Chapter-3

Review of Literature
REVIEW OF LITERATURE

Resuscitation of patients in cardiac arrest - CPR is found to be the most frequently done treatment after rediscovery of closed chest compression and its significant effect in 1960. CPR is provided for victims of cardiac arrest without a palpable pulse or with a feeble pulse. CPR is to be given to the victims who are found to be not adequately breathing and not conscious or agonal respiration. CPR is a very important procedure that is done to save one’s life. This effort preserves the function of the brain till advances treatment is given to bring back spontaneous circulation and respiration. Cardiac arrest is categorised in the International Classification of Diseases (ICD)-9-CM classification and the Diagnosis Code is 427.5.

Cardiopulmonary resuscitation involves Basic Life support (BLS) and Advanced life Support (ACLS). During CPR, the rescuer compresses the chest 5 cm deep with a compression rate of 100/min. This is to generate a circulation artificially by means of compression of chest. Breathing is done through mouth to mouth or mouth to barrier device. The recent recommendation by AHA emphasizes on good quality compression over breathing. If the rescuer is untrained, then he is recommended to do a simple compression only CPR.

Heart does not restart just with CPR. CPR is given to partially restore circulation and oxygenation to the nervous system and heart. Main aim is prolonging the death of tissues and to gain successful resuscitation without permanent brain damage. If the patients are in a rhythm which is shockable, electrical therapy is
needed. There are only two shockable rhythms; they are ventricular fibrillation and ventricular tachycardia. Till we get a (ROSC) or the victim is declared dead by the physician, CPR is to be continued.

Advanced cardiovascular life support (ACLS) affect all the links of chain of survival. It includes measures to stop having the problem, provide therapy, and that improves outcomes of cardiac arrest. Now let us see what the measures that prevent cardiac arrest are. They are airway management, ventilatory support and treatment of cardiac arrhythmias. ACLS interventions should always be progressed up on very strong BLS to the patient. All the links in chain of survival are vital such as timely recognition, timely access, timely CPR and timely defibrillation. Post cardiac life support is very vital for sustaining ROSC, survival to hospital discharge and good neurological outcome. Successful resuscitation from cardiopulmonary arrest performed in the emergency department can be expected in 21 to 33% of cases using advanced cardiac life support (ACLS) techniques.

Cardiac arrests may happen inside the hospital or out of hospital. Out of Hospital cardiac arrests are usually managed through Basic Life support by the bystanders and Advanced Cardiac Life Support by the medical personnel, in most of the cases an Emergency Medical Technician (EMT) or a Respiratory Therapist.

I. IN-HOSPITAL ADULT CARDIAC ARRESTS (IHCA)

In-hospital adult cardiac arrest is defined as cardiac arrest for a person who has palpable pulsation during the admission to the hospital bed. In-hospital cardiac
arrest is identified and the patient is supported by medical, paramedical and nursing personnel but a Code Blue team, well-trained in CPR techniques is called in to help. Code team is necessary for each hospital and may consist of Physicians, respiratory therapists, nurse, and a security person. Team leader in the code blue will guide the CPR. It is mandatory for the code blue team members to have an ACLS card which is issued by AHS and be available to respond to emergency calls while on duty.

II. INCIDENCE OF IN-HOSPITAL CARDIAC ARREST

Reports of incidence of IHCA are not very common in the literature. Sandroni C et al in their review of studies on IHCA summarized incidence of IHCA, Survival and also various causes accountable for prediction as well as probable treatments that increased chance of survival. In this study Sandroni and colleagues found an incidence of in-hospital cardiac arrest (IHCA) as 1 -5 cardiac arrests in a total of 1000 patients admitted in the hospital.\(^1\) The incidence of cardiac arrests that was attended by cardiac arrest team - C A T stayed as 1.25/ 1000 admissions. If the patient’s hospital days are considered, then it is 13 per 100000 days. This study also reported that 50% of patients had cardiac arrests (wards), 33 % - ICU, 13% - ER and 4 % - radiology dept. There were 83% witnessed cardiac arrest events.\(^7\) Sandroni C et al in their study found that in-hospital cardiac arrest incidences ranges from 1-5 per 1000 patients admitted in hospital, in other words it can be 0.175 cardiac arrest events per hospital bed / year. The patients who survive till the patient is discharged is in a range of 0% to 42% and mostly from 15- 20%.\(^1\).
Franczuk P et al conducted a study where the study group had patients admitted in internal medicine department including ICU. The reasons for cardiac arrests and the rhythm were recorded. The following details were also recorded. The number of deaths in the first 24 hours, during the hospital stay, and after 1 year, 5 years and 10 years. They found that in that period there were 152 cardiac arrests. There were 83 cases of successful resuscitation. There were 66 % patients who had cardiac cause and 50.6 % the cause was VF. Mortality rate was 90%. Of which 38.5% was during the first 24 hours and only 10 % of patients left alive from hospital. Survival after 5 years was just 2 of the patients (2.4%). Survival after 10 was no patients. These results show that when cardiac arrest occurred inside the hospital, the patients had high in hospital mortality and they had late prognosis. If there are patients who have non cardiac causes of cardiac arrest, there was better survival after first 24 hours. The general survival to hospital discharge has not improved.

In a systematic review by Chan PS et al and Nadkarni VM et al, the incidence of adult cardiac arrest was 6.65/1000. They also found that implementation of a Rapid Response Teams in adult patients caused a reduction of 33.8 % in rate of cardiac arrests outside ICUs. Even then it did not have any association with mortality rates. Children had a reduction of 37.7 % in cardiac arrests outside ICUs there was a reduction of 21.4 % reduction in mortality rate. They concluded that there is no much evidence to show that RRT can reduce mortality rates.

Among the factors that are prognostic, the significance of age being a predictive factor is controversial: When the co morbidities are considered the
diseases like sepsis, carcinoma, kidney failure and sedentary routine life are associated with considerably poor outcome in terms of survival\textsuperscript{11}. The scores to predict morbidity is not been validated yet. The rhythm in cardiac arrest may be another contributing factor. Sandroni \textit{et al} in their review found that shockable rhythms such as ventricular fibrillation and ventricular tachycardia as the initial ECG rhythms and shorter time from collapse onset to CPR showed better survival \textsuperscript{6}. Sandroni \textit{et al} in another study found that, the rhythms such as ventriculat fibrillation or Ventricular Tachycardia is present in 25 to 35 \% of Inhospital cardiac arrests.\textsuperscript{12}. Abella BS \textit{et al} in their study concluded that if patients are given chest compressions at a rate of 80 / min, short term survival is higher.\textsuperscript{13} Sandroni \textit{et al} concluded that the measures that can increase survival are early recognition, early CPR, and defibrillation. Sandroni and colleagues show that mild hypothermia is effective as treatment for out of hospital cardiac arrests.\textsuperscript{1}

\textbf{III. SEQUENCE OF ADULT BLS}

The steps that are involved in BLS consist of checks and acts. It is exemplified in detail in the algorithm for BLS - Figure 1. It is presented in such a way that the steps of BLS are known in logical way, not difficult for the provider to memorize the steps when the situation comes. Initially these algorithms were presented as different steps to help the rescuer to prioritize the actions. The rescuers need to perform many actions simultaneously. One rescuer activates the EMS, when another begins chest compression; third rescuer gives ventilation and last one or fourth rescuer will set up the AED.
Early call for EMS

For a single rescuer if the victim is found unresponsive with no movements or response to stimulation, or if the victim collapses in the witness of others the rescuer should first make sure that the scene is safe and then check for responsiveness by tapping the victim gently and shouting at victim. The rescuer should activate the emergency medical services which are nearby to the scene. A victim with no breathing or agonal respiration is to be considered as in cardiac arrest. (Class I, LOE C).5

Lay rescuers should do the CPR steps taking guidance from EMS. The EMS system will guide them while they call to activate the EMS. If the rescuer is a health care provider then he/she can look for presence of breathing. This observation could be done while activating EMS. CPR should be started as soon as possible after activating EMS for unresponsive victims.

While the rescuer calls to EMS for help, he/she may specify the place at which the cardiac arrest occurred, cardiac event, how many victims and state of victims.

Checking of pulse

Literature shows evidence that there is difficulty for both lay rescuer as well as health care practitioner to distinguish pulse. Even health care practitioners do pulse check taking longer time duration. If untrained rescuer attends a victim who is not breathing normally or if the adult victim collapses suddenly, then they should not check pulse but start CPR. The health care provider should wait for 10 seconds and
feel for pulse and in victims where pulse is not felt, the compressions should be started - Class IIa, LOE – C.\textsuperscript{14,15}

**Resuscitation: Early cardiac compression**

During cardiac compression, pressure is given rhythmically on the inferior part of the sternum. Chest compressions increase the pressure in the thoracic cavity and compress cardiac chambers, thereby increase blood flow. This provides enough blood flow to the myocardium and brain. This also provides oxygen delivery. Patients in cardiac arrest need good chest compressions and this provides good blood supply during CPR. Therefore it is vital that cardiac arrest victims receive cardiac compression.

Essential skills are required for the proper performance of chest compressions. The recommendation is to push the chest hard and fast to obtain effective compression. The recommended rate of compression for laypersons and health care providers for adults is minimum of 100 cardiac compressions/ min at the deepness of 2 inches or 5 cm. (Class IIa, LOE B).

