ODK Clinic

Design of a Phone-Based Clinical Decision Support System for Resource-Limited Settings

Yaw Anokwa, Win Ribeka,
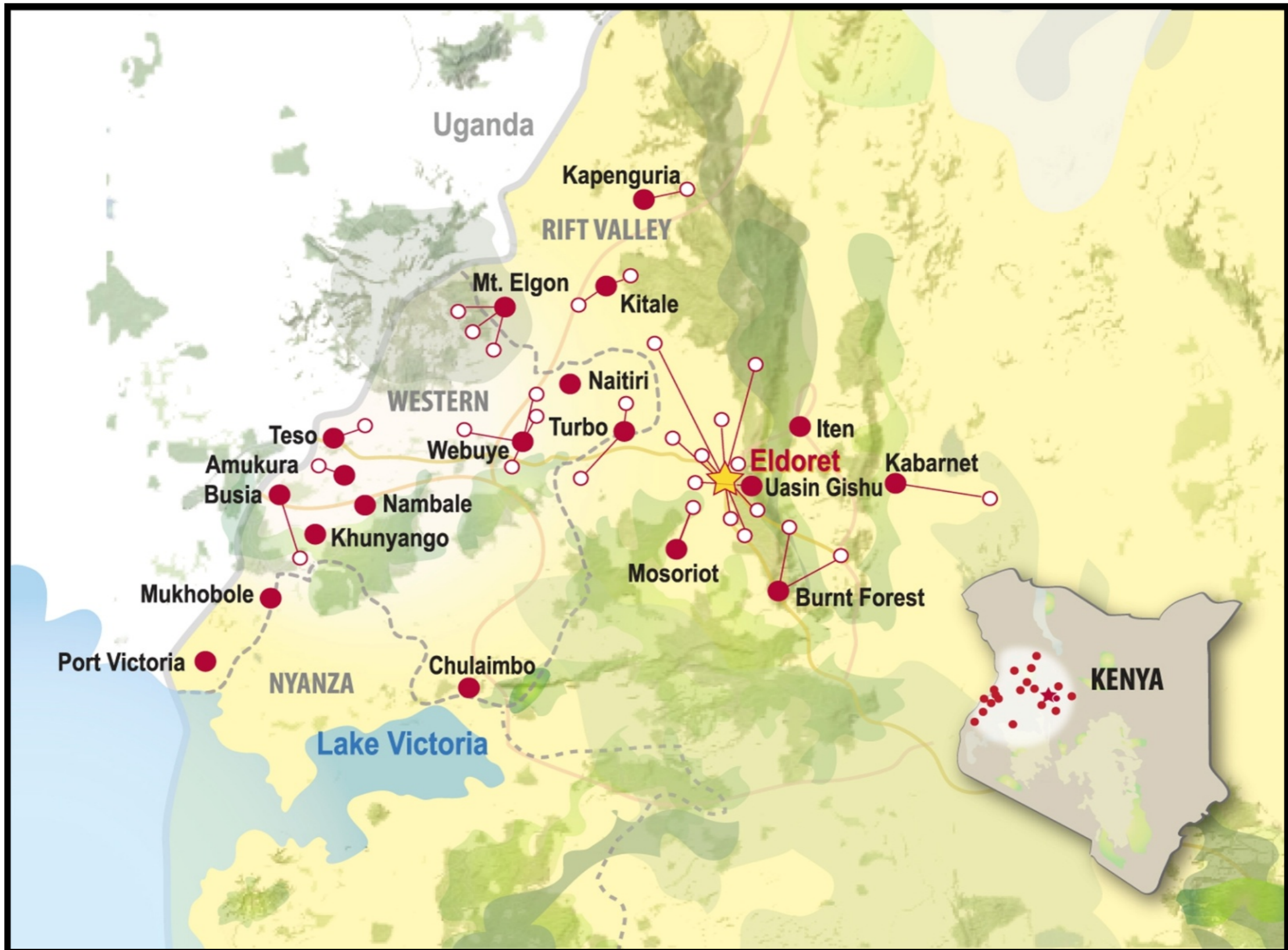Tapan Parikh, Gaetano Borriello, Martin Were

http://opendatakit.org

My name is Yaw Anokwa. I'm a Ph.D student in Computer Science from the University of Washington and this talk is about the design of a phone-based clinical decision support system for resource-limited settings. We call the system ODK Clinic.

This is work that is done with Nyoman Ribeka, Tapan Parikh, Gaetano Borriello and Martin Were. Win and Martin are from Regenstrief Institute and AMPATH in Kenya, Tap is at the iSchool at Berkeley, and Gaetano is obviously from UW.

USAID–AMPATH is the one of the largest HIV treatment programs in sub–Saharan Africa and is Kenya's most comprehensive initiative to combat the virus. The program provides care to more than 130,000 active HIV–positive patients through 26 parent and 26 satellite clinics. Eldoret is their main location, and catchment area has some 2 million people.

