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& INITIATIVES CONTRE LE SIDA

# Health Information Systems for HIV in very poor Countries

## Experience of french NGO Solthis

Grégoire Lurton

Solthis

March 2012

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# Solthis Factsheet

- Created in 2003 in Hôpital Pitié Salpétrière by Pr Christine Katlama, Pr Brigitte Autran, Pr Patrice Debré & Pr Gilles Brucker.
- 5 missions in Africa + Headquarter in Paris.
- 94 employees (37 technical staff, 57 support staff).
- Budget 2011 - 3 450 000€from Bettencourt Schueller Foundation (80%), GFATM, Mairie de Paris.

# Health System Strengthening for HIV

Five main axis of intervention

1. Political coordinating bodies
2. Medical Workforce
3. Health Information System
4. Pharmaceutical System
5. Laboratories

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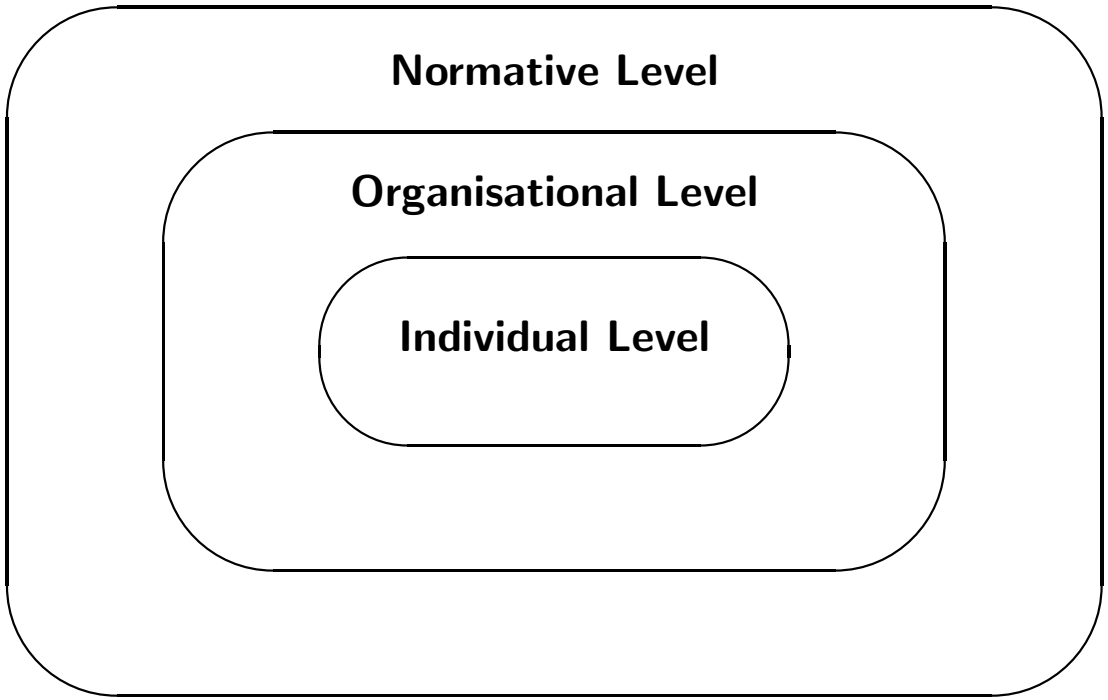
# Health System Strengthening for HIV

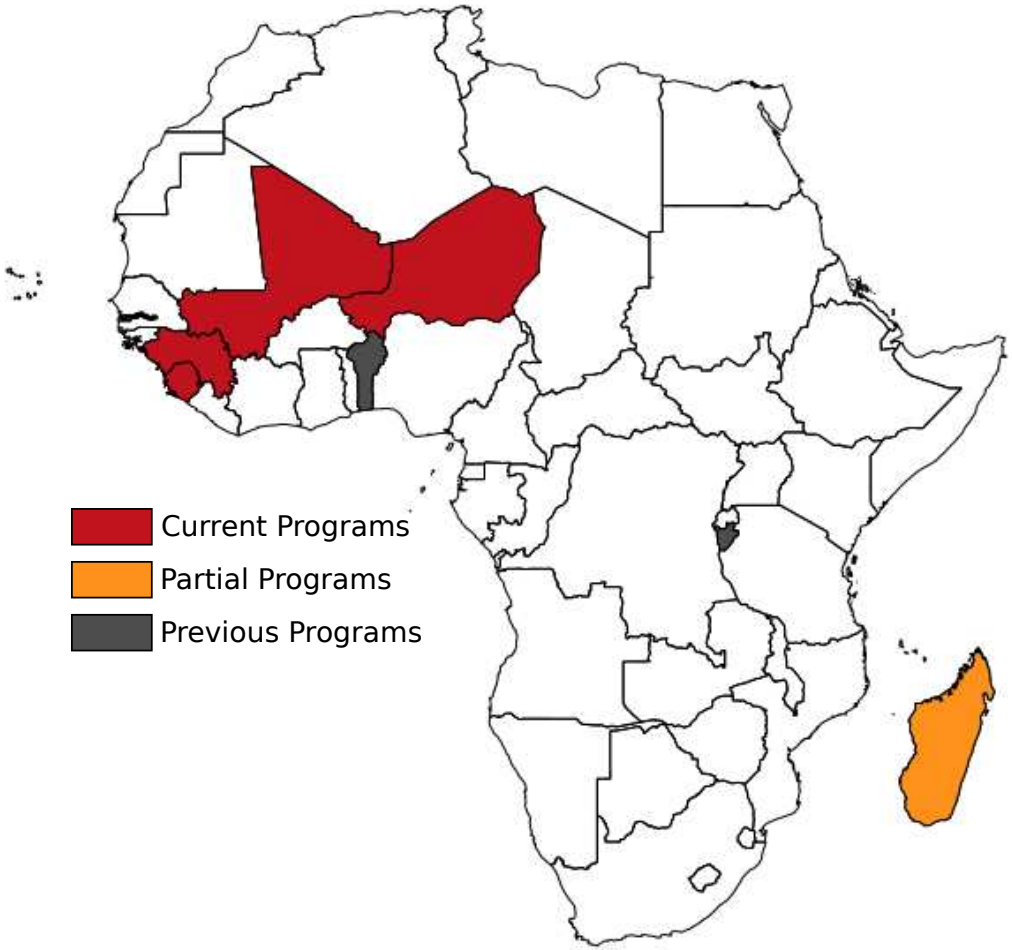
Three means of action

1. Capacity Strengthening
2. Operationnal Research
3. Advocacy

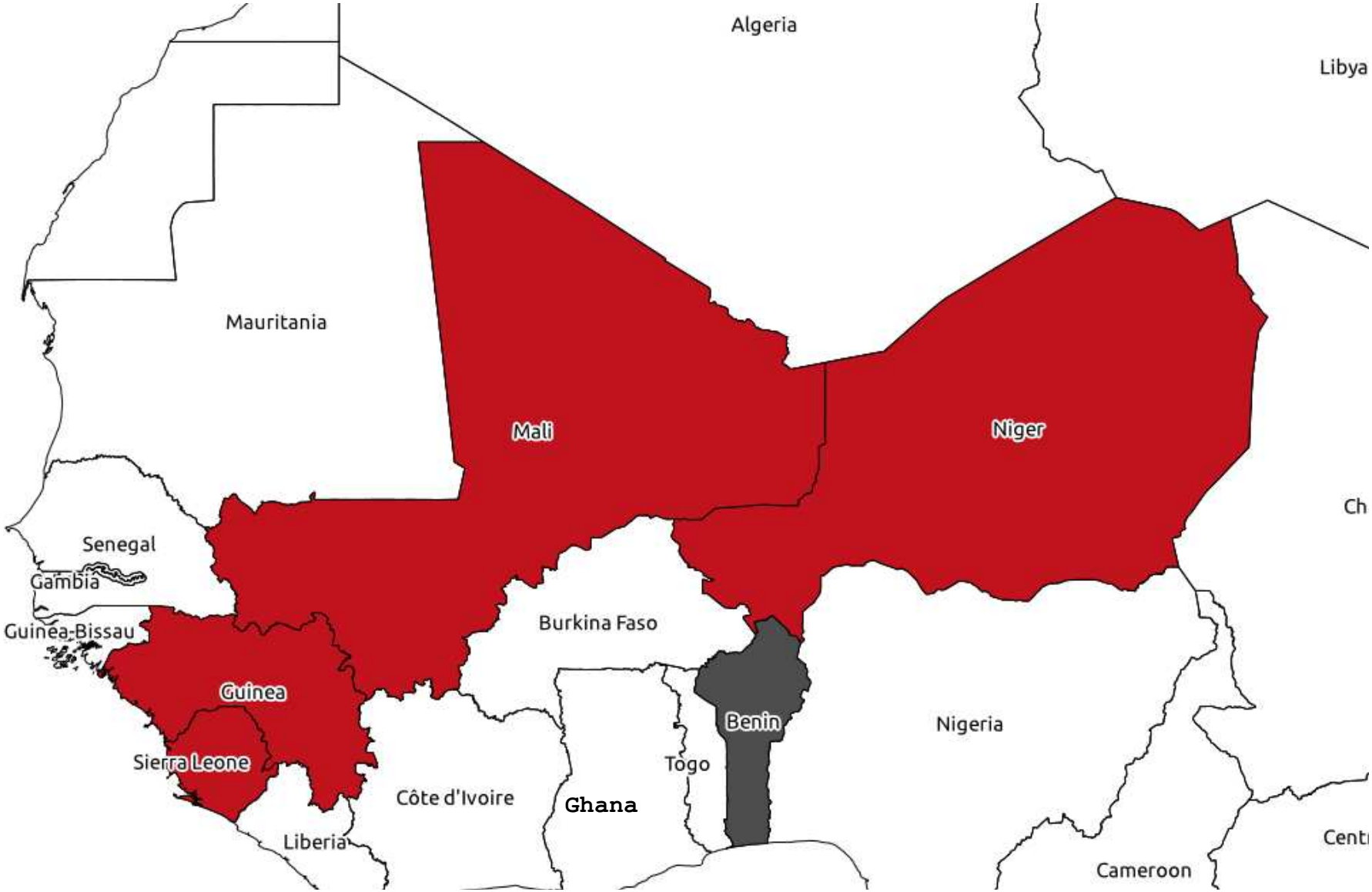
# Capacity Strengthening



# Overview



# Overview


Algeria
Libya
Mauritania
Mali
Niger
Ch
Senegal
Gambia
Guinea-Bissau
Burkina Faso
Guinea
Benin
Nigeria
Sierra Leone
Togo
Côte d'Ivoire
Ghana
Liberia
Cameroon
Centr

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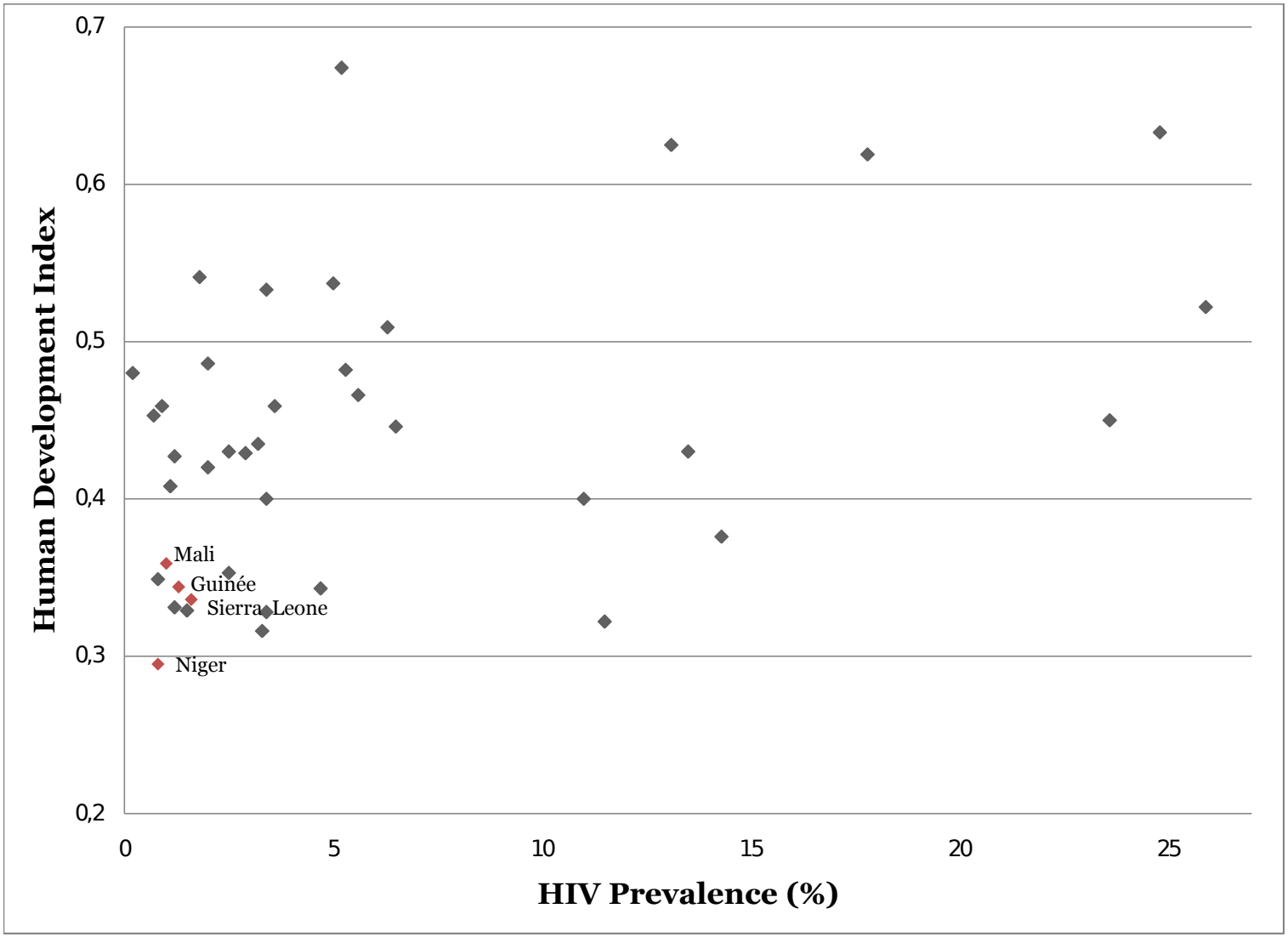
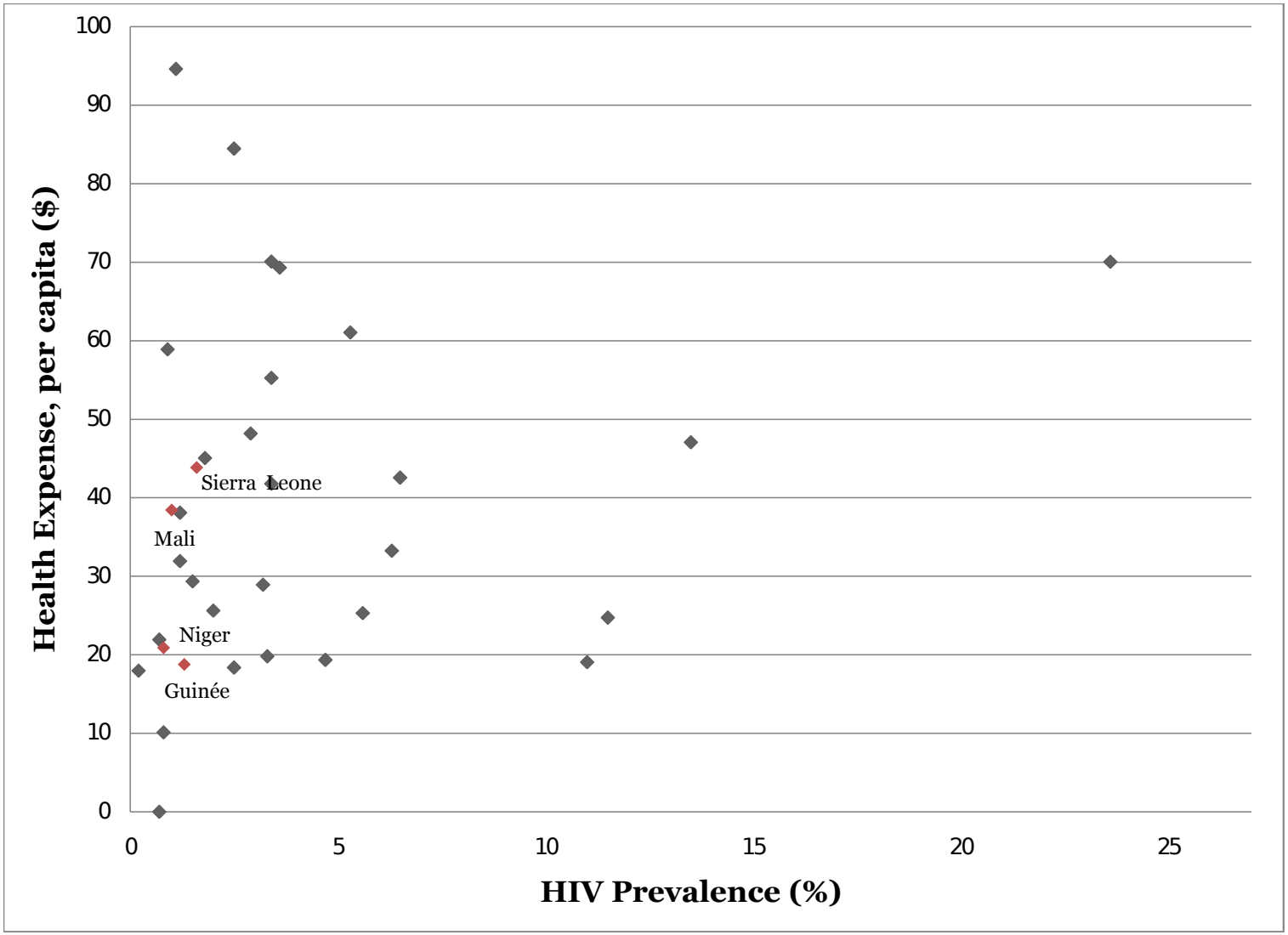
# Overview



