# Implementation and Evaluation of a Point-of-Care Electronic Medical Record [SABER] in Totonicapán, Guatemala

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**Abstract**:

**Background** The adoption of electronic medical records (EMRs) in developing nations has progressed slowly due to the lack of adequate infrastructure, funding, and training. However, EMRs have been successfully implemented previously in resource-limited health systems in South Africa, Haiti, Cameroon, Kenya, and Peru. Detailed, organized, and easily accessible medical records are particularly important in emergency departments due to the volume and acuity of the patient population. **Methods** In order to further study the plausibility of an EMR in a resource-limited emergency department, a web-based, Spanish-language EMR known as SABER was developed for use in Hospital Nacional José Felipe Flores in Totonicapán, Guatemala. The software collects patient data including demographics, triage, initial evaluation, review of systems, physical exam, and evaluation and plan. It then generates a .pdf file consistent with information requirements of the Guatemalan Ministry of Health. Local physicians, medical students, and nurses were trained in the use of the software, which debuted in July 2016. In order to assess the effectiveness of SABER as an EMR, 6 focus groups and 5- and 7-point Likert scale surveys were conducted with 6 physicians and 31 medical students working in the Hospital Nacional emergency department. **Results** 30 of 32 medical students and 6 of 6 doctors would recommend SABER to another provider. Positive aspects identified by staff include ease of use, quick data entry, and the potential for large data set research. **Discussion** Remaining challenges include incorporating electronic nursing orders and lab results, troubleshooting technology problems including printer difficulties, a lack of electronic signature capability, and lack of integration with the rest of the hospital. Our study is consistent with other studies that show use of an EMR helps reduce health disparities through improved patient records, medical data collection, and organization.

*Keywords*: digital, electronic health record, initiative, patient care, developing countries, Latin America

Lago Atitlán, Guatemala

Semuc Champey, Guatemala

## Introduction

*Electronic Medical Record (EMR) Adoption in Developed Countries*

The potential benefits of electronic medical record systems (EMRs) in developed countries have been well described. It has been suggested in the past that successful implementation may have a wide range of measurable benefits, including clinical decision support such as drug allergy warnings and drug incompatibilities[1], support for program monitoring including reporting outcomes, budgets, and supplies[2], support for clinical research, and management of chronic diseases such as diabetes, hypertension, and heart failure.[3]

Additional studies in developed countries have shown that EMRs have demonstrated significantly increased net monetary benefit per provider, cumulative net hospital savings, an increase in provider productivity, and improved provider efficiency.[4-6] A few studies have also shown evidence of improved clinical outcomes upon EMR adoption in developed countries, including shorter hospital length of stay and lower 30-day mortality, decrease in relative odds of death from myocardial infarction and CABG procedures, and improved outcomes for renal disease patients.[7-9]

*EMR Expansion to Developing Countries*

Given the relative benefits of EMR adoption demonstrated in developed countries, efforts have been attempted to expand these systems to developing countries with limited resources. There are several examples of successful EMR and electronic health registry implementation in resource-limited hospitals in the current literature, including the Mosoriot Medical Record System in Kenya[10], PIH-EMR in Peru[11], HIV-EMR in

Haiti, Careware in Uganda[12], the Baobab-ART (BART) system in Malawi[13], and an injury surveillance trauma registry in South Africa.[14] However, there are limited studies assessing the clinical correlates of EMR implementation in developing countries.

Despite successful implementation of the EMR systems described above, global adoption in resource-limited settings remains low. The reasons for this include: (1) resource and infrastructure limitations such as lack of reliable electricity and low-quality Internet access; (2) lack of centralized organization such as a national health information technology (IT) agenda; (3) lack of explicit and broad legal regulation; (4) lack of common interoperability standards; and (5) lack of a trained workforce, including specialized IT workers and medical informaticians.[15] Additionally, EMR implementation represents a significant shift in workflow and organizational culture and thus may face significant barriers to adoption.[16]

*EMR Adoption in Guatemala*

Guatemala is a country with poor health and economic indicators relative to the rest of Latin America and the rest of the world. According to a 2014 report by the National Statistics Institute of Guatemala, 53.7% of the population of 16.58 million of Guatemala lived in poverty, and 13.3% lived in extreme poverty.[17] The life expectancy at birth was 72 years, compared to a life expectancy of 76 years for the associated World Health Organization (WHO) region.[18] Guatemala does not have a national universal health coverage policy or strategy, and it also lacks a national eHealth policy or strategy. EMR adoption in Latin America including Guatemala has been sparse, with only one example in the literature of an emergency surgery registry implemented in

