Special Article

Basic cardiopulmonary life support (BCLS) for cardiopulmonary resuscitation by trained paramedics and medics outside the hospital

Address for correspondence:
Prof. Syed Moied Ahmed, Department of Anaesthesiology and Critical Care, J N Medical College, Aligarh Muslim University, Aligarh, Uttar Pradesh, India.
E-mail: sma99@rediffmail.com

Rakesh Garg, Syed Moied Ahmed[1], Mukul Chandra Kapoor[2], Bibhuti Bhusan Mishra[3], SSC Chakra Rao[4], M Venkatagiri Kalandoor[5], Jigeeshu Vasishtha Divatia[6], Baljit Singh[7]

Department of Onco-Anaesthesiology and Palliative Medicine, Dr. BRAIRCH, All India Institute of Medical Sciences, [2]Department of Anesthesia, Max Smart Super Specialty Hospital, [7]Department of Anaesthesiology and Intensive Care, G B Pant Institute of Postgraduate Medical Education and Research, New Delhi, [1]Department of Anaesthesiology and Critical Care, J N Medical College, Aligarh Muslim University, Aligarh, Uttar Pradesh, [3]Department of Anaesthesiology, NTPC Limited, Bhubaneswar, Odisha, [4]Department of Anaesthesiology, Care Emergency Hospital, Kakinada, Andhra Pradesh, [5]Department of Anaesthesiology, Government General Hospital, Kasaragod, Kerala, [6]Department of Anaesthesia, Critical Care and Pain, Tata Memorial Hospital, Homi Bhabha National Institute, Mumbai, Maharashtra, India

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ABSTRACT

The cardiopulmonary resuscitation guideline of Basic Cardiopulmonary Life Support (BCLS) for management of adult victims with cardiopulmonary arrest outside the hospital provides an algorithmic stepwise approach for optimal outcome of the victims by trained medics and paramedics. This guideline has been developed considering the need to have a universally acceptable practice guideline for India and keeping in mind the infrastructural limitations of some areas of the country. This guideline is based on evidence elicited in the international and national literature. In the absence of data from Indian population, the excerpts have been taken from international data, discussed with Indian experts and thereafter modified to make them practically applicable across India. The optimal outcome for a victim with cardiopulmonary arrest would depend on core links of early recognition and activation; early high-quality cardiopulmonary resuscitation, early defibrillation and early transfer to medical facility. These links are elaborated in a stepwise manner in the BCLS algorithm. The BCLS also emphasise on quality check for various steps of resuscitation.

Key words: Automated external defibrillation, cardiopulmonary resuscitation, chest compression, defibrillation, outside the hospital

DISCLAIMER

Consensus opinions from experts are used where robust Indian data was scarce. The consensus statements, however, remain based on inputs from international data and their suitability to Indian conditions. It is emphasized that these guidelines do not represent the minimum standard of practice, nor are they a substitution for good clinical judgment.

PREAMBLE

Cardiopulmonary arrest is an emergency and warrants immediate action with appropriate cardiopulmonary resuscitation (CPR) for an optimal outcome. Majority of cardiac arrests occur outside the hospital and timely management is essential. The outcomes, especially neurological, are poor in victims of cardiac arrest outside the hospital.[1] Immediate cardiac compression by

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bystander can help buy time till medical help reaches and can improve the outcomes.[2,3] For India, availability of a larger number of CPR-trained laypersons is the need of the hour, as medical help may take time to reach the site of cardiopulmonary arrest. Advanced CPR management outside the hospital is limited by lack of advanced equipment, expertise and workforce, making resuscitation outside the hospital a difficult task. Regional variations further influence resuscitation attempts.[4] In addition, the victim transfer team outside the hospital is usually different from the medical team managing the victim inside the hospital. Many international guidelines have been proposed by scientific bodies.[5-7] They may not, however, be applicable to India due to differences in geography, available infrastructure, economic conditions and availability of trained/educated workforce. There is an emergent need of a simple but robust evidence–based, algorithm-based guideline for management of victims by trained paramedics and medics outside the hospital in India.

Basic Cardiopulmonary Life Support (BCLS) refers to an algorithmic structured plan for management of victims of cardiopulmonary arrest outside the hospital. It will be applicable to trained medics and paramedics who are present at or are called to the site of casualty. These guidelines would be applicable for CPR when the layperson calls the medical team and the team arrives at the scene of arrest or if a trained person is present at the scene of arrest.

