

# Improving Clinical Decision Support In Low-Income Countries

Yaw Anokwa

Final Exam



Hi.

I'm Yaw Anokwa and thanks so much for coming to my defense.

Today, I'll be talking about my work improving clinical decision support in low-income countries, and in particular, at a large hospital network in Kenya.

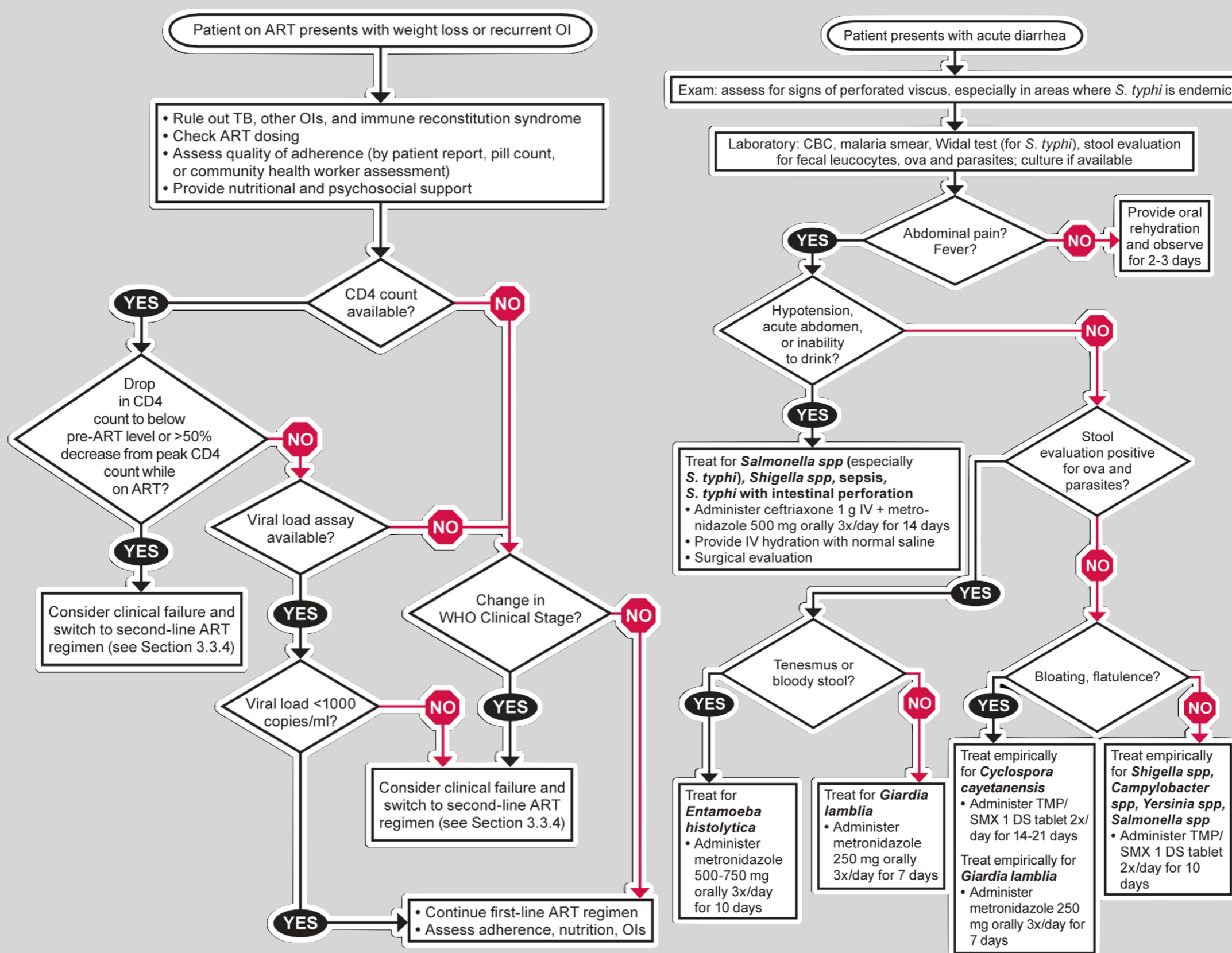
It's a really big and messy problem, and I only have 40 minutes, so I've had to trim things down to focus on the most critical pieces.

For that reason, if anything is unclear, please ask questions at any point!

Oh, and some of the screenshots I'll show look like real patient data. It's not.

Let's start with some background.

# HIV/AIDS is a complex disease that weakens immune systems



HIV/AIDS is a chronic disease and it's been absolutely devastating to the poor in Africa. The virus weakens the immune system, and so patients get sick from a wide array of diseases.

Managing HIV is really about treating all those diseases, often at the same time. The treatment protocols can be really complex. Let me give you an example.

\*

This is just the treatment protocol for an HIV patient suffering from weight loss and diarrhea. You don't have to read this, I just want to show that it is complicated. Add a serious illness like tuberculosis on top of this and the treatments get even more complicated.

Complexity is a problem because

HIV care is often delivered by busy doctors with little training



This situation can result in sub-standard care for patients

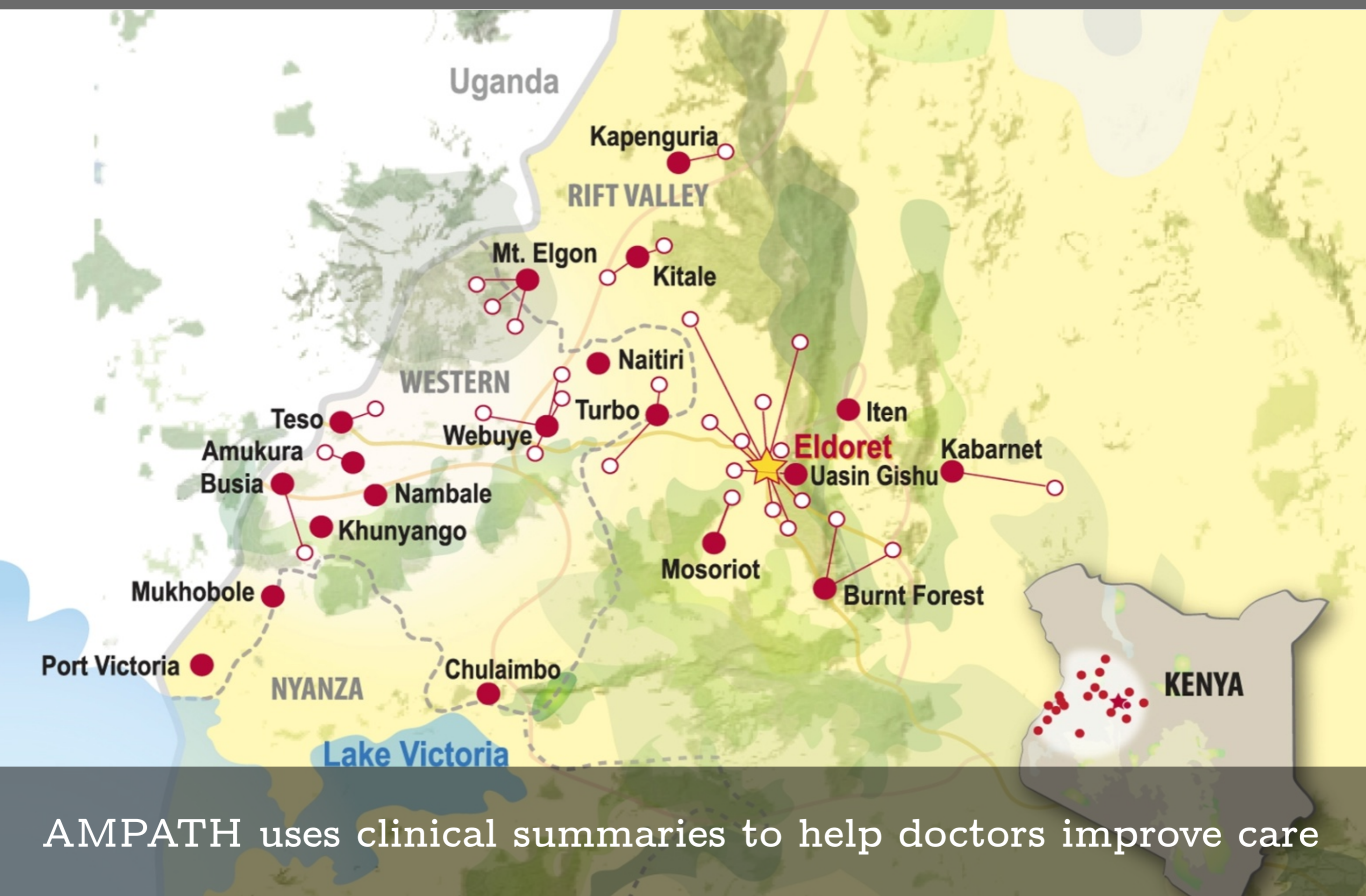
In developing countries, HIV care is primarily delivered by doctors with relatively little training. And most of these doctors work in hospitals that are under-resourced and busy. Kind of like this.

Just for some perspective on how under-resourced, the US has one doctor per 400, Kenya has one doctor per 7,000. And that's across the entire country. The ratio is worse in rural areas.

\*

And as you can imagine, the combination of complex treatments, and lightly trained doctors and busy clinics can result in sub-standard care of patients.

AMPATH provides care to over 130k active HIV patients



AMPATH uses clinical summaries to help doctors improve care

This is a challenge faced by AMPATH, one of the largest HIV treatment programs in Sub-Saharan Africa.