2 urban hospitals in Guatemala City and Paraguay.[19]

Here we describe our experience with the implementation and evaluation of an EMR system in a rural Guatemalan hospital. Over the last several years, the University of Virginia-Guatemala Initiative (UVA-GI) has worked on implementing an EMR in a rural Guatemalan Hospital. Previous research groups identified Hospital Nacional José Felipe Flores (Totonicapán Hospital) as a potential location for EMR implementation, and further researched what the required specifications for EMR software would be at this location.[20-21]

Totonicapán is a city of 500,000 residents in the hot and humid western highlands of Guatemala, approximately 100 miles from the Guatemalan capital, Guatemala City. An overwhelming 97% of the population identify as indigenous peoples speak the K'iche' language, although Spanish is also widely spoken. Totonicapán has many prominent population health concerns including high infectious disease prevalence, high infant mortality, and a lack of medical personnel and resources. The mortality rate by the age of 15 is 13.5% and only 44.5% of the population reach the age of 65.[18] Totonicapán Hospital contains approximately 94 beds, cares for roughly 2,000-5000 patients annually, and employs 28 doctors.[20]

*Objectives*

To address the stated needs of the Totonicapán Hospital Emergency Department, UVA-GI developed and implemented a point of care EMR named SABER [Simple, Accesible, Básico, Electronic Récord] beginning in 2015. Given the need for more research on the implementation, evaluation, and continuing

support for EMRs in developing countries and in particular in Guatemala, this study had three main objectives within the context of a resource-limited environment:

1. Establish a model for the successful implementation of an EMR,
2. Evaluate the perceived benefits of EMR implementation, and
3. Identify specific and unique challenges faced by the implementation of an EMR in such a setting.

**Materials and Methods**

*Software Implementation*

Implementation of the SABER program was conducted in multiple phases. First, we conducted a mixed-methods needs assessment with physicians, medical students, and hospital administration to determine the utility and feasibility of an EMR system in Totonicapán Hospital. Results showed that Totonicapán Hospital would be a potential site for EMR implementation. Based upon the insight from previous research groups, an EMR, SABER 1.0, was developed in-house by two local Guatemalan UVA-GI programmers. The SABER interface is a Spanish language health record programmed primarily in PHP and Java that may be accessed via computers connected to a local area network (LAN) with a MySQL database.

SABER collects data including basic patient information, triage, initial evaluation, review of systems, physical exam, and evaluation and plan. It generates a .pdf file based upon data entered into the browser form. The information collected is consistent with the patient information that is required to be reported to the Guatemalan Ministry of Health. Subsequent versions of SABER after the v1.0 pilot eliminated the need for filling

out a paper chart in addition to inputting information in the EMR. These versions also addressed various bug fixes and expanded the capacity of the EMR to include order input. In the latest version of SABER (v. 6.0), all patient information stored electronically, including medication orders, can be printed directly for reporting to the Ministry of Health.

*Survey Development*

In order to assess the continuing viability of SABER with regards to efficient collection of patient data and provider perceptions of the EMR system, we created a survey for medical students and emergency room healthcare providers. The survey was developed by the investigators, with guidance from the preliminary results of investigations conducted in prior years in the Totonicapán Hospital Emergency Room. We also consulted with other members of the UVA-GI team including healthcare professionals who had worked in Guatemala, in-country administrative professionals who work with the Totonicapán Hospital administration, and individuals involved in the networking and implementation of the SABER system. The survey was also informed by a systematic review of previous surveys that focused on electronic medical record adoption[22,23].

The survey included questions designed to elicit basic demographic information, prior experience using an EMR, and 5- and 7-point Likert surveys evaluating providers' perception of and experiences with the SABER EMR. We interpreted the aggregate responses to the Likert survey by calculating the mean value of participants' responses, which was then coded accordingly as shown in Table 1.

The survey was administered to 31 medical students on their clinical rotations between 4th and 6th year, and to 6 physicians working in the emergency room. There were a total of 40 medical students and 8 doctors working in the emergency room, thus yielding a survey participation of 80% and 75%, respectively.

*Qualitative Evaluation Process*

In addition to surveys of healthcare providers in the Totonicapán Hospital Emergency Room, we also conducted a series of 4 focus group meetings consisting of 4-6 individuals each of either physicians or medical students. Focus group meetings were conducted using a series of 10 standardized open-ended questions.

