

A cross sectional study on the acceptance of pre-hospital continuous positive airway pressure ventilation among ambulance paramedic in an urban emergency medical service system in a developing country

Mohd S. Hafis, MBChB, MD (Emerg Med), Mohd J. Johar, MD, MS (Orth), Abdul-Wahab Mahathar, MBChB, MMed (Emerg Med), Ismail M. Saiboon, MBBS, MS (Orth).

ABSTRACT

الأهداف: تقييم مدى استجابة الدول المتقدمة للمسعفين في المناطق الحضرية تجاه ضغط المجرى الهوائي الإيجابي المستمر (CPAP) قبل الدخول إلى المستشفى .

الطريقة: أجريت دراسة مستعرضة على المسعفين الذين يعملون في وحدة العناية قبل دخول المستشفى لجامعة كيبانجانجان الماليزية المركز الطبي، كوالالمبور، ماليزيا خلال الفترة ما بين مارس 2012م إلى أغسطس 2012م . وتم استخدام استبيان لتقييم تجربتهم وعلمهم وإدراكهم، في حين تم تقييم منافسيهم بواسطة إختبار السريري الموضوعي من قبل 2 من المقيمين المستقلين مستخدمين نظام Boussignac CPAP .

النتائج: اظهرت النتائج بأن هنالك 26 مسعف أكفاء لهذه الدراسة مع متوسط خبراتهم العملية (5.59±3.53) سنة . و 76.9% منهم لم يخوضوا الى تدريب رسمي لـ (CPAP) أثناء سنواتهم الدراسية . و كانت نسبة المسعفين الذين يمتلكون المعرفة صحيحة بالضغط المجري الهوائي الإيجابي المستمر (CPAP) 88.5% . في حين سجل 96.2% من جيد الى جيد جداً لقدرتهم على التشخيص الظروف التي تبرر استخدامه . ويشكل 76.9% من المسعفين لديهم الثقة في مراقبة المرضى في حالة CPAP و 61.5% طبقوه على الجهاز . ويشكل 53.8% و 38.5% فقط من المسعفين يمتلكون الثقة في استخدام وتصليح (CPAP) عند حدوث أي مشكلة . بالنسبة للإدراك والفهم ، شعر 96.2% من المسعفين بأنه من السهل تعلم (CPAP) في حين شعر 88.5% منهم أن بإمكانهم استخدامه دون إشراف ، وشعر 80.8% منهم بأنه لا يجب الاقتصار على اعدادات ED . ويشكل 96.1% الذين كانوا متنافسين على تطبيق (CPAP) .

الخاتمة: يمتلك مسعفين المناطق الحضرية في الدول المتقدمة المعرفة الكافية، وسلوكيات إيجابية، وتصور جيد في تطبيق مهارات (CPAP) في حين يشعر البعض بنقص الثقة في النفس عند اتخاذ القرار المبادرة وإصلاح المضاعفات المحتملة عند العقبات الرئيسة التي تعيق عن استخدامها .

Objectives: To assess the acceptance among the developing country urban paramedics towards pre-hospital continuous positive airway pressure (CPAP) ventilation.

Methods: A cross-sectional prospective study was conducted among the ambulance paramedics working at the pre-hospital care unit of the Universiti Kebangsaan Malaysia Medical Centre, Kuala Lumpur, Malaysia from March 2012 to August 2012 on ambulance paramedics. Questionnaires were used to assess their experience, knowledge, and perception, while their competencies were assessed using an Objective Structured Clinical Examination by 2 independent-calibrated raters on the use of the Boussignac CPAP system.

Results: Twenty-six ambulance paramedics qualified for this study with an average work experience of 5.59±3.53 years. A total of 76.9% had no formal training for CPAP during their study years. Knowledge of CPAP apparatus-arrangement sequence scored as 88.5% correct, while 96.2% scored 'Good' to 'Very-good' in the ability to diagnose conditions that warrant its use. A total of 76.9% were confident to monitor patients on CPAP, and 61.5% in applying the device. However, only 53.8% were confident to start the CPAP, and 38.5% to troubleshoot if any problem arose. For perceptions, 96.2% felt it was easy to learn CPAP, while 88.5% felt that paramedics could use it without supervision, and 80.8% felt that it should not be confined to the Emergency Department setting. A total of 96.1% were competent in CPAP application.