They provide care to more than 130,000 active HIV patients through 52 clinics, which you see here as the red dots.

AMPATH is in the Western Province of Kenya, and they have a huge catchment area with 2 million people.

\*

Over the last few years, AMPATH has used printed clinical summaries to provide some assistance, some decision support, for doctors who are seeing patients.

What's a clinical summary?

# Summaries are printed from medical record system (AMRS)

**Demographics** →

**Problems** →

**Lab tests** →

**Reminders** →

**Medications** →

**Testarius Paul Kungu** 014021634-2  
Male 39 Years, 10 Months ( 01/01/1971 ) 4039MT-6  
HIV STATUS: EXPOSURE TO HIV (06/12/2006)

First Encounter	Highest WHO Stage	6 Months HIV Rx Adherence
31/03/2010		Perfect

**Problem List**  
*Remove resolved problems through encounter form*

- MALARIA (01/06/2010 ...3 more)
- BRUCELLA TEST (31/03/2010)

**Immunizations**

- H.Flu B (1.0)
- DPT (1.0)

**Recent ARVs & OI Meds**

- TRIMETHOPRIM AND SULFAMETHOXAZOLE

**ARV Side Effects**  
NONE

**Maternal pMTCT: Med / Period / Doses Given / Rx Length**

- NEVIRAPINE / POSTPARTUM, ANTEPARTUM, INTRAPARTUM / [Unknown Dose] / 44.0 Weeks
- LAMIVUDINE / POSTPARTUM, ANTEPARTUM, INTRAPARTUM / [Unknown Dose] / 44.0 Weeks
- STAVUDINE / POSTPARTUM, ANTEPARTUM, INTRAPARTUM / [Unknown Dose] / 44.0 Weeks

**Flowsheet (Initial + Last Four Value)**

WT (KG)	HT (CM)	CD4	VIRAL-LD	HGB	SGPT	DNA PCR	ELISA	CREAT
6.0 <small>06/12/2006</small>	6.0 <small>06/12/2006</small>	(Test Ordered) <small>01/02/2010</small>		(Test Ordered) <small>01/02/2010</small>	(Test Ordered) <small>01/02/2010</small>	(Test Ordered) <small>01/03/2010</small>		(Test Ordered) <small>01/02/2010</small>
60.0 <small>01/02/2010</small>	60.0 <small>01/02/2010</small>	200.0 <small>(No Order) 01/09/2010</small>				(Test Ordered) <small>16/03/2010</small>		
60.0 <small>01/03/2010</small>	60.0 <small>01/03/2010</small>	65.0 <small>(No Order) 19/09/2010</small>						

**Last 2 Chest X-Rays** (check chart as needed for results prior to 14-Feb-2006)  
No chest x-ray results available.

**Reminders** : (Write number next to each reminder)  
1-Ordered Today, 2-Not Applicable, 3-Previously Ordered, 4-Pt Allergic, 5-Pt Refused, 6-I Disagree with Reminder, 7-Other(Explain)

- Please order HIV ELISA. Pt > 18 mo old with no valid ELISA result. (\_\_\_)
- Consider starting ARV Meds. Pt > 5 yrs with positive DNA PCR AND CD4 Count < 500 (\_\_\_)

Last seen 31/03/2010 at MTRH Module 1 by The Super User  
Encounter entered by The Super User on 01/03/2010  
Next scheduled visit: 03/01/2007

014021634-2

## Summaries with reminders improve the quality of care

Clinical summaries are a one page sheet that is generated from AMPATH's electronic medical record system, or AMRS. It looks like this.

\*

It gives a nice overview of all the relevant patient data. It has the patient's demographics,

\*

the problems they are having,

\*

recent medications, and

\*

recent lab tests.

So it's a one page overview of the patient. You just print this summary when the patient arrives, and you are good to go.

And the best thing about the summary are the reminders.

\*

These are patient specific reminders to the doctor about how the patient is deviating from these complex care protocols.

If the medical record system, AMRS, sees that the patient is late for a test according to standard care guidelines, it prints a little reminder at the bottom for the doctor to follow.

\*

And there is very convincing evidence from the developed world, and at AMPATH that these summaries with reminders improve the quality of care.

That's great, but unfortunately, there are problems with the whole printed summary process. Let me go over those.

# Problems with summaries and why they matter

## 1. Summaries are not always available

*A patient visit without the assistance of a summary potentially had sub-standard care.*

## 2. Summary usage is difficult to measure

*Summary usage is an important metric for supervisors who monitor quality of care.*

## 3. Corrections are not added quickly to record

*Slow correction of medications and labs affect patient care and usage of summaries by doctors.*

I'm going to give you a quick overview of the problems and why I think they are important to solve. After I give you the overview, then I'll dive into each problem and give you some evidence, and a reason why they exist.

\*

First, the summaries are not always available. That is when a patient shows up, their summary may not be printed by nurses and placed in their patient folders.

\*

This is a problem because a patient visit without the help of summaries and reminders potentially had sub-standard care. We don't want to take that chance.

\*

Second, the summary usage is hard to measure. When the doctor sees the summary, they are supposed to put a check mark through it. They don't always do it.

\*

Summary usage is an important metric for supervisors who monitor the quality of care. Not knowing if doctors are using the summary is a problem.

\*

Finally, corrections are not added quickly to the patient record.

The data in the medical record system that is used to generate the summaries, is not always correct. Doctors correct the summary, but these corrections take a long time before they are applied to the patient's electronic record.

I'll explain why this is in a second, but take my word for it for now.

\*

Slow corrections of medications and labs affect patient care and usage of summaries by doctors.

\*

Let's start with the first problem of summary availability and dig a little deeper. Again, this is important because a patient visit without the assistance of a summary potentially had sub-standard care.

## 1. Summaries are not always available at the point of care

*“We analyzed data on availability rates for summaries for patient return visits in 18 AMPATH clinics. This data was collected by AMPATH from September 2010 to January 2011. Across 51k visits, 20% (10k patients) did not have summaries.”*

Anokwa et al. Design of a Phone-Based Clinical Decision Support System for Resource-Limited Settings. ICTD, 2012.

### Nurses too busy to print and rarely report problems

\*

Over a five month period, I looked over the data AMPATH collected at 18 of their clinics as part of routine care. When I analyzed the data from 51k patients, I saw that 20% of patients did not get summaries. This is work that's published at ICTD 2012.

The way I got this data is that the nurses maintain a daily count of all patients that are seen. Another group of staffers count all the summaries that are printed from the sites each day, and see how many summaries they have. That discrepancy is the 20%.

Beyond that data, I spent a fair bit of time at AMPATH clinics. I watched the workflow at a few clinics, I talked to stakeholders, and the takeaway is that the system for printing and delivering summaries is fragile.

There are lots of reasons for this that I document in my dissertation, but let me give you an example.

\*

It's often the case that the nurses in charge of printing are overwhelmed with taking care of patients and are too busy to print the summaries.

Even if they aren't busy, when there are issues with printing, they don't report those issues. It can take days or weeks before a supervisor finds the problem and starts addressing it.

During that period, patients are being seeing without summaries and that's problem.

Let's move on to the second issue with summaries.

## 2. Summaries usage is difficult to measure

4. HELMINTHIASIS (26-Apr-2007)  
5. (16-Nov-2006)  
6. GASTROENTERITIS (16-Nov-2006 ... 2 more)  
7. DERMATITIS (16-Nov-2006)  
8. TINEA CAPITIS (19-Oct-2006 ... 2 more)  
9. ANEMIA (05-Oct-2006)  
10. RESPIRATORY TRACT INFECTION, NOS (05-Oct-2006 ... 1 more)

Maternal pMTCT: Med / Period / Doses Given / Rx Length  
NONE

Flowsheet (Initial + Last Four Value)

WT (KG)	HT (CM)	CD4	VIRAL-LD	HGB	SGPT	DNA PCR	ELISA
20.0 07-Jan-2010	123.0 07-Jan-2010	846.0 (No Order) 16-Sep-2006		8.6 (No Order) 16-Sep-2006	15.7 (No Order) 16-Sep-2006		
20.0 01-Apr-2010	123.4 01-Apr-2010	Test Ordered 16-Mar-2009		Test Ordered 19-Aug-2010			
19.5 29-Apr-2010	124.0	464.0 (22.0%) 17-Sep-2006					

Doctors ignore procedures and manual monitoring is inefficient

Summary usage is difficult to measure. Again, this is important because summary usage is an important metric for supervisors who monitor quality of care.

Doctors are supposed to put a big mark on the summary sheet, like this.

\*  
And then supervisors go to each site once or twice a week and basically count the marks on the summaries.

But doctors don't always mark the summaries. Why?

Sometimes they forget, sometimes they ignore this procedure.

\*  
Regardless, the current paper system doesn't make it easy to monitor usage.

You literally have to go visit all 52 sites in Western Kenya and count marks on sheets of paper. It's important for AMPATH to know if the summaries are being viewed and current practice is pretty inefficient.

So that's the second problem. Let's move on to the final problem with summaries.



### 3. Corrections are not added quickly to patient record

1. Doctor completes paper form documenting patient encounter.
2. Encounter form is entered into the electronic record by clerk and returned to folder.
3. Electronic record generates printed summary for patient return visit.
4. Discrepancy between forms and summary is seen by doctor during visit and corrected.
5. Summary corrections are collected and sent for data entry and quality checks.

The third problem is that corrections are not added quickly to the patient's electronic record, and that slowdown in correction of medications and labs affect patient care and usage of summaries by doctors. Let me explain why.

\*

During each visit, a doctor fills out an encounter form. It is the form that documents everything that happened during that visit.

