

# Automated external defibrillator

## *Trends of automated external defibrillator training in Saudi Arabia, and global perspectives on use and deployment*

Alamin Berhanu, BSMT, MD, Manal Al Nasser, BScN, MSc.

### ABSTRACT

أصبح الإنعاش القلبي الرئوي والتدريب على استخدام جهاز إزالة الرجفان الخارجي منتشراً على نطاق واسع في المملكة العربية السعودية والحاجة تعمر في جميع قطاعات المهن الصحية. ويُطلب من مقدمي الرعاية الصحية تجديد شهاداتهم كل سنتين للممارسة الأمثل، وأصبح شرطاً لمقدمي الرعاية الصحية في الهيئة السعودية للتخصصات الصحية، وطلاب الطب والتمريض قبل التدريب الميداني. إن التفاوت بين الهدف من التدريب واستخدام مزيل الرجفان ليس مبالغاً. ونحن نقوم في هذا التقرير بجمع واستعراض وتقييم المقالات المتعلقة بالتدريب، والابتكار، والفعالية من حيث التكلفة والسياسات العامة وذلك من أجل وضع جدول أعمال مجدي لتوفير التدريب الحالي في المنطقة. وأيضاً لجذب صنّاع القرار للتفكير في إستراتيجية بشأن استخدام جهاز مزيل الرجفان وتوزيعه في المملكة العربية السعودية مما يجعله أقرب إلى العاملين في الرعاية الصحية والعامة من أجل تحقيق الهدف المتمثل في خفض السكتة القلبية خارج المستشفى.

Cardiopulmonary resuscitation (CPR) and the use of automated external defibrillator (AED) training have become widespread in Saudi Arabia and the need permeated in all sectors of healthcare profession. Healthcare providers are required to renew their certification every 2 years for an optimal practice, and it has become a requisite for healthcare providers in Saudi Commission for Health Specialties and medical and nursing students prior to internship. The disparity between the goal of AED training and the use is no more overstatement. We attempt to collate, review and appraise articles related to training, cost-effectiveness, innovation, and policy, and to extrapolate a meaningful agenda of the current training provision in the region, and to possibly attract policy makers to reflect on a strategy on AED use and implementation for Saudi Arabia bringing it closer to a healthcare practitioner

and a layperson to achieve the goal of decreasing out-of-hospital cardiac arrest.

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*From the Postgraduate Training Center, Deanship of Postgraduate Education & Academic Affairs, King Saud Bin Abdulaziz University for Health Sciences, National Guard Health Affairs, Riyadh, Kingdom of Saudi Arabia.*

*Address correspondence and reprint request to: Dr. Alamin Berhanu, Postgraduate Training Center, Deanship of Postgraduate Education & Academic Affairs, King Saud Bin Abdulaziz University for Health Sciences, National Guard Health Affairs, PO Box 22490, Riyadh 11426 (MBC 3115), Kingdom of Saudi Arabia. Tel. +966 (1) 2520252 Ext. 45442. Fax: +966 (1) 2520252 Ext. 45447. E-mail: alamin.berhanu@gmail.com*

Healthcare providers in the Kingdom of Saudi Arabia (KSA) are required to renew their cardiopulmonary resuscitation (CPR) and automated external defibrillator (AED) recertification every 2 years for an optimal practice in the setting of hospital care practice, and increasingly these courses have become a requisite for healthcare providers in renewing their licensure in Saudi Commission for Health Specialties, pediatric boards, and medical and nursing students prior to internship. Cardiopulmonary resuscitation and AED training are widespread in KSA, and the need permeated in all sectors of healthcare profession in KSA. The instruction in the use of AED forms a core educational training strategy format in a CPR courses. The American Heart Association (AHA) and The International Liaison Committee on Resuscitation (ILCOR) approved the inclusion of AEDs as part of basic life support (BLS) course in the 2000 Guidelines. The guidelines have demonstrated an increase in survival rates from cardiac

arrest following early use of the AED by a number of health providers, first responders, and lay people.<sup>1</sup> The European Resuscitation Council (ERC) also includes the use of AED in their guidelines.<sup>2</sup> The AHA guideline requires that all providers are skillful in the steps of operating an AED. All AHA materials are formatted and designed to testing the core competency in the use of AED in the psychomotor skills and a cognitive written examination. This review article examines the use and deployment of AED in terms of training, cost effectiveness, innovation, and policy. We can learn from the experience of others; and policy makers can adopt and capture the essence of the technology and redefine a strategy for KSA.