Conclusion: Developing country urban ambulance paramedics possessed adequate knowledge, positive attitudes, and demonstrated good CPAP application skills. However, lack of confidence towards decision to initiate and troubleshoot of potential complications were the main obstacles hindering its use.

Saudi Med J 2014; Vol. 35 (8): 855-860

From the Department of Emergency Medicine (Hafis, Johar, Saiboon), Universiti Kebangsaan Malaysia Medical Centre, and the Department of Emergency and Trauma Services (Mahathar), Kuala Lumpur Hospital, Kuala Lumpur, Malaysia.

Received 6th February 2014. Accepted 4th June 2014.

Address correspondence and reprint request to: Prof. Dr. Ismail M. Saiboon, Department of Emergency Medicine, Universiti Kebangsaan Malaysia Medical Centre, Jalan Yaacob Latif, Bandar Tun Razak, Kuala Lumpur 56000, Malaysia. Tel. +603 (9) 1455491. Fax. +603(9) 1456577. E-mail: fadzmail69@yahoo.com.my

Non-invasive ventilation (NIV) is a method for providing positive pressure ventilatory support to patients without the need to perform invasive endotracheal intubation or tracheostomy.¹ The NIV can be delivered via face, nasal, or helmet mask with various ventilatory modes, such as volume ventilation, pressure support ventilation, bi-level positive airway pressure (BiPAP) ventilation, proportional-assist ventilation (PAV), and continuous positive airway pressure (CPAP).² However, the 2 common methods employed for NIV are CPAP and non-invasive positive pressure ventilation (NIPPV) that utilize BiPAP modes.³ The NIV was found to be beneficial in the early improvement of symptoms during the management of acute respiratory failure in the emergency department, especially in the management of acute heart failure and acute exacerbation of chronic obstructive pulmonary disease (AECOPD).⁴⁻⁶ It was associated with reduction in intensive care unit demand, reduction in intubation rates, reduced health-care expenditure, and improved survival.⁵ A retrospective study performed on pre-hospital CPAP application among presumed acute heart failure (AHF) patients found significant improvement in oxygenation, respiratory rate, heart rate, and systolic blood pressure.⁷ However, these early improvements do not translate into improved survival compared with the standard therapy, especially in the management of acute pulmonary edema.⁸ Various studies showed improvement and acceptance of this intervention in the developed countries' emergency medical service (EMS) systems, and also showed beneficial effects, which includes improved oxygenation and reduction in breathlessness, tachypnea, invasive ventilation, and in-hospital mortality.⁹⁻¹³ However, the use of CPAP in a developing country EMS has not been thoroughly evaluated. No major studies were published regarding the use of NIV, either with CPAP, or NIPPV in the EMS system in the South East Asia, especially in the developing countries. In fact, as a result of our own observation, we observed only few pre-hospital care units in our country, which used CPAP in their ambulance services. This is quite unfortunate since NIV practice has shown promising results in many developed countries EMS systems; however, it is not a standard practiced here in Malaysia. We also noted that CPAP or NIPPV was not part of the paramedic curriculum in our local setting.¹⁴ In order to assess the acceptance among the paramedics towards this intervention, we conducted a pilot study exploring their experience, knowledge, level of confidence, and perception using CPAP in their practice. We also assessed the skill on the CPAP usage using the Boussignac CPAP system®.

Methods. This was a prospective cross sectional study performed among the ambulance paramedics working at the pre-hospital care unit of the Universiti Kebangsaan Malaysia Medical Centre (UKMMC), Kuala Lumpur, Malaysia. The study was conducted over a period of 6 months from March 2012 to August 2012. This study was divided into a questionnaire-based section for assessing the knowledge, confidence, and perceptions; and Objective Structured Clinical Assessment (OSCE) section for skill assessment. This study was approved by the UKM Research Ethics Committee. The principles of Helsinki Declaration were strictly adhered to.