METHODS

In a meeting attended by representatives of medical societies/associations in India, involved with resuscitation, a decision was taken to develop Indian resuscitation guidelines. The academic committee of Indian Society of Anaesthesiologists (ISA) identified the five CPR experts, who have experience in conducting, teaching and training of CPR, to formulate the Indian guidelines for CPR. These experts, who are well versed with practising, teaching and training of various international CPR guidelines, formed the Resuscitation Council. Considering the limitations in India, the Resuscitation Council framed three guidelines based on the experience of the rescuer, the place of resuscitation and the availability of facilities.

Search strategy

A list of resuscitation-related search terms were identified. A literature search was conducted for studies published in English between June 2005 and June 2017 using PubMed, EMBASE, MEDLINE, Ovid, Google Scholar Databases and other search engines using the following search items and keywords: outside the hospital cardiac arrest, cardiopulmonary resuscitation, chest compression, defibrillation, automated external defibrillation, early defibrillation, high quality CPR, early transfer, pulse check for cardiac arrest and trained personnel. Additional articles were retrieved by cross referencing and manual searching of the desired manuscripts. The main focus was on randomised clinical trials, but observational cohort studies and case reports/series were also identified. A total of 2133 abstracts were reviewed for relevance and the list was narrowed down to 67 articles. In addition, CPR guidelines of various societies were reviewed. Articles specifically related to the individual guideline were circulated to the experts. Each article was reviewed by at least two members of the Resuscitation Council.

The working group had multiple meetings in person as well as e-meetings and telephonic conferences. Based on these inputs, a draft guideline including the algorithm and core links for CPR was made. The draft guideline was initially presented to the academic committee of the ISA, where members of other academic societies were also invited. The inputs received from all societies were discussed in detail and duly incorporated. Subsequently, the guideline was twice presented to experts and their inputs were incorporated in the revised draft guideline. Thereafter, a trial workshop was conducted, which was attended by anaesthesiologists and invited experts. Verbal and written feedback was taken during this workshop. A questionnaire based on the key elements of each algorithm, addressing certain inconclusive areas where evidence was lacking, was circulated during the meeting/workshop and inputs were taken. Wherever evidence was lacking, recommendations were made by consensus, after extensive discussion among the group members and considering the results of the questionnaire.

BASIC CARDIOPULMONARY LIFE SUPPORT (BCLS) LINKS AND ALGORITHM DESCRIPTION

Core links in adult Basic Cardiopulmonary Life Support (BCLS)

The optimal outcome of cardiopulmonary arrest outside hospital would depend on certain links that need to be followed. The four essential core links during BCLS are as follows [Figure 1]:

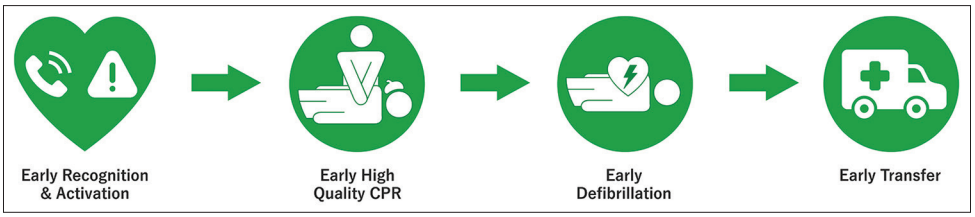

Figure 1: Core links in adult basic cardiopulmonary life support (BCLS)

