Creation and Evaluation of EMR-based Paper Clinical Summaries to Support HIV-Care in Uganda, Africa

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Abstract

Purpose—Getting the right information to providers can improve quality of care. We set out to provide patient-specific Electronic Medical Record (EMR)-based clinical summaries for providers taking care of HIV-positive adult patients in the resource-limited setting of Mbarara, Uganda.

Methods—We evaluated the impact of implementing these clinical summaries using time-motion techniques and provider surveys.

Results—After implementation of EMR-based clinical summaries, providers spent more time in direct care of patients (2.9 vs 2.3 minutes, p<0.001), and the length of patient visits was reduced by 11.5 minutes. Survey respondents indicated that clinical summaries improved care, reduced mistakes, and were generally accurate. Current antiretroviral medication, patient identifying information, adherence information, current medication, and current medical problems were among the highest-rated elements of the summary.

Conclusions—By taking advantage of data stored in EMRs, efficiency and quality of care can be improved through clinical summaries, even in settings with limited resources.

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INTRODUCTION

HIV/AIDS is a chronic disease that currently afflicts more than 33 million persons worldwide, two-thirds of whom live in sub-Saharan Africa.[1] Thus, the greatest burden of disease exists in low-income countries that have the least resources for managing these patients. It therefore behooves such countries to leverage the limited healthcare resources available to maximize the number of persons treated and the quality of care delivered.

Care of HIV-positive patients is data-intensive. In developing countries, treatment guidelines require that patients on antiretroviral medications (ARVs) visit healthcare providers monthly, and those not on ARVs visit less frequently (about once every three months). During each visit, substantial detailed clinical information is collected which accumulates to unwieldy levels over time. Unfortunately, critically important historical data are frequently unavailable to providers during the patient visit; and if available, are usually disorganized or incomplete.

Data are key to effective patient management. As the Director of the Brazilian National Health Service has stated, "*There is no health care without management, and there is no management without information.*"[2] In effect, healthcare is an information business,[3] and the more efficient the data collection and management, the more efficient and effective the care.

Electronic medical records (EMRs) can help to store, organize, and display data. The important role of EMRs in improving care has been well-demonstrated in industrialized countries.[4] Despite increasing numbers of EMRs implementations in developing countries,[5] very few studies have critically evaluated and demonstrated the benefits of these systems in this setting. Without direct proof that EMRs can improve quality and/or efficiency of care, EMRs may not compete successfully for limited healthcare funds available in developing countries.

One big problem with most EMR implementations for HIV-care in developing countries is that they focus on getting reports to institutional stakeholders, rather than on getting patient-level information back to the clinical provider. These systems often lack the ability to automatically organize existing patient data, detect deficiencies in care, and offer specific alerts and solutions to remedy the situation.

We set out to demonstrate that it was possible to use an EMRs to give providers practicing in an HIV clinic in Mbarara, Uganda with just-in-time, contextual, patient-specific information with relevant clinical reminders. In this paper, we report on the details of this implementation and results of a pre-post analysis of the effect of the clinical summaries on time-use and clinic efficiency. We also report findings of a satisfaction survey for providers who used the EMR-based clinical summaries. We hypothesized that these summaries could improve efficiency of care, and would be valued by providers.

METHODS

Setting

We conducted this evaluation at an HIV/AIDS specialty clinic affiliated with Mbarara University of Science and Technology in Western Uganda. This clinic only takes care of adult patients, and as of August 2008 had enrolled over 15,000 HIV-positive patients. Patient care

at the clinic is provided mostly by four full-time medical officers (physicians with no training beyond medical school), with the assistance of five nurses and two pharmacy personnel. Prior to implementing the computer-generated clinical summaries, the HIV clinic had an MS-Access based database that stored a limited set of data extracted from the patient's paper record. To transition to our new system, Mbarara clinicians developed initial and return visit encounter forms which captured selected coded data they deemed important. These paper-based encounter forms were completed for each clinic visit and filed in patients' paper charts as their permanent medical record.