**The AED device.** Automated external defibrillator is a life saving device that healthcare providers and layperson use during a resuscitative effort. The device is placed in hospitals and public locations where there is high likelihood of witnessed cardiac arrest where it is accessible for layperson and healthcare providers. When a person presents with a combination of unresponsiveness, absence of breathing and detectable pulse, the 2 useful interventions are “chest compression” and “prompt use of an AED.” The core concept of the public access defibrillator (PAD) strategy is to bring the defibrillator into the incident sooner than fully equipped emergency medical services (EMS) unit can reach the location.<sup>3</sup> According to meta-analysis on OHCA survival by trained non-healthcare professionals, there is a survival advantage when CPR plus AED is used as oppose to CPR alone.<sup>4</sup> The AED is a voice prompt device that function upon initiation of the first step of an operation. The first step could be pressing the button “power on” or it could simply be removing the device from its location as in case of PAD, and it will automatically start with a voice prompt command instructing the user to follow the different steps of operation. In addition, the device has an illustrations guiding the user for an appropriate placement of an electrode pads and a flashing beam indicating to shock. Automated external defibrillator is easy to use without any prior training and any individuals can operate it, and the value of the technology is that the device will not energize unless an appropriate cardiac rhythm are detected.<sup>3</sup> Furthermore, the steps of operation depend on the clarity of acoustic prompt which has to consider the terms and abbreviations of the respective language.<sup>5</sup> As to safety, there is no report that unintended shock caused harm to the rescuer or bystander during defibrillation of patient.<sup>6</sup> It has also been demonstrated that you can deliver a shock while using a resuscitation blanket so as to allow you to continue uninterrupted chest compression.<sup>7</sup> Some study

has indicated that heart rhythms can be analyzed in a motion helicopter, and the vibrations of an in-motion helicopter did not affect the performance of AED in simulation study<sup>8</sup> and the mobile phone signal may not affect electrocardiograph interpretation of the device.<sup>9</sup> However, rhythm analysis may be affected in a moving vehicle and so that paramedic transporting the patient should be cautious when analyzing a patient in a moving ambulance.<sup>10</sup> The current AED software is updated to comply with a one-shock protocol consistent with the 2005 guidelines and the addition of voice prompts to continue CPR.<sup>11</sup> Some study has demonstrated that an AED can be utilized to review data of the quality of the CPR provided to a patient.<sup>12</sup> Perhaps in the future, the software may integrate a voice prompt command instructing providers to improve the quality of CPR. Why an “AED”? It is simple to use, safe, less training and inexpensive as a unit. The current manual defibrillators (MD) available at the hospitals have an AED function as well but the utilities are limited for trained healthcare providers.

**An optimal training: CPR and AED course.** A valid CPR/AED card certification is not necessary for the finality of a completion of a training. The goal is to constantly engage the healthcare provider or layperson in training and retraining. The adequacy and duration of AED training, frequent reinforcements, quality of instructorship, and even relevance of AED training agenda is one of the many aspects that merit consideration to optimize AED training; however, an optimal AED training is never without controversy. The 2 years certification period for basic and advanced life support courses indicated in the highlights of 2010 AHA guidelines, should include periodic assessment of rescuer’s knowledge and skills, with reinforcement or refresher information provided as needed. However, evidence for recommendation as to the timing and method for this reassessment and reinforcement is not known, and further investigation is required.<sup>13</sup> The term certification was remove by AHA and replaced it with course completion because the goal is to educate not to certify or test.<sup>14</sup> The guideline continues, BLS skills can be learned equally with “practice while watching” a video presentation as well as with longer, traditional, and instructor-led courses.<sup>13</sup> As to the format of an instruction delivery, the didactic information in the training of CPR and AED should be simple and it should not dilute the central message and creates confusion.<sup>15</sup>

The Resuscitation Council of United Kingdom has deliberately chosen not to specify the nature of content or duration of BLS plus AED programs due to the lack of current evidence which to base any such guidance.<sup>16</sup>

It has been stressed that the principles of adult education and flexible learning approaches should be used, and key learning outcome must be achieved. The scope of e-learning lies in flexibility, wide accessibility, and once developed, low provider cost.<sup>17</sup> Learning is a complex psychomotor phenomenon, and we may not fully grasp the process.<sup>18</sup>

The general public may not even be aware about AED, and an attempt to determine whether they can operate without prior exposure resulted that the general population might not even recognize the device in a public place. It is suggested that public exposure and education are crucial to overcoming it.<sup>19</sup> A non-medical people in Japan were unwilling to operate an AED because they do not know what an AED is and/or how to use an AED. However, many are willing to operate an AEDs if they had better understanding. Public knowledge of AEDs and its use can make a difference.<sup>20</sup> A minimal instruction can make a difference, and precisely the performance of a first-year medical student improved a shock administration after one use only.<sup>21</sup> Very young untrained children (third grade students from an elementary school) can perform defibrillation successfully with minimal training, and the time to deliver the first shock was significantly decreased.<sup>22</sup>

