A Study on On-line Education (e-learning) in Advanced Cardiac Life Support among Health Care Professionals in Hospital Universiti Sains Malaysia

BY :

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AKU JANJI

Diperakui bahawa disertasi yang bertajuk **A Study on On-line Education (e-learning) in Advanced Cardiac Life Support among Health Care Professionals in Hospital Universiti Sains Malaysia** merupakan kerja dan penyelidikan asli daripada **JEEWADAS A/L VELUMMYLUM BALADAS**, No Kad Pengenalan : 820830-14-5721**,** No Matrik**: PUM 0178/14,** dari tempoh 2014 hingga 2018 adalah di bawah penyeliaan kami. Disertasi in merupakan sebahagian daripada syarat untuk penganugerahan **Sarjana Perubatan Kecemasan**, segala hasil penyelidikan dan data yang diperolehi adalah hak milik terpelihara Universiti Sains Malaysia.

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LIST OF ABBREVIATIONS

ACLS	Advance Cardiac Life Support
HUSM	Hospital Universiti Sains Malaysia
APEX	Accelerated Programme for Excellent
E-Learning	Electronic Learning
MCQ	Multiple Choice Questions
CAS	Cardiac Arrest Simulation

ABSTRAK

KAJIAN PEMBELAJARAN ATAS TALIAN DALAM "ADVANCE CARDIAC LIFE SUPPORT" (ACLS) DI KALANGAN PEKERJA PERUBATAN PROFESSIONAL DI HOSPITAL UNIVERSITI SAINS MALAYSIA (HUSM)

OBJEKTIF KAJIAN : ACLS diamalkan secara meluas untuk melengkapkan pekerja perubatan professional dalam menangani kes-kes kecemasan jantung. Pembelajaran elektronik (e-learning) memberi suatu platfom untuk memperolehi sumber pembelajaran spesifik pada kos yang lebih rendah. Kajian ini bertujuan untuk membandingkan keputusan antara pembelajaran elektronik (e-learning) ACLS (e-ACLS) dan pembelajaran konvensional ACLS (c-ACLS) dan melihat betapa efektif di kalangan pekerja perubatan professional di Hospital Universiti Sains Malaysia. Kajian ini juga bertujuan untuk melihat persepsi pekerja perubatan professional terhadap pembelajaran elektronik ACLS. **METODOLOGI** : Seramai 96 peserta menghadiri ACLS di HUSM antara tempoh 1 Januari 2016 hingga 30 Mei 2017. Seramai 48 peserta menghadiri kursus e-ACLS manakala 48 lagi menghadiri c-ACLS. Peserta yang menghadiri kursus c-ACLS menjalani kursus selama dua hari bersemuka dengan pensyarah. Peserta kursus e-ACLS pula menghabiskan enam-lapan jam video kuliah elektronik sebelum menghadiri sehari sesi bersemuka dengan pensyarah. Semua peserta dinilai daripada markah pra kursus (pretest) dan markah ujian selepas kursus (posttest) dan ujian praktikal simulasi serangan jantung (CAS-test). Data demografi peserta juga dikumpul dan dikaji. **KEPUTUSAN** : Peserta kursus e-ACLS memperolehi min markah "pretest" lebih tinggi 69.1 (SD 19.1) berbanding peserta c-ACLS, 58.6 (SD 16.6, $p < 0.001$). Min markah "posttest" peserta e-ACLS juga lebih tinggi 78.9 (SD 12.0) berbanding peserta kursus c-ACLS 70.6 (SD 13.9,

p<0.001). Peratus peserta e-ACLS yang lulus CAS-test adalah lebih tinggi 95.8% berbanding c-ACLS 87.5% (p=0.13). Peratus peserta yang lulus kursus ACLS secara keseluruhan adalah 93.8% untuk e-ACLS berbanding 83.3% untuk c-ACLS (p=0.09). Kebanyakan peserta mempunyai sikap yang positif terhadap pembelajaran “e-learning” dan bersetuju ia dapat menjadi pemangkin bagi pembelajaran ACLS.

