CHAPTER

77

Essential Life Saving Skills a Physician Must Know

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" I would especially commend the physician who,

In acute diseases,

By which the bulk of mankind are cut off,

Conducts the treatment better than others"

HIPPOCRATES

INTRODUCTION

The field of medicine is constantly changing and evolving with new technologies, practices, evidence and innovations. The medical profession has experimented with a practice-based model of continuing education since the 1960s.[1] The dynamicity of this field has led to the continuous expansion of the roles and domains of the physicians for which they need to continue their education throughout their career and hone and refine their procedural skills in order to provide the highest possible level of patient care. The role of a physician is no more limited to confinements of the outpatient department and the inpatient department or wards juggling with history taking, differential diagnosis, clinical examination, prescription writing but has expanded and evolved especially in the emergency care setting. The armamentarium of a physician must contain cutting-edge evidence based knowledge, experience and wisdom, life saving procedures and skills especially in the emergency rooms (ER). In recognition of this, a new domain- emergency medicine (EM) was launched in 1960s.[2]

Recent epidemiologic and demographic public health data highlight the growing need for EM, trauma, and acute care development in all countries across the socioeconomic spectrum.[3] However, in countries where EM is not still well established or in developing phase, there is a huge burden on the physicians or residents working in the emergency rooms and emergency wards (EW) for which learning and perfection of the lifesaving procedures and skills is not only desired but required. Although, the list of emergency procedures that are being performed in ER and EW routinely is long and vary in different hospital settings, knowledge of minimum set of life saving invasive procedures and interventions is mandatory (Table1).

CARDIOPULMONARY RESUSCITATION (CPR)

A report of five cases of cardio-respiratory arrest managed successfully with chest compressions, defibrillation and assisted ventilation published in 1960, paved the path or birth of cardiopulmonary resuscitation.[4] In the last

Table 1: List of life saving procedures/skills in emergency room/wards

Cardiopulmonary resuscitation
• Basic life support (BLS) • Advanced cardiac life support (ACLS) • Defibrillation
Airway management
• Endotracheal intubation • Laryngeal mask airway (LMA), Combitube) • Rapid sequence intubations (RSI), • Nasotracheal intubations. • Needle cricothyroidotomy
Oxygen therapy and devices
Venous access
• Peripheral venous access • Central venous access (subclavian, internal jugular, femoral) • Venesection • Intraosseous route
Cardiac
• Cardiac pacing- transcutaneous and transvenous • Pericardiocentesis • Hemodynamic monitoring (noninvasive and invasive)
Pleural procedures
• Needle and tube thoracostomy (chest tube insertion) • Pleural fluid aspiration
Lumbar puncture
Sengstaken Blakemore tube/Minnesota tube insertion, nasogastric tube insertion
Suprapubic catheterization
Abdominal paracentesis
Focussed assessment with sonograpghy (FAST)
Peritoneal dialysis catheter insertion
Hemodialysis catheter insertion
Arterial blood gas (ABG) sampling and analysis
Arterial line placement
Others – regional anaesthetic blocks, intercostals blocks, use of sedation, suturing etc.

Table 2: DO's and DONT's for quality CPR (adapted from AHA2015 update ref 5)

Rescuers Should	Rescuers Should Not
Perform chest compressions at a rate of 100-120/min	Compress at a rate slower than 100/min or faster than 120/min
Compress to a depth of at least 2 inches (5 cm)	Compress to a depth of less than 2 inches (5 cm) or greater than 2.4 inches (6 cm)
Allow full recoil after each compression	Lean on the chest between compressions
Minimize pauses in compressions	Interrupt compressions for greater than 10 seconds
Ventilate adequately (2 breaths after 30 compressions, each breath delivered over 1 second, each causing chest rise)	Provide excessive ventilation (ie, too many breaths or breaths with excessive force)

sixty years, CPR has become a universally mandated practice that requires certification, and is withheld only on request. Since then, various updates and guideline recommendations has added a lot of information to make 'CPR to quality-CPR'. The recent American heart association (AHA) 2015 has recommended few changes in the steps of CPR.[5] CPR training and certification need cannot be overemphasized specially for the physicians working in ER. They must know the steps of a quality CPR (Table 2) and lead the CPR team consists of doctors and paramedical staff.

