

# Delivering Better HIV Care in Sub-Saharan Africa Using Phone-Based Clinical Summaries and Reminders

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Hi, my name is Yaw Anokwa and this is my general talk on “Delivering Better HIV Care in Sub-Saharan Africa Using Phone-Based Clinical Summaries and Reminders”.

This is work that is advised by Gaetano Borriello from UW-CSE and Tapan Parikh from Berkeley iSchool. Both are on my committee, along with Richard Anderson from UW-CSE, Neal Lesh from D-Tree International, and Sherrilyne Fuller from UW’s School of Public Health and Community Medicine. Sherrilyne is also the GSR for the exam.

# Talk Outline

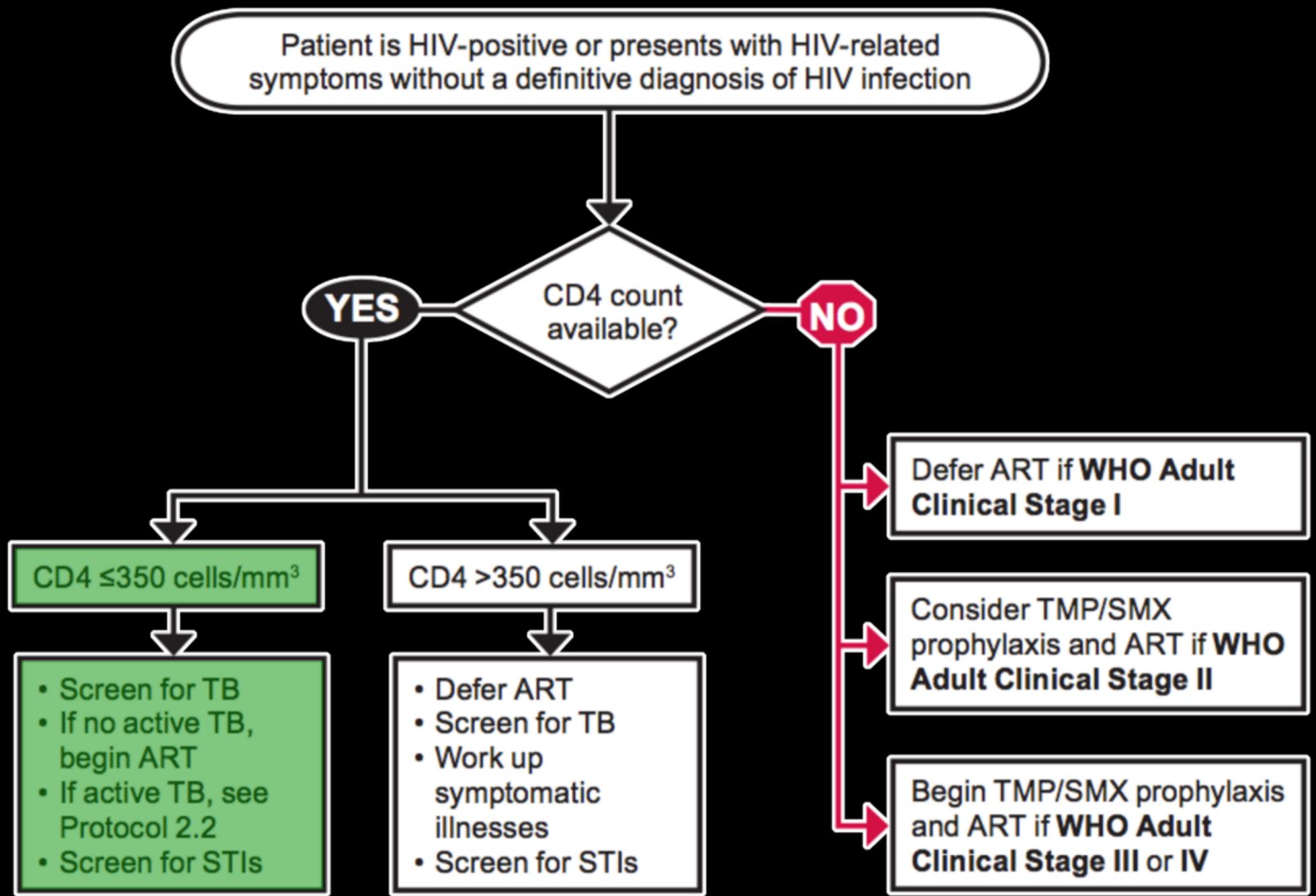
- Explain context of HIV care in Sub-Saharan African and the need for summaries and reminders.
- Explore medical records, clinical reminders, mobile information systems for implications of related work.
- Discuss development and evaluation of proposed clinical summary and reminders system.

I'm going to begin this talk by using some scenarios to explain the context of HIV care and need for clinical summaries and reminders.

I'll go into the related work to give you an overview of what others have done in medical records, clinical reminders and mobile information systems. I'll touch on what the implications of that research are.

Finally, I'll discuss my proposal -- the development and evaluation of a phone-based clinical summaries and reminders system designed to increase the quality of HIV care in Sub-Saharan Africa. The idea behind this system is for providers to use phones to pull up relevant clinical information about a patient.

If you have you questions at any time, feel free to ask.



For most patients in Africa, HIV status is first determined in a clinical or community health care visit. In such visits, the patient is counseled about HIV and tested to determine status.