# Overview


Health Expense, per capita ($)
HIV Prevalence (%)
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
Sierra Leone
Mali
Niger
Guinée

# Niger - some actions

- Training of almost all teams involved in ART care or PMTCT
- Support for Grant Request to Global Fund
- Direct support of PSM at national level
- Development of a Nationwide Database
- Technical support for Viral Load access in the Regions
- Research on HIV among malnourished children

# Mali - some actions

- Decentralization of HIV Care in Ségou and Mopti Regions
- GF financed Technical Support for PSM strengthening
- Support for implementation of computerized data system in Ségou and Mopti
- Participation in installation of DNA sequencer in Bamako
- Operationnal research on Loss to Follow-up

# Guinea - some actions

- Development of TB/HIV coinfection care
- Deconcentration of care in Conakry
- Revision of Monitoring and Evaluation Framework and Tools
- Installation of VL machine in Conakry
- Support for quantifications of HIV drugs needs
- Research Project on the care of neurological infections

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# Sommaire

# Information Needs

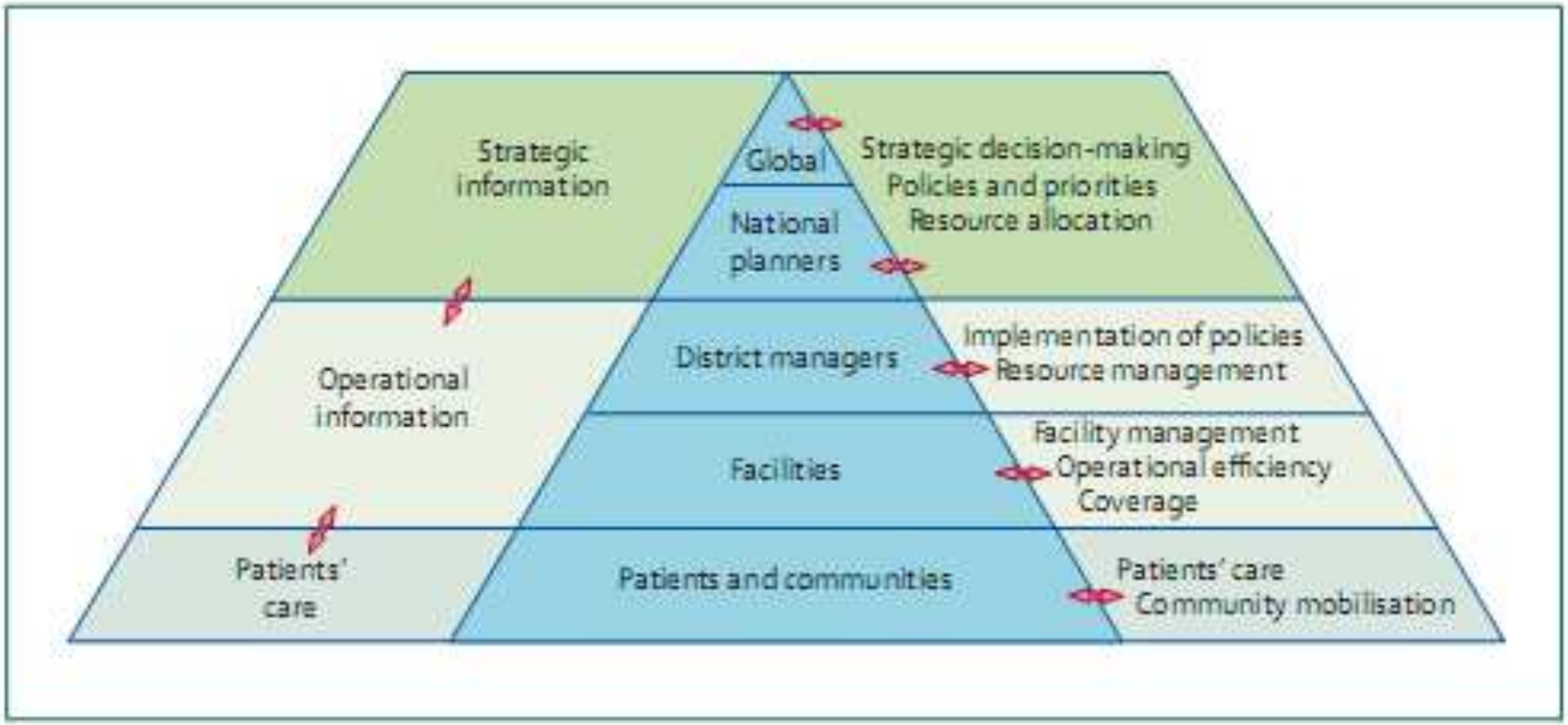
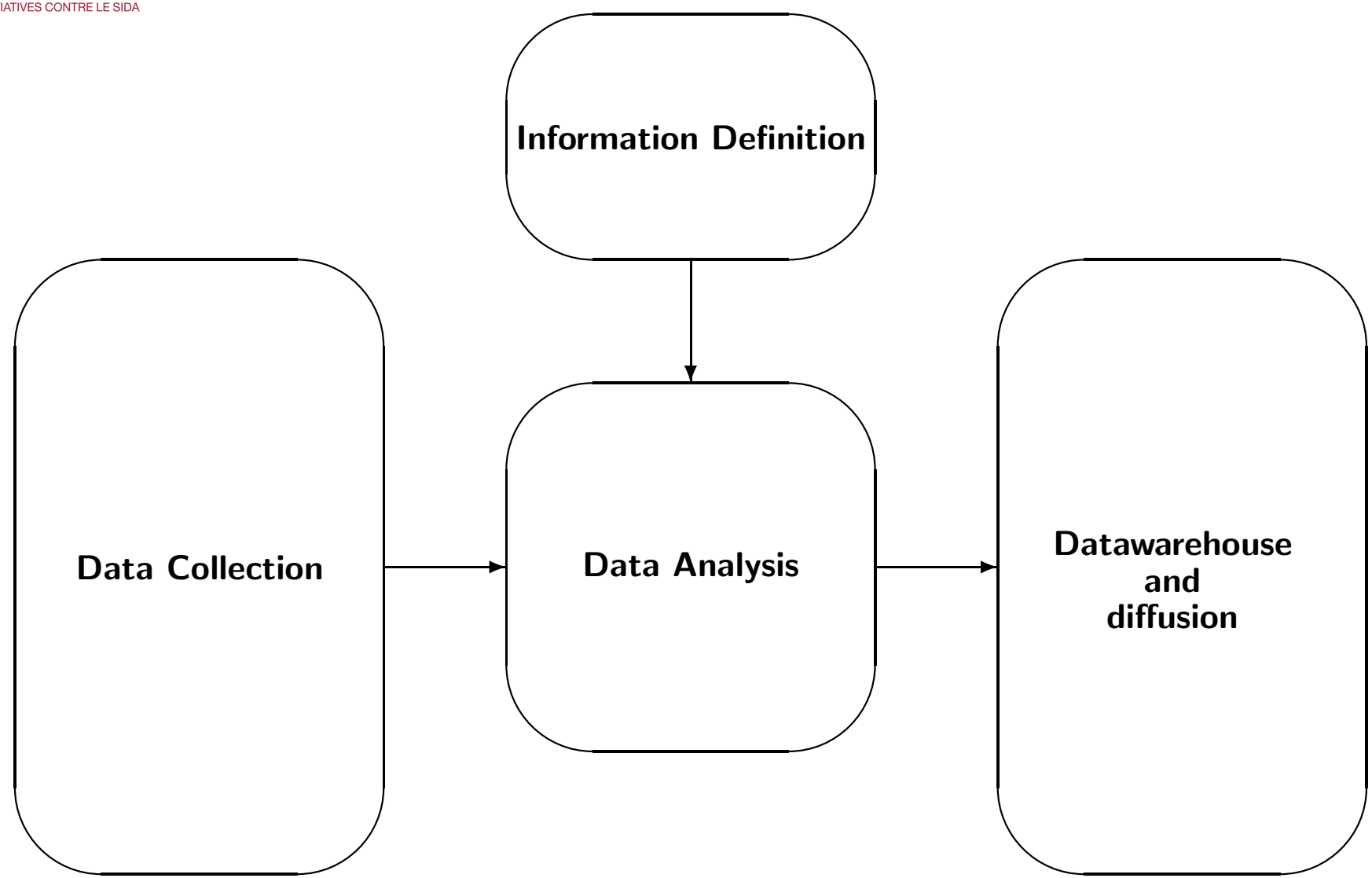



*Figure 1:* Various data needs at different levels

Abou Zahr et al. (2007) From Data to policy: good practices and cautionary tales

# Building Blocks of HIS Strengthening



# Paper vs. Computer data collection

## Paper based system

**Strength**

- Applicable everywhere
- Robust System

**Weakness**

- Data collection and analysis at base level
- Workload

## Computer based system

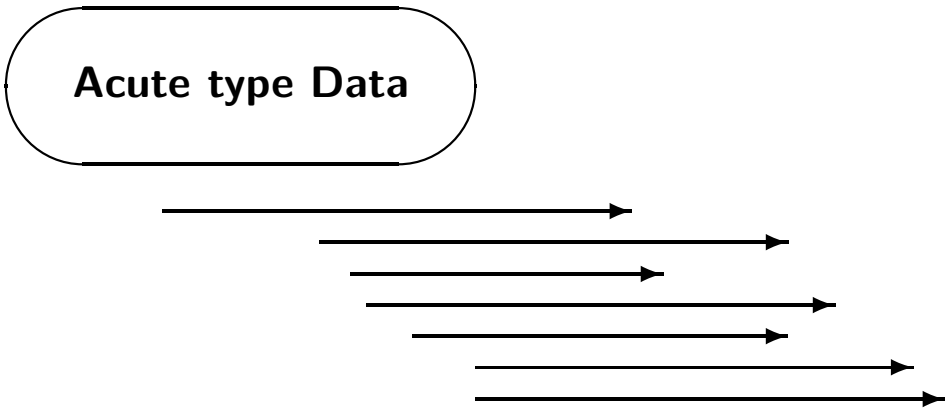
**Strength**

- Computerized...

**Weakness**

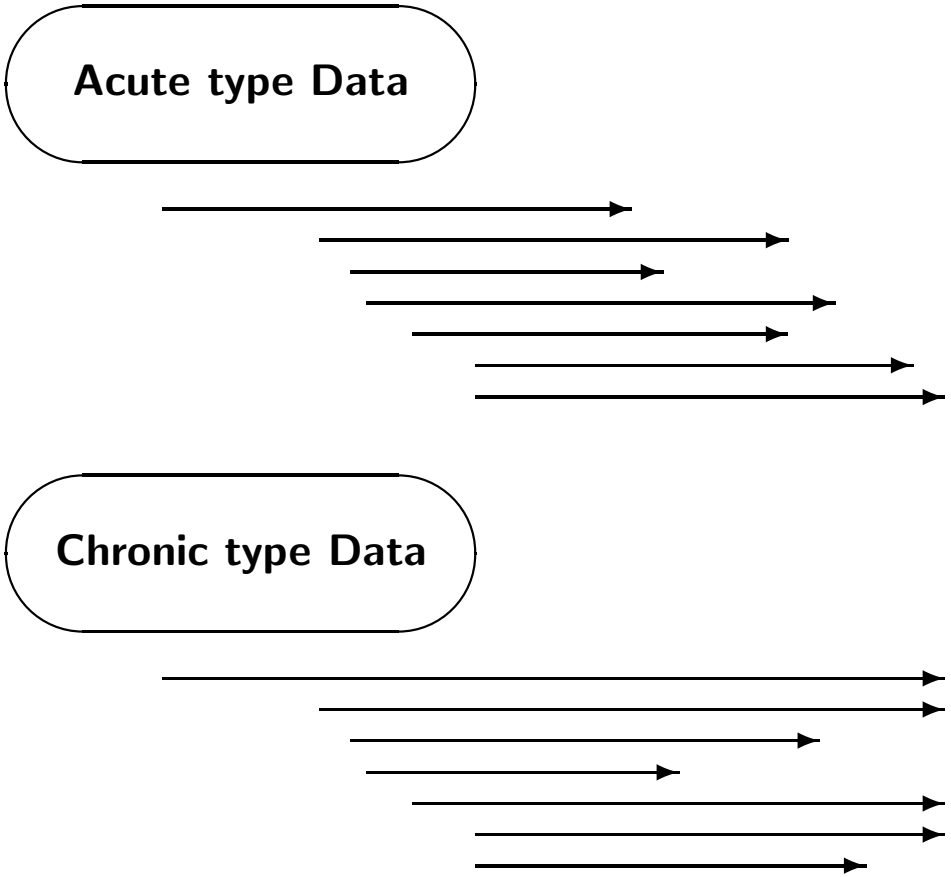
- Need for infrastructure
- Need for Human Resource
- Fragile System