*Statistical Analysis*

In analyzing Likert scale data, the 95% confidence interval was calculated to assist in the interpretation of score ranges. If the 95% confidence interval fell between two or more score ranges, the score was interpreted as ambiguous.

**Results**

Results of the survey as described in Tables 2 and 3, are summarized below:

*Quality of continuing service and support for SABER*

The quality of continuing service and support for SABER was reported to be appropriate by medical students, with 26 out of 31 (84%) agreeing or strongly agreeing that UVA-GI provided continuous and appropriate support to use SABER, and 24 out of 31 (78%) agreeing or strongly agreeing that UVA-GI provided the training necessary to use SABER.

The quality of continuing service and support for SABER was ambiguous for physicians, as the confidence interval of the data set overlapped with our defined interpretations for the mean Likert score. However, 4 out of 6 (66%) doctors agreed or strongly agreed that the support provided by UVA-GI for SABER was appropriate.

*Overall satisfaction with SABER*

In general, participants appeared to be satisfied with the use of SABER in the hospital, including both medical students and physicians. 30 of 32 (94%) medical students and 6 of 6 doctors said they would recommend the use of SABER to another healthcare provider. Zero medical students or physicians reported on the survey that they were unsatisfied with the SABER system.

In response to the question, "If I could return to paper-based medical records, I would do so", participants' responses were divided between "No" or "Neutral." The majority of medical students (32%) responded to the question with "somewhat disagree", but 26% of medical students stated that they were unsure of their response to the question. For physicians, 3 out of 6 (50%) said that they strongly disagreed with the statement. The rest were evenly divided between unsure and affirmative responses.

*Computer skills*

Self-reported responses to the survey generally indicated that participants felt comfortable using a computer, although some scores remained Ambiguous in their interpretation. Medical students reported knowing how to use specific functions of SABER to carry out specific tasks as printing a chart or admitting a patient. However, while the majority of respondents reported that they felt they had sufficient experience using both a computer and SABER, statistical analysis yielded an Ambiguous result according to our methods.

4 out of 6 (66%) doctors who responded to our survey reported that they had sufficient experience using SABER and carrying out specific functions related to SABER. However, these results were interpreted as Ambiguous according to our statistical analysis methods.

**Focus Group Results**

*Understanding of SABER*

Focus groups with both students and physicians elicited a response describing the utility of SABER for collecting and organizing basic patient data, improved access to data and search functionality, assisting with arriving at a diagnosis for a patient, analysis of economic information, the ability to share medical data with other facilities, and analysis of epidemiologic data.

*Positive Aspects of SABER*

Participants of both student and physician groups identified the following positive aspects of SABER:
1. Faster data entry, especially in recent versions which avoid double data entry into both paper and electronic charts.
2. Increased legibility.
3. Increased administrative data access and legal matters.
4. Increased control and analysis of hospital data.

*Negative Aspects of SABER*

Participants of the student groups identified the following negative aspects of SABER:

1. Technological and troubleshooting challenges (e.g. printing errors and unreliable power supply)
2. Lack of consistency among stakeholders (e.g. some nursing staff still handwrite orders)
3. Lack of technical proficiency (e.g., shortcut algorithms are implemented but participants have not received sufficient training to utilize them)
4. Lack of integrated emergency room and laboratory computer systems

Participants of the physician groups identified the following negative aspects of SABER:

1. Lack of electronic signature function, requiring printing of charts for doctors to sign and stamp.
2. Lack of integration with the rest of the hospital medical records, resulting in incomplete patient data.
3. Lack of experience among providers, including medical students and nurses who are new to the rotation.
4. Lack of sufficient technical support personnel.
5. Cultural and workplace culture preventing effective expansion of the EMR (e.g. some nursing staff have been adamant in maintaining their use of paper charts)
6. Difficulty integrating other providers from other units not experienced with SABER during emergency code situations.

## Discussion

*Lessons Learned*

Although there have been significant challenges to the implementation of SABER in the Totonicapán Hospital Emergency Room, we contend that it represents a viable model for EMR implementation in low-resource settings. We learned several important lessons for successful implementation in such a setting. We contend that the most important issue elucidated by this study was the shift in workplace culture and workflow that must take place for a transition from paper charting to an EMR to occur. Implementation of the latest version (v. 6.0) of SABER was met with significant resistance from nursing staff which delayed its rollout, even after over one month of technical training was provided. UVA-GI staff is currently working in close partnership with hospital administration and leadership to ensure further development and successful implementation of this next version. UVA-GI has engaged in extensive pre-implementation surveys, ongoing focus group meetings, and leadership meetings to ensure the continuing efficacy of SABER. We recognize that workplace culture remains a significant barrier to successful EMR implementation and is also significant in future implementation sites.

