# TEE GUIDED POST-OPERATIVE HEMODYNAMIC MANAGEMENT OF CARDIAC **SURGERY PATIENTS**

# Harold M Hastings<sup>1</sup>, PhD, Scott L Roth<sup>1</sup>, MD, Chad E Wagner<sup>2</sup>, MD, David C McGiffin<sup>3</sup>, MD, James E Davies Jr.<sup>3</sup>, MD

### PURPOSE

The purpose of this study was to determine the potential of a miniaturized TEE probe (the ImaCor ClariTEE (TM), approximately NG tube size) to perform hemodynamic monitoring of cardiac function and ventricular volumes in post-operative cardiac surgery patients. TEE has been cited as especially appropriate for hemodynamic monitoring because hemodynamic abnormalities are multifactorial; possible causes include hypovolemia, left ventricular systolic dysfunction, and tamponade. The recently introduced ImaCor Zura (TM) cardiac monitoring system uses a miniaturized, detachable, single-use TEE probe to obtain a variety of cardiac images, including the trans-gastric short axis view. In contrast to conventional TEE probes, the ImaCor system was designed and cleared by the FDA to remain indwelling up to 72 hours for episodic hemodynamic monitoring.

## METHODS

The ImaCor Zura imaging system was used to monitor 33 postoperative cardiac surgery patients at two clinical centers: a series of 16 patients at the University of Alabama at Birmingham and a series of 17 patients at Vanderbilt. Effects on patient management were recorded, and analyzed retrospectively.

## **SUMMARY OF RESULTS**

TEE monitoring led to changes in hemodynamic (fluid and vasopressor) management in 17 of 33 patients (52%) based. Projected re-operations were avoided in three patients (9%). TEE monitoring also detected tamponade requiring re-operation in one patient, guided re-operation in a second patient and was used to optimize pulse index by adjusting LVAD flow rate in a third patient.

Re-operation for effusion avoided -TEE monitoring detected a cardiac effusion in a hemodynamically unstable patient. A decision was made to monitor the patient to see how the effusion progressed. The effusion was unchanged overnight, and eventually resolved without surgery



1. ImaCor, Uniondale, NY, 2. Anesthesiology, Vanderbilt University, Nashville, TN 3. Cardiovascular Thoracic Surgery, University of Alabama, Birmingham, AL

### 

Transducer placed close to heart, position easily reproducible, making it possible to compare images over time



Trans-Gastric Short Axis View (TGSAV) shows cross-section of left ventricle, useful for estimating size and pumping function.

# **TEE and HEMODYNAMIC MANAGEMENT**

What is the current status? Why? Where is he/she going? Why How do we reach goals?

# **IMACOR TEE MONITORING SYSTEM - designed** for HEMODYNAMIC MANAGEMENT



Miniaturized probe, can remain indwelling for up to 72 hours. Disposable.



**Detachable from handle**: one system, may probes, many patients.

### **Two key views: TGSAV and Mid-Esophageal Four Chamber View.**



TGSAV at midpapillary level. Useful for (filling) and function.



Only TEE answers the question why TEE monitoring through time helps answer the question how

monitoring LV size



Mid-Esophageal Four Chamber View Shows RV, valves.

# **CLINICAL IMPACT**

MANAGEMENT CHANGES in 20 of 33 patients (61%), Including

> Fluid and vasopressor changes in 17 of 33 patients (52%) Projected re-operations avoided in 3 of 33 patients (9%) Re-operations guided in 3 of 33 patients (9 %) VAD adjusted in 1 patient

# **ECONOMIC IMPACT**

METHODOLOGY: determine complications, find rate and cost of complications from our data and the literature, estimate the rate of avoided complications from our experience.

- = \$2,080 per patient.

employee (SLR), respectively.

Cardiac re-operations. Ranucci M et al., Ann Thorac Surg. 2008; 86: 1557-62 cited a re-operation rate of: 2 - 6% due to bleeding. Extrapolation from Speir, AM et al's (Ann Thoracic Surg. 2009; 88: 40-46) 2004-2007 data yields a savings of \$ 25,000 per avoided re-operation. TEE monitoring here avoided re-

operations in 9% of patients. A reduction in the re-operation rate from 6% to 2%, would avoid re-operations in 4% of patients, saving  $4\% \times $25,000 = $1,000$  per patient.

2. <u>AKI.</u> (Elahi M et al., Eur. J. Cardiothorac. Surg., 2009; 35: 854 -63, supported by Shaw, et al., Nephron Physiol. 2008;109:55-60) cite a 5% rate. Kidney failure costs \$60,000 per patient

(extrapolated from Speir et al. (2009). If better hemodynamic management were to reduce the kidney failure rate by 2% per patient, this would save  $2\% \times \$60,000 = \$1,200$  per patient. Long hospital stay. Pölönen P et al. (Anesth Analg.

2000;90:1052-9) cite an average reduction of 1 day from goaldirected therapy postcardiac surgery; Pearse R et al.(Crit Care. 2005;9:R687-93) cite 3 days for general surgery patients. We estimate a 2 day reduction in hospital length of stay would save

\$4,000 per patient. We changed hemodynamic management in 52% of patients; we estimate an average savings of  $52\% \times $4,000$ 

CONCLUSION: Reasonable estimated reductions in the rate of these three complications implies that TEE monitoring has the potential to save \$4,080 in a patient population similar to those studied here, not including savings from reduced mortality, reduced vent time, fewer pressors, etc. For which we have insufficient data to quantify. Note – we sharply reduced pressor usage in many patients, potentially resulting in shorter ICU and

hospital stays. However, further study is needed.