Electronic Medical Record

The EMR we employed was OpenMRS®.[6,7] This open-source system was initially developed through collaboration between Regenstrief Institute, Inc. and Partners In Health in the U.S.A, but now has a world-wide community of developers. OpenMRS has a robust patient-centric data model and a rich java-based Application Programming Interface (API). A web-based front-end sits on top of this API, and all data in the system are transmitted via HL7. Most current OpenMRS implementations use the MySQL relational database, with data stored as coded concepts to allow for easy retrieval and analysis. Data security is handled by access control through user authentication, with content and interactions served through secure security layer (SSL) connections where necessary. Data within the system can be encrypted, and most implementation sites physically secure their hardware.

Over the past two years a strong OpenMRS implementers community has emerged to serve the needs of a growing number of implementers.[8] Because most resource-limited settings do not support use of computers during patient visits, OpenMRS offers an option which allows providers to complete paper-based encounter forms which capture numeric and coded data. Visit notes are also recorded on the same paper-based encounter forms.

Data from these encounter forms are then entered into entered into the OpenMRS system by data-entry clerks who only require basic computer skills and minimal medical knowledge. Unfortunately, most OpenMRS implementations have no provisions to allow providers to query patients' EMRs directly. Providers usually must leaf through old encounter forms to review patients' clinical data.

Intervention: Clinical Summaries

Collaborative Development with Providers—To create the clinical summaries, we started by engaging all the providers (particularly the clinicians) to identify elements to be included in the summary. Two investigators, MCW and MB, spent two weeks outlining and analyzing the workflow and policies at the clinic. This helped to determine how the summaries would be generated, who would have access to them, and what would happen to them after the visit ended.

Programming of Clinical Summaries—OpenMRS has a module-system which allows developers to write and integrate code into OpenMRS without having to modify the core codebase. Modules are packaged as java code that can then be installed into a running OpenMRS instance – such as the HIV clinic OpenMRS implementation. To generate clinical summaries, we built a "clinical summary module" which was then installed into the OpenMRS implementation at the clinic. This module was built using Business Intelligence and Reporting Tools (BIRT) and Eclipse's Rich Client Platform (RCP) technology (Eclipse Foundation, Inc. Portland, OR). These tools allow for extraction of information from databases, analysis of information, and generation of reports. The queries used in BIRT were done in the Standard Query Language (SQL), and optimized to improve speed with which summaries were generated.

Elements for the summaries were populated by querying the database for patient demographics, diagnoses, drugs prescribed, and lab test results. In addition, a clinical reminder was programmed which alerted providers to check a CD4 count if none had been done in over six months. OpenMRS uses a robust concept-dictionary, so all extracted clinical data were tied to explicitly defined concept dictionary terms.

Workflow and resources available—We implemented the clinical summaries with special consideration to the workflow and resources that were available at the HIV clinic. The clinical summaries were iteratively tested with providers and improvements made as needed prior to deployment. Because the registration area in the clinic was not connected to the data-entry room via a local area network, summaries had to be generated in the data-entry room. Furthermore, patients were not given specific appointment dates so it was difficult to tell which patients would visit on a particular day.

We decided to generate summaries as soon as new information from an encounter form was entered into OpenMRS after a visit. Data-entry clerks printed the summary and placed it at the front of the paper chart to be used at the next visit. To save paper, the clinical summaries were printed on the reverse side of empty prescription forms, which were already being used by providers. When the patient presented for their next visit, he/she carried the chart and the printed clinical summary to all provider visits. Patients took the summaries home with them at the end of the visit.

Study Design

Time Motion Study—To evaluate the impact of clinical summaries on time-use and clinic efficiency, we conducted a formal time motion study at the HIV clinic using methods we have previously employed in the Kenya[9] and in the U.S.[10] For the time-motion study, we recorded activities for patients and primary care providers (PCPs) to assess differences in time-use before and after implementing the clinical summaries. Before the clinical summaries were implemented, PCPs paged through prior encounter forms for historical information. After implementing clinical summaries (Figure 1), the PCPs could review the patient-specific clinical summary along with the patient's chart.