KESIMPULAN : Kursus e-ACLS mempamerkan keputusan yang lebih tinggi berbanding dengan kursus c-ACLS. Kelebihan menjalankan kursus e-ACLS adalah lebih kos efektif memandangkan tempoh kursus yang lebih pendek, maka beban pensyarah juga berkurang. Oleh itu, kursus ACLS secara pembelajaran elektronik patut digalakkan atas faktor-faktor tersebut.

ABSTRACT

A STUDY ON ON-LINE EDUCATION (E-LEARNING) IN ADVANCED CARDIAC LIFE SUPPORT (ACLS) AMONG HEALTH CARE PROFESSIONALS IN HOSPITAL UNIVERSITI SAINS MALAYSIA

INTRODUCTION : ACLS is extensively practiced to equip health care professionals to deal with cardiac related emergencies. E-learning provides a platform for easier accessibility of learning materials and a more personalized learning schedule at a lower overall cost. The aim of this study is to compare the outcome of e-learning ACLS (e-ACLS) courses versus conventional ACLS (c-ACLS) courses and measure its effectiveness among health care professionals in HUSM. This study also aims to determine the attitude on e-learning among health care professionals in HUSM.

METHODS : A total of 96 candidates attended ACLS courses in Hospital Universiti Sains Malaysia (HUSM) between 1st January 2016 and 30th May 2017. Fourty-eight candidates were enrolled on a c-ACLS course and 48 on an e-ACLS course. Candidates participating in c-ACLS course undertook the 2-day face-to-face course. Candidates participating in e-ACLS course completed 6-8 hours of online e-learning lecture videos prior to attending the one day modified face-to-face course. All candidates were assessed by pre- and post-course MCQ and practical cardiac arrest simulation (CAS-test). Only post course & CAS-test marks contributes to the pass or fail of the candidates. Demographic data were collected in addition to assessment outcomes. **RESULTS :** Candidates on the e-ACLS course had higher mean scores on the pre-course MCQ (69.1, SD 19.1) compared to those on the c-ACLS course (58.6, SD 16.6, P<0.001). Similarly, they had higher mean scores on the post-course MCQ (e-ACLS 78.9, SD 12.0 vs. c-ACLS 70.6, SD 13.9; P<0.001). The CAS-test pass rate on the e-ACLS course was higher than

the pass rate on the c-ACLS course (95.8% vs. 87.5%; P=0.13). The overall pass rate was 93.8% for candidates in the e-ACLS versus 83.3% in c-ACLS courses (P=0.09). Majority of candidates have a positive attitude towards e-learning and agreed that it could be used as an adjunct to face-to-face instructor teaching.

CONCLUSION : The e-ACLS course demonstrates better results when compared to traditional conventional face-to-face learning (c-ACLS) in equipping candidates with ACLS skills. Added benefit occurs when considering increased candidate autonomy, cost-effectiveness, decreased instructor burden and improved standardization of course material. Further dissemination of the e-ACLS course should be encouraged in view of the benefits.

KEYWORDS: Advance Cardiac Life Support, E-Learning, Conventional, Cardiac Arrest Simulation

CHAPTER 1 : INTRODUCTION

1.1 LITERATURE REVIEW

1.1.1 Background

Advanced Cardiac Life Support (ACLS) is known to be extensively used and practiced in our health care setting to equip our health care professionals from various departments with knowledge and skills to effectively deal with cardiac related emergencies. Conducting ACLS are of great importance as it directly improves outcome of patients with cardiac arrest (Spearpoint et al., 2009). It provides a uniform approach to management of cardiac arrest, that include manual defibrillation, advanced airway, drug therapy, peri-arrest circumstances, and post-resuscitation (Perkins G et al 2002). A health care professional is an individual who provides preventive, curative, promotional or rehabilitative health care services in a systematic way to people, families or communities (Frost et al., 2011). In Malaysia, most tertiary hospitals offer ACLS training as it is essential for health care professionals especially to those working in acute care. However, due to the limited number of courses and the cost, quite a number of health care professionals do not have the opportunity to attend an ACLS course.

Recently, e-learning has become very important. Due to the availability of internet and the ability to spread educational material rapidly, medical education has moved to delivering content via the web as an alternative to traditional teaching methods. At the same time, rapid medical advancements has decreased time for academicians to deliver formal teaching and there is an increase of accessibility of online material via the internet that has transformed education into learner centered rather than instructor centered (Ruiz

et al., 2006). In this way, more courses of ACLS via e-learning can be conducted as it has lesser burden on the lecturers.