# Acute vs Chronic Disease Data




Fixed data quantity
Constant data workload

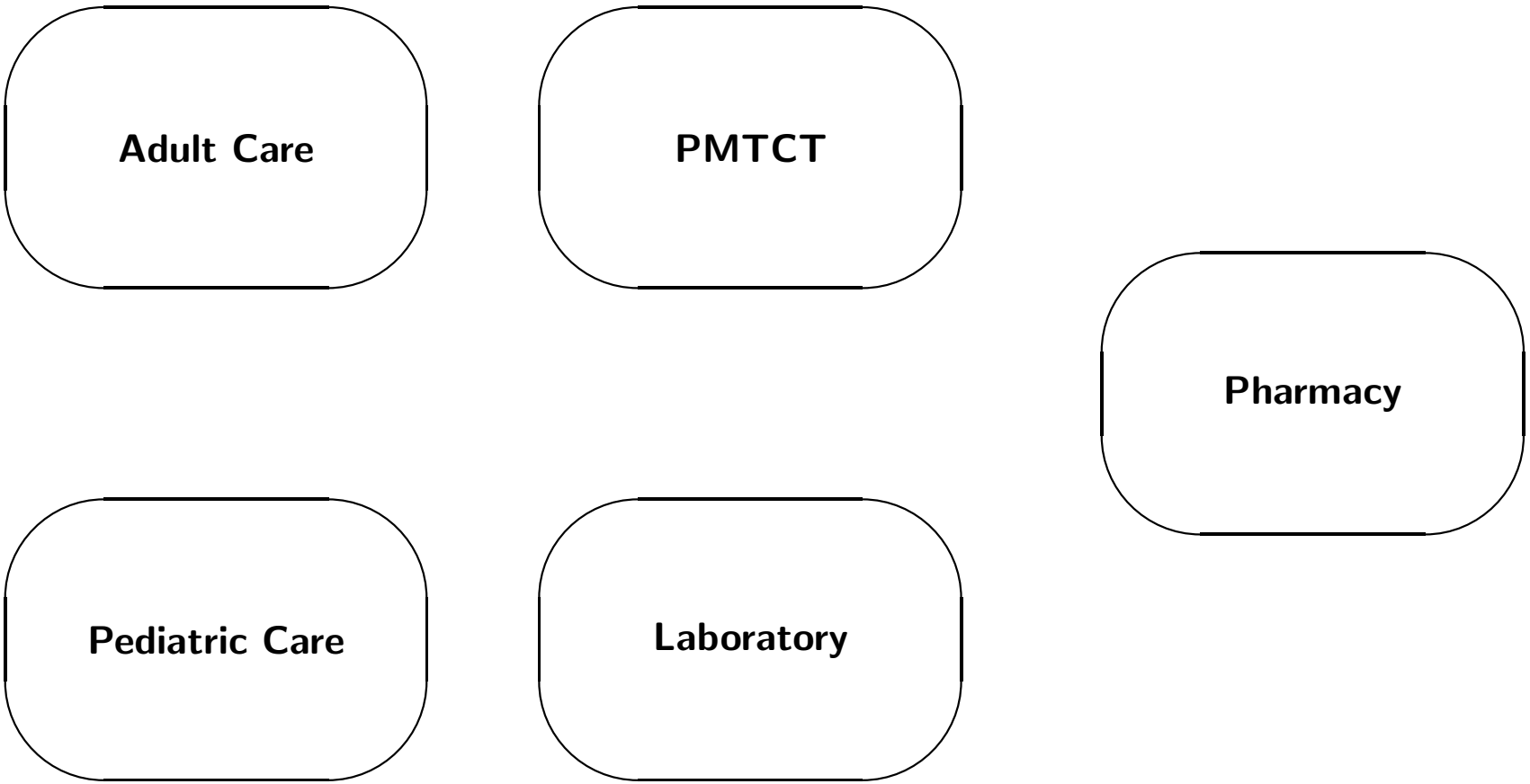
# Acute vs Chronic Disease Data




Fixed data quantity
Constant data workload

Variable data quantity
Growing data workload

# Different domains



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# So... what we are aiming at

- Chronic data collection systems
- No work overload at Facility level
- Fit for different data needs
- Unified immatriculation systems

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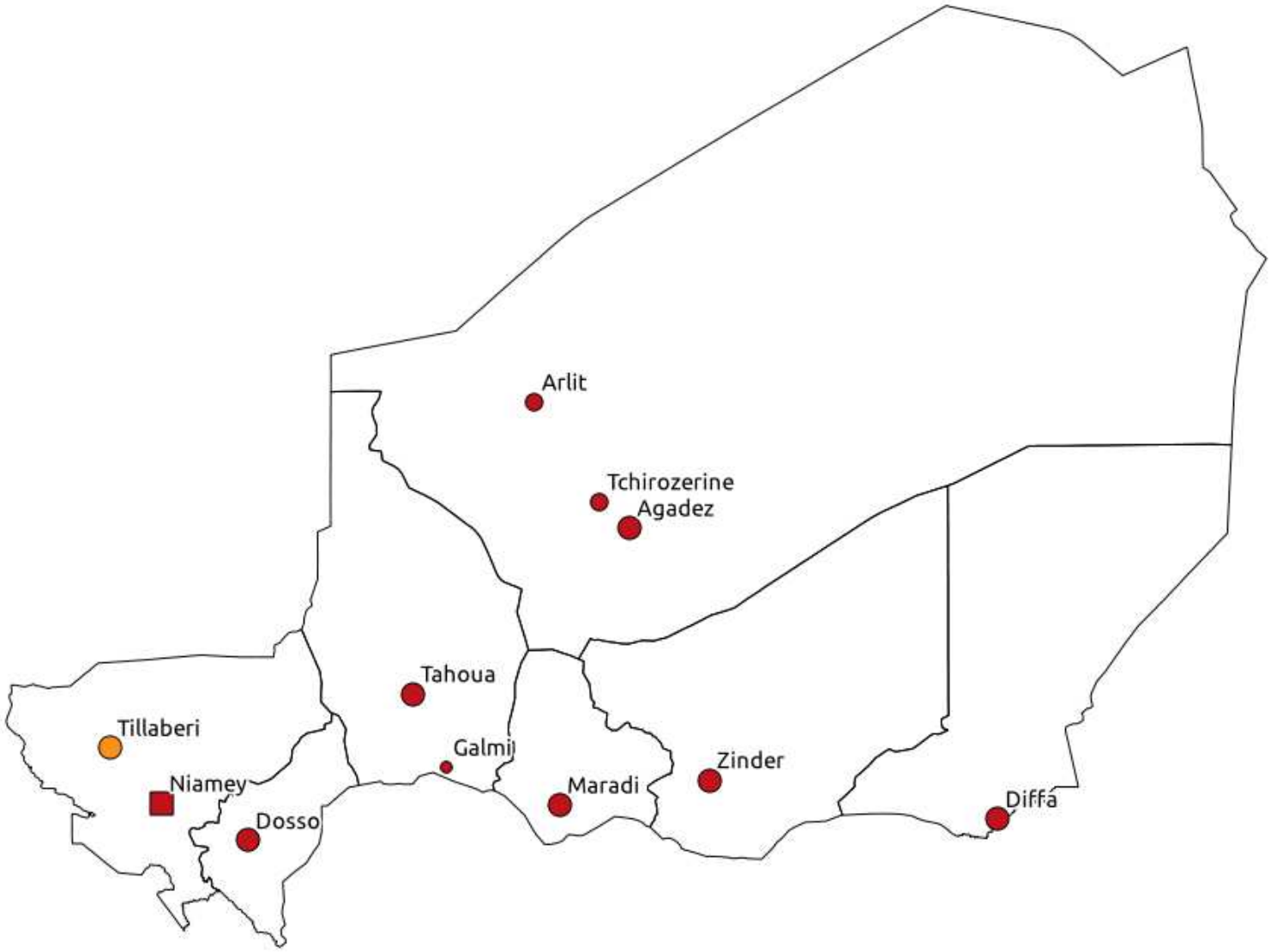
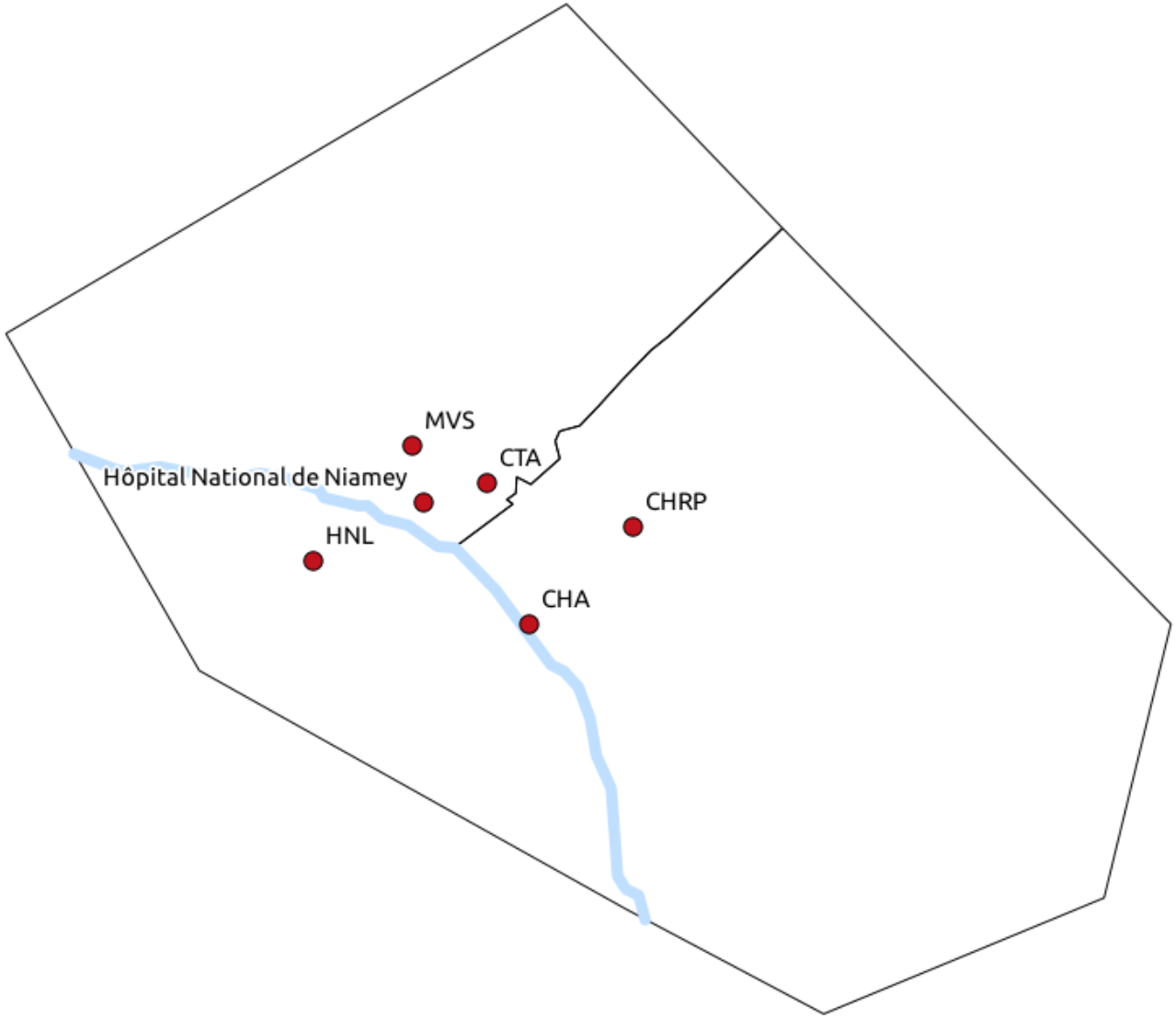
# Sommaire

