insurance system. Lessons learnt from each of
49 358 these scenarios should be further examined and documented.
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53 360 Overall, more countries reported systems for registering birth events relative to deaths. This is consistent
54 361 with globally available data suggesting that birth registration rates are higher than death registration rates
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56 362 [6]. ICD-10 remains the global norm for classifying the cause of death within the health sector [22]. In

this survey, the majority of responding countries reported use of ICD-10 for classifying the cause of death. Death registration, and methods to ascertain the cause of death, are more heterogeneous in communities. Verbal autopsy has shown promise as an option to incorporate within CRVS systems when medical certification of cause of death is not possible [23] and many countries reported using this approach. Vital statistics were required for a wide range of government services. The most common government service requiring birth registration was school enrolment; this requirement has been shown to be associated with higher coverage of national birth registration rates [24,25]. The most common requirement for death registration was the need for a burial permit. This requirement may also be important in improving national death registration rates [26,27].

There were several cross-cutting issues relevant to case reporting, patient monitoring, and vital statistics systems. For example, there were a range of approaches for identification of people in systems. These included using national identification, health identification, and system-generated identification. Across all systems national identification was used most often. Given the global momentum behind achieving SDG target 16.9, achieving free and universal legal identity by 2030, use of national identification may increase further with time [28]. Security measures to protect data from unauthorised use has emerged as a critical issue in light of the transition to electronic data systems [29]. In this survey, physical barriers, software barriers, legal barriers, encryption, and use of unique identifiers were security measures used. Software and physical barriers were most common, suggesting opportunities for using encryption, legal protection measures, and unique identifiers. Unique identifiers can offer complementary protections by limiting the number of locations, both paper and electronic, where names are used but do have additional risks such as re-identification of an identity from an available data source that uses the same unique identifier. Linking different information systems can provide improved inferences for patients longitudinally over their life course [30]. The majority of case reporting systems were linked to patient monitoring and laboratory information systems with a small proportion being linked to vital statistics. The majority of patient monitoring systems were linked to case reporting and laboratory information systems with a minority linked to vital statistics and health insurance systems. Linking systems with health insurance may have implications on improved data quality since the data will directly affect staff remuneration for services rendered [31].

One of the major limitations of this survey was the low response rate. Specifically, there were limited responses from the Americas, Central Asia, and Eastern Europe. These regions are comprised of middle-

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3 395 income countries that may have a different health information system context. Reducing the number of
4 396 questions and administering the survey later in the year may help improve the number of respondents in
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6 397 the future. We relied on knowledge and experience of participating staff members which may vary from
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8 398 office to office. Although attempts were made to extract missing information, and verify provided
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10 399 information from government counterparts, there were still questions without answers from some
11 400 respondents. This may have been because they had less developed systems or because they did not know
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13 401 the answer at the time they filled the survey. Requiring all questions to be answered could improve our
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15 402 confidence in the final estimates. Moreover, since we conducted this survey electronically, there may have
16 403 been differences in the way questions were interpreted across different key informants. This could have
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18 404 affected their answer selection. For example, linkage could be interpreted as interoperability across
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20 405 different systems or producing summary information for the same location and time while coverage have
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22 406 used health facilities, regions, or other measures as a denominator. Including more definitions in the survey
23 407 tool could establish common terminology during future iterations of this survey. The electronic format of
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25 408 the survey also meant that there were limited opportunities to qualify answers. For example, although we
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27 409 collected information on whether individual or aggregated data was available in electronic systems, we
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29 410 did not describe pathways of data flow. In the future, use cases, success stories, and lessons learnt may be
30 411 based on specific answers during subsequent qualitative interviews of stakeholders. During the
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32 412 implementation of this survey, CDC placed additional field staff in countries through its Division of
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34 413 Global Health Protection. In the future, it may be worth reaching out to key informants in CDC countries
35 414 irrespective of their programme focus to have the widest reach. Some important aspects of health
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37 415 information systems, such as interoperability, standards, and required workforce competencies, were not
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39 416 covered in this survey and may merit further exploration. Since some countries may manage civil
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41 417 registration and vital statistics separately there is potential for confusion from key informants on how to
42 418 respond to questions encompassing CRVS holistically. Finally, evaluating the quality of data generated
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44 419 from systems requires different methods that should be evaluated as part of future assessments.

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47 421 To our knowledge this is the first detailed assessment of national case reporting, patient monitoring, and
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49 422 vital statistics systems. Most responding countries have a solid foundation for policy, planning, legislation,
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51 423 and organisation of health information systems. There are opportunities to link systems, strengthen
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53 424 security measures for electronic data, and use data more effectively. Periodic evaluations may help
54 425 understand progress in strengthening and harmonising these systems over time to achieve the SDGs.
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Table 1. Corresponding health information systems for SDG Goal 3, Ensure healthy lives and promote well-being for all at all ages

Target	SDG Indicator	Contributing Health Information System
3.1: By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births	3.1.1: Maternal mortality ratio	Civil registration and vital statistics
	3.1.2: Proportion of births attended by skilled health personnel	Patient monitoring
3.2: By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births	3.2.1: Under-five mortality rate	Civil registration and vital statistics
	3.2.2: Neonatal mortality rate	Civil registration and vital statistics
3.3: By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases	3.3.1: Number of new HIV infections per 1,000 uninfected population, by sex, age and key populations	Case reporting
	3.3.2: Tuberculosis incidence per 100,000 population	Case reporting
	3.3.3: Malaria incidence per 1,000 population	Case reporting
	3.3.4: Hepatitis B incidence per 100,000 population	Case reporting
	3.3.5: Number of people requiring interventions against neglected tropical diseases	Case reporting
3.4: By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being	3.4.1: Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease	Civil registration and vital statistics
	3.4.2: Suicide mortality rate	Civil registration and vital statistics
3.5: Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol	3.5.1: Coverage of treatment interventions (pharmacological, psychosocial and rehabilitation and aftercare services) for substance use disorders	Patient monitoring
	3.5.2: Harmful use of alcohol, defined according to the national context as alcohol per capita consumption (aged 15 years and older) within a calendar year in litres of pure alcohol	Civil registration and vital statistics (denominator)
3.6: By 2020, halve the number of global deaths and injuries from road traffic accidents	3.6.1: Death rate due to road traffic injuries	Civil registration and vital statistics
3.7: By 2030, ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programmes	3.7.1: Proportion of women of reproductive age (aged 15-49 years) who have their need for family planning satisfied with modern methods	Patient monitoring (numerator), Civil registration and vital statistics (denominator)
	3.7.2: Adolescent birth rate (aged 10-14 years; aged 15-19 years) per 1,000 women in that age group	Civil registration and vital statistics
3.8: Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all	3.8.1: Coverage of essential health services (defined as the average coverage of essential services based on tracer interventions that include reproductive, maternal, newborn and child health, infectious diseases, non-communicable diseases and service capacity and access, among the general and the most disadvantaged population)	Patient monitoring
	3.8.2: Proportion of population with large household expenditures on health as a share of total household expenditure or income	Civil registration and vital statistics (denominator)
3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination	3.9.1: Mortality rate attributed to household and ambient air pollution	Civil registration and vital statistics
	3.9.2: Mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene (exposure to unsafe Water, Sanitation and Hygiene for All (WASH) services)	Civil registration and vital statistics
	3.9.3: Mortality rate attributed to unintentional poisoning	Civil registration and vital statistics
3.a: Strengthen the implementation of the World Health Organization Framework Convention on Tobacco Control in all countries, as appropriate	3.a.1: Age-standardized prevalence of current tobacco use among persons aged 15 years and older	Civil registration and vital statistics (denominator)