AMPATH is unique in that they've really invested in building out a medial records system based on OpenMRS that supports these patients, and they are doing it at really massive scale.
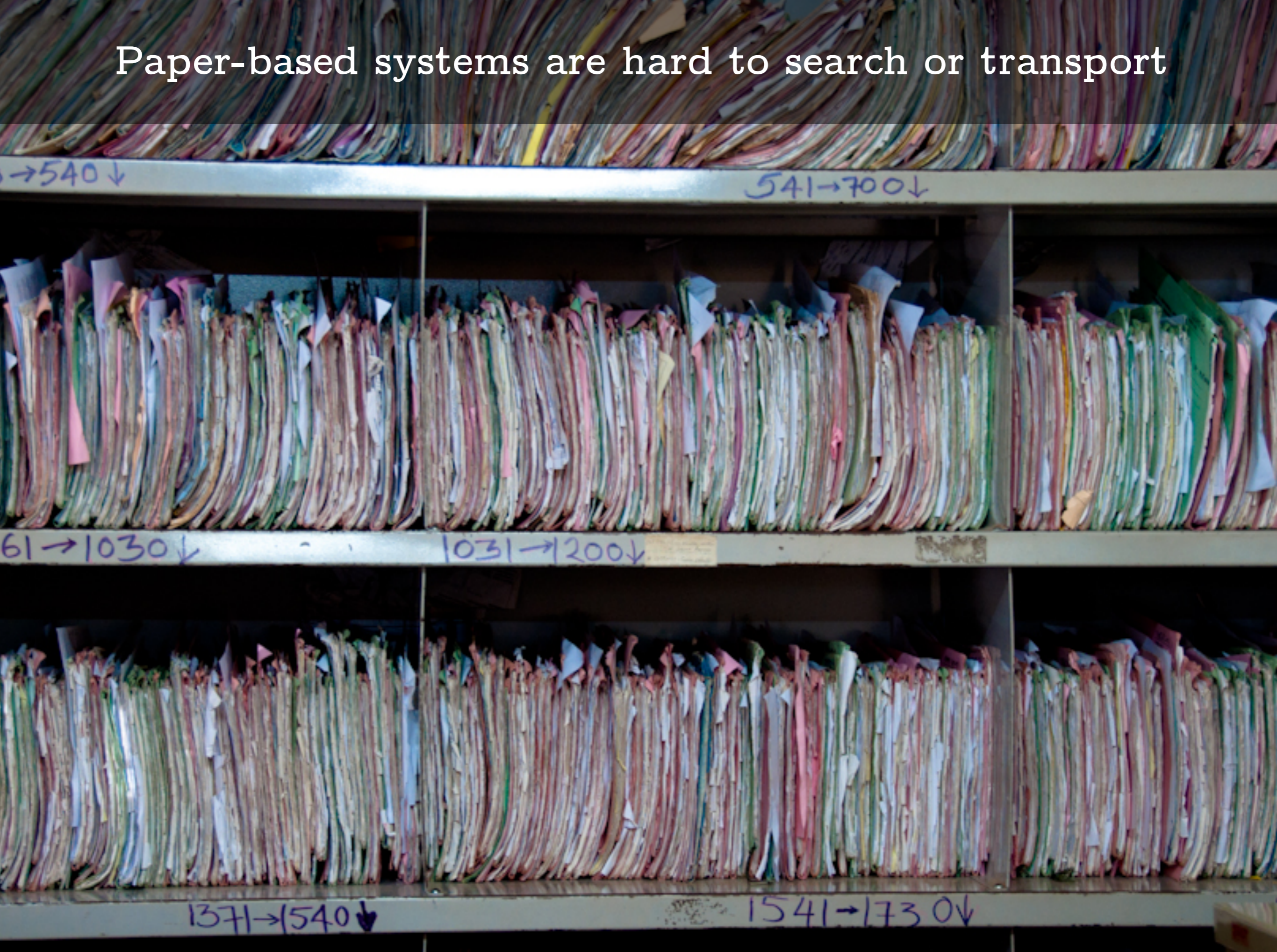
When a patient comes into an AMPATH clinic, the doctor fills out a paper form about the visit.

The paper form goes into a folder, and when the patient comes back a few months later, the doctor reviews the information in that folder and uses that to make decisions.

So paper provides both the data capture and retrieval.

With a paper-based system like this becomes really easy to make clinically relevant mistakes like missing a trend in a record or misread someone's handwriting.

Even if you are really careful, when you get thousand of patients, the system becomes hard to search or transport.

This is especially important if you are treating HIV or TB (or other chronic care) patients who generate a lot of paper records.

Add to that the fact that these clinics (especially the remote ones) are very busy and under-resourced. The US has one doctor per 400, Kenya has one doctor per 7,000. Tanzania has one doctor per 50,000. You can imagine it's much worse in rural places.

And if that wasn't bad enough, many of the clinicians delivering care are lightly-trained.

Testarius Paul Kungu

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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
1. MALARIA *(01/06/2010 ...3 more)*
2. BRUCELLA TEST *(31/03/2010)*

Immunizations
1. H.Flu B (1.0)
2. DPT (1.0)

Recent ARVs & OI Meds
1. TRIMETHOPRIM AND
   SULFAMETHOXAZOLE

ARV Side Effects
NONE

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

1. NEVIRAPINE / POSTPARTUM,ANTEPARTUM,INTRAPARTUM / [Unknown Dose] / 44.0 Weeks
2. LAMIVUDINE / POSTPARTUM,ANTEPARTUM,INTRAPARTUM / [Unknown Dose] / 44.0 Weeks
3. 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 *06/12/2006*	6.0 *06/12/2006*	(Test Ordered) *01/02/2010*		(Test Ordered) *01/02/2010*	(Test Ordered) *01/02/2010*	(Test Ordered) *01/03/2010*		(Test Ordered) *01/02/2010*
60.0 *01/02/2010*	60.0 *01/02/2010*	200.0 (No Order) *01/09/2010*				(Test Ordered) *16/03/2010*		
60.0 *01/03/2010*	60.0 *01/03/2010*	65.0 (No Order) *19/09/2010*						

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)

