

# **Botswana's Lab-In-A-Briefcase – A Position Paper**

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- What is a Lab-in-Briefcase?
- A Novel eHealth Extension Initiative for Sub-Saharan Countries (NeEISS)
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- Significance of Project NeEISS
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# Introduction – Needs Statement

**Detecting and managing communicable and non-communicable diseases in rural settings of Africa raises numerous structural, syntactical and semantic issues.**

**Both Communicable Diseases (CDs) such as TB and Non-Communicable Diseases (NCDs), such as cancer, diabetes, cardiovascular diseases and chronic respiratory disease, are on the rise in sub-Saharan African countries and estimated to account for about 25% of deaths (Bloomfield et al., 2014) [8].**

In Botswana, NCDs are estimated to account for 37% of all deaths in the country (WHO NCD country profile, 2014) [9]. This has created a huge burden to the healthcare system which is already resource constrained.

One approach to reducing death related to CD/NCD is early detection and control through data collection and appropriate intervention.

**In sub-Saharan Africa countries, the majority of the population lives in rural areas where access to healthcare facilities is very limited.**

A low-cost and mobile healthcare facility along with associated Information and Communication Technologies (ICT) would be of great assistance.

# What is a Lab-in-Briefcase?

- ***“Lab-in-a-briefcase”* provides a portable laboratory diagnosis toolkit with rapid results (about 15 minutes) that can be used in areas where access to laboratory or healthcare facility is limited and can be used with minimal training.**
- **It contains all the necessary tools and chemicals/reagents which are packaged in a briefcase form so that they can easily be carried. In addition, the Lab-in-a-briefcase employs mini-HPLC and smart camera, microphone, credit card-sized ECG and microscope so that a variety of tests can be performed quickly and efficiently in a portable manner.**
- The design and deployment of *“Lab-in-a-briefcase”* and associated software tools at primary care health facilities so that diagnosis can be quickly carried out and the resulting medical records are automatically generated, converted into appropriate format and securely shared with different health information systems.
- The deployment of this system requires adaptation of the system in the context of the linguistic, legal, security, and other policy requirements of the participating countries.
- As part of the demonstration of the applicability, pilot studies will be extended to all participating African countries.
- Our end-objective is to develop a fully optioned prototype.

# A Novel eHealth Extension Initiative for Sub-Saharan Countries (NeEISS)

Cultural and Survival Quarterly Magazine [1] on sub-Saharan Africa:

- i) *It is a diverse region of 47 countries stretching from the rolling savannas south of the Sahara desert to the coastal mountains and valleys of the Cape,*
- ii) *70 percent of the people in Sub-Saharan Africa still lack basic healthcare, civil liberties and human rights,*
- iii) *Humanitarian crisis as a combination of drought, civil conflict, and economic decline threaten nearly 60 million of the region's 550 million people, iv) Millions more, possibly a quarter of the total population, are poverty-stricken”.*
- iv) Sub-Saharan ethnic diversity characterizes almost every African state – for example, Nigeria contains as many as 160 different groups.
- v) Even a small country as Swaziland is occupied almost entirely by a single ethnic group, yet is subdivided along lines of kinship and social affiliation.
- vi) An additional complication is that the various African societies speak as many as 2,000 different languages and have an array of religious beliefs [2].
- vii) These countries are governed by indigenous elites who also vary greatly in size and cultural characteristics.

# Deliverables of Project NeEISS

1. Deploy Smartphones as the mass mechanism for the masses to communicate information on various diseases.
2. Deploy Africa-appropriate ICT technology so that medical related information can be provided to people at large – both on just-in-time and on just-in-case bases.
3. Explore the use of cheap and reliable medical devices for community medical needs.
4. Initiate automatic health record generation and management.
5. Facilitate adaptation of ICT technologies by practitioners, nursing professionals and common people.
6. Seed an underlying infrastructure for health intelligence gathering and understanding so that people can be actively and proactively helped in many circumstances.
7. Create a common database and platform of algorithms and architectures to handle large scale information.
8. The big data analysis will help in guiding appropriate medical policies for various Governments in sub-Saharan countries.
9. Seed and/or foster two NGOs: i) “The Sweet Bodies” for helping Diabetic sufferers and ii) “People Under Pressure” for helping those with hypertension.