The basic rationale to provide CPR is to support the circulation, maintain the airway and breathing and once patient successfully revive then provide post arrest care. The original mnemonic for elements of basic life support (BLS) i.e ABC -Airway, Breathing, and Circulation has been rearranged to CAB- Circulation, Airway, Breathing that reflects a recent shift in emphasis from ventilation to chest compressions in the resuscitation effort.[6] Time factor is an important consideration in initiating CPR and is an independent variable that predicts the survival. The most recent recommendations for chest compressions are: rate- 100-120/min, depth- at least 2 inches and avoiding excessive compression depth (Table2).[5] The number of chest compressions delivered per minute during CPR is an important determinant of return of spontaneous circulation (ROSC) and survival with good neurologic function. Advanced cardiovascular life support (ACLS) includes a variety of interventions such as airway intubation, mechanical ventilation, defibrillation, and the administration of life supporting or resuscitation drugs.[7] ACLS protocol is a rhythm-based approach and divides the management of cardiac arrest into 2 pathways: one for the management of ventricular fibrillation (VF) and pulseless ventricular tachycardia (VT), and the other for the management of pulseless electrical activity (PEA) and asystole (Figure 1). The use of drugs is considered a second-line treatment in cardiac arrest because there is

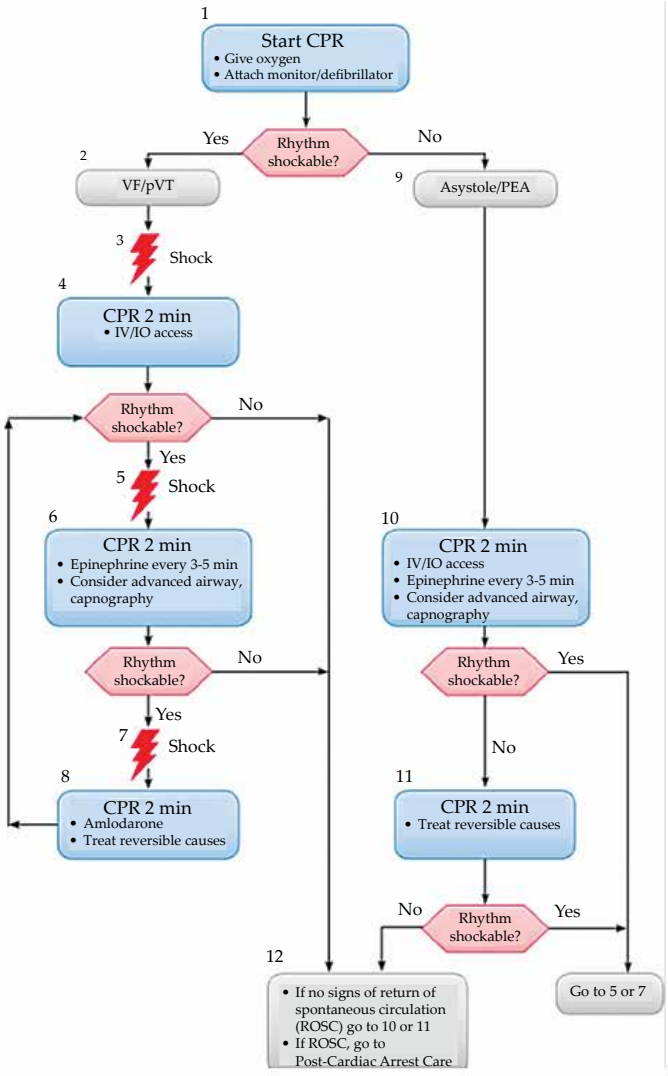

Fig 1: Algorithm for ACLS (adapted from ref 5)

no documented survival benefit.[7] The cardiac arrest drugs are either vasopressors or antiarrhythmic agents. Use of vasopressin in combination of epinephrine has been removed in the recent guidelines as it offers no added advantage.[5] Moreover, resuscitation monitoring and post resuscitation care is equally important and physicians must be taught about its importance.