1. Please order HIV ELISA. Pt > 18 mo old with no valid ELISA result. (___)
2. 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
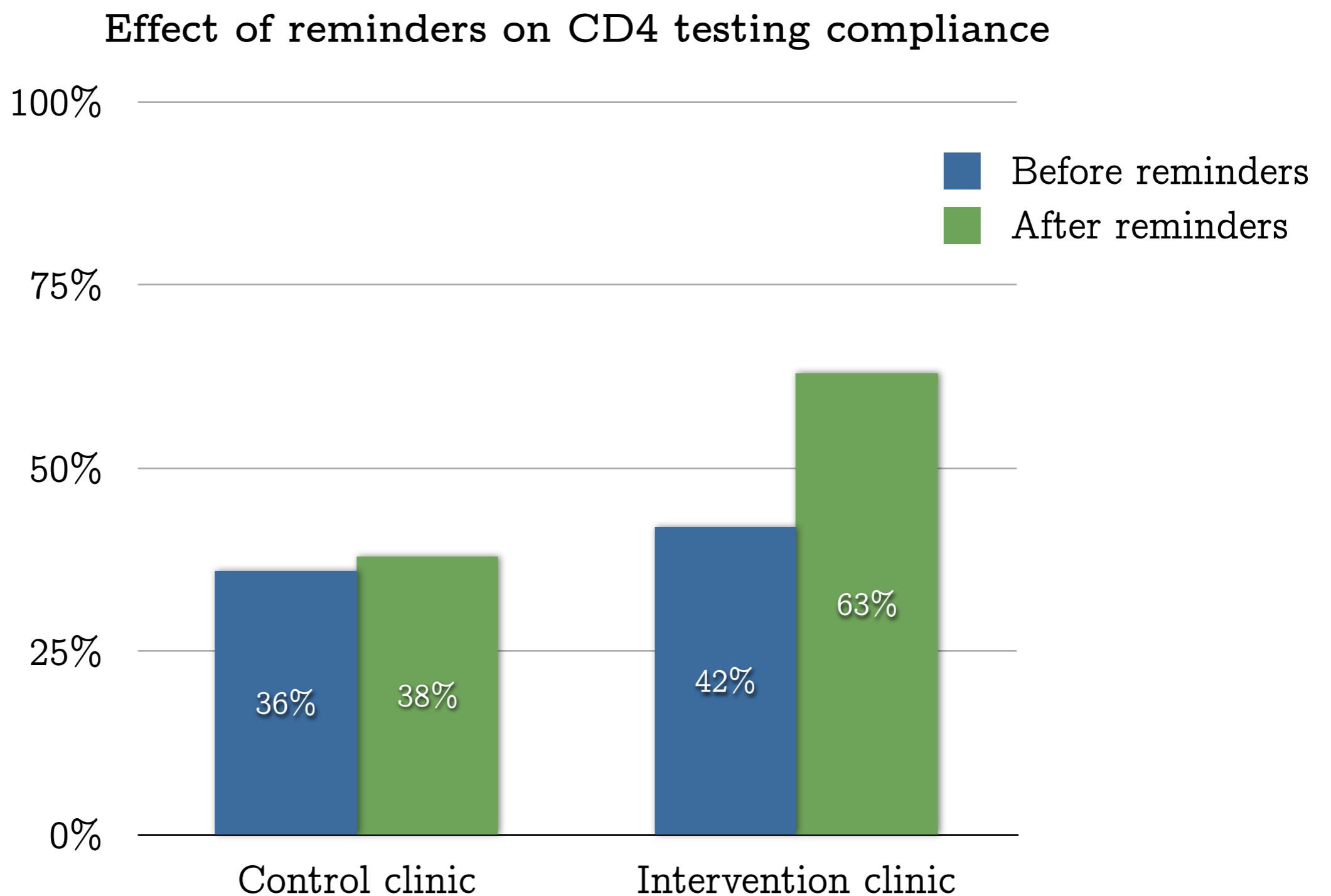Next scheduled visit: 03/01/2007

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In the West, we use a number of decision support tools to address problems like these and AMPATH has been doing the same.

In particular, they use a paper clinical summary that is printed when the patient visits. It has some care reminders at the bottom about deviations in care.

This is a really important tool that can improve the quality of care.

Effect of reminders on CD4 testing compliance

Legend:
- Before reminders (blue)
- After reminders (green)

Control clinic: 36% (Before reminders), 38% (After reminders)
Intervention clinic: 42% (Before reminders), 63% (After reminders)

Were et al. Evaluation of computer-generated reminders to improve CD4 laboratory monitoring in sub-Saharan Africa. JAMIA, 2011.