When chest is compressed without any disruptions, sum of cardiac compressions is the function of rate of chest compression and the proportion of time. Compression rate is nothing but speediness of compression and will not be the real figure of compressions. When the actual number of compressions per minute is determined, we take in to account the speediness of cardiac compressions, figure and period of intervals for other interventions like airway, rescue breaths and use of AED.\textsuperscript{21,22} More importantly the ROSC and neural status is depended upon the number of chest compressions delivered.
Abella et al in a research about IHCA indicated that when chest compressions were given at a rate >80 / min, there was a better ROSC. The study also demonstrated that when compression rate was as high as 120 /min, the survival was better. This comes to conclusion that an average value of 100 compressions /min is better to be followed by lay rescuers and healthcare providers.13

Word “duty - cycle” represents duration between starting of one compression and the starting next. Duty cycle has role in determining the coronary blood supply. The blood supply through the coronary vessels will be a function of the “duty cycle “and how completely the thorax is in the relaxation phase after the cardiac compression. Wolfe JA stated, even with 20% and 50 % duty cycle range, there can be adequate coronary and cerebral circulation. 16 The recommended duty cycle is 50% and is simple to comply with. Few observational studies showed that the interruptions of chest compression were common and it ranged between 24 % and 57% of the total cardiac arrest time.17,18

Kobayashi M et al and Babbs CF et al suggested that the time taken for cardiac compression and decompression must be similar.18,19 It is recommended to provide time for relaxation of the heart so that the cardiac chambers will fill completely prior to the upcoming cardiac compression. Studies have shown that while the provider is fatigued, half-finished cardiac relaxation was common when the event happened inside the hospital as well as outside the hospital.19, 20 Basic Life support with partial chest relaxation was found to have relation with increased pressure in the thoracic cavity, this can significantly decrease hemodynamic
parameters such as educed coronary perfusion, myocardial blood flow, cerebral perfusion and cardiac index. Real time feedback given by electronic recording devices can reduce the incidence of incomplete chest recoil. Studies on CPR manikins have suggested that during the decompression phase lifting the heel of the palm slightly can improve chest recoil.\(^{21,22}\)

The rescuer should attempt to reduce the breaks in compression so as to increase the number of compressions / min. AHA recommends 30: 2 as compression and ventilation ratio.\(^5\)

**Managing the airway**

*Lay rescuer, Airway opening*

A lay rescuer who is trained in CPR and is assured that they are able to do cardiac - compressions and ventilation may do the airway opening by means of the triple airway maneuver. If provider wants to give just hands only resuscitation, there is no strong evidence to support regarding passive airway eg: hyperextension of the neck to allow passive ventilation.\(^5\)

**Health care provider: Opening the airway**

Rescuers who are in health care may do the airway opening via triple maneuver such as head tilt and chin lift in case there is no evidence of head or neck trauma. Clinical and radiographic evidence and a case series show that lifting the head and lifting the chin maneuver is effective though it is not being studied in victims of cardiac arrest. (Class IIa, LOE B).\(^{23}\)
In victims with cervical spine injury, the airway should be opened using the maneuver jaw thrust. In case the jaw thrust doesn’t open the airway completely use head tilt chin lift as the priorities in resuscitation are preserving the patency of airway as well as provision of adequate ventilation.\(^{24}\)

**Breathing**

AHA guidelines published in 2010 recommends more stress to compression and compression should be done before ventilation. Though there is no evidence as in published literature regarding the compression ventilation ratio, the blood flow is controlled by the cardiac compression. Hence the interruptions in cardiac compressions must always be reduced during resuscitation. When rescuers find a victim with cardiac arrest the compressions should be started immediately without any delay.\(^{25}\) After the cardiac compressions are started the trained rescuer can start ventilation to improve oxygenation and ventilation. Current guidelines recommend that rescue breaths should always be delivered over 1 second.

In the presence of an advanced airway in place such as endotracheal tube, Combitube or laryngeal mask airway (LMA) for two people CPR, give one breath every 6-8 seconds and there is no need to synchronize breaths with compressions. This will ensure 8-10 breaths/ min. This will also minimize interruptions in compressions as there is no pause for ventilation.

A study conducted on anaesthetized adults, with blood pressure within the normal limits, the volume suggested is from 8 -10 milli liter per Kg body weight that preserves the normal gas exchange. As the proportion of cardiac output is around 25
-33% of the actual value normal in victims with cardiac arrest, oxygen uptake and CO\textsubscript{2} delivery also is reduced. Therefore low minute ventilation will be able to keep the normal oxygen and ventilation.\textsuperscript{26}

While CPR is done, a Tidal Volume (VT) of 500 to 600 mL should be enough to cause the chest to rise which can be seen easily.\textsuperscript{27}

Unnecessary delivery of excessive ventilation can be detrimental and result in gastrointestinal entry of air, other difficulties like regurgitating the content and aspirating the vomitus. It is also to be noted that excessive ventilation becomes detrimental as this upsurges intra-thoracic tension, decrease the return of venous blood, and reduces Cardiac output (COP) and also the chance of survival. In conclusion excessive ventilation should be avoided in the form of more breaths or large volumes. (Class III, LOE B).\textsuperscript{28}

While resuscitating a patient, administration of ventilation will help to maintain normal oxygenation. Secondly it will remove carbon dioxide. Level of fraction of inspired oxygen, VT & RR to attain these points of ventilation stay unclear yet. For a victim with cardiac arrest who is in Ventricular Fibrillation (VF), chest compressions are more important than rescue breaths in the first few minutes as there will be reserve of oxygen in the non-circulating volume and that oxygen content would be sufficient in the initial some duration in resuscitation. Additionally the efforts for opening the airway and giving the ventilation may delay the start of chest compressions.\textsuperscript{29}
Different methods

Artificial breaths are provided to maintain adequate levels of oxygen and CO\textsubscript{2}\textsuperscript{30}. Mouth breathing is usually done by opening the airway, pinching victim's nose, and creating a seal mouth to mouth. Current regulation tells us to give one breath over one second. Rescuer need to inhale normally, and provide the ventilation in one sec. An adult victim with spontaneous circulation with less respiratory effort should be given artificial respiration every five to six sec. That becomes almost equal to 10-12 breaths / minute. Even if definite tube is present, each breath must be given over 1 second. It is advisable that each breath causes visible chest rise.

Bag and mask ventilation

During CPR rescuers can provide breaths using the manual resuscitator connected to oxygen source or without oxygen. Positive pressure ventilation could be given through bag and mask. An adult bag which provides 1-2 L should be used and deliver 600 ml VT for adult victims. (Class IIa, LOE C).

Subglottic airway

Health care practitioners can use the subglottic airways to provide ventilation.\textsuperscript{31}

Definite airway

With a definite airway in the trachea, the CPR can be provided without maintaining the ratio. Compressions are to be given continuously at 100/ min and ventilation should be provided with a speed of each breath in 6 to 8 sec. This speed of breath delivery would result in a breath rate of 8 to 10 breaths/ min.
Cricoid Pressure

The technique of cricoid pressure is to apply pressure on the cricoid cartilage. This technique can be used in situations such as viewing vocal cords during tracheal intubation. But its repetitive usage is not currently advised in adults.\(^{32}\)

Ratio of compression and ventilation

In adult victims in cardiac arrest, the proportion at which the chest is compressed is 30:2 which is recommended, although there is need for additional authentication.\(^{33}\)

CPR- Hands only

Among the victims of adult cardiac arrest in the out of hospital set up only 20 to 30% receive bystander CPR. Some prefer to do only hand only CPR. This has shown to improve survival following adult cardiac arrest in the out of hospital set up than no bystander CPR. The bystanders do not seem to have any reluctance to do CPR when they were interviewed. They were expressing concerns on the panic among bystanders as the major obstacle for lay person’s performance of bystander CPR.\(^{35}\)

Defibrillation with Automated External Defibrillator (AED)

In the sequence of BLS after the rescuer activates EMS the lone rescuer get the AED if it is easily available.

Among the initial rhythms, VF is the commonest and treatable initial ECG waveform among adult victims who are in the event of IHCA. For this reason it is mandatory to train the BLS providers with defibrillation skills.\(^{36}\) Witnessed cardiac
arrest in adults are common to have VF initially and the proportion of survival are higher in situations where the relatives give the compressions and ventilations occurs immediately and use of AED happened in a span of three to five min after the cardiac event\textsuperscript{37}.

**IV. SPECIAL SITUATIONS**

**Acute Coronary syndrome (ACS)**

Among the patients with acute myocardial infarction around 70\% of death occurs outside of the hospital, maximum death occurs within 4 hours after the onset of symptoms\textsuperscript{34}.

For patients with ACS, it is advisable to provide aspirin 160-325 mg to the patient. (Class IIa, LOE C)\textsuperscript{38}.

**Stroke**

The estimates state that around eight lakh people get stroke / year among USA population. Stroke could be estimated to be a leading cause of death and long term disability. First hours of the onset of stroke is very crucial and Fibrinolytic therapy administered in the initial hours limits neurological injury and improves outcome. Early detection of signs of stroke, prompt activation of EMS, speedy hospital admission, assessment treatment can improve the outcome\textsuperscript{39}.

Administer oxygen to stroke patients who are hypoxemic and to patients with unknown oxygen saturation (Class 1, LOE C)\textsuperscript{40}.
Victim with Hypothermia

For victims with hypothermia, CPR should be provided as other victims. Wet clothes should be removed so that there is no further heat loss.\(^5\)

The BLS quality

Evaluation of CPR which is unprompted when provided to both IHCA and OHCA show less outcome\(^4\). Kramer-Johansen J \textit{et al}, in their study have demonstrated many indicators of CPR performance\(^4\).

V. ADVANCED CARDIAC LIFE SUPPORT (ACLS)

ACLS improves factors in the process of resuscitation and survival which consists of measures that can avert collapse of the victim and treat it accordingly.

Achieving Return of Spontaneous Circulation (ROSC), advanced airway insertion and management, and monitoring are integral part of ACLS. Post cardiac arrest care is very important following ROSC to sustain survival and good neurological outcome.

The following are the changes in 2005 guidelines\(^4\):

- Capnography with continuous quantitative waveform is recommended for confirmation and monitoring of ET tube placement.
- Algorithms are simplified and redesigned in an effort to emphasize the importance of high quality CPR (which includes chest compressions of adequate rate and depth complete chest recoil after each compression less interruptions in chest compressions and avoiding excessive ventilation)
● Use of atropine is no longer recommended for routine use in the management of pulseless electrical activity/Asystole.

● In the new recommendations there is increased emphasis on monitoring of the patient to optimize CPR quality and to detect ROSC.

● In symptomatic and unstable Bradycardia chronotropic drug infusions are recommended as an alternative to pacing.