The relationship between the training duration and skill retention has been a subject of a prospective randomized study, and 2 hours class is found sufficient to attain CPR and AED skills for extended period provided that a re-evaluation is carried out every 6 months. Furthermore, the deterioration skills are well described in 6 months after an initial training, more than 80% of the trainees were unable or forgot to call the correct emergency number, 80% unable to release the first shock with 90 seconds and 40% did not provide correct artificial ventilation.<sup>23</sup> In contrast, the findings of the investigators of PADS trial<sup>24</sup> is that the CPR skills of targeted lay responders deteriorate nominally, but 80% remain competent up to one year while 90% remain competent in AED skills up to a year. Basic life support and AED manuals distribution a month prior to the course may not affect the theoretical knowledge, skill acquisition, and skill retention in laypeople.<sup>25</sup> A randomized trial on the effectiveness and retention of 30-minutes layperson training for CPR and AED confirmed that a 30-minutes CPR training course including instruction in basic adult life support CPR technique and AED use was effective in terms of skills performance as a traditional 3-4 hours training courses. The retention of CPR and AED skills at the critical 6-months mark was not significantly different.<sup>15</sup> An innovative learning technique of a 30-minutes

CPR and AED training is as effective as traditional multi-hour courses, even after 6 months. The benefits include less labor intensity, less time, and frequent retraining.<sup>15</sup> To standardize the duration of an AED training, a reference AED provider course for laypeople is proposed based on the synthesis of existing European courses. The AED course suggested is a 2-hour and 45 minute durations, but prior to that BLS provider course is mandatory.<sup>6</sup> According to a systematic review on alternative method of AED training such as self directed learning; computer based learning (CBL), video and poster are effective and it is even suggested that training might not be needed.<sup>26</sup> In particular, alternatives such as e-Learning are comparable to traditional courses. A non-randomized study comparing an e-Learning versus classroom did not show any differences in performance between the 2 groups. The advantages of e-Learning are that they do not require a classroom or facilities, no strain on staffing requirements and you do not have to leave the workplace.<sup>16</sup> A self directed learning approach to CPR-AED training, available as heartsaver AED anytime, is also equally effective to traditional classroom based training programs and it is an efficient means of training large numbers of individuals.<sup>27</sup> Other alternative training is the web-based interactive micro-simulation training for BLS and AED while at the comfort of your home and time.<sup>28</sup>

Cardiopulmonary resuscitation and AED skills deteriorate overtime, and there is a need to engage in re-training again. A repeated video clip-viewing reminder on a mobile phone may increase retention of CPR and AED skills in lay responders.<sup>29</sup> Idefibrillate, a software application designed and developed in Canada for iPod touch and iPhone user is an innovative form of CPR and AED training for smart mobile technology users and moreover, it serves to re-enforce the skills retention frequently. Others tried to advance the issue of optimal training to see the rapidity of getting an AED from the undisclosed location. A randomized control trial on the effectiveness of the new "mobile AED map" to find and retrieve an AED reduced the distance travelled but failed to shorten the time.<sup>30</sup> Notwithstanding, most resident in Saudi Arabia is not familiar with names of the smaller street in the neighborhood and information of their postal codes and customarily prominent landmarks such as shopping malls; and the pharmacies or mosques are the people's guide. It is interesting that in 1997, Conroy and Jolin abstract accurately described the condition in Riyadh. The article states that Riyadh has "a large number of unnamed streets, low public awareness of public ambulances services, most patient's transportation was carried out by private vehicle".<sup>31</sup> It is paradoxical while Japan is utilizing innovative

technology to accurately pinpoint the whereabouts of 1.5 kg size unit. Various studies do support for a minimal duration of BLS and AED training with frequent re-enforcement. To this end, the National Guard Health Affairs (NGHA)-Postgraduate Training Center (PTC), an International Training Center affiliated by AHA, adopted the agenda and format of practice while watching video based instruction, and made an effort to introduce the e-Learning for re-certification.

**Data from Postgraduate Training Center, National Guard Health Affairs.** In contrast to Gulf Cooperation Council (GCC) countries and Middle Eastern regions, KSA ranks ahead in terms of the CPR and AED courses conducted and able to integrate the CPR as a pre-requisite for healthcare professionals to maintain their affiliation with their institution. There are several centers providing the BLS, Advanced Cardiac Life Support course (ACLS) and Pediatric Advanced Life support courses (PALS), but the experience of NGHA have been tremendous in the widespread dissemination of the sciences and practices of AHA guidelines.