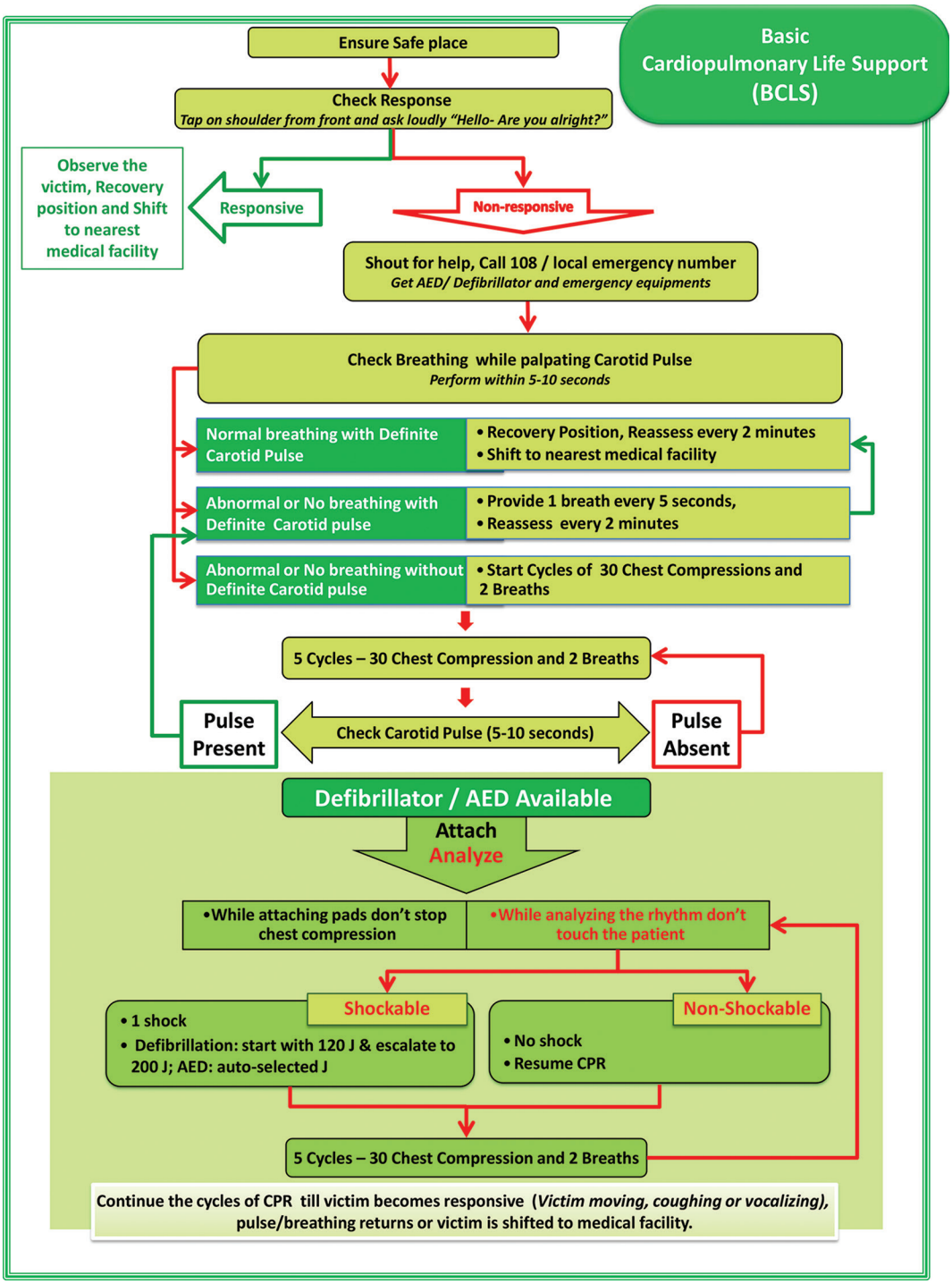

Figure 2: Basic cardiopulmonary life support (BCLS) algorithm

- Early recognition and activation
- Early high-quality CPR
- Early defibrillation
- Early transfer.

Steps in adult Basic Cardiopulmonary Life Support (BCLS)

The management of a victim with cardiopulmonary arrest requires a systematic approach for an optimal outcome. This requires following a sequential series of predefined steps for assessment and management of the victim of cardiac arrest for return of spontaneous cardiac activity. The BCLS approach is a simplified algorithm-based approach to be followed for a victim with cardiopulmonary arrest outside the hospital. The BCLS approach is easy to understand, remember and follow in actual real-time situations [Figure 2]. Though the recommended algorithm of BCLS is in sequential series, when more than one trained rescuers are present, the steps may be done simultaneously. However, the ethos of the algorithm needs to be followed i.e., division of work needs to be done in such a way that the victim gets optimal care at the earliest while all steps are being followed. The steps of BCLS are described in the following sections.