# Significance of Project NeEISS

*The sub-Saharan Africa is a diverse region of 47 countries stretching from the rolling savannas south of the Sahara desert to the coastal mountains and valleys of the Cape. As a result, a medical solution that can span diverse regions is required and ICT based solution is the only acceptable solution.*

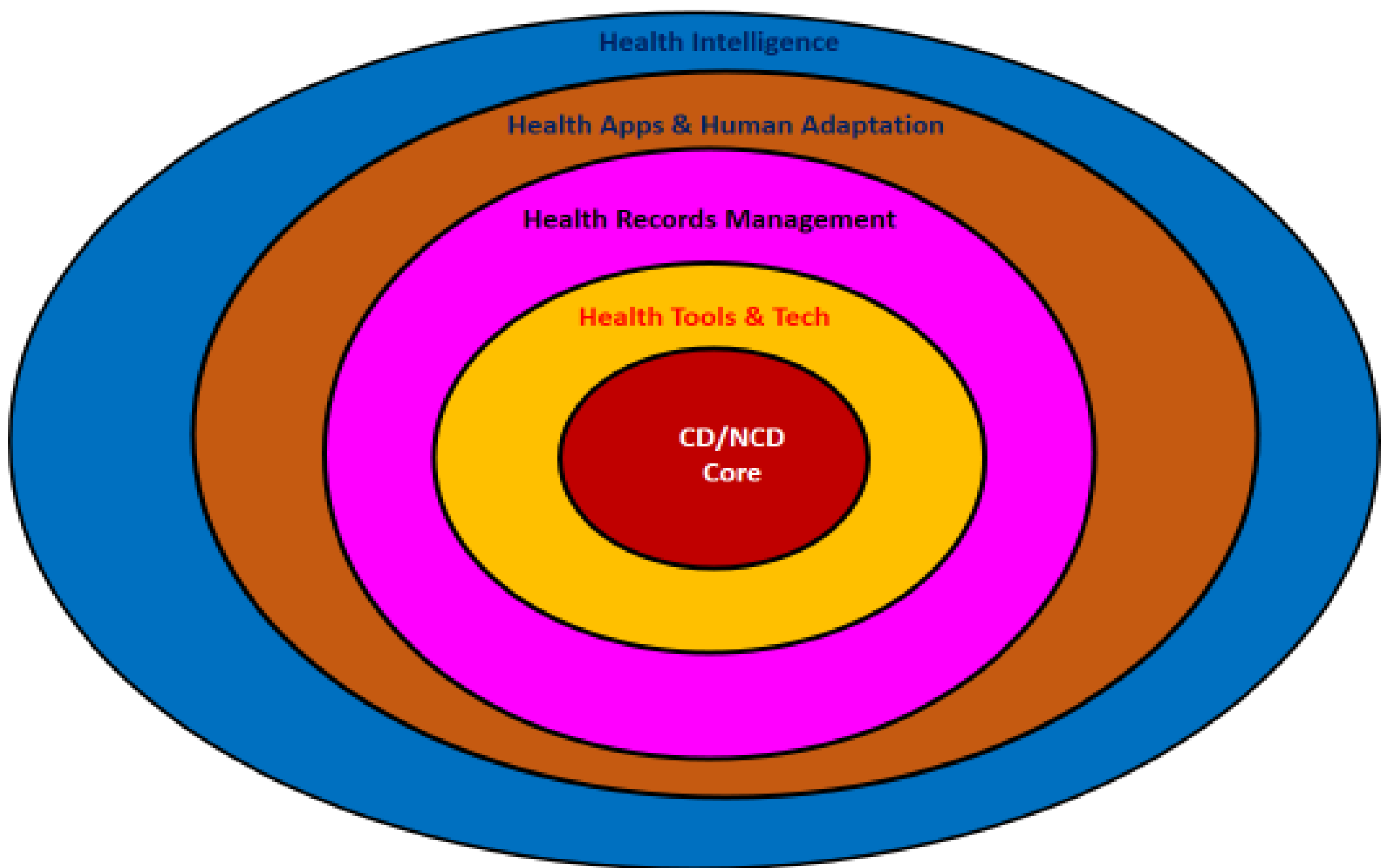
- *The gross national product (GNP) per capita averaged \$500 in 1999, ranging from less than \$200 in the [Burundi](#), [Ethiopia](#), [Malawi](#), [Niger](#), and [Sierra Leone](#) to more than \$3,200 in [Botswana](#), [Gabon](#), [Mauritius](#), and [South Africa](#). On the whole, the region's GNP growth and human development indicators lag behind those of other regions. Hence the medical solution should be cheap and once again ICT based approach satisfies this requirement.*
- *Within the continent, communications and travel are difficult. Communication through ICT based solution, in particular smartphone based approach is the best.*
- *The Cultural and Survival quarterly Magazine [1] further observes that many of the elite are reluctant to acknowledge the existence of distinct indigenous groups within their countries' boundaries. Rather than grand one groups primacy, states maintain that all resident groups are indigenous. Thus, it is extremely difficult to obtain reliable census data broken down along tribal affiliation or ethnic group membership. Targeted development at improving the living standards of groups are difficult to achieve.*