We followed about 100 established HIV-positive adult patients presenting for routine visits at the HIV clinic before and after implementing the clinical summaries. Observations for each patient began as soon as he/she was registered in the clinic on the visit day and ended when the patient left the clinic grounds. All PCPs scheduled to work regular shifts during the study period were eligible for observation, and all agreed to be observed for three full workdays in both the before and after-summary phases of the study.

We programmed a list of provider tasks and patient activities into Personal Digital Assistant (PDA) devices using the HanDBase® software (DDH Software, Inc., Wellington, Florida). These PDAs were used by trained observers to record provider and patient activities. When an observer first contacted a subject (either a patient presenting for a visit or a provider beginning his or her workday), he or she opened a HanDBase visit record in the PDA. When the subject initiated the first observed activity (such as talking), the observer initiated an observation record in the PDA which assigned a beginning time to the activity. Once it became clear to the observer what the activity was, he or she recorded the activity by picking it from the pre-established list in a structured menu. When the next activity began, the observer entered a new observation into the PDA, which assigned an ending time to the previous activity and a beginning time to the next activity. "Down time" or inactivity was recorded as "waiting." No conversation was allowed between the person being observed and the observer. At the end of each observation day, the data were transferred an MS-Access® database (Microsoft Corp, Redmond, WA).

Survey—To assess provider attitude towards clinical summaries, we gave an anonymous self-administered survey to a convenience sample of 22 providers (including PCPs, nurses, pharmacy staff, and counselors). Providers were asked to rate the value of various elements in the clinical summary on a 7-point scale, from 1 (Useless) to 7 (Indispensible). Overall perception of the clinical summaries was also rated on a 7-point scale, from 1 (Never) to 7 (Always). All evaluations were approved by the relevant Institutional Review Boards.

Data Analysis

Data from the time-motion study were analyzed using SAS® (version 9.1, SAS Institute, Cary, North Carolina). The duration of an activity was calculated as the difference between its start and end time. The unit of analysis for patients was the clinic visit, which we recorded from the time the patient was registered for the day's visit to the time he or she left the clinic. We excluded from analysis all times before formal clinic registration because some patients presented several hours before the clinic's doors opened. We computed the mean number of patients who visited the clinic each day, and the mean length of each visit. We also computed the time patients spent in various activities during their visits. We did not control the analyses for provider because (a) each patient was seen by multiple providers and (b) we did not keep patient nor provider identifiers in order to assure patient and provider anonymity.

For PCPs, we computed the mean length of PCPs' workdays and mean number of patients seen per day. We also compared the percentage of workday spent in each major task category before and after implementation of clinical summaries. In addition, we compared mean amount of time providers spent in direct and indirect care per each patient-encounter. Kruskal-Wallis test was used to compare relevant continuous measures and all tests were two-sided. We computed descriptive statistics for the survey.

RESULTS

Providers in Mbarara started using the clinical summaries in January 2008. On average, about 150 summaries were printed each day depending on the number of return patients coming for visits.

Time Motion Study

The pre-implementation time motion study was performed from Nov–Dec, 2006 and the post-implementation between Aug–Sep, 2008.

Clinicians—All three PCPs working as full-time providers during the study period participated in the study. We observed each for three full workdays during both the pre-implementation and post-implementation phases, for a total of 109 hours of observation. In the pre-implementation phase, PCPs cared for a mean of 41 ± 18 patients each day (range 23–75, 5–10 patients/hour) while in the post-implementation phase they saw a mean of 44 ± 12 patients each day (range 28–63, 4–10 patients/hour) (p = 0.70). The time the PCPs spent delivering care per day was the same in both periods (6.5 vs. 6.4 hours, p=0.96), although the number of patients seen per day increased by 10% in the "after" period. This result did not change substantially after subtracting time physicians spent in personal activities.