And it turns out that these summaries and reminders work well to improve care. We ran a study at AMPATH to measure the effect of reminders on CD4 testing compliance. This is work published at AMIA (
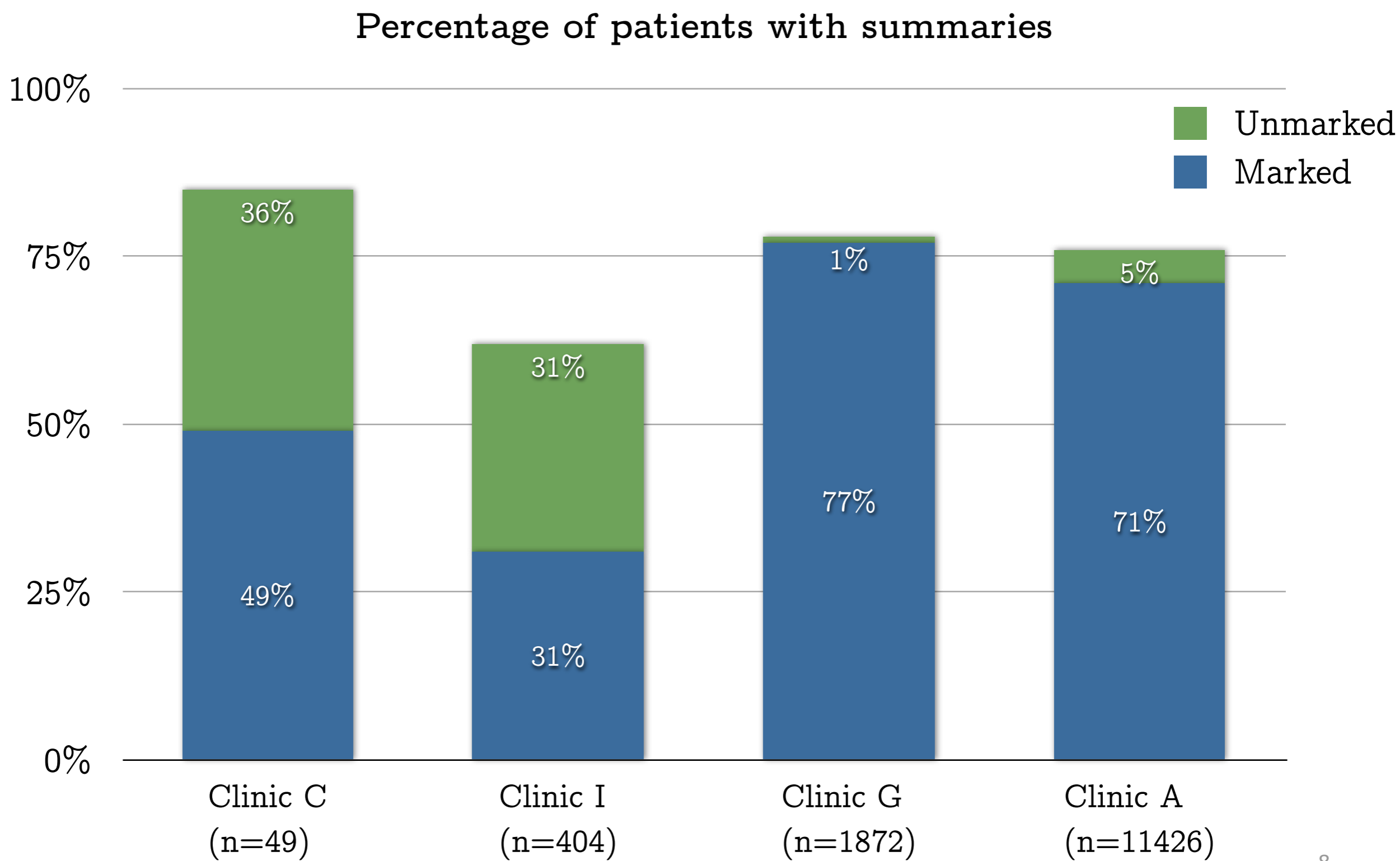
CD4 tests are the most important indicator in determining the health of an HIV+ patient and there are care guidelines that clinicians to be following.

So on the Y-axis, is compliance. The more compliance the better. On the X are the two arms of the study -- the control and the intervention.

So in the control, you see that compliance with these rates is around 42% for the intervention clinic. Add the reminders and we can show an increase to 63%, and so better care is being delivered.

Great, why not do more of this?

Percentage of patients with summaries

Legend: Unmarked, Marked

- Clinic C (n=49): Marked 49%, Unmarked 36%
- Clinic I (n=404): Marked 31%, Unmarked 31%
- Clinic G (n=1872): Marked 77%, Unmarked 1%
- Clinic A (n=11426): Marked 71%, Unmarked 5%

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Well, it's really hard to get the summaries at the point of care. We looked at 50k return visits, and of those, only 80% had summaries available. Let me dive down into some of the clinics..

Marked means the patient put a physical mark that said they had seen the summary. The gap is the patients who didn't have summaries.

So on the Y-axis, the more marking, the better. On the X are a few of clinics we looked at in detail.

You can see that marking rates are bad (especially at remote sites). Even at the big sites where marking is high, some 25% of summaries don't even get printed.

Why is this?

Couple of reasons.

First, the physical transport of summaries is hard. It's not just transport, it's things like making sure all sites have paper and toner and the printer works. And making sure all the summaries get collected up and transported back to a central location for data entry.

This process of generating the summaries and getting them to the remote sites is very failure prone.

Take this picture as an example. You see where the problem is? If the patient sits at the left, and has some children with her, those kids are going to yank on those cables of the printing computer. And no one will report it because of the power dynamics.

Without a more transparent monitoring system, it is difficult to correct these failures.

Monitoring clinician response in real-time is difficult

Second, even if you have reliable delivery, it's hard to know what the clinicians are doing in a timely manner.

This is really important because all the literature stresses that decision support works best when it's iterative.

So are they looking at the summary? Are they responding to reminders? There are potentially hundreds of reminders, and you need regular insight into what the doctors are doing so you can ensure the best standard of care.

Waiting a few weeks to get the data entered is not adequate.

- Physical movement of paper-based summaries is unreliable.

- Critical feedback on availability and response rates are not timely or reliable.

- Reminders expose incorrect data that slows clinic workflow.

- Inadequate training and supervision of clinicians, nurses and data assistants.

- Surges of unscheduled patients can prevent summaries from being printed.

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We've covered these first two already.

The last three are really interesting.

So each time you add a new reminder, it tends to expose really bad data in the EMR. So it has to be corrected by a clinician and the change has to be verified and entered by a data clerk (sometimes by returning to a remote clinic to review the encounter form).

The correction process generally introduces a backlog of data entry work and so the bad reminder keeps showing up each time the patient visits. The clinicians get frustrated at the system, loose faith in it, and and ignore reminders all together.

We've also talked a bit about training. Every few months, the CDSS team goes out and retrains everyone to maintain a high standard of care. It's hard to do but failure to do it means workers don't follow procedure and things slip up.