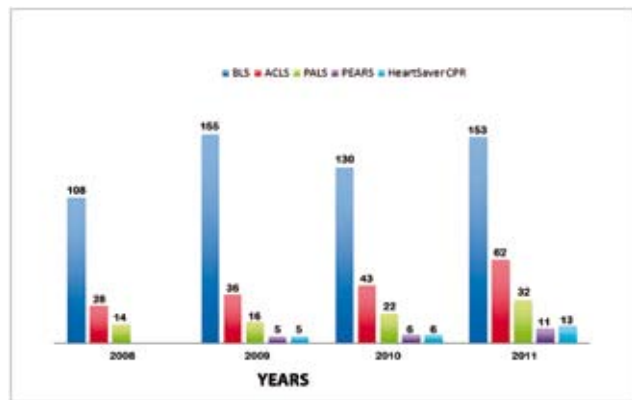
The NGHA provide support to the PTC to make the CPR courses available, and encourage creative approaches to disseminate knowledge beyond the confines of NGHA to other institution in the Gulf region. The PTC in Riyadh has been conducting life support courses for more than a decade. An average of approximately 200 life support courses are conducted per annum. In spreading these courses, the forefront of the campaign are committed administrators, coordinators, and instructors able to disseminate the knowledge and skills necessary to train healthcare providers and layperson to become efficient skill providers. At the same time, the bulk of the courses are targeted to the healthcare providers of the hospital and the infrequent heartsaver CPR are provided to employees in the recreation centers and administrative department at NGHA. In addition, the PTC has provided a heartsaver CPR training to private companies, schoolteachers, and staff of fitness centers.

Language of instruction for all courses is in English and translation of heartsaver CPR and BLS into Arabic to further extends the scope of the center's training provision to members of NGHA personnel. The instructors considered an extended duration to convey the cognitive knowledge and skill retention in Arabic heartsaver CPR consistent with the study on the modified 3-hours AED, the instruction in AED is easy for healthcare providers. However, layperson require an extended duration of time to explain to them rationale and reason for using it. More so, most of the instructors

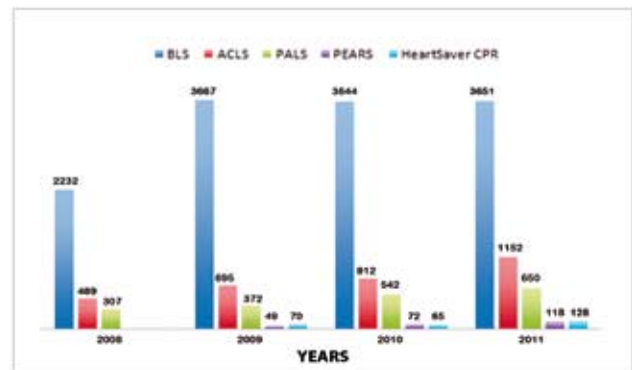
can teach it with ease in English because that is how they learned it.<sup>32</sup>

The AED training duration takes an average of 20-40 minutes per training course, depending on the type of the course and instructor's emphasis on its thorough training. The graph below shows the number of BLS, ACLS, PALS, PEARS, and heartsaver CPR courses conducted between years 2008-2011 (Figure 1). All of these courses have an integrated AED training for a successful completion of a course. In particular, BLS course devotes an extensive training on AED use. Approximately 39 minutes is consumed during the training of AED use in BLS class. Moreover, AED training is a major component in the BLS course as oppose to ACLS and PALS wherein the emphasis is the training of an advanced management of emergency cardiovascular care. Figure 2 illustrates the number of attendees at the PTC-NGHA, Riyadh, KSA.

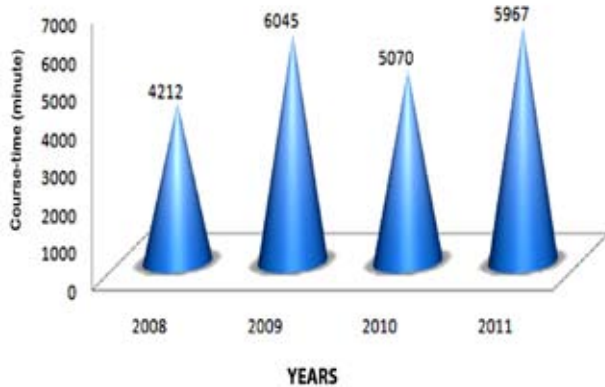
Figure 3 illustrates AED training in minutes per year in BLS courses at the PTC-NGHA, KSA. In the



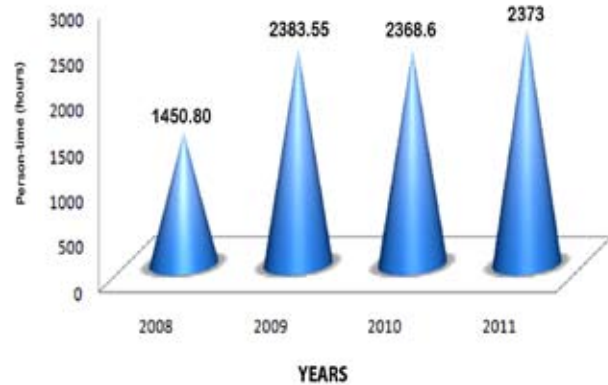
**Figure 1** - Number of courses conducted at the Post-Graduate Training Center, National Guard Health Affairs, Riyadh, Kingdom of Saudi Arabia.



