GOAL DIRECTED THERAPY

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Definition

Goal directed therapy (GDT) is a term used to describe the use of cardiac output measurement to guide intravenous and inotropic therapy, to ensure adequate tissue perfusion and cellular oxygenation.

Background

Peri-operative mortality risk after general surgery is less than 1%. High risk patients have a far greater mortality risk of up to 30%. In 1992, Shoemaker showed that measurement and increase of oxygen delivery reduced mortality from 33% to 4%.

The normal physiological response to surgery is to increase cardiac output, resulting in an increase in oxygen delivery. Shoemaker showed that those who couldn't increase their oxygen delivery developed an oxygen debt. The proposition is that the speed at which this debt is repaid determines not only the likelihood of death but also the incidence of complications, such as infection and multiple organ failure, in survivors.

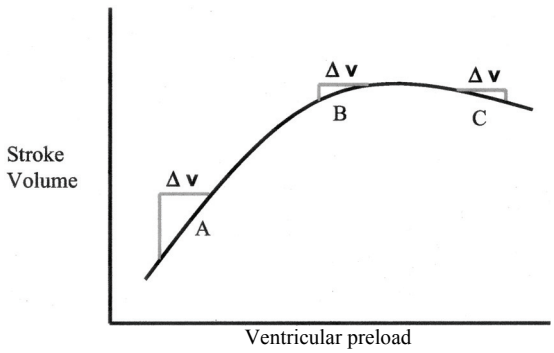
The rationale behind GDT is that restoring or improving oxygen delivery repays, or prevents an oxygen debt. Optimisation needs to occur at an early stage, prior to organ damage, when given late; it is ineffective, or even harmful.

Physiology

The fundamental principle behind GDT is optimising tissue perfusion. All four parameters should be targeted to obtain maximal oxygen delivery: DO_2=HR x SV x 1.34 x Hb x SaO_2 / 100.

It is assumed that initially the patient is on the ascending portion of the Frank-Starling curve where they have recruitable cardiac output. A fluid challenge will result in more than 10% rise in the stroke volume (SV). Once the left ventricle is functioning near the flat part of the Frank-Starling curve, fluid loading has little effect on cardiac output.

Normovolaemia is the preload that is required to establish a maximal cardiac output.



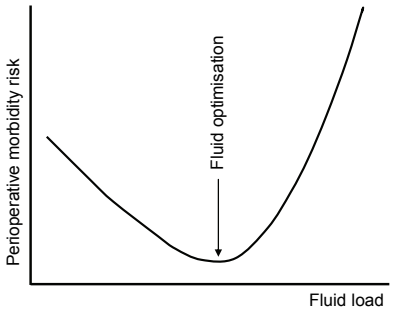
Excessive Fluid

Increased venous pressure results in loss of fluid from the intravascular to interstitial space. Pulmonary oedema and peripheral oedema ensue, impairing systemic and local tissue oxygenation. Pulmonary oedema results in an increase in A-a gradient and hypoxia. Studies comparing liberal versus restrictive fluid in general surgical patients show better outcome in fluid restricted patients. Thoracic surgical procedures have poorer outcomes with excess fluid.

Inadequate Fluid

Reduced effective circulation results in diversion of blood toward the vital organs (brain, heart), and away from nonvital organs (gut, skin, kidneys). Gut mucosa is susceptible to hypoperfusion; it leads to bacterial translocation, endotoxaemia and activation of inflammatory cascades. The resulting organ dysfunction leads to an increased complication rate, hospital stay and mortality.

It is difficult to reconcile the different schools of thought on fluid therapy. The relationship between fluid load and risk may be related like a U shaped curve, with increased risk at both ends of the spectrum and optimal fluid balance at the nadir point.



Evidence for Goal Directed Therapy

There are 9 GDT outcome studies looking at intra-operative fluid therapy. Most GDT studies (eight) used the oesophageal doppler to optimise SV, one used the LIDCO. These studies were in hip fractures, cardiac and colorectal surgery.

These studies showed a reduction in length of hospital stay, PONV and complication rate. A meta-analysis compared 5 studies in 420 patients undergoing major abdominal surgery. They were randomly allocated to GDT using the oesophageal doppler or to fluid given by conventional parameters.

Hospital stay was compared in 4 trials and was significantly reduced. There were fewer ITU admissions and complications, including cardiac, renal, respiratory and GIT. Gut function returned more rapidly in the intervention group. Cardiac output, oxygen delivery and colloid use were higher in the intervention group.