In medical field, e-learning courses are also widely used due to the greater accessibility of learning materials and a more personalized learning schedule tailored to each individual needs. Having ACLS in the form of e-learning would have so many benefits. Firstly, it is much cheaper to be organized due to the shorter duration of the course. Subsequently, the materials for the ACLS course are easier to be assessed by health care professionals without having to leave their busy schedule to attend the course. As most of acute care workers operate in shifts, learning materials can be sought in their own leisure time and at their own pace. This has been proven by a large, multicentre, randomised controlled trial where it established equivalence in outcome by comparing learning methods (e-Learning vs traditional) for Advanced Cardiac Life Support (Perkins et al., 2012).

Our aim in this study is to introduce e-learning in ACLS and measure its effectiveness among our health care professionals in HUSM and also to gauge the participants' reactions and perceptions to the learning materials.

Advanced Cardiac Life Support (ACLS) knowledge is of utmost importance to health care professionals as they are dealing with life-threatening conditions related to cardiac events. As first liners, their knowledge in managing cardiac emergencies are crucial as it can determine the survival of a patient.

Health care professionals can improve their knowledge on ACLS through self-learning, hands on experience and attending ACLS courses. However, the conventional ACLS courses may be translated into higher expenditure and time allocation in attending such courses, thus reducing the number of courses that are organized.

In this study, focus is on developing free on-line modules for healthcare professionals to improve their knowledge on ACLS. These modules can be accessed at any time at their own convenience. They may also learn at their own pace, style and capability. At the same time, the cost involved in them acquiring ACLS knowledge via e-learning is much lesser.

By conducting this study, it is hoped that it will pave a pathway for us in developing free on-line courses which are accessible and are of high value to our medical community. More health care professionals can be trained & therefore patient outcomes will be improved very much. This study is done in HUSM to gauge the response of e-learning in our population and to see its feasibility in addition to our conventional ACLS.

1.1.2 Advance Cardiac Life Support

Advanced Cardiac Life Support (ACLS) refers to a set of clinical interventions for the urgent treatment of cardiac arrest, stroke and other life-threatening medical emergencies, as well as the knowledge and skills to deploy such interventions (Mutchner et al., 2007). ACLS was first introduced in 1974 by the American Heart Association and subsequently updated in 1980, 1986, 1992, 2000, 2005 and 2010 (Mutchner et al., 2007). Since the introduction of ACLS, there is compelling evidence where intervention in cases of cardiac arrest by ACLS trained personnel has significantly and dramatically increased the survival to discharge rates (Dane et al., 2000). Conventional ACLS training is time consuming as it usually takes 3 whole days to run a course and it's expensive. The number of courses is also limited due to the availability of qualified instructors. Studies also show that theoretical knowledge and performance skills degrade quickly in the span of 6 to 12 months (Smith et al., 2008). ACLS certification lasts for 2 years and it's clear to see that the duration is inadequate. Suggestions have been made to reduce the length of certification and increase the number of refresher courses (Smith et al., 2008). However, this may place a big burden on the health care system regarding cost and logistics to run such a large number of ACLS courses yearly.

1.1.3 Health Care Professional

A health care professional is an individual who provides preventive, curative, promotional or rehabilitative health care services in a systematic way to people, families or communities (Frost et al., 2011).

1.1.4 E-Learning

E-learning, also known as electronic educational technology is the effective use of technological tools in learning. As a concept, it involves an array of tools, such as machines, media and networking hardware, as well as considering underlying theoretical perspectives for their effective application (Garrison et al., 2003). It has gained a lot of popularity in the past decade, however its use has been limited to medical schools and basic sciences rather than clinical settings (Moberg and Whitcomb et al., 1999). E-learning has been proven to be effective in the studies of higher education, corporate, government and military environment (Li et al., 2015). More centers have started to incorporate e-learning into their ACLS programs. Studies have shown that ACLS when incorporated with e-learning has had the same or better outcome than the traditional method of full time learning with instructors (Thorne et al., 2015). Health care personnel who attended ACLS with e-learning courses reported greater satisfaction than traditional didactic courses (Thorne et al., 2015). By reducing the face-to-face aspect, the monetary cost of facilitating an ACLS course is drastically reduced by almost 50% (Perkins et al., 2012). Cheaper ACLS course means more health care professionals would be able to attend it and this would directly benefit the tertiary centers in the form of greater cardiac emergency care. Since the number of instructors can be reduced, more refresher courses can be provided to enhance retention of ACLS knowledge. Online learning has also been proven to improve long term memory retention among doctors (Kerfoot et al., 2010). With the aim of developing free online ACLS videos, free access to it would be beneficial in retention of knowledge.