\*

That form is eventually then typed (often with mistakes introduced) into the medical record system. The entry is done by a data entry clerk who has no medical training. The forms are then returned to the patient folder.

\*

It is the electronic data, which is supposed to be ground truth, that gets synthesized into the printed summary when the patient returns.

\*

So during a return visit, when a doctor sees a discrepancy between the hand written encounter forms and the printed summary, they are supposed to note and correct that discrepancy on summary.

\*

Then the corrections on the summary are again entered by a data entry clerk into the record. Where again, they may make more mistakes, and the cycle continues.

\*

Let me give you an example. This picture is an example of a missing lab test on the summary. So the doctor has seen the lab result on the encounter form in the patient's folder, but somehow the data did not get entered in the patient's electronic record, so it's missing in the summary. These corrections are especially important for medications.

\*

Why is this? Lots of reasons, but the biggest problem is that it turns out the data entry team is always busy with entering all the other paper forms in the hospital and so corrections take a long time to enter and get approved by the data quality team.

Doctors are human and so after they correct the same mistake multiple times, they end up getting irritated and stop correcting.

That's bad because you aren't getting corrections of bad medication or lab data by providers who are medically trained and are physically there with the patient. That's a big problem.

So to summarize the problems I wanted to solve,

### 3. Corrections are not added quickly to patient record

Date	Value	Test
07-Jan-2010	120	Order)
01-Apr-2010	123.4	Test Ordered 16-Mar-2009
29-Apr-2010	124.0	464.0 (22.0%) 17-Sep-2009
24-Jun-2010	123.6	464.0 (No Order) (22.0%) 17-Sep-2009
19-Aug-2010	125.0	Test Ordered 19-Aug-2010

602 (39)

Last 2 Chest X-Rays (check chart as needed for results prior to 14-Feb-2006)

1. 16-Mar-2009 : NORMAL
2. 14-Sep-2006 : INFILTRATE

### Data entry team is easily backlogged with data entry

During each visit, a doctor fills out an encounter form. It is the form that documents everything that happened during that visit.

\* That form is eventually then typed (often with mistakes introduced) into the medical record system. The entry is done by a data entry clerk who has no medical training.

\* Lab data from another electronic system is added to the record.

\* The forms are returned to the patient folder.

\* The lab results are also returned to the patient's folder. All the paper-based data should always be in in the folder.

\* It is the electronic data that gets synthesized into the printed summary. And this electronic record is supposed to be ground truth.

\* So during a visit, when a doctor sees a discrepancy between the hand written encounter forms and the printed summary, they are supposed to note that discrepancy on summary.

\* Then the corrections on the summary are again entered by a data entry clerk into the record. Where again, they may make more mistakes, and the cycle continues.

\* Let me give you an example. This picture of a missing lab test on the summary. So the doctor has seen the lab result of 1602 on the encounter form in the patient's folder, but somehow the data did not get entered in the patient's electronic record, so it's missing in the summary.

\* These corrections are especially important for medications.

\* Why is this? Lots of reasons, but the biggest problem is that it turns out the data entry team is always busy with entering all the other paper forms in the hospital and so corrections take a long time to enter and get approved by the data quality team.

Doctors are human and so after they correct the same mistake multiple times, they end up getting irritated and stop correcting.

That's terrible because you aren't getting corrections of bad medication or lab data by medically trained professions who are physically there with the patient. That's a big challenge.

So to summarize the problems I wanted to solve,

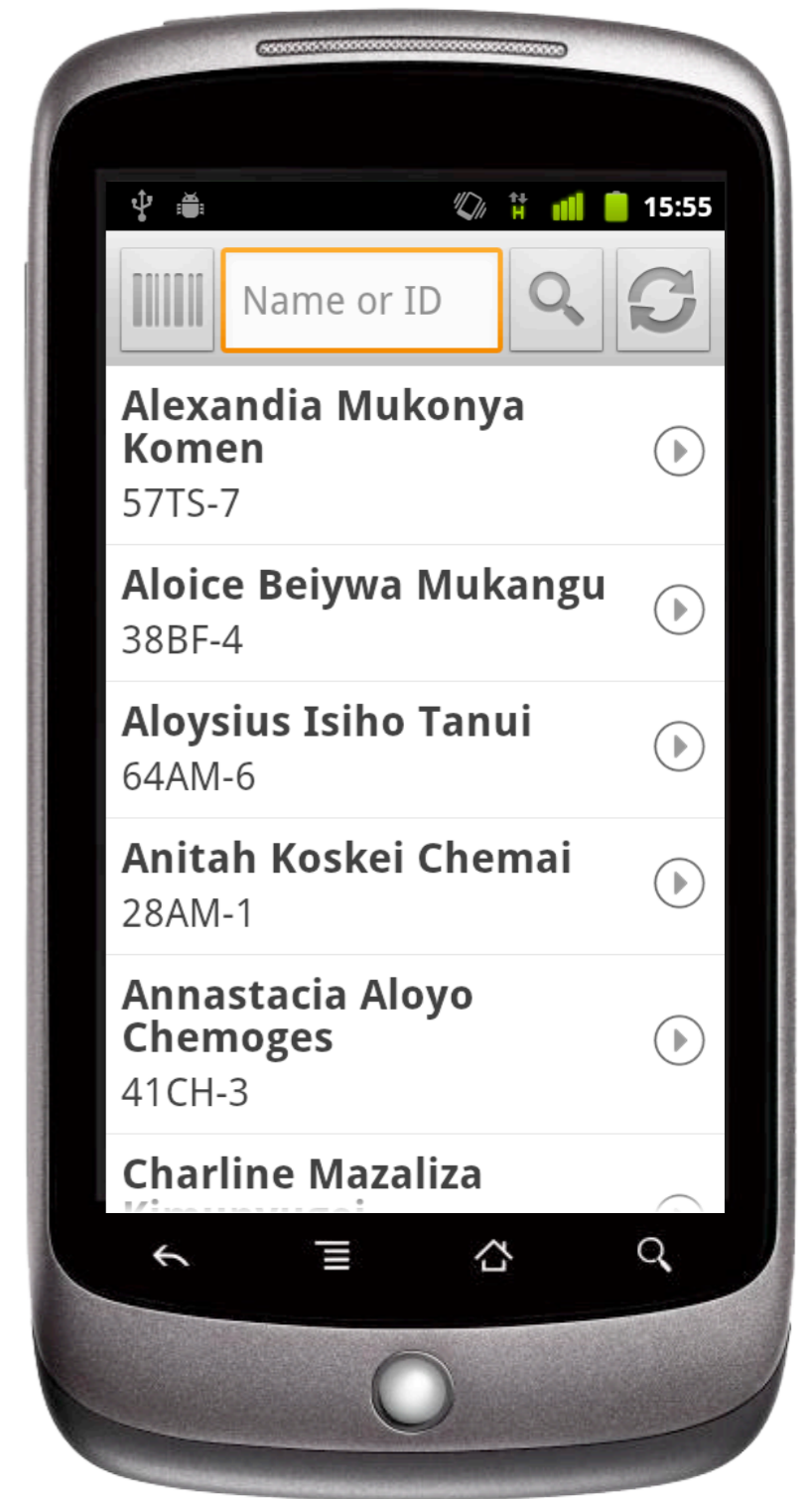
# A mobile app could solve these problems

## Problems

1. Summaries are not always available.
2. Summary usage is difficult to measure.
3. Corrections are not added quickly to record.

## Why Mobile?

1. Summaries are not just for doctors, but for community health workers, pharmacists, etc.
2. Logistics of installing and maintaining computers are non-trivial.
3. Mobile device is more appropriate as far as power, connectivity, and user interface.



Summaries are not always available. Usage is difficult to measure. Corrections are not being added quickly to the record.

A lot of these are limitations of a paper-based system, and AMPATH has been trying lots of techniques to improve this system. As part of that work, they wanted to try to see if an electronic system would work better.

My intuition was that yes it would.

\*

I believed that building a mobile application would be a good first step towards solving these problems.

\*

So why mobile and not say a desktop app?

\*

First, summaries are not just for HIV doctors. AMPATH is moving to a model of care where chronic care patients don't come to the hospital. They go to their dispensary (basically a Bartell's) nearest their house where a lightly trained nurse or pharmacist will check vitals and if everything is proceeding OK, they don't have to travel to the hospital. Mobile summaries are perfect for those situations.

\*

Second, the logics of installing desktop computers in African hospitals is non-trivial. Just ensuring they have reliable power is a full time job. There just isn't a lot of technical capacity to manage all those computers.

\*

Third, mobile devices are just a really nice fit. They can run a long time on a charge, you can easily connect to WiFi or the cell network, and the user interfaces are easy to master. AMPATH has had really good luck using smartphones for these kinds of projects, so we wanted to give it a try.

# Outline

## Background

- The state of HIV care and how clinical summaries help
- Problems with availability, supervision and corrections

## Contributions

- Mobile app targeted at solving the identified problems
- Evidence suggesting doctors prefer phone summaries

## Conclusion

- Future research directions

So here's where we are and where we are going.

\*

I've given you some background about the state of HIV care and how summaries help. And I've talked about the problems with availability, supervision and corrections.

\*

In this next section, I'll present the primary contributions of my dissertation. The first is ODK Clinic, which is a mobile application that is a first step towards solving these problems.

I'll describe how Clinic helps with availability, supervision and corrections, and I'll show some evidence of the effects on decision support at AMPATH.

\*

I'll also show some data that suggests that doctors prefer phone-based summaries to paper-based summaries.

\*

I'll end with some reflection on this work and future research directions.

