

## Availability of Resources, Knowledge, Applicability and Preferred Teaching Methods regarding Electrocardiography in a Resource-Limited Clinic in Rural Thailand

Cassidy M. Dahn MD<sup>1</sup>, Gabrielle A. Jacquet MD MPH<sup>1,2,3</sup>, Patricia Mitchell RN<sup>1</sup>

<sup>1</sup>*Boston Medical Center*

<sup>2</sup>*Boston University School of Medicine*

<sup>3</sup>*Center for Global Health and Development, Boston University School of Public Health*

**Introduction:** Electrocardiography (ECG) is a rapid, non-invasive and inexpensive test requiring minimal training to perform. ECG is used ubiquitously in the developed world to assess the cardiac and metabolic status of Emergency Department (ED) patients; however, its utility in resource-limited settings has not yet been assessed. In order to shed light on ECG utility in developing areas around the world, as well as the perceptions of resources availability, knowledge, applicability and preferred teaching methods regarding ECGs were examined in a resource-limited clinic in Mae Sot, Thailand.

**Methods:** Focus group discussions and self-administered surveys were conducted among healthcare workers in a clinic in rural Thailand in November 2013.

**Results:** Five administrative staff and supervising providers participated in focus groups; twenty-nine medics and two physicians participated in the survey. Providers described limited knowledge of ECG interpretation and limited availability of treatments for diagnosed conditions. Providers reported that ECGs are useful when counseling patients and families on prognosis and when deciding when and where to transfer patients to facilities with more resources. Reported preferred training methods include hands-on training, lectures with handouts and specific ECG case examples.

**Conclusion:** Despite limited treatment options in low-resource settings, ECG can be an informative diagnostic and prognostic tool. Implementation of an ECG educational program at this clinic should focus on training in three areas: ECG interpretation, delivering available treatments even when the “gold standard” treatment is not available, and counseling of patients and family members.

### Background

According to the Centers for Disease Control and Prevention, the second most common cause of death in Thailand is coronary artery disease (CAD), plaques form along the walls of the blood vessels that supply heart muscle. CAD accounts for more than 15% of deaths. While the gold standard of care (catheterization for acute ST elevation MI or pacemaker placement for complete heart block) may not be available in resource-poor settings, Electrocardiograms (ECGs) may still assist in making correct diagnoses. Despite these facts, ECG has not been studied in such environments within Thailand. In this study, the authors aim to address the large knowledge gap regarding the diagnostic utility of ECG in this setting, where resources are low but the prevalence of CHD is high.

ECG is a non-invasive bedside test used ubiquitously in cardiac and metabolic assessments of Emergency Department (ED) patients in the developed world. The American Heart Association (AHA) provides guidelines for education and competency in electrocardiography within the United States; however, guidelines for ECG education and competency in resource-limited settings—places that do not have the capability to perform cardiac catheterization or to give thrombolytic agents to open occluded coronary vessels in myocardial infarction—have not yet been published.<sup>1</sup> Yet it has

been shown that ECG is a useful modality in these settings as it is quick, noninvasive, inexpensive, and requires minimal training to perform.<sup>2,3</sup>

There are many obstacles to the deployment of ECG for patient assessment in these settings. Some of the limiting factors include the need for trained individuals to accurately read ECG findings and the ongoing need for supplies and maintenance. Some rural and low-resource settings have shown telemedicine—the remote diagnosis and treatment of patients by means of telecommunications technology—to be useful in addressing these issues.<sup>4,6</sup> Such methodology may eliminate some of the resource needs (e.g. paper) and education needs (i.e. ECG interpretation), but still requires an electrocardiography machine and training to operate and maintain it.