Finally, nurses are supposed print summaries for scheduled patients ahead of time, but patients often do not arrive on the day they are scheduled. If a surge of unscheduled patients arrives, the nurses cannot both manage patient care and print all the necessary summaries. They generally stop printing at that point...
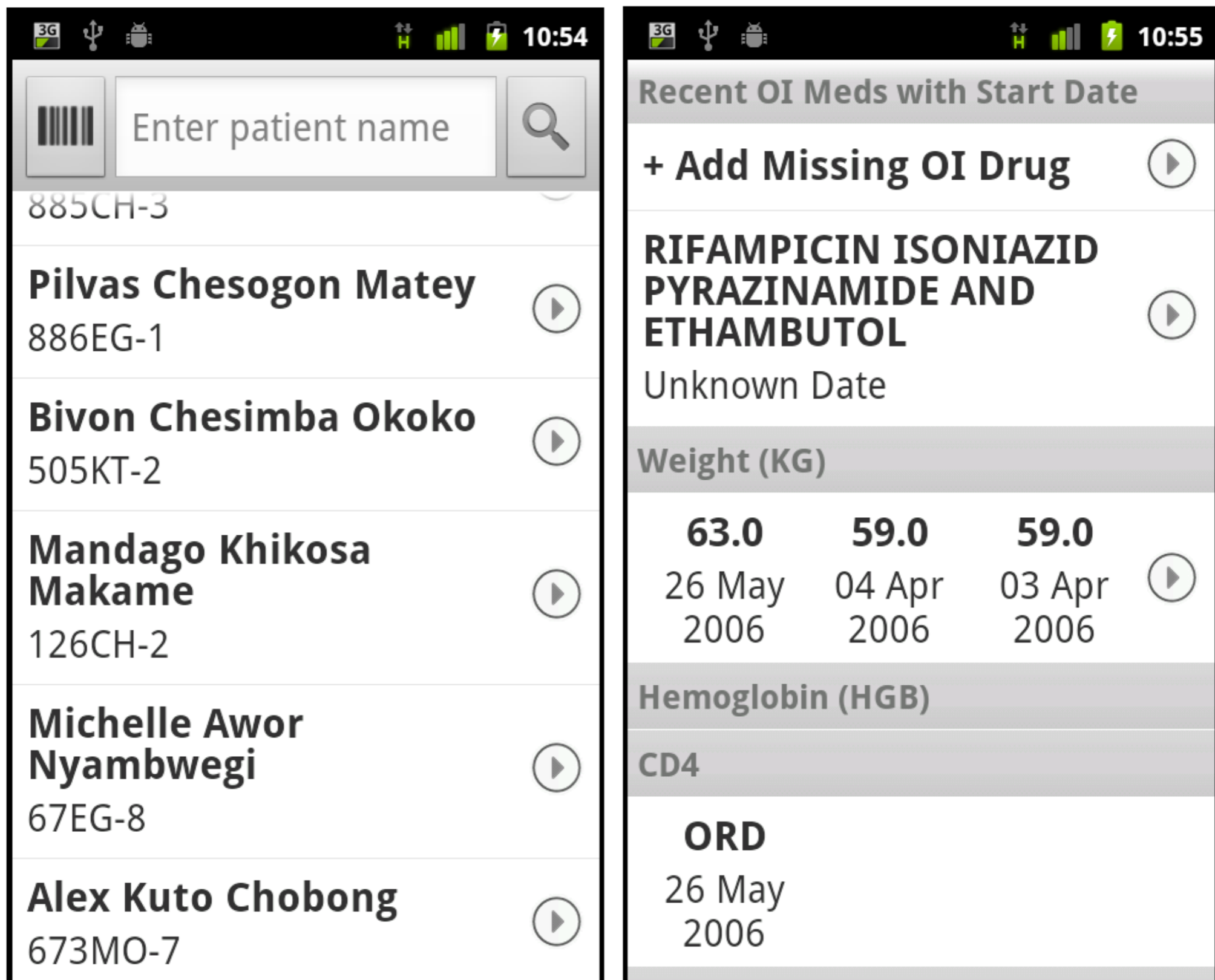
So we built a mobile app that addresses the failures we saw at scale and we did a lot of leg work before hand to guide the design. So you have a list of patients here, and when you tap on it, it gives you the summary for that patient.

I think the big things are, it's really a tightly focused app that replaces just the summary sheet. So whatever you do on that sheet, you do in the app. It even looks like the sheet because we really want to drive down training costs.

The other thing is that everything that you need to know about the app is in front of you and we use a fixed and consistent set of interactions. The doctors get how to use it immediately and it's fast to use.