Table I shows activities by PCPs as a percentage of the workday. When summaries were available, the percent of time spent in direct patient care increased by 8.9% while time spent in miscellaneous activities fell by 10.1%. None of the differences in Table I are statistically significant. However, when just assessing time spent per each patient encounter, time spent in direct care increased significantly from 2.3 minutes per visit in 237 encounters before the

summaries to 2.9 minutes per visit in 395 encounters after the summaries became available (p<0.001). Time spent in indirect care did not change (3.2 minutes vs. 2.9 minutes, p=0.7).

Patients—The results for the patient time-motion study are shown in Table II. Returning patients spent 11.5 minutes less time per visit after the Patient Summary Reports were generated than during the "before" period when the OpenMRS encounter forms were used but no Summaries were printed (197.7 minutes before vs. 186.2 minutes after, p<0.001). While patients spent significantly more time after summaries became available with non-clinical staff and interacting with pharmacy personnel, they spent significantly less time waiting: the overall waiting time dropped by more than half an hour which more than made up for the 26 extra minutes spent with providers after the summaries were initiated (53 minutes before vs. 79 minutes after the summaries).

Satisfaction with clinical summaries

The survey response rate was 68% (15/22). Overall satisfaction with the summaries was high as were reports to positive questions in the survey (Figure 2). The highest-rated five elements in the clinical summary were (1) Current ARVs, (2) Patient ID, (3) Last Visit Date, (4) All Current Medication, and (5) Adherence history. Past Medical Problems, Past Opportunistic Infections, and All Past Medications were rated the lowest (Figure 3).

DISCUSSION

The impact of EMRs in resource-limited settings has not been well-demonstrated. Most EMRs implementations are primarily used for gathering information for generating reports to various institutional stakeholders. This is unfortunate, because these systems can potentially play a significant role in improving patient-care in these resource-constrained settings. In this paper, we demonstrate that even in settings where providers have almost no direct interaction with the computer, it is possible to provide well-organized, relevant, and up-to-date EMR-based clinical information to assist in patient care. In a resource-poor setting in Uganda, an EMR generating clinical summaries improved the efficiency of care for PCPs, allowing them to spend more time directly interacting with and examining the patient. The presence of clinical summaries for providers was also associated with shorter visits for patients. Providers expressed very positive opinion about clinical summaries, and felt that it improved quality of care and reduces mistakes.

To implement EMR-based clinical summaries and decision support tools, systems must be designed with special sensitivity to the workflow, and the resources available.[11] Further, developers of clinical summaries must be in constant contact with the providers (to understand their needs), and with staff responsible for developing or modifying encounter forms and updating concept dictionary terms for the specific implementation. These steps will ensure that summaries generate are relevant to care, and that the correct data-elements are extracted from the information stored in the EMRs.

The clinical summary can also be used to improve the quality of data stored in the EMRs. Through the summaries, deficiencies in data-quality can be recognized – for example, it is easy to tell that when only two ARVs are displayed on a summary, this is likely a mistake as patients should be on triple-therapy. By identifying the source of an error – whether in the capture or entering of data, the error can be corrected and the quality of EMR data improved.

At the HIV clinic we studied, providers have been asking for more elements to be incorporated into the summaries once they realized their usefulness. For example, they want the dates ARVs were first prescribed to be included in the summary. In response to these requests, we are modifying the clinical summary module to enable it to scale easily along several dimensions,

namely: (a) to easily produce different kinds of summaries (e.g. for TB or antenatal care); (b) to more easily add new elements to existing summaries (e.g. SGPT); and (c) to create more complex derived concepts (such as "never on ARVs") which require integration of several concept terms. Maintaining dictionaries and derived concepts is quite challenging but is key to interoperability and thus needs to be critically addressed, especially in these resource-limited settings.[12]

Several limitations in our study deserve mention. The before-and-after design may introduce bias. Observing the providers and patients may have changed their behavior (Hawthorne effect). Observations for the clinicians were not randomly selected, and the number of providers and clinics studied was small, thus limiting the generalizability of the results. The survey results may not have been representative of the whole group, and paper-based clinical summaries could have an uncertain role in clinics where providers interact directly with the computer or have no electronic records. Our study also did not account for seasonal changes, and the time duration between the two phases of the study was almost a year.