VASCULAR ACCESS

Werner Forssmann experiment of self-insertion of plastic urethral catheter in basilic vein in 1929 marked the beginning of vascular cannulation using plastic catheters.[8] Securing a vascular access is important in resuscitation protocols for the administration of resuscitation drugs and intravenous fluids. Central venous cannulations is an integral part of providing critical care support to the patients in ER and EW. The higher flow rates of large veins reduce the damaging effects of infused fluids and decrease the propensity for local thrombosis. The major indications for securing central venous access are:[9]

1. When peripheral venous access is difficult to obtain specially in obese patients or intravenous drug

Table 3: Central line bundle for reduction of CRBSI[10]

Components	Recommendations
Hand Hygeine	Use an alcohol-based handrub or a soap and water handwash before and after inserting or manipulating catheters.
Barrier Precautions	Use maximal barrier precautions, including cap, mask, sterile gloves, sterile gown, and sterile full body drape, for catheter insertion and or guidewire exchange
Skin Antiseptics	Apply a chlorhexidine-based solution to the catheter insertion site and allow two minutes to air-dry
Cannulation Sites	When possible, avoid femoral vein cannulation, and cannulate the subclavian rather than the internal jugular vein
Catheter Removal	Remove cathter promptly when it is no longer needed.

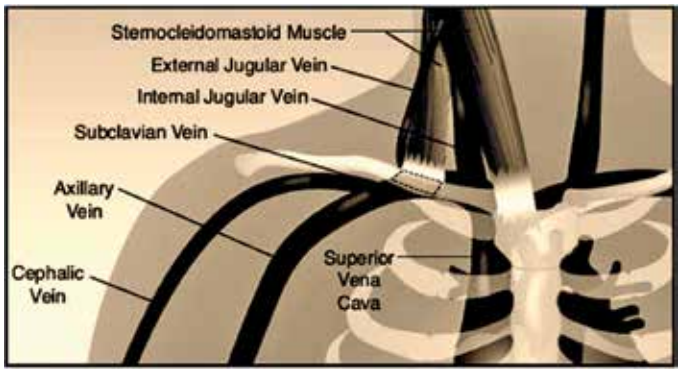

Fig. 2: Anatomic relationships of the internal jugular vein and subclavian vein

abusers or difficult to maintain (e.g., in agitated or delirious patients).

2. For the delivery of vasoconstrictor drugs (e.g., dopamine, norepinephrine), hypertonic solutions (e.g., parenteral nutrition formulas), or multiple parenteral medications.
3. For prolonged parenteral drug therapy requiring more than 5-7 days.
4. For specialized tasks such as hemodialysis, transvenous cardiac pacing, or hemodynamic monitoring.

The current guidelines for preventing catheter-related infections advocates that femoral vein cannulation should be avoided, and cannulating the subclavian vein is preferred to cannulating the internal jugular vein and are based on the perceived risk of catheter-related infections at each site (i.e., the highest risk from the femoral vein and the lowest risk from the subclavian vein).[10] Other considerations should also take into account for site. Subclavian vein is the least desirable site for insertion of

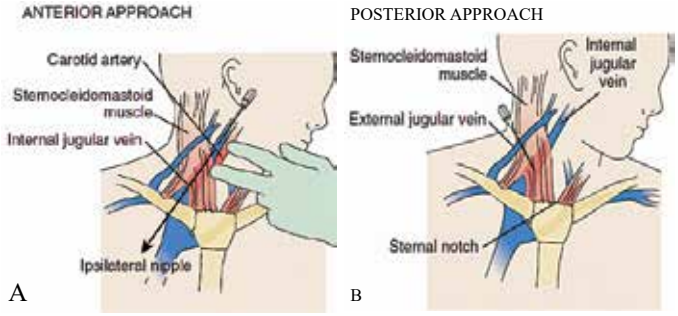

Fig. 3a: IJV cannulation – anterior approach,: 3b: IJV cannulation-posterior approach

hemodialysis catheters. Infection control is an essential part of vascular cannulation, and the pre-ventive measures recommended for central venous cannulation when used together as a "bundle" (Table 3) have been effective in reducing the incidence of catheter-related bloodstream infections (CRBSI).[10,11] Although ultrasound guidance during central venous cannulation is desired to minimise the complication rates it is not readily available in ERs. A sound knowledge of the landmarks and the anatomy of the vein to be cannulated is required if ultrasound is not available (Figure 2). The procedure is done using seldinger technique- threading of catheter over a guidewire.