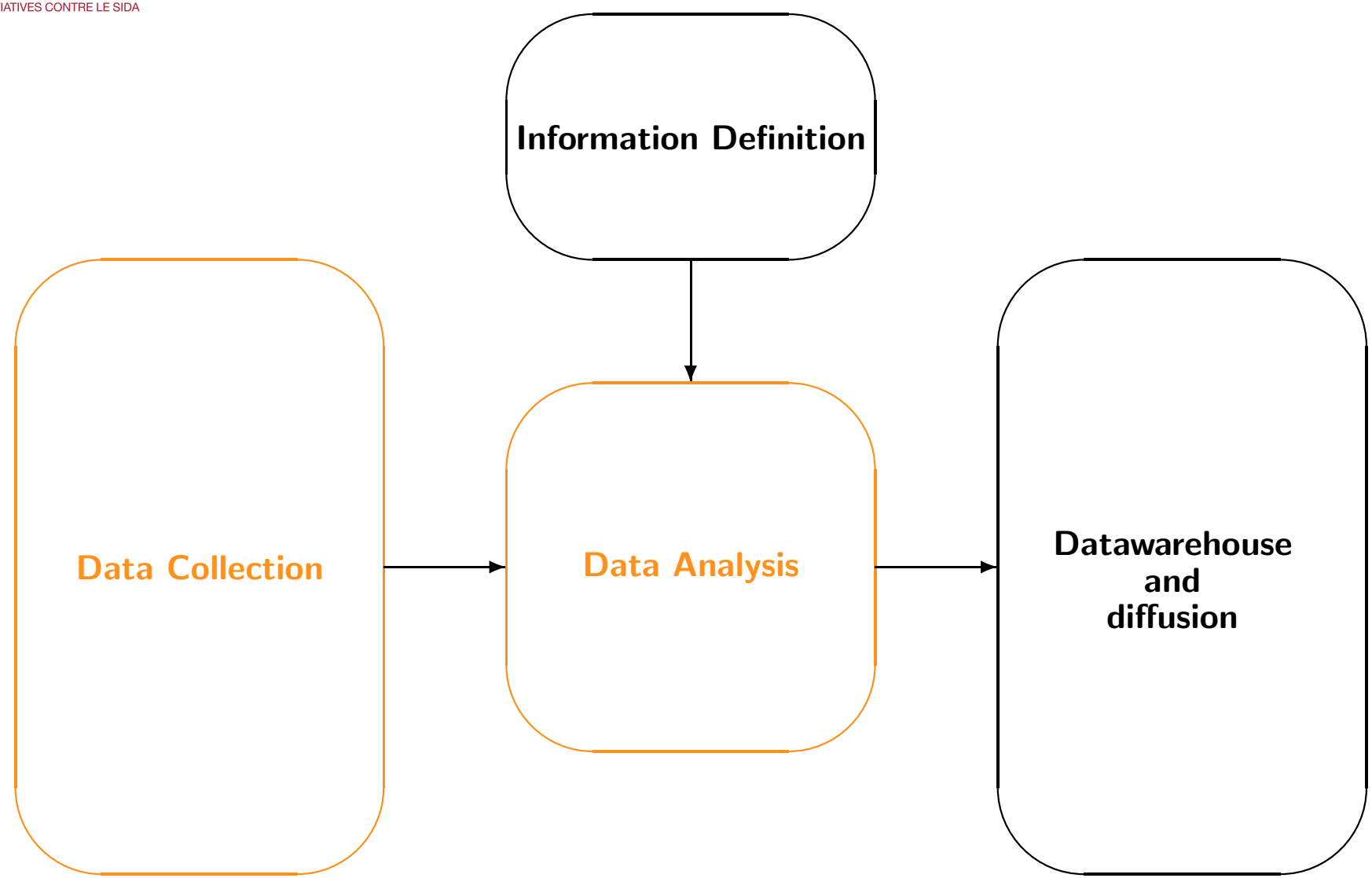
# HIV facilities



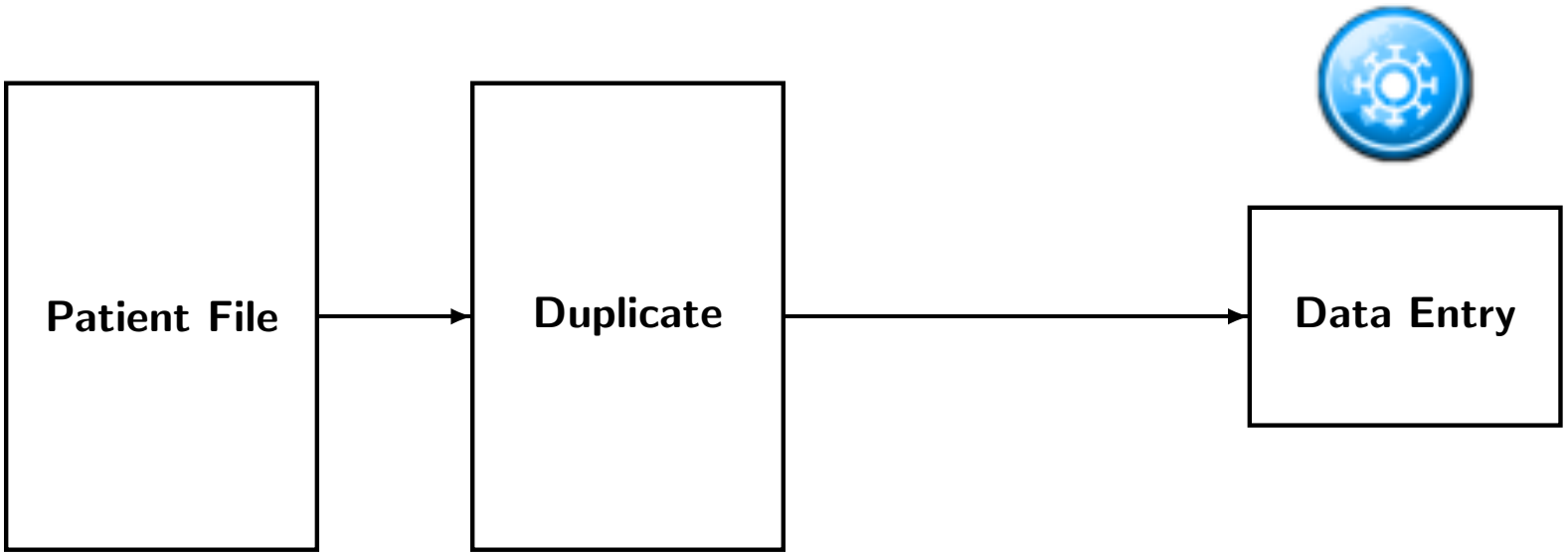
# HIV facilities



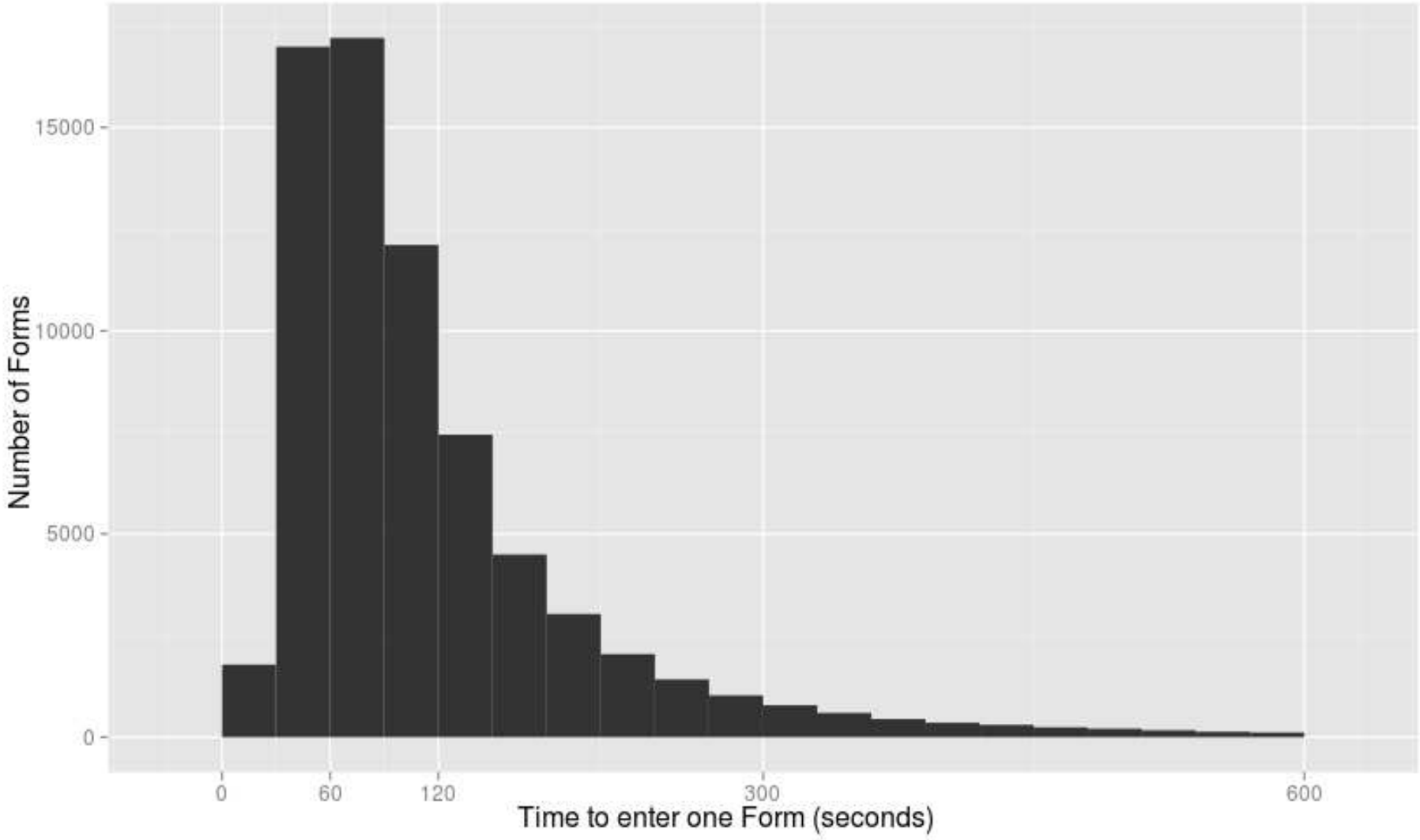
# Aim of a computerized Datasystem



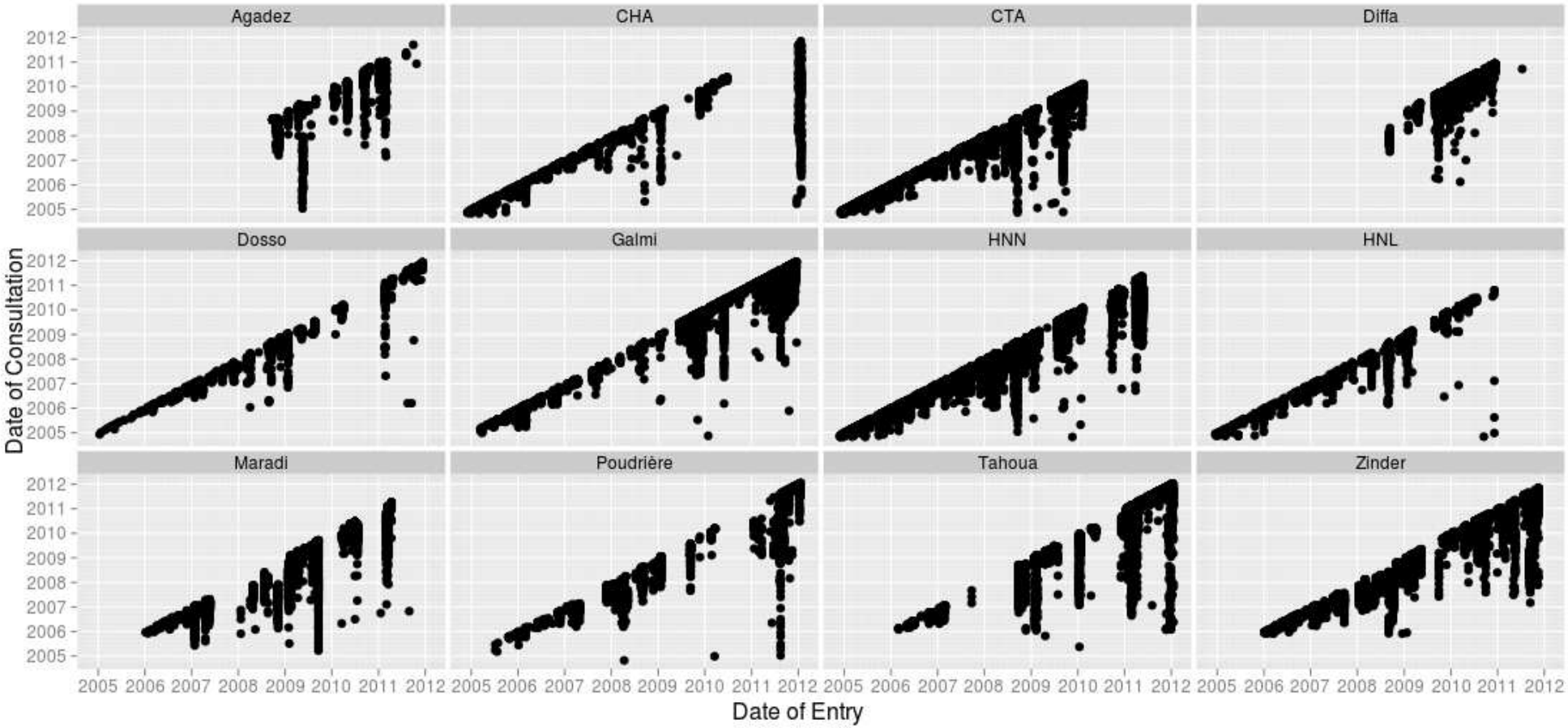
# Data Entry System



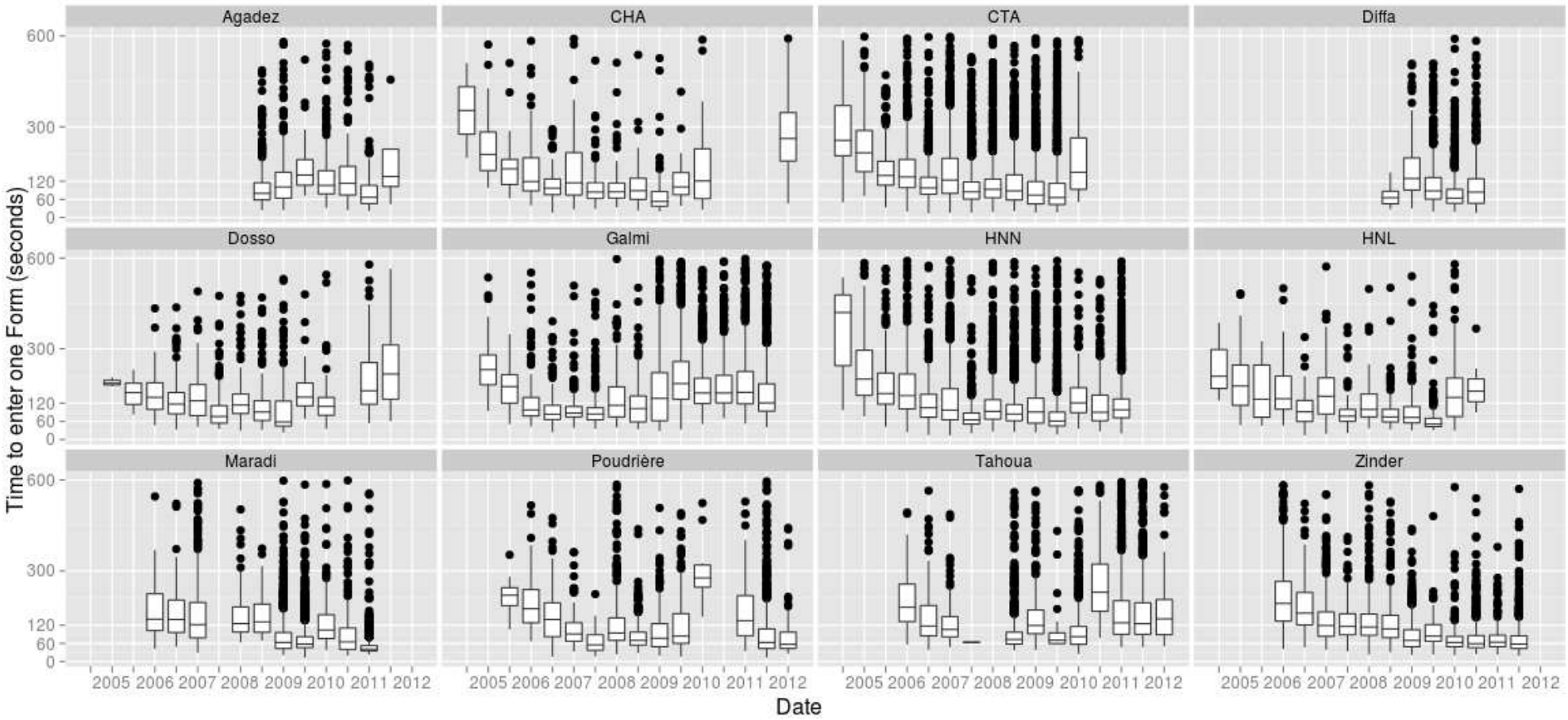
# How long does it take ?



