INTRODUCTION
Institute for Health Care Improvement (IHI), USA has developed the concept of ‘Bundle’ to help clinician deliver bedside care more reliably and effectively. Each bundle consists of three to five elements, all of which are well established practices and evidence based but are not usually, uniformly practiced at the bedside. This concept has been initiated as a quality improvement process as it was realized that clinicians’ practice pattern vary and bedside application of standard guidelines are not uniform reflecting in inappropriate care. This is mostly applicable to Critical Care Practice as the patient group are heterogeneous, have a high mortality, many care givers involved in patient care resulting in heterogeneous care delivery with resultant increase in mortality.

Each element of this bundle may be practiced separately but application of the entire bundle gives the most consistent result in achieving best patient outcome. It is the best practical way of taking research to bedside in the most comprehensive manner. The power of a bundle comes from the body of science behind it and the method of execution. A bundle ties the changes together into a package of intervention which people know must be followed for every patient, every single time. Bundles may resemble a checklist but it is more than that. Bundles are different from a checklist as the latter contains many elements (more than five usually), all are not necessarily evidence based.

A bundle has specific element that makes it unique. These are

1. All the elements of the bundle are necessary and removing any one of them will result in inferior result.
2. All the elements in the bundle are based on randomized controlled trial (Level 1 evidence) and the recommendations are beyond any controversy.
   A bundle rather focuses on how to deliver this evidence of care rather than what the right care should be.
3. All elements in the bundle involve an all or none phenomenon and the Bundle itself also bears the same characteristic. That is to say each element in the bundle is either “performed” or “not performed” and entire Bundle performance also follows the same principle without leaving any scope for partial performance.
4. Implementation of all Bundle elements should take place simultaneously at a specific time and place with a minimum delay.

There is a level of accountability tied to a performance of Bundle as it is assigned to particular person or team who has to deliver within a specific time frame. He accountability and focus gives a Bundle lot of its power. The essential property of a good Bundle is to keep it small, simple, doable and patient centred.

TYPES OF BUNDLE
The following four bundles are most widely practiced in critical care units
1. Ventilator Bundle
2. Central Line Bundle
3. Sepsis Resuscitation Bundle
4. Sepsis Management Bundle

**VENTILATOR BUNDLE**

The key components of a Ventilator Bundle are (Table 1):

- **Elevation of the Head of the Bed**

Elevating head of the Bed to 30-45 degree is one of the most simple and effective way of preventing Ventilator Associated Pneumonia (VAP). The semi recumbent position may decrease chances of oropharyngeal aspiration or aspiration of gastric contents, which may take place even in intubated patient and is a source for VAP.

Draculovic et al conducted a randomized controlled trial in 86 mechanically ventilated patients assigned to semi-recumbent position or supine body position. The trial demonstrated that confirmed cases of VAP were 23 percent in the supine group while in the semi-recumbent position it was 5 percent (p=0.018). Practical way of implementing this element is to include this as an order list for patients on ventilator, getting the nurses to chart this every shift in the nursing record, discuss this in daily rounds and make family aware of the importance of this. Put a mark on the wall or at the bedside i.v. pole to indicate the desired height of the head end of the bed. Nowadays ICU beds are available with indicators for angle adjustment built in. Perform regular audit to ensure compliance and post the performance measure at a prominent place in the intensive care unit (ICU).

- **Daily “Sedation Vacations” and Assessment of Readiness to be Extubate.**

It appears that lightening sedation decreases the amount of time spent on mechanical ventilation. In addition early weaning from ventilator and extubation becomes easier and quicker and patients are able to participate and cooperate with physiotherapists and nurses in coughing out secretions and mobilizing out of bed. These attributes would help in preventing VAP.

Kress et al conducted a randomized controlled in 128 adult patients on mechanical ventilation, randomized to daily interruption of sedation irrespective of clinical state or interruption at the clinicians’ discretion. Daily interruption resulted in a marked and highly significant reduction in time on mechanical ventilation. The duration of mechanical ventilation decreased from 7.3 days to 4.9 days (p=0.004). Sedation vacations are not without risks, however. Patients who are not sedated deeply will have an increased potential for self-extubation. Therefore, the maneuver must be conducted in a careful fashion. In addition, there may be an increased potential for pain and anxiety associated with lightening sedation.

- **Daily Oral Care With Chlorhexidine**

Dental plaques develop in patients that are mechanically ventilated because of lack of chewing and absence of saliva. Dental plaques are covered by a biofilm which are colonized by bacteria, which can be aspirated resulting in VAP. A metaanalysis of eleven studies concluded that oral decontamination of mechanically ventilated patient with chlorhexidine is associated with a lower incidence of VAP. The recommended chlorhexidine solution strength is 0.12%.