INTERNAL JUGULAR VEIN

The internal jugular vein is located under the sternocleidomastoid muscle on either side of the neck (Figure 2). The right side of the neck is preferred for cannulation of the internal jugular vein because the vessels run a straight course to the right atrium. A head-down body tilt of 15° would distend the internal jugular vein and facilitate cannulation. The head should be turned slightly in the opposite direction to straighten the course of the vein.[12] When ultrasound imaging is not available, cannulation of the internal jugular vein is guided by surface landmarks.

There are two approaches to the internal jugular vein using surface landmarks (Figure 3a & b). In the anterior approach, the operator insert the probe needle at the apex of the triangular area created by the separation of the two heads of the sternocleidomastoid muscle in which the internal jugular vein and carotid artery run. Carotid artery pulse is located in this triangle and is gently retracted toward the midline and away from the internal jugular vein. The probe needle is advanced toward the ipsilateral nipple at a 45° angle from the skin. In posterior approach, the insertion point for the probe needle is 1 cm above the point where the external jugular vein crosses over the lateral edge of the sternocleidomastoid muscle. The probe needle is inserted at this point and then advanced along the underbelly of the muscle in a direction pointing to the suprasternal notch. Complications include accidental puncture of the carotid artery, accidental puncture of the pleural space (resulting in hemothorax and/or pneumothorax), septicaemia.

SUBCLAVIAN VEIN

The subclavian vein is a continuation of the axillary vein

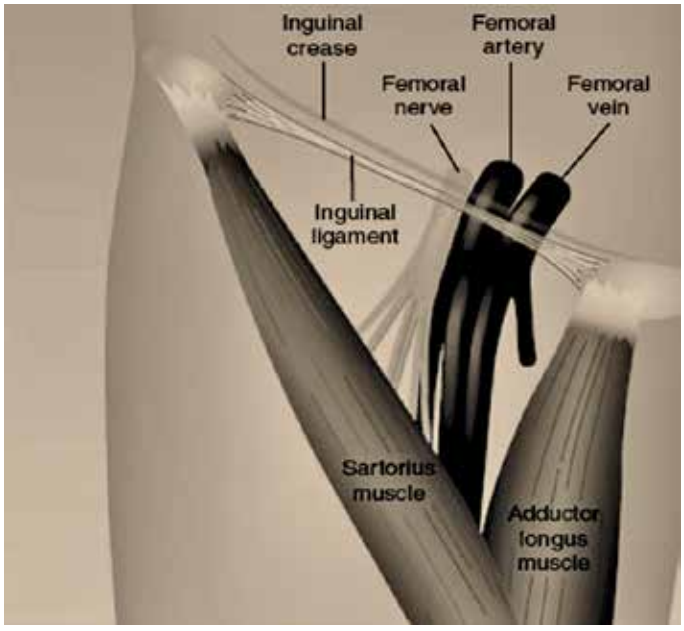

Fig. 4: Anatomy of the femoral triangle and relation of femoral vein

as it passes over the first rib. It runs most of its course along the underside of the clavicle. Situated just deep to the vein, on the underside of the anterior scalene muscle, is the subclavian artery and brachial plexus. The head-down body tilt distends the subclavian vein and can facilitate cannulation.[13] However, other maneuvers used to facilitate cannulation, such as arching the shoulders or placing a rolled towel under the shoulder, actually cause a paradoxical decrease in the cross-sectional area of the vein.[14]

The vein can be located by identifying the portion of the sternocleidomastoid muscle that inserts on the clavicle (Figure 2). The subclavian vein lies just underneath the clavicle at this point, and the vein can be entered from above or below the clavicle i.e supraclavicular approach and infraclavicular approach. Complications include puncture of the subclavian artery, pneumothorax, brachial plexus injury, and phrenic nerve injury.[15] Complications associated with indwelling catheters include septicemia and subclavian vein stenosis. The risk of stenosis is the principal reason to avoid cannulation of the subclavian vein in patients who might require a hemodialysis access site (e.g., arteriovenous fistula) in the ipsilateral arm.[16]

Femoral vein

The femoral is the main conduit for venous drainage of the legs. It is located in the femoral triangle along with the femoral artery and nerve (Figure 4). The vein is easier to locate and cannulate when the leg is placed in abduction. For cannulation of the femoral vein, locate the femoral artery pulse and insert the probe needle 1 - 2 cm medial to the pulse. If the femoral artery pulse is not palpable, draw an imaginary line from the anterior superior iliac crest to the pubic tubercle, and divide the line into three equal segments. The femoral artery should be just underneath the junction between the middle and medial segments, and the femoral vein should be 1- 2 cm medial to this point. This method of locating the femoral vein results in successful cannulation in over 90% of cases.[17] The major concerns with femoral vein cannulation include puncture of the femoral artery, femoral vein thrombosis, and septicemia. The femoral vein is a favored site for temporary hemodialysis catheters,[18] and for central venous access during cardiopulmonary resuscitation as it does not disrupt resuscitation efforts in the chest.[19] Other procedures which are done for assessing venous access are peripherally inserted central catheters (PICC), venous cutdown procedures, intraosseous route specially in pediatric patients and should be known to the physician.