As such we hope that we can successfully incorporate e-learning into our existing ACLS programs in HUSM and see a rise in the quality of patient care in cardiac emergencies. We also hope that this study will lay the platform in developing a standardized module of e ACLS which can be widely used and accessible online.

1.2 METHODOLOGY

1.2.1 Study design and Participants

This was a prospective interventional study. Study was performed from June 2016 to May 2017 in Hospital Universiti Sains Malaysia (HUSM), Kelantan. All health care professionals that fulfilled inclusion and exclusion criteria were included in this study.

1.2.2 Inclusion and exclusion criteria

6.7.1 Inclusion criteria :

All health care professionals with written consent in HUSM.

6.7.2 Exclusion criteria :

Health care professionals who did not participate in the assessment.

Those who withdrew from the study or did not complete the course.

1.2.3 Sampling method and sample size

Participants were given a choice to undergo conventional ACLS (c-ACLS) or e-learning ACLS (e-ACLS) course according to their preferences.

Sample size calculation was done using PS software t-test for independent sample.

Standard deviation of mean knowledge score in control group (⌠) = 8.2 (Thorne C.J. *et al*, 2015).

Estimated difference of mean knowledge score between intervention and control (⊗) = 5, 〈 = 0.05, Z_{alpha} = 1.96, power of study = 0.80, ratio between 2 groups = 1.0.

Minimum required sample size (n) = 43 per group

Additional 10.0% was added after considering drop-outs. Thus minimum required sample size was 47 per group.

Total sample size = 47 x 2 = 94.

From the above calculation, we decided to have a sample size of 50 per group, or 100 total.

1.2.4 Research Tools and Data collection

There were 2 phases in this study.

Phase 1: Designing the assessment tools and e-learning modules

Theory multiple-choice questions (MCQs) and a practical cardiac arrest simulation test (CAS-test) regarding ACLS were selected from our ACLS data bank as the assessment tool validated by senior lecturers and specialist of Emergency Medicine Department HUSM. Three sets of theory questions were chosen for the pre course knowledge, post course assessment and remedial for those who fail. Each consisted of different sets of 30 questions using best of five questions. The CAS-test would assess the candidates' abilities in airway management, patient assessment, defibrillation and basic life support. The MCQs and CAS-test questions were assessed for content validity by 3 experts' opinion. E-learning modules were produced by Emergency Department team using videos and on-line notes and validated by expert of senior lecturers of the Emergency Medicine Department HUSM. Lectures on ACLS were recorded and uploaded on-line using YouTube as a platform. For this study, only those invited to join the intervention group had access to the modules during the study period.

Phase 2: Intervention

We conducted two conventional then followed by two e-learning ACLS courses to reduce bias among our subjects. Conventional ACLS subjects were recruited from our annually held ACLS courses in HUSM. The e-learning subjects were participants who consented to participate in our e-learning course. The conventional group would undergo

conventional ACLS course which will be conducted for 2 days face to face. They received an ACLS manual 4 weeks before the course. The course included pre-course MCQs, lectures and practical CAS session for the first day followed by post course MCQs and practical CAS-test on the following day. The pre-course MCQ results did not contribute towards the final assessment. The outcome of the candidate was determined if the candidate passed or failed their post-course MCQs and practical CAS-test. The passing mark for the post-test theory questions was 60% as derived from expect opinions following validation process of the questions used in the assessment. If the candidate failed, a maximum of 2 attempts for each assessment were allowed. In order to be an ACLS provider, the candidate had to pass both the post-course MCQ and CAS-test.