There was no difference in MAP, urine output and crystalloid use between groups. No difference was found in mortality, but studies not large enough.

Identifying the patient who will benefit. Shoemaker suggested a set of physiological conditions that deem patients high risk. A number of trials have based their selection on this. Pearse identified and added surgical factors which deem the patient high risk.

Optimisation Inclusion Criteria

- Known history of severe cardiac or respiratory illness: COPD,MI, CHF.
- Extensive surgery for carcinoma involving bowel anastamosis.
- Acute massive blood loss (>2.5 litres).
- Aged more than 70 with limited physiological reserve in one or more vital organ.
- Septicaemia (positive blood cultures or septic focus).
- Respiratory failure (PaO_2 <8 kPa on FIO_2>0.4).
- Acute abdominal catastrophe.
- Acute renal failure (urea> 20 mmol litre1; creatinine >260 mmol litre1).
- Late stage vascular disease.

There are multiple devices available to perform perioperative optimisation. Conventional parameters used to monitor blood volume are insufficient to detect mild hypovolaemia. A patient can lose 15% of blood volume without a change in heart rate or blood pressure. Urine output is also a poor indicator of volume; it is affected by the stress response.

Options for Flow Measurement

PICCO

Is the most validated system in pulse contour analysis. It is calibrated to transpulmonary thermodilution, and is invasive requiring a central line and a central arterial line. It has not been validated intraoperatively and is difficult to interpret in arrhythmias. It has been found to be as accurate as thermodilution.

LIDCO

Is an alternative form of pulse contour analysis. It requires a small lithium bolus, which is not associated with any side effects. It requires arterial and venous lines. It is beneficial in that it can be used perioperatively. There is interference with non-depolarisers; calibration with lithium needs to be done away from these.

Oesophageal Doppler

A doppler probe is inserted into the mouth or nose, to the midesophagus, and measures the velocity of blood in the descending aorta. A nomogram is used to measure the cross sectional area of the aorta. It calculates SV, CO and can give a measurement of systemic flow time which indicates resistance. It doesn't require calibration; little training is needed, but needs to be used in a sedated or anaesthetised patient.

Central Line (CVL)

The role of the CVL shouldn't be forgotten; fluid challenging the CVP rather than accepting static measurements has been established. Fluid given to patients with a CVL in situ tends to be less than those with a flow monitoring device. Central venous saturation (SCVO2) measurement is used in the ITU setting as part of the treatment of sepsis. It has been suggested that normovolaemia in the supine patient is reached when the SVCO2 reaches a maximal level, likely to be >70%. It has been shown to be useful in directing fluid replacement postoperatively.

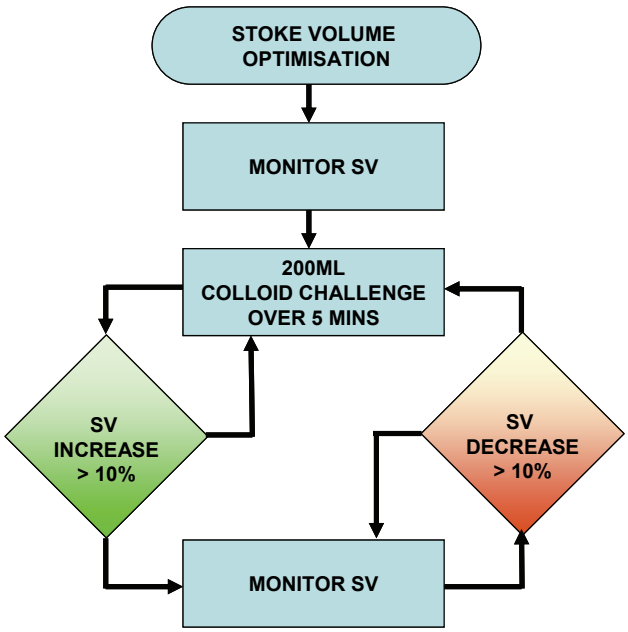
PAC

This is regarded as the gold standard for cardiac output monitoring, but has fallen out of favour because of its invasiveness, and perceived high complication rate.

Gastric Tonometry

Reduced perfusion results in decreased pH, which is associated with a poorer outcome. It is probably preferable to prevent hypovolemia by measuring SV, than detecting tissue acidosis. This won't become a monitor of choice for GDT

Algorithm For Goal Directed Therapy



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