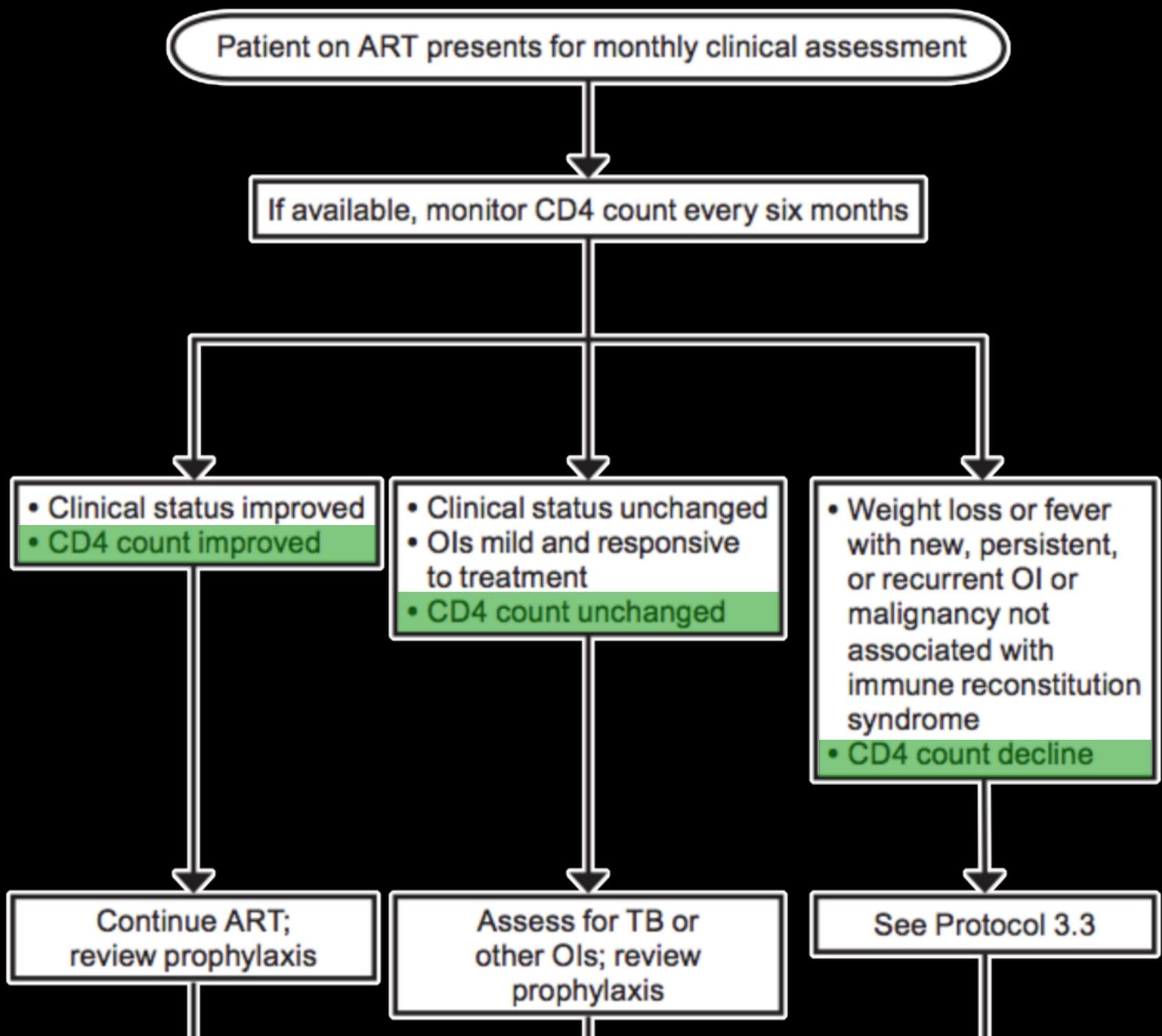
If the patient is positive in that initial test, a CD4 test is performed to determine how much damage the virus has caused.

Once those results come back, you have two options. As you can see in the green, if the CD4 count is low, say under 350 cells/mm<sup>3</sup>,

the patient is screened for major illnesses and enrolled on an antiretroviral (ART) drug regimen -- a cocktail of drugs.

If CD4s are not available, you have more options, but generally CD4s are available.

ARTs are not a cure for the disease, but instead control the viral load in the body.

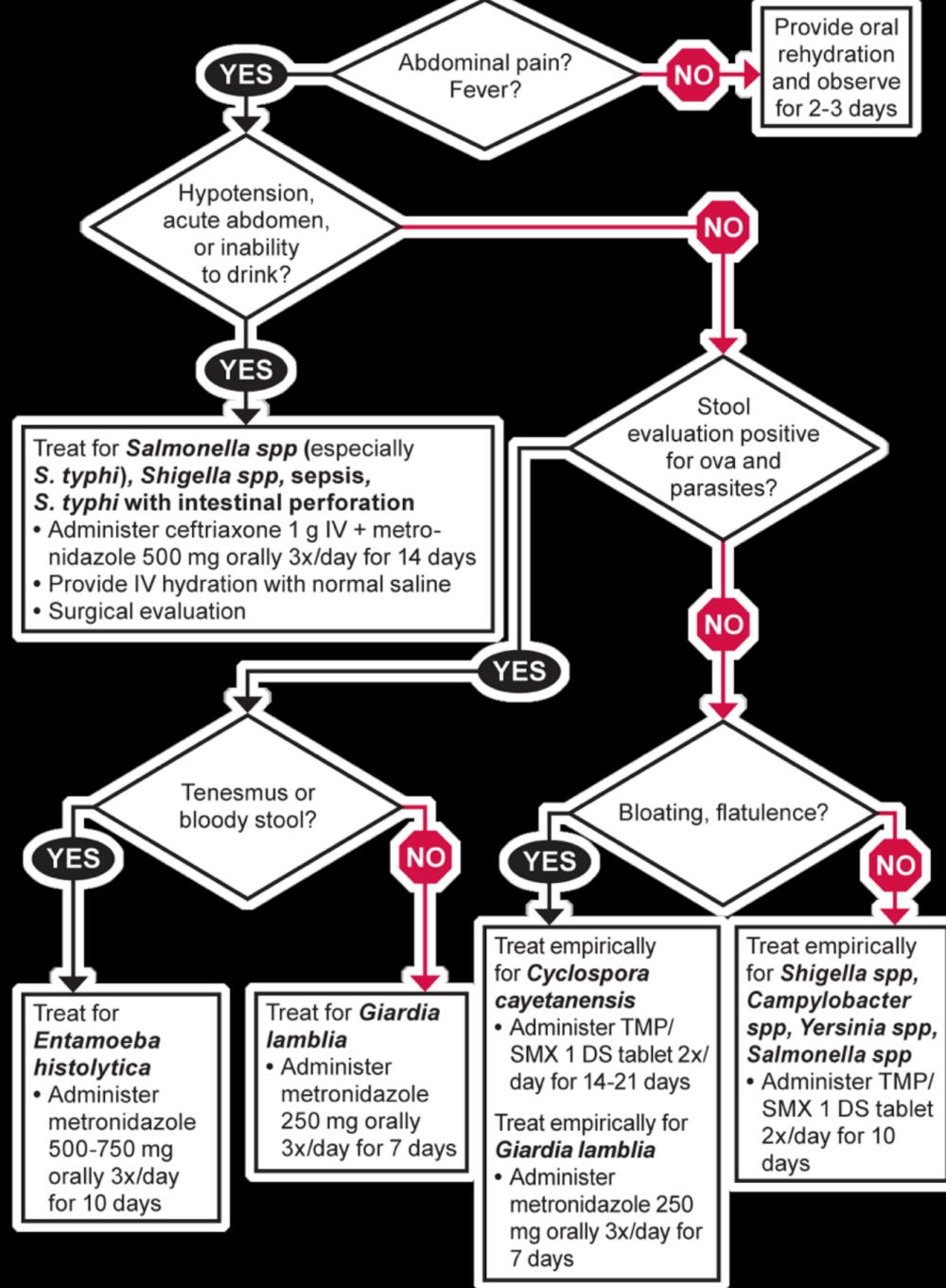
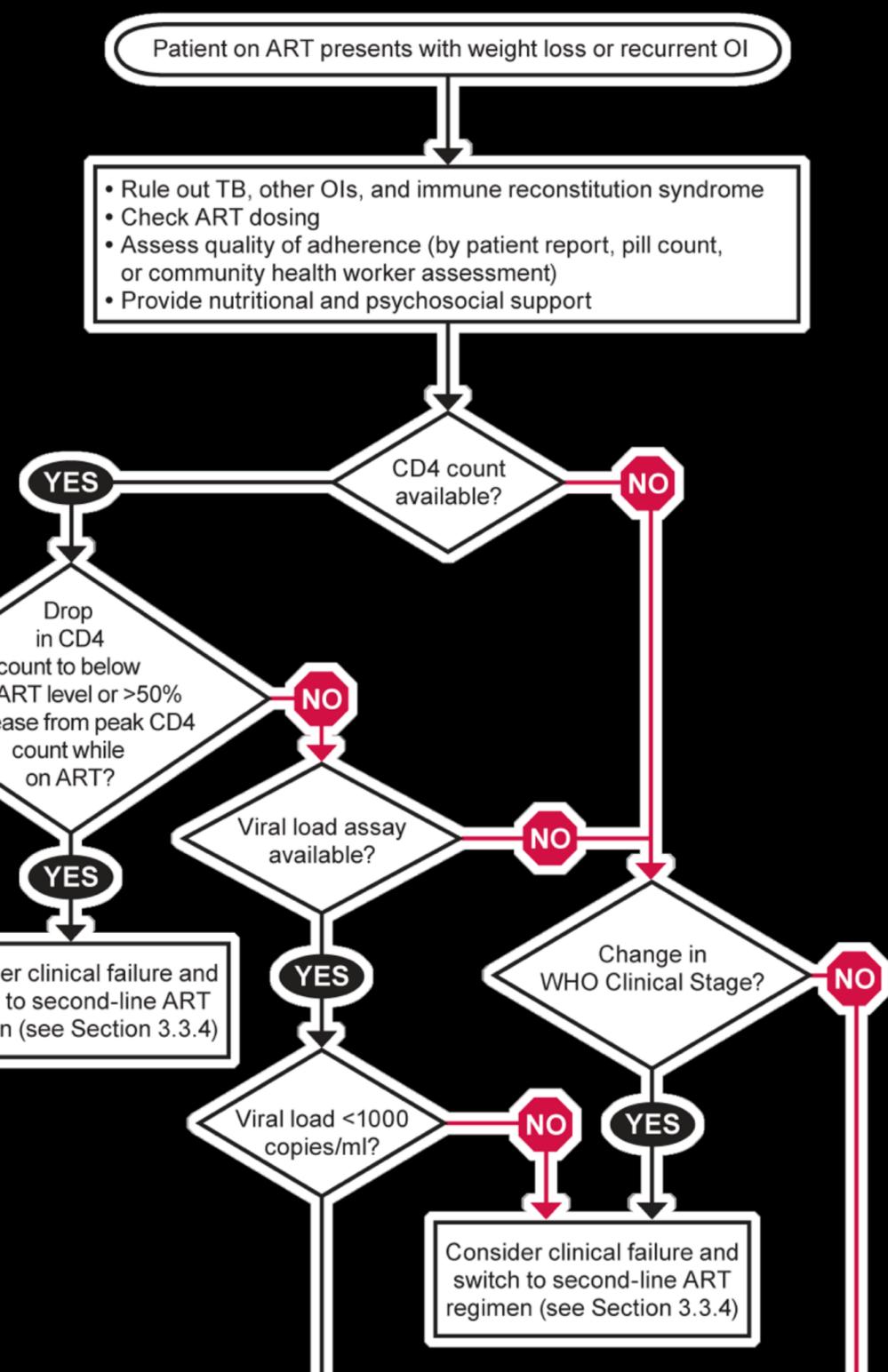