## Background

- The state of HIV care and how clinical summaries help
- Problems with availability, supervision and corrections

## Contributions

- Mobile app targeted at solving the identified problems
- Evidence suggesting doctors prefer phone summaries

## Conclusion

- Future research directions

Let's get started.

For this contribution, I'll show you individual features of ODK Clinic, and show you how it solves the three problems I talked about earlier. I'll start with availability, go to supervision and then end with corrections.

Everything I will show you is from a 90 day deployment.

90 day deployment with 12 doctors in 10k encounters

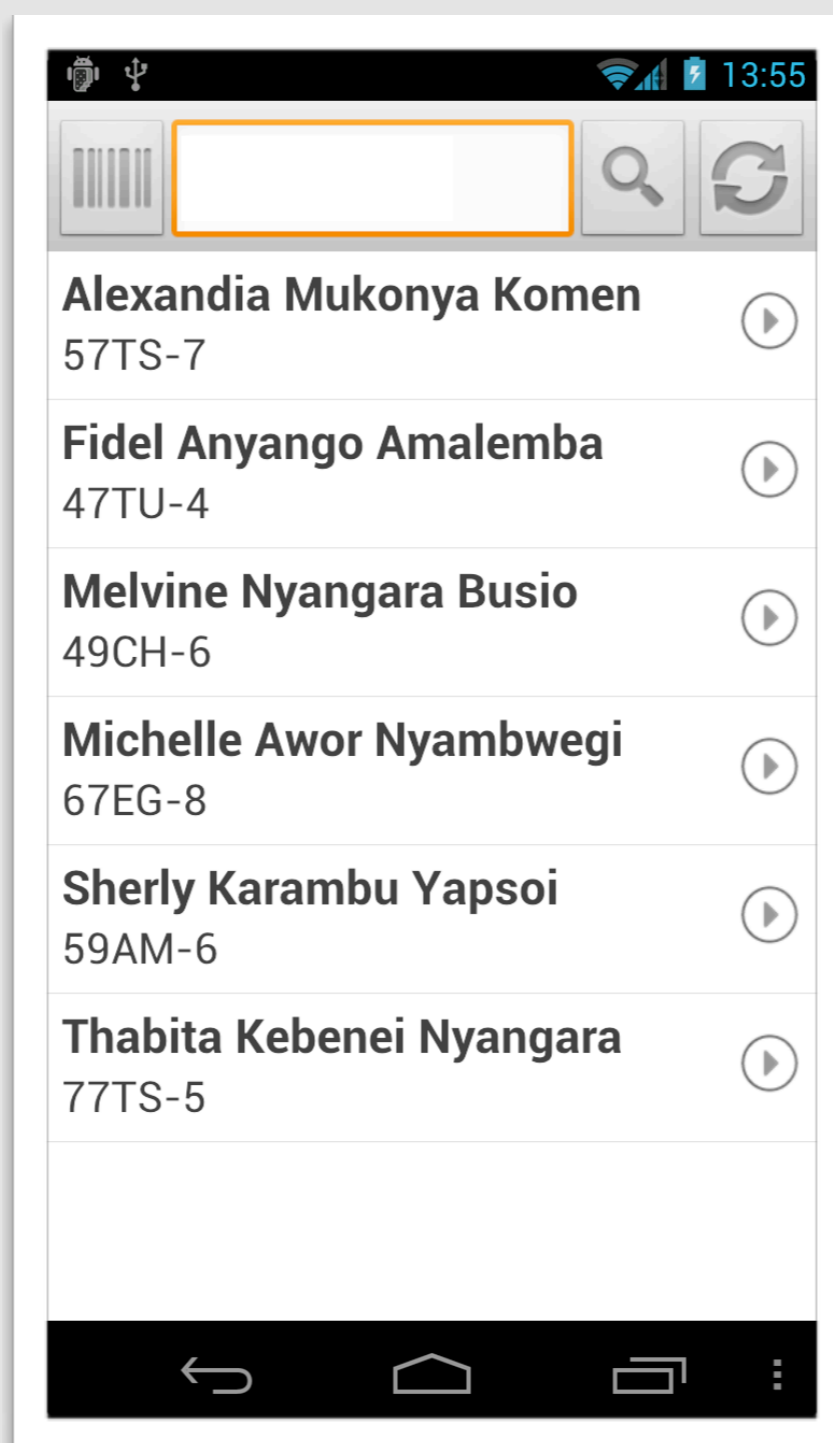


ODK Clinic was deployed at two adult HIV clinics at AMPATH. There were 12 doctors using the system, and they had some 10k patient encounters.

The system is still in use today. There are now about 19k patient encounters, but in this talk, I'm only going focus on data in the 90 day period.

Let's go over some of the features.

# ODK Clinic downloads scheduled patients in a two week range



Summaries for scheduled patients are always available

Clinic is an Android app that replaces the summary and the main screen looks like this.

\*

Each doctor gets a phone and in the morning, they download a big batch of patient summaries from the medical record system to the phone.

\*

ODK Clinic downloads scheduled patients in a two week range. These are the summaries of patients that are likely to visit a week before today and a week from now. All that data is stored on the phone for offline use.

The app is structured that way because medical record system is pretty unreliable. It's usually not down for more than 30 minutes, but it goes down every hour or so.

With the caching system, I solve the first problem I talked about.

\*

The summaries for scheduled patients are always available. Even if the server goes down for a few days, doctors still have summaries. Also, doctors don't have to rely on nurses to get their summaries.

And I have some evidence that shows this availability.

# At already good clinics, availability is about the same

Period	Device	Patients Seen	Unmarked or Missing Summaries	Viewed Summaries	% Visits with Summaries Viewed
Jul 1 to Aug 31	Paper	9,802	925	8,877	90.6%
Sep 18 to Dec 18	Phone	13,518	-	12,381	91.6%

The two clinics turned out to be particularly good, so the availability of the summaries on phone was about the same as paper.

\*  
If you remember in my earlier slides, I found that 20% of patients were not getting summaries. That data was very old when I deployed, and so I did a similar analysis a few months before I rolled out the phones at these two clinics.

Let me break down the numbers.

\*  
From Jul 1 to Aug 31, I looked at the summaries on paper.

\*  
For that period, I know 9,802 patients were seen at that clinic.

\*  
From the summaries that were collected, 925 were either missing or unmarked -- so essentially unseen.

\*  
Take the difference, and you get 8,877 which were likely viewed.

\*  
That makes the % of visits where the summary was viewed around 90.6%.

\*  
In the study period, from Sep 18 to Dec 18. I looked at the phone summaries.

\*  
13,518 patients were seen.

\*  
There is no way to measure if something was unseen, so I looked at distinct doctor/patient summaries that were viewed in that period.

\*  
There were 12,381.

\*  
That makes the % of the visit where the summary was viewed about 91.6%.

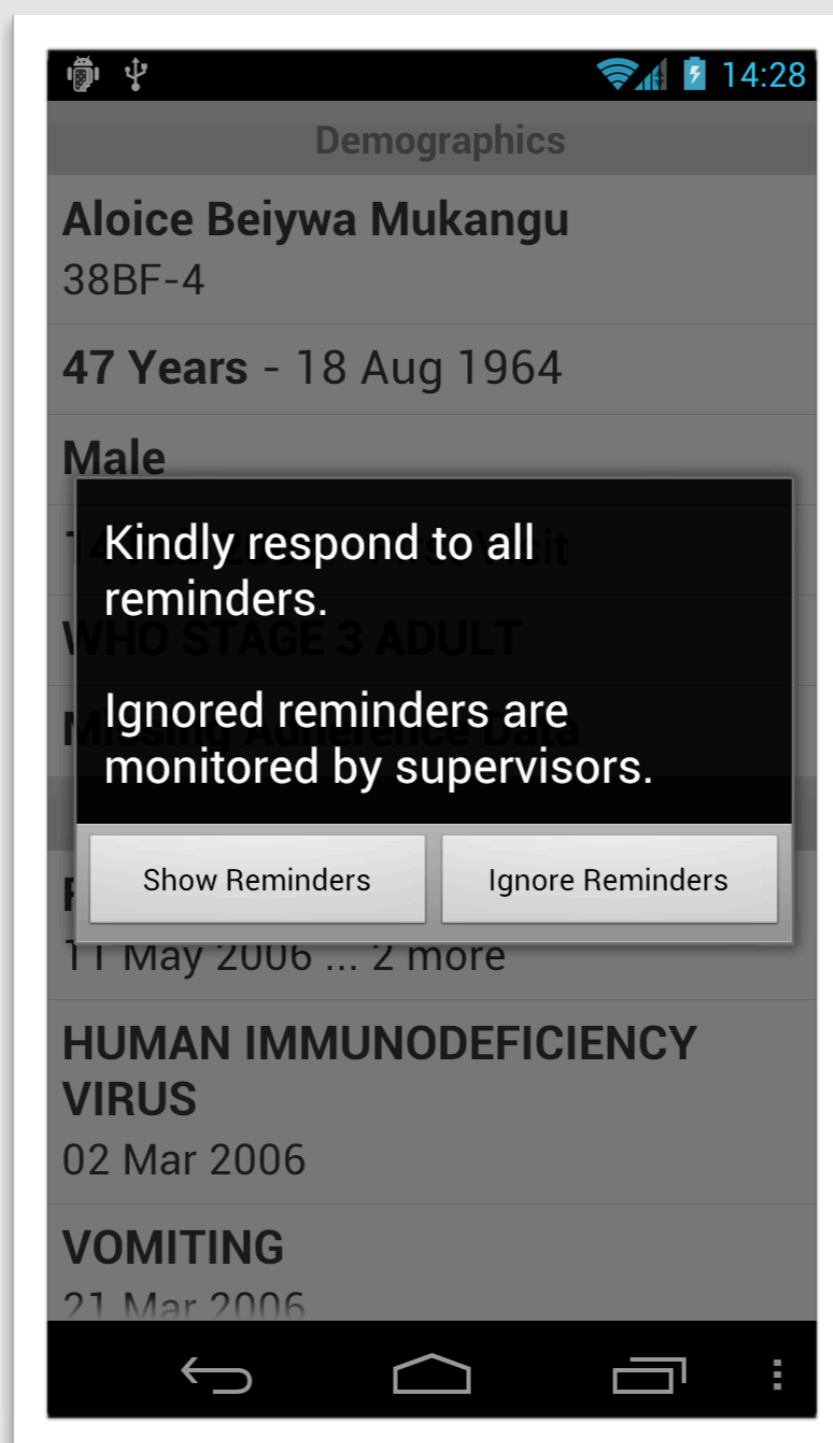
My intuition is that at clinics with much lower availability, the system would perform better than their baseline, but I was not able to test at a clinic with low numbers.