3.b: Support the research and development of vaccines and medicines for the communicable and non-communicable diseases that primarily affect developing countries, provide access to affordable essential medicines and vaccines, in accordance with the Doha Declaration on the TRIPS Agreement and Public Health, which affirms the right of developing countries to use to the full the provisions in the Agreement on Trade-Related Aspects of Intellectual Property Rights regarding flexibilities to protect public health, and, in particular, provide access to medicines for all	3.b.1: Proportion of the target population covered by all vaccines included in their national programme	Patient monitoring
	3.b.2: Total net official development assistance to medical research and basic health sectors	N/A
	3.b.3: Proportion of health facilities that have a core set of relevant essential medicines available and affordable on a sustainable basis	N/A
3.c: Substantially increase health financing and the recruitment, development, training and retention of the health workforce in developing countries, especially in least developed countries and small island developing States	3.c.1: Health worker density and distribution	N/A
3.d: Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks	3.d.1: International Health Regulations (IHR) capacity and health emergency preparedness	N/A

Table 2. Human development indicators and World Bank economy classification for responding countries

Country	Life expectancy at birth	Mean years of schooling	Gross national income per capita (\$USD, PPP)	Composite Human Development Index
China	76	7.6	13,345 (Upper-middle income)	0.738
Cote D'Ivoire	51.9	5	3,163 (Lower-middle income)	0.474
Democratic Republic of The Congo	59.1	6.1	680 (Low-income)	0.435
Dominican Republic	73.7	7.7	12,756 (Upper-middle income)	0.722
Ghana	61.5	6.9	3,839 (Lower-middle income)	0.579
Lao People's Democratic Republic	66.6	5.2	5,049 (Lower-middle income)	0.586
Malawi	63.9	4.4	1,073 (Low-income)	0.476
Namibia	65.1	6.7	9,770 (Upper-middle income)	0.64
Nigeria	53.1	6	5,443 (Lower-middle income)	0.527
Papua New Guinea	62.8	4.3	2,712 (Lower-middle income)	0.516
South Africa	57.7	10.3	12,087 (Upper-middle income)	0.666
Thailand	74.6	7.9	14,519 (Upper-middle income)	0.74
United Republic of Tanzania	65.5	5.8	2,467 (Low-income)	0.531
Vietnam	75.9	8	5,335 (Lower-middle income)	0.683
Zambia	60.8	6.9	3,464 (Lower-middle income)	0.579

*PPP, purchasing power parity

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Table 3. Characteristics of case reporting systems by region

	Number responding 'Yes'	Total number of responses	Percentage of countries that responded 'Yes' (%)
Entity is responsible for case reporting	15	15	100
Ministry of Health	14	15	93
National Public Health Institute	1	15	7
Law exists that mandates case reporting for at least one disease	13	15	87
Case reporting data is used in country	15	15	100
Program response	15	15	100
Diagnostics forecasting	8	15	53
Burden of disease estimates	12	15	80
Case reporting system is currently funded	14	15	93
Domestic	12	14	86
Multilateral	10	14	71
Bilateral ¹	9	14	64
Private sector reports newly diagnosed cases of disease using the same system	11	13	85
Case reporting system is linked to other systems	10	14	71
Patient monitoring	8	10	80
Laboratory information system	7	10	70
Vital statistics	1	10	10
Unique identifiers are used for case reporting	8	14	57
National ID	4	7	57
Health ID	1	7	14
System-specific ID	1	7	14
Client demographics	4	7	57
Biometric data	0	7	0
Security measures used for <i>electronic</i> case reporting systems	14	14	100
Physical barrier	8	14	57
Software barrier	13	14	93
Legal barrier	5	14	36
Encryption	4	14	29
Unique ID	3	14	21

Note: Missing or "N/A" responses are excluded from the denominator number of responses. ¹ Bilateral organizations include both government agencies and non-government agencies

Table 4. Characteristics of patient monitoring systems by region

	Number responding 'Yes'	Total number of responses	Percentage of countries that responded 'Yes' (%)
Entity is responsible for patient monitoring	14	15	93
Ministry of Health	13	14	93
National Public Health Institute	1	14	7
Other	1	14	7
Patient monitoring data is used in country	13	14	93
Service coverage calculation	12	13	92
Service quality improvement	8	13	62
Commodity forecasting	10	13	77
Patient monitoring system is currently funded	12	14	86
Domestic	9	12	75
Multilateral	9	12	75
Bilateral ¹	9	12	75
Private	1	12	8
Private sector monitors patients using the same system	5	12	42
Patient monitoring system is used for social health insurance reimbursement	2	14	14
Patient monitoring system is linked to other systems	7	13	54
Case reporting	3	7	43
Laboratory information system	5	7	71
Vital statistics	3	7	43
Health insurance system	1	7	14
Unique identifiers are used for patient monitoring	7	12	58
National ID	1	6	17
Health ID	1	6	17
System-specific ID	2	6	33
Client demographics	3	6	50
Biometric data	0	6	0
Security measures used for electronic patient monitoring systems	11	11	100

Physical barrier	7	11	64
Software barrier	9	11	82
Legal barrier	3	11	27
Encryption	5	11	45
Unique ID	3	11	27

Note: Missing or "N/A" responses are excluded from the denominator number of responses. ¹ Bilateral organizations include both government agencies and non-government agencies

For peer review only

Table 5. Characteristics of CRVS systems by region

	Number responding 'Yes'	Total number of responses	Percentage of countries that responded 'Yes' (%)
An entity is responsible for CRVS	15	15	100
Ministry of Health or similar	8	15	53
Ministry of Interior or similar	7	15	47
Ministry of Justice or similar	4	15	27
Law exists that mandates birth and death registration	13	14	93
Vital statistics data is used in country	13	15	87
To quantify health service need	7	12	58
To analyze cost-effectiveness	6	12	50
To measure impact of disease programs	7	12	58
National burden of disease estimates	10	12	83
Vital statistics system is currently funded	13	14	93
Domestic	11	12	92
Multilateral	2	12	17
Bilateral ¹	6	12	50
Private sector reports birth events using same electronic system	6	9	67
Private sector reports death events using same electronic system	5	10	50
Birth or death registration is required to access government services	15	15	100
Immunizations	9	15	60
Health insurance	10	14	71
School enrollment	14	15	93
Welfare	10	15	67
Legal services	11	15	73
Burials	11	15	73
Inheritance	8	15	53
Life insurance	10	15	67
Unique identifiers are used for vital statistics	5	14	36
National ID	4	5	80
Health ID	0	5	0

System-specific ID	1	5	20
Client demographics	1	5	20
Biometric data	0	5	0
Security measures used for electronic vital statistics system	8	11	73
Physical barrier	6	8	75
Software barrier	6	8	75
Legal barrier	4	8	50
Encryption	1	8	13
Unique ID	2	8	25

Note: Missing or "N/A" responses are excluded from the denominator number of responses. ¹ Bilateral organizations include both government agencies and non-government agencies

Figure 1. Case reporting systems by system type and geographic coverage. Map created with OpenStreetMap images

Figure 2. Patient monitoring systems by system type and geographic coverage. Map created with OpenStreetMap images

Figure 3. Vital statistics systems for registering births by system type and geographic coverage. Map created with OpenStreetMap images

Figure 4. Vital statistics systems for registering deaths by system type and geographic coverage. Map created with OpenStreetMap images

Figure 5. Cause of death classifications in death registration and mortality surveillance. Map created with OpenStreetMap images