Nursing staff needs to be educated regarding use of chlorhexidine oral rinse and it should be incorporated in the daily medication order.

- **Peptic Ulcer Disease Prophylaxis**

Stress induced gastrointestinal erosions and ulcers with bleeding is a common occurrence in sicker group of ICU population in general and ventilated patient in particular. These groups of patients should be put on routine stress ulcer prophylaxis. Incorporating this in the ventilator bundle reminds physician of its importance. H2 receptor blockers are more efficacious than sucralfate and are the preferred agents. Proton pump inhibitors have not been directly assessed against H2 blockers in this population therefore their relative efficacy is unknown.

- **Deep Venous thrombosis prophylaxis**

Ventilated patients are at a high risk of developing deep venous thrombosis (DVT) and its complications due to immobility. The risk of DVT is decreased if applied consistently according to guidelines.

**Table 1: Ventilator Bundle**

- Elevation of the Head of the Bed
- Daily “Sedation Vacations” and Assessment of Readiness to be Extubate.
- Daily Oral Care With Chlorhexidine
- Peptic Ulcer Disease Prophylaxis
- Deep Venous thrombosis prophylaxis

**Table 2: Central Line bundle**

- Hand Hygiene
- Maximum Barrier precautions during insertion
- Chlorhexidine skin antisepsis
- Optimal catheter site selection with avoidance of the femoral vein for central venous access in adult patients
- Daily review of Line necessity with prompt removal of unnecessary lines.
Bundle Therapy in Critical Care

Table 3: Sepsis Resuscitation Bundle

- Measuring Lactate levels
- Blood cultures obtained prior to antibiotic administration
- Improve time to broad spectrum antibiotics
- Treat hypotension and/or elevated lactate with fluids
- Treat hypotension and/or elevated lactate with fluids
- Apply vasopressors for ongoing hypotension
- Maintain adequate Central Venous Pressure
- Maintain Adequate Central Venous Oxygen saturation

Table 4: Sepsis Management Bundle

- Administer Low Dose Steroid by a standard Policy.
- Maintain adequate glycemic control
- Prevent excessive Inspiratory Plateau pressure
- Do not use Activated Protein C in any form of sepsis

CENTRAL LINE BUNDLE

Approximately 48% of ICU patients have central venous catheters (CVC) and majority of catheter related blood stream infections (CRBSI) are due to the use of CVC. Attributable mortality for these infections is around 20%.

The key components of a Central Line Bundle are (Table 2):

- Hand Hygiene
  Proper compliance with hand hygiene procedures by all health care workers reduces incidence of all nosocomial infections and particularly of CRBSI. Easy accessibility of an alcohol based hand cleaner or soap and water solution is a necessity for this.

  Appropriate time for hand washing includes
  - Before and after touching a patient
  - Before and after an invasive procedure
  - After removing gloves
  - If contamination is suspected
  - Maximum Barrier precautions during insertion

  Maximum barrier precautions mean strict compliance with hand washing, wearing cap, mask, sterile gown and gloves, covering the patient from head to toe with a sterile drape with a small opening at the incision site. Odds of developing CRBSI are six times if these precautions are not taken.

- Chlorhexidine skin antisepsis

  Use of 2 percent chlorhexidine in 70 percent isopropyl alcohol is an essential component for preventing CRBSI. It provides better antisepsis than Povidone-Iodine solution. Allow antiseptic solution to dry for two minutes before puncturing the skin.

- Optimal catheter site selection with avoidance of the femoral vein for central venous access in adult patients

  Whenever possible the femoral site should be avoided and subclavian site should be preferred over jugular for line insertion in adults. These recommendations are only from prevention of CRBSI view point. Other considerations like operator experience, chance of mechanical complication and bleeding risk has also to be considered.

- Daily review of Line necessity with prompt removal of unnecessary lines.

  Risk of infection increases over time as the line remains in place and these should be taken out at the earliest hen no more utilized.

SEPSIS BUNDLE

Sepsis is the fourth biggest killer disease in the world. A protocolised manner of managing sepsis has been shown to reduce mortality.

- Sepsis Resuscitation Bundle (Tables 3 and 4)

These are the elements which need to be accomplished within six hours of patient presenting to the hospital with severe sepsis or septic shock.

- Measuring Lactate levels
  Hyperlactatemia due to anaerobic metabolism and tissue hypoperfusion is usually present in severe sepsis and septic shock and is an important prognostic marker. It is particularly useful in detecting occult hypoperfusion in patients who are normotensive. A raised lactate should alert physician for early triage and instituting prompt therapy. In the absence of availability of lactate a base deficit of more than 2 and increasing metabolic acidosis in arterial blood gas or low serum bicarbonate may be taken as a surrogate marker.