Widely followed care guidelines specify that patients on ARTs be evaluated monthly to track laboratory results, regimen changes, and any adverse events.

The care is fairly algorithmic.

If you look at the green highlights, the key thing here is that no matter what you are doing, you rely on the CD4 count and viral load to track how well a patient is doing.

ARTs must be taken daily for the rest of the patient's life. As the virus evolves or opportunistic infections develop, providers modify the combination of drugs to ensure the patient stays healthy.



As you can see, there are plenty of guidelines for this care.

But as infections crop up, it can get pretty complex, and you end up gathering and keeping a lot of data about how well a patient is doing.



With a small number of patients in a clinic, this data can be monitored using detailed paper records.

But as the number of patients increase, the relevant data quickly grows to unmanageable levels.

With search and retrieval limited to paper, critical information is not available to providers at the point of care.

Increasingly, electronic medical records (EMRs) systems are being used in low-income regions to help manage patient data. In clinics where EMRs are being used, the process of using patient data is still primarily paper-based. In fact, the pictures I've showed you so far come from hospitals with EMRs.

Here you can see data entry clerks typing in patient data.

Let me give you a quick overview of the process.



With paper, it is easy  
to lose patient history  
or miss trends in data.

When providers see patients, they complete paper forms that document the encounter.

These forms are eventually added to a patient's chart. Every few days, the encounter form (along with lab data) is manually entered into an electronic system and then returned to the patient's chart.

When that patient returns for a monthly visit, the provider reviews the patient's record on paper using past encounters and lab results to guide decision making.

The providers operate only with paper. All the data that is typed about the patient in the EMR is never fed back to the providers.

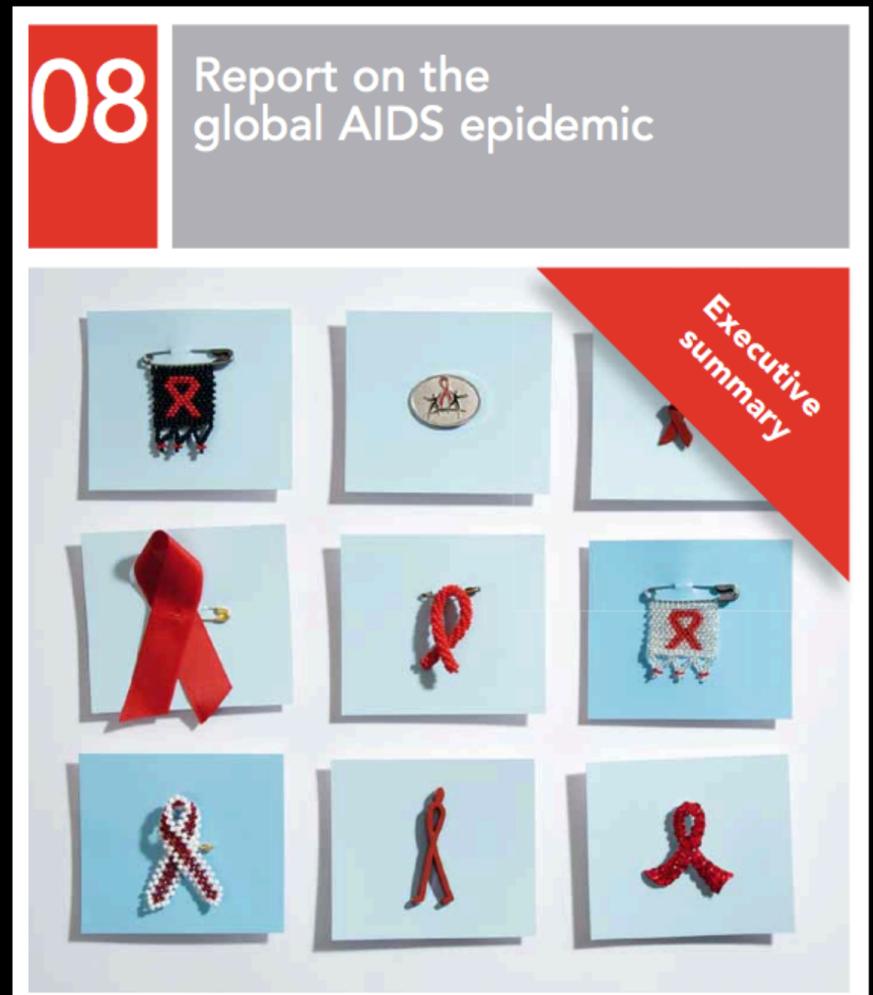
The most important thing is this about this process is this. It is easy to lose a patient's history, or miss trends in the CD4 count or overlook a step in the care guidelines.