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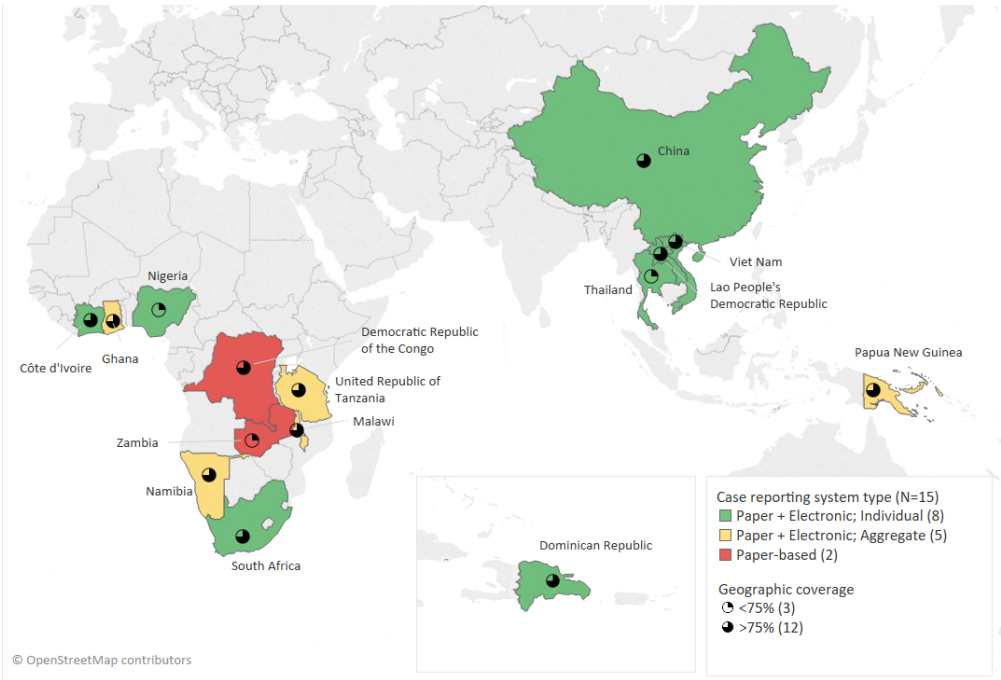
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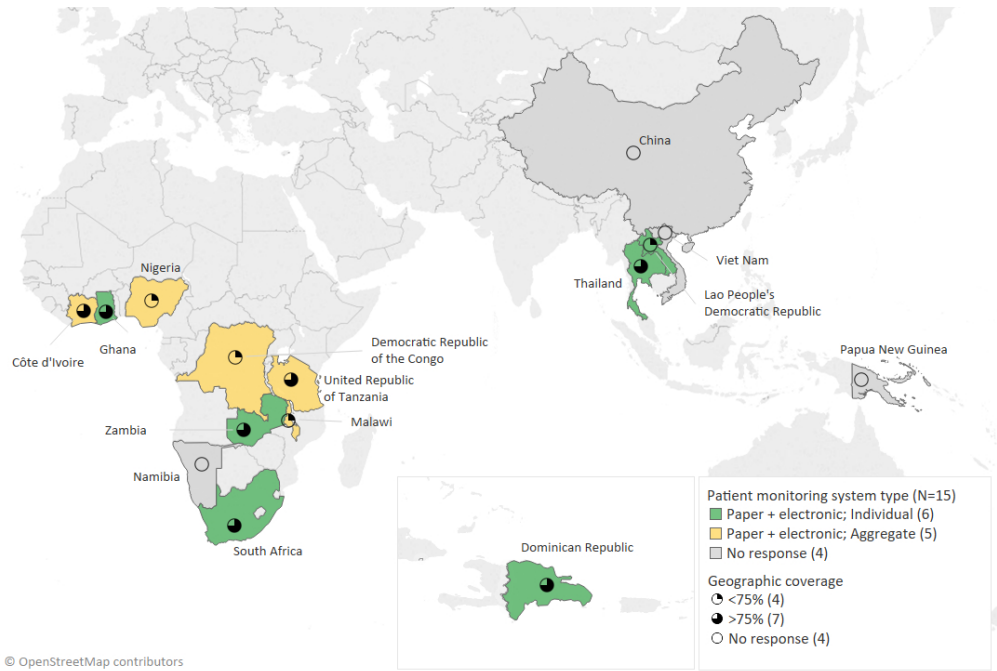
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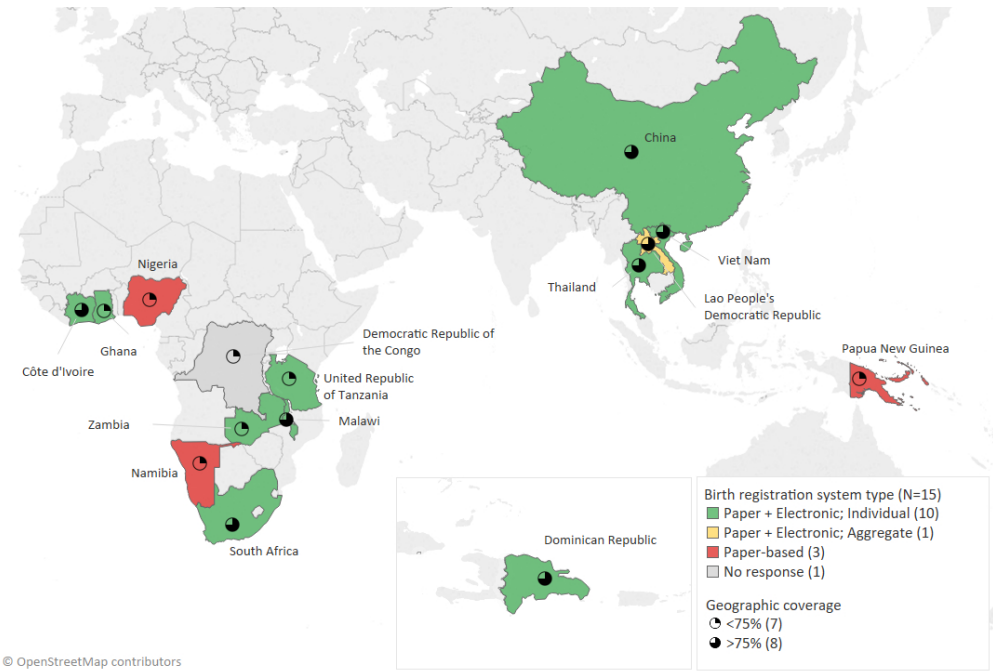
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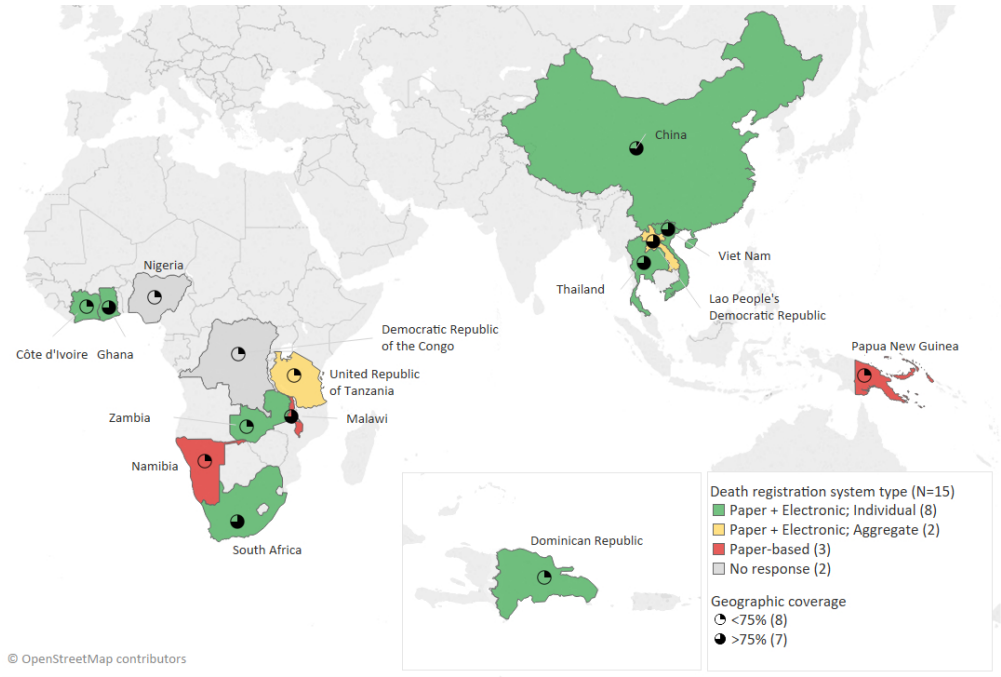
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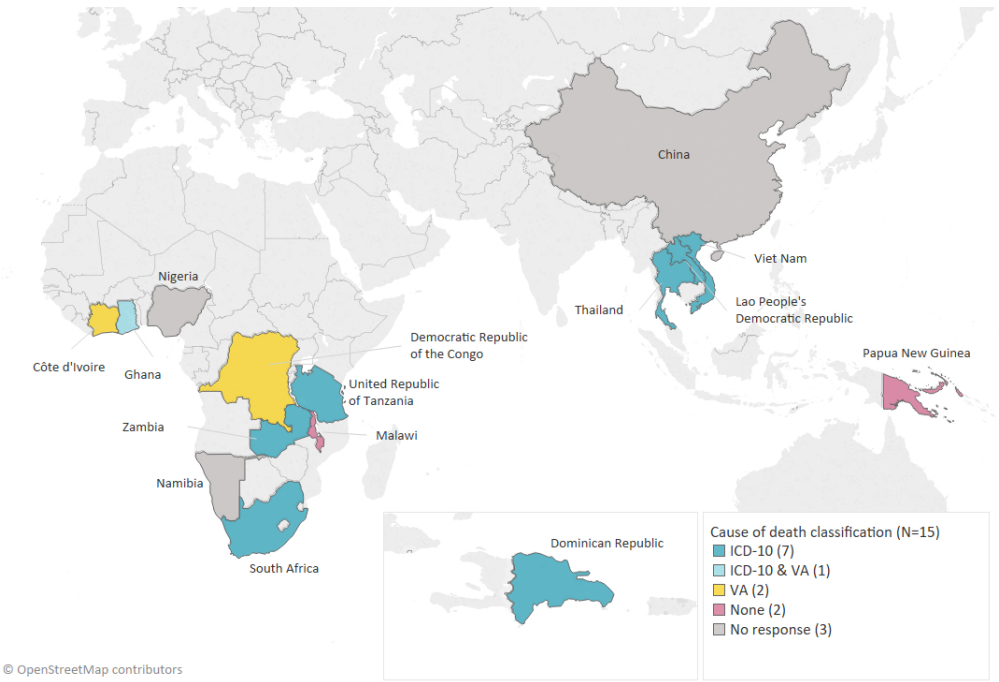
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System A. Case Reporting

