Clinical References

CDI® Blood Parameter Monitoring System 550

An extensive body of peer reviewed evidence supports the importance of monitoring and maintaining adequate oxygen delivery levels and 11 other essential blood gas parameters during cardiac surgery.

TERUMO

Cite key messages from current research.

Recent clinical studies indicate that properly maintained DO_2 levels may result in:

- Reduced incidence of acute kidney injury (AKI)
- Reduced intensive care unit and overall hospital length of stay
- Reduced hospital costs
- Better patient outcomes and lower rates of morbidity and mortality

What is Goal Directed Perfusion?

- Goal directed perfusion aims to use intensive monitoring during cardiopulmonary bypass (CPB) to reduce mortality and postoperative complications. Perfusionists have the opportunity to administer therapy to patients intraoperatively, which is one of the most critical times for goal-directed therapy.[1]
- Goal-directed therapy is a patient care strategy that is designed to improve patient outcomes. This patient care strategy incorporates aggressive and individualized patient management and monitoring during periods of critical care.[1]
- Optimal perfusion requires intensive and focused monitoring to maintain the desired parameters within a very narrow therapeutic range for each individual patient. This goal-directed patient management should be associated with optimal oxygen delivery (DO_2) and tissue perfusion with reduced inflammatory response, preservation of the coagulation cascade, maintenance of colloid oncotic pressure, and fluid balance. This results in “the best long-term patient outcome in terms of survival and function of all major organ systems” resulting in low morbidity and reduced postoperative recovery periods.[1]

How many cardiac surgeries are performed worldwide?

- Every year there are 800,000 cardiac surgical procedures performed worldwide.[2] With up to 40% of these cases resulting in Acute Kidney Injury (AKI), there are nearly 320,000 patients who may benefit from continuous monitoring of their DO_2 thresholds. The CDI® Blood Parameter Monitoring System 550 provides the data you need, in real time, to help reduce the incidence of AKI.

What is Acute Kidney Injury?

- Acute Kidney Injury is defined as an abrupt or rapid decline in renal filtration function. It is a episode of kidney failure or kidney damage that happens within a few hours or a few days. AKI causes a build-up of waste products in the blood and makes it hard for the kidneys to keep the right balance of fluid in the body.

What is the current incidence of AKI related to CPB surgeries?

- AKI occurs in 2–30% of patients undergoing cardiac surgery, depending on the definition.[3]
- The nadir DO_2 level during CPB is independently associated with postoperative AKI.[4]
- After cardiac surgery, renal function impairment is common, and acute kidney injury (AKI) has an incidence that may reach 50% according to some definitions.[4]
- The early mortality rate in patients with AKI is around 5% but climbs to 50% when renal replacement therapy (RRT) is required.[4]

What is the clinical impact of AKI?

- Some of the consequences are extended intensive care unit stay, hospital stay, increased need for short- and long-term renal replacement therapy, progression of chronic kidney disease, including end-stage renal disease, and increased short- and long-term mortality.[3]
- Patients with even mild degrees of AKI have increased mortality and morbidity compared with their matched counterparts. Interventions that prevent or mitigate AKI after cardiac surgery can yield substantial clinical benefits.[10]

Link the importance of AKI to patient outcomes.

- AKI after cardiac surgery is one of the major determinants of bad outcomes, with increased early and late mortality rates and a considerable consumption of human and financial resources.[4]
- The ICU and postoperative costs and LOS for patients with AKI are higher than comparable costs for healthy patients, and the gap widens as AKI severity worsens.[5]
- Patients exhibiting symptoms of acute renal failure (ARF) after cardiopulmonary bypass surgery had a significantly higher mortality rate (11% vs 1.7%; $p = 0.014$), longer ICU stay (5.2 ± 1.2 days vs 2.5 ± 0.9 days; $p < 0.001$), and postoperative hospital stay (15.3 ± 3 vs 7.4 ± 0.2 days; $p < 0.001$) than patients without RR-ARF.[6]

What are the associated costs of AKI?