Turns out rather than providing support in the form of patient-level recommendations, many of these EMRs focus on reporting aggregate statistics to institutional stakeholders.

Patient data entered into EMRs are not used by doctors. It is aggregated and sent to institutional stakeholders.

Sub-Saharan Africa has 25% of the global burden of disease but only 3% of the world's health workers.

Healthcare providers need patient level data.



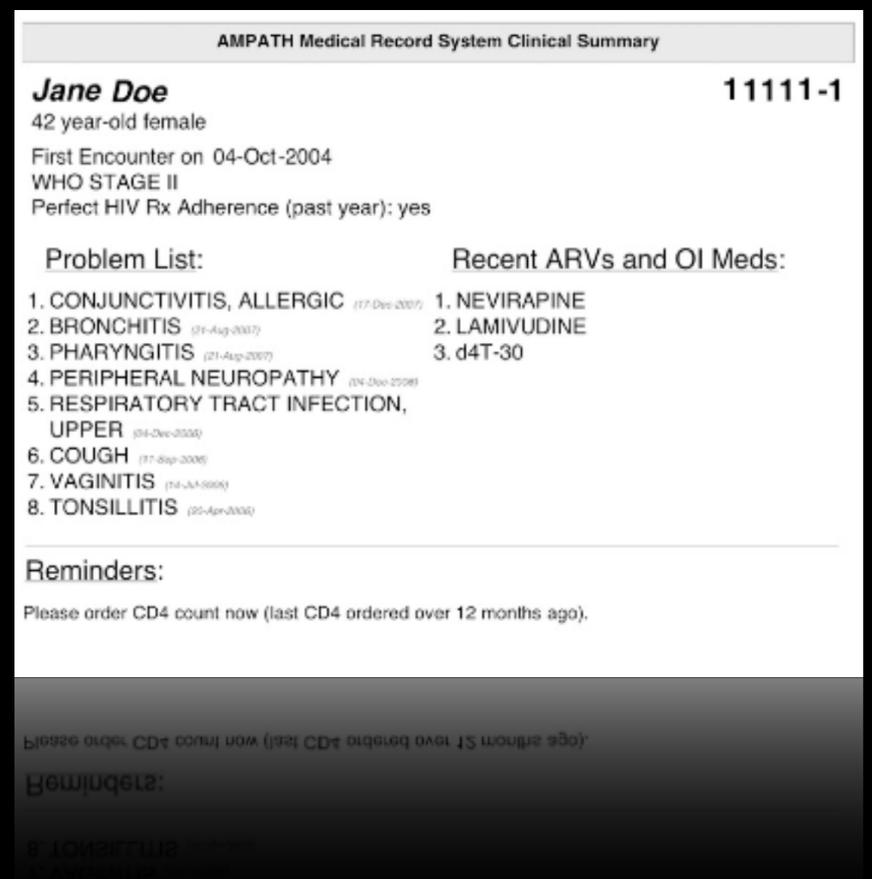
Those stakeholders then make reports to funders and other higher level stakeholders.

This is unfortunate because healthcare in developing countries is primarily delivered by overworked providers who might benefit from this assistance. In fact Sub-Saharan Africa has 25% of the global burden of disease but only 3% of the world's healthcare workers.

Healthcare providers need more patient level data to be more efficient.

There has been recent work that has tried to address this problem.

Printed summaries have significantly increased compliance with guidelines in multiple deployments.



- Reliability challenges: 39% of reminders were not printed due to computer or printer unavailability.
- Adoption challenges: Consider sending reminders to mobile devices or desktop computers

At AMPATH in Kenya, We put printed clinical summaries and reminders like these inside the patient's chart.

In their trials, they showed that printed summaries improved compliance with CD4 testing guidelines. The reminders pointed out deficiencies in care, like a late CD4 test.

Fantastic. Why not scale this up? Well, there were reliability problems.

Turns out 39% of the summaries were not printed. Either the computer or the printer in the clinic was down or the nurse was busy.

A year later at AMPATH, Noormohammad tried something similar with paper reminders and had problems with adoption. They recommend future work should try sending reminders to mobile devices or computer terminals.

This idea of using computer terminals is not new.

Summaries on a desktop computer are hard to implement in the average clinic.



## Paul Persil Patient

Gender **Male**  
 Age **44 years** (~ Jun 01, 1934)  
 Last Visit **1 week ago** (Aug 14, 2008)  
 Doug Doctor, Rwinkwavu Hospital

TRACnet ID: 12345  
 Carte d'Identité: 1234567

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IMB ID **12345678-A**

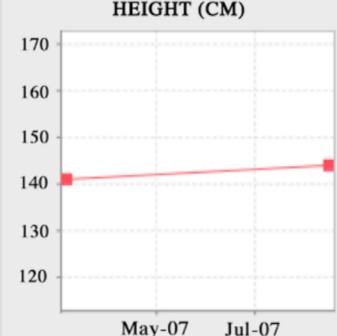
Alerts	Notes
<b>NO XRAY RESULT IN THE LAST 6 MONTHS</b> <b>NO CXR RESULT</b>	No known allergies

Drug Order	Dose	Frequency	Start Date	Stop Date	Notes
<b>AZT+3TC</b>	1.0 tab(s)	2/d x 7 d/w	Sep 13, 2007		
<b>D4T</b>	150 mg	1/d x 7 d/w	Aug 02, 2007		
Triomune-40 (stopped)	1.0 tab(s)	2/d x 7 d/w	Sep 01, 2007	Sep 13, 2007	Unexplained facial rash
EFV 600 (stopped)	1.0 mg	1/d x 7 d/w	Aug 02, 2007	Sep 13, 2007	

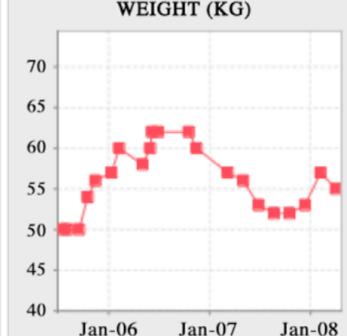
Lab Test	Result	Date	Notes
<b>CD4</b>	<b>512</b>	Aug 15, 2008	Ordered by Dr. Doctor
<b>CD4</b>	<b>259</b>	Aug 01, 2008	
<b>Viral load</b>	<b>515</b>	Jul 28, 2008	Second test for verification of status
Viral load	200	Jul 27, 2008	Ordered by Dr. Green

Graphs

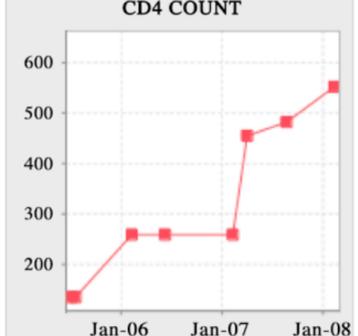
**HEIGHT (CM)**



**WEIGHT (KG)**



**CD4 COUNT**



A few years ago I built a clinical summary module for Partners in Health in Rwanda. While it was never evaluated, it is still in use in a number of countries.