We also learned that efficient and effective hospital workflow is important in maintaining accurate medical records and continued use of an EMR. Without clearly defined roles for data input, oftentimes patient data was not collected in a timely fashion resulting in potential loss of information. Additionally, without a clearly defined triage system patients could end up waiting up to two hours to receive treatment, and were often not identified as patients in the waiting room. This is a potential future application of SABER.

*Recommendations*

Based on the barriers to EMR implementation identified from survey responses, focus group discussions, and observation of delivery of care in the Totonicapán Hospital Emergency Room, we categorized our recommendations for future implementation of EMR in low-resource settings into seven categories which had previously been identified as success criteria in such a setting in Table 3.[24] Based on our observation that there was significant organizational and political resistance from providers in adopting the SABER electronic medical record, we suggest that these barriers to adoption be addressed first, before then addressing additional important technical, financial, ethical, functionality, and training barriers. If there is not significant organizational and leadership buy-in from the entire hospital unit, including all key stakeholders, we predict that addressing these secondary needs will not result in higher user adoption rates.

*Study Limitations*

Given the size of the Totonicapán Emergency Department, we were faced with a limited sample size for our research given the small population size. For example, we only collected quantitative survey data from 6 doctors, which limited further statistical analysis of their responses. However, by collecting qualitative data from the participants we elicited valuable information about the continuing efficacy of SABER even with the limitations of our data analysis.

We also recognize that SABER is an EMR in a very specific setting with a unique user interface, support structure, and patient demographic. Therefore, we caution against the generalizability of the results of this study when compared to EMR implementation in other care settings and/or

countries. The hope is that this study provides information for others hoping to implement EMRs in low-resource settings, but not direct replication of our system in other settings without consideration of local contexts.

Finally, we understand the limitations of using central tendency measures on ordinal data, such as calculating the mean of a Likert data set. There is some ambiguity in the literature on how to interpret these results, but with a symmetric set of clearly defined ordinal qualifiers a mean can be calculated. We also advise readers to interpret these results with caution, and to look at additional pieces of data such as the mode of the data set in addition to corresponding qualitative data from the focus groups.

*Future Directions*

While SABER is a robust program that is currently operating successfully in the Totonicapán Hospital Emergency Room, we have several initiatives and research opportunities for future consideration that we argue would improve both quality of care and quality of data, including (1) expansion of SABER to include pharmacy data, (2) increasing provider education through development of an online and in-person laminated troubleshooting handbook, (3) integration with waiting room triage procedure, (4) correlation of SABER metadata to patient outcomes, and (5) potential for mobile health expansion. With these future initiatives, we hope to successfully expand SABER within the Totonicapán Emergency Department and eventually to the rest of the hospital, providing a model for successful implementation of an EMR in a resource-limited setting.

| Table 1. Likert Scale Score Interpretations | | | |
|---|---|---|---|
| **5-point Likert scale for Medical Student Survey** | | **7-point Likert scale for Physician Survey** | |
| **Interpretation** | **Score Range*** | **Interpretation** | **Score Range*** |
| Affirmative | 3.6-5.0 | Affirmative | 5.5-7 |
| Neutral | 2.5-3.5 | Neutral | 2.5-5.4 |
| Negative | 0-2.4 | Negative | 0-2.4 |