Recent exploratory studies have recommended more innovation, education and research on the utility of ECG in the developing world as a potential solution to this lack of resources.<sup>3</sup> ECG can identify patients who would benefit from inexpensive intervention like beta-blockers, ACE inhibitors, and dietary modification.<sup>2,7,8</sup> In addition to identifying coronary artery disease, electrocardiography can also be used to diagnose left ventricular hypertrophy when echocardiography is not readily available,<sup>9</sup> to identify patients with conditions such as Brugada and Long QT Syndromes that put them at risk for sudden

cardiac death and who would benefit from implantable cardioverter defibrillator (ICD) placement and to diagnose of AV block in patients who may require a pacemaker.<sup>10-12</sup>

In addition to being a leading cause of death in Thailand, ischemic heart disease is also the third leading cause of death in Myanmar.<sup>13</sup> As economies and health care systems improve, countries' disease burdens change from infectious disease, sanitation and nutrition to heart disease, stroke, cancer and trauma. Due to this epidemiologic transition, non-communicable diseases are becoming more prevalent in low- and middle-income populations as well.

In Myanmar, total health expenditure is very low at 2.2% of GDP, of which 89.4% is private expenditure; as a result, there are only a small number of healthcare facilities, which are only financially accessible to wealthier populations.<sup>14</sup> For this reason and many others, Burmese people often seek care across the border in Thailand, where free public healthcare is available and inexpensive.<sup>15,16</sup> The study site is a low-resource health clinic that provides medical and social services to a population of approximately 150,000 Burmese refugees and displaced people near the Thai-Burma border at no cost to the patients and their families. There has been no formal assessment of the utility of ECG at this site, despite the availability of ECG machines.

This study's objective was to assess the utility of ECG in one clinic located in a resource-limited setting in Thailand on the border of Myanmar by examining the perceptions of resource availability, knowledge and applicability of ECG and preferred teaching and evaluation methods among staff. A needs assessment on this topic is novel in global health education research and could inform Emergency Medicine (EM) providers interested in working in this area of Thailand and perhaps other resource-limited settings.

## Methods

### Study Design

This was an exploratory, descriptive needs-assessment designed to understand the utility of ECG machines in a small clinic located in a resource-limited setting in Thailand. We did not aim to generalize to other sites. We made no hypotheses. As such, no primary or secondary outcome measures were indicated. The Institutional Review Board at Boston University approved this study.

### Selection of Participants and Study Setting

Participants in the study included both administrative staff as well as clinical staff among the different subsections of the clinic (including adult, pediatric, obstetric, surgical). Voluntary informed consent was obtained. Only English-speaking subjects were included. This represented about 75% or more of the candidates, as English is often used as a common language given the many dialects of Burmese languages and the unfamiliarity of many with Thai. Participants who could not be present during the study period were excluded. Given the small size of the clinic, the total sample size was limited as there were only about 40 clinical staff, the vast majority included as mentioned above.

The study setting was chosen based on its resource limitations in a population with a presumed high risk of cardiac disease, based upon population statistics from the World Health Organization (WHO) and Centers for Disease Control (CDC).<sup>13,16</sup> The study site is both a clinical and an educational training site open to foreign educators. The clinic serves a target population of about 150,000 people, half of whom are Burmese migrant workers living in Thailand and the other half of whom travel from Myanmar. The clinic provides basic adult, pediatric and obstetric medical and surgical care as well as social services.

### Examination Methods

All data was collected at the study setting. Informed consent was obtained from staff willing to participate in focus groups and surveys.

**Table 1: Example probe questions from focus groups**

<b>Do you have medications to treat cardiac rhythm abnormalities?</b>
<b>Do you have medications to treat electrolyte abnormalities?</b>
<b>Do you have transfer capabilities where patients can receive a higher level of care if needed?</b>
<b>Is there a cardiac catheterization lab where patients can be transferred for treatment?</b>
<b>What is the current level of staff training in ECG interpretation?</b>
<b>How do you think training could be improved?</b>
<b>How will you use electrocardiography training to care for patients?</b>

No personal identifying data was recorded.