# Significance of Project NeEISS

- *Poverty is pervasive across the region. More than 290 million people live on less than \$1 per day [2]. Yet, mobile phone uptake is some 80%. This implies that smartphone based ICT solutions would have significant uptake.*
- *Africa has the lowest enrollment rate at every level and is the only region where the number of out-of-school children continues to rise. The average African adult has fewer than three years of schooling, lower than the attainment level for any other region. Almost one in three males and one in two females is illiterate. This implies that the use of Icon-driven approach would enhance use of our system by common people.*

Project NeEISS will lead to several results and achievements in the short-to-medium term in terms of medical technological uptake through ICT to the common people, while providing substantial long-term outcomes of significant empowerment of common people in the healthcare sector.



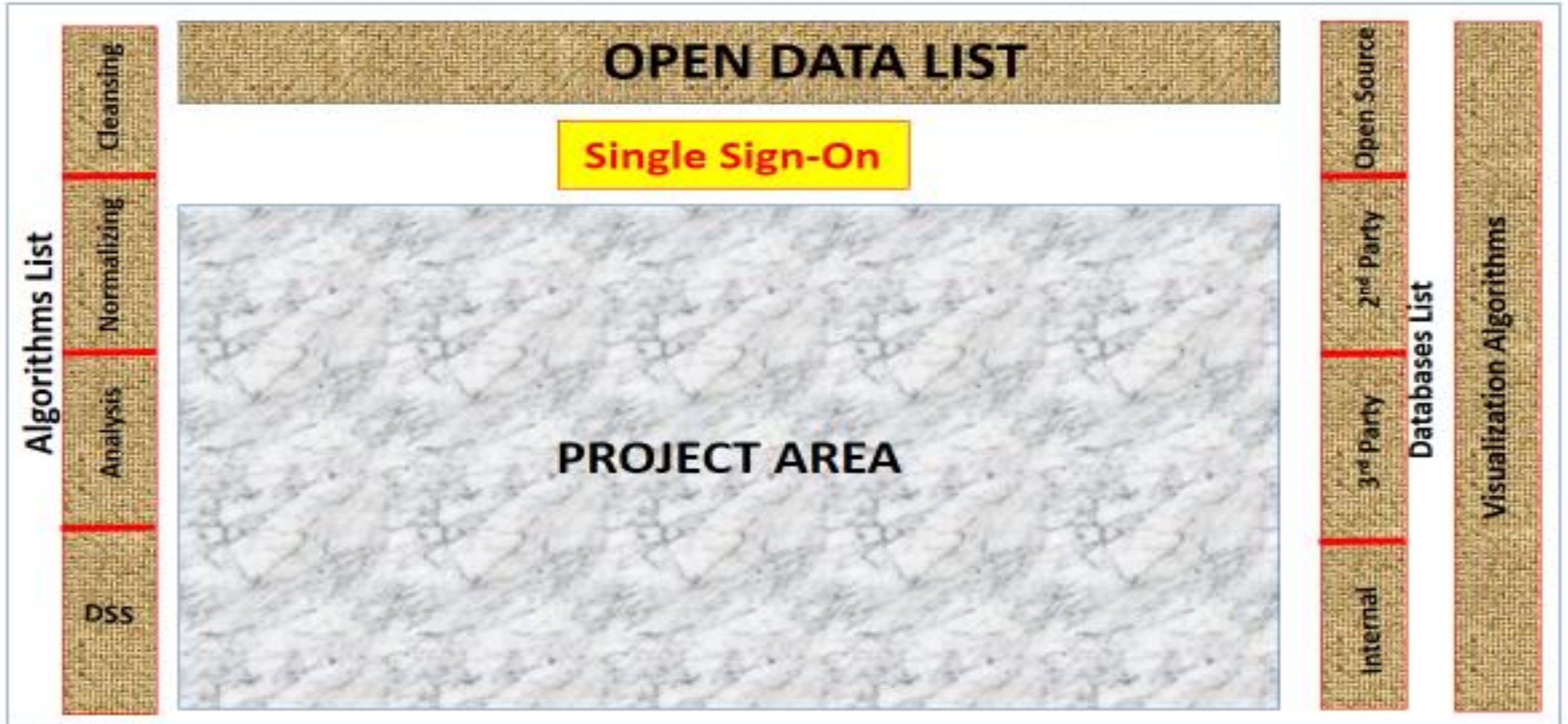


**Information Architecture of Project NeEISS**

# Five Themes of Project NeEISS

- 1. Theme-1: Developing CD/NCD Core:** Collection of CD/NCD core algorithms and providing a single point (or single Sign-on) entry to CD/NCD Databases and underlying information architecture. This also will contain corresponding National Health Registry .
- 2. Theme-2: Deployment of Health tools and technologies:** Specifically, deployment of Lab-in-a-briefcase and Smartphone Apps that are managed over Health Portals (targeting a variety of diseases specific to the countries of the sub-Saharan region).  
**Theme-3: Automatic health-records generation and management:** Development and management of health records as derived from (ii) above automatically.
- 3. Theme-4: Health Apps & Human Adaption:** Development and/or deployment of sub-Saharan specific health Apps, along with local linguistic support. This environment will run over Cloud computing environment.
- 4. Theme-5: Health Intelligence:** Seeding the design of small scale medical intelligence applications, such as *diseases follow-through, e/m Grouping of patients of interests, self-management of diseases*, and the like.

# Theme-1: Developing CD/NCD Core



**Front-End Graphical User Interfaced for Project NeEISS**

# Questions to be considered

- How to enter patient records?
- How to get the medical data from the detecting device/sensor to the computer/laptop?
- How to compress the datasets?
- How to store them locally?
- How to encrypt the data to ensure privacy?