Intervention. *A) Questionnaire.* A 4-part questionnaire was developed to assess the experience, confidence, knowledge, and perceptions among paramedics in the practiced of pre-hospital CPAP. It consisted of 27 questions or items. There were 4 questions on experience with CPAP; confidence level (4 questions); knowledge (9 questions), and perception (10 questions). Knowledge was assessed in 2 components; 1) knowledge of CPAP apparatus-arrangement sequence for initiating treatment; and 2) the decision on starting CPAP based upon clinical scenario given. There were 8 clinical scenarios, which include pneumonia, acute heart failure, traumatic pneumothorax, mild asthma, altered level of consciousness, acute pulmonary edema, congestive cardiac failure with vomiting, and chronic obstructive pulmonary disease (COPD) patient who had collapsed. Based on the correct response, the participants' marks were graded according to this scale: very-good (7-8 marks); good (5-6 marks); weak (3-4 marks); and very-weak (1-2 marks).

The questionnaire was constructed by the authors and reviewed by the experts' panel that consisted of Emergency Physicians (EPs). It was prepared bilingually in English and local Malay language in order to ensure maximum understanding, and comprehension by the participants. The content was validated by a language expert translator. Finally, it was then validated by a group of paramedics that had the same level of education as the participants. A sample testing was conducted to ensure the validity and reliability of the questionnaire.

B) Skill competency. Evaluation of the CPAP application skill was assessed through an OSCE. The OSCE checklist was created by a group of Emergency Physicians who had vast experience in the usage of Boussignac CPAP system®. There were 10 important steps outlined, each step carried one mark. A scale was then created to classify the scores obtained by the participants. The scores were categorized into 4 categories, which were, very good (7.6-10 marks); good (5.1-7.5 marks); weak (2.6-5.0 marks); and very weak

(0.0-2.5 marks). Rater's calibration process was carried out prior to the actual OSCE. The raters were briefed regarding the scoring scale of a performance. This was achieved through sample videos that were shown to the raters during the calibration marking process. The videos were samples of successful CPAP applications, and also videos on various mistakes committed during the application, and the appropriate scores for each performances.

Population recruitment. Convenience sampling was used to recruit the participants. Inclusion criteria were those who were actively working or practicing in the ambulance unit, and registered with the Medical Assistant Board of Malaysia, during the study period. The consent obtained was for their participation in the self-filled questionnaire, and permission to video tape their performance. Once the consent was obtained, the questionnaire was distributed to the participants for them to answer. Following completion of the questionnaire, a competency testing in the form of OSCE was conducted. During the competency testing, the paramedics' performances were captured on videos. These videos were shown later to 2 calibrated-independent raters who were not involved in the preparation of the questionnaire and OSCE. They watched the videos individually, and gave their scores, according to the scale given.

Data analysis. The data collected was tabulated and analyzed using the Statistical Packages for the Social Sciences version 21 (IBM Corp, Armonk, NY, USA). Descriptive analysis was conducted on experience, confidence, and knowledge data to obtained frequency and percentage. Cronbach alpha was used to measure the validity of the items within the questionnaires that assessed the perception towards pre-hospital CPAP practice. While in the skill section, the reliability of the 2 raters was analyzed by measuring the Intraclass Correlation Coefficient (ICCs).

Results. Out of 72 paramedics who were working in the UKMMC Emergency Department, 30 fulfilled the inclusion criteria. This is due to the system, where all the paramedics belong to the emergency department and they were on ambulance call based on 6 monthly rotations. Since the inclusion criteria required only those who were actively involved in the ambulances run during the study period, this leaves only 30 eligible for the study. Out of the 30, only 26 agreed and consented to participate in this study. The mean age of the participants was 28.59 (\pm 3.34) years old, and the mean number of practice in the pre-hospital care unit was 5.59 (\pm 3.53) years. In terms of certification, 76.9%

were diploma holders, while 23.1% were degree holders in the field related to Emergency Medical System (EMS) services. A total of 20 out of 26 (76.9%) did not receive formal teaching regarding CPAP application during their study years. In terms of frequency of usage, 15 out of 26 (57.7%) only applied the CPAP device less than once a month, while 7 (26.90%) used the device at least once a month.