● In the initial management of stable regular monomorphic wide complex tachycardia adenosine is recommended as a safe and potentially effective therapy.

Ventricular Fibrillation characterizes an electrical action which is disorganized but pulseless Ventricular Tachycardia is a structured activity of electrical impulses in the heart. VF/ VT do not generate significant blood flow. A-systole is a flat line in ECG and it denotes the lack of ventricular activity with or without the presence of atrial electrical activity.
Algorithms of VF/VT, Asystole/PEA, Tachycardias

Figure 1: Adult cardiac arrest algorithm
Figure 2: Tachycardia Algorithm

**Adult Tachycardia**

(With Pulse)

1. Assess appropriateness for clinical condition. Heart rate typically ≥150/min if tachyarrhythmia.

2. Identify and treat underlying cause
   - Maintain patent airway; assist breathing as necessary
   - Oxygen (if hypoxemia)
   - Cardiac monitor to identify rhythm; monitor blood pressure and oximetry

3. Persistent tachyarrhythmia causing:
   - Hypotension?
   - Acutely altered mental status?
   - Signs of shock?
   - Ischemic chest discomfort?
   - Acute heart failure?

4. **Yes**
   - Synchronized cardioversion
     - Consider sedation
     - If regular narrow complex, consider adenosine

5. **No**
   - Wide QRS? ≥0.12 second

6. **Yes**
   - IV access and 12-lead ECG if available
   - Consider adenosine only if regular and monomorphic
   - Consider antiarrhythmic infusion
   - Consider expert consultation

7. **No**
   - IV access and 12-lead ECG if available
   - Vagal maneuvers
   - Adenosine (if regular)
   - β-Blocker or calcium channel blocker
   - Consider expert consultation

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Figure 3: Pulseless arrest algorithm
Apart from high-quality CPR, it is proven that the rhythm specific treatment of VF/VT will increase survival to hospital discharge. When rhythm check reveals VF/pulseless VT, the intervention for the same is an integral part of CPR cycle. When we
consider other ACLS therapies during cardiac arrest, it is seen to increase the frequency of ROSC still may not be able to improve the survival to discharge.

It is very important to understand, diagnose and treat underlying causes of various arrhythmias that leads to cardiac event. Various etiologies of a cardiac arrest may be abbreviated in to 5 Hs and 5 Ts. During the CPR, the ACLS provider should find out the Hs and Ts and treat it to have a successful resuscitative outcome. *(Table 1).*

*Table 1: Treatable causes of cardiac arrest.*

<table>
<thead>
<tr>
<th>Treatable Causes of Cardiac Arrest: The H’s and T’s</th>
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<tbody>
<tr>
<td>1. Hypoxia</td>
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<tr>
<td>2. Hypovolemia</td>
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<tr>
<td>3. Hydrogen ion (acidosis)</td>
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<tr>
<td>4. Hypo-/hyperkalemia</td>
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<tr>
<td>5. Hypothermia</td>
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*VF/ VT (Pulseless)*

Immediately after the AED is attached, if the AED reveals that it is shockable (in case of VF/VT), provide shock to the victim. Resume CPR immediately after defibrillation for all cardiac arrests (Class I, LOE B).44

**Defibrillator Success prediction**

Eftestol T et al analyzed the ECG patterns in various research studies and suggests that it is likely to foresee the outcome of electrical therapy of ECG patterns
with different rhythm consistency. There are no human studies to show that the therapy changed according to the determination of good outcome of electrical therapy through electrical therapy may increase the outcome of electrical therapy, ROSC rate or survival from the cardiac arrest event. It also not certain if the VF analysis will guide the treatment of electrical therapy in IHCA and OHCA. (Class IIb, LOE C).45

**Pharmacological management in VF and Pulseless VT**

The algorithm suggests indication of a vasopressor when the shockable rhythms persist after DC shock and the compression and ventilation cycle. Vasopressors are given for improving the perfusion to the heart while CPR is provided. (Class IIb, LOE A). The Vasopressor given after the shock in case of defibrillation not being successful will help in optimizing the perfusion prior to the myocardial blood flow before the succeeding electrical therapy. But if the defibrillation resulted in a perfusing rhythm, then the treatment with vasopressor in resuscitation would have side effects on the CVS. That throws light to need of monitoring during CPR. Callaham M et al suggest the use of monitoring such as quantitative waveform capnography, intra-arterial pressure monitoring and continuous central venous oxygen saturation to determine the ROSC during chest compressions.46

In the antiarrhythmic agents Amiodarone is considered as the choice of drug for cardiac arrest. This seems to be due to its capability towards increasing ROSC rate also survival in victims who have had non - reactive VF/ VT. Amiodarone is indicated for VF when it becomes un-responsive to electrical and vasopressor
therapy. (Class IIb, LOE A). In case amiodarone is not available then, lignocaine could be given. Medical research has n’t proven that use of lidocaine improves rate of ROSC and admission to hospital bed when compared to Amiodarone. (Class IIb, LOE B). Magnesium sulfate is indicated for patients with torsades de Pointes.

*Torsades de Pointes*

**Physiologic Parameters**

Cardiac arrest might be the most serious disease situation in humans and can be observed by rhythm assessment by means of particular ECG leads and checking pulsation to be the single physiologic factor to monitor treatment. Studies on animals and humans show that monitoring physiological parameters gives imperative evidence about the victim’s disease status and reaction to the treatment. Paradis NA found that end tidal carbon dioxide (PETCO₂), cerebral perfusion pressure (CPP), and ScvO₂ had good relation with cardiac output and myocardial blood flow during CPR and if the parameters are lower than threshold then the ROSC is never attained.⁴⁷

**Checking of pulse**

Rescuers and healthcare professionals check pulse during cardiac massage in order to evaluate the efficiency of compressions. Unfortunately not any research has presented the legitimacy or scientific use of examination of pulse on the event of CPR for cardiac arrest. Connick M *et al* have said that the backward flow of blood into the circulatory system possibly will create the pulsation of the femoral vein as no valves exist in the IVC.⁴⁸
**ETCO₂**

ETCO₂ is the amount of CO₂ in the expired air at the completion of exhalation. ETCO₂ is can be also represented as partial pressure in mm Hg (PETCO₂).

PETCO2 value of 10 mm Hg in intubated patients is an indicator of cardiac output not adequate to achieve ROSC. The measure which improves the rate of ROSC is not proven yet. There is no doubt that monitoring of PETCO₂ trends during CPR has the ability to guide the compression rate and depth and it also aids in detecting the fatigue in the provider who is performing compressions. A sudden sustained increase in PETCO₂ during CPR is an indicator of ROSC.⁴⁹

**CPP**

Coronary Perfusion pressure recorded while CPR is going on has good correlation with myocardial blood flow and ROSC. Arterial relaxation pressure is a good indicator of CPR quality. If the value of arterial relaxation pressure is <20 mm Hg then consider to use vasopressor and compressions (Class IIb, LOE C).

**ScvO₂**

ScvO₂ indicates oxygen delivery changes very well if parameters like VO₂, SaO₂ and Hb are constant. The normal value of ScvO₂ ranges from 60% to 80% and is measured using oximetric tipped central venous catheters placed in the superior vena cava. The value ranges from 25% to 35% during CPR, which indicates the inadequacy of blood flow during CPR. ScvO₂ value <30% is suboptimal⁴³.
Pharmacological therapy for Arrest Rhythms

The main aim of medications in the event of cardiac event is to enable the re-establishment and the preservation of a normal rhythm. There is enough proof for the use of vasopressor agents in cardiac arrest and associated increased rate of ROSC.

**Epinephrine**

Epinephrine has α adrenergic receptor stimulating properties and it this property helps to produce beneficial effects. Epinephrine should be administered in the interval of 3-5 min with a dosage of 1 milligram IV/IO during cardiac arrest event.

**Vasopressin**

Vasopressin is a vasoconstrictor that is recommended for the treatment of cardiac arrest as first or second dose of epinephrine and the dosage is 40 units IV/IO. (Class IIb, LOE A).

**Antiarrhythmics**

Evidences are not there to prove the routine usage of any antiarrythmic medications during human cardiac arrest and the evidence does not suggest that there is any increase in survival to hospital discharge.

**Amiodarone:**

It can be considered for treatment of VF or pulseless VT unresponsive to shock delivery, CPR and a vasopressor. In blinded, randomised controlled clinical trials in adults with refractory VF/pulseless VT in the out-of-hospital setting, amiodarone may be considered for VF or pulseless VT unresponsive to CPR,
defibrillation, and a vasopressor therapy. An initial dose of 300 mg IV/IO can be followed by 1 dose of 150 mg IV/IO.

VI. INTERVENTIONS THAT ARE NOT RECOMMENDED FOR ROUTINE USE TO TREAT CARDIAC ARREST

1. **Atropine**

Atropine is an anticholinergic agent which reverses cholinergic mediated reduction in heart rate and atrio-ventricular nodal conduction. Guidelines do not suggest the routine use of Atropine during PEA or asystole as it does not give a therapeutic effect (Class IIb, LOE B). So atropine is removed from the cardiac arrest algorithm.

**Sodium bicarbonate**

In the treatment of pre-existing metabolic acidosis, hyperkalemia or tricyclic antidepressant overdose bicarbonate can be beneficial. Acidosis occurs during cardiac arrest due to no blood flow from cardiac arrest or low blood flow during CPR. Even then the routine use of sodium bicarbonate is not recommended for patients in cardiac arrest (Class III, LOE B). The dosage of bicarbonate is 1 mEq/kg in the special situations and whenever it is possible bicarbonate therapy should be guided by the concentration of bicarbonate or calculation of calculated base deficit which is given by blood gas analysis or lab measurement.

**Calcium**

Calcium administration routinely for the treatment of cardiac arrest in hospital or out of hospital is not recommended. (Class III, LOE B).
Fibrinolytic therapy is recommended only as an empirical therapy for pulmonary embolism. It is not recommended for routine use in cardiac arrest. (Class IIa, LOE B).