It features clinical alerts, drug changes, lab tests, and graphs of trends. Pretty nice, but it only works if you have computers in every consult room, and the printers have paper, and the staff has some free time.

For a well-funded and well-run hospital, that is easy. For the average clinic in Sub-Saharan Africa, it is nearly impossible.



Add to that slow network links, and unreliable power and the harsh environment and the task becomes much harder.

That dusty box you see is the Partners in Health EMR. That room flooded a few days after I took that picture.



- Widely available device
- Powerful portable computing
- Good power management
- Ubiquitous communication
- Robust to environment
- Cheaper than desktops
- Relatively easy to deploy
- Familiar user interface

Fortunately, with the growth of mobile phone usage in low-income regions, there have come opportunities to transition to more mobile clinical summaries and reminders systems.

Phones these days are widely available. They are powerful, have reasonable battery life, and connect to a pretty ubiquitous cell network. They are pretty tough, pretty cheap, pretty easy to deploy. And as a bonus, they have familiar user interfaces.

Bottom line, is that they hold much promise. That promise is what I want to explore for my dissertation work.

# Research Contributions

- Deliver summaries and reminders despite user and infrastructure limitations.
- Enable provider decision making using phone-based flowsheets containing relevant clinical data.
- Determine if summaries, reminders and flowsheets result in greater compliance with care guidelines.

There are three contributions that I hope to make,

First, deliver summaries and reminders despite user and infrastructure limitations we've discussed.

Second, I want to make it easier for providers to make decisions. I'm hoping to use phone-based flowsheets to help doctors, nurses, supervisors, and maybe patients see the underlying data about the reminders. Flowsheets are basically tables with time on the x-axis and values on the y.

Finally, I want to determine if the summaries and reminders result in greater compliance with care guidelines. One idea I'll explore is using CD4 testing rates as an indicator for increasing the quality of care.

These contributions are built on what I've seen in the related work.

# Related Work

- **Electronic Medical Records**

Reliable storage of patient-centered data.

- **Clinical Reminders**

Best-practice guidelines and deficiency catching.

- **Mobile Information Systems**

Appropriate delivery mechanism for average clinics.

There are three broad areas that provide the foundation of this work.

First, I'll discuss Electronic Medical Record systems (EMRs) because of their ability to reliably store and generate patient-centered data. I'll focus on systems that have been deployed in low-income regions and have met the high bar of sustained operation.

From EMRs, we look at clinical reminder systems because they can automate practice guidelines and catch deficiencies in care. I'll provide a bit of the history of clinical reminders, and describe their impact on clinical care.

Finally, I'll talk about mobile information systems because they are likely the appropriate delivery mechanism.

- EMRs evaluations show more efficient visits and improvements in patient documentation.
- AMPATH, PIH, iSanté, and others use paper-based input. Paper-based output is generally unreliable.
- Focus on a better alternative with real-time and dynamic information at point of care.

The screenshot displays the MSPP Système de Collecte de Données VIH interface. The patient's name is John arifRaPwR. Key information includes:
 

- Date du éligibilité:** 05/09/2005
- Stade OMS au démarrage des ARV:** Stade II
- Régime:** ZDV-3TC-EFV
- Historique de CD4 (2 années):** A line graph showing CD4 counts (C/mm<sup>3</sup>) from 07/06 to 01/08, with values fluctuating between approximately 200 and 400.
- Historique de poids (2 années):** A line graph showing weight (Kgs.) from 07/06 to 01/08, with values fluctuating between approximately 108 and 111.
- Alertes:** A section indicating allergies to Penicillin and Cotrimoxazole (TMS), and a table for 'Changement de Régime' showing transitions between ARV regimens (ZDV-3TC-EFV, ABC-ZDV-EFV, ZDV-3TC-ABC) on various dates.

The impact of electronic medical record systems (EMRs) on clinical care in low-income regions cannot be understated. There is a lot of evidence that EMRs result in more efficient visits.

Rotich et al. in Kenya found patient visits were shorter, with clinician time per patient reduced, and patients spending less time waiting in the clinic. Similar studies show improvements in legibility of clinical notes, readily available patient charts, management of chronic diseases and, reminders and alerts about lab results and prescriptions.

Most long-lasting medical record systems in the literature are server-based, designed for low-income regions and augment existing paper-based systems. They use paper for input, but paper for output is rare. One example of these systems is the AMPATH MRS. Supports about 100k patients and uses paper-based encounter forms, has clerks entering the data, and they export paper summaries. Similar functionality exists with work from Partners in Health (PIH) in Peru, Haiti, and Rwanda and iSanté in Haiti which is shown here.

The thread that runs through this work is the input is easy, but output is not. For example, at iSanté, a decision was made to “reject preprinting forms with identification or historical information due to unreliable printing capacity at the clinic sites.” They did this even though that would have afforded “considerable workflow benefit”.

Our research will differ by focusing on providing more automated and real-time information to providers at point of care. We focus on augmenting the existing EMR system with an alternate (and possibly better) path for accessing clinical information.

- **Hard to build and sustain EMRs. Projects of all sizes fail within months of implementation.**
- **Issues of inadequate infrastructure, but problems go beyond technology and finances.**
- **Prudent to build on an existing platform where you can leverage long term relationships.**



Another common thread in the EMR literature is how hard it is to build and sustain. Projects tend to fail.

A good example is MEDCAB in Cameroon. This system was used for 14 months before it was shut down. Reasons for the failure included trained personnel leaving the facility, management giving lower attention to the project, continual hardware breakdown and departure of the main investigators. Even large (and presumably well-resourced) projects like the FUCHIA system from the experienced Doctors Without Borders have suffered a similar fate.

Work from Littlejohns et al analyzes why their health system in South Africa failed. They note that “Problems arise because of inadequate infrastructure”. This is similar to MEDCAB, but problems went beyond how hard it is to build or finance the system. In their case, the users didn’t know why the systems was being built.

Given that it seems like leveraging an existing platform and those relationships that come with it is the best approach. This is not a revolutionary finding when it comes to ICTD. Good example of this from the software piece is OpenMRS.

Of course, software is the easy part.

- Workers are burdened, so involving them early and designing iteratively is important.
- Touchscreen at Baobab Health in Malawi is an example of an effective interface designed iteratively.
- User-centered approaches in HCI4D literature provide guidelines and techniques for design.



Given the existing burdens providers face, it is critical to understand the workflow of each clinic and involve providers at each stage of the design process. Iterating with them helps ensure a usable and relevant system.