**Figure 2** - Number of attendees at the Post-Graduate Training Center, National Guard Health Affairs, Riyadh, Kingdom of Saudi Arabia.



**Figure 3** - Automated external defibrillator training in minutes at the Post-Graduate Training Center, National Guard Health Affairs, Riyadh, Kingdom of Saudi Arabia.



**Figure 4** - HCP time and effort expended in automated external defibrillator (AED) at the Post-Graduate Training Center, National Guard Health Affairs, Riyadh, Kingdom of Saudi Arabia.

training of AED use and safety, providers are subject to a rigorous training in the use of AED. They are required to verbalize the 4 universal steps of operating an AED “To turn power on”, “to attach electrode PADS”, “to clear and analyze” and “to shock when indicated”. In the competency testing, they are required that they verbalize to activate emergency response system and to get an AED. In fact, numbered items in the competency checklist are to “activate emergency medical services and get an AED”. Failure to verbalize the phrase would be marked as need remediation (NR). The Hawthorne effect may have an impact on their performance when the subject are aware that they are being observed.<sup>16</sup> It is not uncommon for a candidate to miss a step in a sequence of critical skill performances during the skill testing. HCP time and effort expended in hours in AED training in BLS at the PTC-NGHA (Figure 4).

The PTC-NGHA has a pool of more than 150 AHA certified instructors to fulfill the demands of the numerous courses. Instructors include physicians, nurses, emergency medical technician, pharmacists, physiotherapists and paramedics and most of the instructors for BLS and ACLS classes are nurses while physicians are the majority of instructors for PALS course. At NGHA, the nursing services prefer to offer exclusive course for their nursing staff. The quality of instructorship does not seem to show any difference among the physicians, nurses, EMT or paramedics. One study claims that nurses are more efficient than doctors in teaching BLS and AED course to nurses yet the same study asserts the interaction between the candidates and instructor is important in achieving behavioral change in

practice and mastery of CPR.<sup>33</sup> The course directors and coordinators are responsible for overseeing the optimal training to maintain consistency based on the guideline standards. The center administrators and the instructors create a suitable condition and adopt the principle of adult learning, to ensure CPR skill retention in the participants. To optimize skill retention in CPR and AED course, a small group of participants is maintained in a class with a ratio of one instructor to 6 candidates, and a ratio of one mannequin to 3 candidates.

*Implementation strategies: Policies, innovation, and cost effectiveness.* To highlight outstanding developments, experiences, and innovations on AED deployment in land, sky, sea, and mountains, a revisit into published literature on the burden of out-of-hospital-cardiac arrest (OHCA), policy, cost effectiveness and innovation are a natural extension of the argument suggested in the abstract of the article. The video in BLS provider class begins by suggesting a vital message and impression to informing providers that every 90 seconds a person dies from cardiac arrest. In the late 1990s, the number of cardiac arrest in the US was estimated 350,000 deaths annually.<sup>34</sup> Some estimates put it in 250,000 Americans die each year from OHCA. According to the Japanese health statistics, 100 people die each day from sudden cardiac arrest in Japan. In Riyadh, the experience of one hospital survival from out-of-hospital is poor despite modern equipment and trained staff in the emergency department. The outcome reflects the level of out-of-hospital care available in the city.<sup>31</sup> The rate of survival after OHCA is low. It is not known whether this rate will increase if laypersons are trained to attempt



defibrillation with the use of automated AEDs. Many prehospital care providers have adopted the concept that "a gram of good prehospital care can save a kilogram of in-hospital ICU care."<sup>35</sup> In the case of AEDs, it seems that the 1,500 grams constituting the typical weight of an AED may indeed save much more than that. In fact, the technological evolution of AEDs has now also changed our traditional notions of a "critical care practitioner."<sup>35</sup> When analyzed in different territories, overall survival is significantly larger in the city when compared with the countryside and is associated with a shorter total response time and a larger number of deployed devices per population density.<sup>36</sup> It should however be remembered that there is a need for further deployment of AEDs in both public and residential areas while further development of AED programs is in process.<sup>2</sup> On the other side, caution must be used when these results are extrapolated to broad and nationwide efforts. The actual effect of widespread implementation of public AED programs on survival after OHCA in such locations is likely to become moderate, since most of the OHCA (79-84%) occur in the home.<sup>37</sup>