Table 1 shows the results of the confidence level among participants in using the CPAP. In the knowledge section, 23 out of 26 (88.5%) participants were successful in showing the correct CPAP apparatus-sequence arrangement required when initiating the treatment. Regarding the indications and contraindication based on the 8 scenario-based questions, 25 out of 26 (96.2%) score either 'good' or 'very-good' (Table 2).

The results of perception is shown in Table 3 with the Cronbach alpha measurement of 0.6, indicating that there was fair to good agreement between the items

Table 1 - Confidence level of paramedic on continuous positive airway pressure (CPAP) therapy.

Confidence levels	Not confident	Less confident	Confident	Very confident
Confidence to decide when to start CPAP	1 (3.9)	11 (42.3)	14 (53.8)	0 (0.0)
Confidence to apply CPAP on patients	1 (3.9)	9 (34.6)	16 (61.5)	0 (0.0)
Confidence to monitor patient on CPAP	0 (0.0)	5 (19.2)	20 (76.9)	1 (3.9)
Confidence to troubleshoot if any problem arise during CPAP	3 (11.5)	13 (50.0)	10 (38.5)	0 (0.0)

Table 2 - Knowledge on decision making in initiating pre-hospital continuous positive airway pressure (CPAP) and knowledge score.

Knowledge	n (%)
Knowledge on decision making	Correct answer
Pneumonia	26 (100)
Acute heart failure	25 (96.2)
Traumatic pneumothorax	25 (96.2)
Mild asthma	26 (100)
Altered level of consciousness	25 (96.2)
Acute pulmonary edema	21 (80.8)
Severe vomiting	12 (46.2)
Collapsed with chronic obstructive pulmonary disease (COPD)	24 (92.3)
Knowledge score	Score
Poor	0 (0.0)
Fair	1 (3.9)
Good	6 (23.1)
Very good	19 (73.1)

within the questionnaire in assessing the perception among the paramedics.

In the skill assessment of CPAP, ICC was 0.67 (95% confidence interval (CI); 0.183, 0.867) indicating there was good agreement and reliability among both of the raters (rater 1 and 2) when giving the scores for the practical skills performed by the participants. We noted that 96.1% of the participants were able to perform CPAP application correctly (score 'good' and 'very-good') (Table 4). However, after correlation of the 2 raters' score with ICC, the mean score of the participants in performing CPAP application was 'good' (rater 1: 6.5; rater 2: 7.3; average score - 6.9).

Table 5 showed neither knowledge nor experience were significant factors in influencing the performance of CPAP application.

Discussion. The UKMMC pre-hospital care unit is a hospital-based urban EMS system that caters for 800,000 populations of the southern Klang Valley, Malaysia. It is one of the few pre-hospital care system in the country that utilizes CPAP as a standard item and practice in their ambulances. Based on the results of the present study, we observed that most diploma holder paramedics did not receive formal teaching of NIV, neither with CPAP, nor NIPPV during their pre-employment education. This was expected since it was not part of their basic training curriculum.¹⁴ The only training regarding CPAP they had was on-the-job experience. Only those from the degree program had training on CPAP prior to the employment. In terms of confidence to initiate CPAP, there was not much difference between those who were confident and those who were not. A total of 14 out of 26 (53.8%) were confident in initiating CPAP by themselves, but 12 out of 26 (46.2%) were less or not confident to such. This suggests that although they had the appropriate

knowledge on selecting patients who needed this therapy, a large percentage of the paramedics in this sample did not have the confidence to initiate the treatment by themselves. We could not compare this result with other studies, as no similar study was performed on the same research area.

In terms of knowledge, we assessed the knowledge component in 2 manners, which was knowledge of 'recall' and 'decision-making'. Most paramedics had 'good' to 'very-good' knowledge that is necessary of pre-hospital CPAP. In the recall component, we asked them to arrange the proper sequence of applying CPAP device, in which 88.5% did correctly. In the decision making aspect, looking at correct indications of CPAP, most scenarios had more than 80% being answered correctly, except for severe vomiting, where only 46.2% got it correct. This could be due to misunderstanding of the situation, but further studies are needed to address this issue. Overall, the results showed that even without formal training but a good on-the-job training with

Table 4 - The paramedics' scores on practical skills of continuous positive airway pressure (CPAP) application.