So that's some evidence about availability. At good clinics, availability is about the same.

Let's move on to supervision.



# ODK Clinic reminds about standard operating procedures



Usage data is sent back to electronic medical record daily

I have prompts through out ODK Clinic that are designed around the standard operating procedures that AMPATH has.

For example, if a doctor doesn't respond to reminders in the summary and tries to exit, they are reminded to respond to reminders.

\*

The goal here is to help doctors follow standard operating procedures.

\*

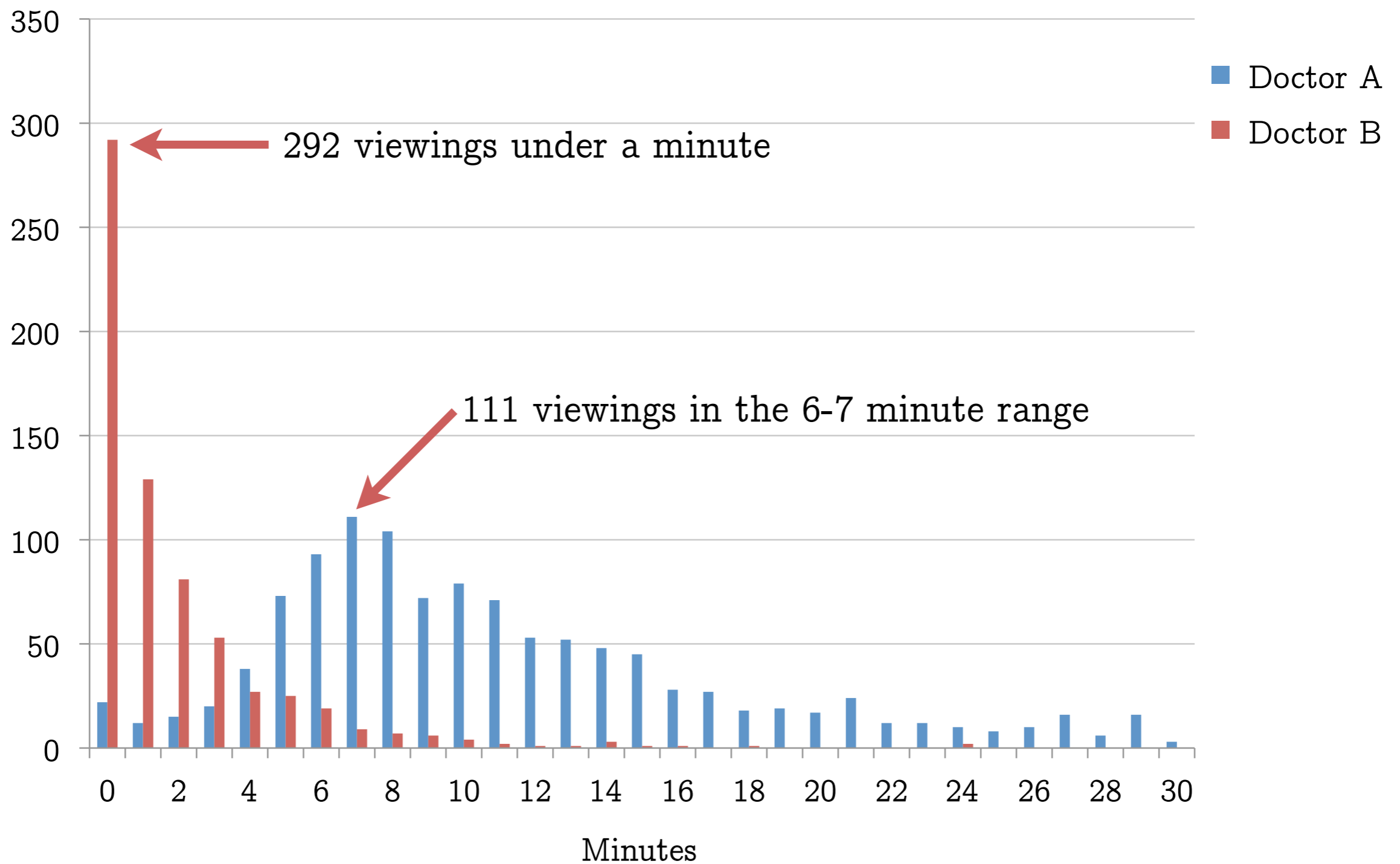
And as a bonus, the details of how they are using the application is logged daily and is sent back to the medical record system where it can be analyzed.

This data solves one of the problems I defined earlier with monitoring usage. Now supervisors do not have to go to every site and pick up old summary sheets and count if the doctor has put a check mark on it.

And that means I can now quantify differences in how doctors use the system. And that data is really interesting.

# Summary usage patterns vary by doctor

Frequency of Summary Viewing Lengths



It turns out summary usage patterns vary widely by doctors.

I'm going to show you differences between the summary viewing lengths of two doctors. That is, for each patient visit, how long do they have the summary open.

Let's start with Doctor A.

\*

Here on the X-axis is the number of minutes that a summary was open for that patient. The Y-axis is the frequency or count.

\*

So for example, of all the summary viewings that Doctor A had for the study period, 111 of them were in the 6-7 minute range. This is what I expected, but turns out some doctors deviate from this pattern.

Here for example is Doctor B. Notice there are 292 viewings under a minute.

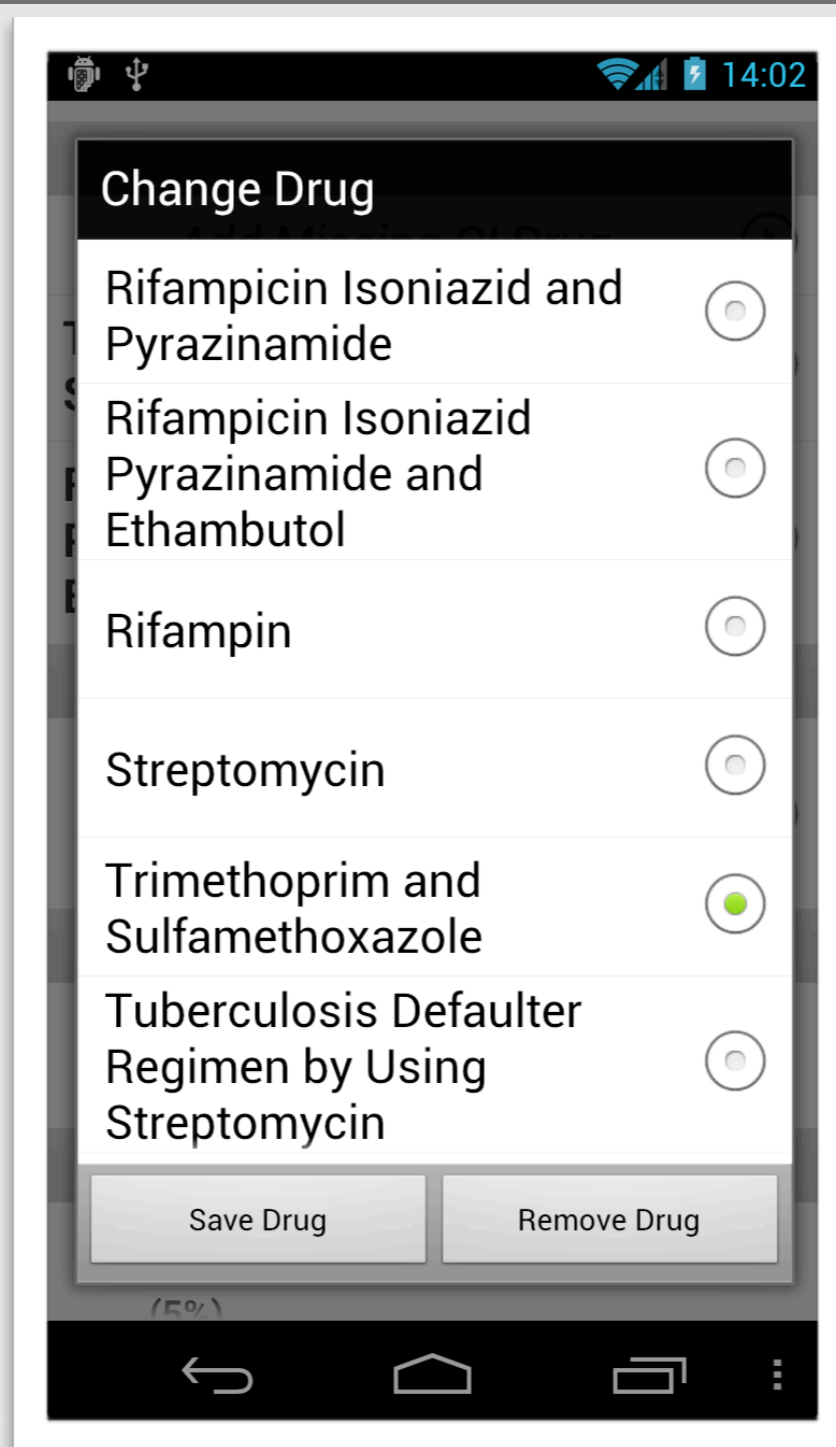
\*

This data does not mean that Provider B is not really seeing patients. She might just open and close the summary at the end of the patient visit to make sure nothing was missed, instead of keeping it opening during the whole time.