Through this study, we were able to demonstrate the impact of implementing EMR-based clinical summaries to support HIV-care at an HIV clinic in Uganda. Our findings add to the growing body of evidence on the impact of EMRs in developing countries [5]. Functionality to generate clinical summaries, both at the level of the individual patient and at the patient cohort level, should be considered essential in any EMRs implementation in these resource-limited settings. We have made the clinical summary module available to the wider OpenMRS community, and this should enable this functionality to be rolled out to other sites. Future evaluations will assess the impact of the clinical summaries and reminders on patient outcomes. We also intend to conduct cost-benefit analyses of these systems.

CONCLUSIONS

EMR-based, patient-specific clinical summaries were associated with improved clinic efficiency and shorter patient visits. Providers expressed strong preference to having clinical summaries available to them when they were taking care of a patient.

SUMMARY TABLE

What was already know on the topic

- Increasing numbers of HIV-positive patients are seeking care at clinics in the resource-limited setting of Africa

- The care for these patients is data-intensive

- Increasingly, clinical sites are implementing Electronic Medical Records

What this study has added to our knowledge

- Patient-specific data stored in an Electronic Medical Record System can effectively be organized in a printed clinical summary and presented to providers in a resource-limited setting

- These EMR-based, patient-specific clinical summaries were associated with improved clinic efficiency and shorter patient visits

- Providers expressed strong preference to having clinical summaries available to them when they were taking care of a patient.
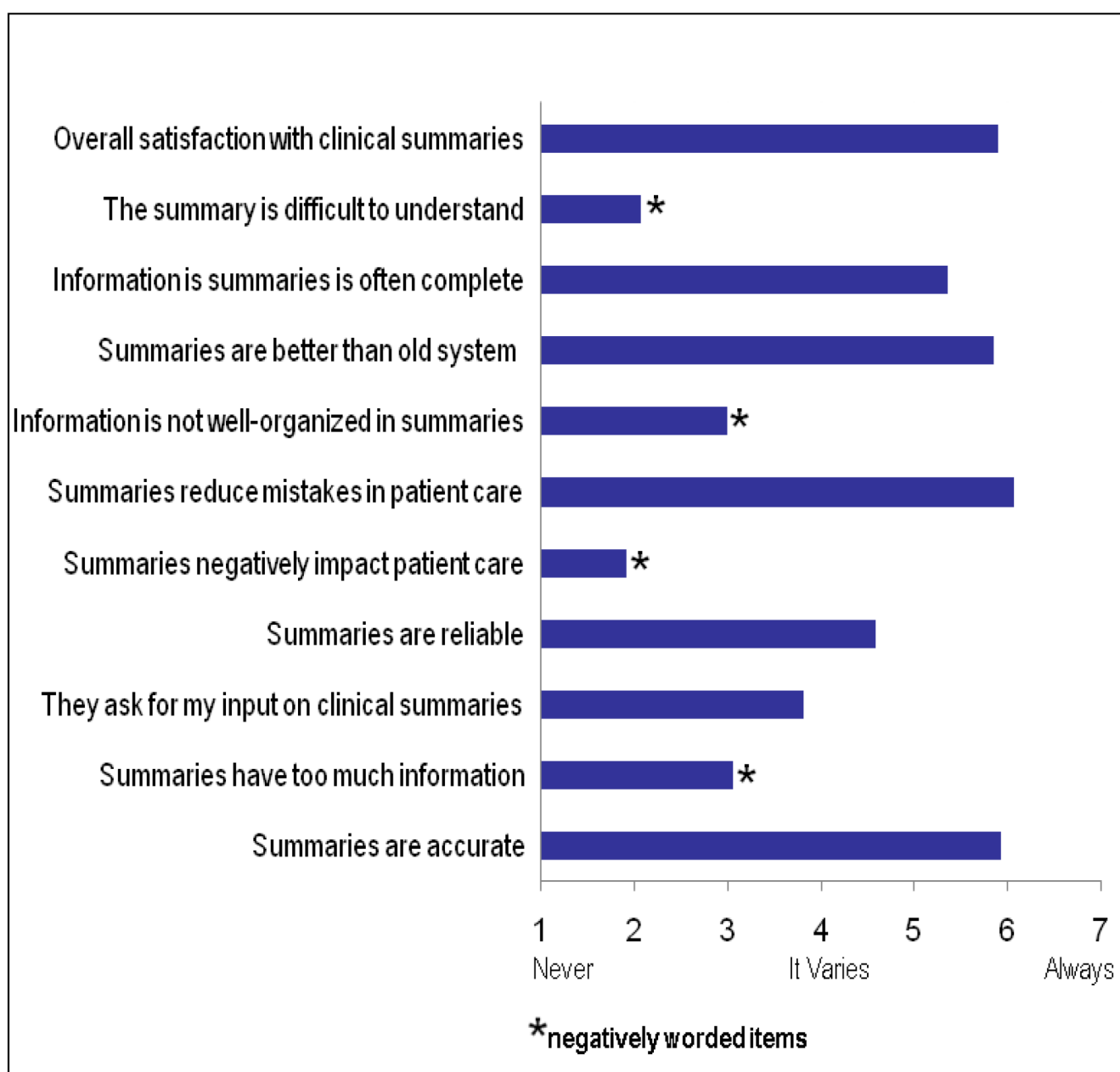