Safe place for resuscitation

Time is of the essence in the initiation of resuscitation. However, the safety of the rescuer is paramount. If the safety measures are not followed or if a safe place is not available during management of the victim with cardiac arrest, mishaps can happen causing injury to the rescuer. It is essential that the rescuer should look around the site for any imminent danger. If the site is safe, the rescuer should immediately proceed to the initiation of BCLS. In case any imminent danger is perceived (such as risk of accident, fire, electrocution, drowning and riots), the rescuer should activate the concerned authority or seek help from the available people to shift the victim to a safe place. The help of police personnel, fire brigade or Life Guard needs to be taken in unsafe sites by calling them and providing all the information of the site. The resuscitation should be initiated, as soon as feasible, while this activity of information is being undertaken.

Victim's response check

The victim's response check needs to be done to decide the further actions. The rescuer should approach from the front facing the victim's face, tap on the shoulder and speak loudly (e.g., hello, are you alright?) in a language victim could understand to elicit the response from the victim. The victim should not be shaken nor neck movements done (like tapping on face) as it could cause further harm, in cases of injury to cervical spine. If the victim responds either by verbal response and/or by purposeful movement, then cardiopulmonary arrest is unlikely. Such victims need to be monitored constantly and shifted to a nearby medical facility at the earliest for further evaluation and management. If no response is elicited, then victim may be having cardiopulmonary arrest. In such a case, emergency medical service needs to be activated for early dispatch of help including emergency equipment.

Call for help, inform emergency medical system and get emergency equipment

If the rescuer is alone, he/she should himself/herself inform the emergency medical service and seek expertise, emergency equipment and arrangement for transfer to the medical facility. With usual availability of personal mobile phones, it is suggested that rescuer call from his/her mobile phone, with the speaker phone on and continue with subsequent steps of BCLS. In case help is available nearby, that person may be instructed to inform the emergency medical service about the victim and ask for help including automated external defibrillator (AED)/defibrillator. The rescuer should be aware of local emergency contact details. In India, till the acceptance of a uniform number for pan-India, local emergency number should be called by the rescuer. The number 108 has been proposed as the pan-India emergency contact number, and it has been accepted by many states of India.

Check pulse and breath simultaneously

After informing the emergency medical system, the rescuer should assess for the presence of pulse and breathing simultaneously. The rescuer should identify the carotid pulse and check for its definite presence. The pulse needs to be checked for 5–10 s. During this pulse check, the rescuer should observe the chest for breathing movements. Absent breathing or abnormal breathing like gasping or agonal breaths and definite absence of carotid pulse are suggestive of cardiopulmonary arrest. In cases where the presence of pulse and breath cannot be determined, the rescuer should assume the victim to be in cardiopulmonary arrest. The check of pulse and breath should not take more than 10 s. The rescuer may chant loudly 1001, 1002, 1003,….1010 for time assessment of 10 s to avoid delay in initiating 'early high-quality CPR'. During the check of pulse and breathing, the three clinical situations that may be encountered are as follows:

- Normal breathing with definite carotid pulse: The victim needs to be assessed every 2 min or earlier to determine any change in condition. Based on these repeated checks, the victim should be managed as per steps defined in the algorithm. Wait for the medical team and shift the victim to the nearest medical facilities at the earliest
- Abnormal or no breathing with a definite carotid pulse: The victim is in respiratory arrest. The victim should be provided normal tidal volume breaths every 5 s (12 breaths every minute) using mouth to mouth (with/without barrier device), mouth to mask or bag mask device ventilation. Each breath should be delivered over 1 s. The end point of the ventilation breath is visible chest rise. The rescuer may chant loudly 1001, 1002, 1003,….1010 for time assessment, with each numeral taking about 1 s. Reassess the victim for pulse every 2 min or earlier to observe any change in condition of the victim. Wait for the medical team and shift the victim to the nearest medical facilities at the earliest
- Abnormal or no breathing without a definite carotid pulse: The victim is in cardiopulmonary arrest and requires high-quality CPR including cycles of compression and breaths at the earliest.

Early high-quality cardiopulmonary resuscitation

Once the cardiac arrest is recognised, the rescuer should start providing chest compression immediately. Cycles of CPR (cycles of 30 chest compressions: 2 breaths) should be initiated.