# Data entry


Agadez
CHA
CTA
Diffa
Dosso
Galmi
HNN
HNL
Maradi
Poudrière
Tahoua
Zinder
2005
2006
2007
2008
2009
2010
2011
2012
Date of Consultation
Date of Entry

# Data entry


Agadez
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Galmi
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HNL
Maradi
Poudrière
Tahoua
Zinder
Time to enter one Form (seconds)
600
300
120
60
0
2005 2006 2007 2008 2009 2010 2011 2012
Date

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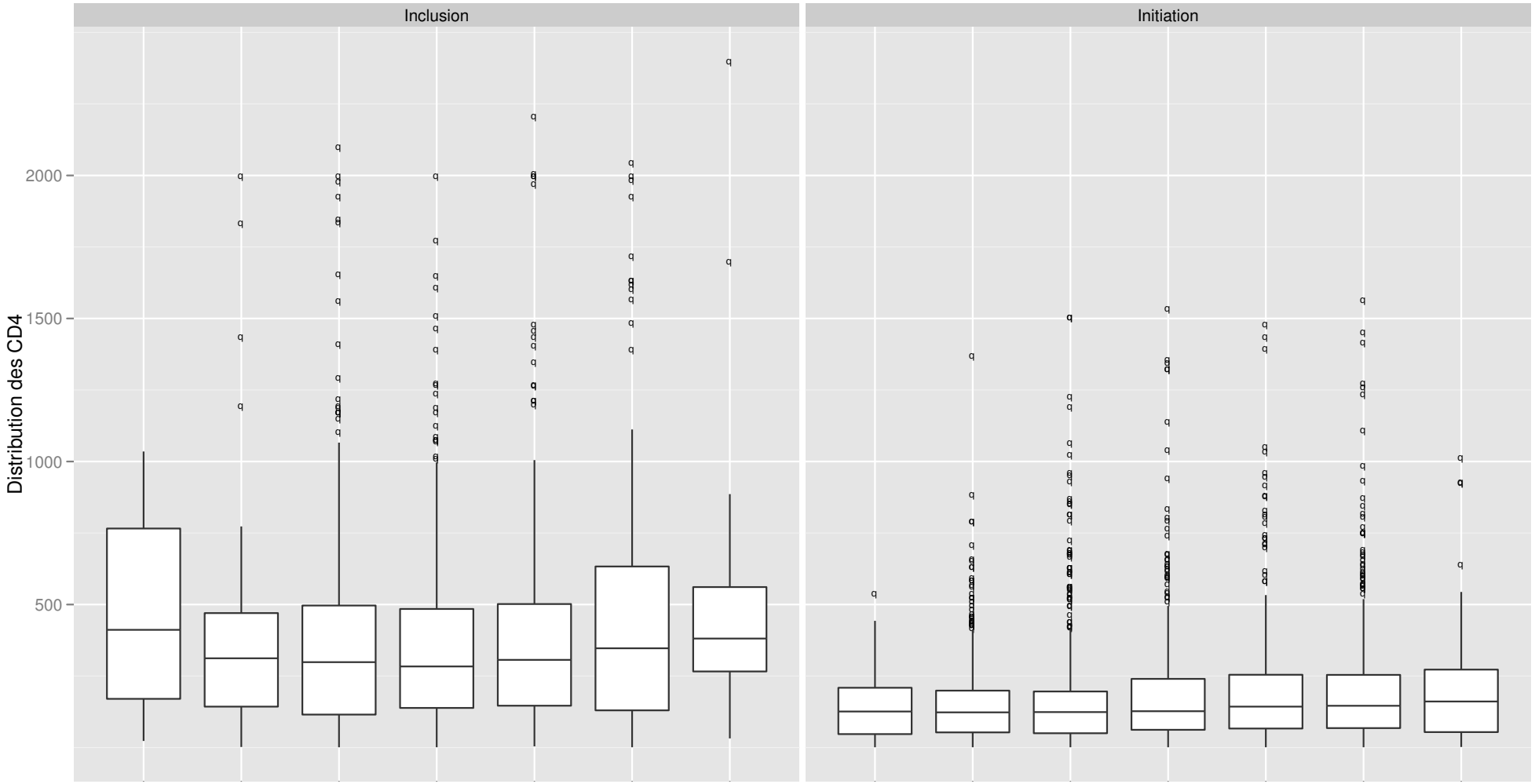
# Useful for basic epidemiology



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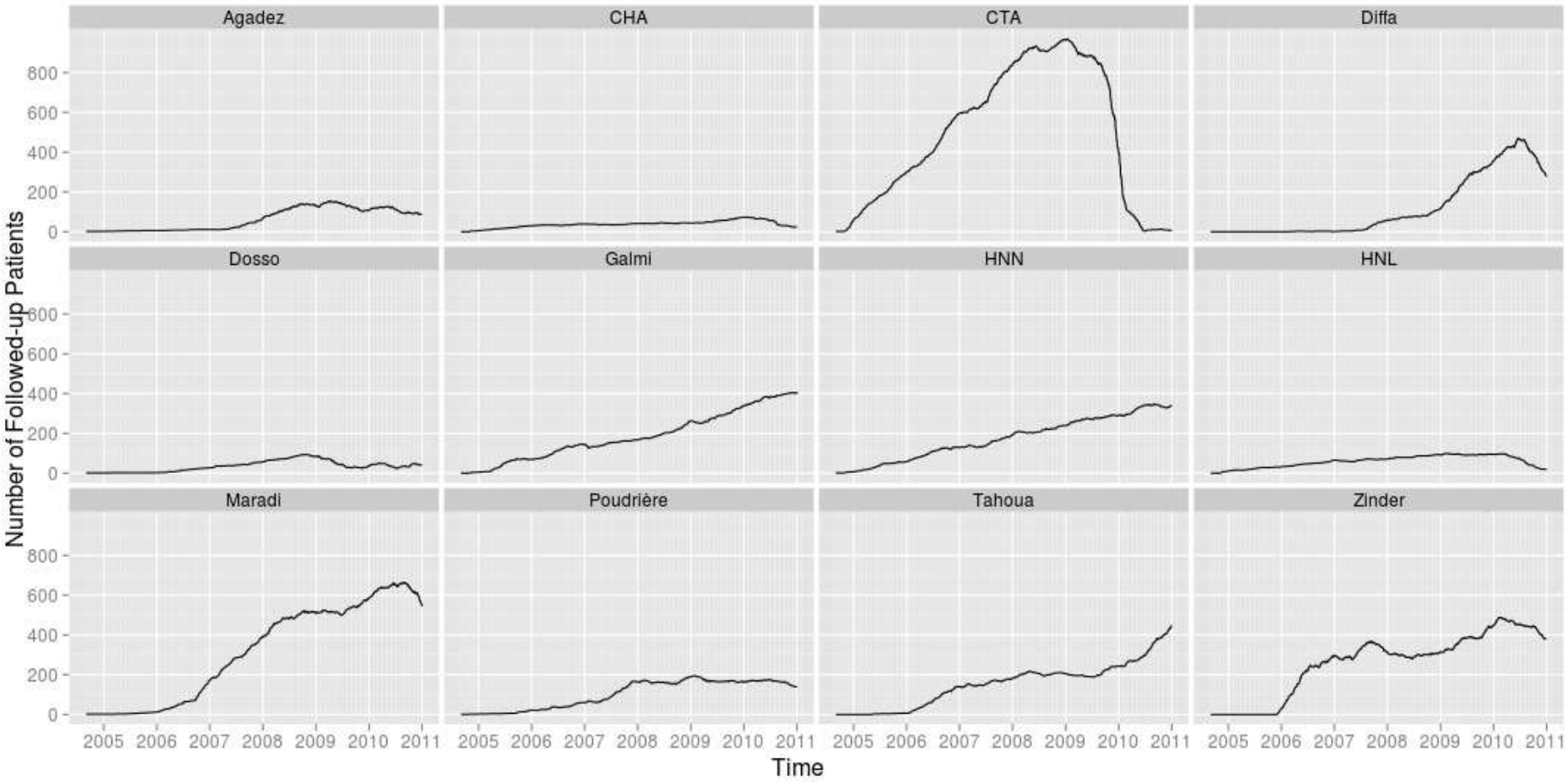
# Useless for M& E



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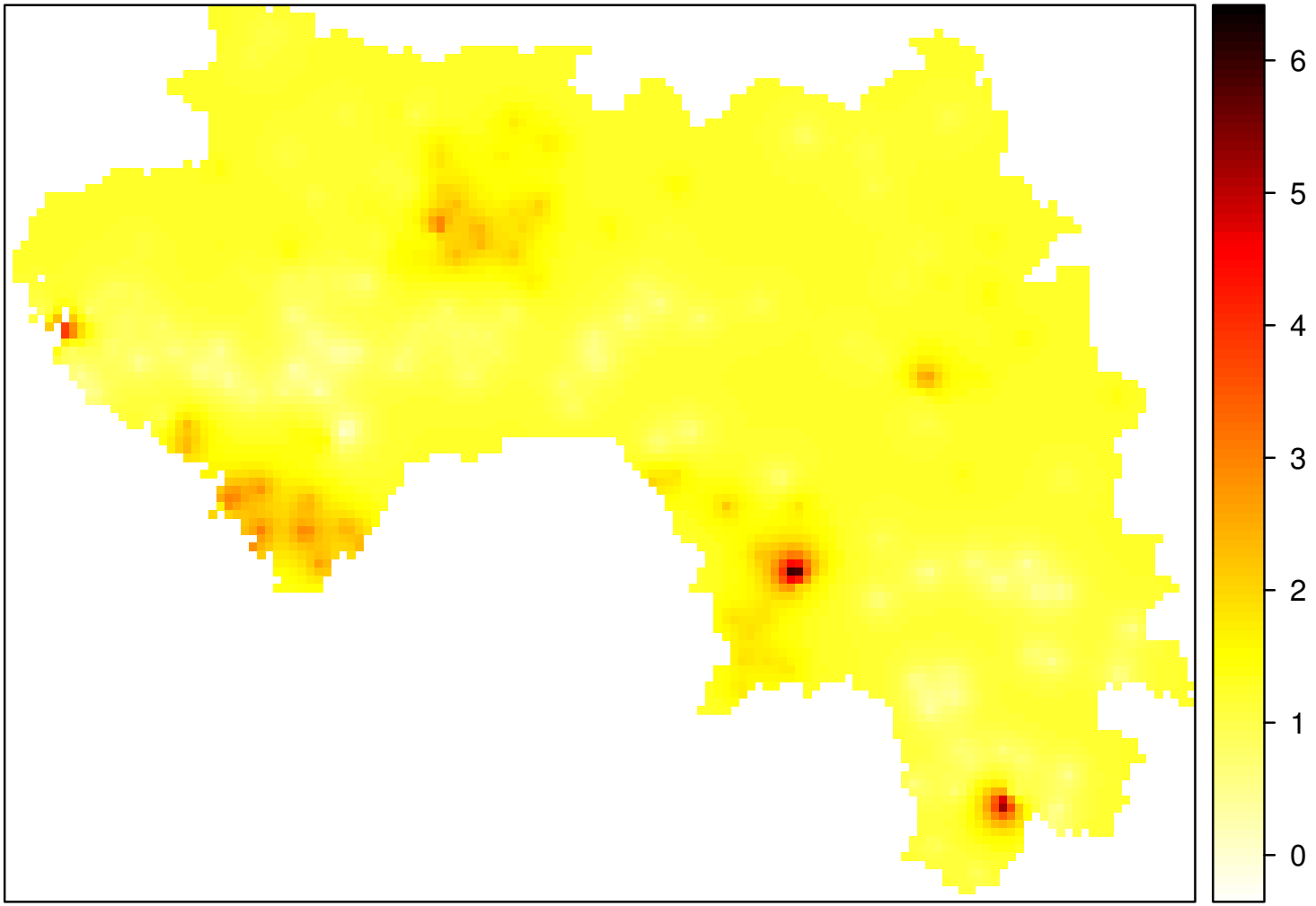
# Next steps

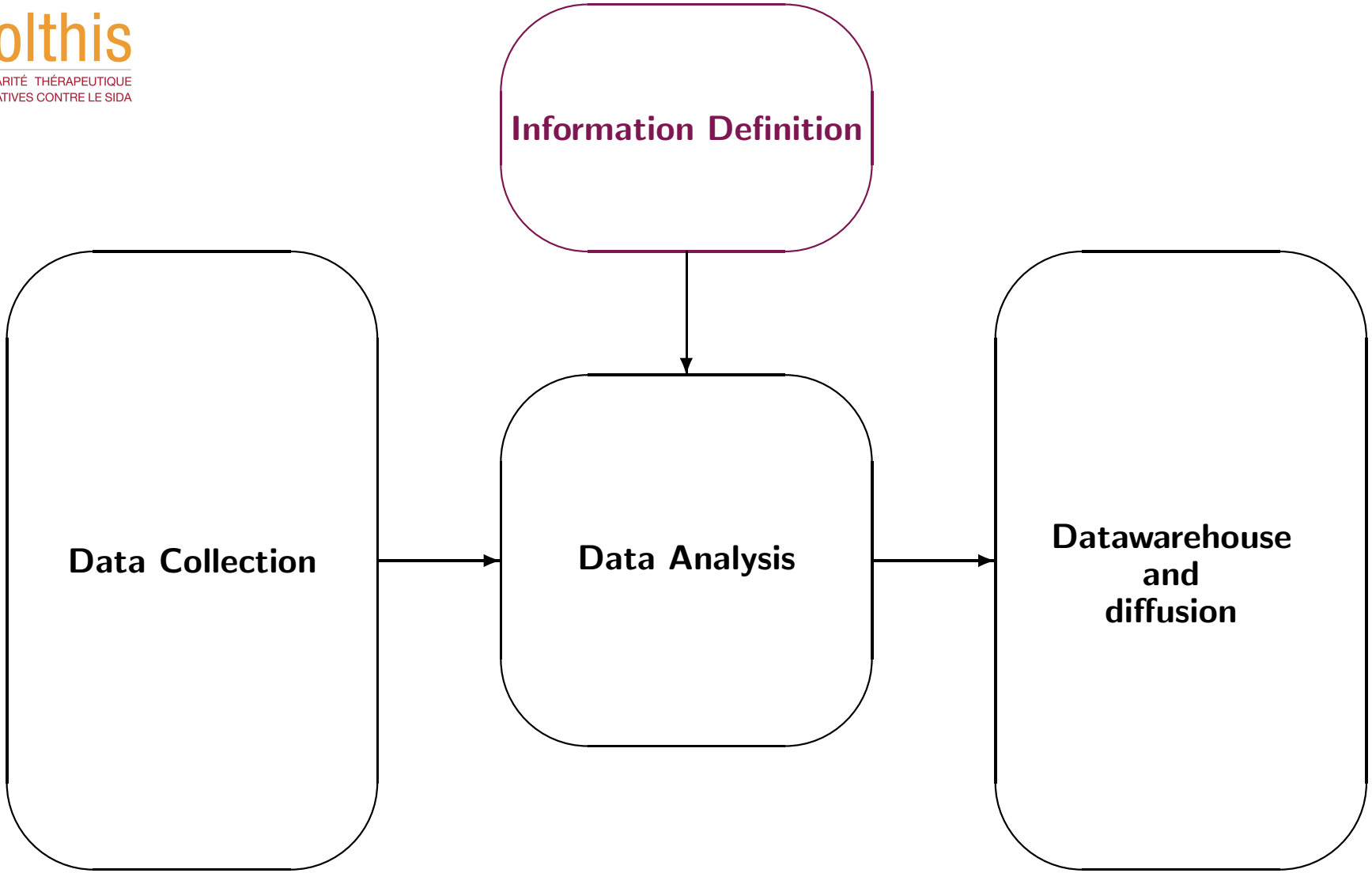
1. Strengthen supervision
2. Backup with a paper system

# Guinea

**Prévalence du VIH estimée**




**Guinée – EDS 2004**


Information Definition
Data Collection
Data Analysis
Datawarehouse
and
diffusion

# Redefinition of M&E Needs

Document de référence sur l'opérationnalisation du système de Suivi/Evaluation de la lutte contre le VIH en Guinée

Harmonisation des indicateurs et définition des outils

PNPCSP, SE/CNLS, SNIS, PNLT, ONUSIDA, OMS, UNICEF, Solthis

| | |
|---|---|
| **FM-O1-07** | **Nombre de femmes enceintes conseillées et testées pour le VIH** |
| **OMS#I8** | **Pourcentage de femmes enceintes ayant bénéficié d'un dépistage du VIH qui ont reçu les résultats au cours de leur grossesse, durant leur travail et l'accouchement, et pendant la période post-partum (≤ 72 heures), y compris celles dont le statut sérologique vis à vis du VIH était déjà connu.** |