Also, the connection issues, we've been able to make downloading big cohorts of patients really fast, even over terrible network connections.
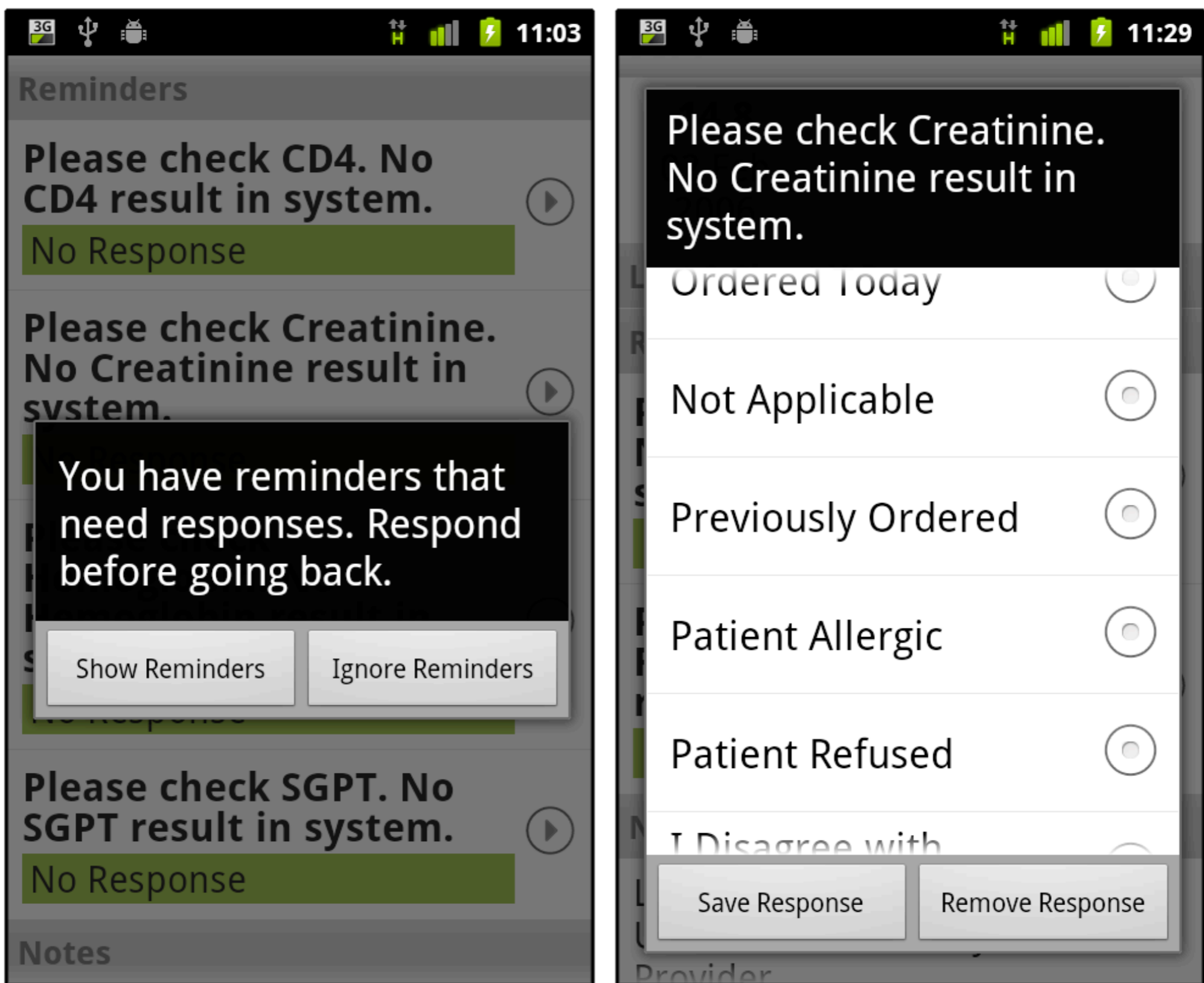
To address the more training and decision support that we improve care, we have dialogs that remind about the reminders and make it easy to respond.

More importantly, we can track everything. We know when you see patients, how long you see them, when you respond, how long you look at reminders, etc, etc.

We now have the system in two adult HIV clinics in AMPATH, it's been running for about a month for about 4k patients, and the results have been great all around.

First, the doctors like using the phone.

They've expressed a desire to task shift summary retrieval and data entry to clinicians and to use phone for other clinical functions. This was unexpected and opens up a lot of possibilities for what we can do.

Second, they although they learn really quickly, we find that it was best not to use the cheapest device (say $80) for those totally new to smart phones. We are using $275 Nexus Ones, and the mix of a big and better touch screen and the caché it gains the doctors is totally worth the savings in complaints and training.

The only real concern the doctors have is with phone security -- no one wants to buy a replacement phone. We've put in place lots of physical security (door locks, cabinets, etc) to address some of those issues.

Reminder response rate (phone v paper)

Legend: Paper (blue), Phone (green)
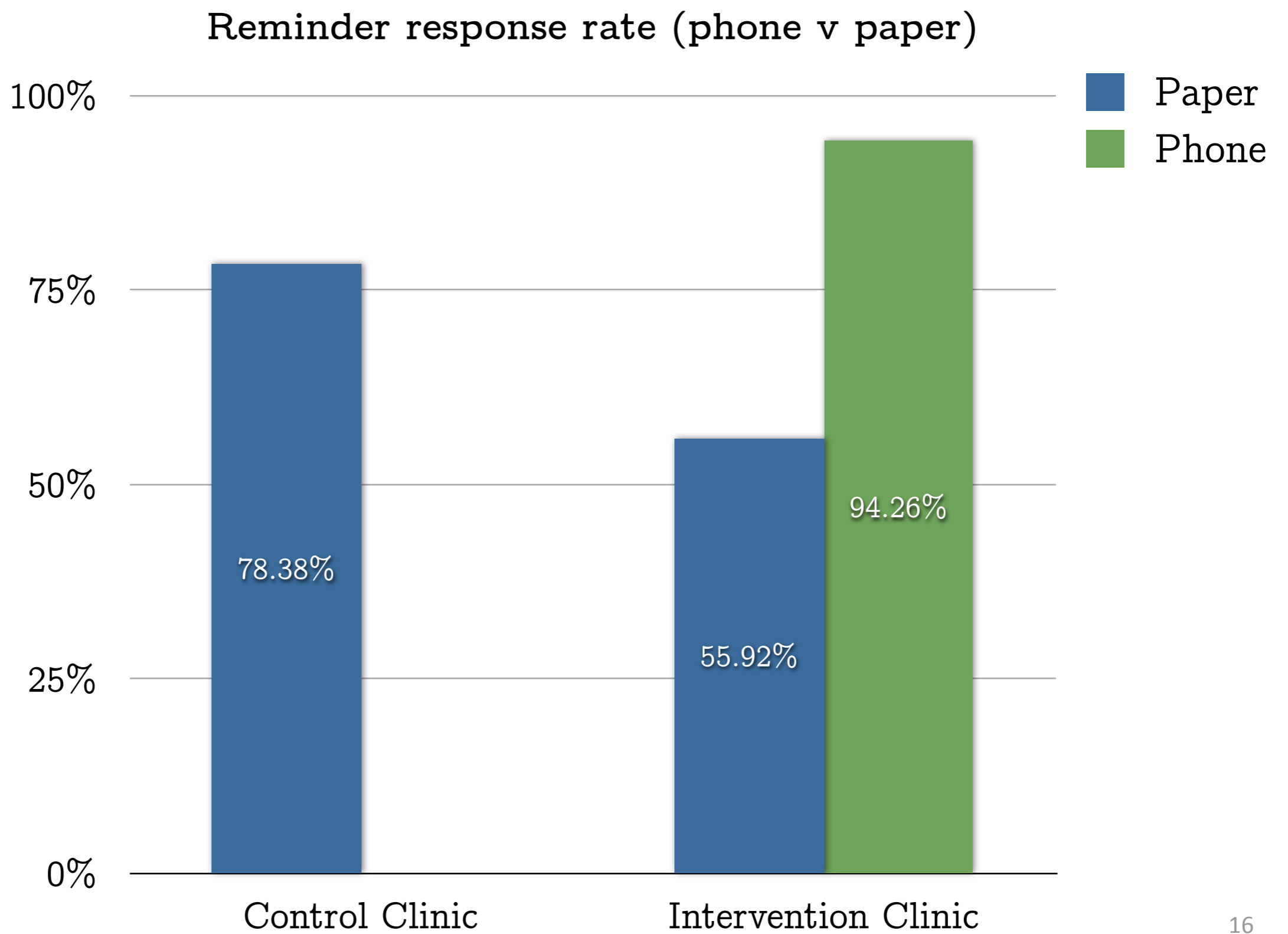
Bars: Control Clinic — Paper 78.38%; Intervention Clinic — Paper 55.92%, Phone 94.26%