According to a systematic review, AED is an efficient method of delivering defibrillator to person OHCA and its use by both traditional and non-traditional first responders appears to be safe and effective.<sup>38</sup> A large prospective population based study in Japan showed that nationwide dissemination of AEDs increased frequency of shock administration and improved outcome after OHCA.<sup>39</sup> There was a doubling of survival after OHCA when a AEDS is applied in a population-based cohort study.<sup>40</sup> A number of patients who collapsed in Chicago airport and had an AED applied regained consciousness spontaneously, and the rescuer who applied the AED has no prior training.<sup>41</sup> In a span of 10 years, AEDs' were widely deployed in a city owned buildings and airports in Los Angeles city, and the PADS program resulted in high survival rates.<sup>42</sup> A 1-year experience in Germany demonstrated that the rate of return of spontaneous circulation and rate of discharge was 88.9% and 55.6% respectively.<sup>43</sup> In The Netherland, onsite AED use is associated with a 2-to-3 fold increase of hospital survival and is associated with total lower cost.<sup>44</sup> In Italy (Brescia), diffuse implementation of AED with integration of EMS system with an emergency layperson-integrated service (ELPIS) resulted with a significantly higher long-term survival from cardiac arrest.<sup>36</sup> The impact of community-wide deployment of biphasic waveform AED on OHCA in Taipei significantly enhanced survival from out-of-hospital ventricular fibrillation arrest in metropolitan city. This is made possible with a robust EMS system with BLS capability equipped with

AEDs. In certain congested circumstances, paramedics are unable to provide immediate shock.<sup>45</sup> In flight, the use of AED has resulted in 50% survival among patients presenting with ventricular fibrillation and ventricular tachycardia.<sup>46</sup> Principal barrier to the deployment of AED and use by layperson in public location and large community gathering are the policy regulating the laws of a nation or states and implication of legal liability. The installation of AED in public locations is prohibited in South Korea. A licensed medical practitioner can only operate the AED.<sup>47</sup>

The AHA policy statement document is designed to help policymakers develop new legislation or revise existing legislation to remove barriers for effective community lay rescuer AED programs. The document is developed in response to variations in state law and Federal legislation in regard to lay rescuer AED program.<sup>48</sup> To iron out the differences, the recommendation addressed 4 key components in AED legislation: good Samaritan limited immunity, CPR and AED training for anticipated rescuers, link with EMS system, and support of essential community AED program. Policy maker should strengthen PAD policies by enacting laws such as strategic placement of AEDs in high risk locations, mandatory PAD registries, and coordination with local EMS can reduce the time from collapse to shock.<sup>49</sup>

The US Food and Drug Administration (FDA) regulates AEDs, which is responsible for overseeing medical device manufacturing, sales and post marketing surveillance. In 2004, the FDA authorized sales of AEDs without a prescription. In fact, in USA, numerous lawsuits are filed for not deploying the device. Even Amazon.com, the world largest online retailer conducted an online consumer opinion on home AED. The opinions expressed by reviewers of such devices will provide a valuable and timely insight into the public understanding of and attitude towards AEDs within home.<sup>50</sup>

The death of Prince in Japan due to sudden cardiac arrest while engaging in a sport would bring about an ease in the Japanese law to accommodate for a laypersons to use an AED in the event that a trained healthcare provider are not present in a vicinity. While the government removed the primary barrier in part due to public demand, the initiative of the private and public sectors were responsible for the wide spread dissemination of an AED. A unique concepts and ideas are employed to expand public use of AEDs such as the vending machines that are used to house an AED and revenue are generated from all stakeholders of the

vending machine who purchase drinks, manufacturers, distributors, and advertisement.<sup>51</sup>

A European counterpart to the US AHA Policy statement is European Society of Cardiology (ESC) and the ESC joint recommendation. The ESC-ERC developed European recommendation for legislation on defibrillation for training in AED use and development of AED community program. The document has 4 key objectives: i) to provide critical appraisal of the studies published in scientific literature on the use of AED, ii) to present data on the status of legislation, iii) to promote recommendation, and iv) to identify area wherein a research is needed. The participants of ESC-ERC conference made 10 important recommendation related to the use of AED program within and outside EMS, home programs, cost-effectiveness AED legislation, and organization in Europe, organization of AED programs, analysis of local conditions, priorities, intervention protocol, training of responders, data reporting, quality control system, and program maintenance.<sup>52</sup>

Spain is introducing a wide network of defibrillator by introducing 650 AED in Girona, and Portugal has passed a law that regulates and encourages the use of an AED outside hospital environment. In fact, they are equipping the hotels in the countries with an AED. The Federal Republic of Germany installed AEDs with electrocardiography display and transmission in all German flagged merchant vessels. The new regulation will demonstrate if AEDs are useful and cost effective in ships without a physician.<sup>53</sup> A guideline for rational use of AED and PAD has also been proposed in areas or under high cliffs such as popular ski, highly frequented mountain huts, remote and highly frequented locations without medical coverage, and mass participation events in the mountains.<sup>54</sup>