**Cardiac Pacing** is not recommended for routine use in cardiac arrest (Class III, LOE B).

**Precordial thump:** When defibrillator is not available, precordial thump may be considered for the termination of witnessed and monitored unstable ventricular tachyarrhythmia. It should never delay the CPR and shock delivery.

**VII. THERAPEUTIC HYPOTHERMIA**

Since 1950s moderate hypothermia was effectively utilized before cardiac arrest to guard the CNS from the global ischaemia which follows after CABG. Induction of low temperature as a treatment modality is used since then after ROSC and it enhances purposeful regaining and abridged neurological insufficiencies in a number of studies.

On the basis of the published literature to date, the Advanced Life Support (ALS) Task Force of the International Liaison Committee on Resuscitation (ILCOR) made recommendations in October 2002. It is given below:

- Unconscious adult patients with spontaneous circulation after out-of-hospital cardiac arrest should be cooled to 32°C to 34°C for 12 to 24 hours when the initial rhythm was ventricular fibrillation (VF).
- Such cooling may also be beneficial for other rhythms or in-hospital cardiac arrest.\(^{50}\)
Survival

Survival of cardiac arrest is expressed in relation to time and it is categorized as

1. Immediate: just return of spontaneous circulation (ROSC)
2. Short-term: discharge alive from the hospital
3. Long-term: alive at 6 months to 12 months.

The commonly quoted outcome is discharge from hospital at a survived status. Survival rates of in-hospital cardiac arrest ranges from 0 to 42%.\(^{51}\)

Moretti MA et al in their study found that ROSC was present in 96 patients which come to 84% and 64 patients survived more than 24 hours. There were 37 patients which accounts for 32% survived to hospital discharge. There were 24 patients who survived at 6 months to 1 year and it accounted to 23%. After 12 months of the cardiac event, twenty one of them survived and they had better recovery or moderate disability which comes in CPC 1-2. 5 had severe disability or persistent vegetative state with CPC 3-4.

R.C. Peatfield, et al in their ten years of treating patients with arrest in a general hospital set-up, conducted a study on 1063 patients. They excluded CCU and ICU. Among 1063 patients 718 (67%) patients, ROSC did not happen. 252 patients had death in the hospital later and 93 patients were discharged alive. The mortality was 7% for the first five years but after that no patients died. The chance of ROSC seems to be present in primary heart disorders: 11.8%, then increased dosage of medication was 22.2%, and patients undergoing anesthesia was 20.0%.\(^ {52}\)
Thomas D. Rea, et al evaluated the community centered study of emergency medical services treated cardiac events of patients since the year 1983 to 2000 in Washington. They assessed the relationship of the rate of persistence of life till the patient’s discharge from hospital and different categories of resuscitation: 1) no bystander CPR before the EMS arrives 2) bystander CPR and 3) bystander CPR without dispatch requirement. The survival was 15.3%. They concluded that the CPR done at the category EMS assisted bystander CPR increases ROSC among patients who are in cardiac arrest.\textsuperscript{53}

**VIII. SURVIVAL TO HOSPITAL DISCHARGE**

The rate of patients discharging alive who had ROSC is different in different studies. Study by Carr BG et al found that the in hospital survival rates have increased by 3 % when they considered rates from 2000 to 2004. Total patients included were 109739. The in-hospital mortality was 70.6%. Mortality was lower in hospitals which were teaching in nature, urban set up and hospitals which are large. This study also establish the implications for the propagation of finest treatments in the post resuscitation care.\textsuperscript{54}

In a study conducted by Nadkarni VM and colleagues, the rate of patients getting discharged alive after the in hospital cardiac arrest was greater in pediatric group rather than in the adult patients when all the rhythms are considered. The difference was 9 % between adults and children. The study included 36902 adults and 880 children. This research study was taken from a multi-center trial or registry of cardiac arrest events in different Canadian and American hospitals for duration of 4
years. The neurological outcome was good and in children was 65% and in adults it was 73%. The occurrence of VF or VT being the initial rhythm was in 14% of pediatrics and also 23% times in adult victims. The occurrence of PEA: 24% (children), 32% (adults). In this study only first documented rhythm was related with survival to moving out from hospital. The first documented rhythm was predominantly PEA or asystole in both adults and children.\textsuperscript{10}

Study by Bloom HL \textit{et al} compared the survival after IHCA in terms of short term and long term. They found 6.6% patients to survive at the time of moving out from hospital. Of which 5.2% patients were living at 12 months and 3% were living at three years. The study also found that VF/VT, and the drugs used were the factors that were associated with increased survival. The investigators evaluated the three year survival rate and it was 41%. They found that the chance of long life for patients who sustained cardiac arrest have reduced long term prognoses. This study concluded that alive at the time of going out from hospital might be not a adequate end point or outcome for further resuscitation trials.\textsuperscript{55}

Geocadin and colleagues have evaluated the neurological prognosis after cardiac arrest. This study reported worthy outcomes of the neurological status from the in hospital cardiac event which was assessed through CPC - cerebral performance category. It was around - 64% in pediatrics and 75% among adult population those were alive at the time of hospital discharge. Cardiac arrest creates a global ischemic insult to the brain cells. Extend of cerebral damage is depended on the duration of interruption of cerebral blood flow. It is vital to minimize the period of
collapse and CPR interval which are considered to be the interval where there is not at all flow also the time where there is less flow. ROSC provides a phase of cerebral hyperaemia followed by a stage of vasoconstriction and global and multifocal hypoperfusion. Within 20 minutes of the onset of cardiac arrest, the victim loses consciousness and within matter of 5 minutes the victim loses glucose and adenosinetriphosphate stores. This ensues a cascade of complex chemical derangements which leads to neuronal death and results in the post cardiac arrest coma.56

Glasgow-Pittsburgh Cerebral Performance Categories (CPC) are given below57,58

1. **Good Cerebral Performance**

   The patient is conscious, alert, able to work and lead a normal life. He may have minor psychological or neurological deficits (mild dysphasia, non-incapacitating hemiparesis, or minor cranial nerve abnormalities).

2. **Moderate Cerebral Disability**

   The patient is conscious. Sufficient cerebral function is present for part-time work in sheltered environment or independent activities of daily life (dressing, travelling by public transportation and preparing food). He may have hemiplegia, seizures, ataxia, dysarthria, dysphasia and permanent memory or mental changes.

3. **Severe Cerebral Disability**

   The patient is conscious. He is dependent on others for daily support because of impaired brain function (in an institution or at home with exceptional family effort).
He has at least limited cognition. A wide range of cerebral abnormalities from ambulatory with severe memory disturbance or dementia may exist precluding independent existence to paralytic and able to communicate only with eyes, as in the locked-in syndrome.

4. **Coma, Vegetative State**

The patient is not conscious. He is unaware of surroundings with no cognition. No verbal or psychological interactions with environment.

5. **Death**

The patient is certified brain dead or dead by traditional criteria.

**IX. UTSTEIN STYLE OF RECORDING CARDIAC ARREST**

Recording form of arrest, the Utstein style was introduced at a meeting held at an ancient abbey near Stavanger, Norway. The legislatures from AHA, ERS, the heart and stroke foundation of Canada, and the Australian Resuscitation Council attended this conference another later in the same year. The major concern arose during these conference was that there was no uniformity in the resuscitation initiative between different countries and also even within the country. As there were no uniform definitions and standard methods, it was not possible to make useful comparisons.

Researchers in the field of resuscitation adopted Utstein style and the terminology towards reporting outcomes of pre-hospital CPR. This global programme was successful and headed to the even global style.\(^{59, 60}\)
In-hospital resuscitation

Challenge exists in the research and evaluation of in-hospital resuscitation. The Utstein mission group in 1990 took in to consideration comprising the IHCA treatment as per the new format however it was not done and was postponed due to its complexity. The main problem was the inconsistency in definitions that are used to describe the resuscitation emergencies and its outcome, comorbid illness and the effects of interventions that are done during cardiac event.

A cardiac arrest is defined in the Utstein style as ‘the cessation of cardiac mechanical activity confirmed by the absence of a detectable pulse, unresponsiveness and apnoea (or agonal respirations).

Patients in cardiac arrest who requires resuscitation may have illness which may not influence the resuscitation outcome. There are not many publications on in-hospital resuscitation which has reviewed the level of comorbid diseases.

Table 2 consists of different variables that are recommended by the task force.
Table 2: In-hospital resuscitation data: recommendations for information to report on individual patient*