And it turns out it's also likely going to improve outcomes.

It's been running in two clinics for about a month now (about 13 doctors, 5k patients) and the metrics we care about are all very promising.

Availability at the point of care is basically perfect now -- when a doctor needs patient data, they just look it up. it works well even there is no connection to the medical record system.

Here is some initial analysis.

Y-Axis is response rate. The higher, the better. The X are the different arms.

You can see response rates have gone up from 55% to about 94% in the intervention. And the control is one of the better clinics.

Ordering rates in response to late lab reminders
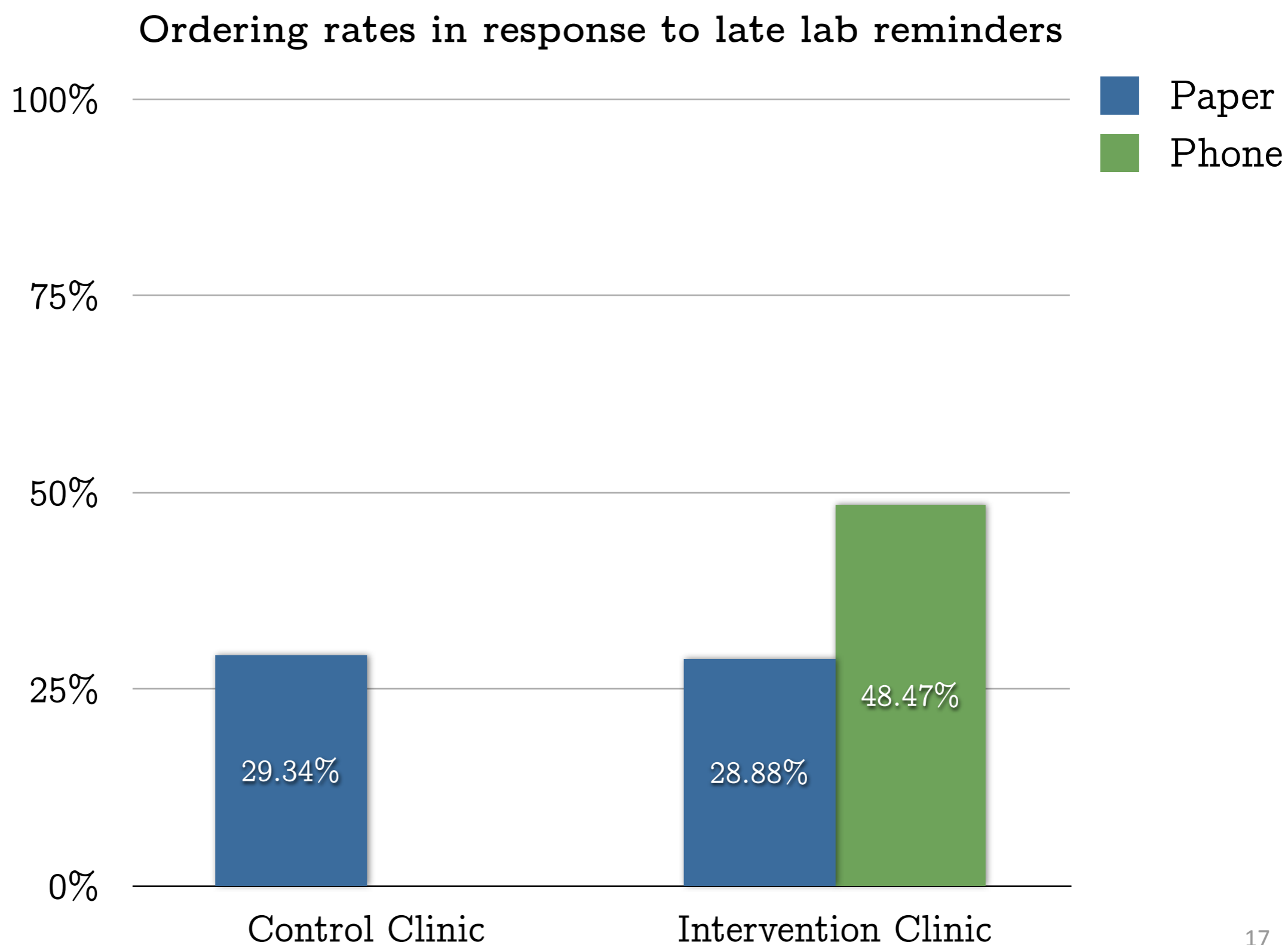

More importantly, clinicians are responding greater percentage to the really important reminders (like cd4).