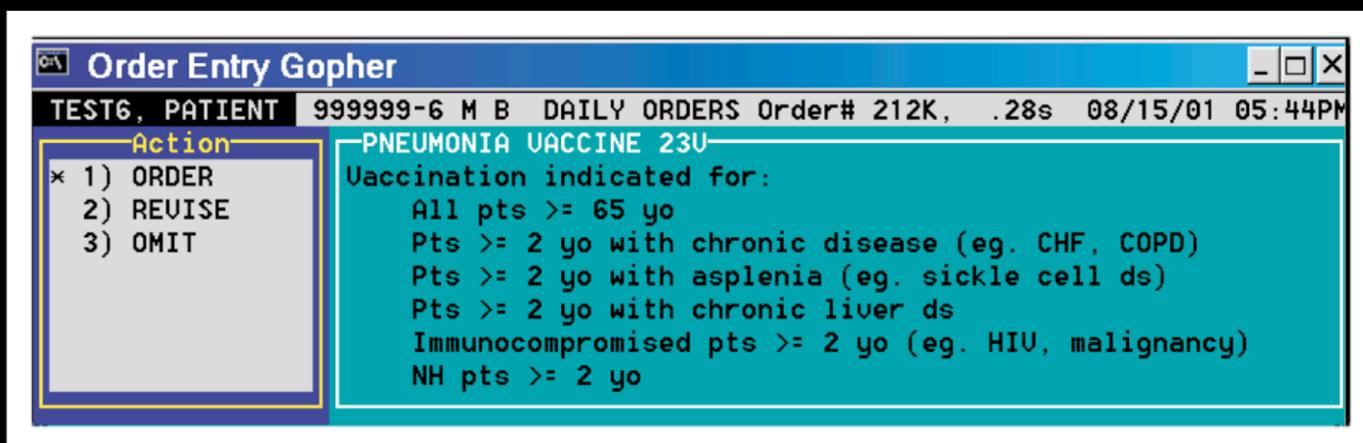
This theme is supported by work by Sequist et al. describe an electronic health record for rural and underserved Native Americans. In their survey of providers, they conclude that their research “supports prior evidence of the importance of enlisting clinician support in the implementation” phase.

There is evidence for this in Africa as well. Baobab Health's EMR has this unique simple touchscreen user interface supports over 160,000 patients. Douglas et al. report that the system is intuitive and easy to use, with providers eager to use the system and reaching proficiency with 30 minutes of training. The authors attribute their success to “an appropriately designed system”. As far as techniques go, to achieve this, what we learn previous work, is to gather feedback from stakeholders, start with small solutions, focus on usability, and build incrementally.

While these lessons apply to most human-computer interaction concerns, we must modify them with context. For that, we will build on the user-centered design methods in HCI4D. Ho et al have a great paper that details these.

Next up are clinical reminding system.

- Clinical decision support like reminders provide specific and timely information to enhance care.
- Alerts and reminders are delivered to desktop computers in consult rooms. Paper is also available.
- System design and user interface of existing systems are unlikely to work in Sub-Saharan Africa.



Broadly speaking, clinical decision support gives providers person-specific information at appropriate times to enhance care. This includes clinical guidelines, patient summaries, diagnostic support, workflow tools and of course, alerts and reminders.

The first mention of computerized reminders come from Clement McDonald in 1976 who imagined they would could bypass the imperfect memory of man. They are now delivered to computers in consult rooms where providers are seeing patients. Print outs of the reminders are a common alternative.

The implementation and interface of existing systems probably won't work in Africa. These systems assume desktop computers and often have no graphical user interface.

Here's an example.

- **Reminders and alerts are particularly critical for HIV care where providers must monitor and intervene.**
- **Effectiveness of reminders varies. Success is often reported without describing critical components.**
- **Paper-based reminders tried in low-income regions do show promise, but have reliability and scale issues.**
- **Clearly documented facilitators and barriers offer guidance but note the difficulty of implementation.**

As I noted earlier, Reminders and alerts are particularly critical for HIV care where providers must frequently monitor patient status and intervene with various treatments.

As the care is highly algorithmic, it is amenable to decision support. One study by Kitahata et al. found that HIV clinical reminders delivered at the time of care was associated with more timely initiation of recommended practice. Another by Safran et al. concluded that when alerts and reminders were linked to patient's record, adherence to HIV practice guidelines increased.

The literature exhibits discrepancies in regards to the proven effectiveness of clinical reminders on patient outcomes and physician behavior. While there have been systems that show improvements, others show little to no effect. Moreover, adherence to an individual system has been shown to vary across clinics, providers and reminders.

Much of this literature focuses on if a system worked (increased adherence to guidelines, changed patient outcomes, etc.) rather than what properties (format of reminder, delivered at point of care, etc.) contributed to success or failure. Essentially, we cannot extract the guiding principles of design. A systematic review of reminders notes that "there are no 'magic bullets'...future research will need to identify key factors that reliably predict larger improvements in care".

Narrowing the scope of the research to low-income regions, we learn that summaries and reminders provably benefit HIV care, but with some reliability and scale issue.

Were et al. in Uganda note "efficiency and quality of care can be improved through clinical summaries, even in settings with limited resources". The authors replicate and build on this success in Kenya concluding that summaries increase compliance. So while the broader reminders literature suggests the keys to success are likely context-sensitive, in Africa summaries and reminders show promise in increasing the quality of care.

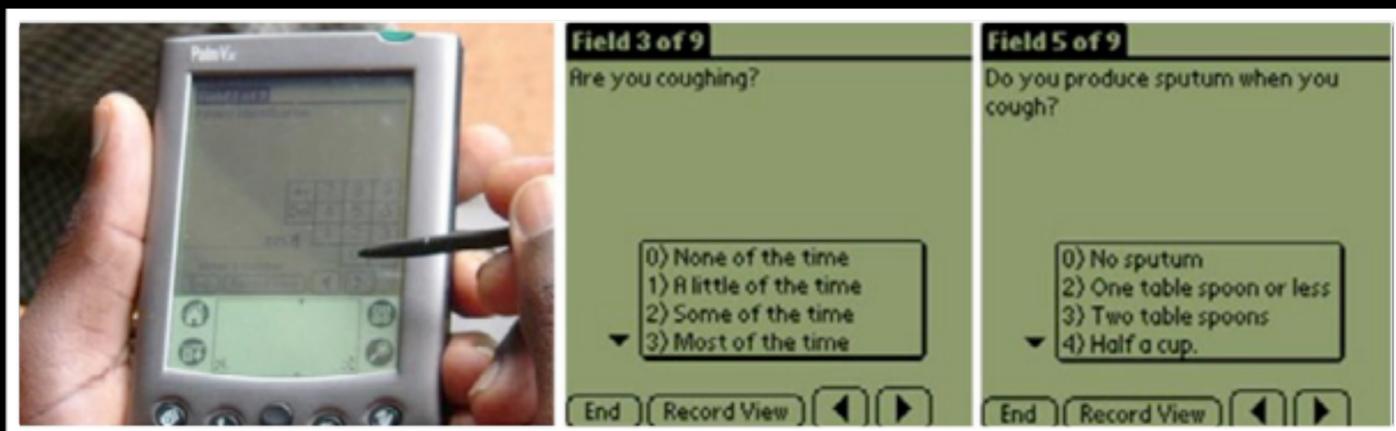
Given the importance of context, I also looked at research that identifies facilitators and barriers to adoption.