The e-learning ACLS group were given access to on-line ACLS module 4 weeks before the course. It consisted of 4 to 6 hours of recorded lectures in videos. They could access the modules at any given time. They will undergo a modified 1 day face-to-face course which consisted of pre-course MCQs, refresher lectures and practical CAS session followed by post course MCQs and practical CAS-test on the same day. Similar method of assessment were conducted compared to the conventional ACLS group. Additional questionnaires to assess the attitude towards e-learning were given to the intervention group on the same day after the practical assessment. Attitude on e-learning questionnaire was adapted from a questionnaire on e-learning done by Ruiz et al (4). Honorarium were given to subjects who participated in the E-Learning course. Participants could withdraw themselves from any part of the study if they chose to do so due to any unavoidable circumstances.

1.2.5 Data entry and data analysis

Statistical analysis were done using Statistical Packages for Social Science (SPSS) version 22.0. Descriptive analysis were expressed as frequencies, means with standard deviation and percentages and presented as bar chart, pie chart, or line graphs as seen appropriate. Statistical significance were calculated using independent t-test between groups and paired t-test within groups for continuous variables. A p value < 0.05 was considered as statistically significant for all statistical analysis in this study.

1.2.6 Ethical Approval

Ethical approval was obtained from Human Research Ethical Committee, Universiti Sains Malaysia on 10th March 2015 (Ref: USM/JEPeM/14100389) and Medical Research and Ethics Committee, Ministry of Health Malaysia on 1st Jun 2015 (Ref: (5) KKM/NIHSEC/P15-467).

CHAPTER 2 : OBJECTIVES

The general objective was to study the effectiveness of on-line education (e-learning) ACLS course among health care professionals in HUSM.

Specific objectives were :

1.) To compare the outcome of e-learning ACLS courses versus conventional ACLS courses among health care professionals in HUSM.

2.) To determine the attitude on e-learning among health care professionals in HUSM.

CHAPTER 3 : MANUSCRIPT

The prepared manuscript is included in the following pages. The manuscript was prepared following the Hong Kong Journal of Emergency Medicine guidelines as attached at the end of the manuscript.

3.1 Manuscript

3.1.1 Title Page

A STUDY ON ON-LINE EDUCATION (E-LEARNING) IN ADVANCED CARDIAC LIFE SUPPORT AMONG HEALTH CARE PROFESSIONALS IN HOSPITAL UNIVERSITI SAINS MALAYSIA

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ABSTRACT

A STUDY ON ON-LINE EDUCATION (E-LEARNING) IN ADVANCED CARDIAC LIFE SUPPORT (ACLS) AMONG HEALTH CARE PROFESSIONALS IN HOSPITAL UNIVERSITI SAINS MALAYSIA

INTRODUCTION : ACLS is extensively practiced to equip health care professionals to deal with cardiac related emergencies. E-learning provides a platform for easier accessibility of learning materials and a more personalized learning schedule at a lower overall cost. The aim of this study is to compare the outcome of e-learning ACLS (e-ACLS) courses versus conventional ACLS (c-ACLS) courses and measure its effectiveness among health care professionals in HUSM. This study also aims to determine the attitude on e-learning among health care professionals in HUSM.

METHODS : A total of 96 candidates attended ACLS courses in Hospital Universiti Sains Malaysia (HUSM) between 1st January 2016 and 30th May 2017. Fourty-eight candidates were enrolled on a c-ACLS course and 48 on an e-ACLS course. Candidates participating in c-ACLS course undertook the 2-day face-to-face course. Candidates participating in e-ACLS course completed 6-8 hours of online e-learning lecture videos prior to attending the one day modified face-to-face course. All candidates were assessed by pre- and post-course MCQ and practical cardiac arrest simulation (CAS-test). Only post course & CAS-test marks contributes to the pass or fail of the candidates. Demographic data were collected in addition to assessment outcomes. **RESULTS :** Candidates on the e-ACLS course had higher mean scores on the pre-course MCQ (69.1, SD 19.1) compared to those on the c-ACLS course (58.6, SD 16.6, $P<0.001$). Similarly, they had higher mean scores on the post-course MCQ (e-ACLS 78.9, SD 12.0 vs. c-ACLS 70.6, SD 13.9; $P<0.001$). The CAS-test pass rate on the e-ACLS course was higher than

the pass rate on the c-ACLS course (95.8% vs. 87.5%; P=0.13). The overall pass rate was 93.8% for candidates in the e-ACLS versus 83.3% in c-ACLS courses (P=0.09). Majority of candidates have a positive attitude towards e-learning and agreed that it could be used as an adjunct to face-to-face instructor teaching.