<table>
<thead>
<tr>
<th>Data element</th>
<th>Definition</th>
<th>Priority</th>
<th>Directions or comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient name</td>
<td>Someone who occupies a hospital bed; no duration of occupancy required.</td>
<td>Essential</td>
<td>Tabulate separately outpatients who have events inside the hospital and patients who have in-hospitals but whose original arrest was outside the hospital. Patient confidentiality must be respected in all data acquisition and reporting.</td>
</tr>
<tr>
<td>Patient identifier</td>
<td>Allows tracking of all hospital and subsequent audit reports</td>
<td>Essential</td>
<td>In US, social security number recommended may be hospital number. Patient confidentiality rules must be applied.</td>
</tr>
<tr>
<td>Date of birth</td>
<td>Self-explanatory</td>
<td>Essential</td>
<td>Record as dd/mm/yr</td>
</tr>
<tr>
<td>Date of admission</td>
<td>Self-explanatory</td>
<td>Essential</td>
<td>Record as dd/mm/yr</td>
</tr>
<tr>
<td>Age</td>
<td>Self-explanatory</td>
<td>Essential</td>
<td>Record as years and months/12 for patients &lt;21 yr</td>
</tr>
<tr>
<td>Gender</td>
<td>Self-explanatory</td>
<td>Essential</td>
<td>Record as male, female, unknown</td>
</tr>
<tr>
<td>Height</td>
<td>Self-explanatory</td>
<td>Essential</td>
<td>Record as metric scale, essential for infants and children</td>
</tr>
<tr>
<td>Weight</td>
<td>Self-explanatory</td>
<td>Essential</td>
<td>Record in kilo-grams, essential for infants and children</td>
</tr>
<tr>
<td><strong>Witnessing/monitoring the event</strong></td>
<td>Resuscitation emergency was seen, heard or monitored</td>
<td>Essential</td>
<td>Record as yes, no or unknown. For yes, indicate it was monitored or un-monitored</td>
</tr>
<tr>
<td>Location of event</td>
<td>Area of hospital where event was recognized</td>
<td>Essential</td>
<td>Record as general care floor, emergency department, operating suite, intensive care unit, coronary care unit, postanaesthetic recovery area, diagnostic or treatment area, outpatient evaluation unit, or other in-hospital unit</td>
</tr>
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<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>ALS interventions in place at time of event</td>
<td>Interventions in place and available at time of event</td>
<td>Essential</td>
<td>Record the following: endotracheal intubation, mechanical ventilation, IV access, intra-arterial catheterization, IV medication, and implantable defibrillator-cardioverter</td>
</tr>
<tr>
<td>Previous cardiopulmonary events</td>
<td>Location and no of previous full cardiac events that required resuscitation attempts; previous events must have occurred &gt;24 h before index event</td>
<td>Desirable</td>
<td>Record the no of previous cardiac events in the following categories; out of hospital, in hospital, prior admissions, same admission 9only if &gt;24 h before index arrest)</td>
</tr>
<tr>
<td>Reason for admission</td>
<td>Full clinical details and diagnosis may not be immediately available to the event term. Summary categories can be used.</td>
<td>Desirable</td>
<td>Record as cardiac (medical &amp; surgical); noncardiac, medical, surgical, procedural (scheduled/elective, scheduled/non-elective or nonscheduled/elective, or nonscheduled/emergen) or trauma, multiple reasons</td>
</tr>
<tr>
<td>Prevent functional capacity</td>
<td>Use CPC score based on chart review, family or staff interviews, and information recorded at admission</td>
<td>Desirable</td>
<td>See detailed definitions of CPC score under outcome variables below. Use pediatric modifications for patients&lt;18 yr.</td>
</tr>
<tr>
<td>Comorbid conditions</td>
<td>Major medical and surgical conditions present at the time of event and judged most related to the event</td>
<td>Desirable</td>
<td>Record major ICD-9-CM codes entered in medical record attestation sheet or discharge / transfer or death summary. Indicate whether autopsy was performed and record major cause of death, using autopsy information or death certificate.</td>
</tr>
<tr>
<td>Event variables Immediate precipitating cause</td>
<td>Immediate trigger for cardio respiratory event</td>
<td>Essential</td>
<td>Record as lethal arrhythmia, myocardial ischemia infraction, hypotension, respiratory depression, metabolic or unknown. The immediate trigger may be uncertain</td>
</tr>
</tbody>
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<table>
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</thead>
<tbody>
<tr>
<td>Resuscitation attempted</td>
<td>Airway interventions, chest compressions, defibrillation or DNAR status</td>
<td>Essential</td>
<td>Indicate yes or no (template boxes 2 &amp; 3) if yes, list all the following possibilities used; airway only, defibrillation only, chest compressions only, if no indicate whether the patient was found dead; resuscitation attempt considered futile, or DNAR order existed</td>
</tr>
<tr>
<td>Initial resuscitation condition</td>
<td>Condition of patient at the time of arrival of first health care professional</td>
<td>Essential</td>
<td>Record as yes, no for presence of apnea, pulselessness and unconsciousness</td>
</tr>
<tr>
<td>Initial rhythm</td>
<td>First monitored cardiac rhythm recorded after call for help</td>
<td>Essential</td>
<td>Record as VT/VF, asystole, Pulseless electrical activity, bradycardia, or normal Perfusing rhythm.(template boxes 5 &amp; 6)</td>
</tr>
<tr>
<td>Method to time events and intervals</td>
<td>Audit forms should use 24 h clock time. An interval is the duration of time between the timed events</td>
<td>Essential</td>
<td>Establish hospital wide synchronization of clocks. defibrillator clock can and should be standard synchronization clock for all interventions during resuscitation effort</td>
</tr>
<tr>
<td>Time collapse noted</td>
<td>Time at which the victim was seen or heard to collapse</td>
<td>Essential</td>
<td>For patients on telemetry, onset may be evident from telemetry monitor. However, resuscitation cannot begin until patient is physically located. Hence, this is the time to be recorded for audit purpose.</td>
</tr>
<tr>
<td>Time CPR team called</td>
<td>Time of call to hospital switch board to mobilize cardiac event team</td>
<td>Essential</td>
<td>A listing of all cardiac patients calls should be kept by the hospital switch board and audited against return of cardiac event report forms on a monthly basis</td>
</tr>
<tr>
<td>Time CPR team arrives</td>
<td>Time of arrival of personnel specifically responsible for performing resuscitation</td>
<td>Essential</td>
<td>Does not apply in settings where specific event teams do not exist. In emergency departments e.x., team is constantly present</td>
</tr>
<tr>
<td>Time arrest confirmed</td>
<td>Best estimate of time of professional confirmation of absence of central pulse</td>
<td>Essential</td>
<td>Normally confirmed by first healthcare professional at the scene of the event</td>
</tr>
<tr>
<td>Data element</td>
<td>Definition</td>
<td>Priority</td>
<td>Directions or comments</td>
</tr>
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</tr>
<tr>
<td>Time CPR started</td>
<td>Time of first chest compression</td>
<td>Essential</td>
<td>Record provider of first CPR for audit purposes. Record as nurse, clinical assistant, physician, respiratory therapist or other</td>
</tr>
<tr>
<td>Time CPR stopped</td>
<td>Time chest compressions stopped. Not to be resumed; represents either time of death or time of ROSC</td>
<td>Essential</td>
<td>Most forms with resuscitation matrices allow space to record that CPR was stopped and started multiple times during ‘stuttering’ events. In Utstein style, multiple starting and stopping is unnecessary. Report only final events</td>
</tr>
<tr>
<td>Time of first defibrillatory shock</td>
<td>Time of first and all subsequent defibrillations should be recorded</td>
<td>Essential</td>
<td>Newer defibrillators, especially shock advisory devices, possess event documentation capabilities that facilitate recording this information.</td>
</tr>
<tr>
<td>Time advanced airway achieved</td>
<td>Time of achievement of advanced airway management (not even first attempt is made.)</td>
<td>Essential</td>
<td>Advanced airway mgt includes endotracheal intubation or alternative airway strategies (laryngeal mask airway or esophageal obturator airway)</td>
</tr>
<tr>
<td>Time of first IV dose of medication</td>
<td>Time of completion of administration of first dose of epinephrine, adrenaline or other medication</td>
<td>Essential</td>
<td>The time, dose and route of administration of all drugs should be recorded</td>
</tr>
<tr>
<td>Time of ROSC</td>
<td>Return of any palpable central pulse in absence of ongoing chest compressions. When intra arterial BP recording is present, a systolic BP&gt;= 60mm Hg is equivalent to a palpable central pulse</td>
<td>Essential</td>
<td>Record time ROSC was achieved. Record as yes, never achieved, or achieved but not sustained. (template box no.9)</td>
</tr>
<tr>
<td>Time of end of ROSC</td>
<td>Applies to patients who have unsustained ROSC or who died in hospital.</td>
<td>Essential</td>
<td>Categorize as never achieved, &lt;=20 min, &gt;=20 min but &lt;=24 hr, or &gt;=24 hr</td>
</tr>
<tr>
<td><strong>Outcome variables</strong></td>
<td><strong>Date and time of in hospital death</strong></td>
<td>Essential</td>
<td>Allows calculation of length of hospital stay and hospital survival after ROSC, not applicable for patients who survive to be discharged from hospital(template box no.9)</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
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<th>Directions or comments</th>
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</thead>
<tbody>
<tr>
<td>Predeath status</td>
<td>After arrest, clinical status of patients who have ROSC may be reclassified</td>
<td>Desirable</td>
<td>Record as not applicable (patients who survive to be discharged) full Resuscitation status, changed to DNAR, support withdrawn from ROSC, declared brain dead, or referred for organ donation (template box no.9)</td>
</tr>
<tr>
<td>Date &amp; time of hospital discharge or transfer</td>
<td>Self-explanatory</td>
<td>Essential</td>
<td>Allows circulation of length of stay for successfully Resuscitated patients. Record as not applicable (patients not Resuscitated or died in hospital) or dd/mm/yr (template box no.10)</td>
</tr>
<tr>
<td>Glasgow Coma score</td>
<td></td>
<td>Essential</td>
<td>Record every 24 hr ROSC, at time of discharge until stable, at 6 months and 1 year. For patients who die in hospital, record best achieved. Record separate scores for eye-opening response to speech and pain (1-4), verbal response to speech and pain (1-5) and motor response to voice commands and painful stimuli (0-6). Note that eye opening (3-4), verbal response (6), motor response (5) constitutes ‘awake’ (see time of awakening)</td>
</tr>
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<tr>
<th>Data element</th>
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<th>Priority</th>
<th>Directions or comments</th>
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</thead>
<tbody>
<tr>
<td>CPC</td>
<td></td>
<td>Essential</td>
<td>Record separate score for 5 components. Record at time of discharge 6 months and 1 year. For patients who die in hospital, record best CPC achieved. 0=NA, not discharged alive. 1 = good cerebral performance. Conscious, alert, able to work and lead a normal life. May have minor psychological or neurological defects. (mild dysphagia, hemiparesis or minor CNs abnormalities ) 2 = moderate cerebral disability. Conscious, sufficient cerebral function for part time work in sheltered environment or independent activities of daily life. (e.g.; dressing, travelling on public transport, preparing the food.) may have hemiplegia, seizures, ataxia, dysthria, dysphagia or permanent memory or mental changes. 3 = severe cerebral disability. Conscious, dependent, on others for daily support because of impaired brain function. Atleast limited cognition, includes a wide range of cerebral abnormalities from independent existence to paralytic and able to communicate minimally. 4= comatose, vegetative state. Not Conscious; unaware of surroundings, no cognition, no verbal or psychological interactions with environment 5=brain death / organ donation candidate</td>
</tr>
<tr>
<td>Data element</td>
<td>Definition</td>
<td>Priority</td>
<td>Directions or comments</td>
</tr>
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</tr>
<tr>
<td>Time of awakening</td>
<td>Patient is considered awake if he or she responds appropriately to commands, makes spontaneous verbal statements, makes appropriate eye contact, makes appropriate motor responses, or appears conscious or oriented</td>
<td>Essential</td>
<td>Record as interval, in hours, from arrest to awakening. An interval of 6-24 hr may be used when awakening event is precise</td>
</tr>
<tr>
<td>Alive at 6 months / 1 yr</td>
<td>Self-explanatory</td>
<td>Essential</td>
<td>Record as yes ( only if confirmed by reliable means) no, or unknown</td>
</tr>
<tr>
<td>Date of death after hospital discharge</td>
<td>Applies to patients who are discharged alive form hospital</td>
<td>Essential</td>
<td>Allows calculation of length of survival. Record as still alive , survival status and unknown(dd/mm/yr)(template boxes 11 &amp;12)</td>
</tr>
<tr>
<td>Principle cause of death</td>
<td>Applied to patients who die after discharge</td>
<td>Essential</td>
<td>Record as cardiac, other medical trauma, or other. Add ICD-CM-9 codes when possible. Indicate source of information for cause of death.(medical records, death certificates, autopsy, personal physician, other)(template box 12)</td>
</tr>
<tr>
<td>Immediate mechanism of death</td>
<td>Applied to patients who die after discharge</td>
<td>Essential</td>
<td>Record as sudden cardiac death, acute myocardial infarction, CHF, CVA, other medical, trauma, other or unknown</td>
</tr>
<tr>
<td>Audit of resuscitation attempt</td>
<td>Self-explanatory</td>
<td>Essential</td>
<td>To assess quality of resuscitation attempt, review time or team arrival, time of equipment arrival, equipment function, team leadership and task performance. The audit form can be developed as a separate form used for quality assessment purposes and therefore does not become part of patient’s medical record. Data items can be phrased as yes or no questions; space should be allocated for comments on problems experienced during resuscitation</td>
</tr>
</tbody>
</table>
To formulate uniformity in reporting of cardiac arrests, the Utstein task force defined four kinds of variables.