Acknowledgments

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ISS Clinic Patient Summary Sheet

Jane Doe

F   33 (15/06/1975)

last seen by Winnie Muyindike (30/04/2008)

File Number: 2222-22-2222

ART Number: FTF

Diagnosis at last visit:
WHO STAGE 3
TB Status: NO SIGNS
painful sensory Neuropathy
Allergies:

Toxicities:
PERIPHERAL NEUROPATHY

Non Art Medications at last visit:
amoxyl

Current ART Regimen
COMBIVIR
NEVIRAPINE
Previous ART Regimen(s)
TRIOMUNE 30

VITAL SIGNS

	Date	Weight	Temp	BP	K Score
Enrollment	18/10/2007	46	36	84/66	60
ART Start	31/10/2007	46	37	80/60	90
3rd Last visit	13/03/2008	50	35	90/60	90
2nd Last visit	10/04/2008	53	36	120/80	95
Last visit	30/04/2008	53	35	113/76	90

LAB HISTORY

CD4	Date	HB	Date	Viral load	Date
227.0	18/10/2007	10	23/10/2007		

ALERT! REPEAT CD4

Figure 1.
Example of Clinical Summary

Figure 2.
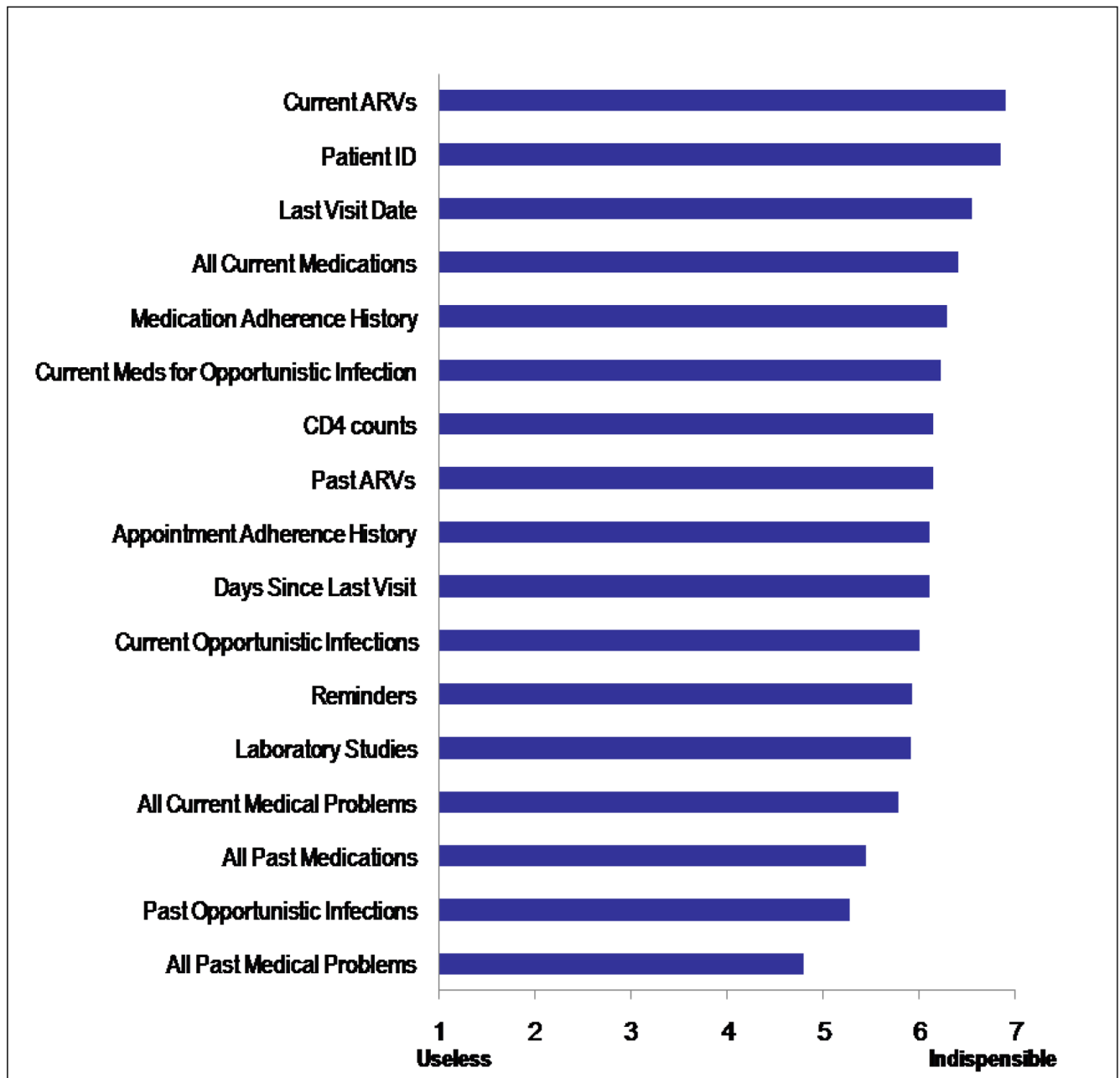Satisfaction with Clinical Summaries

Figure 3.
Desirability of Elements in Clinical Summary

Table I

Results of Mbarara Time-Motion Study: Providers[*]

Measure	Before Summaries	After Summaries	Before–After Difference