Two separate focus groups were conducted with staff members during a one-month period (November 2013) to ascertain the staff's perceptions of the usefulness of the ECG machine and to determine whether or not they had the ability to treat specific medical problems identified by ECG in patients who present to the clinic. The focus groups were chosen based upon availability of subjects during set times. Efforts were made to include the most senior staff members to obtain the most expansive knowledge of resources, as well as less senior staff to gain a representative sample of all staff; there was no random assignment. The survey asked questions regarding the availability of medications and other diagnostic and treatment resources and perceived comfort level and knowledge of ECG interpretation and treatment of ECG-diagnosed conditions. Examples of these probe questions can be found in Table 1.

### Data Analysis

Responses from focus group discussions were recorded and summarized. Survey responses were combined and reported in aggregate. Descriptive statistics were analyzed and reported for survey responses.

## Results

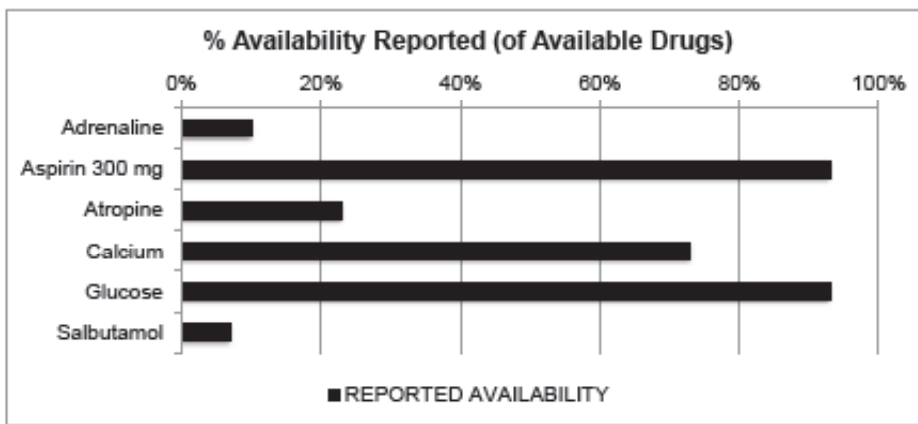
### Characteristics of Study Subjects

Five administrative staff and supervising health care providers participated in two focus group discussions. The administrative staff physicians participated in one focus group, and three supervising providers participated in another. A total of 35 surveys were distributed and 31 were returned; respondents included 29 medics and two physicians with a mix of both clinical and administrative duties. Many clinic staff members spoke both English and their own native language: Karen, Burmese or another Myanmar state dialect. Participants in the focus groups were separate from the survey respondents.