CONCLUSION : The e-ACLS course demonstrates better results when compared to traditional conventional face-to-face learning (c-ACLS) in equipping candidates with ACLS skills. Added benefit occurs when considering increased candidate autonomy, cost-effectiveness, decreased instructor burden and improved standardization of course material. Further dissemination of the e-ACLS course should be encouraged in view of the benefits.

KEYWORDS: Advance Cardiac Life Support, E-Learning, Conventional, Cardiac Arrest Simulation

3.1.3 Introduction

Advanced Cardiac Life Support (ACLS) refers to a set of clinical interventions for the urgent treatment of cardiac arrest, stroke and other life-threatening medical emergencies, as well as the knowledge and skills to deploy such interventions (7). It provides a uniform approach to management of cardiac arrest, that include manual defibrillation, advanced airway, drug therapy, peri-arrest circumstances, and post-resuscitation (18). ACLS knowledge and skills is of utmost importance and extensively practiced by health care professionals from various departments as they deal with life-threatening cardiac related emergencies and directly improves outcome of patients with cardiac arrest (1).

In Malaysia, most tertiary hospitals offer ACLS training as it is essential for health care professionals. However, due to the limited number of courses and the cost, quite a number of health care professionals do not have the opportunity to attend an ACLS course as conventional ACLS training which takes 3 whole days to run a course is expensive. The number of courses are limited due to the availability of qualified instructors. Theoretical knowledge and performance skills degrade quickly in the span of 6 to 12 months (9).

ACLS certification lasts for 2 years and it's clear to see that the duration is too long. Suggestions have been made to reduce the length of certification and increase the number of refresher courses (9). However, this may place a big burden on the health care system regarding cost and logistics to run such a large number of conventional ACLS courses yearly. A health care professional is an individual who provides preventive, curative,

promotional or rehabilitative health care services in a systematic way to people, families or communities (3). E-learning, also known as electronic educational technology is the effective use of tools, such as machines, media and networking hardware, as well as considering underlying theoretical perspectives for their effective application (10). It has gained a lot of popularity in the past decade, however its use has been limited to medical schools and basic sciences rather than clinical settings (12).

ACLS when incorporated with e-learning has comparable outcome with traditional method of full time learning with instructors (6). Health care personnel that attended the ACLS with e-learning courses reported greater satisfaction than traditional didactic courses (6). By reducing the face-to-face aspect, the monetary cost of facilitating an ACLS course is drastically reduced by almost 50% (5). Cheaper ACLS course means more health care professionals would be able to attend it and better cardiac emergency care can be provided. Since the number of instructors can be reduced, more refresher courses can be provided to enhance retention of ACLS knowledge. Online learning has also been proven to improve long term memory retention among doctors (13). With the aim of developing free online ACLS videos, access to it would be beneficial in retention of knowledge. More health care professionals can be trained and therefore patient outcomes will be improved very much.

Our aim in this study is to introduce e-Learning in ACLS and measure its effectiveness among our health care professionals in HUSM and also to gauge the participants' reactions and perceptions to the learning materials. We hope that this study will lay the platform in developing a standardized module of e ACLS which can be widely

used and accessible online. More health care professionals can be trained and therefore patient outcomes in terms of cardiac emergencies will be greatly improved.

3.1.4 Methods

A prospective interventional study was carried out in Hospital Universiti Sains Malaysia (HUSM), Kelantan from a period of January 2016 to May 2017. Participants were given a choice to undergo conventional ACLS (c-ACLS) or e-learning ACLS (e-ACLS) course according to their preferences. Post hoc analysis to control the confounding factors were done.

Eligibility criteria excluded all health care professionals without written consent or who did not want to participate in the assessment. Ethical approval was obtained from Human Research Ethical Committee, Universiti Sains Malaysia (Ref: USM/JEPeM/14100389). A minimum sample size of 94 was obtained from calculation.