## Theme-2: Deployment of Health Tools and Technologies

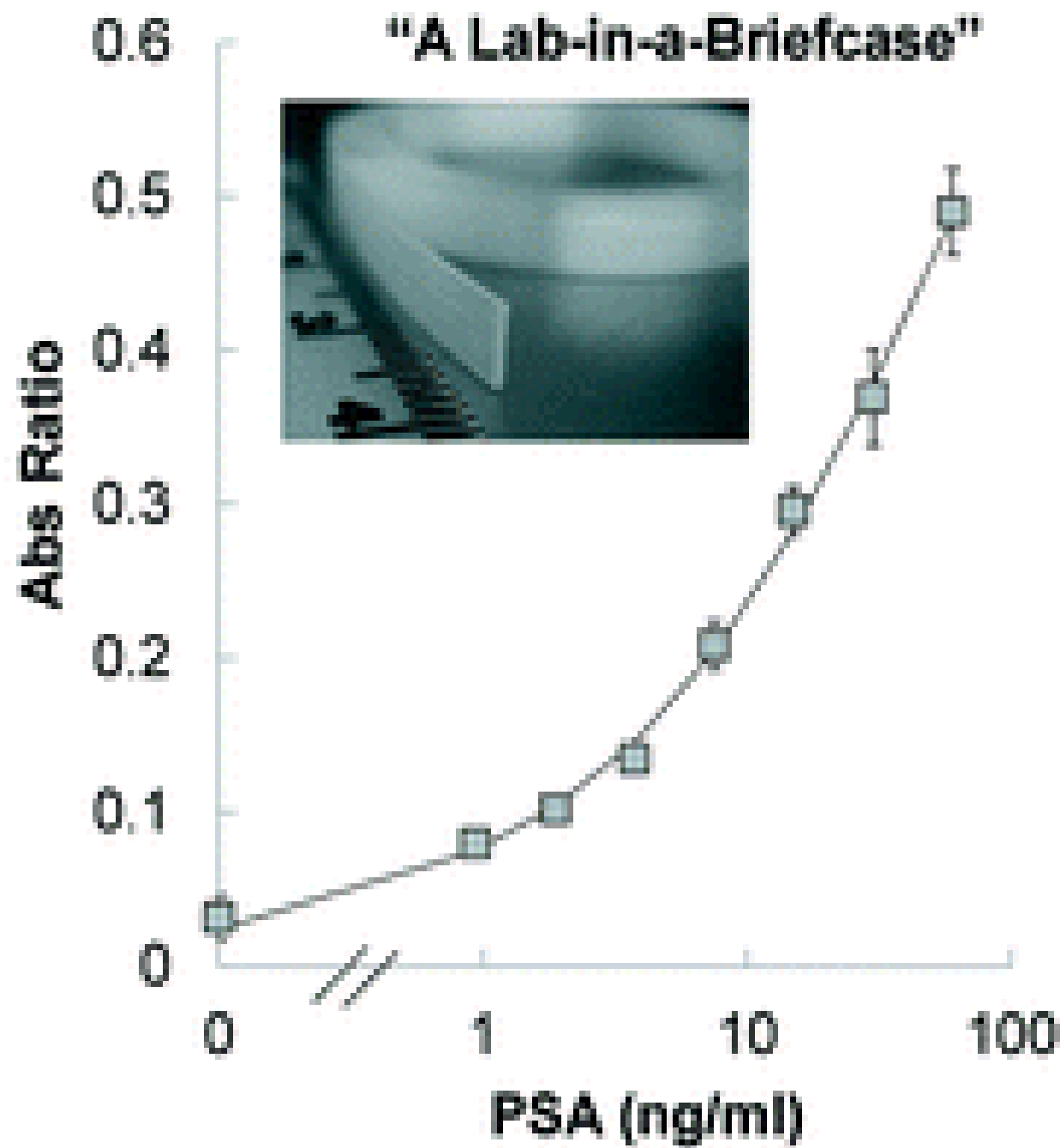
- a) Enhancing the (already existing) HIV Portal developed at the University of Botswana so that additional functionalities such as MobileApp, Personalization, Tracking of medications, etc, can be carried out.
- b) Post-HIV Health self-management App will provide a facility whereby HIV patients can monitor their medications, health and well-being on an on-going basis. This App has the ability to provide constructive feedback to the patients and has a built-in age-based feedback mechanism also.
- c) Diabetes self-management App will provide a facility whereby diabetes patients can manage their diet, sugar levels, exercise routines, pedometric observations, and other such details. The diet facility will be based on the National Institute of Health (NIH of USA) based research.
- d) Cardiovascular diseases self-management App will provide a facility whereby patients can monitor their blood pressure (current mobile technology is limited in its applicability) and heart rate, besides taking care of their diet restrictions. The diet facility will be based on the National Institute of Health (NIH of USA) based research.

## Theme-2: Deployment of Health Tools and Technologies

- e) Melanoma self-management App will provide a facility whereby patients can send pictures of their melanoma to WebMD and seek indicative opinions on the nature of melanoma, besides prevention measures.
- f) Aged-care self-management App will provide a facility whereby an aged person can be monitored on an on-going basis. The patients will be given a mobile ring/bangle/waist belt so that their vital signs can be monitored, besides giving them a ping to check their wellness conditions.
- g) Wound healing self-management App will provide a facility whereby patients can take a photo of their wounds and analyze the photo and identify wound healing/spread vectors so that appropriate medications can be applied to speed up healing; this is particularly useful for patients with such conditions as diabetes.
- h) Linguistic support provides an ability to flip between one or more African languages over an given App. Such a facility is not available only in an isolated manner, but not in an integrated manner.
- i) FAQ & Query by example App will provide a facility whereby patients can provide data set so that answers can be given based on the example. For example, a heart patient can SMS his/her ECG signals as an MMS message and the App will respond with similar ECGs and possible treatment patterns.