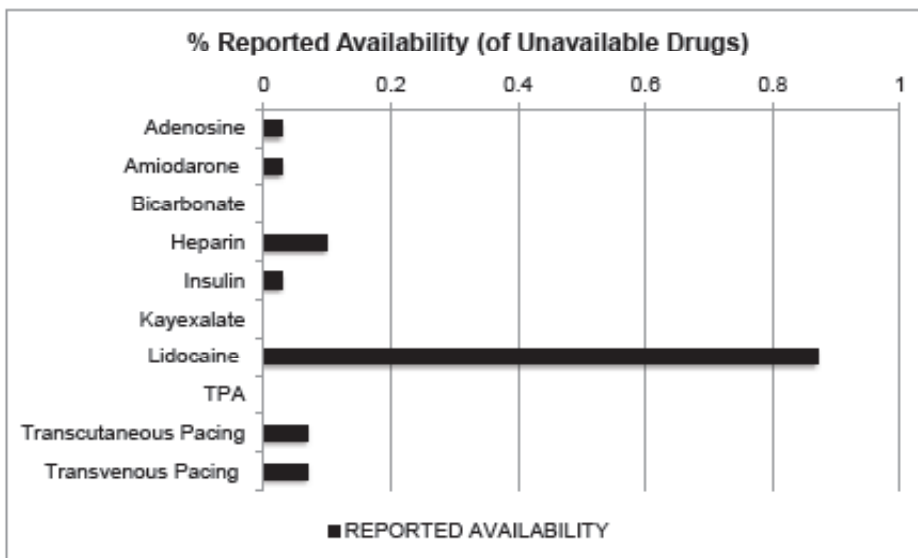
### Survey and Focus Group Results

During the focus group discussions, providers described the potential treatment options for ECG diagnoses including: atrial fibrillation (aspirin, atenolol); heart block (never transfer for pacemaker due to cost); acute coronary syndrome (aspirin, isosorbide dinitrate, atenolol); hyperkalemia (furosemide; never transfer for dialysis due to cost); and hypokalemia (banana). Based upon discussion with the providers, these are treatments that are regularly given for the above diagnoses. Providers felt ECG is useful when determining diagnosis (40% of respondents would use ECG for this purpose), for counseling patients and families on prognosis (50% of respondents would use ECG for this purpose) and when arranging transfer to another facility (40% of respondents would use ECG for this purpose). The most desired training methods, reported similarly in both the survey and focus group, include specific ECG case study examples (86%), lectures with handouts (50%) and hands-on

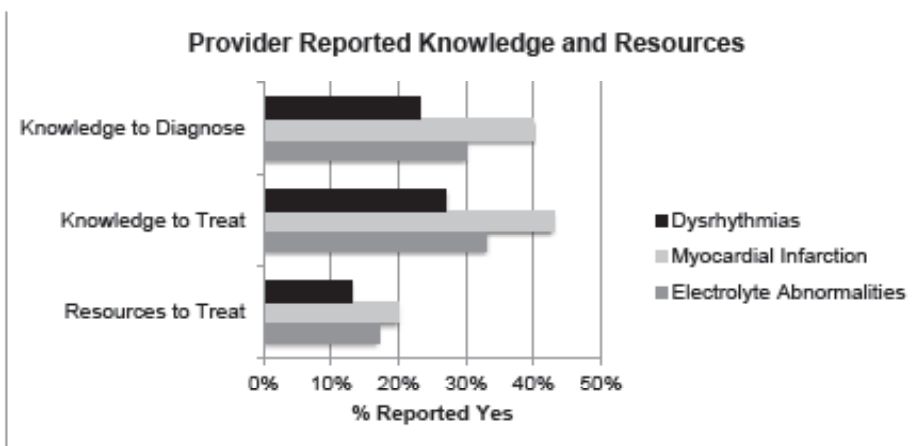
**Fig 1. Surveyed provider-reported availability of medications available at the clinic**



**Fig 2. Surveyed provider-reported availability of medications unavailable at the clinic**



**Fig 3. Reported knowledge and resources regarding common ECG diagnoses**



training (43%).

This study also compared the provider-reported clinic availability of ECG-related drugs (medications commonly given for diagnoses related to ECG interpretation) with the actual availability of drugs at the clinic as reported by the supervising physician at the clinic. Figure 1 compares the list of available drugs within the clinic with the provider-reported availability. There was a wide variation in provider knowledge of availability from drug to drug. For example, aspirin and glucose were correctly identified as available drugs for the majority

of providers (93% for both). Adrenaline and atropine were less familiar to providers and less frequently identified (10% and 23%, respectively), despite being available. On the other hand, treatments that were unavailable were mostly reported as unavailable, as shown in Figure 2. Providers knew that treatments such as adenosine, insulin and thrombolytics were not readily available (3%, 3% and 0% reported availability, respectively). Lidocaine was the only outlier with a reported availability of 87%.

As shown in Figure 3, certain cardiac diagnoses, such as myocardial infarction, are more familiar to providers in the clinic in terms of ECG diagnosis (40% provider comfort) and treatment (43% provider comfort) than other pathologies such as dysrhythmia diagnosis (23% provider comfort) and treatment (27% provider comfort). The resources that are available to treat ECG-based diagnoses are reported as low in all groups. Figure 3 also shows the percentages of provider-reported resource availability.