Select your country -->

Definition: A functioning case reporting system routinely collects information on diagnosed disease-specific cases. This system can be used to measure the first ninety; number of people living with HIV with known status. These cases may be reported from health facilities or providers to a central level. At subnational and national levels, these data can be used to track epidemics and quantify the burden of disease in order to inform public health programs. For example, some countries may use Integrated Disease Surveillance and Response (IDSR) to track individual and aggregated newly diagnosed cases of disease.

A.1 Policy, Planning, and Legislation: case reporting of all diseases		Complete	Notes/Comments:
A.1.1 Is there an entity responsible for managing the case reporting system for all newly diagnosed cases of disease?	<input type="radio"/> No	X	
	<input type="radio"/> Yes, check all that apply:		
	<input type="checkbox"/> Ministry of Health		
	<input type="checkbox"/> National Public Health Institute		
	<input type="checkbox"/> Another entity, specify:		
A.1.2 Are there laws (or similar policies) in place mandating the reporting of newly diagnosed cases of disease? <i>If yes, please provide a soft copy.</i>	<input type="radio"/> No	X	
	<input type="radio"/> Yes		
	<input type="radio"/> Partially		
A.1.3 Has a strategic plan or other strategic document been developed? <i>If yes, please provide a soft copy.</i>	<input type="radio"/> No	X	
	<input type="radio"/> Yes		
A.1.4 Are data on newly diagnosed cases of disease being used in the country?	<input type="radio"/> No	X	
	<input type="radio"/> Yes, check all that apply:		
	<input type="checkbox"/> National program response		
	<input type="checkbox"/> Subnational program response		
	<input type="checkbox"/> National diagnostics forecasting		
	<input type="checkbox"/> Subnational diagnostics forecasting		
	<input type="checkbox"/> National burden of disease estimation		
	<input type="checkbox"/> Subnational burden of disease estimation		
<input type="checkbox"/> Other use, specify:			
A.1.5 Is there a funding source for the case reporting	<input type="radio"/> No		
	<input type="radio"/> Yes, specify below:		
	<input type="checkbox"/> Domestic		
	<input type="checkbox"/> Global Fund		

system?

☐ PEPFAR☐ Other bilateral, specify☐ Other multilateral, specify☐ Other private, specify

X

A.2 Policy, Planning, and Legislation: HIV case reporting**Complete****Notes/Comments:**

A.2.1 Is there an entity responsible for managing the case reporting system for HIV/AIDS?

☐ No☐ Yes, check all that apply:☐ Ministry of Health☐ National Public Health Institute☐ Another entity, specify:

X

A.2.2 Are there laws (or similar policies) in place mandating the reporting of diagnosed cases of HIV/AIDS? *If yes, please provide a soft copy.*☐ No☐ Yes, check all that apply:☐ The HIV-specific law/policy exists within the general communicable disease reporting policy☐ The HIV-specific law/policy exists independently of the general communicable disease reporting policy

X

A.2.3 Has a strategic plan or other strategic document been developed for the reporting of diagnosed cases of HIV/AIDS? *If yes, please provide a soft copy.*☐ No☐ Yes, check all that apply:☐ The HIV case reporting strategic plan exists within the strategic plan for general case reporting of communicable diseases☐ The HIV case reporting strategic plan exists independently of the strategic plan for general case reporting of communicable diseases

X

A.2.4 Are HIV case reporting data being used in the country?