Table 4: Non-invasive and invasive techniques for airway management

Technique
Non-invasive
• Bag-and-mask
• LMA and ILMA
• Combitube
Invasive (non-surgical)
• Endotracheal intubation
• Direct
• laryngoscopy
• Bronchoscopic
• Retrograde
Invasive (surgical)
• Jet ventilation
• Cricothyroidotomy
1. Percutaneous
2. Surgical
• Tracheostomy
1. Percutaneous
2. Surgical

AIRWAY MANAGEMENT

The primary objective of airway management is to secure unobstructed gas exchange and protect the lungs from aspiration. Because of the critical importance of maintaining gas exchange, compromise of upper-airway patency is a life-threatening emergency. physician must be capable of performing a variety of airway management techniques and instituting them in a logical and systematic way as there is no single airway modality that is universally applicable. Airway management techniques are generally classified as non-invasive or invasive, depending on whether instrumentation occurs above or below the glottis, surgical or non-surgical (Table 4). Bag-and mask ventilation and direct laryngoscopic tracheal intubation remain the routine methods of airway management in the emergency rooms.[20] Non-invasive techniques include bag and mask ventilation, laryngeal mask airway (LMA), intubating LMA (ILMA), use of combitubes and the physician should be acclimatized with these techniques.

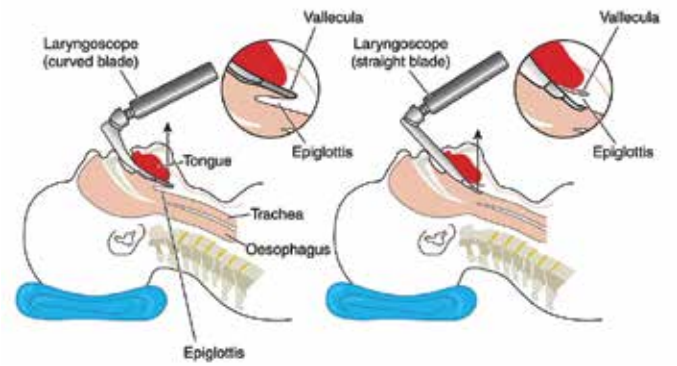

Fig. 5: Endotracheal intubation using A) Macintosh blade and B) Miller blade

Airway maneuvers must be instituted to maintain airway patency. The head tilt/chin lift is the basic maneuver for establishing an airway in someone without a cervical spine injury while the jaw thrust maneuver should be considered in all victims who may have sustained an injury to the cervical spine.

ENDOTRACHEAL INTUBATION

Endotracheal intubation remains the 'gold standard' of definitive airway management, allowing for spontaneous and positive-pressure ventilation and protection from aspiration. Walls et al through a multicentre study determined the characteristics of intubations in the ED in terms of indications, techniques, rates of success, and unplanned events in 8,937 subjects mostly intubated using rapid-sequence intubation. The first-attempt success rate was 95%, and 99% of subjects eventually received a successful procedure.[21]

Indications include acute airway obstruction, facilitation of tracheal suctioning, protection of the airway in those without protective reflexes, and respiratory failure requiring ventilatory support. Preparation and checking of all relevant equipment are essential before embarking intubation. Tracheal intubation should be preceded by adequate preoxygenation. The decision to use a straight or curved laryngoscope blade depends partly on the specific anatomical features of the airway, and partly on the personal experience and preference of the operator. The Macintoch blade is the most widely used curved laryngoscope blade,[22] while the Miller blade is the most popular style of straight blade[23] (Figure 5). Patient should be assessed for difficult intubation using mallampatti score, thyromental distance and examination of upper airway anatomy and if assessment is positive then difficult airway management equipment should also be accessible. Tracheal tube of optimal size should be selected according to the patient as small size tube would lead to increase resistance and work of breathing. Usually, in adult females tube size should be 7.5-8mm while in males it should be 8.5-9mm. Sometimes, use of stylet is needed inorder to facilitate the tube insertion.