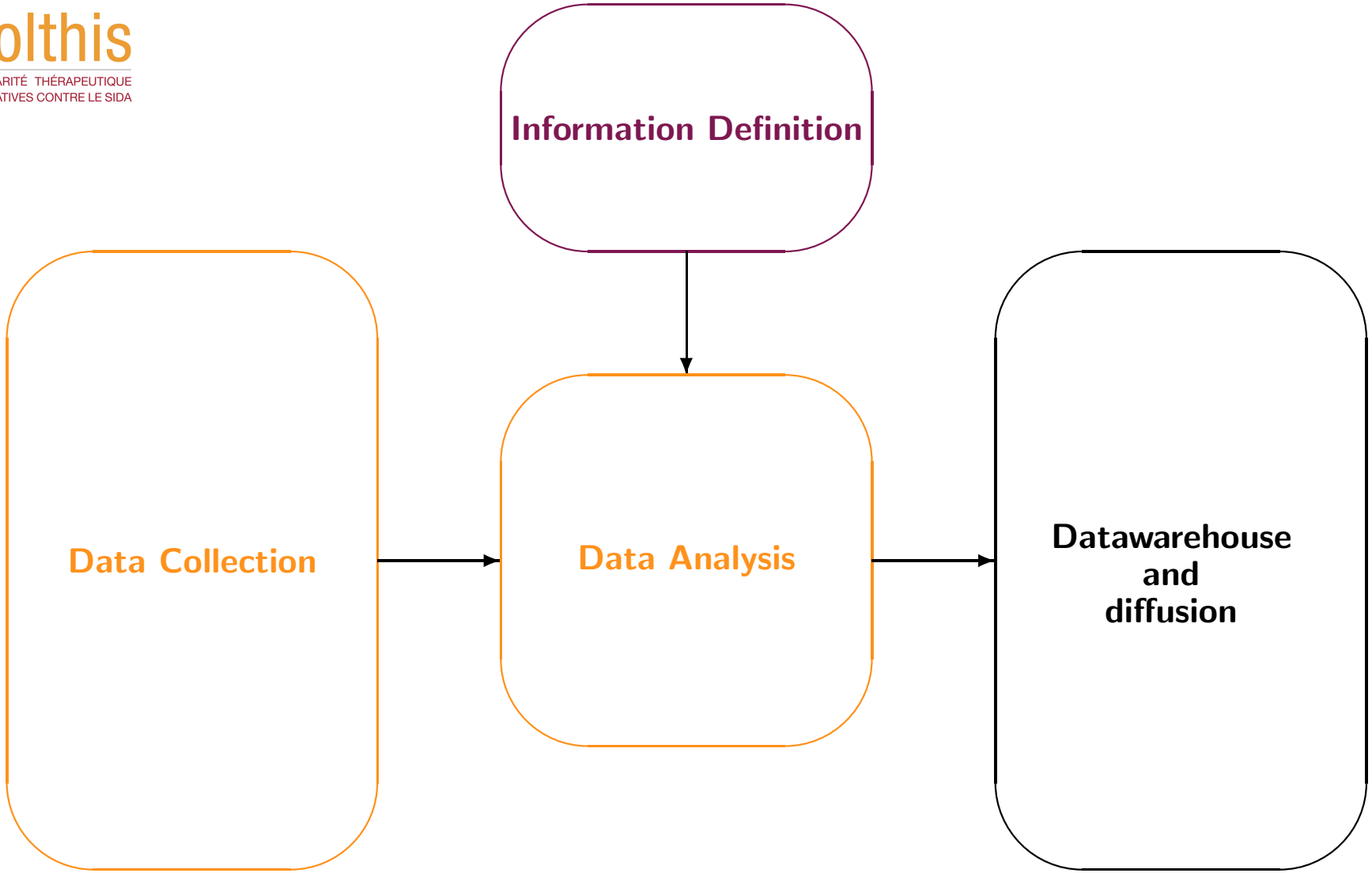
L'indicateur PTME-05a est disponible à travers les registres de laboratoire des centres de consultation prénatale. Il est recommandé de veiller à ce que l'identification des femmes qui viennent pour une consultation prénatale soit effective dans ces centres.

Le dénominateur de l'indicateur PTME-05b est disponible au SNIS.

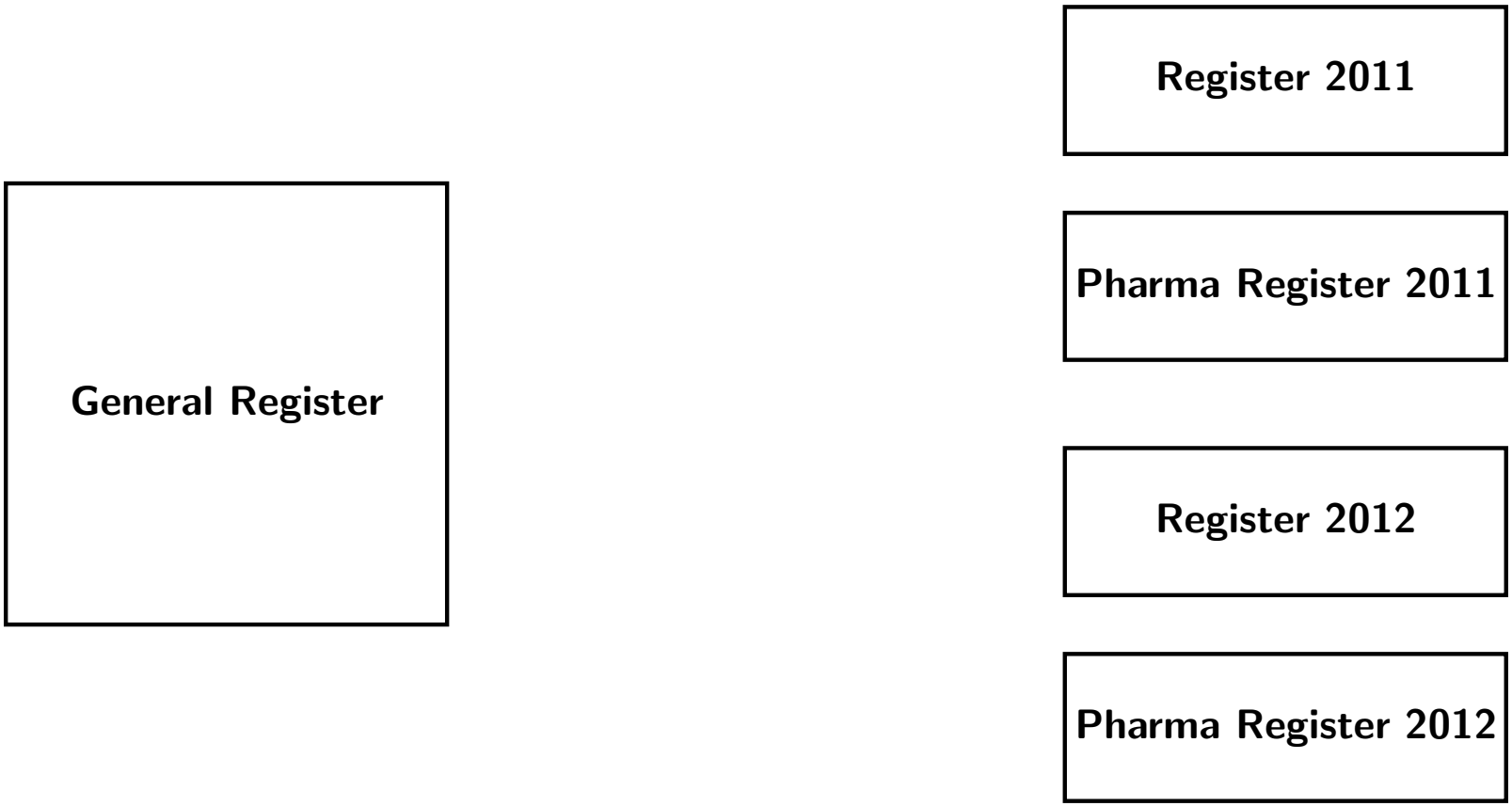
Le PNPCSP est responsabilisé pour la mise à disposition de cet indicateur.

| **PTME-05a** | **Nombre de femmes vues en consultation prénatale qui ont été conseillées et testées pour le VIH.** |
|---|---|
| **Outil de base** | Registres de CPN |
| **Remontée** | Rapports CPN |
| **Fréquence** | Trimestrielle |
| **Responsable** | PNPCSP |

| **PTME-05b** | **Pourcentage de femmes vues en consultation prénatale qui ont été conseillées et testées pour le VIH.** |
|---|---|
| **Numérateur** | Nombre de femmes vues en consultation prénatale qui ont été conseillées et testées pour le VIH. |
| **Source** | PTME-05a |
| **Dénominateur** | Nombre de femmes vues en consultation prénatale. |
| **Source** | PTME-04 |
| **Fréquence** | Trimestrielle |
| **Responsable** | PNPCSP |


Information Definition
Data Collection
Data Analysis
Datawarehouse
and
diffusion

# A new data collection system



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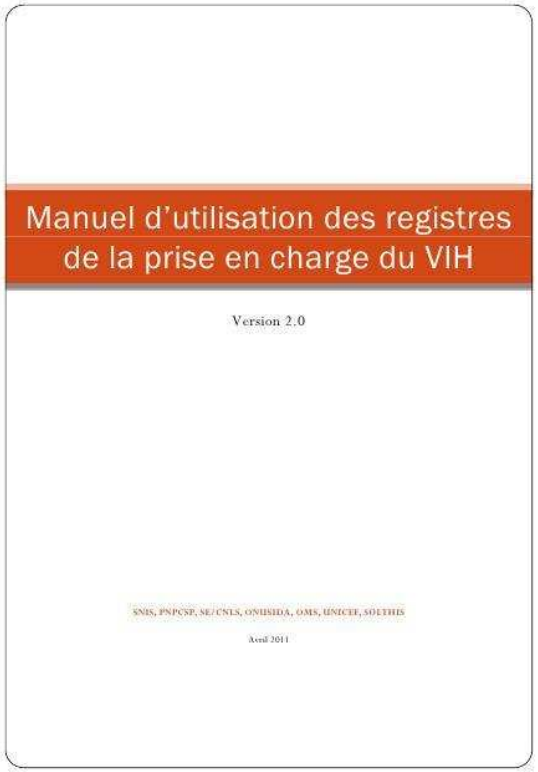
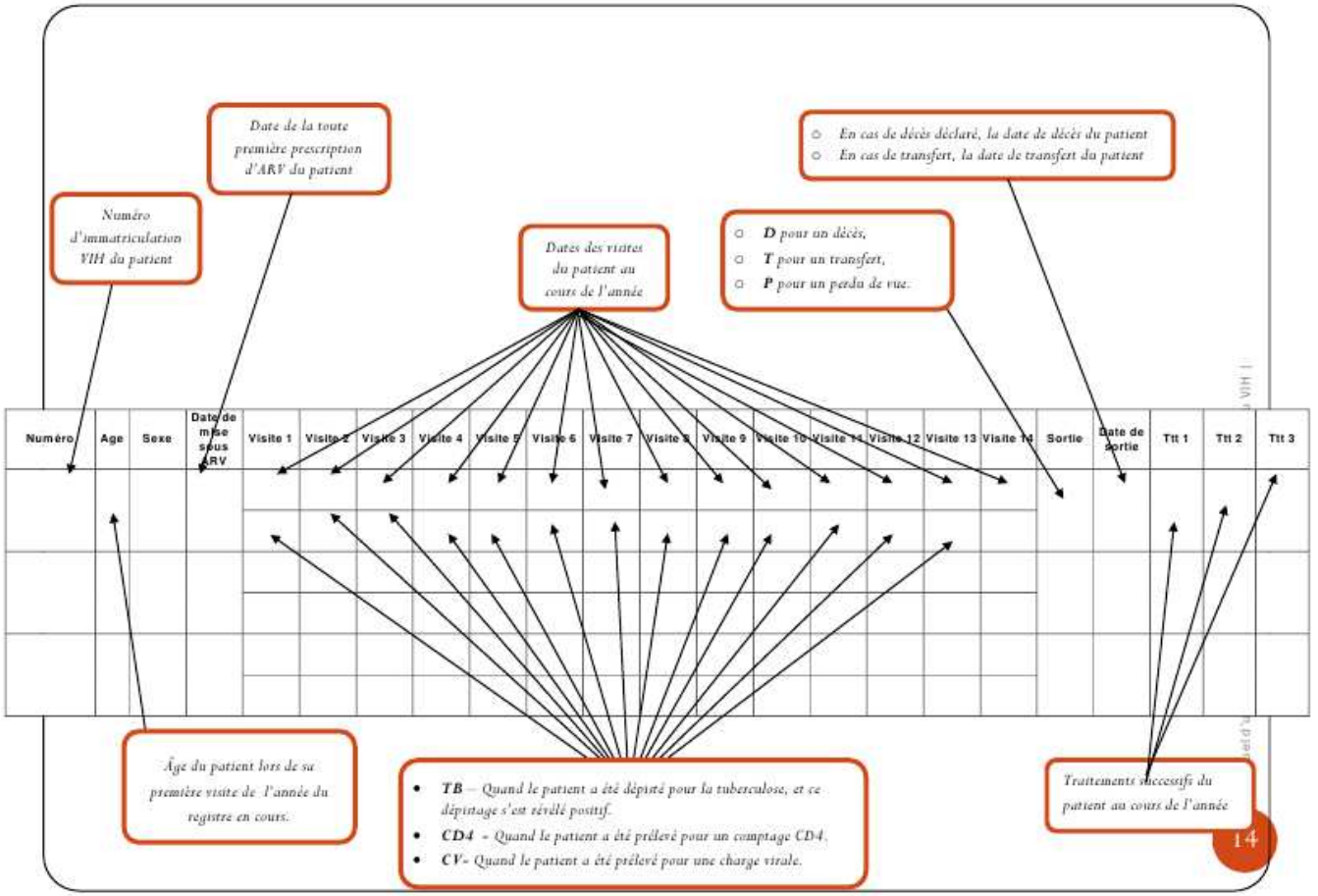
# A new data collection system

- Patient file only used for patient monitoring
- Progressive computerization where possible

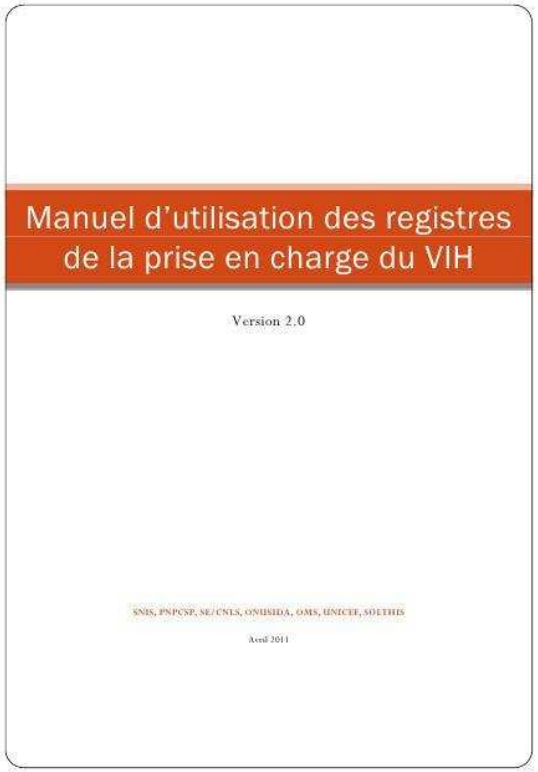
- Yearly reevaluation of actively followed patients
- Adult and pediatric in the same tools
- easy to Analyse