☐ No☐ Yes, check all that apply:☐ National HIV program response☐ Subnational HIV program response☐ National HIV diagnostics forecasting☐ Subnational HIV diagnostics forecasting

X

	<input type="checkbox"/> National burden of HIV estimation		
	<input type="checkbox"/> Subnational burden of HIV estimation		
	<input type="checkbox"/> Other use, specify:		
	<input type="radio"/> No		
	<input type="radio"/> Yes, specify below:		
	<input type="checkbox"/> Domestic		
A.2.5 Is there a funding source for the HIV case reporting system?	<input type="checkbox"/> Global Fund	X	
	<input type="checkbox"/> PEPFAR		
	<input type="checkbox"/> Other bilateral, specify		
	<input type="checkbox"/> Other multilateral, specify		
	<input type="checkbox"/> Other private, specify		
A.3 System Organization: General case reporting for all diseases		Complete	Notes/Comments:
	<input type="radio"/> N/A		
	<input type="radio"/> 1% - 25%		
	<input type="radio"/> 26% - 50%		
A.3.1 What is the approximate geographic coverage of the case reporting system	<input type="radio"/> 51% - 75%	X	
	<input type="radio"/> 76% - 100%		
	If geographic coverage is above 0%, specify if:		
	<input type="checkbox"/> Reporting is in urban areas		
	<input type="checkbox"/> Reporting is in rural areas		
	<input type="checkbox"/> Reporting is in both urban and rural areas		
	<input type="radio"/> N/A		
A.3.2 What is the lowest level at which data are collected on newly diagnosed cases of disease?	<input type="radio"/> National	X	
	<input type="radio"/> Subnational level 1		
	<input type="radio"/> Subnational level 2		
	<input type="radio"/> Subnational level 3		
	<input type="radio"/> N/A		
	<input type="radio"/> No		

A.3.3 Are data on newly diagnosed cases of disease linked to other systems?

☐ Yes, check all systems that are linked:

☐ Patient monitoring system

☐ Laboratory information system

☐ Vital statistics system

☐ Other, specify:

X

A.3.4 Does the private sector report newly diagnosed cases of disease using the same system?

☐ N/A

☐ No

☐ Yes

☐ Partially

X

If yes or partially, check all that apply:

☐ Private sector reports through the same paper-based system

☐ Private sector reports through the same electronic system

A.3.5 Does the case reporting system use a unique identifier?

☐ N/A

☐ No

☐ Yes, check all that apply:

☐ The unique identifier is the National ID

☐ The unique identifier is the Health ID

☐ The unique identifier is system-specific

☐ The unique identifier is created from client demographics (e.g. algorithm)

☐ The unique identifier is linked to biometric data

X

A.3.6 Is an electronic system used for case reporting in any area of the country?

☐ N/A

☐ No

☐ Yes, check all that apply:

☐ Electronic system is in urban areas

☐ Electronic system is in rural areas

☐ Electronic system is in urban and rural areas

X

A.3.7 What is the lowest level at which data on new cases of disease are collected through electronic systems?	<input type="radio"/> N/A	X	
	<input type="radio"/> National		
	<input type="radio"/> Subnational level 1		
	<input type="radio"/> Subnational level 2		
	<input type="radio"/> Subnational level 3		
A.3.8 What is the approximate electronic coverage of the case reporting system across all health facilities?	<input type="radio"/> N/A	X	
	<input type="radio"/> 1% - 25%		
	<input type="radio"/> 26% - 50%		
	<input type="radio"/> 51% - 75%		
	<input type="radio"/> 76% - 100%		
A.3.9 Does the electronic system capture data at the individual or aggregate level?	<input type="radio"/> N/A	X	
	<input type="radio"/> Individual		
	<input type="radio"/> Aggregate		
	<input type="radio"/> Both individual and aggregate		
A.3.10 Are security measures in place for the electronic case reporting system?	<input type="radio"/> N/A	X	
	<input type="radio"/> No		
	<input type="radio"/> Yes, check all security measures that apply:		
	<input type="checkbox"/> Physical barrier		
	<input type="checkbox"/> Software barrier		
	<input type="checkbox"/> Legal barrier		
	<input type="checkbox"/> Encryption		
	<input type="checkbox"/> Unique identifier		
A.4 System Organization: HIV case reporting		Complete	Notes/Comments:
A.4.1 What is the approximate geographic coverage of the HIV case reporting system	<input type="radio"/> N/A	X	
	<input type="radio"/> 1% - 25%		
	<input type="radio"/> 26% - 50%		
	<input type="radio"/> 51% - 75%		
	<input type="radio"/> 76% - 100%		

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2		If geographic coverage is above 0%, specify if:	
3		<input type="checkbox"/> HIV case reporting is in urban areas	
4		<input type="checkbox"/> HIV case reporting is in rural areas	
5		<input type="checkbox"/> HIV case reporting is in urban and rural areas	
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7			
8		<input type="radio"/> N/A	
9		<input type="radio"/> National	
10	A.4.2 What is the lowest level at which data are collected	<input type="radio"/> Subnational level 1	X
11	on newly diagnosed HIV cases?	<input type="radio"/> Subnational level 2	
12		<input type="radio"/> Subnational level 3	
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15		<input type="radio"/> N/A	
16		<input type="radio"/> No	
17		<input type="radio"/> Yes, check all linked systems that apply:	
18	A.4.3 Are data on newly diagnosed HIV cases linked to	<input type="checkbox"/> Patient monitoring system	X
19	other systems?	<input type="checkbox"/> Laboratory information system	
20		<input type="checkbox"/> Vital statistics system	
21		<input type="checkbox"/> Other, specify:	
22			
23			
24			
25			
26		<input type="radio"/> N/A	
27		<input type="radio"/> No	
28		<input type="radio"/> Yes	
29		<input type="radio"/> Partially	
30	A.4.4 Does the private sector report on newly diagnosed		X
31	HIV cases through this system?	If yes or partially, check all that apply:	
32		<input type="checkbox"/> Any portion of the private sector reports through the paper-based system	
33		<input type="checkbox"/> Any portion of the private sector reports through the electronic system	
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38		<input type="radio"/> N/A	
39		<input type="radio"/> No	
40		<input type="radio"/> Yes, check all that apply:	
41	A.4.5 Is an electronic system used for HIV case reporting	<input type="checkbox"/> Electronic system is in urban areas only	X
42	in any area of the country?		
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2		<input type="checkbox"/> Electronic system is in rural areas only	
3		<input type="checkbox"/> Electronic system is in urban and rural areas	
4			
5	A.4.6 What is the lowest level at which data on new HIV cases are collected through electronic systems?	<input type="radio"/> N/A	X
6		<input type="radio"/> National	
7		<input type="radio"/> Subnational level 1	
8		<input type="radio"/> Subnational level 2	
9		<input type="radio"/> Subnational level 3	
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12	A.4.7 What is the approximate electronic coverage of the HIV case reporting system across all health facilities?	<input type="radio"/> N/A	X
13		<input type="radio"/> 1% - 25%	
14		<input type="radio"/> 26% - 50%	
15		<input type="radio"/> 51% - 75%	
16		<input type="radio"/> 75% - 100%	
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18			
19			
20	A.4.8 Does the electronic HIV case reporting system capture data at the individual or aggregate level?	<input type="radio"/> N/A	X
21		<input type="radio"/> Individual	
22		<input type="radio"/> Aggregate	
23		<input type="radio"/> Both individual and aggregate	
24			
25			
26	A.4.9 Are security measures in place for the electronic HIV case reporting system?	<input type="radio"/> N/A	X
27		<input type="radio"/> No	
28		<input type="radio"/> Yes, check all security measures that apply:	
29		<input type="checkbox"/> Physical barrier	
30		<input type="checkbox"/> Software barrier	
31		<input type="checkbox"/> Legal barrier	
32		<input type="checkbox"/> Encryption	
33		<input type="checkbox"/> Unique identifier	
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System B. Patient Monitoring

Definition: Patient monitoring systems collect routine data from health facilities related to clinical patient management. In HIV programming, patient monitoring systems are useful in measuring the second and third nineties as they capture program indicators such as service use, patient retention and treatment outcomes. Patient monitoring systems are often used to improve quality of services across various service areas. Data are often used to assess the health sector response from the facility to the national level.

B.1 Policy, Planning, and Legislation: Patient monitoring system for all diseases

Complete

Notes/Comments:

B.1.1 Is there an entity responsible for managing the patient monitoring system for all diseases?