Rapid sequence intubation (RSI) is the preferred method of endotracheal intubation in the emergency department (ED) because it results in rapid unconsciousness (induction) and neuromuscular blockade (paralysis). This is important in patients who have not fasted and are at much greater risk for vomiting and aspiration.[24] Steps of RSI includes preparation, preoxygenation, pretreatment (lidocaine, fentanyl, atropine according to case), paralysis with induction, placement of tube, post intubation care and can be easily remebered as seven Ps. Tube placement must be confirmed by auscultation, using EtCo2 and imaging techniques. Other techniques include video laryngoscopy, fibreoptic bronchoscopic intubation.

CRICOTHYROIDOTOMY

Cricothyroidotomy is a reliable, relatively safe and easy way of providing an emergency airway.[25] It is the method of choice if severe or complete upper-airway obstruction exists. The simplest method uses a horizontal incision through the cricothyroid membrane with the space held wide open by the scalpel handle or forceps. This is followed by insertion of a small tracheostomy or endotracheal tube. If available, a small surgical hook is useful to hold down the inferior margin of the incision to facilitate cannulation. A tube with internal diameter of 3.0 mm will allow adequate gas flow for self-inflating bag ventilation provided supplemental oxygen is used. Complications such as subglottic stenosis (1.6%), thyroid fracture, haemorrhage and pneumothorax occur during and after the procedure. Cricothyroidotomy is generally contraindicated in complete laryngotracheal disruption and age < 12 years. Other techniques include transtracheal jet ventilation, tracheostomy (percutaneous or surgical).

PLEURAL PROCEDURES- Intercostal drain insertion (ICD), needle thoracostomy, pleural aspiration

Pneumothorax, hydropneumothorax, pyopneumothorax, hemothorax in the emergency rooms demand intercostal drain and a physician must be trained to put the chest tubes and provide ICD care. The most basic instruments required are a scalpel, a large (Kelly) clamp, and the thoracostomy (chest) tube. Tube sizes vary from 12 to 42 Fr, with smaller tubes being used for smaller pneumothoraces and larger (a minimum of 36 Fr) tubes for hemothorax and empyma. Tube thoracostomy can be extremely painful, so parenteral analgesics or procedural sedation to stabilize the patients before the procedure is required. Use generous local anesthesia, such as up to 5 mg/kg of locally injected 1% lidocaine with or without epinephrine. Insert the tube over the top of the rib rather than near the bottom to avoid the neurovascular structures located on the inferior aspect of the ribs. The most common location for a chest tube is the midaxillary to anterior axillary line, usually in the fourth or fifth intercostal space. After incision, blunt dissection with Kelly clamp is done and then pleural surface is punctured with the clamp. An ICD is then introduced in the pleural cavity using a curved clamp. The drain is then secured with sutures and connected to the water seal bottle. The most common complications include infection, laceration of an intercostal vessel, laceration of the lung, and intraabdominal or solid organ placement(liver,spleen) of the chest tube.[26] Pleural fluid aspiration for diagnostic

and therapeutic (massive and recurrent pleural effusion for relief of dyspnoea) and needle thorocostomy in cases of tension pneumothorax are also being done in ERs routinely.

CARDIAC PROCEDURES- Pericardiocentesis and cardiac pacing

The purpose of cardiac pacing is to restore or ensure effective cardiac depolarization. Emergency cardiac pacing may be instituted either prophylactically or therapeutically.

Prophylactic indications include patients with a high risk for atrioventricular (AV) block. Therapeutic indications include symptomatic bradyarrhythmias and overdrive pacing. Transcutaneous and transvenous are the two techniques most commonly used in the emergency department (ED). Because it can be instituted quickly and noninvasively, transcutaneous pacing is the technique of choice in the ED . Transvenous pacing should be reserved for patients who require prolonged pacing or have a very high (>30%) risk for heart block. The transvenous method of endocardial pacing is commonly used and is both safe and effective. In skilled hands, the semifloating transvenous catheter is successfully placed under electrocardiographic (ECG) guidance in 80% of patients.[27] Usually a catheter of 3-5 Fr and 100cms is used. Right IJV and subclavian is generally cannulated. Once in the right ventricle and the position secured, the catheter is connected to the pacing generator. The procedure can be done either blind or under ultrasound guidance. Emergency pericardiocentesis is done in case of pericardial tamponade. In emergency setting, it can be done with 18 G needle,10ml syringe while monitoring ECG using subxiphoid approach. Catheter placement can also be done under ultrasound guidance using seldinger technique.