Japanese embrace AED for their innovation and public optimism. An Internet based maps showing the location of AED's have been produced for several cities in Japan. The maps are magnified to display AED locations accurately and even the location of the devices inside a buildings.<sup>51</sup> Other novel innovation also emerged in Singapore. They utilized a geographic-time distribution to find a definite geographical distribution pattern of cardiac arrest. The ability of geographic information system with a national cardiac arrest database have implications for planning a community PAD program, targeted CPR training, and AED placement and ambulance deployments.<sup>55</sup> The AED registry is established in Singapore to strengthen the chain of survival. The AED registry contains information on the list of establishments with AED installed on their

premises, number of AEDs in the facilities, contact details of the front desk, and fire command center operation and description of an AED whereabouts. Another innovative iPhone applications development is able tech's AED locator in New Zealand and Project AED4EU from University Nijmegen Medical Center, The Netherlands. Able Tech AED will quickly localize the nearest AED to your current iPhone location. The New Zealand wide database collects the information of AED location and the AED owners. The AED4EU allows users to place where AED is located. The application of the information technology will facilitate provision of CPR and use of AED during resuscitative efforts and there are several such attempts. Mobile phone technology and positioning system can be used to utilize, identify, and recruit CPR-trained citizens to the scene of suspected OHCA prior to ambulance arrival.<sup>56</sup> The EMS services in The Netherlands have an innovative way of involving volunteers by sending a short message service (SMS) alert to the mobile phone of a layperson trained in BLS and AED when there is an OHCA nearest to their home and work place, and the layperson can initiate CPR and retrieve AED on their way to the patient.<sup>57</sup>

The device, deployment, and setting of training are never without a deterrent. The California Research Bureau's Briefing on Health Technology Assessment asserts the US, as leader in the biotechnology and medical research, has not translated into improved population health outcome.<sup>58</sup> Indisputably, the use of AED by a layperson is the US initiative and has advanced it into global recognition of the importance of the technology. In US, the number of AED sold for public is approximately 200,000 and an expenditure of \$500 million.<sup>40</sup> Notwithstanding, cost effectiveness as oppose outcome are factors that warrants further scrutiny. Under such circumstances, economic data should be taken into consideration as an integral part of the trial from the perspective of the government healthcare payer as an endpoint. Resource use includes purchase and updating of AEDs, and costs of trainings.<sup>36</sup> What accounts at the start of this process is the financial headache that we have to deal with it appropriately in order to save not only the critically ill patients but also all the people in Saudi Arabia. Automated external defibrillator saves very few lives in residential unit such as private homes or apartment complexes. But, AED is a cost effective at sites where there is a high density of both potential victims and resuscitators. Placement of AED at golf courses, health clubs, and similar venue is not cost effective; however, the visible device are good

for public awareness of the problem of sudden cardiac death and provide reassurance.<sup>59</sup>

To further elaborate cost effectiveness, the airline industry experience is relevant in particular Qantas and American Airline. In 1991, the Airline Qantas placed AED at major airports in Australia and on all international aircraft. The use of AED was evaluated over 65 months involving more than 200,000 flight segments and 31 million passengers. The AED was used 109 times to monitor ill patient and patient in cardiac arrest. Qantas made an appropriate decision to not divert planes if the documented rhythm of cardiac arrest was asystole and PEA. This provided substantial cost savings to the airline to partially offset the cost of AED program. In 1997, the American airlines followed the programs by equipping planes with AEDs and they trained their flight attendants about AEDs. Onsite placement of AED with high density places such as aircraft, large airport, and casinos result in an average cost per year of life saved of approximately \$35,000-\$50,000. Placing of an AED on all aircraft costs an additional \$94,700. Since the average cardiac arrest survivor lives approximately 5 years following resuscitation, it would cost approximately \$250,000 to save a life. Placing AEDs in large public venues such as shopping malls or sport venue cost \$500,000 to more than \$2 million per quality year of life saved. Cost of placement at large industrial sites, golf courses, health clubs and community center can range from \$1 million to \$10 million per quality of life year saved.<sup>59</sup>

Accordingly, to optimize the benefit of limited health care resources in each community, program planners should review community-wide cardiac arrest data to identify sites with the highest incidence of cardiac arrest and target those locations for AED placement and presence of trained rescuers in the site. Criteria recommended for selecting an appropriate sites for AED program, lay rescuers AED setting have an estimated incidence of cardiac arrest event that would give reasonable probability of one AED use in 5 years and a call-to-shock interval for conventional EMS of more than 5 minutes for 50% or more of cardiac arrest.<sup>47</sup>

The Japanese model is more of social responsibility rather than government's involvement. The estimated annual world market for AED's in 2006 was projected at \$650 million and \$200 million in 2003. It is expected that the cost of AEDs for consumers will range from \$1000 to \$2500.<sup>60</sup> The cost of the unit is affordable and inexpensive, the financial burdensome has to do with the cost of maintenance, training and personnel involvement.

