PERIOPERATIVE RISK ASSESSMENT AMONG PATIENT WITH CONGESTIVE HEART FAILURE: A CALL FOR GUIDELINES

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ABSTRACT

More than 10 million major noncardiac surgical procedures are performed annually. Current perioperative risk assessment has focused on ischemic heart disease and shows that adherence to practice guidelines reduces morbidity and mortality. An estimated 10 million people in the United States suffer from ventricular dysfunction (class B), and half are symptomatic (class C) despite medical therapy. Individuals with heart failure who undergo surgical procedures are at higher risk for perioperative complications than those with ischemic heart disease. There is no current consensus on the best approaches to risk stratify individuals with heart failure who undergo surgical procedures. This review will provide information on the current state of risk assessment for heart failure and emphasize the role of 2D/Doppler echocardiography as a tool to optimally stratify risk.

INTRODUCTION

Heart failure afflicts nearly 2.5% of the adult U.S. population. With 550,000 new cases diagnosed annually, experts believe that by the year 2012 roughly 20 million Americans will suffer from congestive heart failure (CHF).1 Despite significant strides in treatment strategies, hospitalizations have topped 950,000, attributable deaths approach 265,000 and costs reached $27 billion in 2005.2 CHF is common in individuals over age 65 (roughly 1/1000) and is predominantly cared for by general internal medicine or family practice physicians. Unfortunately, unless specific hospital or practice-based interventions are established to optimize treatment, compliance with basic medical therapies documented to reduce morbidity and mortality are generally no higher than 30%.[3]

The last 15 years have documented a change in the epidemiology of noncardiac surgical procedures.3•5 In 2000 there were 40 million procedures performed in the United States; 10 million were major noncardiac surgical procedures, and four million of those were performed in individuals over age 65.[5,6] Undoubtedly, a significant number of patients undergoing major surgical procedures have occult or established left-ventricular dysfunction.

Published data among heart failure patients who undergo major noncardiac surgery have reported a wide range of morbidity and mortality (Figure 1).[6-7] Most recently, Hernandez and colleagues determined that individuals with an antecedent diagnosis of heart failure who underwent major surgery have a 30-day readmission and mortality rate of 20% and 11.7%, respectively.[6] These rates are significantly worse than individuals diagnosed with either ischemic heat disease (14.2% and 6.6%) or age-matched controls (11% and 6.2%).8

In 2001, the American College of Cardiology, the American Heart Association and the American College of Physicians put forth guidelines for managing cardiac patients undergoing noncardiac surgery. The guidelines feature the identification, risk assessment and treatment strategies for ischemic heart disease but dedicate a mere two paragraphs to heart failure. The authors recognize its important prognostic implications by pointing

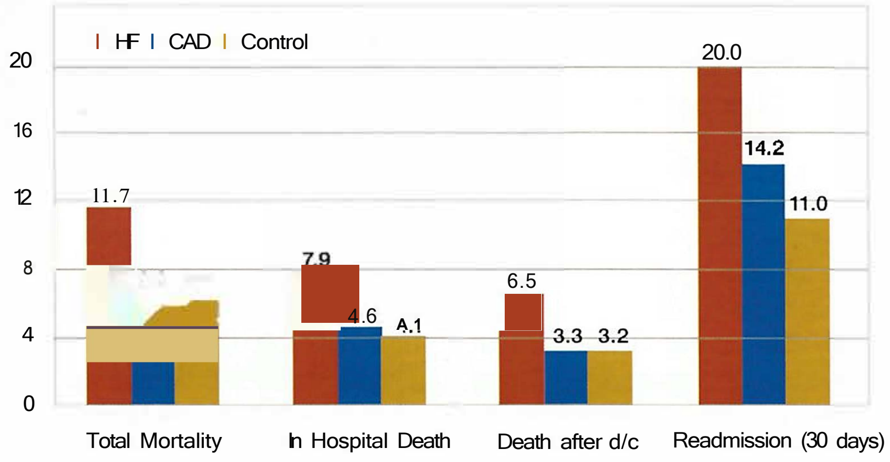

Figure 1. Risk-adjusted events rates among patients undergoing noncardiac surgery. Statistically significant higher rates were observed among patients with a diagnosis of heart failure (HF) compared with either coronary artery disease (CAD) or control.[8]

out that "little information is available" and every effort must be made to "detect unsuspected heart failure," but they fail to present specific risk assessment paradigms or management strategies.