The fact that I can now document this is a contribution that helps AMPATH monitor usage to find variations like these, and then follow up.

So that's evidence that supervisors can now monitor usage. Let's move on to corrections of data.

## Corrections in ODK Clinic are made without free-text



## Changes are sent to the medical record system daily

Since data from AMRS is not always correct, I added the ability to correct mistakes. These could be previously ordered labs or in this image, medication errors.

When a doctor sees a mistake in the medications of a summary, they can double-check with the historical encounter forms in the patient's folder, and also ask the patient what medications they are taking. If there is a discrepancy, they correct it right there in the summary.

Because it's on the phone, it's not handwritten free-text, it's strongly coded.

\*

This is a big deal because it means that you don't have to manually collect all the corrections from all sites, transport them to a central location for data entry and try to interpret the doctor's handwriting.

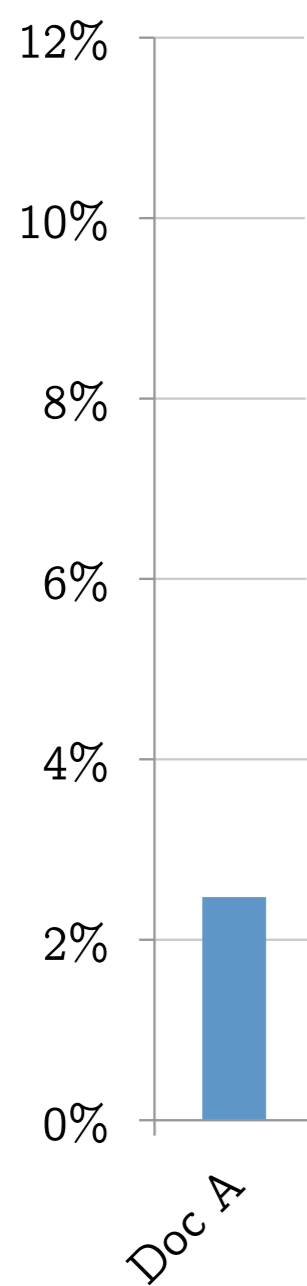
\*

The changes are just automatically sent to the medical record system at the end of the day.

And from those changes, I learned some surprising things about medication corrections.

# Doctors correct medications at different rates

Medication Correction Rates of Doctors



It turns out doctors do correct mistakes in the medications, but at totally different rates.

Let me give you an example.

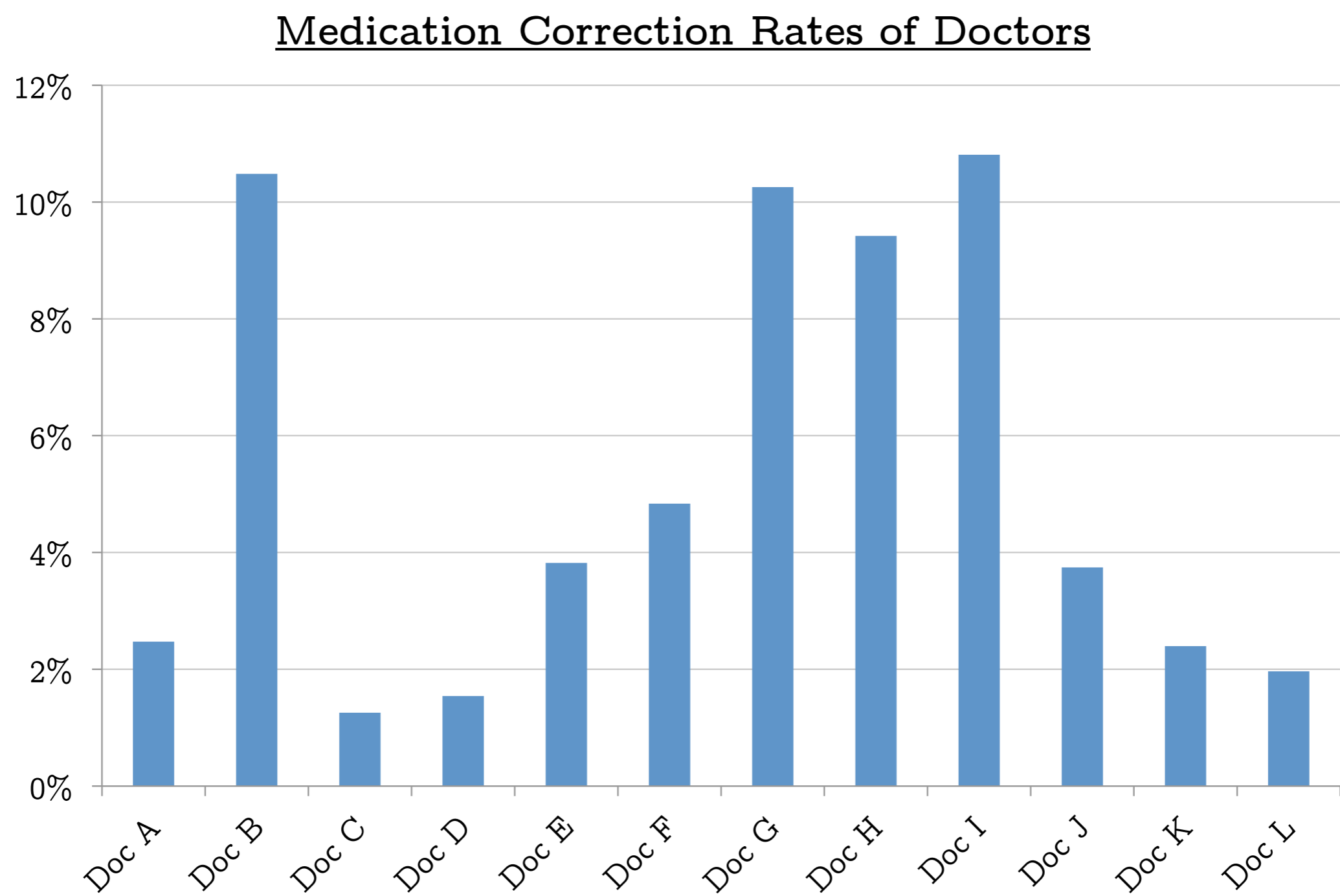
\*

On the X-axis is Doctor A. On the Y-axis is the medication correction rate.

So for example, Doctor A had a correction rate of about 2%. That means, across all the summaries they saw in the study period, and all the medications they saw in all those summaries, they changed 2% of them.

But if you compare to Doctor B, you notice this doctor corrects about 10% of the medications they see.

# Doctors correct medications at different rates



This variation happens across all Doctors.

Why? I have to be very careful here. Just because a doctor corrects a medication doesn't mean that the medication is actually wrong.

It's unlikely, but it could be an accidental click.

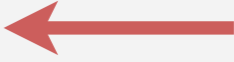

Also, although patients are generally randomized across doctors, it could be that somehow, that Doctor B tends to see patients whose previous doctor makes a lot of mistakes.

I predicted that this would be a problem, so as part of the deployment, the summaries team asked the data quality team to look at each of these medication corrections, and either approve or deny them.

The data quality team is the final judge of what is "correct".

# Data quality team has not looked at any corrections

## Aloice Beiywa Mukangu ( Requested by Super User )

1. Please remove ZIDOVUDINE AND LAMIVUDINE from encounter on 18/05/2006    
[View Encounter](#) Comment  | [Accept](#) | [Ignore](#)
2. Please add DARUNAVIR to encounter on 18/05/2006  
[View Encounter](#) Comment  | [Accept](#) | [Ignore](#)
3. Please remove EFAVIRENZ from encounter on 18/05/2006  
[View Encounter](#) Comment  | [Accept](#) | [Ignore](#)

AMPATH gave them a system inside the medical record to Accept or Ignore/Reject drug changes and it looks like this.

The data quality team would get a message like this to remove this drug that was a mistake.

\*

And then they could Accept or Ignore/Reject the change.

\*

In the study period, there were 842 corrections sent to the medical record system by the doctors.

\*

The data quality team has not looked at any of the corrections. Not a single one has been approved or denied.

And that's unfortunate because there are likely serious mistakes that need to be corrected. I think this situation, shows the realities of building these kinds of systems. As you add technology, you reveal more gaps, and then you iterate to address those.

At least now AMPATH knows that there needs to be a closer look at why doctors correct and different rates, and why their changes aren't being approved or denied by the data quality team. There is some process breakdown that needs to be fixed.

So to summarize,

## Problems with summaries solved?

### 1. Summaries are not always available

*At already good clinics, availability is about the same. Remote clinics would likely see improvements.*

### 2. Summary usage is difficult to measure

*Supervisors now have increased visibility into usage. Acting on the data is the next challenge.*

### 3. Corrections are not added quickly to record

*Corrections go directly from doctor to the medical record system. Data quality process is broken.*

The problems I set out to solve had to do with availability, supervision and correction.