That work, primarily by Patterson et al., notes that limiting the overall number of reminders, improving integration of reminders into workflow, and adding the ability to document problems and receive feedback are critical to adoption. Sittig et al. note that improving the effectiveness of CDS interventions remain a grand challenge.

As is the case with EMRs, clinical reminders require a good understanding of the context to succeed.

So with that, let's look at the last piece of related work.

- Historically, mobile information systems for low-income regions have been PDA-based.
- In HIV, research has focused on appropriateness of technology for sensitive work.
- PDAs are functional. Adoption is dependent on usability, security and organization support.



Historically, mobile information systems for low-income regions have been PDA-based.

Early examples include a malaria morbidity survey tool in the Gambia, a Newton MessagePad-based device for nurse midwives in India, decision support for paramedics in India and Epihandy Mobile, a generic data collection system.

As the technology matured, Pendragon Forms, a commercial solution came to dominate the space. Pendragon-based systems have been used for tuberculosis result collection in Peru, surveying in Tanzania and assessing health outcomes in Kenya.

In work with PDAs and HIV, there has been a focus on how appropriate the technology is. Kurth et al. suggest that PDAs may be a culturally appropriate way to support ART adherence and safer sex for patients living with HIV in Peru. This is in contrast with work from Cheng et al. whose results suggest that using PDAs for data collection in Angola may have led to social acceptable reports of related risk behaviors. Needless to say, it is hard to generalize.

What we can broadly say is that PDAs are functional for documentation, reference and access to patient data. We know that adoption is dependent on usability, security and organization support.

Since PDAs are functional but no longer available, lessons from how they are adopted and used can be applied to newer systems like basic phones.

- Voice and SMS while popular are not applicable modalities for this work.
- Feature phones are popular due to programmability and low cost.
- Tradeoff is limited hardware and software functionality.
- Previous work shows the importance of deeply considering the platform.



Touchtone, speech and SMS-based systems used on basic phones have shown promise for delivering information in Pakistan, providing health surveillance in Peru, and data collection in India, they can't enable the rich data presentation and interaction we wish to enable with reminders.

So while systems like FrontlineSMS and RapidSMS are widely used, for our research, SMS is unreliable and expensive as a transport mechanism and is impractical for transferring large amounts of data needed deliver clinical summaries and reminders.

Feature phones add more programmability to basic phones and are typically built on Java Platform, Micro Edition (J2ME). Data collection clients like FrontlineForms, EpiSurveyor, OpenXData and JavaRosa have become powerful tools as improvements in mobile technology have trickled down to lower cost phones.

The trade of is, the phones come with small screens, slow processors and inadequate memory. The software isn't much better. Using images, audio, video, and location is hard because each device implements the interface to the underlying hardware differently.

Previous work shows that these tradeoffs must be deeply considered. For example, Parikh et al.'s CAM and Froehlich et al.'s MyExperience demonstrated exciting possibilities of mobile information systems, but were hampered by the limitations of their chosen platforms.

I believe smart phones are a better choice for this work.

- Open Data Kit shows smartphones can enable better systems in low-income regions.
- Smartphone applications in high-income regions are not appropriate.
- Sana Mobile, Android OpenMRS and ODK Clinic are promising, but have not been deployed and evaluated.



Hartung et al.'s work on Open Data Kit presents a convincing case that modern smart phones and modular design enable and encourage better mobile information systems in low-income regions. Smart phones, although more expensive than feature phones, provide more functionality.

In the high-income regions, there are systems like Epocrates and WebMD for clinical reference, AirStrip for critical patient information, and others that connect to medical record systems. These systems primarily run on the iOSs and Android platforms which leverage advanced programming interfaces, fast processors, large amounts of RAM, high speed wireless connectivity, and a wide variety of form factors.

As with much of the previous work, these smart phone applications are generally tied to expensive and proprietary servers and have not been designed or deployed in low-income regions.

More appropriate examples include Sana's telemedicine platform, Android OpenMRS and ODK Clinic. With Clinic, providers download a customizable patient list and view each patient's entire record. While ODK Clinic is conceptually sound, it does not deliver clinical reminders nor has it been deployed in a clinical setting.

Our goals are to build on this existing work and rigorously evaluate its efficacy.

So with that, I want to move on to the proposal.

# Proposal

- Research will be guided by AMPATH's needs and designed to improve outcomes.
- Code will build on existing work by the OpenMRS and Open Data Kit communities.
- Evaluation will target clinicians, but nurses, community health workers, and patients are options.
- Two core hypothesis: summaries and flowsheets.

Effectively designing, implementing, deploying and evaluating a clinical summaries and reminders system is a challenging research problem.

As context is key to success, research will be done with AMPATH in Kenya to improve patient outcomes. I will work with their providers, researchers and programmers. The results will be used by AMPATH to determine how they deploy clinical summaries and reminders.

I'm not reinventing the wheel. My work will build on experiences generating clinical summaries in OpenMRS and collecting and delivering data on mobile devices using Open Data Kit.

Much of this work assumes that this tool is best for clinicians. I do want to try targeting nurses, chws, and patients. Regardless of the target, I want to see if an alternate path to clinical data can result in greater compliance. As I broaden the "provider" term, i think we will have to look at more workflow automation and management.

All this will be shaped by what I see at AMPATH next week, but until then, there are two hypothesis about summaries and flowsheets I want to test.

*A mobile device with clinical summaries and reminders will be more consistently available at the point of care than a printed page with the same data. The availability will lead to greater compliance with guidelines.*

<b>Problem List:</b> <small>Remove resolved problems through encounter form</small> NONE		<b>Recent ARVs and OI Meds:</b> 1. LAMIVUDINE 2. NEVIRAPINE 3. STAVUDINE 4. TRIMETHOPRIM AND SULFAMETHOXAZOLE			
<b>Flowsheet (Initial + Last Four Value)</b>					
WEIGHT (KG)	HGB	CD4	VIRAL LOAD	SGPT	CREATININE
70.0 <small>04-Apr-2006</small>					
<b>Last 2 Chest X-Rays:</b> <small>(check chart as needed for results prior to 14-Feb-2006)</small> No chest x-ray results available.					
<b>Reminders:</b> (Write number next to each reminder) <small>1-Ordered Today, 2-Not Applicable, 3-Previously Ordered, 4-Pt Allergic, 5-Pt Refused, 6-I Disagree with Reminder, 7-Other(Explain)</small>					
1. Please check CD4. No CD4 result in system (___) 2. Please check Creatinine. No Creatinine result in system (___) 3. Please check Chest X-Ray. No Chest X-Ray result in system (___) 4. Please check Hemoglobin. No Hemoglobin result in system (___) 5. Please check SGPT. No SGPT result in system (___)					

AMPATH clinics generate a patient summary with important information from the patient record. It has the patient's recent data and includes reminders for providers.

The summary is generated when the patient arrives at the clinic and is placed in the patient's chart before being seen by the provider. Again, the problem with this approach is the availability of the data at the point of care.