- Total and departmental level costs, length of stay (LOS) and requirement for renal replacement therapy were higher in AKI patients compared to controls. Statistically significant differences in all costs, mortality rate and requirement for RRT were seen in the patients suffering from AKI post cardiac surgery. Even patients with least severe forms of AKI had a 2.2-fold greater mortality, a 1.6-fold increase in intensive care unit LOS and 1.6-fold increase in total postoperative costs compared to controls.[5]
- At the population level, 1,078,036 individuals underwent major cardiac procedures from 2008 to 2011, with AKI developing in 105,648 (9.8%). Specifically, AKI developed in 8.0% of CABG, 11.4% of valve replacement, and 17.0% of CABG plus valve replacement patients ($p < 0.001$). Death was more common among patients with AKI vs those without (13.9% vs 1.3%, $p < 0.001$). Mean total index hospitalization cost was $77,178 for patients with AKI vs $38,820 for those without ($p < 0.001$). At the national level, the overall incremental annual index hospitalization cost associated with AKI was $1.01 billion.[9]

What is the relationship between goal directed perfusion, DO_2 and AKI?

- Severe hemodilution during cardiopulmonary bypass (CPB) is associated with an increased acute kidney injury (AKI) risk and is a risk factor for red blood cell (RBC) transfusions. Transfusions, in turn, are associated with bad outcomes, including AKI. CPB techniques may exert a great impact on the degree of hemodilution during CPB.[8]
- Therefore, it is likely that a comprehensive approach to renal protection, with specific attention to the containment of hemodilution during CPB and the maintenance of adequate oxygen delivery may represent an effective strategy to limit cardiac operation–induced AKI.[7]

Which studies recommend monitoring DO_2 and maintaining a threshold above 272 mL/min/m^2?

- Perfusionists have an important role to play regarding better patient outcomes. The nadir DO_2 level during CPB has been independently associated with postoperative AKI. Since DO_2 during CPB is a modifiable factor through pump flow adjustments, research indicates that goal-directed perfusion management aimed at maintaining the DO_2 level above the identified critical value might limit the incidence of postoperative AKI.[4]
- Published research indicates the best predictor for acute renal failure is the lowest oxygen delivery, with a critical value at 272 mL/min/m^2.[6] Using the calculated DO_2 value provided by Terumo's CDI System 550, perfusionists can continuously monitor this vital threshold and intervene before DO_2 reaches a critical low.
- Therefore, DO_2 must be considered as one of the most significant determinants of "optimal" perfusion during CPB. Targeting DO_2 levels above a critical threshold (>262 mL/min/m^2) is more important in preserving organ function than targeting individual hematocrit or pump flow values.[1]

Reducing the risk of morbidity and mortality from AKI saves costs at the hospital.

- Maintaining healthy DO_2 during cardiac surgery can lead to cost savings for hospitals. Patients with AKI have longer lengths of stay and consume significant resources beyond those with normal kidney function. AKI increases the resources used by patients by doubling their average length of stay in the ICU.[2]

How can the CDI System 550 be used to maintain an adequate DO_2 threshold?

Adopting monitoring technologies provides early warning of dynamic changes during surgery. The CDI Blood Parameter Monitoring System 550 allows constant visibility of DO_2 levels, hematocrit, hemoglobin, and other critical parameters such as pH, pCO_2, pO_2 and K^+.

How can CDI System 550 improve patient outcomes?

Appropriate regulation of blood gas parameters is essential to avoid the negative outcomes linked to sub-optimal blood gas parameter control.[11, 12, 13]

How do other products, offered by Terumo, fit into goal directed perfusion?

Tailored tubing packs with Xcoating™ Surface Coating and CAPIOX® low prime oxygenators can minimize hemodilution, leading to maximized hemoglobin levels and maintaining an optimal DO_2 threshold. [14, 15] Adopting the Terumo Prescriptive Oxygenation™ approach allows sizing the oxygenator to the patient and contributes to optimal fluid management.

A modular pumping system, like the Terumo® Advanced Perfusion System 1, offers the flexibility to mount pumps within a small footprint and closer to the patient. This allows reduced tubing lengths, leading to maximized hemoglobin levels and maintaining an optimal DO_2 threshold.

The Nonin SenSmart™ Model X-100 Universal Oximetry System helps to ensure adequate oxygen delivery to the brain and other areas of the body, continuously displaying important data for optimal perfusion practice.

Summary

Numerous studies have shown that careful control of oxygen delivery during cardiac surgery can reduce morbidity and mortality. The CDI System 550 measures and displays continuous DO_2, allowing the user to maintain levels known to lower the risk of AKI.

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