Score on practical skills	n (%)
Poor	0 (0.0)
Fair	1 (3.9)
Good	18 (69.2)
Very good	7 (26.9)

Table 5 - Comparison between knowledge and years of experience against performance.

Item	Performance		P-value
	Good Median (IQR)	Poor Median (IQR)	
Knowledge	15.0 (4.0)	13.0 (4.5)	0.21 (>0.05)
Experience (in years)	10.0 (10.0)	3.0 (4.0)	0.07 (>0.05)

Table 3 - Paramedics' perceptions towards pre-hospital continuous positive airway pressure (CPAP)

No	Item	Strongly disagree	Disagree	Agree	Strongly agree
1	CPAP use should be confined in ED. Not in pre-hospital	4 (15.4)	17 (65.4)	5 (19.2)	0 (0.0)
2	Paramedics are not qualified to use CPAP without doctors supervision	4 (15.4)	19 (73.1)	3 (11.5)	0 (0.0)
3	CPAP and high flow mask give same effects	6 (23.0)	19 (73.1)	1 (3.9)	0 (0.0)
4	CPAP will delay transport	4 (15.4)	16 (61.5)	5 (19.2)	1 (3.9)
5	It is difficult to apply CPAP during ambulance call	1 (3.9)	12 (46.1)	13 (50.0)	0 (0.0)
6	Ambulance journey is short. No need CPAP	0 (0.0)	15 (57.7)	11 (42.3)	0 (0.0)
7	CPAP use should be thought during post basic course before can be used by paramedics	0 (0.0)	2 (7.7)	9 (34.6)	15 (57.7)
8	Learning CPAP is complicated	4 (15.4)	21 (80.8)	1 (3.85)	0 (0.0)
9	CPAP use during ambulance call is risky. Will not take the risk	1 (3.9)	14 (53.9)	10 (38.5)	1 (3.9)
10	Not sure what to do if complication arises	0 (0.0)	10 (38.5)	16 (61.5)	0 (0.0)

adequate experience (average: 5.6 years) was sufficient for them to know which patients needed CPAP.

Most of the participants indicated that they were confident in applying (61.5%) and monitoring (80.8%) patients on CPAP. These results showed positive attitude and strong acceptance among ambulance paramedics towards the use of CPAP in pre-hospital care. Most paramedics also believed that pre-hospital CPAP application was easy, would not cause delay of patient transport, and it was useful even if the ambulance journey was short. However, the benefit of putting on NIV for a short journey has been questioned.¹⁵

However, 42.3% of them felt that using CPAP during an ambulance call was risky and would not take such risk, if complications occurred. This was supported by the findings that most of the respondents (62.5%) were not sure what to do whenever complication occurs when it is used in the ambulance. Understandably, most paramedics were not confident in trouble-shooting the complications or problems that may arise during the pre-hospital CPAP therapy. This could be explained with regard to the paramedics CPAP training since most of the respondents reported they had not received adequate or formal training regarding CPAP during their study period, and all of them agreed or strongly agreed to the notion that the training should be provided during the basic paramedic diploma course, or additional post-basic course before it can be used by the paramedics during an ambulance call. An earlier study by Carlucci et al,¹⁶ showed that experience of the operator played an important role on the success of NIV application. However, the study focused on the use of BiPAP, and not CPAP.

Trouble-shooting and problem solving demand critical thinking and require more complex and higher learning processes. Based on these findings, higher training that focuses on trouble-shooting and problem solving should be emphasized if we wish to improve our current prehospital CPAP. This can be achieved by providing proper training with accreditation towards the end of the course.¹⁷ Proper credentialing, a set of predetermined criteria is constructed and fulfilled by these paramedics in performing safe and effective pre-hospital CPAP therapy, including the management of possible complications, and potential problems. Courses and trainings, such as these, may solve this issue by keeping the good standard of practice and at the same time, encourage continuous improvements in the paramedics' performances, rather than just maintaining minimal, or average quality and standards.