**Typical Lab-in-a-Briefcase** (Adapted from [13])



# Typical Instruments in a Lab-In-A-Briefcase

- Glucometer to measure blood sugar
- HBA1C analyzer\*
- Tuberculosis (TB) Analyzer (including drug-resistant variety)\*
- Rabies Analyzer\*
- Anthrax Analyzer\*
- Built-in microscope with a high resolution camera so that pictures and slides can be made easily
- Blood pressure measurement\*
- Lung air volume measurement (both for inhaling and exhaling)\*
- Pedometric observation instruments
- ECG instrument\*
- Mini-HPLC analyzer for typical proteins, metals and other trace elements
- Oxygen measurement\*
- Sperm count measurement (for both bovine and human applications)\*
- Digital Auroscope for observations and recordings of Ear, Nose and Throat (ENT) events\*
- Audiometer for measuring deafness and related ear diseases
- Instrument for eye lens corrections
- HIV testing\*
- Detection of Malaria and other such diseases\*
- Performing Biomarkers on-site\*
- Viral load analysis\*
- Detection of cancers of the Lung, Cervix, Skin, Prostate, etc



## Typical Software Systems in a Lab-In-A-Briefcase

- Slide cutting and object culling software\*
- Query –by-example (QBE) facility that can handle image, text, audio, video, signals and medical image-cuts.
- Melanoma processing software
- Wound heal understanding software
- Diet management advising software
- Digital data management for Auroscope ENT data sets
- Access to Disease Life-Cycle Analyses software systems (for cardiac, diabetics, TB, HIV and others)

# Medical Data Packing, Encryption, Communication and Records Management

- Data acquisition and packing\*
- Data Encryption\*
- Data Communication\*
- Records management & related database management

# Seeding of Medical Banking Technologies

## Localization and Customization

- Tissue typing and Bone Marrow Bank seeding and management\*
- Blood donation seeding and management\*
- Organ donation seeding and management\*

- Local linguistics support

# Theme-2: Deployment of Health Tools and Technologies

## Study Objectives

- Acquisition and training of the trainers for Lab-in-a-briefcase
- Acquisition of appropriate smartphones
- Acquisitions and customization of appropriate disease management Apps
- Demonstration of the various software, Apps and Portals
- Adaptation to local languages and customizing to the needs of partnering countries
- User indoctrination to the system and Apps
- Evaluation of system – Efficiency & Effectiveness metrics
- Understanding the policy implications for the relevant Department of Health

## Expected Outcomes

Deploy and train local personnel on software systems, Portal and Apps.

Train the local people on the relevance and importance of the systems.

Liaise with the local IT and Communication industries in order to enhance service provisions.

Use Surveys, sampling techniques, and other methods to collect datasets that are useful to our study.

Investigate policy changes with the country's Health Department.

Carry out other miscellaneous activities.

# Theme-3: Automatic Health-Records Generation and Management

## Study Objectives

- Development and customization of the Health Record Generation App and Bridging Apps to Government mandated format.
- Demonstration of the App to clinicians and health workers and getting their approval.
- Providing data protection and security
- Providing end-to-end encryption
- Providing privacy protection
- Allowing data to be stored securely over Cloud environment
- Adaptation to local languages and localized-iconic support service
- User indoctrination to the system and Apps
- Provide data portability and interoperability
- Make sure the system is HIPPA and other Legal framework compliant
- Evaluation of system – Efficiency & Effectiveness metrics.

## Expected Outcomes

- >90% uptake of most of the automatic Health record generator App by clinicians
- Education of patients and participants for self-management of their Health records
- Understanding the policy implications for the relevant Department of Health

# Theme-4: Health Apps & Human Adaption

Project NeEISS would consider the following issues:

1. Deployment in the field of tools and systems considered in Theme 2 and Theme 3
2. Training the trainers, clinicians, technicians and users on the use of tools & technologies
3. Providing FAQ Services
4. Providing local Linguistic support tools and related iconic mechanisms
5. Indoctrination of common users on the tools and systems
6. Developing appropriate training manuals
7. Development of appropriate techniques to collect data and information about the usefulness to public
8. Investigating Efficiency & Effectiveness metrics for this project
9. Investigating/Implementing changes in Healthcare Management policies & procedures
10. Understanding the impact of Lab-in-a-briefcase
11. Conducting socio-economic study of Lab-in-a-briefcase and Smartphone Apps
12. Understanding the policy implications for the relevant Department of Health