| Table 2. Survey results of provider perceptions of SABER | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Survey response** *Medical students (n=31)* | **1** | **2** | **3** | **4** | **5** | **Mean score [95% CI]** | **Interpretation** |
| **Quality of continuing service and support for SABER** | | | | | | | |
| UVA-GI provides continuous appropriate support in order to use SABER effectively. | 0 | 3 (10%) | 2 (7%) | 12 (39%) | 14 (45%) | 4.2 [3.87 - 4.55] | Affirmative |
| UVA-GI helps with the training necessary to use SABER. | 3 (10%) | 1 (3%) | 4 (13%) | 17 (55%) | 7 (23%) | 3.9 [3.59 – 4.21] | Affirmative |
| **Overall satisfaction with SABER** | | | | | | | |
| If I had the opportunity to select another EHR, I would choose SABER. | 0 | 0 | 4 (13%) | 20 (65%) | 7 (23%) | 4.09 [3.88 – 4.30] | Affirmative |
| SABER improves the quality of care in the emergency room in Totonicapán. | 0 | 0 | 9 (29%)) | 17 (55%) | 5 (16%) | 3.87 [.23] | Affirmative |
| I would recommend SABER to another healthcare provider. | 0 | 0 | 1 (3%) | 16 (52%) | 14 (45%) | 4.42 [.19] | Affirmative |
| If I could return to paper-based medical records, I would do so | 7 (23%) | 10 (32%) | 8 (26%) | 4 (13%) | 2 (7%) | 2.48 [.42] | Ambiguous |
| Survey response Physicians (n = 6) | 1 | 2 | 3 | 4 | 5 | Mean score [95% CI] | Interpretation |
| **Quality of continuing service and support for SABER** | | | | | | | |
| UVaGI provides continuous appropriate support in order to use SABER effectively. | 0 | 1 (17%) | 0 | 2 (33%) | 3 (50%) | 4.2 [3.27 – 5.13] | Ambiguous |
| UVaGI helps with the training necessary to use SABER. | 0 | 1 (17%) | 0 | 2 (33%) | 3 (50%) | 4.2 [3.27 – 5.13] | Ambiguous |
| **Overall satisfaction with SABER** | | | | | | | |
| If I had the opportunity to select another EHR, I would choose SABER. | 0 | 0 | 0 | 3 (50%) | 3 (50%) | 4.5 [4.06-4.94] | Affirmative |
| SABER improves the quality of care in the emergency room in Totonicapán. | 0 | 0 | 0 | 4 (67%) | 2 (33%) | 4.33 [3.92 – 4.74] | Affirmative |
| I would recommend SABER to another healthcare provider. | 0 | 0 | 0 | 3 (50%) | 3 (50%) | 4.5 [4.06 – 4.94] | Affirmative |
| If I could return to paper-based medical records, I would do so | 3 (50%) | 0 | 1 (17%) | 1 (17%) | 1 (17%) | 2.5 [1.1 – 3.9] | Ambiguous |

| Table 3. Survey results of participant skills using SABER | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Survey response** *Medical students* *(n = 31)* | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **Mean score [95% CI]** | **Interpretation** |
| In general, I have sufficient experience using a computer | 0 | 0 | 1 (3%) | 5 (16%) | 2 (7%) | 4 (13%) | 17 (55%) | 5.7 [5.1 – 6.3] | Ambiguous |
| In general, I have sufficient experience using SABER | 1 (3%) | 1 (3%) | 1 (3%) | 7 (23%) | 7 (23%) | 7 (23%) | 7 (23%) | 5.2 [3.7 – 6.7] | Ambiguous |
| I know how to print a chart using SABER | 1 (3%) | 1 (3%) | 0 | 0 | 0 | 5 (17%) | 24 (77%) | 6.5 [6.0 – 7.0] | Yes |
| I know how to admit a patient using SABER | 3 (10%) | 0 | 0 | 1 (3%) | 0 | 4 (13%) | 22 (71%) | 6.2 [5.5 – 6.9] | Yes |
| I always user SABER to input patient information in the Totonicapán Emergency Room | 2 (7%) | 0 | 0 | 3 (10%) | 3 (10%) | 6 (19%) | 17 (55%) | 5.9 [5.3 – 6.5] | Yes |
| **Survey response** *Physicians (n = 6)* | | | | | | | | | |
| In general, I have sufficient experience using a computer | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 7 | Yes |
| In general, I have sufficient experience using SABER | 1 (17%) | 0 | 0 | 0 | 1 (17%) | 2 (33%) | 2 (33%) | 5.3 [3.5 – 7.1] | Ambiguous |
| I know how to print a chart using SABER | 1 (17%) | 0 | 0 | 0 | 1 (17%) | 2 (33%) | 2 (33%) | 5.3 [3.5 – 7.1] | Ambiguous |
| I know how to admit a patient using SABER | 1 (17%) | 0 | 0 | 0 | 0 | 2 (33%) | 3 (50%) | 5.7 [3.8 – 7.6] | Ambiguous |
| I always user SABER to input patient information in the Totonicapán Emergency Room | 1 (17%) | 0 | 0 | 0 | 0 | 1 (17%) | 4 (66%) | 5.8 [3.9 – 7.7] | Ambiguous |

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