In terms of application skill, most of the respondents scored good to very good in their competency of CPAP

application and the scores given by the raters were in good agreement, reflecting the scores good reliability. As we know, the ability to successfully perform a particular practical task, depends on the necessary knowledge and skills, the manual dexterity to manipulate each of the device component and most importantly, the confidence to apply the CPAP on patients. The Boussignac CPAP system[®] was used in this study because it was readily available in our ambulance system. The familiarity to the device could be another factor that contributed to the good scores, as observed in this study. Applying the device was quite evident despite that most of the paramedics applied CPAP less than once a month, and most of them performed well in the practical sessions. A study performed by Templier et al¹⁸ looking at the practical use of this the Boussignac CPAP system[®] in their pre-hospital medical care unit, found that the system had many advantages including flexibility, pressure monitoring, lower oxygen consumption, and ease of use in their pre-hospital environment.

Even though we observed that neither knowledge nor experience were significant factors in influencing the performance of CPAP application, experience showed a better score ($p=0.07$) compared with knowledge ($p=0.21$). The main reason for the non-significant result was mainly due to the small sample size. As mentioned earlier in another study,¹⁶ the more experienced the personnel, the better was the success rate of CPAP. While performing this study, there were some unavoidable limitations. Firstly, since this was a pilot study, the sample size of the study population was small. This was due to the fact that the pre-hospital CPAP was relatively new in the Malaysian EMS, and UKMMC was one of the very few centers that provided this therapy. Hopefully, when the practice is more established and expanded, a bigger sample size involving several centers can be achieved. We suggest similar studies to be performed in these centers for more accurate results. Secondly, the skill assessment was performed on simulated patients in a controlled environment of the simulation lab. This may under-represent the more hostile, stressful, and chaotic environment within the ambulance during its run. This may influence the performance of the ambulance paramedic to apply the CPAP.

There are clear differences in the practice of pre-hospital care in the developing countries compared with developed countries, especially in terms of technology and system used. In developing countries, the EMS systems usually are less mature and often no clear protocols available to guide the practice. In Malaysia, a fast developing country, the ambulance services

were provided by 2 large organizations, which are government funded ambulances and non-governmental organizations (NGOs) ambulances.^{19,20} In Malaysia, the hospital-based government ambulance services were guided by the emergency physicians (EPs) acting as the Emergency Medical Service Medical Director (EMSMD). The government health center ambulances, do not have their own EMSMD, but can have access to the nearby hospital EMSMD. However, for the rest of the paramedics, they may have limited access to EMSMD.²⁰ From these findings, we suggest that the pre-hospital unit in Malaysia should develop a proper Standard Operating Procedures (SOP) on the usage of pre-hospital CPAP in order to improve ambulance paramedic confidence, while using it when required. We also suggest the provision of regular CPAP teachings and systematic trainings among paramedics to consolidate their knowledge and confidence in CPAP applications. Bruge et al,¹⁷ suggested a training session of using NIV at different setting among each other for one hour, routine intervention and annual 2-hour updates to improve the performance of the provider among physicians. We look forward to a similar but more rigorous regime will also be implemented to the paramedics with the hope of improving their confidence and performance level.

In conclusion, from this study we found that paramedics in an urban EMS system of a developing country have good knowledge in the indications, positive perceptions, and good skill performance on the use of CPAP in the prehospital care setting. However, there seem to be lack in confidence with regard to initiating CPAP therapy, and dealing with possible complications that may arise during the usage. These were the obstacles that needs to be addressed in order to overcome the hindrance of its usage in the pre-hospital setting.