- Chest compressions: Effective chest compressions should be started with 30 compressions in one set. The speed of chest compressions should be 120/min and compression depth should be at 5–6 cm. The hands should be placed on the lower half of the sternum (centre of the chest). The rescuer should chant loudly 1, 2, 3, 4,….30 to maintain the speed and number of chest compressions. The rescuer should allow the complete chest recoil between compression without lifting hand from the chest but without leaning on the victim's chest. There should be minimum interruptions between chest compressions
- Breaths: Once chest compression has been initiated, rescue breaths need to be delivered using mouth to mouth (with/without barriers device), mouth to mask or a bag mask device. After opening the airway by head tilt and chin lift (only jaw thrust or chin lift in victims of suspected cervical spine trauma), a breath should be delivered over 1 s. The breath should be tidal volume breath with an end point of visible chest rise. After allowing 1 s for exhalation, another breath over 1 s should be provided. Chest compression is restarted immediately without waiting for exhalation.

If there is more than one rescuer, then the chest compression and administration of breath can be done by two different rescuers. The rescuer giving chest compressions and the rescuer providing rescue breaths should be interchanged every five sets of CPR (five cycles of 30 chest compressions and 2 breaths) to prevent exhaustion and maintain effective BCLS, especially chest compression. After five sets of CPR, the victim should be reassessed again with carotid pulse check. During this check, the possible situations encountered are as follows:

- Pulse present: Check for the presence of breath. If absent, provide a breath every 5 s and reassess every 2 min. In case of presence of breath, reassess every 2 min till victim is shifted to the nearest medical facility
- Pulse absent: Continue with another five sets of CPR (five cycles of 30 chest compressions: 2 breaths) and reassess the carotid pulse thereafter. Continue CPR following the steps described above depending on whether pulse is present or absent.

It is emphasised that once the AED or defibrillator is available, rather than the pulse check, rhythm analysis needs to be done after five sets of CPR till return of spontaneous circulation.

Early defibrillation

The defibrillation should be done at the earliest, especially if sudden cardiac arrest is witnessed in the victim. The defibrillation shock may be administered by AED or manual defibrillator by a trained rescuer. The rescuer or any layperson may retrieve the AED nearby and is used by the trained personnel at the earliest. In case it is not available, defibrillation should be done at the earliest, once the emergency medical team arrives with the device. Till that time, high-quality CPR should be continued. The first shock must be administered at the earliest, irrespective of the stage of the CPR cycle. Thereafter, the rhythm should be assessed using the defibrillator monitor and defibrillation should be given, if required. It is to

be done after every five sets of CPR (five cycles of 30 chest compressions and 2 breaths).

Automated external defibrillator: The steps of using automated external defibrillator include

- Switch ON the AED
- Follow the voice prompts
  - Attach AED pads without interrupting the chest compressions
  - Analyse the rhythm by AED for need of electric shock. Do not touch the victim during rhythm analysis
  - Administer electric shock if prompted by AED
  - Resume CPR, starting with chest compression.
- Defibrillator: The steps of using manual defibrillator:
  - Switch on the defibrillator
  - Attach electrocardiography (ECG) leads of the defibrillator or keep paddles on the chest (one at apex of the heart at the left side of the chest and other below the clavicle on the right side in mid-clavicular line). Continue CPR during lead attachments
  - Analyse the rhythm. Do not touch the victim during rhythm analysis
  - If rhythm is shockable, charge the defibrillator with 120 J. Continue chest compressions during charging. Deliver the shock ensuring no part of the rescuer's body is touching the victim or his/her bed. After delivery of the shock, resume CPR, starting with chest compression. Subsequent shock, if needed, may be escalated to 200 J
  - If rhythm is non-shockable, continue CPR.

Recovery position

In case of return of spontaneous circulation and normal breathing, the victim should be positioned in recovery position till the medical help arrives and the victim is to be shifted to medical facility. The recovery position can be either left or right lateral. The recovery position allows maintenance of the airway and drainage of any oral secretions. Victim should be reassessed every 2 min or earlier if required.

Transfer

The victim needs definitive medical care and management of the underlying aetiology of the cardiopulmonary arrest and so should be shifted to the nearest suitable healthcare facility. The BCLS needs to be continued till victim is shifted to definitive care medical facility or becomes responsive and has definitive pulse and breathes normally.