**Discussion**

ECG is easy to perform, requires few resources and quickly renders life-saving information. While the gold standard of care may not be available in resource-poor settings, ECGs can still assist in making correct diagnoses. Prognosis and patient/family education are important aspects of care. The ability to give a family a definitive diagnosis was unanimously thought among the surveyed health providers to be a useful and powerful tool; ECG may enhance this capability. Furthermore, certain diagnoses, such as ischemic heart disease and arrhythmia may be recognized by ECG alone and provide patients with readily available and affordable preventative medications such as daily aspirin or blood pressure control. This study did not collect clinical data to describe the incidence of these findings, but existing population data suggests a high incidence of ischemic disease and arrhythmia.

Based on the survey analysis there are apparent discrepancies in what medications are available within the clinic and what providers report are available. Understandably, in a place where ECG is not yet universally used, medications—such as aspirin—that are given for diagnoses other than ECG-related diagnoses have a higher reported availability (93%) than those—such as atropine (23%) and adrenaline (10%)—that are only given for ECG-related diagnoses in the setting of significant heart rate abnormalities or cardiac instability. Interestingly, there is no list of all available drugs given to the providers. Obtainment of this list of medications for this study was time-intensive and involved discussion with multiple staff members. Different areas of the clinic

(i.e. pediatric, adult, obstetrics, surgical) also might have different familiarity with and frequency of use of different medications based on their patient population and common ailments. The survey did not require specification of the clinical specialty, but it would be interesting to include this in future studies. Intriguingly, providers in the study reported a high degree of comfort with the diagnosis and treatment of myocardial infarction, and a high level of resources for treatment of these conditions, despite the poor availability of catheterization or thrombolytics. One possible reason for this may



**“While the gold standard of care (e.g. catheterization for acute ST elevation MI or pacemaker placement for complete heart block) may not be available in resource-poor settings, Electrocardiograms (ECGs) may still assist in making correct diagnoses.”**

be that heart attack may be diagnosed based upon clinical presentation alone, which means a lot in a clinic without monitors and with minimal blood results. On the other hand, providers reported a lower level of comfort with the diagnosis and treatment of dysrhythmias and electrolyte disturbance, as well as lower availability of treatments for these conditions. However, patients with these diagnoses actually had more treatments available than did patients with myocardial infarction (heart attack): atropine, adrenaline, magnesium, potassium and calcium were all available. Based on our descriptive results as well as previous work,<sup>9-12</sup> implementing an education program to improve knowledge of ECG interpretation, subsequent patient treatment, available medications could prove beneficial.

Based on the reported findings from the survey and focus groups discussions (Figures 1-3), a training program on ECG interpretation and diagnosis would be well received and useful. About two-thirds of respondents found knowledge of ECGs useful (60%) and interesting (63%). Given these results, the implementation of an ECG training program for medics should aim to increase knowledge of ECG interpretation and treatment, as well as medications availability in clinic, treatment of arrhythmias (i.e. adenosine for symptomatic bradycardia, diltiazem or digoxin for atrial fibrillation), gold standard treatment and counseling of patients and family members. Based upon the data gathered in this study, one possible solution would be to hold training of supervisory clinicians with outside staff either in person or via telecast. The supervisors could be trained to then hold trainings with other staff, and to educate other staff about diagnoses and treatments most relevant to their specialty. Including gold standard treatments in the training would not only be helpful

prognostically, but also for the purpose of familiarity with treatments as resources and available medications change over time.

While these findings provide information that may be useful in other similarly resourced locations, this needs assessment is specific to this clinic and therefore the curriculum would not necessarily be generalizable to other sites and recommendations should be used with caution. However, this is the first study of its kind to evaluate the needs and utility of ECG in a low-resource setting; more work needs to be done in this area to further our knowledge and increase the meaningful use of ECG in the developing world.

#### Limitations

As portrayed in the media, access to medical care for refugees and migrants the study had a small number of participants and was conducted at only one clinical site. Therefore the results of this study are not generalizable to other populations or sites. Another limitation is that a language barrier among all staff allowed only supervisory medics and physicians who spoke English to participate. This sample of providers was subject to selection bias as they may have more baseline knowledge than other providers who could not participate due to a language barrier. Finally a reporter bias may have been introduced by the fact that the information gathered here was all self-reported.