There were 2 phases in this study.

Phase 1: Designing the assessment tools and e-learning modules

Theory multiple-choice questions (MCQs) and a practical cardiac arrest simulation test (CAS-test) regarding ACLS were selected from our ACLS data bank as the assessment tool validated by senior lecturers and specialists of Emergency Medicine Department HUSM. Three sets of theory questions were chosen for the pre course knowledge, post course assessment and remedial for those who fail. Each consisted of different sets of 30 questions using best of five questions. The CAS-test were carried out to assess the candidates' abilities in airway management, patient assessment, defibrillation and basic life support. The MCQs and CAS-test questions were assessed for content validity by 3 experts' opinion. In the meantime, E-learning modules were produced by Emergency Department team using videos and on-line notes and it was

validated by expert of senior lecturers cum specialist of the emergency medicine department HUSM. Lectures on ACLS were recorded and edited and uploaded on-line. For this study, only those invited to join the intervention group had access to the modules during the study period.

Phase 2: Intervention

We conducted two conventional followed by two e-learning ACLS courses to reduce contamination bias among our subjects. Conventional ACLS subjects were recruited from our annually held ACLS courses in HUSM. The e-learning subjects were participants who consented to participate in our e-learning courses. The control group underwent conventional ACLS course which were conducted for 2 days face to face. They received an ACLS manual 4 weeks before the course. The course included pre-course MCQs, lectures and practical CAS session for the first day followed by post course MCQs and practical CAS-test on the following day. The pre-course MCQ results did not contribute towards the final assessment. The outcome of the candidate was determined if the candidate passed or failed their post-course MCQs and practical CAS-test. The passing mark for the post-test theory questions was 60%, as decided based on expert opinions following the validation process. If the candidate failed, the number of attempts for each assessment and the respective marks were recorded. A maximum of 2 attempts for each assessment were allowed. In order to be an ACLS provider, the candidate had to pass both the post-course MCQ and CAS-test.

The e-learning ACLS group were given access to on-line ACLS module 4 weeks before the course. It consisted of 4 to 6 hours of recorded lectures in videos. They were able to access the modules at any given time. They underwent a modified 1-day face-to-face course which consisted of pre-course MCQs, refresher lectures and practical CAS

session followed by post course MCQs and practical CAS-test on the same day. Similar method of assessment were conducted compared to the conventional ACLS group. Additional questionnaires to assess the attitude towards e-learning were given to the intervention group on the same day after the practical assessment. Attitude on e-learning questionnaire was adapted from a validated questionnaire on e-learning by Ruiz et al (4). Eight components were asked on e-learning. The suitability of the questions in our population were tested by face validation. Honorarium were given to subjects who participated in the e-learning course. Participants were allowed to withdraw themselves from any part of the study if they chose to do so due to any unavoidable circumstances.

Statistical analysis was done using Statistical Packages for Social Science (SPSS) version 22.0. Descriptive analysis were expressed as frequencies, means with standard deviation and percentages. Statistical significance were calculated using independent t-test between groups and paired t-test within groups for continuous variables. A p value < 0.05 is considered as statistically significant for all statistical analysis in this study.

3.1.5 Results

There were 4 ACLS courses carried out between 1st June 2016 and 30th May 2017 in Hospital Universiti Sains Malaysia. A total of 48 candidates participated in c - ACLS course while e - ACLS courses had a total of 48 candidates as well.

A total of 48 (50.0%) candidates participated in a c-ACLS course. The remaining 48 (50.0%) candidates undertook an e-ACLS course. Mean age on the e-ACLS course was 30.2 years (SD 5.4) and on the c-ACLS course 33.2 years (SD 6.6). Table 1

demonstrates participants' demographics. Candidates on both courses were highly comparable.

Candidates' overall results for c-ACLS and e-ACLS are portrayed in Table 2. All participants completed the course. From the study, it showed that the mean pre-course MCQ marks in e-ACLS participants are higher than those in c-ACLS group (69.1 (SD 19.1) vs 58.6 (SD 16.6)) and the difference was significant with p-value < 0.001. The mean post-course MCQ marks was also significantly higher on the e-ACLS course at 78.9 (SD 12.0) compared to 70.6 (SD 13.9) on the c-ACLS course (p-value < 0.001). Both groups showed an increase in the mean post-course marks as compared to the pre-course marks using paired t-test analysis. The difference were significant for both groups (mean difference 12.0, p-value < 0.001 in c-ACLS group and mean difference 9.8, p-value < 0.001 in e-ACLS group).