Number of physicians	3	3	0
Number of clinic hours/day	6.5	6.4	−0.1
Number of patients/day	41	44	3
Direct patient care (%)	25.7	34.6	8.9
Indirect patient care (%)	35.6	33.2	−2.4
Administration (%)	6.0	8.8	2.8
Personal (%)	14.5	13.3	−1.2
Miscellaneous (%)	16.7	6.6	−10.1
Waiting (%)	1.4	3.4	2.0

[*] Time is measured in percent of a provider's workday. No between group differences were statistically significant (p-value <0.05)

Table II

Results of Mbarara Time-Motion Study: Patients[*]

Measure	Before Summaries n = 88	After Summaries n = 94	Before–After Difference
Time in registration	1.2	1.0	−0.2
Time with clinicians	7.7	6.4	−0.7
Time with other staff	42.3	61.3	+19.0
Time with pharmacy	1.7	11.6	+9.9
Miscellaneous activities	22.9	17.9	−5.0
Waiting	121.9	88.0	−33.9
Waiting for registration	0.3	0.0	−0.3
Waiting for clinicians	45.1	44.5	−0.6
Waiting for other staff	52.4	28.9	− 23.5
Waiting for pharmacy	24.1	14.6	−9.5
Total visit time	197.7	186.2	−11.5

[*] Time is measured in minutes per patient visit observed. Statistically significant differences (p-value <0.05) are indicated by shading.