☐ No

☐ Yes, check all entities that apply:

☐ Ministry of Health

☐ National Public Health Institute

☐ Another entity, specify:

X

B.1.2 Has a strategic plan or other strategic document been developed? *If yes, please provide a soft copy.*

☐ No

☐ Yes

X

B.1.3 Are patient monitoring data being used in the country?

☐ No

☐ Yes, check all that apply:

☐ National service coverage calculation

☐ Subnational service coverage calculation

☐ National quality of services improvement

☐ Subnational quality of services improvement

☐ National commodity forecasting

☐ Subnational commodity forecasting

☐ Other use, specify:

X

B.1.4 Is there a funding source for the patient monitoring system?

☐ No

☐ Yes, specify below:

☐ Domestic

☐ Global Fund

☐ PEPFAR

☐ Other bilateral, specify

☐ Other multilateral, specify

X

	<input type="checkbox"/> Other private, specify		
	<input type="radio"/> No		
	<input type="radio"/> Yes		
B.1.5 Is the patient monitoring system used for social health insurance reimbursement?	<input type="radio"/> No, but other system is used (specify:)	X	
B.2 Policy, Planning, and Legislation: HIV Patient monitoring system		Complete	Notes/Comments:
	<input type="radio"/> No		
	<input type="radio"/> Yes, check all that apply:		
B.2.1 Is there an entity responsible for managing the patient monitoring system for HIV/AIDS?	<input type="checkbox"/> Ministry of Health	X	
	<input type="checkbox"/> National Public Health Institute		
	<input type="checkbox"/> Another entity, specify:		
	<input type="radio"/> No		
	<input type="radio"/> Yes, check all that apply:		
B.2.2 Has a strategic plan or other strategic document been developed for HIV patient monitoring? If yes, please provide a soft copy.	<input type="checkbox"/> The HIV patient monitoring plan exists within larger patient monitoring system strategy document	X	
	<input type="checkbox"/> The HIV patient monitoring plan exists independent of the larger patient monitoring system strategy document		
	<input type="radio"/> No		
	<input type="radio"/> Yes, check all that apply:		
B.2.3 Are HIV patient monitoring data being used in the country?	<input type="checkbox"/> National HIV service coverage calculation	X	
	<input type="checkbox"/> Subnational HIV service coverage calculation		
	<input type="checkbox"/> National quality of service improvement		
	<input type="checkbox"/> Subnational quality of service improvement		
	<input type="checkbox"/> National HIV commodity forecasting		
	<input type="checkbox"/> Subnational HIV commodity forecasting		
	<input type="checkbox"/> Other use, specify:		
	<input type="radio"/> No		

B.2.4 Is there a funding source for the HIV patient monitoring system?

- ☐ Yes, specify below:
- ☐ Domestic
- ☐ Global Fund
- ☐ PEPFAR
- ☐ Other bilateral, specify below
- ☐ Other multilateral, specify below
- ☐ Other private, specify below

X

B.3 System Organization: Patient monitoring system for all diseases

Complete

Notes/Comments:

B.3.1 What is the approximate geographic coverage of the patient monitoring system?

- ☐ N/A
- ☐ 1% - 25%
- ☐ 26% - 50%
- ☐ 51% - 75%
- ☐ 76% - 100%
- If geographic coverage is > 0%, specify if:
- ☐ Patient monitoring is in urban areas
- ☐ Patient monitoring is in rural areas
- ☐ Patient monitoring is in urban and rural areas

X

B.3.2 What is the lowest level at which patient data are collected?

- ☐ N/A
- ☐ National
- ☐ Subnational level 1
- ☐ Subnational level 2
- ☐ Subnational level 3

X

B.3.3 Are patient data linked to other systems?

- ☐ N/A
- ☐ No
- ☐ Yes, check all linked systems that
- ☐ Case reporting system
- ☐ Laboratory information system
- ☐ Vital statistics system
- ☐ Health insurance system(s)

X

	<input type="checkbox"/> Other, specify:	
B.3.4 Does the private sector monitor patients using the same system?	<div><div><input type="radio"/> N/A</div><div><input type="radio"/> No</div><div><input type="radio"/> Yes</div><div><input type="radio"/> Partially</div></div> <div>If yes or partially, check all that apply:<div><div><input type="checkbox"/> Any portion of the private sector monitors patients through the same paper-based system</div><div><input type="checkbox"/> Any portion of the private sector monitors patients through the same electronic system</div></div></div>	X
B.3.5 Does the patient monitoring system use a unique identifier?	<div><div><input type="radio"/> N/A</div><div><input type="radio"/> No</div><div><input type="radio"/> Yes, check all that apply:<div><div><input type="checkbox"/> The unique identifier is the National ID</div><div><input type="checkbox"/> The unique identifier is the Health ID</div><div><input type="checkbox"/> The unique identifier is system-specific</div><div><input type="checkbox"/> The unique identifier is created from client demographics (e.g. algorithm)</div><div><input type="checkbox"/> The unique identifier is linked to biometric data</div></div></div></div>	

	<input type="radio"/> Subnational level 3		
B.3.8 What is the approximate electronic coverage of the patient monitoring system across all health facilities?	<input type="radio"/> N/A	X	
	<input type="radio"/> 1% - 25%		
	<input type="radio"/> 26% - 50%		
	<input type="radio"/> 51% - 75%		
	<input type="radio"/> 76% - 100%		
B.3.9 Does the electronic system capture patient data at the individual or aggregate level?	<input type="radio"/> N/A	X	
	<input type="radio"/> Individual		
	<input type="radio"/> Aggregate		
	<input type="radio"/> Both individual and aggregate		
B.3.10 Are security measures in place for the electronic patient monitoring system?	<input type="radio"/> N/A	X	
	<input type="radio"/> No		
	<input type="radio"/> Yes, check all security measures that apply:		
	<input type="checkbox"/> Physical barrier		
	<input type="checkbox"/> Software barrier		
	<input type="checkbox"/> Legal barrier		
	<input type="checkbox"/> Encryption		
	<input type="checkbox"/> Unique identifier		
B.4 System Organization: HIV Patient monitoring system		Complete	Notes/Comments:
B.4.1 What is the approximate geographic coverage of the HIV patient monitoring system?	<input type="radio"/> N/A	X	
	<input type="radio"/> 1% - 25%		
	<input type="radio"/> 26% - 50%		
	<input type="radio"/> 51% - 75%		
	<input type="radio"/> 76% - 100%		
	If geographic coverage is > 0%, specify if:		
	<input type="checkbox"/> HIV patient monitoring is in urban areas		
	<input type="checkbox"/> HIV patient monitoring is in rural areas		
	<input type="checkbox"/> HIV patient monitoring is in urban and rural areas		

B.4.2 What is the lowest level at which HIV patient data are collected?	<div><input type="radio"/> N/A</div> <div><input type="radio"/> National</div> <div><input type="radio"/> Subnational level 1</div> <div><input type="radio"/> Subnational level 2</div> <div><input type="radio"/> Subnational level 3</div>	X	
B.4.3 Are HIV patient data linked to other systems?	<div><input type="radio"/> N/A</div> <div><input type="radio"/> No</div> <div><input type="radio"/> Yes, check all linked systems:</div> <div><input type="checkbox"/> Case reporting system</div> <div><input type="checkbox"/> Laboratory information system</div> <div><input type="checkbox"/> Vital statistics system</div> <div><input type="checkbox"/> Health insurance system(s)</div> <div><input type="checkbox"/> Other, specify:</div>	X	
B.4.4 Does the private sector monitor HIV patients using the same system?	<div><input type="radio"/> N/A</div> <div><input type="radio"/> No</div> <div><input type="radio"/> Yes</div> <div><input type="radio"/> Partially</div> <div>If yes or partially, check all that apply:</div> <div><input type="checkbox"/> Any portion of the private sector monitors HIV patients using the same paper-based system</div> <div><input type="checkbox"/> Any portion of the private sector monitors HIV patients using the same electronic system</div>	X	
B.4.5 Is an electronic system used for HIV patient monitoring in any area of the country?	<div><input type="radio"/> N/A</div> <div><input type="radio"/> No</div> <div><input type="radio"/> Yes, check all that apply:</div> <div><input type="checkbox"/> Electronic system is in urban areas</div> <div><input type="checkbox"/> Electronic system is in rural areas</div> <div><input type="checkbox"/> Electronic system is in urban and rural areas</div>	X	