QUALITY ASSURANCE OF BASIC CARDIOPULMONARY LIFE SUPPORT (BCLS) CONDUCT

The high-quality BCLS, and not just following the steps of BCLS, is paramount to ensure optimal outcome after a cardiorespiratory arrest. The emphasis on continued quality check is essential.

The various aspects enhancing the outcome include:

- High-quality chest compressions
  - Chest compressions speed, rate and recoil: Ensure a chest compression speed of 120 compressions/minute to a depth of 5–6 cm. Allow complete chest recoil between compression without lifting hand from the chest (do not lean on the victim's chest).
  - Avoid unnecessary interruption of chest compressions.
- Optimal ventilation and airway management:
  - Do not interrupt chest compression to secure the airway, apply ECG electrodes or defibrillator pads/paddles
  - Do not hyperventilate
  - End point for ventilation is visible chest rise; deliver normal tidal volume breaths.

DISCUSSION

The BCLS emphasises the need to follow core links in a structured algorithmic manner for optimal outcome of the victim of cardiopulmonary arrest. BCLS is designed for trained personnel, who have adequate skill and knowledge for providing effective ventilation without compromising chest compression, as opposed to layperson. Improved survival has been reported with early CPR involving chest compression along with ventilation.[5,6]

Time is of the essence for neurological recovery after cardiopulmonary arrest. Good assessment is essential to determine specific management. Identification of cardiac and respiratory arrest in a non-responsive victim needs to be done in a definite and time-bound manner. The guideline suggests that breathing and pulse check need to be assessed simultaneously and completed within 10 s. Gasping is a common event prior to cardiac arrest. Identification of gasping as a

pre-arrest event is essential. Early initiation of CPR, in the gasping phase, is associated with better outcome.[7] Cardiac arrest may present as brief episodes of seizures. In emergency situations, assessment of breathing and pulse may be inconclusive. In such cases, cardiac arrest must be assumed and BCLS algorithm should be followed. Not more than 10 s must be spent to identify pulse or breathing, as the chance of return of spontaneous circulation reduces with time.

Chest compression should be given a priority over airway and breathing management.[8,9] The identification of lower chest and the xiphisternum can be difficult, especially outside the hospital. The management of arrested victims outside the hospital by undressing, especially female victims, is a contentious cultural issue in India. Identifying the centre of the chest with inter-mammary line may be difficult and as a result chest compression may be done low on the chest and close to the epigastrium.[10] There is no conclusive evidence with regard to appropriate fixed placement of hands for cardiac compression. This guideline suggests identification of centre of the chest by identifying the xiphoid process and keeping heel of the hand 2 fingers above it for chest compression.

The speed and depth of the chest compression have to be maintained.[11-14] We recommend a speed of 120 compressions per minute and depth of 5–6 cm to maintain better coronary perfusion and cardiac output.[15,16] Injuries were not increased with compression up to a depth of 5–6 cm.[5,15-18] Better survival has been reported with compression rates of 100–120/min.[19,20] To maintain uniformity, we fixed the compression rate at 120/min. This ensures a minimal rate of at least 100 compressions per minute, considering inadvertent development of rescuer fatigue. Minimal interruption of chest compressions and complete chest recoil during chest compressions have been emphatically emphasised in literature.[11,21,22] Two tidal volume breaths, after 30 effective chest compressions, are required for adequate ventilation. The compression-to-ventilation ratio of 30:2 has been reported as optimal for improved outcome.[23,24] During ventilation, the airway management needs to be ensured to provide breaths. The two breaths need not be repeated, even if the breaths delivered are ineffective. In subsequent ventilation steps, attempt should be made to observe for effective chest rise by appropriate airway management. Patency of the airway may be achieved by head tilt and chin lift manoeuvre or jaw thrust, in case cervical spine injury is suspected.