There are some other benefits. Doctors can now correct mistakes (wrong drugs, wrong labs) they see in the patient record, and supervisors have a detailed and real time view of what is going on. If they see a deviation in care or something going wrong, they know who they have to talk to.

This is all objective which is great. We don't have to take the doctor's or data assistant's word for it. The data speaks for itself.
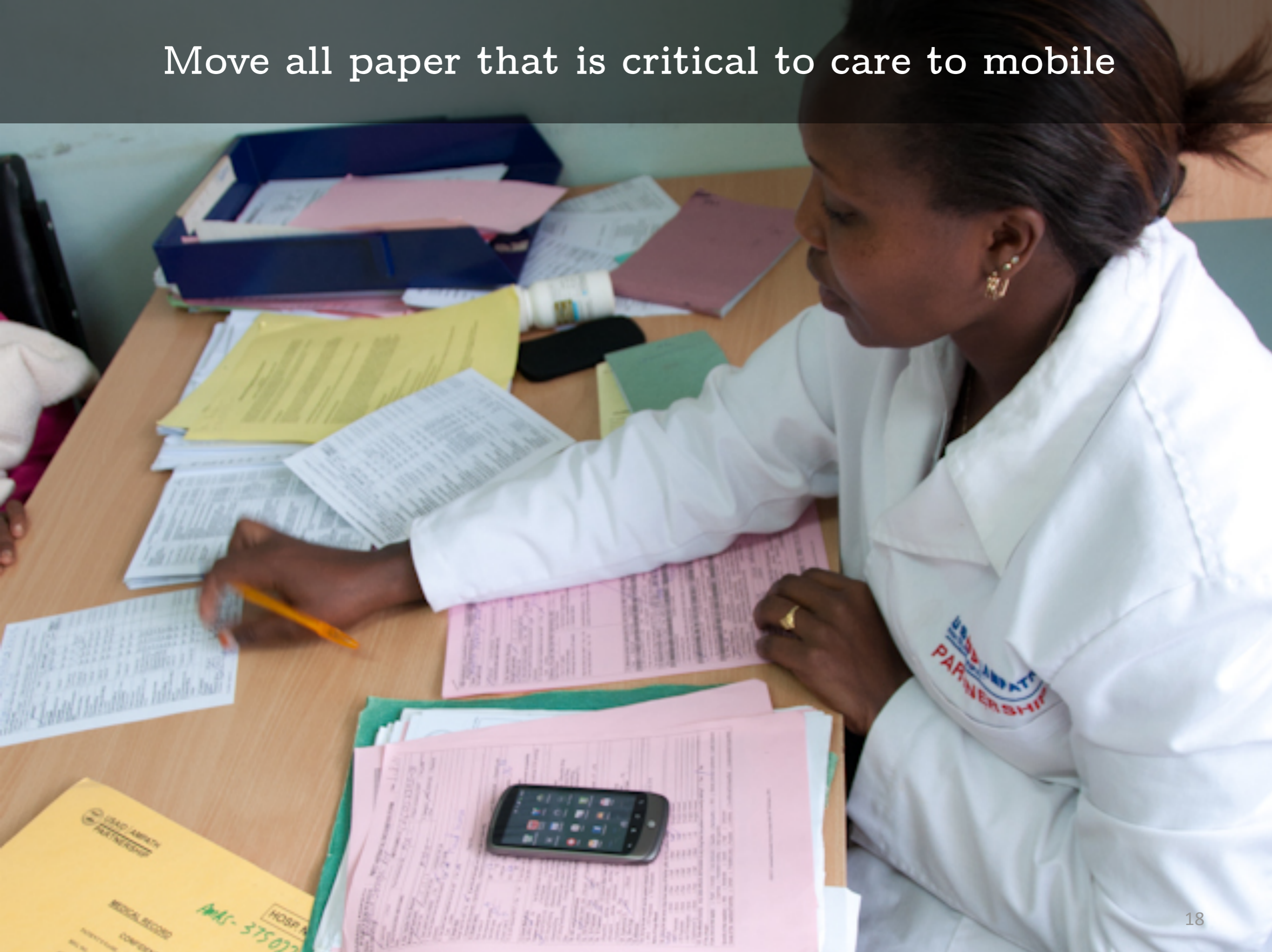
See all the forms there, we want to move those dense forms to a tablet and save a ton of money (and time) entering and correcting paper. This is similar to our ODK Collect work, but a new UI for these kinds of forms.

Next is chronic care. So there are a lot of patients with heart disease and diabetes and hypertension and they don't need to (or want to come to the hospital). Ideally they could go to their neighborhood pharmacy where the phone could walk a nurse through protocols.

Last is mobile-based diagnostics, and I hope to share more on that very soon!

change

A group at the University of Washington exploring how technology can improve the lives of underserved populations.

http://cs.washington.edu/homes/yanokwa (@yanokwa)

http://change.washington.edu (@uwchange)

http://opendatakit.org (@opendatakit)

The Change group at UW

Are there are any questions I could answer?