References

- Hoo GW, Byrd Jr RP. Noninvasive Ventilation. Overview. Medscape. [Updated 2014 April, 4; Accessed 10th May 2014]. Available from URL: <http://emedicine.medscape.com/article/304235-overview>
- Hoo GW, Byrd Jr RP. Noninvasive Ventilation. Methods of Delivery Medscape. [Updated 2014 April, 4; Accessed 10th May 2014]. Available from URL: <http://emedicine.medscape.com/article/304235-overview#aw2aab6b3>
- McMurray JJ, Adamopoulos S, Anker SD, Auricchio A, Böhm M, Dickstein K, et al. ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure 2012: The task force for the diagnosis and treatment of acute and chronic heart failure 2012 of the European Society of Cardiology. Developed in collaboration with the Heart Failure Association (HFA) of the ESC. *Eur Heart J* 2012; 33: 1787-1847.
- Masip J. Non-invasive ventilation. *Heart Fail Rev* 2007; 12: 119-124.
- Crummy F, Naughton MT. Non-invasive positive pressure ventilation for acute respiratory failure: justified or just hot air? *Intern Med J* 2007; 37: 112-118.
- Bolton R, Bleetman A. Non-invasive ventilation and continuous positive pressure ventilation in emergency departments: where are we now? *Emerg Med J* 2008; 5: 190-194.
- Kallio T, Kuusima M, Alaspää A, Rosenberg PH. The use of prehospital continuous positive airway pressure treatment in presumed acute severe pulmonary edema. *Prehosp Emerg Care* 2003; 7: 209-213.
- Gray AJ, Goodacre S, Newby DE, Masson MA, Sampson F, Dixon S, et al. A multicentre randomised controlled trial of the use of continuous positive airway pressure and non-invasive positive pressure ventilation in the early treatment of patients presenting to the emergency department with severe acute cardiogenic pulmonary oedema: the 3CPO trial. *Health Technol Assess* 2009; 13: 1-106.
- Craven RA, Singletary N, Bosken L, Sewell E, Payne M, Lipsey R. Use of Bilevel positive airway pressure in out-of-hospital patients. *Acad Emerg Med* 2000; 7: 1065-1068.
- Mal S, MacLeod S, Iansavichene A, Dukelow A, Lewell M. Effect of out-of-hospital noninvasive positive-pressure support ventilation in adult patients with severe respiratory distress: a systematic review and meta-analysis. *Ann Emerg Med* 2014; 63: 600-607.
- Dib JE, Matin SA, Luckert A. Prehospital use of continuous positive airway pressure for acute severe congestive heart failure. *J Emerg Med* 2012; 42: 553-558.
- Thompson J, Petrie DA, Ackroyd-Stolarz S, Bardua DJ. Out-of-hospital continuous positive airway pressure ventilation versus usual care in acute respiratory failure: a randomized controlled trial. *Ann Emerg Med* 2008; 52: 232-241.
- Templier F, Labastire L, Pes P, Berthier F, Le Conte P, Thys F. Noninvasive ventilation use in French out-of-hospital settings: a preliminary national survey. *Am J Emerg Med* 2012; 30: 765-769.
- Medical Assistant Board, Medical Practice Division, Ministry of Health Malaysia. Standards and Guidelines for Medical Assistant Education Programme. Malaysia: Ministry of Health; 2010. p. 1-65.
- Taylor DM, Bernard SA, Masci K, MacBean CE, Kennedy MP, Zalstein S. Prehospital noninvasive ventilation: a viable treatment option in the urban setting. *Prehosp Emerg Care* 2008; 12: 42-45.
- Carlucci A, Delmastro M, Rubini F, Fracchia C, Nava S. Changes in the practice of non-invasive ventilation in treating COPD patients over 8 years. *Intensive Care Med* 2003; 29: 419-425.
- Bruge P, Jabre P, Dru M, Jbeili C, Lecarpentier E, Khalid M, et al. An observational study of noninvasive positive pressure ventilation in an out-of-hospital setting. *Am J Emerg Med* 2008; 26: 165-169.
- Templier F, Dolveck F, Baer M, Chauvin M, Fletcher D. 'Boussignac' continuous positive airway pressure system: practical use in a prehospital medical care unit. *Eur J Emerg Med* 2003; 10: 87-93.
- Hisamuddin NA, Hamzah MS, Holliman CJ. Prehospital emergency medical services in Malaysia. *J Emerg Med* 2007; 32: 415-421.
- Ismail MS, Hasinah AB, Syaiful MN, Murshidah HB, Thong TJ, Zairi Z, et al. Study on advanced life support devices in the ambulances for emergency cases in Klang Valley, Malaysia. *Clin Ter* 2012; 163: 115-122.