

# CASE STUDY

## Minimally Invasive Monitoring Elective Liver Resection

### INTRODUCTION

The most commonly used method of measuring a patient's cardiac output involves placement of a catheter in the pulmonary artery and performing thermodilution measurements. Although, this method is accurate under most clinical conditions, it is invasive. A minimally invasive and simple method of monitoring cardiac output would be invaluable in high-risk critically ill patients undergoing surgery.

Patient details: 54-year-old male, 170 cm, 74 kg, BSA 1.87 m<sup>2</sup>

Medical history: Hypertension, diabetes mellitus, and coronary artery disease with poor left ventricular ejection fraction of 35%

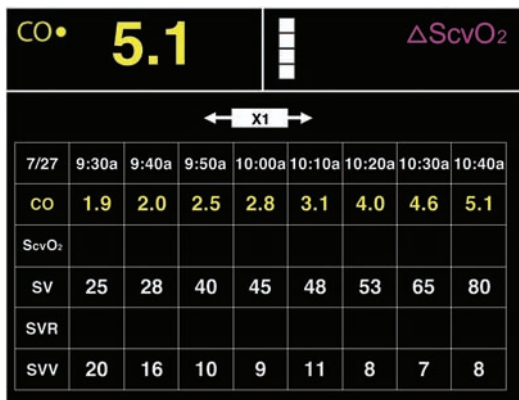


Figure 1

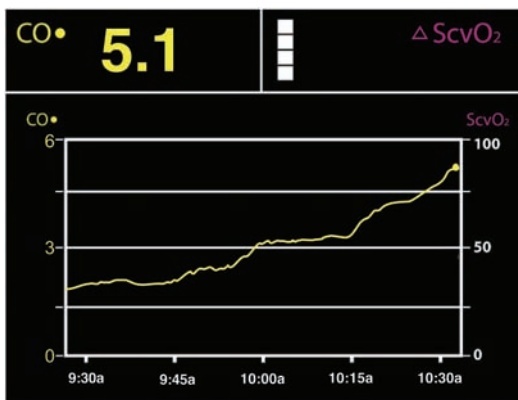


Figure 2

### CASE NOTES

This patient arrived in the operating room for an elective liver resection for hepatocellular carcinoma. Vital signs prior to surgery were as follows: blood pressure (BP) 150/85; heart rate (HR) 66/min; and respiratory rate 14/min. General anesthesia with endotracheal intubation was performed after induction with intravenous propofol 2 mg/kg and muscle paralysis with rocuronium 0.9 mg/kg. Monitors were placed after induction and included continuous arterial blood pressure and central venous pressure (CVP) monitoring. Initial CVP was 8 mmHg. Anesthesia was maintained with isoflurane in oxygen and nitrous oxide.

Two hours into surgery, the anesthesiologist noted changes in the patient's vital signs. BP decreased to 95/44. Electrocardiogram showed a HR of 126/min, sinus tachycardia with no ST segment changes. CVP was 7 mmHg. Blood loss thus far was approximately 600 ml. Urine output was 30 ml from the start of



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surgery. The anesthesiologist administered a fluid challenge of 500 ml colloid solution with no improvement in hemodynamic parameters.

A cardiac output sensor (Edwards FloTrac sensor, Edwards Lifesciences, Irvine, CA, USA) was connected to the existing arterial line. Initial readings revealed a cardiac output (CO) of 1.9 L/min (cardiac index of 1.0 L/min/m<sup>2</sup>). Stroke volume (SV) was decreased at 25 ml (stroke volume index 13 ml/m<sup>2</sup>) and stroke volume variation (SVV) was 20% (Figure 1). Additional fluid boluses of 250 ml each (total 750 mL) colloid solution increased the CO to 2.5 L/min. SVV improved to 10% but SV remained low at 40 ml. BP was 99/54 and HR was 110/min.

An intravenous infusion of epinephrine was therefore started at 0.05 mcg/kg/min and gradually escalated to 0.1 mcg/kg/min according to hemodynamic parameters. CO increased to 5.1 L/min with return of vital signs to near normal values (BP 125/67, HR 102/min, CVP 6 mmHg). At the end of surgery, patient remained intubated and ventilated and was transferred to the Intensive Care Unit for postoperative care. He was extubated the following day. Laboratory tests for cardiac enzymes performed in Intensive Care on the day of surgery showed raised troponin I and creatine kinase MB fraction levels consistent with myocardial ischemia.

## DISCUSSION

This case demonstrates the usefulness of a less invasive, easy to use continuous CO monitor in the operating room. In this clinical setting where significant blood loss is usually associated with liver resection, the initial management is commonly fluid resuscitation to replace the effective circulating blood volume. When hemodynamic parameters do not improve, persisting with additional fluid loading may be detrimental as this patient has poor left ventricular function. Injudicious and excessive fluid replacement may lead to congestive heart failure. When initial fluid challenge did not improve this patient's BP, measurement using the FloTrac sensor revealed a low CO and SV and a SVV of more than 10%. Hypovolemia is associated with an exaggerated SVV. Despite improvement in the SVV with additional fluid, CO remained low. This was indicative of poor cardiac contractility. Therefore, the correct intervention was inotropic support with an intravenous infusion of epinephrine to improve cardiac function.

The FloTrac sensor is a less invasive hemodynamic monitoring device that can be used to monitor continuous CO, SV and SVV measurement through an arterial pressure line. It is useful in the perioperative environment and allows monitoring of high-risk patients with significant cardiac disease undergoing major surgery with potentially large fluid shifts and blood loss. It is also used to guide inotropic therapy and facilitate precise titration of cardiovascular medication in real time.

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