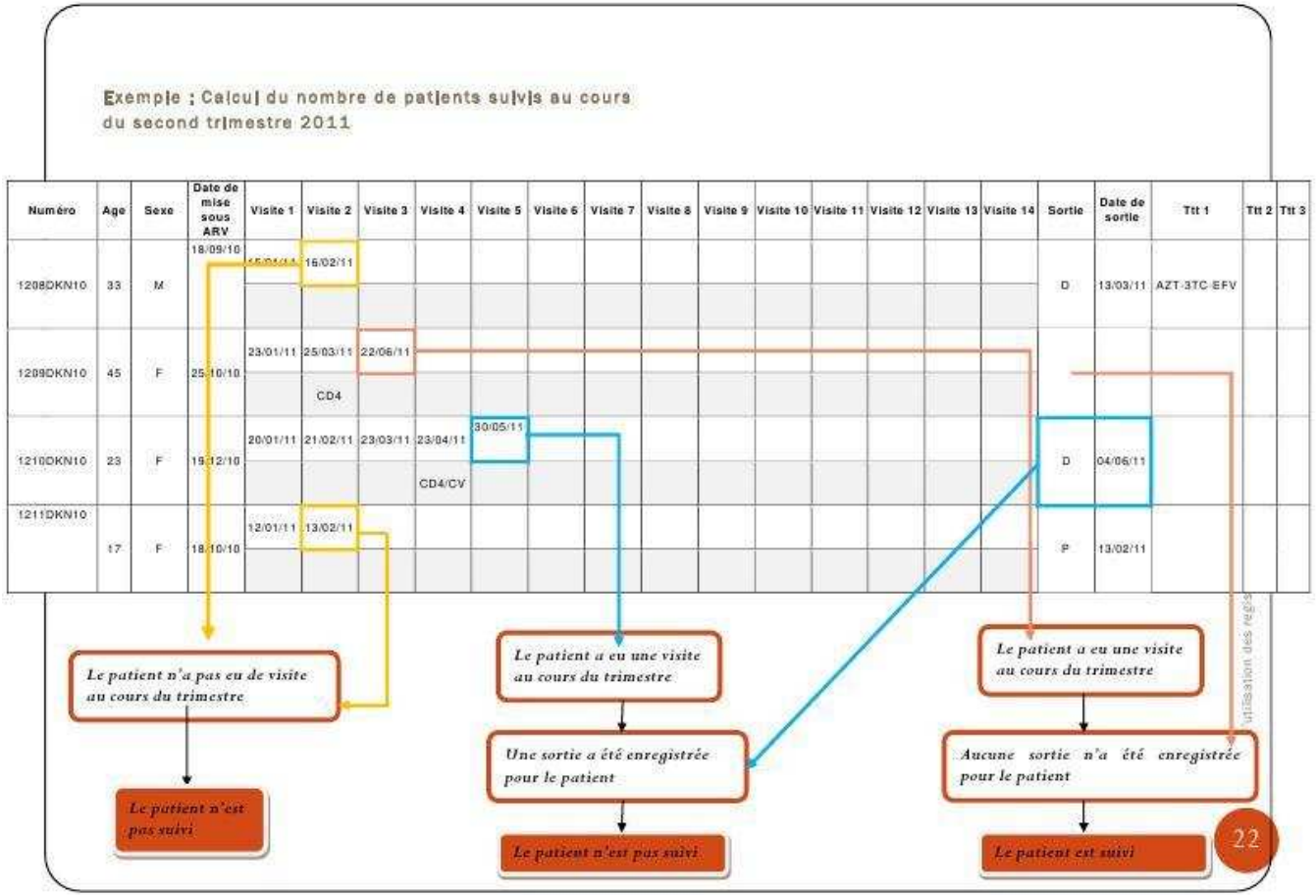
# Modification of Tools and methods



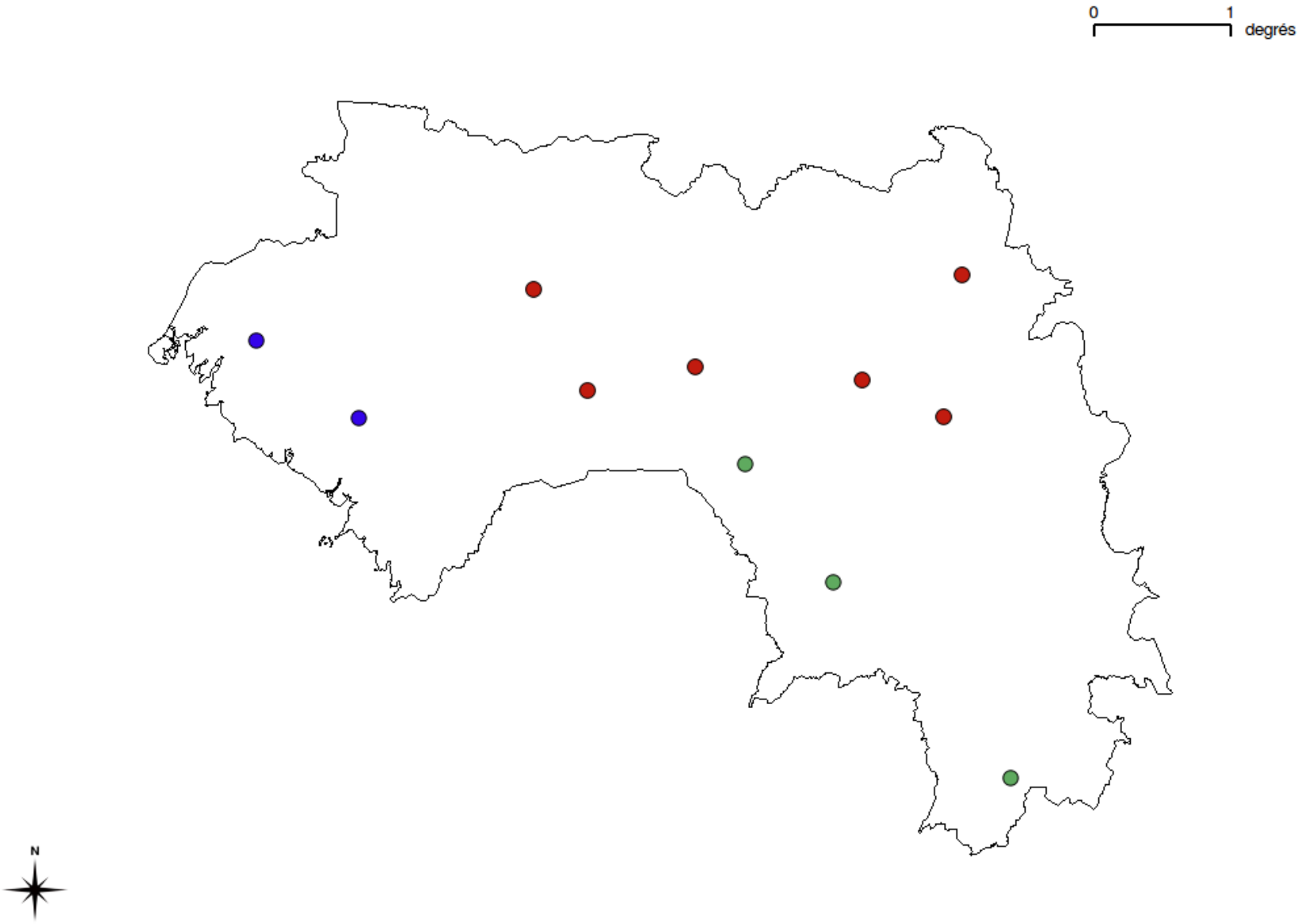



# Modification of Tools and methods

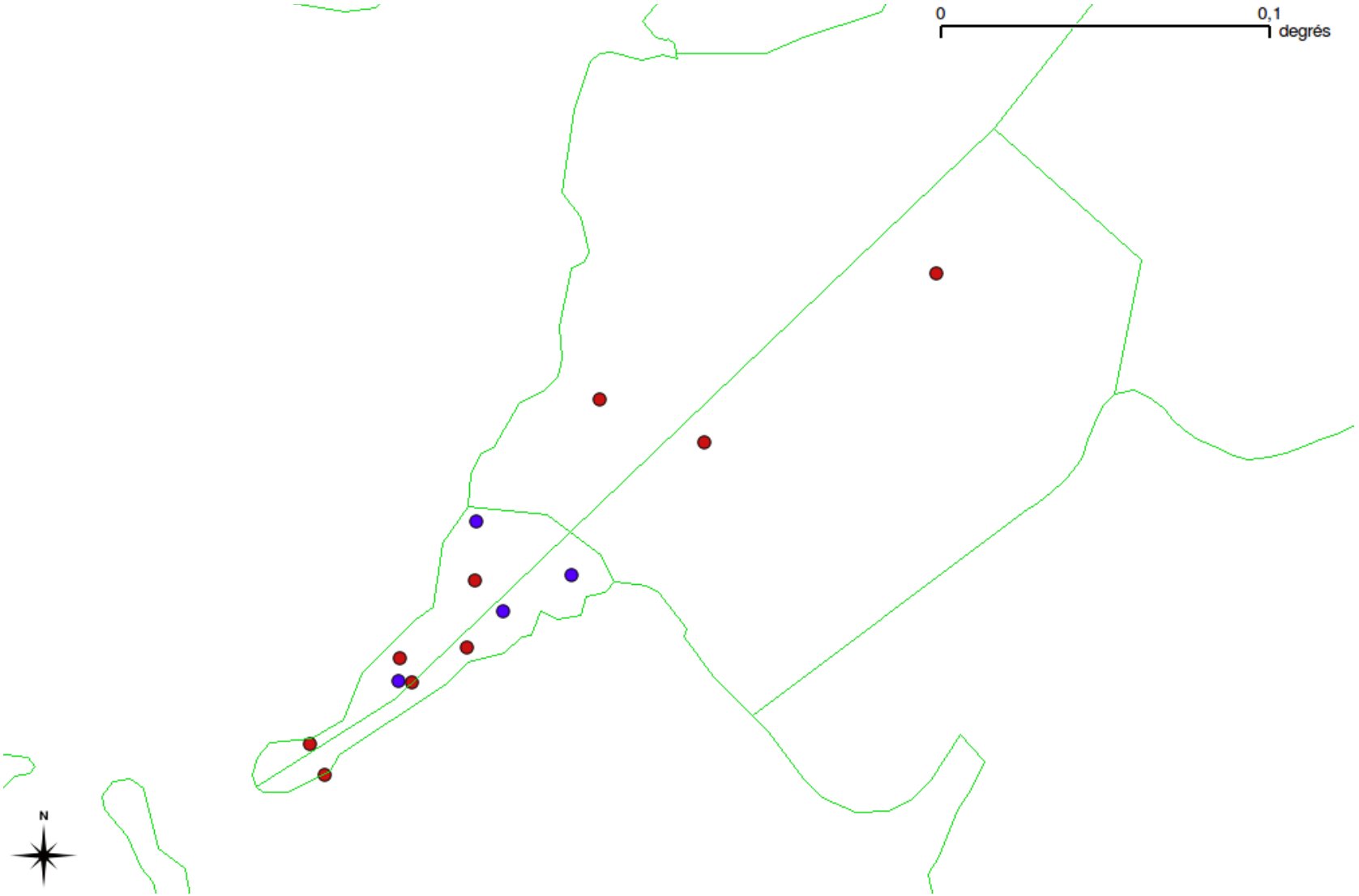


# Implementation of new tools



# Implementation of new tools



# Results and next steps

- Revision of cohort estimations
- Revision of PMTCT and Labs registries
- Strengthening of HIS Management and Supervision

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# Sommaire

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# Simplifying Data analysis

OPEN ACCESS Freely available online

PLoS one

## Evaluation of Three Sampling Methods to Monitor Outcomes of Antiretroviral Treatment Programmes in Low- and Middle-Income Countries

**Jean-Michel Tassie[1]*, Karen Malateste[2], Mar Pujades-Rodriguez[3], Elisabeth Poulet[3], Diane Bennett[4], Anthony Harries[5,6], Mary Mahy[7], Mauro Schechter[8], Yves Souteyrand[1], François Dabis[2] for the ART Linc of IeDEA and MSF collaborations**

1 Department of HIV/AIDS, World Health Organization, Geneva, Switzerland, 2 INSERM U897 and Institut de Santé Publique, Epidémiologie et Développement (ISPED), Université Victor Segalen, Bordeaux, France, 3 Epicentre, Paris, France, 4 Centers for Disease Control and Prevention, Atlanta, Georgia, United States of America, 5 International Union Against Tuberculosis and Lung Disease, Paris, France, 6 London School of Hygiene and Tropical Medicine, London, United Kingdom, 7 The Joint United Nations Programme on HIV/AIDS (UNAIDS), Geneva, Switzerland, 8 Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil

**Abstract**

***Background:*** Retention of patients on antiretroviral therapy (ART) over time is a proxy for quality of care and an outcome indicator to monitor ART programs. Using existing databases (Antiretroviral in Lower Income Countries of the International Databases to Evaluate AIDS and Médecins Sans Frontières), we evaluated three sampling approaches to simplify the generation of outcome indicators.

***Methods and Findings:*** We used individual patient data from 27 ART sites and included 27,201 ART-naive adults (≥15 years) who initiated ART in 2005. For each site, we generated two outcome indicators at 12 months, retention on ART and proportion of patients lost to follow-up (LFU), first using all patient data and then within a smaller group of patients selected using three sampling methods (random, systematic and consecutive sampling). For each method and each site, 500 samples were generated, and the average result was compared with the unsampled value. The 95% sampling distribution (SD) was expressed as the 2.5th and 97.5th percentile values from the 500 samples. Overall, retention on ART was 76.5% (range 58.9–88.6) and the proportion of patients LFU, 13.5% (range 0.8–31.9). Estimates of retention from sampling (n = 5696) were 76.5% (SD 75.4–77.7) for random, 76.5% (75.3–77.5) for systematic and 76.0% (74.1–78.2) for the consecutive method. Estimates for the proportion of patients LFU were 13.9% (12.6–14.5), 13.9% (12.6–14.3) and 14.0% (12.5–15.5), respectively. With consecutive sampling, 50% of sites had SD within ±5% of the unsampled site value.

***Conclusions:*** Our results suggest that random, systematic or consecutive sampling methods are feasible for monitoring ART indicators at national level. However, sampling may not produce precise estimates in some sites.

**Citation:** Tassie J-M, Malateste K, Pujades-Rodriguez M, Poulet E, Bennett D, et al. (2010) Evaluation of Three Sampling Methods to Monitor Outcomes of Antiretroviral Treatment Programmes in Low- and Middle-Income Countries. PLoS ONE 5(11): e13999. doi:10.1371/journal.pone.0013999

**Editor:** Landon Myer, University of Cape Town, South Africa

**Received** June 25, 2010; **Accepted** October 19, 2010; **Published** November 10, 2010



**Funding:** Funding for this collaborative analysis using existing databases was provided by the World Health Organization. The World Health Organization participated in study design, data analysis, decision to publish, and preparation of the manuscript.

**Competing Interests:** This collaboration was initiated by the World Health Organization which funded it. The World Health Organization is part of the agencies overseeing this paper.

*E-mail: tassiej@who.int

### Introduction

As the end of 2009, more than 5 million people were receiving antiretroviral therapy (ART) in low- and middle-income countries,[1] out of 33.4 million people (estimated range: 31.1 million–35.8 million) living with HIV [2,3]. This represents a 30% increase in one year and a 13-fold increase in ART uptake in six years. Monitoring of ART programmes is critical for understanding when sites are under-performing and estimating the potential impact of treatment, at the population level and for program management at different levels of the health system. In addition, reporting of such indicators helps to sustain national and global commitment to monitor quality of care while expanding access to ART and its growing use.