The CAS-test passing rate of 95.8% on the e-ACLS course was compared to 87.5% on the c-ACLS course. However, the result was not significant (p-value = 0.134). Although the overall course passing rate were higher in e-ACLS (93.8% vs 83.3%), the difference was not statistically significant (p-value = 0.099).

Based on questionnaire prepared to assess the attitude on e-ACLS among health care professionals (which consists of 7 positive ended questions towards e-ACLS and 1 negative ended question against e-ACLS), most candidates reviewed on the questionnaire favoured e-ACLS in comparison with c-ACLS (Table 3).

3.1.6 Discussion

Pre-course MCQ mean marks for the e-ACLS course (69.1) were markedly higher compared to the c-ACLS course (58.6). This is a result of candidates in c-ACLS course having only ACLS course manual in comparison to e-ACLS having the priviledge to access both online video lectures and the ACLS course manual. It has a direct benefit to the e-learning candidates as they are well prepared prior to attending the pretest and instructor based course. This was also demonstrated in an observational study by Thorne et al whereby pre-test marks of the e-ACLS candidates were significantly higher than c-ACLS (13). Both groups showed increase in the mean post-course marks as compared to the pre-course marks using paired t-test analysis. The difference were significant for both groups (mean difference 12.0, p-value < 0.001 in c-ACLS group and mean difference 9.8, p-value < 0.001 in e-ACLS group) with c-ACLS having higher increase in marks. This is due to the fact that candidates on the c-ACLS course have more face-to-face time to enhance their knowledge in ACLS compared to those on the e-ACLS course. The data from our study were similar to a systematic review by the International Liaison Committee on Resuscitation (ILCOR) in 2010 that candidates having prior study modules in e-Learning before an ACLS course gets them prepared equally or better than conventional learning for the theoretical aspects of the course (15).

In our study, the candidates in the e-ACLS courses performed better in the CAS-test assessments compared to their c-ACLS counterparts, with passing rates of 95.8% and 87.5%, respectively, although the difference was not statistically significant. Interestingly this is contrary to the randomized controlled trial (RCT) done by Perkins et al which demonstrated that candidates on e-ACLS courses had lower CAS-test pass rates when

compared to candidates of the c-ACLS course. The pass rates were 74.5% and 80.2% respectively with an absolute difference of 5.7% (9). This is due to the reduced face-to-face time of e-ACLS course thus creating concern that candidate's practical capabilities may be compromised and this would result in deterioration of patient care. This may also be attributed to candidates having lesser time to discuss with their instructors, thus being unable to have adequate interaction to clarify their doubts pertaining to ACLS (16).

The baseline demographics for both the c-ACLS course and the e-ACLS course are similar (Table 1). Parameters such as gender, race, designation and previous experience in managing ACLS care were similarly distributed among the two groups and tested. The results were not significant for all the parameters except previous ACLS course attended. In our study, more participants in the c-ACLS had attended ACLS course before (39.6% in c-ACLS vs 10.4% in e-ACLS). Based on a study by Thorne et al (20), participants with previous ACLS course attended performed better in current ACLS test. However, in our study, those in e-ACLS had higher mean marks and passing rates. Therefore, the difference could be minimal.

As for the overall passing rates, 95.8% candidate passed for e-ACLS course and it was higher compared to 87.5% in c-ACLS course, although the difference was not significant. The overall passing rate was similar to that found on previous ACLS courses in the UK (9) and Italy (14). This shows that e-ACLS course is as effective as the c-ACLS course at preparing candidates for the post-course MCQ and the practical CAS-test simulation despite the fact of reducing the lecturer-candidate face to face time.

There are many advantages of e-ACLS course. Firstly, it gives extreme flexibility to the candidates in deciding what materials or modules they would like to learn. At the same time, it also gives them the freedom to learn at the best and conducive time for them