\*

For the problem of summaries not being available,

\*

I have shown that availability at already good clinics is about the same. My intuition is that at remote sites, availability would be better, but that will have to be proven in another deployment.

\*

For the problem of monitoring usage,

\*

I have shown that supervisors have increased visibility into usage. There is now a lot more objective and near real time data that supervisors can use. Whether or not they act on it is the next challenge.

\*

For corrections not being added quickly to the record,

\*

I have shown that corrections can go directly from doctors to the medical record system, but that the data quality team process is broken in some way.

So that's the end of the contributions that are directly related to the problems I set out to solve. Going back to the outline...

## Background

- The state of HIV care and how clinical summaries help
- Problems with availability, supervision and corrections

## Contributions

- Mobile app targeted at solving the identified problems
- Evidence suggesting doctors prefer phone summaries

## Conclusion

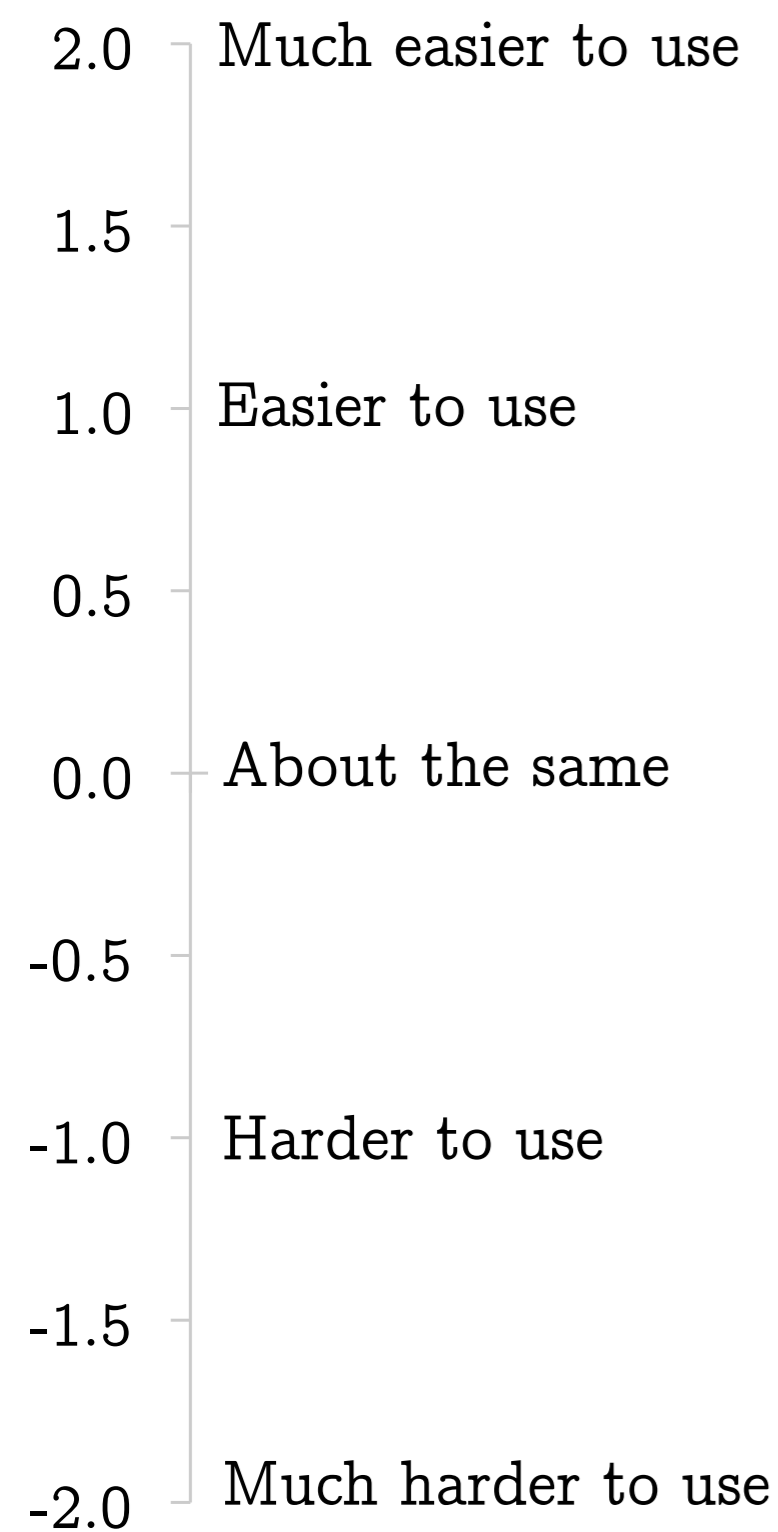
- Future research directions

As part of the deployment, I also wanted to get some data from the doctors to see if they liked or disliked phone summaries. The evidence I have has its limits, but I think it shows some interesting trends, so I want to share those.

I did audio interviews with the doctors right after they were trained, and then every few months after. The data I am going to show you is from those interviews.



# Doctors were asked to compare ODK Clinic to paper



In audio interviews, I asked doctors to compare phone summaries to paper summaries on a 5 point Likert scale. The questions I asked were framed like this.

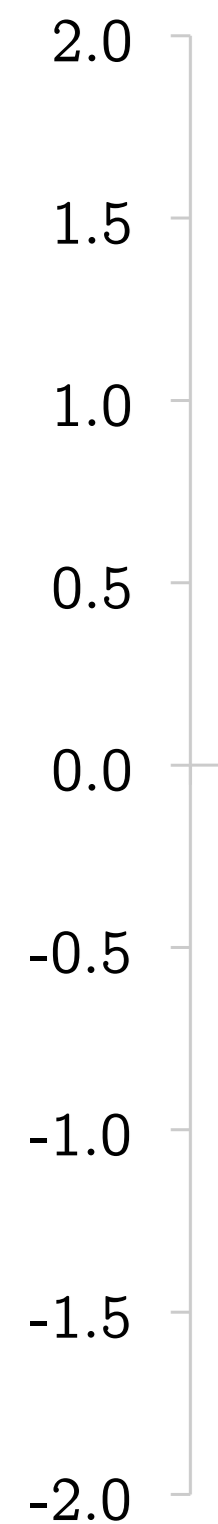
“On a scale of 1 to 5, with 1 being much harder to use and 5 being much easier to use, and 3 being about the same, how would you compare the phone summary to the paper summary?”

\*

I used a five point Likert scale, but it's adjusted on this graph to make it easier to see. So for example, if a doctor thought the phone's usability was about the same as paper, the value would be 0.

If they thought it was easier to use, it'd be at 1, and much easier at 2. Harder to use at -1, much harder to use at -2.

## Doctor Ratings (Phone vs. Paper, 5 point Likert)



I surveyed all doctors right after their training in Week 0 about their expectations

\*  
and then in Week 8, I surveyed them again.

\*  
You'll notice that n is small because not all doctors I trained in Week 0 were available in Week 8, so I'm only looking at the six that were in both groups.

The thing I have to stress here is that these numbers are not significant. The n is small and the variance isn't great either, especially in Week 0. I'm showing you these numbers just to give you a sense of the trends. And I'll frame these numbers in a bit with some qualitative data.

The first thing I asked was about ease of use. Did they think the phone was easier, much easier, harder, or much harder to use than the paper.

\*  
So the blue here is Week 0. The red is Week 8. The average is higher after doctors used the phone for a few weeks.

You see a similar change when I asked about speed. Did doctors think the phone it was faster, much faster, slower, or much slower.