B.4.6 What is the lowest level at which HIV patient data are collected through electronic systems?	<input type="radio"/> N/A	X	
	<input type="radio"/> National		
	<input type="radio"/> Subnational level 1		
	<input type="radio"/> Subnational level 2		
	<input type="radio"/> Subnational level 3		
B.4.7 What is the approximate electronic coverage of the HIV patient monitoring system across all health facilities?	<input type="radio"/> N/A	X	
	<input type="radio"/> 1% - 25%		
	<input type="radio"/> 26% - 50%		
	<input type="radio"/> 51% - 75%		
	<input type="radio"/> 76% - 100%		
B.4.8 Does the electronic system capture HIV patient data at the individual or aggregate level?	<input type="radio"/> N/A	X	
	<input type="radio"/> Individual		
	<input type="radio"/> Aggregate		
	<input type="radio"/> Both individual and aggregate		
B.4.9 Are security measures in place for the electronic HIV patient monitoring system?	<input type="radio"/> N/A	X	
	<input type="radio"/> No		
	<input type="radio"/> Yes, check all security measures that apply:		
	<input type="checkbox"/> Physical barrier		
	<input type="checkbox"/> Software barrier		
	<input type="checkbox"/> Legal barrier		
	<input type="checkbox"/> Encryption		
	<input type="checkbox"/> Unique identifier		

1	HIV?	<input type="checkbox"/> Measure impact of HIV programs	X	
2		<input type="checkbox"/> National burden of HIV estimation		
3		<input type="checkbox"/> Subnational burden of HIV estimation		
4		<input type="checkbox"/> Other use, specify:		
5				
6				
7				
8	C.1.6 Is there a funding source for CRVS system development?	<input type="radio"/> No	X	
9		<input type="radio"/> Yes, specify below:		
10		<input type="checkbox"/> Domestic		
11		<input type="checkbox"/> Global Financing Fund		
12		<input type="checkbox"/> PEPFAR		
13		<input type="checkbox"/> Gates Foundation		
14		<input type="checkbox"/> Bloomberg Data for Health		
15		<input type="checkbox"/> Other bilateral, specify		
16		<input type="checkbox"/> Other multilateral, specify		
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18				
19				
20				
21	C.1.7 Is proof of birth or death registration required for any government services? (e.g. birth or death certificate)	<input type="radio"/> No	X	
22		<input type="radio"/> Yes, specify below:		
23		<input type="checkbox"/> Immunization		
24		<input type="checkbox"/> Health insurance		
25		<input type="checkbox"/> School enrollment		
26		<input type="checkbox"/> Welfare		
27		<input type="checkbox"/> Legal services		
28		<input type="checkbox"/> Burial		
29		<input type="checkbox"/> Inheritance		
30		<input type="checkbox"/> Life insurance		
31		<input type="checkbox"/> Other service, specify:		
32				
33				
34				
35				
36	C.2 System organization		Complete	Notes/Comments:
37	C.2.1 Which vital events are registered?	<input type="radio"/> N/A	X	
38		<input type="radio"/> Births		
39		<input type="radio"/> Deaths		
40		<input type="radio"/> Both births and deaths		
41				
42				
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C.2.2 Does the CRVS system use a unique identifier?	<div><div><input type="radio"/> N/A</div><div><input type="radio"/> No</div><div><input type="radio"/> Yes, check all that apply:<div><div><input type="checkbox"/> The unique identifier is the National ID</div><div><input type="checkbox"/> The unique identifier is the Health ID</div><div><input type="checkbox"/> The unique identifier is system-specific</div><div><input type="checkbox"/> The unique identifier is created from client demographics (e.g. algorithm)</div><div><input type="checkbox"/> The unique identifier is linked to biometric data</div></div></div></div>	X	
C.2.3 Are security measures in place for the CRVS system?	<div><div><input type="radio"/> N/A</div><div><input type="radio"/> No</div><div><input type="radio"/> Yes, check all that apply:<div><div><input type="checkbox"/> Physical barrier</div><div><input type="checkbox"/> Software barrier</div><div><input type="checkbox"/> Legal barrier</div><div><input type="checkbox"/> Encryption</div><div><input type="checkbox"/> Unique identifier</div></div></div></div>	X	
C.3 System organization for <u>birth</u> registration		Complete	Notes/Comments:
C.3.1 What is the approximate geographic coverage of birth registration?	<div><div><input type="radio"/> N/A</div><div><input type="radio"/> 1% - 25%</div><div><input type="radio"/> 26% - 50%</div><div><input type="radio"/> 51% - 75%</div><div><input type="radio"/> 76% - 100%</div><div>If geographic coverage is > 0%, specify if:<div><div><input type="checkbox"/> Birth registration is in urban areas</div><div><input type="checkbox"/> Birth registration is in rural areas</div><div><input type="checkbox"/> Birth registration is in urban and rural areas</div></div></div></div>	X	
C.3.2 What is the approximate population coverage of birth registration?	<div><div><input type="radio"/> N/A</div><div><input type="radio"/> National</div></div>		

C.3.2 What is the **lowest** level at which birth events are registered?

☐ Subnational level 1

☐ Subnational level 2

☐ Subnational level 3

X

C.3.3 Are data on birth events linked to other systems?

☐ N/A

☐ No

☐ Yes, check all linked systems:

☐ Case reporting system

☐ Patient monitoring system

☐ Health insurance system

☐ Legal system/policing

☐ Voter registration system

☐ National ID

☐ Other, specify:

X

C.3.4 Is an electronic system used for registering births in any area of the country?

☐ N/A

☐ No

☐ Yes, check all that apply:

☐ Electronic system is in urban areas

☐ Electronic system is in rural areas

☐ Electronic system is in urban and rural areas

X

C.3.5 What is the **lowest** level at which birth events are registered through electronic systems?

☐ N/A

☐ National

☐ Subnational level 1

☐ Subnational level 2

☐ Subnational level 3

X

C.3.6 What is the approximate electronic coverage of the birth registration system across all health facilities and/or registrar offices?

☐ N/A

☐ 1% - 25%

☐ 26% - 50%

☐ 51% - 75%

X

	<input type="radio"/> 76% - 100%			
C.3.7 Does the electronic system capture birth events at the individual or aggregate level?	<input type="radio"/> N/A	X		
	<input type="radio"/> Individual			
	<input type="radio"/> Aggregate			
	<input type="radio"/> Both individual and aggregate			
C.3.8 Does the private sector report birth events using the same electronic system?	<input type="radio"/> N/A	X		
	<input type="radio"/> No			
	<input type="radio"/> Yes			
	<input type="radio"/> Some			
C.4 System Organization for <u>death</u> registration		Complete	Notes/Comments:	
C.4.1 What is the approximate geographic coverage of death registration?	<input type="radio"/> N/A	X		
	<input type="radio"/> 1% - 25%			
	<input type="radio"/> 26% - 50%			
	<input type="radio"/> 51% - 75%			
	<input type="radio"/> 76% - 100%			
	If geographic coverage is > 0%, specify if:			
	<input type="checkbox"/> Death registration is in urban areas			
	<input type="checkbox"/> Death registration is in rural areas			
C.4.2 What is the lowest level at which death events are collected?	<input type="checkbox"/> Death registration is in urban and rural areas	X		
	<input type="radio"/> N/A			
	<input type="radio"/> National			
	<input type="radio"/> Subnational level 1			
	<input type="radio"/> Subnational level 2			
	<input type="radio"/> Subnational level 3			
	<input type="radio"/> N/A			
	<input type="radio"/> No			
	<input type="radio"/> Yes, check all linked systems:			
	<input type="checkbox"/> Case reporting system			

C.4.3 Are data on death events linked to other systems?