The need of early defibrillation is emphasised. Once the AED or defibrillator is attached, it would assess the rhythm either automatically or manually. However, availability of these devices is restricted in most parts of India. Till the defibrillator is made available at the site, the patient response to CPR needs to be checked by pulse check after every 5 sets of CPR. Once the defibrillator is available, the pulse check will be replaced with rhythm analysis after every 5 sets of CPR. International guidelines too emphasize the need of pulse check after every 2 min in cases of respiratory arrest.[5,6] One international guideline emphasizes the need of rescuer rest for 10 s after 100 chest compressions, as exhaustion may hamper the quality of chest compressions.[7] This guideline also emphasises the need of pulse check after every 2 min by trained personnel.[7] These guidelines emphasise for pulse check or rhythm analysis (if AED/defibrillator is available). We have extrapolated these evidences to recommend pulse check (for no more than 10 s) after every 5 sets of CPR. Considering these supportive evidences and restrictions in our infrastructure, checking pulse, in absence of AED, is valid and acceptable.

The incidence of coronary disease is on the rise. Most cardiac arrests outside the hospital are sudden and of cardiac origin.[25-28] The initial rhythm is usually malignant ventricular arrhythmia, including ventricular fibrillation and pulseless ventricular tachycardia.[29-31] This mandates inclusion of early defibrillation along with high-quality BCLS outside the hospital.[32] In India, the availability of defibrillator and AED is limited, but we have depicted AED or defibrillator use (when summoned by the rescuer for medical help) at the earliest, in the algorithm. Traditional monophasic defibrillators have been largely replaced by biphasic defibrillators. To avoid confusion, the BCLS guideline algorithm only depicts energy settings for biphasic waveform-based defibrillators. In case of monophasic defibrillators, the initial energy to be delivered is 300 J which should be escalated to 360 J in subsequent defibrillations. Various energy levels for defibrillation have been evaluated and energy levels from 120 to 200 J have been found to be effective.[33] Higher biphasic energy levels, like 360 J, are harmful nor their use is associated with better success.[34-36] Equipment-specific recommendation needs to be followed for an optimal energy level for defibrillation. If the initial energy delivered is unable to convert the arrhythmias into sinus rhythm, subsequent shock energy may be escalated.

The paddles or pads for defibrillation or AED need to be placed at sternal-apical position. The sternal paddle is placed on the right side of the sternum just below the clavicle and the apical paddle is placed on left mid-axillary line, in the fifth intercostal space (just at the apex of the heart). In certain specific situations, the placement may be altered such as in the presence of pacemaker and drug delivery patches. In such situations, the paddle is placed away from these devices i.e., around 4 fingers.[21]

Defibrillation outside the hospital may be achieved with either AED or manual defibrillators. The operator needs to analyse the rhythm in manual defibrillator, whereas AED itself decides the need for defibrillation. It has been observed that use of AED by ambulance teams shortens the time for delivery of the first shock.[37,38] Early defibrillation has been emphasised as every minute delay in defibrillation decreases the chances of survival by 7%–10% in cardiac arrest victims with ventricular fibrillation.[39] Defibrillation done within 3 min of cardiac arrest increases the survival rate by up to 74%.[40] Drug management, especially use of adrenaline, has been found to be useful in improving the outcome of the victim with cardiac arrest by increasing the success of defibrillation.[41]

Availability of infrastructure and trained personnel, with fully equipped ambulances, is a critical issue in our country. To improve outcome after out-of-hospital cardiac arrest in our country, there is a need to improve the basic equipment and infrastructure facilities, apart from imparting training to paramedics and medics in BCLS. In out-of-hospital cardiac arrest, additional provision of comprehensive cardiopulmonary life support (CCLS) does not improve survival when resuscitation services have prior assigned to early defibrillation.[42]

Good-quality CPR, with early defibrillation, remains an essential component and no drug has been shown to improve the outcome with regard to neurological recovery. It is pertinent that the proposed BCLS algorithm remains the minimum standard to be followed for victims with cardiac arrest outside the hospital. In exceptional circumstances, when advanced facilities and resources are available outside the hospital, CCLS approach may be followed.

SUMMARY

The management of victims of cardiopulmonary arrest outside the hospital requires early recognition along with early high-quality resuscitation, including defibrillation and early transfer to the nearest medical facility for definitive management. Following the core links in adult resuscitation would improve the overall outcome. Early intervention, high-quality chest compression and early defibrillation are emphasised for an optimal outcome in victims of cardiopulmonary arrest outside the hospital. Considering the limitations of the available medical emergency facilities, a major part of our country, the development of this indigenous BCLS algorithm should strengthen the training of medical and paramedical personnel involved in resuscitation outside the hospital.

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Conflicts of interest

There are no conflicts of interest.

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