Many countries are still struggling to report national programme indicators. In 2009, 70 out of 149 low- and middle-income countries (47%) reported statistics on patient retention on ART at 12 months and 30 (20%) at 48 months [4]. This outcome indicator is one of several core indicators recommended to monitor the Declaration of Commitment on HIV/AIDS during the United Nations General Assembly Special Session on HIV/AIDS (UNGASS) [5]. Although some countries have highly automated information systems, many ART sites within countries have difficulty in maintaining the register/database necessary to produce these statistics. A number of factors may explain the difficulties in generating good quality information. Many ART programmes are relatively recent, yet facing large and rapid increases in the number of patients starting therapy. They have

# Improving data monitoring

- Provide tools to screen data from facilities
- Handle Overdispersion of indicators

# Improving data monitoring

## Papers

### Bias in meta-analysis detected by a simple, graphical test

Matthias Egger, George Davey Smith, Martin Schneider, Christoph Minder

**Abstract**

**Objective:** Funnel plots (plots of effect estimates against sample size) may be useful to detect bias in meta-analyses that were later contradicted by large trials. We examined whether a simple test of asymmetry of funnel plots predicts discordance of results when meta-analyses are compared to large trials, and we assessed the prevalence of bias in published meta-analyses.

**Design:** Medline search to identify pairs consisting of a meta-analysis and a single large trial (concordance of results was assumed if effects were in the same direction and the meta-analytic estimate was within 30% of the trial); analysis of funnel plots from 37 meta-analyses identified from a hand search of four leading general medicine journals 1993-6 and 38 meta-analyses from the second 1996 issue of the *Cochrane Database of Systematic Reviews*.

**Main outcome measure:** Degree of funnel plot asymmetry as measured by the intercept from regression of standard normal deviates against precision.

**Results:** In the eight pairs of meta-analysis and large trial that were identified (five from cardiovascular medicine, one from diabetic medicine, one from geriatric medicine, one from perinatal medicine) there were four concordant and four discordant pairs. In all cases discordance was due to meta-analyses showing larger effects. Funnel plot asymmetry was present in three out of four discordant pairs but in none of concordant pairs. In 14 (38%) journal meta-analyses and 5 (13%) Cochrane reviews, funnel plot asymmetry indicated that there was bias.

**Conclusions:** A simple analysis of funnel plots provides a useful test for the likely presence of bias in meta-analyses, but as the capacity to detect bias will be limited when meta-analyses are based on a limited number of small trials the results from such analyses should be treated with considerable caution.

**Introduction**

Systematic reviews of the best available evidence regarding the benefits and risks of medical interventions can inform decision making in clinical practice and public health.[1,2] Such reviews are, whenever possible, based on meta-analysis: "a statistical analysis which combines or integrates the results of several independent clinical trials considered by the analyst to be 'combinable'."[3] However, the findings of some meta-analyses have later been contradicted by large randomised controlled trials.[4] Such discrepancies have brought discredit on a technique that has been controversial since the outset.[5] The appearance of misleading meta-analysis is not surprising considering the existence of publication bias and the many other biases that may be introduced in the process of locating, selecting, and combining studies.[6,7]

Funnel plots, plots of the trials' effect estimates against sample size, may be useful to assess the validity of meta-analyses.[8–10] The funnel plot is based on the fact that precision in estimating the underlying treatment effect will increase as the sample size of component studies increases. Results from small studies will scatter widely at the bottom of the graph, with the spread narrowing among larger studies. In the absence of bias the plot will resemble a symmetrical inverted funnel. Conversely, if there is bias, funnel plots will often be skewed and asymmetrical.

The value of the funnel plot has not been systematically examined, and symmetry (or asymmetry) has generally been defined informally, through visual examination. Unsurprisingly, funnel plots have been interpreted differently by different observers.[11] We measured funnel plot asymmetry numerically and examined the extent to which such asymmetry predicts discordance of results when meta-analyses are compared to single large trials of the same issue. We used the same method to assess the prevalence of funnel plot asymmetry, and thus of possible bias, among meta-analyses published in leading general medicine journals and meta-analyses disseminated electronically by the Cochrane Collaboration.

**Methods**

**Measures of funnel plot asymmetry**

We used a linear regression approach to measure funnel plot asymmetry on the natural logarithm scale of the odds ratio. This corresponds to a regression analysis of Galbraith's radial plot,[12] although in the present context the regression is not constrained to run through the origin. The standard normal deviate (SND), defined as the odds ratio divided by its standard error, is regressed against the estimate's precision, the latter being defined as the inverse of the standard error (regression equation: $\text{SND} = a + b \times \text{precision}$). As precision depends largely on sample size, small trials will be close to zero on the x axis. Small trials may produce an odds ratio that differs from unity, but because the

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# Improving data monitoring

Papers

## Bias in meta-analysis detected by a simple, graphical test

Matthias Egger, George Davey Smith, Martin Schneider, Christoph Minder

### Abstract

**Objective:** Funnel plots (plots of effect estimates against sample size) may be useful to detect bias in meta-analyses that were later contradicted by large trials. We examined whether a simple test of asymmetry of funnel plots predicts discordance of results when meta-analyses are compared to large trials, and we assessed the prevalence of bias in published meta-analyses.

**Design:** Medline search to identify pairs consisting of a meta-analysis and a single large trial (concordance of results was assumed if effects were in the same direction and the meta-analytic estimate was within 30% of the trial); analysis of funnel plots from 37 meta-analyses identified from a hand search of four leading general medicine journals 1993-6 and 38 meta-analyses from the second 1996 issue of the *Cochrane Database of Systematic Reviews*.

**Main outcome measure:** Degree of funnel plot asymmetry as measured by the intercept from regression of standard normal deviates against precision.

**Results:** In the eight pairs of meta-analysis and large trial that were identified (five from cardiovascular medicine, one from diabetic medicine, one from geriatric medicine, one from perinatal medicine) there were four concordant and four discordant pairs. In all cases discordance was due to meta-analyses showing larger effects. Funnel plot asymmetry was present in three out of four discordant pairs but in none of concordant pairs. In 14 (38%) journal meta-analyses and 5 (13%) Cochrane reviews, funnel plot asymmetry indicated that there was bias.

**Conclusions:** A simple analysis of funnel plots provides a useful test for the likely presence of bias in meta-analyses, but as the capacity to detect bias will be limited when meta-analyses are based on a limited number of small trials the results from such analyses should be treated with considerable caution.

### Introduction

Systematic reviews of the best available evidence regarding the benefits and risks of medical interventions can inform decision making in clinical practice and public health.[1 2] Such reviews are, whenever possible, based on meta-analysis: "a statistical analysis which combines or integrates the results of several independent clinical trials considered by the analyst to be 'combinable'."[3] However, the findings of some meta-analyses have later been contradicted by large randomised controlled trials.[4] Such discrepancies have brought discredit on a technique that has been controversial since the outset.[5] The appearance of misleading meta-analysis is not surprising considering the existence of publication bias and the many other biases that may be introduced in the process of locating, selecting, and combining studies.[6-8]

Funnel plots, plots of the trials' effect estimates against sample size, may be useful to assess the validity of meta-analyses.[4 9 10] The funnel plot is based on the fact that precision in estimating the underlying treatment effect will increase as the sample size of component studies increases. Results from small studies will scatter widely at the bottom of the graph, with the spread narrowing among larger studies. In the absence of bias the plot will resemble a symmetrical inverted funnel. Conversely, if there is bias, funnel plots will often be skewed and asymmetrical.

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### Methods

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**ORIGINAL ARTICLE**

## Handling over-dispersion of performance indicators

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**Objectives:** A problem can arise when a performance indicator shows substantially more variability than would be expected by chance alone, since ignoring such "over-dispersion" could lead to a large number of institutions being inappropriately classified as "abnormal". A number of options for handling this phenomenon are investigated, ranging from improved risk stratification to fitting a statistical model that robustly estimates the degree of over-dispersion.

**Design:** Retrospective analysis of publicly available data on survival following coronary artery bypass grafts, emergency readmission rates, and teenage pregnancies.

**Setting:** NHS trusts in England.

**Results:** Funnel plots clearly show the influence of the method chosen for dealing with over-dispersion on the "banding" a trust receives. Both multiplicative and additive approaches are feasible and give intuitively reasonable results, but the additive random effects formulation appears to have a stronger conceptual foundation.

**Conclusion:** A random effects model may offer a reasonable solution. This method has now been adopted by the UK Healthcare Commission in their derivation of star ratings.

Quantitative performance indicators are increasingly being used to monitor providers of health care, particularly when comparing each "institution"—which may be a health authority, hospital, or even an individual surgeon—against a "standard" or "target", which may be externally imposed or simply an average rate. A common technique for making such comparisons is to produce a confidence interval for the (possibly risk adjusted) performance in each institution and to compare it with the standard—for example, the New York State Department of Health compares individual surgeons and hospitals against the state-wide average mortality rate for coronary artery bypass graft surgery.[1] It is natural to present such analyses as "forest" or "caterpillar" plots similar to those commonly used in meta-analysis. Figure 1A shows 95% confidence intervals for 30 day mortality in 25 hospitals conducting bypass grafts in England in 2002–2003,[2] in which the standard is the national average (these and all other data in this paper can be downloaded from Commission for Health Improvement (CHI)[3] which contains full details of the construction of the indicator and the names of all institutions).

An alternative way of presenting such data is by a "funnel" plot, which has been recommended as a means of avoiding the rather spurious ranking explicit in caterpillar plots and is used in an increasing number of applications;[4–6] it also avoids any difficulties assigning 95% intervals for low counts. This plots the observed indicator against a measure of its precision (typically the sample size), superimposes the target as a horizontal line, and indicates thresholds at which the observed indicator is significantly different from the target; 95% and 99.8% limits correspond to testing whether the observation is significantly different from the target at the two sided $p<0.05$ and $p<0.002$ levels. This relates to the use of control charts[10] which typically use 3 standard deviations as indicating a system is not "in control": 3 standard deviations essentially corresponds to the 99.8% limits and 2 standard deviations to 95%. The two sets of limits might be taken as indicating a "warning" and an "alarm".

A funnel plot of the English data on coronary artery bypass grafts is given in fig 1B, showing five hospitals in the "warning" sector and one "alarm". It needs to be strongly emphasised that these indications take no formal account of the multiple comparisons implicit in the funnel plot and that crossing a threshold does not indicate high or low "quality", but it may be useful to investigate reasons for the apparent discordance.

### OVER-DISPERSION

Figure 2 shows readmission rates within 30 days following discharge from hospitals in England.[11] The pattern is clearly different from that of fig 1 in that the majority of hospitals now lie outside the 99.8% threshold indicating "in control" institutions; the number lying in each of the five bands formed by the four control limits is shown in row 2 of table 1.

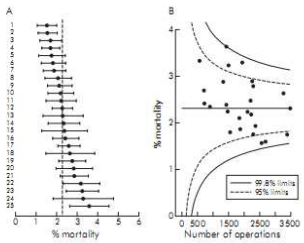


**Figure 1** 30 day mortality following coronary artery bypass grafts in 25 English NHS acute trusts, 2002–2003.[2] (A) A "forest" plot showing 95% confidence intervals compared with the "target" overall average rate. (B) A "funnel" plot of observed rate against number of operations showing trusts that differ from the target at the two sided $p<0.05$ and $p<0.002$ levels, essentially corresponding to 2 and 3 standard deviations from the target.

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# Provide new tools for data analysis

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## Correcting Mortality for Loss to Follow-Up: A Nomogram Applied to Antiretroviral Treatment Programmes in Sub-Saharan Africa

Matthias Egger[1]*, Ben D. Spycher[1], John Sidle[2], Ralf Weigel[3], Elvin H. Geng[4], Matthew P. Fox[5], Patrick MacPhail[6], Gilles van Cutsem[7], Eugène Messou[8], Robin Wood[9], Denis Nash[10], Margaret Pascoe[11], Diana Dickinson[12], Jean-François Etard[13], James A. McIntyre[14], Martin W. G. Brinkhof[1], for IeDEA East Africa, West Africa and Southern Africa

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**Abstract**

*Background:* The World Health Organization estimates that in sub-Saharan Africa about 4 million HIV-infected patients had started antiretroviral therapy (ART) by the end of 2008. Loss of patients to follow-up and care is an important problem for treatment programmes in this region. As mortality is high in these patients compared to patients remaining in care, ART programmes with high rates of loss to follow-up may substantially underestimate mortality of all patients starting ART.

*Methods and Findings* We developed a nomogram to correct mortality estimates for loss to follow-up, based on the fact that mortality of all patients starting ART in a treatment programme is a weighted average of mortality among patients lost to follow-up and patients remaining in care. The nomogram gives a correction factor based on the percentage of patients lost to follow-up at a given point in time, and the estimated ratio of mortality between patients lost and not lost to follow-up. The mortality observed among patients retained in care is then multiplied by the correction factor to obtain an estimate of programme-level mortality that takes all deaths into account. A web calculator directly calculates the corrected, programme-level mortality with 95% confidence intervals (CIs). We applied the method to 11 ART programmes in sub-Saharan Africa. Patients retained in care had a mortality at 1 year of 1.4% to 12.0%; loss to follow-up ranged from 2.8% to 28.7%; and the correction factor from 1.2 to 8.0. The absolute difference between uncorrected and corrected mortality at 1 year ranged from 1.6% to 9.8%, and was above 5% in four programmes. The largest difference in mortality was in a programme with 28.7% of patients lost to follow-up at 1 year.

*Conclusions:* The amount of bias in mortality estimates can be large in ART programmes with substantial loss to follow-up. Programmes should routinely report mortality among patients retained in care and the proportion of patients lost. A simple nomogram can then be used to estimate mortality among all patients who started ART, for a range of plausible mortality rates among patients lost to follow-up.

*Please see later in the article for the Editors' Summary.*

Citation: Egger M, Spycher BD, Sidle J, Weigel R, Geng EH, et al. (2011) Correcting Mortality for Loss to Follow-Up: A Nomogram Applied to Antiretroviral Treatment Programmes in Sub-Saharan Africa. PLoS Med 8(1): e1000390. doi:10.1371/journal.pmed.1000390

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Competing Interests: The authors have declared that no competing interests exist.

Abbreviations: AMPATH, Academic Model Providing Access to Healthcare; ART, antiretroviral therapy; ART-LINC, ART in Low-Income Countries; CDC, US Centers for Disease Control and Prevention; CI, confidence interval; IeDEA, International epidemiologic Databases to Evaluate AIDS; WHO, World Health Organization

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## Funnel plots for comparing institutional performance

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SUMMARY

'Funnel plots' are recommended as a graphical aid for institutional comparisons, in which an estimate of an underlying quantity is plotted against an interpretable measure of its precision. 'Control limits' form a funnel around the target outcome, in a close analogy to standard Shewhart control charts. Examples are given for comparing proportions and changes in rates, assessing association between outcome and volume of cases, and dealing with over-dispersion due to unmeasured risk factors. We conclude that funnel plots are flexible, attractively simple, and avoid spurious ranking of institutions into 'league tables'. Copyright © 2004 John Wiley & Sons, Ltd.

KEY WORDS: control charts; outliers; over-dispersion; institutional profiling; ranking

### 1. INTRODUCTION

Demands for increased accountability of public services have led to increased attention to institutional comparisons on the basis of quantitative outcome measures, whether school examination results, surgical mortality rates, or research output from universities. Here 'institution' refers to any unit of analysis, which in the health context could be a health authority, hospital, surgical team or even an individual named surgeon. Such comparisons commonly lead to the production of 'league tables', in which institutions are ranked according to a performance indicator and, possibly with the aid of confidence intervals, 'outlying' institutions identified. For example, Figure 1 shows a league table of hospitals based on mortality following a fractured hip—this display is similar to that of the original publication [1].

Such presentations have been criticized as leading to a spurious focus on rank ordering, when it is known that the rank of an institution is one of the most difficult quantities to estimate [2, 3]. Mohammed *et al.* [4] argued strongly that a more appropriate presentation would be based on Shewhart's control charts [5], in which 'in-control' institutions are assumed to be subject to 'common-cause' variability, whereas those that are 'out-of-control' will exhibit

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