- Blood cultures obtained prior to antibiotic administration

  30-50 percent of patients presenting with severe sepsis or shock have positive blood cultures. All attempts should be made to send two sets of blood culture (at least one from the periphery) of adequate amount, preferably inoculated at the bedside for an automated culture identification system. This should ideally be done prior to any antibiotic use (within 45 minutes) but this should not delay prompt institution of antibiotic.

- Improve time to broad spectrum antibiotics

  Every hour delay of starting empirical broad spec-
trum antibiotic increases mortality in severe sepsis and shock. In most observational studies this attribute turns out to be the most important factor linked to survival of sepsis patient. Appropriate intravenous antibiotic therapy should be started within one hour of presentation with severe sepsis.

- Treat hypotension and/or elevated lactate with fluids

All patients of sepsis presenting with hypotension or lactate level of more than 4 mmol/l should be aggressively resuscitated with fluids. Recent surviving sepsis guidelines recommend crystalloid resuscitation over colloids. An initial fluid challenge of 1000 ml of crystalloid (normal saline or Ringer solution) to achieve a minimum of 30 ml/kg of fluid should be given in the first 4-6 hours. If the serum albumin is low or anticipated to be low 4% Albumin may be used as a resuscitation fluid. Colloids, particularly hydroxyethyl starch with higher molecular weight of more than 200 Daltons should be avoided to prevent occurrence of nephropathy.

- Apply vasopressors for ongoing hypotension

When an appropriate fluid challenge fails to restore an adequate arterial pressure and organ perfusion therapy with vasopressor agents should be started to keep mean arterial pressure (MAP) above 65 mm Hg preferably monitored through an arterial line. Current recommendation for the choice of vasopressor is intravenous norepinephrine infusion titrated to an appropriate MAP. Epinephrine infusion may be considered as an alternative agent in refractory shock. Vasopressin 0.3 Units/min may be subsequently added or substituted for norepinephrine to achieve an equivalent result. Dopamine at a vasopressor dose may be used in selected patients with low cardiac output and heart rate and who have low risk of arrhythmias.

- Maintain adequate Central Venous Pressure

Early goal directed therapy protocolised by Rivers et al for resuscitating severe sepsis patients have an essential component of continuing fluid resuscitation to achieve a CVP of 8-10 mm Hg in non-mechanically ventilated patient. In patients on mechanical ventilation, diastolic dysfunction or increased intraabdominal pressure a higher CVP of 10-12 mm Hg is desirable.

- Maintain Adequate Central Venous Oxygen saturation

Central venous oxygen saturation measured by intermittent blood gas analysis of a central venous sample or continuously through a fiberoptic catheter reflects a global oxygen supply and demand ratio of the body. Normal values are more than 70%. This may be achieved by sequential infusion of fluid resuscitation, achieving a CVP of 10 mmHg, then packed red blood cell to achieve a hematocrit of more than 30 percent and Dobutamine infusion. This protocol was associated with an improvement in survival.

- Sepsis Management Bundle

These are evidence based goals that must be completed within 24 hours of presentation of severe sepsis and shock.

- Administer Low Dose Steroid by a standard Policy.

Intravenous hydrocortisone (200-300 mg/hour) preferably as a continuous infusion or in 3-4 divided doses for 7 days is suggested for adult patients with septic shock in whom blood pressure is refractory to fluid resuscitation and vasopressor therapy. Serum cortisol level or corticotrophin stimulation test should not be used as a guide for selecting steroids. Higher doses of corticosteroids, addition of mineralocorticoids or use of dexamethasone or other steroids should be avoided in these patients.

- Maintain adequate glycemic control

Present recommendation is to use a protocolised approach to blood glucose management of patients in ICU with severe sepsis. Intravenous insulin infusion should be started when two consecutive blood glucose level is 180 mg/dl or more. The infusion should be subsequently titrated to keep a blood sugar level below 180 mg/dl.

- Prevent excessive Inspiratory Plateau pressure

Present recommendations for septic patients on mechanical ventilation are to target a tidal volume of 6 ml/kg of predicted body weight in patients with different severity of acute respiratory distress syndrome. Plateau pressure should always be measured in these patients and kept below 30 cm of H2O, particularly in patients with normal extrapulmonary compliance. These strategies minimise the incidence of Ventilator induced lung injury/

- Do not use Activated Protein C in any form of sepsis

As opposed to previous recommendations Activated Protein C has not been found to be useful in a
recent study of septic shock patients and the drug has subsequently been withdrawn from the market.

REFERENCES