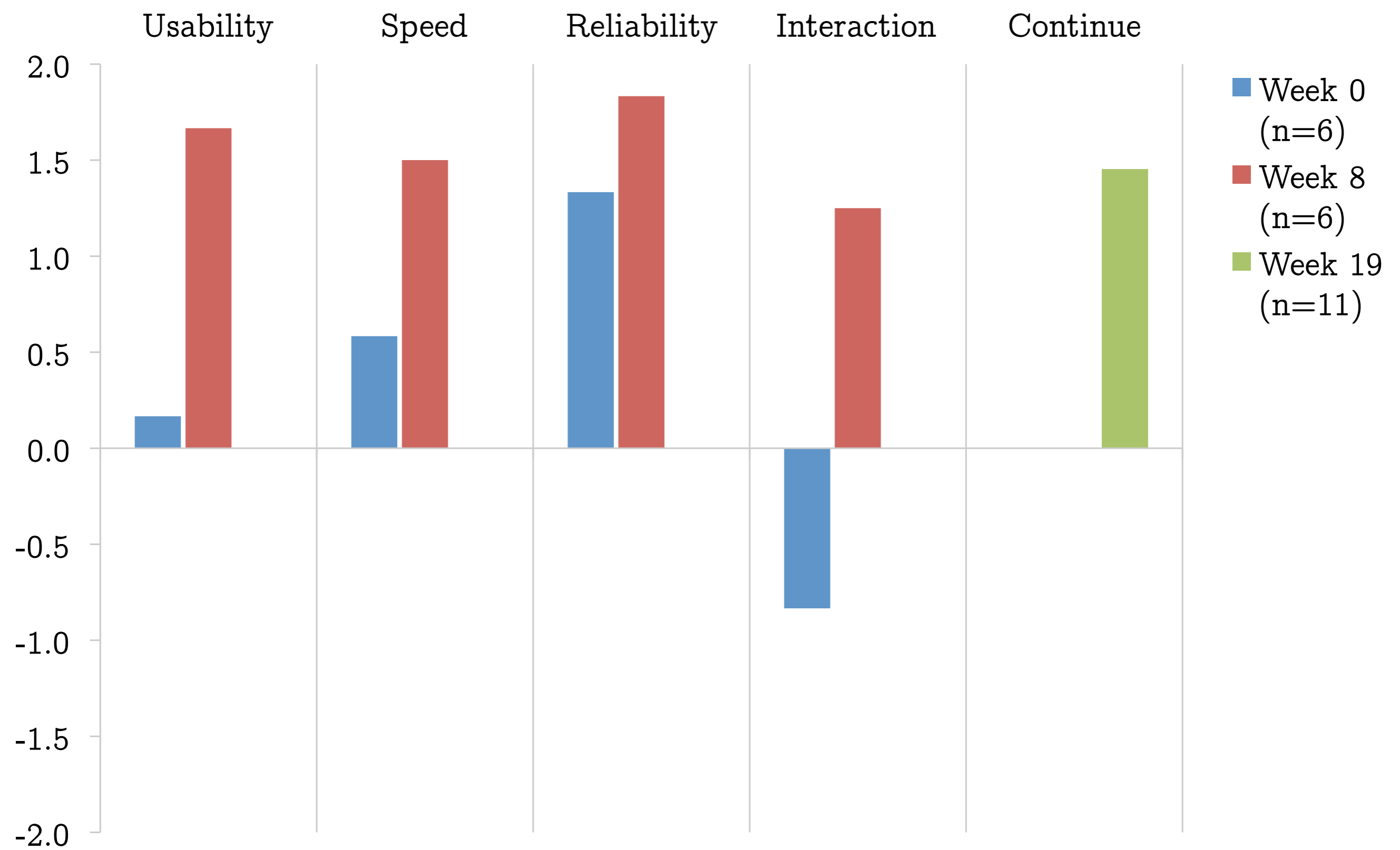
\*  
And the same story again when I asked about reliability. Was the whole phone summaries process reliable, more reliable, unreliable or much more unreliable than the paper-summaries process.

\*  
I also wanted to know if the quality of patient interaction on the phone was better, much better, worse or much worse than on paper. The average score goes from negative to positive.

\*  
If you are familiar with Nicki Dell's work, you know that there is definitely a bias in responses from participants in cross cultural research. It's hard to control for that, but that's why I did things over time, and that's also why I did another set of surveys in Week 19.

These were anonymous surveys given by a local person. One of the questions I asked was if they wanted to continue, strongly continue, switch back, strongly switch back.

## Doctor Ratings (Phone vs. Paper, 5 point Likert)



Of the 11 responses I got, almost everyone wanted to continue.

Caveat here is that not all doctors in Week 0 and Week 8 are in the Week 19 group. They are anonymous, so I don't know who is in that group. But whomever it is, they want to continue.

I also did interviews over time with doctors and I want to share some of anecdotes.

Speed of patient visit about same, but convenience is higher

*“I do not depend on other staff to print for me [the] summary ... [or] to put the summaries in charts [patient folder]. I can assess AMRS with the phone while in the room thus enabling me to make corrections.”*

Speed of patient visit about same, but convenience is higher

\*

“I do not depend on other staff to print for me the summary ... or to put the summaries in patient folders. I can assess AMRS with the phone while in the room thus enabling me to make corrections.”

Across all doctors, you get the sense that it's not so much the speed of the patient visit that makes ODK Clinic fast. It's more the speed of the entire process and the independence it enables.

Doctors don't have to rely on nurses anymore. They can do both the retrieval and correction themselves and that's why they consider ODK Clinic fast.

Reliability, especially for scheduled patients, is better

*“Sometimes the AMRS is down and you can't get a summary even for scheduled patients. I can't even remember the last time I had that problem [finding patients on the phone].”*

Reliability, especially for scheduled patients, is better

\*

Sometimes the AMRS is down and you can't get a summary even for scheduled patients. I can't even remember the last time I had that problem of finding patients on the phone”

From the usage data the phone generates and the surveys, it looks like doctors get summaries of scheduled patients when they need them. I think the caching mechanism I have in place worked pretty well and that's why doctors think the system is reliable.

## Patient interaction is better if you explain phone usage

*“When we were rolling down this thing, someone thought I was doing Facebook. So when I realized that, I started educating our patients. If a patient comes in, I tell them, look, this gadget is your file [patient folder]. I'm going to use it to have a look at your case. And now they understand. So the interaction is good.”*

Patient interaction is better if you explain phone usage

\*

“When we were rolling down this thing, someone thought I was doing Facebook. So when I realized that, I started educating our patients. If a patient comes in, I tell them, look, this gadget is your patient folder. I'm going to use it to have a look at your case. And now they understand. So the interaction is good.”

I think this quote speaks volumes. The obvious thing here is that a patient, when you educate them are OK with the technology. I dug a little deeper and you get this sense from the doctors, that patients actually appreciate the technology.

That is, as a patient if you see a doctor using technology, you seem to think that doctor is more advanced, and maybe better in some way. Whether that's true or not remains to be seen.

## Reported problems changed with more use of system

Week 0: “[One concern is] the slowness in learning since I have not used the touch screen, and the kind of phone.”

Week 8: “[Phone] depends on AMRS to search for patients not downloaded [unscheduled patients] and AMRS is down mostly.”

There were problems with the deployment. The problems that doctors reported change over time.

Right after the training in Week 0, many of the doctors were really concerned about learning the system. As one said,

\*

“One concern is the slowness in learning since I have not used the touch screen, and the kind of phone”

Eight weeks in, they’ve mastered it, and they start seeing the biggest limitations of the system.

\*

“The phone depends on AMRS to search for patients not downloaded, the unscheduled patients and AMRS is down mostly”.

This is a big problem with ODK Clinic. If the patient is unscheduled, you can’t find their record if the medical record system is down.

I don’t have a good sense of how bad this problem is. About 30% of patients at these sites are unscheduled -- they don’t show up on the day they are supposed to.

But there is no data on how far off their visit date they are. Is it a day or two, is it a week, a month?

If you remember, I have a two week window, to try to catch these patients, but I think I need a totally different approach to solve the problem of unscheduled patients.

*“If the problem was happening every day, the solution is not to go back to the paper work. The solution is to look where the problem is and we sort it out.”*

*“It's a part of me now. I really can't see a patient without this phone. It's like something is amiss.”*

But overall, doctors they seem to like ODK Clinic. There is a can-do and aspirational side of using the technology, especially with the younger doctors.

\*

“If the problem was happening every day, the solution is not to go back to the paper work. The solution is to look where the problem is and we sort it out.”

I think there is also some recognition that ODK Clinic is there to help improve their care of patients and not to forget the standard operating procedure. Two of doctors said something like this.

\*

“It's a part of me now. I really can't see a patient without this phone. It's like something is amiss.”

I'm running out of time, so we should move on to the conclusion.



## Background

- The state of HIV care and how clinical summaries help
- Problems with availability, supervision and corrections

## Contributions

- Mobile app targeted at solving the identified problems
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## Conclusion

- Future research directions

The biggest lesson I've learned here is that technology in this space is really best when it can help improve an existing system.

This work has been an evolution of a paper-based system that AMPATH created, and working with them, I've been able to create an electronic version that gives them more capabilities than they had before.

AMPATH is pushing ahead with this work, and I suppose as a researcher, that might be the best I can hope for. There are a handful of things that I think are important to pursue in the short and long term and I want to share those directions.

# Research directions to explore

- More unscheduled patients to the phone
- Increased flexibility in summary definition
- Tablet form filling to replace encounter forms
- Tools to visualize breakdowns in workflow
- Does ODK Clinic increase quality of care?

\*

More unscheduled patients to the phone.

One big limitation in this work is just how poorly I handle unscheduled patients.

The numbers of unscheduled are just too large to rely on AMRS to be online when a doctor needs that summary.

There needs to be a deeper dive into understanding how “unscheduled” these patients are in order to build a more intelligent algorithm about what summaries are put on the phone.

\*

Increased flexibility in summary definition.

There is a lot of business logic that sits on the phone client. I think all that could be encoded in a more flexible summary definition.

This is important because as you scale, you can't always update the phones. You want to put as much logic into the server as possible.

\*

Tablet form filling to replace encounter forms.

Doctor adapted quickly to touch. Could we leverage this to build richer form interaction, say on a tablet?

I stayed away from the encounter form because it's just too big and complex to do well on a phone. I've got some ideas of how I can do it better on a tablet and doctors are really excited about those possibilities.

\*

Tools to visualize breakdowns in workflow

I know the corrections aren't ending up in the patient record, and that's an instance of a larger problem.

I think tools that empower local and remote staff to see where there are breakdowns in a workflow would be very useful. The graphs I showed could be operationalized, but those tools need to be targeted at non-experts.

\*

And then finally, does ODK Clinic actually make a difference in care. That is, with all the support for supervision, and data correction and reminders in the phone, does that actually make a measurable difference in the patient's outcomes.

I've got some data on this in the dissertation, but the conclusions that can be drawn are weak. We need a more controlled and rigorous evaluation to really answer this question.

So that's all I have prepared.

This work was a collaborative effort, and I want to publicly thank...

Special thanks go to...

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Martin Were, Win Ribeka from Indiana University, Regenstrief Institute and OpenMRS, and John Lagat from AMPATH. I'm just a computer scientist and so it's only through collaboration that this kind of work can get done. Martin, Win, Lagat and I have been working together for a few years now and they are great partners.

\*

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\*

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