1. Hospital variables
2. Patient variables
3. Arrest variables
4. Outcome variables

It would be difficult for the hospital or researcher to collect all of these variables. The variables are usually collected in order to find out specific things. CPR provided during cardiac arrest needs to be recorded and it becomes an important part of the medical records of the patient. The recorded data are usually incomplete in the emergency situation during in hospital resuscitation.
Utstein style of reporting divides the factors associated with survival as patient variables and event variables.

X. PATIENT VARIABLES OF IN-HOSPITAL CARDIAC ARREST

Age: Some studies have reported an association between age and survival. The chance of survival has been shown to decrease in older patients. Not much is studied about the long term outcomes in the older patients who survive from cardiac arrest. Chan P.S et al conducted a study on patients who survived cardiac arrest in terms of long term survival and readmissions. This study was conducted by linking the national registry of inpatients to Medicare files. The investigators identified 6972 adult patients who are aged 65 or older and those who have got discharged from hospital after surviving a cardiac arrest event between the years 2000 to 2008. The predictors for the survival and readmission were also analyzed. The findings of the study were as follows, after the patients were out of the hospital, 58.5 % patients were alive, and however 34.4 % were not admitted again to the hospital bed. After risk adjustment one year outcome was lesser as the age progressed (63.7 % for 65-74 years old, 58.6 % for 75-84% old and 49.7% for ≥85 years of age). The survival was better among men than women and in blacks than whites.

The 12 months rate of patients being alive was 72% in victims who had slight or no neurologic incapacity on hospital release when paralleled to patients who may have moderate neurologic disability which accounted for 61.1% and patients with severe neurological disability which accounts for 42.2% and 10.2% in patients who were comatose (there was statistical significance for all the comparisons, P < 0.001).
Authors concluded that among the elderly patients who survived the cardiac event, around 60 percent have survived to 1 year. Readmission and survival rates were different in different patients at hospital discharge.\textsuperscript{62}

**Race, Ethnicity and gender** - Ayanian JZ et al found a significant relation between race and outcome from different cardiovascular disorders. Ebell MH et al in his paper concluded that survival is lower in black patients.\textsuperscript{62,63}

**Morbidity:** Dautzenberg PL et al found that comorbidities such as sepsis, kidney failure, cancer, stroke and house bound life style has significant relation to worsening of IHCA. Cohn EB et al found that pre-arrest morbidity scores such as APACHE II and III have some correlation to the patient’s survival to discharge but these pre-arrest variables cannot properly predict the outcome of cardiac arrest. APACHE II and III are predominantly done in patients admitted to intensive care units. The pre-arrest morbidity score (PAM) consists of these comorbidity factors. PAM has been only validated for predicting the outcome patients in cardiac arrest.\textsuperscript{64,65}

In a comparative study by O’ Keeffe S the PAR score which is the Prognosis after Resuscitation score which has less variables than PAM score was found to be a better predictor of the patients who are not able to survive from the resuscitation measures for IHCA.\textsuperscript{66}

Muhammed Junaid Patel et al conducted a study of 738 patients admitted from 2002 to 2007 at a University Hospital, Karachi by the review of the charts. The investigators included all adult patients and APACHE II score was calculated for the
patient individually and regarding the demographic data and the clinical features a
descriptive analysis was done. The findings of the study showed that patients with a
lower APACHE II score, less than 20 had 4.6 times more chance of survival
compared to patients with higher scores, scores >35. Patients who had less duration
of CPR and also males than females were also other important predictors of CPR
outcome. The investigators concluded that the APACHE II score with various other
patient variables may be taken in to consideration while clinical decisions are taken
related to CPR delivery.\(^6^7\)

The above said reasons demonstrate the inability of the scores to be
considered as prognostic tools in the clinical decision making for patients.

Girotra S et al conducted a study in 374 hospitals in the registry between 2000
to 2009. Multivariate regression was done to analyze the risk adjusted rates of
survival to discharge and the relation between the trends and survival and the
neurologic disability.

The study results showed that 79.3% of the patient’s initial rhythm was
asystole or pulseless electrical activity and 20.7% patients had VF/VT. When the two
rhythms were compared outcome was not different in both the groups of patients and
this improvement was owed to both ROSC and also the presence of life after post
resuscitation care. The clinically significant neurologic disability reduced during these
years and the rate in 2000 was 32.9% and 28.1% in 2009. The study concluded that
the survival and neurological outcome of the victims who sustained IHCA have
improved over the years.\(^6^8\)
Pre-arrest functional capacity of the patients.

Comparison of post arrest status with prearrest status provides the evaluation for resuscitation outcomes.

A study conducted by E.O Jorgenson and Soren Holm analyzed the impact of pre-arrest, arrest and post arrest factors on the neurological and circulatory recovery till 1 year following cardiac arrest of 231 patients with cardio pulmonary etiology.

When assessment was done initially all patients were unconscious. Group I patients accounted for 106 and had some cortical activity present while EEG was recorded immediately after resuscitation. Group II patients accounted for 125 patients and they did not have any cortical activity initially. In the year 1 survival was 33% among the Group I patients and was 16 % in Group II. The investigators concluded that global ischemic insults during the cardiac arrest epoch determine the circulatory and cerebral outcomes.69

Simple tool to assess the neurological outcome after cardiac arrest is lacking. The most commonly handled methods to assess functional outcome after the CPR efforts in adults are the different Glasgow – Pittsburgh outcome categories which includes Glasgow coma score, cerebral performance categories (CPCs) and overall performance categories (OPCs)

1. Good overall performance Healthy, alert, capable of normal life Good cerebral performance (CPC 1) plus only mild functional disability from non-cerebral organ system abnormalities.
2. Moderate overall disability
Conscious Moderate cerebral disability alone (CPC 2) or moderate disability from non-cerebral system dysfunction alone or both
Performs independent activities of daily life (dressing, traveling, and food preparation) May be able to work part-time in sheltered environment but disabled for competitive work.

3. Several overall disability
Conscious Severe cerebral disability alone (CPC 3) or severe disability from non-cerebral organ system dysfunction alone or both
Dependent on others for daily support.

4. Coma, vegetative state
Not conscious Unaware of surroundings, no cognition
No verbal or psychological interactions with environment.

5. Death. Certified brain dead or dead by traditional criteria.\textsuperscript{70}

**Comorbid illness**

Although many factors of IHCA is found to be associated with recovery from cardiac arrest, association of pre arrest comorbid illness with the outcome has not been evaluated well.

Hallstrom et al in their study defined the comorbidity index which was developed using the account of chronic conditions and few latest indicators in 282 patients of OHCA in VF. Comorbidity index has a strong association to outcome where \( p < 0.05 \). The investigators summarized in this study comorbid illness to be considered as one of the predictive factors for sustaining life and VF.\textsuperscript{71}
Sandroni C et al summarises in their study the incidence of survival after in hospital cardiac arrest, major predictive factors and probable treatment that increases survival.

Sandroni C et al reported that the IHCA incidence is not reported frequently in existing evidence. Incidence ranges to 1-5 cardiac arrests / 1000 patient admission or when it is calculated by cardiac arrest events per hospital bed annually. Survival rate ranges from 0% to 42% and overall range is from 15% and 20%.