In contrast, the assessment of Medical Advisory Secretariat in Canada based on a review of 8 reported finding of a 2 large studies (OPALS study<sup>61</sup> and PADS trial) and review of 71 articles, concluded that the OPALS model appears cost effective, and the effectiveness can be further enhanced by training community volunteers to improve bystander initiated CPR rates. Deployment of AEDs in all public access areas and in houses and apartments is not cost effective.<sup>62</sup> In OPALS study, firefighters were equipped and trained in the use of AEDs, and EMS system was optimized for rapid defibrillation. In addition, the Medical Advisory Secretariat supported another study on cost effectiveness analysis based on published literature and data from Canadian Institute of Health Information. The investigators used cost per quality-adjusted life-year (QALY) as their main outcome, and the outcome of their analysis is that indiscriminate deployment of AEDs is not a cost-effective means of improving health outcomes of cardiac arrest. The use should be restricted to emergency response programs, high-risk sites (such as hospitals), and high risk-patients.<sup>63</sup>

*Kingdom of Saudi Arabia.* The health institutions of Saudi Arabia embrace the significance of AED training for healthcare providers and layperson, and there lingers a general feeling of lack of AED operation and resources in a community. Conroy and Jolin warns that community education in CPR and provision of emergency medical services able to provide early defibrillation and stabilization are reasonable long-term public health goals for Riyadh, Saudi Arabia.<sup>31</sup>

Scenery of a mounted AED device box on the wall is totally devoid in shopping malls, recreation facility, gymnasium, banks, airport terminals or Mosques. A gap exists in AED implementation can be obvious to anyone strolling in a mall or waiting in a terminal and yet knowledge that an AED should have been present is totally absent either. Contrast to Japan, there is a public enthusiasm and are able to embrace and integrate the technology in their community. To an extent, the number of AED increased from 9906 to 88265 during a 3-year period.<sup>3</sup>

Reflection and intuition can temporarily define the goal of AED training and to possibly identify an extended role for healthcare providers in a community. Trainees include healthcare providers and the scopes of responsibility are within the vicinity of the hospitals and clinics. The healthcare provider resides with family in a community; hence, a potential responders. The current training simulation should reflect the healthcare and community facility. Guidelines ought to underscore the



need to tailor training to the available resources. Manual defibrillators are widely used in hospitals and private clinics as opposed to AED. Current available manual defibrillator has an AED mode as one of its function and can be used instead to train in the AED use if healthcare facility are equipped with MD not AED's.

To deduce a meaningful agenda as to the practicality of current training provision as it stands now. This process can begin by undertaking scientific research to address the scarcity of available published literature on AED and report of prevalence of OHCA in Middle East. Therefore, it remains a task to engage researchers on AED use and implementation in the region; and critically appraise available published literature on policy, cost effectiveness, innovation and even training. Indisputably, published literatures on AED has a large number and has a strong evidence and consensus as to the recommendation of CPR and early defibrillation. An assessment of experience of US initiative, implementation, policy, cost effectiveness, ESC-ESC joint recommendations, Japanese innovation and public optimism; Singapore's AED registry; and Canada's evidence based analysis of AED deployment are exemplar to reproduce in a local setting and need.

Thus, it is said "Japan has learnt from western countries and now advances from Japan should in turn be shared with the rest of the world".<sup>51</sup> Should Saudi Arabia advance as well in the ways and trend of Japan or adopt caution of Ontario's Medical advisory Secretariat assessment, now at least we know the process has begun. Saudi Ministry of Health has installed 88 AED in Makkah at Pilgrims site during the Hajj season while millions are performing the duty of one of the pillars of Islam. The Hajj initiative bring forth a momentum to highlight the relevance of AED device and necessitate the need for healthcare institutions and academia to launch, prioritize, and introduce the Saudi AED strategy to identify the gap prevalent and to assess potential benefits and drawbacks of a limited selective site installment vis-a-vis community wide deployment and its implication on civic, public education, and policy.

**Study limitation.** Any scientific work is never complete and inherently bound to limitation. Our limitation is obviously the absence of materials from Saudi Arabia and Middle East. It is a major limitation when one embarks on a review and trying to link it to the region. At the same time, it is the strength of the article because we are highlighting a prevalent literary void.

In conclusion, the number of AED device available in Saudi Arabia is unknown to us. In Scotland, to determine weather a defibrillator has been purchased, a cross sectional survey was carried out at an eligible site such as airport, shopping malls, leisure centers, train, and bus station. Despite the absence of funding from healthcare sector in the country, the results of their finding was that private organizations; charities or local authorities contributed to the purchase of most of them and are able to document the number of available AEDs in each eligible site.<sup>64</sup> At this stage, an assessment of AED use and training; perception and attitude in our local setting is but a proper initiative.

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