- ☐ Patient monitoring system
- ☐ Health insurance system
- ☐ Legal system/policing
- ☐ Voter registration
- ☐ National ID
- ☐ Other, specify:

X

C.4.4 Is an electronic system used for registering deaths in any area of the country?

- ☐ N/A
- ☐ No
- ☐ Yes
- ☐ Electronic system is in urban areas
- ☐ Electronic system is in rural areas
- ☐ Electronic system is in urban and rural areas

X

C.4.5 What is the **lowest** level at which deaths are registered through electronic systems?

- ☐ N/A
- ☐ National
- ☐ Subnational level 1
- ☐ Subnational level 2
- ☐ Subnational level 3

X

C.4.6 What is the approximate electronic coverage of the death registration system across all health facilities or registrar offices?

- ☐ N/A
- ☐ 1% - 25%
- ☐ 26% - 50%
- ☐ 51% - 75%
- ☐ 76% - 100%

X

C.4.7 Does the electronic system capture death events at the individual or aggregate level?

- ☐ N/A
- ☐ Individual
- ☐ Aggregate
- ☐ Both individual and aggregate

X

C.4.8 Does the private sector report death events using

- ☐ N/A
- ☐ No

y

1				
2	the same electronic system?	<input type="radio"/> Yes	^	
3		<input type="radio"/> Some		
4				
5	C.5 Cause of death information		Complete	Notes/Comments:
6		<input type="radio"/> N/A	X	
7		<input type="radio"/> No		
8		<input type="radio"/> Yes, check all methods used to ascertain cause of death		
9		<input type="checkbox"/> Verbal autopsy		
10	C.5.1 Are sentinel surveillance approaches used to measure cause of death? (e.g. alternative methods for cause-specific mortality surveillance)	<input type="checkbox"/> Minimally invasive autopsy		
11		<input type="checkbox"/> Full autopsy		
12		<input type="checkbox"/> Hospital-based system		
13		<input type="checkbox"/> Other ascertainment method, specify:		
14				
15				
16				
17				
18				
19		<input type="radio"/> N/A	X	
20		<input type="radio"/> No		
21		<input type="radio"/> Yes, check all methods that apply:		
22		<input type="checkbox"/> ICD-10		
23	C.5.2 Do these sentinel surveillance approaches utilize a method of classification to report cause of death?	<input type="checkbox"/> Verbal autopsy - InterVA		
24		<input type="checkbox"/> Verbal autopsy - Tarrif2		
25		<input type="checkbox"/> Verbal autopsy - SmartVA		
26		<input type="checkbox"/> Other classification method, specify:		
27				
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30				
31		<input type="radio"/> N/A	X	
32		<input type="radio"/> No		
33		<input type="radio"/> Yes, check all methods used to ascertain cause of		
34		<input type="checkbox"/> Verbal autopsy		
35	C.5.3 Does the vital statistics system collate cause of death information?	<input type="checkbox"/> Minimally invasive autopsy		
36		<input type="checkbox"/> Full autopsy		
37		<input type="checkbox"/> Hospital-based system		
38		<input type="checkbox"/> Other ascertainment method, specify:		
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C.5.4 Does the vital statistics **system** utilize a method of classification to report cause of death?

- ☐ N/A
- ☐ No
- ☐ Yes, select all methods that apply:
- ☐ ICD-10
- ☐ Verbal autopsy - InterVA
- ☐ Verbal autopsy - Tarrif2
- ☐ Verbal autopsy - SmartVA
- ☐ Other classification method, specify:

X

C.5.5 What is the **lowest** level at which cause of death is collated in the system?

- ☐ N/A
- ☐ National
- ☐ Subnational level 1
- ☐ Subnational level 2
- ☐ Subnational level 3

X

Country	Contacted	Provided response with government concurrence
Brazil	Yes	
Angola	Yes	
Barbados	Yes	
Botswana	Yes	
Burundi	Yes	
Cambodia	Yes	
Cameroon	Yes	
China	Yes	Yes
Cote d'Ivoire	Yes	Yes
Dem Rep of the Congo	Yes	Yes
Dominican Republic	Yes	Yes
El Salvador	Yes	
Ethiopia	Yes	
Ghana	Yes	Yes
Guatemala	Yes	
Guyana	Yes	
Haiti	Yes	
Honduras	Yes	
India	Yes	
Indonesia	Yes	
Jamaica	Yes	
Kazakhstan	Yes	
Kenya	Yes	
Krygyzstan	Yes	
Laos	Yes	Yes
Lesotho	Yes	
Malawi	Yes	Yes
Mali	Yes	
Mozambique	Yes	
Myanmar	Yes	
Namibia	Yes	Yes
Nicaragua	Yes	
Nigeria	Yes	Yes
Panama	Yes	
Papua New Guinea	Yes	Yes
Rwanda	Yes	
Senegal	Yes	
Sierra Leone	Yes	
South Africa	Yes	Yes
South Sudan	Yes	
Suriname	Yes	
Swaziland	Yes	
Tajikstan	Yes	
Tanzania	Yes	Yes
Thailand	Yes	Yes
Trinidad and Tobago	Yes	
Uganda	Yes	
Ukraine	Yes	
Vietnam	Yes	Yes
Zambia	Yes	Yes
Zimbabwe	Yes	

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (Page 1, Line 2)
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found (Page 5, Lines 137-153)
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported (Pages 8-9, Lines 182-205)
Objectives	3	State specific objectives, including any prespecified hypotheses (Page 9, lines 204-205)
Methods		
Study design	4	Present key elements of study design early in the paper (Page 9, lines 209-217)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection (Page 10, lines 237-245)
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants (Page 10, lines 237-242)
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable (Page 9, lines 220-234 and annex)
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group (Full survey provided in annex)
Bias	9	Describe any efforts to address potential sources of bias (Page 10, lines 240-245)
Study size	10	Explain how the study size was arrived at (Page 10, Lines 237-238 and Table S4)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why (Page 10, Lines 251-253 and lines 256-258 and annex)
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses Analytical methods described on page 10, lines 248-255. Since our unit of measure was a country, there were limited formal statistical analyses possible.
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (Table 1) (b) Give reasons for non-participation at each stage (Annex includes non-respondents) (c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (Table 2) (b) Indicate number of participants with missing data for each variable of interest (Tables 3-5)
Outcome data	15*	Report numbers of outcome events or summary measures (Tables 3-5)

Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(b) Report category boundaries when continuous variables were categorized
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
		Results described fully on pages 11-12, lines 274-321)
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives (Pages 12-14, Lines 324-391)
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias (Pages 14-15, Lines 393-419)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence (Page 15, lines 422-424)
Generalisability	21	Discuss the generalisability (external validity) of the study results (Page 7, lines 169-170)
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based (Page 4, Lines 100-103)

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.