The intra arrest factors such as shockable rhythms being the first monitored ones and a shorter duration of cardiac stand still are associated with better survival. The proportion of VF/ VT as the initial rhythm during cardiac arrest is only 25-35% of the In-hospital cardiac arrests. There are few interventions that have proven to improve the survival rate. That includes early detection and stabilization of patients who are at risk of IHCA.¹

BRESUS investigators conducted the determination of circumstances, incidences and consequence of CPR in Europe. This study included population who had CPR which included victims with OHCA. Patients who had ROSC at 24 hours, when they get discharged from hospital and at one year were the main outcome measures. The survival at one year was 12.5% including out of hospitals and including these cases. The patients who had cardiac arrest in accident and emergency department, cardiac care unit or other specialized units had better survival rates. The investigators concluded that mortality at 1 year was 71% who had initial arrest. The resuscitation that the hospital gives is lifesaving and is cost
Chapter 3

Review of Literature

effective. There needs to be appropriate attention, training, coordination and equipment.\textsuperscript{72}

XI. EVENT VARIABLES OF IN-HOSPITAL CARDIAC ARREST

The event variables during cardiac arrest include first monitored rhythm, the event intervals, the event duration and the event location.

\textit{i. Initial rhythm}

Initial rhythm as VF / VT is better in terms of recovery from IHCA than a non-shockable rhythm which is asystole or pulseless electrical activity (PEA). First monitored ECG pattern being VF/VT reported 18\% to 64\% survival rate and 1.2\% to 14 \% for rhythms which are nonshockable.\textsuperscript{55}

The reasons behind the better outcome from VF/VT rhythms are (1) Defibrillation of the fibrillating heart in VF or in VT can be treated promptly and successfully. (2) If not treated the VF/VT rhythm may worsen to asystole and if the rhythm is VF/VT then one can infer that the cardiac arrest has occurred recently.

Meaney \textit{et al} did a study to find out the association between ECG rhythms present at the time of arrest with the recovery. There were 51,919 cardiac arrests in which first documented rhythm was VT in 3810 (7\%), VF in 8718 (17\%), PEA in 19,262 (37\%) patients, flat line or asystole in 20,129 patients (39\%). One portion of patients, \textit{i.e.} 5154 (27\%) patients had initial rhythm as PEA or asystole and then changed as VF/VT. Patients with PEA had more chance of survival than patients with asystole 12\% Vs 11\%). The investigators concluded that first documented rhythm as VF/VT had more likelihood for survival than non-shockable rhythms.\textsuperscript{73}
Hallstrom A et al points out the recent report of fact constantly that there is a considerable reduction in the manifestation of VF to be the initial documented ECG pattern which are observed by EMS personnel. There is a corresponding increase in the incidence of PEA and asystole. In earlier days efforts were made to increase survival after cardiac arrest for patients who are in VF. The study reports that more patients survive from the nonshockable rhythms. Hence the investigators suggested that the treatment should be evaluated for PEA and asystole.\textsuperscript{71}

\textit{ii. Event intervals of IHCA}

Herlitz et al in their study showed that resuscitation in 1 minute after the collapse there was significantly higher outcome also it was statistically significant - 33\% Vs 14\%, \textit{p} = 0.008.\textsuperscript{74}

Peberdy et al stated recovery from cardiac arrest to be 38\% Vs 21\% once the initial defibrillation for VF/VT provided in 3 minutes or > 3 min. The chance of survival was more when the defibrillation was given within 3 minutes and the difference was statistically significant.\textsuperscript{75}

The NRCPR database (National registry for Cardiopulmonary resuscitation) included 14,720 events where neurological outcome was good in patients who were discharge alive to home. 86\% of the patients who were in CPC 1 at the time of hospital admission had a post arrest CPC-1 at the time of hospital discharge.\textsuperscript{10}
iii. Event duration of In – hospital cardiac arrest

Literature shows that shorter duration of cardiac arrest had comparatively improved outcome. The reason behind the better outcome during the shorter arrest is the possibility of swiftly treating the causes during these cardiac events. Additionally when the patients have longer resuscitation period there is an associated global tissue hypoperfusion and hypoxic damage.

iv. Location inside the hospital

Most of the studies report that there is a better outcome for patients who have cardiac arrests in the ICUs than in the wards. The reason for this irony may be that ICU patients are well monitored; there is an immediate availability of ACLS, the younger age of the patients and good selection of patients who needs to be resuscitated.

Time of the day when cardiac arrest occurred as a predictor.

One study conducted by Herlitz et al showed the cardiac arrest during the day has better survival than night. The reported survival of cardiac arrest occurring in the night is half of the survival that occurs in the day. The study also showed that the incidence of unwitnessed cardiac arrest was considerably greater at the night hours. In the night hours reduced survival rates are seen due to the decreased proficient emergency system in the hospital.

The study conducted by Dumot et al showed that there were a high proportion of cardiac arrests occurring in the night (12 AM to 6 AM) which are unwitnessed in the hospital beds that are unmonitored. This resulted in poor survival to hospital
discharge (0%). Survival of the cardiac arrests (25%) which were witnessed were better than that for non-witnessed arrests (7%) and the difference was statistically significant (P= 0.005). The authors concluded that very sick inpatients on less monitored beds are at a very high threat of unwitnessed cardiac arrest and decreased recovery from resuscitation during the night hours. It is recommended that these patients needs close observation in the night. Limited resuscitation efforts produces poorer outcome.\textsuperscript{76}

**Post resuscitation care**

Comparison of patients with cardiac arrest and admitted in ICU has a decreased prognosis than other patients admitted in ICU. Post resuscitation care is very significant as it may influence the final result considerably. There are very less data in the literature regarding this phase. Two RCTs reported that mild therapeutic hypothermia provided in the first 12-24 hours after cardiac arrest involving VF enhanced the survival and the neurological recovery.\textsuperscript{77,78}

Studies have reported the association between high levels of blood glucose after CPR for patients sustaining cardiac arrest and the neurological functioning. Clinically control of blood glucose to 4.4 - 6.1 mmol/l or 80 -110mg/dl by using insulin has shown to decrease the mortality in the hospital and also guard the central and peripheral nervous system of the seriously ill patients. This effect has not been yet established in the post resuscitation care or post cardiac arrest patients.\textsuperscript{79}
Outcome from cardiac arrest: Functional outcome

Literature shows a fairly good functional outcome in survivors from IHCA. De Vos R and colleagues in their study showed that CPC of 1-2 was present in 85% of the patients of the 91.4% who were in this CPC category during admission.\textsuperscript{80}

Cummins RO et al in their study concluded that there is a chance of relatively less functional outcome for patients aged more than 70 years. There was no correlation seen with the period of resuscitation or the extend of coma that occurred after the cardiac arrest.\textsuperscript{81}
XII. TEMPLATE FOR THE REPORTING OF IN-HOSPITAL CARDIAC ARREST

In-hospital patients with a pulse (including out-patients and ED; excludes patients admitted for out-of-hospital arrests who should be reported separately; actual numbers not required)

1. Cardiac arrest, no resuscitation attempted
   - Patients designated DNAR, N=____
   - Patients not designated DNAR, N=____
   - Found dead, N=____
   - Considered futile, N=____

2. Non-VF/VF
   - PEA, N=____
   - Asystole, N=____

3. Attempted in-hospital resuscitations
   - Total, N=____
   - Defibrillation only, N=____
   - Chest compressions only, N=____
   - Airways interventions only, N=____
   - Combination interventions, N=____

4. False arrests (BLS or ALS actions not needed)
   - N=____

5. Initial rhythm VF/VT
   - N=____
   - (see "Denominator Note")

6. Non-VF/VF
   - PEA, N=____
   - Asystole, N=____

7. Never achieved ROSC
   - N=____

8. Any ROSC
   - N=____

9. Died in hospital classify as
   - ROSC < 20 min, N=____
   - ROSC > 20 min but < 24 hours, N=____
   - ROSC > 24 hours, *n=____
   - Reattempts/rearrests, N/N=____/

10. Discharged alive
    - N=____
    - Alive at 6 month, * N=____

11. Died within 1 year of discharge*

12. Alive at 1 year*
    - n=____

13. Identify patients who had
    - DNAR status declared, N=____
    - Support withdrawn, N=____
    - Brain death established, N=____
    - Organ donor status declared, N=____

Denominator note
Outcome boxes 7-13 can be completed for any subset of "attempted in-hospital resuscitations" (box 3), including box 5. For comparison purpose, however, only outcomes for patients with initial rhythm VF/VT are recommended.

Functional outcomes measure best outcomes at
   Time of discharge
   6 months
   1 year

Figure 6: Template for the reporting of in-hospital cardiac arrest
The Utstein style was created for uniform display of outcomes. The template concept is based on the following principles:

- The initial boxes of the template define a population; this population must be accounted for in subsequent boxes of the template.
- The number of each box serves both as the numerator for the box above it and as the denominator for the box below it.
- The template displays a central trunk which is considered the most important subpopulation to report.
- Depending on the objectives of the study, several branches can be identified and analyzed, analogous to a hierarchial filing system or pull down menus in the organisation of computer files.
- Although numerous branches of the algorithm can be developed, in most instances this is not necessary.
- Concerns about sample size will necessitate combining rather than splitting population subsets. Investigators should make clear which subsets are being considered and which have been combined or subdivided.

**Template boxes**

i. Template box 1: in-hospital patients with pulse

This template box provides the conceptual starting point to analyze resuscitation results obtained in a hospital.

ii. Template box 2: Cardiac arrest, no resuscitation attempted

Patients designated DNAR, Patients not designated DNAR, Found Dead and considered futile.
iii. Template box 3: attempted in-hospital resuscitations

- Total
  - Defibrillation only
  - Chest Compression only
  - Airway interventions only
  - Combination interventions

iv. Template box 4: false arrests

**BLS or ACLS actions not needed**

v. Template box 5: non-VF/VT
  - Asystole
  - PEA

vi. Template box 6: initial rhythm VF/VT

vii. Template box 7: never achieved ROSC

viii. Template box 8: any ROSC

ix. Template box 9: died in hospital

- ROSC ≤ 20 min
- ROSC > 20 min but ≤ 24 hours
- ROSC > 24 hours

x. Template box 10: discharged alive

- Total
- Alive at 6 months
- Alive at 1 year

xi. Template box 11: died within 1 year of discharge
There is a problem of data syncopation wherein different variable in the event become available at different timings.