#### Conclusion

This study concludes that despite limited treatment options in low-resource settings, ECG is a useful diagnostic and prognostic tool. Knowledge regarding ECG utility and interpretation is minimal in this setting; providers are particularly eager to learn the material through hands-on training, lectures with handouts and specific ECG case study

examples. Further research regarding the utility of and education about ECG use in resource-limited settings is needed.

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#### References

- Kadish AH, Buxton AE, Kennedy HL, et al. ACC/AHA clinical competence statement on electrocardiography and ambulatory electrocardiography: A report of the ACC/AHA/ACP-ASIM task force on clinical competence (ACC/AHA Committee to develop a clinical competence statement on electrocardiography and ambulatory electrocardiography) endorsed by the International Society for Holter and noninvasive electrocardiology. *Circulation*. Dec 18 2001;104(25):3169-3178.
- Khane RS, Surdi AD, Bhatkar RS. Changes in ECG pattern with advancing age. *Journal of basic and clinical physiology and pharmacology*. 2011;22(4):97-101.
- Varma N. Role of the surface electrocardiogram in developing countries. *Journal of electrocardiology*. Nov-Dec 2010;43(6):612-614.
- Bagchi S. Telemedicine in rural India. *PLoS medicine*. Mar 2006;3(3):e82.
- Mavrogeni SI, Tsirintani M, Kleanthous C, et al. Supervision of thrombolysis of acute myocardial infarction using telemedicine. *Journal of telemedicine and telecare*. 2000;6(1):54-58.
- Solla DJ, Paiva Filho Ide M, Delisle JE, et al. Integrated regional networks for ST-segment-elevation myocardial infarction care in developing countries: the experience of Salvador, Bahia, Brazil. *Circulation*. Cardiovascular quality and outcomes. Jan 1 2013;6(1):9-17.
- Jelinek H, Warner P, King S, De Jong B. Opportunistic screening for cardiovascular problems in rural and remote health settings. *The Journal of cardiovascular nursing*. May-Jun 2006;21(3):217-222.
- Li N, Tuomilehto J, Dowse G, Virtala E, Zimmet P. Prevalence of coronary heart disease indicated by electrocardiogram abnormalities and risk factors in developing countries. *Journal of clinical epidemiology*. Jun 1994;47(6):599-611.
- Prakash O, Karki P, Sharma SK. Left ventricular hypertrophy in hypertension: correlation between electrocardiography and echocardiography. *Kathmandu University medical journal (KUMJ)*. Apr-Jun 2009;7(26):97-103.
- Kunavarapu C, Bloomfield DM. Role of noninvasive studies in risk stratification for sudden cardiac death. *Clinical cardiology*. Apr 2004;27(4):192-197.
- Tantchou Tchoumi JC, Foresti S, Lupo P, Cappato R, Butera G. Follow up in a developing country of patients with complete atrio-ventricular block. *Cardiovascular journal of Africa*. Nov 2012;23(10):538-540.
- Thamaree S, Sunsaneewitayakul B. Clinical characteristic and clinical course of aborted sudden cardiac death patients with structurally normal heart in King Chulalongkorn Memorial Hospital. Chotmaihet thangphaet [Journal of the Medical Association of Thailand]. Mar 2013;96(3):272-279.
- Centers for Disease Control and Prevention. (2010). Global Health - Thailand. Retrieved from <https://http://www.cdc.gov/globalhealth/countries/thailand/>.
- The World Bank. (2013). World Health Organization Global Health Expenditure database. Retrieved from <http://data.worldbank.org/indicator/SH.XPD.TOTL.ZS>.
- Centers for Disease Control and Prevention. (2016). Global Health. Retrieved from <http://www.cdc.gov/globalhealth>.
- World Health Organization. (2016). Global Health Observatory (GHO). Retrieved from <http://who.int/gho>.