ULTRASOUND USE IN EMERGENCY ROOM

Point-of-care ultrasonography (POCUS) is a useful imaging technique for the physician working in the ED. Comprehensive training in POCUS is desired for emergency physicians. In using POCUS, the EM physician performs all image acquisition and interpretation at the point of care and uses the information immediately to address specific hypotheses and to guide ongoing therapy. The EM physician typically uses POCUS in a more extended fashion than the intensivist in the icu to include advanced abdominal, obstetric, testicular, musculoskeletal, and ocular ultrasonography. Another important assessment is the goal directed echocardiography (GDE). The GDE examination uses a limited number of standard echocardiography views in order to allow the physician to rapidly assess cardiac anatomy and function in the patient with hemodynamic failure.[28] Ultrasonographic examination of the thorax allows the EM physician to rapidly assess the patient with respiratory failure for normal aeration pattern, pneumothorax, lung interstitial syndrome (LIS), consolidation, or pleural effusion.[29] Focussed assessment with sonography using ultrasound (FAST) examination allowes physician to rapidly assess the patient with thoracic and abdominal trauma.[30]

OTHER PROCEDURES

Other procedures that are frequently done in emergency settings for diagnostic and therapeutic indications are paracentesis (massive ascites), peritoneal dialysis catheter insertion, hemodialysis catheter insertion, lumbar puncture, arterial blood sampling for blood gases analysis, arterial line insertion for intraarterial blood pressure monitoring, analgesia(intercostals blocks, regional anaesthetic blocks, insertion of nasogastric/orogastric tube, Minnesota tube insertion etc. Use of ultrasound for focussed assessment in trauma patients (FAST) is desired in the ERs

CONCLUSION

Role of physician in acute care is not only evolving but expanding too. In the absence of well established ED, there is a huge burden on physicians working in ERs for providing critical care to the patients. For this, a sound knowledge and training of life saving skills/procedures is not only desired but mandatory. Early interventions in the form of these essential life saving interventions not only buy time but also decrease mortality.

REFERENCES

1. Al-Azri, H., & Ratnapalan, S. Problem-based learning in continuing medical education: Review of randomized controlled trials. *Canadian Family Physicia* 2014; 60:157-165.
2. Robert E. Suter. Emergency medicine in the United States: a systemic review .*World J Emerg Med* 2012; 3:5–10
3. Anderson P, Hegedus A, Ohlen G, Holliman CJ, Williams D, Suter R: Worldwide growth of Emergency Medicine as a recognized medical specialty. *Acad Emerg Med* 2011; 18:S22-S23
4. Kouwenhoven WB, Ing, Jude JR, Knickerbocker GG. Closed-chest cardiac massage. *JAMA* 1960; 173:1064–1067.
5. Neumar RW, Shuster M,Callaway CW, Gent LM, Atkins DL et al.2015 American heart association guidelines update for cardiopulmonary resuscitation and emergency cardiac care. Circulation:2015(suppl2)
6. 2010 American Heart Association Guidelines for Cardiopulmonary Resusci-tation and Emergency Cardiovascular Care Science with Treatment Recom-mendations. Circulation, volume 122, issue 16, supplement 2, October 16, 2010. (Available online@ http://circ.ahajournals.org/content/122/16_suppl_2.toc)
7. Neumar RW, Otto CW, Link MS, et al. Part 8: adult advanced cardiovascular life support: 2010 American Heart Association Guidelines for Cardiopul-monary Resuscitation and Emergency Cardiovascular Care. *Circulation* 2010; 122 (suppl 3):S729–S767.
8. Mueller RL, Sanborn TA. The history of interventional cardiology: Cardiac catheterization, angioplasty, and related interventions. *Am Heart J* 1995; 129:146–172.
9. Taylor RW, Palagiri AV. Central venous catheterization. *Crit Care Med* 2007; 35:1390–1396.
10. O'Grady NP, Alexander M, Burns LA, et. al. and the Healthcare Infection Con-trol Practices Advisory Committee (HICPAC). Guidelines for the Prevention of

Intravascular Catheter-related Infections. *Clin Infect Dis* 2011; 52:e1–e32.