**Comparison of data: Gold standard**

Considering patients with documented Ventricular Fibrillation, the time interval between the collapse from cardiac arrest to first shock was considered to be the simple and strong gold standard method as concluded by the task force. It is recommended to document this interval for all hospital areas. There can be three different comparisons. They are 1) interval from the collapse to first shock for patients who have VF/VT as the rhythm 2) Time interval from collapse to the securing the artificial airway 3) time interval from collapse to first IV administration of epinephrine.
Criterion Standard “comparison variables”

Figure shown above establishes the interventions which are essential for successful in hospital resuscitation. Many studies described above in this document have demonstrated that shorter the time interval between these interventions, the greater the chance of survival.

- Emergency is recognised, response team is activated (early access)
- Personnel start CPR (early CPR)
- Personnel assess rhythm and deliver defibrillatory shock for patients in VF/VT (early defibrillation)
- Personnel arrive and perform endotracheal intubation, establish an intravenous line, deliver resuscitative medications and consider the differential diagnosis(early ACLS).
Resuscitation quality

Quality of resuscitation is very much important for patient’s survival, so CPR should be done not just early but well. Van Honeyweghen RJ and colleagues reported that in some cases all the four modules of CPR can be done suboptimal such as Compression and ventilation, defibrillation, endotracheal intubation and IV administration of medications.\textsuperscript{82}

In a research conducted by Cummins RO \textit{et al}, there were 83 \% of the compression rates and almost 100 \% of the rates of ventilation different from the AHA, BLS guidelines. The study found out a good relation between CPR quality and the rates of successful resuscitation. When the incorrect CPR steps were followed the 14 day survival was 4\% of the patients who were resuscitated and there was 16\% survival rate seen when the CPR steps were followed properly.\textsuperscript{81}

\textbf{XIII. TRAINING AND EDUCATION IN IN-HOSPITAL CARDIAC ARREST}

Ongoing training of code blue team staff is very much essential for better enactment and improved outcome.

Van Honeyweghen RJ in their study found out that since in hospital cardiac arrest is an event that occurs less frequently, the team members of the IHCA seems to be not well prepared to lead and perform the CPR when event occurs.\textsuperscript{82}

The treatment for In-hospital cardiac arrest depends on the hospital code blue team members. The team members in code blue changes often and the team members might not be dedicated only on the provision of the emergency efforts to
resuscitate the patient. Retention of the skills and training is a concern and the study by Hayes CW *et al* showed that there has to be recurrent training and retraining of the code blue team to make sure that the skills are retained, the mistakes are reduced and the outcome is improved.\(^{83}\)

Sutton RM, conducted a study and found that when training was provided by simulations to the house staff of an academic institute ICU, in addition to the ACLS training that they had was associated with good compliance to the CPR guidelines from AHA.\(^{84}\)

Literature does not have many studies which show the effectiveness of CPR training on the CPR outcome. Weidman EK *et al* in their study which was performed at a tertiary care hospital which is 550 bedded, found out that there was a huge difference between the survival rate of patients resuscitated by nurses who are trained and the nurses who are not trained in ACLS. The rate of survival was 37.5% when it was initiated by a trained nurse and was just 10.3% while done by a staff nurse who lacked CPR knowledge. The difference was almost 4 times between the two. The study concluded that while training is done matters such as knowledge gaps, hesitancy to perform and the crew or the team work, all can be addressed.\(^{85}\)

Marsch SC *et al* conducted a study on the first responder’s performance on simulated cardiac arrests. The authors found that when the CPR feedback devices or prompt devices are used for the CPR training, there is an improvement of CPR skill attainment and retaining it in the memory. The devices need a firm surface to support while used for CPR. Additional researches are recommended by the author for the use of these devices to increase the outcome of patient.\(^{86}\)
Yeung J suggested that if the outcome from IHCA needs to be improved then there needs to be changes in the reporting of cardiac arrest, knowledge base, training in ACLS and the improvement in the care settings. It is seen that there will be a change in the outcome from IHCA outcome if there is a hostile execution of the resuscitation, CPR according to the guidelines, and the initiatives for improvement.\textsuperscript{87}

Survival is a function of Science, education and implementation

Survival = Science × Education × Implementation

Among three aspects that decide survival, less literature exists regarding the implementation in In-hospital cardiac arrest. As there is but there are considerable studies on knowledge base in other different diseases, it can be deduced to the care of In-hospital cardiac arrest. Institutional culture and Individual’s behavior are driven by perception. Evans et al suggested that it is necessary to have evidence obtained from reliable and trusted place; approval of institution by most of it which comprises point of care testing that will help in adherence to each patient. There has to be useful, accessible, trustable and findable information.\textsuperscript{88,89}

Pathman et al suggested the four different stages of change such as awareness, agreement; adoption and adherence are to be noted in any new strategies. Literature articles alone may not help in faster dissemination of the information and adoption.\textsuperscript{90}
XIV. EARLY WARNING SCORE - MODIFIED

The patient flow is much more than the past. Each patient admitted in the hospital usually has an observational chart wherein the vital signs of the patient are entered. The scan through this observational chart can actually give an insight to the doctor or the nursing staff about the condition about the patient. Early warning score tool have been evolved scientifically and it is a very important tool to determine the changes in the condition of the patient early so that it can be corrected at an earlier stage.

Most of the physiological scoring systems are scored by providing points to the observed values which include pulse rate, blood pressure, and respiratory rate. The final score is obtained by adding up each of the individual scores. Action plan for the score is provided to the staff.

Saxon Ridley in his review stated that severe illness or disease is an emergency as the inflammatory response has multiple pathways. When the process is started, it is very difficult to control or eradicate it. Critical illness usually comes with antecedent infection which later leads to organ dysfunction and mortality. If the inflammatory process remains for long time then it results in increased mortality.91

There are signs and symptoms that follow a critical ailment that warns an awaiting physiological instability. Early warning scores are used to quantify the physiological signs and are profound. Emergency management is required to normalize the physiological parameters and rapid admission to critical care area is done. Monitoring of physiological values in the general ward by early warning scores
increases the chance of recognizing patients who are not stable and the severely ill. Earlier recognition and treatment will revert the worsening of physiological parameters and enable judicious transfer to the intensive care unit for additional and more intensive support.\textsuperscript{92}

CP Subbe \textit{et al} in a prospective cohort study investigated the capability of Modified early warning score to detect patients admitted in the hospital in a very busy clinical ward. This study was performed in a 56 bedded acute ICU and details of 709 patients were recorded. MEWS score greater than five score had an increased chance for death. The modified early warning score (MEWS) could be applied with ease in district level hospital and this can identify patients who are at the verge of deterioration and who require improved levels of patient care in HDU or in the intensive care unit.\textsuperscript{92}

MEWS is a very easily doable score which enhances the management of surgical patients admitted in the ward.

J Gardner Thorpe \textit{et al} studied 334 ward patients in a prospective model. The early warning score was documented on all patients and the key end point was transferal to the intensive thoracic unit or to high dependency unit. There were 57 ward patients which comes up to 17% who activated the MEWS algorithm having been scored $\geq 4$. It was observed that patients who had emergencies were at higher chance of triggering the system when compared to the patients who were selected electively. There were sixteen patients who got admitted in the ITU and high dependency unit. This accounts for 5% of the patients. The study reported that the
sensitivity of MEWS is 75% and specificity was 83% for those patients who were transferred to the ICUs. This study concluded that MEWS along with a call out algorithm is a beneficial and suitable tool for detecting and managing the patients at risk in surgical patients.\textsuperscript{93}

Burch and colleagues evaluated usefulness of MEWS as one of the tools to determine the medical patients who are at risk of in-hospital death and who require admission to the hospital. Results from the study revealed that patients who had higher MEWS died in the hospital (P < 0.001). The independent predictors were identified are systolic blood pressure less than 100 mmHg, pulse rate more than or equal to 130 b/min, RR more than or equal to 30 b/min, temperature more than or equal to 35\textdegree{}C and altered level of consciousness. Abnormal systolic blood pressure, respiratory rate more than or equal to 30 breaths/minute, and an altered conscious level were considered as independent predictors for in-hospital death. The authors concluded that the five parameter MEWS could be used as a tool which is simple and rapid and can easily determine the patients who may need better care in the ICU or who may be at the verge of a cardiac arrest.\textsuperscript{2}

C. Stenhouse \textit{et al} developed the early warning score with two aims. They were timely identification of the patients with critical illness or who are at the verge of critical illness, Enable the nursing staff and junior medical doctors to obtain the expert help via the call out or trigger threshold. Early warning score system is potential enough to improve the excellence of patient monitoring, enhance the communication to the expert team, timely transfer to ICU, better medical judging, help in the right
assistance for seriously ill patients, provides a better hint of physiological trends, and abnormal physiology, as a prognostic factor of outcome, clinical examination or assessment tool, and as a replacement for clinical judgment.\textsuperscript{94}

Nauman Naeem \textit{et al} found that MEWS score introduction helped in the increase of patients with the rhythm as VF/VT in the present study, 8.5\% Vs 23.7\%. Introduction of MEWS resulted in a better survival to hospital discharge and it was statistically significant - (5.2\% Vs 16.8\%). Introduction of MEWS helped in reducing the percentage of in-hospital cardiac arrest by 16 \% and death had reduced by 11.6\%. Early introduction of MEWS might decrease the occurrence of cardiac arrests, mortality and will increase the survival of patients who are admitted in the HDUs, wards and ICUs. Early detection of the physiological deterioration and the imminent cardiac arrest can allow the help to arrive early or on time which may indirectly prevent the event of cardiac arrest.\textsuperscript{95}

A study conducted by Bellomo \textit{et al pre and post introduction of ICU based medical emergency team (MET)}, it was observed that there is a significant decrease in the in hospital cardiac arrest incidence. There was also reduction in death after cardiac arrest (56\%) and overall in-hospital mortality (88\%).\textsuperscript{96}

Buist \textit{et al} in their study reported a substantial decrease in the incidence of in-hospital unexpected cardiac arrests. There was a decrease from 3.77 to 2.05 per 1000 hospital admissions and mortality reduced from 77\% to 55\%.\textsuperscript{97}