# Theme-4: Health Apps & Human Adaption

## Study Objectives

- Demonstration & Training of the Lab-in-a-briefcase
- Adaptation of Lab-in-a-briefcase into local languages
- User indoctrination to the system and Apps
- Evaluation of system – Efficiency & Effectiveness metrics
- Understanding the policy implications for the relevant Department of Health

## Outcomes

>90% uptake of Lab-in-a-briefcase by clinicians and >60% uptake by common people

Creating belief mechanisms in Lab-in-a-briefcase

Understanding the policy implications for the relevant Department of Health

# Theme-5: Medical intelligence applications

Specifically we will consider the following:

- Design of Vertical services for pharmaceuticals, cancer, diabetes, HIV and others
- Provision of FAQ Services
- Multi-lingual support tools
- Investigating/Implementing changes in Healthcare Management policies and procedures
- Design of App that facilitates electronic/mobile (e/m) Support Group formation amongst patients sharing common interests and the like.
- Understanding the policy implications for the relevant Department of Health



# Theme-5: Medical intelligence applications

## Study Objectives

- Demonstration and application to Epidemiological studies
- Active usage of e/m Support Groups amongst patients sharing commons interests.
- Adaptation of the Apps to local languages
- User indoctrination to the system and Apps
- Evaluation of system – Efficiency & Effectiveness metrics

## Outcomes

>90% uptake of most of the Apps by clinicians and >60% uptake by common people

Active and vibrant e/m Support Groups amongst patients sharing commons interests.

Understanding the policy implications for the relevant Department of Health

# CROSS-CUTTING CONCERNS BETWEEN ANY TWO THEMES

Issues between Theme-1 and Theme-2	Issues between Theme-2 and Theme-3	Issues between Theme-3 and Theme-4	Issues between Theme-4 and Theme-5
<ul style="list-style-type: none"><li>• How to enter patient records?</li><li>• How to get the medical data from the detecting device/sensor to the computer/laptop?</li><li>• How to compress the datasets?</li><li>• How to store them locally?</li><li>• How to encrypt the data to ensure privacy?</li></ul>	<ul style="list-style-type: none"><li>• How to encrypt the data to ensure privacy?</li><li>• Secure transmission of patient datasets</li><li>• Records conversion</li><li>• Records interoperability</li><li>• Managing medical legal issues</li></ul>	<ul style="list-style-type: none"><li>• Training Trainers, clinicians and users in generation, storage &amp; Management of datasets</li><li>• Ensuring privacy protection</li><li>• Ensuring data integrity protection</li><li>• Managing interoperability of datasets between systems and nations.</li><li>• Records interoperability</li><li>• Managing medical legal issues</li></ul>	<ul style="list-style-type: none"><li>• Developing integrated database management solutions</li><li>• Multi-database querying and their optimization</li><li>• Ensuring privacy protection and composite inference</li><li>• Ensuring data integrity protection</li><li>• Managing medical ethical issues</li><li>• Managing medical legal issues</li></ul>

# CONCLUSIONS

Project NeEISS, which is based on the concept of lab-in-a-briefcase so that lab facilities and Communicable and non-communicable diseases present among rural population can be detected locally and the information processed and sent to the city specialists for further perusal and considerations.

The five themes of Project NeEISS detail various technical challenges and underlying study objectives and outcomes.

Cross-cutting concerns between the themes are also explained.

Once operational Project NeEISS will provide extensive medication service the sub-Saharan population of Africa.

The level of health literacy amongst people need not be high for this project to succeed, as significant training is envisaged thru' (formally and informally qualified) nurse-practitioners.

The deployment of the project thru' appropriate source/s of funding, and taking them to the very people that deserve the facility is the future challenge.

A silhouette of an acacia tree and an ostrich against a sunset sky. The tree is on the left, and the ostrich is on the right. The sky is a mix of orange and yellow, with some clouds. The text "Thank You All" is written in black, bold, sans-serif font in the upper right quadrant.

**Thank You All**