11. Furuya EY, Dick A, Perencevich EN, et al. Central line bundle implementation in U.S. intensive care units and impact on bloodstream infection. *PLoS- ONE* 2011; 6:e15452.
12. Feller-Kopman D. Ultrasound-guided internal jugular access. *Chest* 2007; 132:302–309.
13. Fortune JB, Feustel. Effect of patient position on size and location of the subclavian vein for percutaneous puncture. *Arch Surg* 2003; 138:996–1000.
14. Fragou M, Gravvanis A, Dimitriou V, et al. Real-time ultrasound-guided subclavian vein cannulation versus the landmark method in critical care patients: A prospective randomized study. *Crit Care Med* 2011; 39:1607–1612.
15. Rodriguez CJ, Bolanowski A, Patel K, et al. Classic positioning decreases crosssectional area of the subclavian vein. *Am J Surg* 2006; 192:135–137.
16. Hernandez D, Diaz F, Rufino M, et al. Subclavian vascular access stenosis in dialysis patients: Natural history and risk factors. *J Am Soc Nephrol* 1998; 9:1507–1510.
17. Getzen LC, Pollack EW. Short-term femoral vein catheterization. *Am J Surg* 1979; 138:875–877.
18. Parienti J-J, Thirion M, Megarbane B, et al. Femoral vs jugular venous catheterization and risk of nosocomial events in adults requiring acute renal replacement therapy. *JAMA* 2008; 299:2413–2422.
19. Hilty WM, Hudson PA, Levitt MA, Hall JB. Real-time ultrasound-guided femoral vein catheterization during cardiopulmonary resuscitation. *Ann Emerg Med* 1997; 29:311– 316.
20. Practice Guidelines for Management of the Difficult Airway. An updated report by the American Society of Anesthesiologists Task Force on management of the difficult airway. *Anesthesiology* 2003; 98:1269–77.
21. Walls RM, Brown CA 3rd, Bair AE, Pallin DJ, NEAR II Investigators. Emergency airway management: a multi-center report of 8937 emergency department intubations. *J Emerg Med* 2011; 41:347354.
22. Scott, J; Baker, PA (2009). "How did the Macintosh laryngoscope become so popular?". *Paediatric Anaesthesia* 2009: 19(Suppl 1): 24–9.
23. Amornyotin, S; Prakanrattana, U; Vichitvejpaisal, P; Vallisut, T; Kunanont, N; Permpholprasert, L (2010). "Comparison of the Clinical Use of Macintosh and Miller Laryngoscopes for Orotracheal Intubation by Second-Month Nurse Students in Anesthesiology". *Anesthesiology Research and Practice* 2010; 1–5
24. Sagarin MJ, Barton ED, Chng YM, et al. Airway management by US and Canadian emergency medicine residents: a multicenter analysis of more than 6,000 endotracheal intubation attempts. *Ann Emerg Med* 2005; 46:328-36
25. Kress TD, Balasubramaniam S. Cricothyroidotomy. *Ann Emerg Med* 1982; 11:197–201.
26. Sesieme EB, Dongo A, Ezemba N, et al. Tube thoracostomy: complications and management. *Pulm Med* 2012; 2012:256878.
27. Francis GS, Williams SV, Achord JL, et al. Clinical competence in the insertion of a temporary transvenous ventricular pacemaker. *Circulation* 1994; 89:1913.
28. Walley PE, Walley KR, Goodgame B, Punjabi V, Sirounis D. A practical approach to goal-directed echocardiography in the critical care setting. *Crit Care* 2014; 18:1–1.
29. Volpicelli G, Elbarbary M, Blaivas M, Lichtenstein DA, Mathis G, Kirkpatrick AW, Melniker L, Gargani L, Noble VE, Via G, Dean A. International evidence-based recommendations for point-of-care lung ultrasound. *Intensive Care Med* 2012; 38:577–91.
30. Holmes JF, Harris D, Battistella FD. Performance of abdominal ultrasonography in blunt trauma patients with out-of-hospital or emergency department hypotension. *Ann Emerg Med* 2004; 43:354–61.