We hypothesize that...

*A mobile device with clinical summaries and reminders will be more consistently available at the point of care than a printed page with the same data. The availability will lead to greater compliance with guidelines.*

- **Separate providers into Paper, Paper +Phone, Phone groups.**
- **When patient presents, use provided modality to review summaries and reminders and perform an encounter.**
- **Measure availability using instrumentation and compliance using order rates.**

To test this hypothesis, I want to hold a study at AMPATH clinics.

The plan is to get thirty providers from the clinics and randomly place them in three groups -- Paper, Paper+Phone and Phone. The Paper group is our control, and Paper+Phone and Phone are the interventions.

For a month, when an adult HIV-positive patient presents for a return visit at the clinic, a patient summary report with reminders will be generated and put in the patient's chart. This is standard practice and we expect about 4500 people will be in the trail.

For the Phone group, those providers will be given a phone which will download data from patients who have had encounters at the clinic. Instead of using the paper summary, they will be required to use the phone.

The Paper+Phone group will have the choice to use the phone and/or paper. I believe that having both modalities available will result in the greatest compliance. That is, the phone will be more available, but the paper will be more familiar and thus more preferable to the providers.

At the end of each encounter, providers must complete a form. The form will be modified to ask the provider which method, if any, was used to access summaries and reminders. Between the forms and the instrumentation on the phones and EMR, we can measure availability. We will also collect the order rates of indicators for all providers a month before, during and a month after the intervention to see if compliance changed.

So that's the first hypothesis. The second has to do with flowsheets.

*Providers will reach a decision about a patient's next steps more quickly using a phone-based flowsheet than with a paper-based version.*

Vitals	14-Apr 07.15	14-Apr 03.32	13-Apr 23.43	13-Apr 21.20	13-Apr 14.58	13-Apr 11.56	Units
Temp	98.5	98.4	98.3	99.9	100.1	100.2	degrees F
Heart Rate	95	94	102	102	104	109	beats/ min
Resting Rate	20	20	20	20	20	20	beats/ min
BP Systolic	119	107	108	104	116	114	mm_Hg
BP Diastolic	88	58	62	67	51	59	mm_Hg
Diastolic Bb	88	28	62	67	21	28	mm_Hg

One of the research contributions I want to make is to enable the exploration of the underlying data. Access to this data is important because for providers to act, they often need historical or circumstantial data.

Traditionally, providers use paper-based flowsheets to organize this data. You get elements arranged on a grid -- with time along the one axis and data elements along another axis. Flowsheets help synthesize complex data.

I have argued for the potential benefits of a mobile device, but it is not clear that phones match the familiarity and information density of paper. I believe many of these tradeoffs can be captured in how quickly providers can reach clinical decisions. For that reason, I propose testing the following hypothesis...

*Providers will reach a decision about a patient's next steps more quickly using a phone-based flowsheet than with a paper-based version.*

- Use representative set of encounter data from actual patients in lab study. Separate providers into two groups.
- Providers make a decision about next steps for patient. Return after three weeks and switch groups.
- Timing data and correctness of results will be measured to test hypothesis.

To test the hypothesis, I want to hold lab-based study at AMPATH.

The study will be based on a small but representative set of HIV scenarios found at AMPATH. Each scenario will build on a set of anonymized encounter forms from actual patients.

Providers will be randomly assigned to two groups, A and B. The A group will receive the paper forms and a paper-based flowsheet (essentially the control). The B group will receive the paper forms and a phone-based flowsheet. So, the intervention.

Based on only the information on the flowsheet and paper forms, the providers will decide and document what the patient's next steps are. Providers will be asked to return three weeks after the initial trial to perform a second trial. In that trial, the group that used the paper flowsheet will use the phone version and vice versa.

At the end of the study, we will use timing data to test our hypothesis. We will measure correctness as determined by World Health Organization (WHO) guidelines.

*Providers will reach a decision about a patient's next steps more quickly using a phone-based flowsheet than with a paper-based version.*

- Replicate study in clinic with providers in Paper, Paper+Phone, Phone groups.
- When patient presents, use provided modality to review flowsheet and perform an encounter.
- Measure differences in visit lengths and correctness of result.

I also want to do a field study to strengthen whatever results I find in the early study.

Thirty providers from the clinics will be randomly placed in three groups -- Paper, Paper+Phone and Phone. For a month when a patient presents for a return visit, providers will use the appropriate flowsheet. In the case of Paper+Phone, the provider will have the choice of either flowsheet. Again, we expect 4500 patients will present for a visit.

At the end of each encounter, providers must complete an encounter form. The forms will be modified to ask the provider which method, if any, was used to access the flowsheet. At the end of the month, we will stop the intervention.

We will use the data in the encounter forms and the instrumented phones and timing data test our hypothesis. If we can show that the phone makes for faster decisions, we can argue that they increase efficiency of care.

I have a rough timeline laid out for these studies.

# Timeline

**Autumn 2010 Analyze workflow, build reminder system.**

**Winter 2011 Conduct reminder study.**

**Spring 2011 Build flowsheet system.**

**Summer 2011 Conduct flowsheet study.**

**Autumn 2011 Conduct follow up studies.**

**Winter 2012 Finish remaining analysis.**

**Spring 2012 Prepare dissertation and defend.**

Autumn 2010 Finish analysis of existing HIV summaries and reminders system at AMPATH clinics. Begin building and iterating the summaries and reminders system with AMPATH.

Winter 2011 Setup and conduct reminder study at AMPATH. Design and field-test high-fidelity prototype for phone-based flowsheet system.

Spring 2011 Implement system for flowsheet study.

Summer 2011 Conduct flowsheet study at AMPATH. Integrate flowsheet system with encounter form system.

Autumn 2011 Conduct any follow up studies.

Winter 2012 Finish remaining analysis and research.

Spring 2012 Prepare dissertation and defend.

Again, all this is targeted at these broader research contributions I hope to make.

# Research Contributions

- Deliver summaries and reminders despite user and infrastructure limitations.
- Enable decision making using phone-based flowsheets containing relevant clinical data.
- Determine if summaries, reminders and flowsheets result in greater compliance with care guidelines.

First, deliver summaries and reminders despite user and infrastructure limitations we've discussed.

Second, enable phone-based flowsheets of relevant historical clinical data. That is, help providers look at the data underlying the reminders. These providers could be clinicians, nurses, supervisors, patients, etc.

Finally, determine if the summaries and reminders result in greater compliance with care guidelines. Showing compliance is a good approximation with increasing the quality of care.

So to conclude.

Thanks to Gaetano Borriello, Tapan Parikh, Neal Lesh,  
Sherrilynn Fuller, Richard Anderson, Martin Were,  
Carl Hartung, Brian DeRenzi, H el ene Martin



I've explained the context of HIV care and need for clinical summaries and reminders.

I have given you an overview of what others have done in medical records, clinical reminders and mobile information system and touched on what the implications of that research are.

Finally, I have discussed my proposal -- the development and evaluation of a phone-based clinical summaries and reminders system designed to increase the quality of HIV care.

Are there any questions?