This manuscript will review the current literature regarding risk assessment and perioperative management of patients with heart failure undergoing noncardiac surgical procedures. The authors will support the widespread use of 2D echocardiogram with Doppler along with clinical criteria as the foundation of risk assessment. A simple algorithm will help unify concepts and set the groundwork for further research. (Figure 3)

Risk Factor	Definition	Points
Ischemic heart disease	*Any of:* History of MI History of positive exercise test result Current chest pain Nitrate use ECG with Q wave	1
Congestive heart failure	*Any of:* History of HF Pulmonary edema PND Bilateral rates S3 gallop CXR with pulmonary vascular redistribution	1
Type of surgery	High risk (intraperitoneal, intrathoracic, or supralinguinal vascular)	1
Cerebrovascular disease	TIA or stroke	1
Diabetes mellitus	Preoperative treatment with insulin	1
Renal function	Creatinine level > 2.0 mg/dl (> 177μmol/L)	1

Table 1. Revised cardiac risk index (RCRI)

PRESENT MODELS OF PERIOPERATIVE RISK

Generally speaking, perioperative risk is based on four factors: urgency of surgery, complexity of procedures involved, extent of medical comorbidities and severity of underlying heart disease. Each factor requires thorough investigation before assessing perioperative risk.[9]

All current models of perioperative risk assessment include a cardiovascular-directed history and physical examination.[9] Various permutations of rhe original concepts of Goldman[10] and lacer Detsky11 have been modified by Lee and colleagues and are now known as the revised cardiac risk index (RCRI),12 which stratifies cardiovascular risk by relying on two major cardiovascular disease entities: ischemic cardiovascular disease and congestive heart failure. The RCRI (Table l) has been validated prospectively, utilized at a number of large clinical centers and recently implemented in the design of major clinical investigations.13·[14] Among the specific clinical factors that carried the highest risk for perioperative cardiovascular events are signs, symptoms or a hiscory of heart failure. In fact, in the original Goldman risk index, the physical findings of a cardiac S3 or jugular venous distension were the most significam predictors of perioperative events.[10] The RCRI also found that chest radiographic findings of pulmonary edema carried a 4.3-fold increase in major perioperative cardiovascular complications.11

The challenge associated with diagnosing heart failure is apparent on review of available literature. Earlier single-center risk assessments such as the Goldman Criteria relied on physical examination and interpretation of radiographic studies by a limited group of physicians, which minimized intra-observer variability and limited mulcicenter reproducibility. Lacer efforts simply documemed a "history of hearc failure" as a significant risk factor, thereby achieving greater reproducibility. While either definition carries sufficient power to assign risk, the latter identifies a nonmodifiable risk factor while the former allows for pocemial treatment paradigms.

While current ACC/AHA guidelines3 include a combination of CHF signs and symptoms as well as established therapies (e.g. diuretics, vasodilators), no published risk indices include the complete definition of CHF. Furthermore, heart failure can be assigned to cwo groups: Systolic Heart Failure {impaired systolic function) and Oiascolic Heare Failure (preserved syscolic function), each with variable intrinsic risk.3 Although the phenotypes of these two categories are disparate, they share a common underlying pathophysiology. The congestive (or symptomatic) aspect of heart failure irrespective of syscolic function implies that the heart is unable co adequately maintain the body's metabolic demands in association with a significant rise in ventricular diastolic pressure. Therefore, CHF mandates a rise in diastolic pressure that may manifest as classic signs (S3, rales, peripheral edema) and symptoms (orchopnea, dyspnea) and would be expected co respond to established therapies. While symptoms of heart failure can be elicited by a carefully targeted history, physical examination is a late manifestation of elevated ventricular diastolic pressure and is neither sensitive nor reproducible. Symptoms of heart failure carry particular prognostic information and are used to risk stratify patients with chronic heart failure.[3] Stages of heart failure are typically categorized into four classes of severity using the New York Hean Association (NYHA) functional classification system, which relates sympcoms co everyday activities.3 A higher class of hean failure corresponds to more severe symptoms and hence restricted physical activity and higher surgical risk. For example, NYHA class IV heart failure is an independent factor that signals caucion for surgery regardless of the type.5 If elevated ventricular filling pressure is a symptom and symptoms are necessary to stratify risk among patients with heart failure, then an objective measure of ventricular diastole (more importantly left ventricular filling pressure) would be advantageous.

POTENTIAL ROLE OF DOPPLER ECHOCARDIOGRAPHY FOR RISK STRATIFICATION

The last 20 years of Doppler cardiac ultrasound has revolutionized our understanding of both ventricular systole and diastole. Advancements have allowed accurate quantification of ventricular filling irrespective of systolic function, and invesrigacors have segregated the impact of diastolic abnormalities with regard to clinical outcome (see below).15 Furthermore, Nagueh and colleagues at the Methodist DeBakey Heare Center in Houston have developed regression equations using specific Doppler indices to estimate diastolic filling pressures.16 While a full review of the technical and interpretive aspects of the Doppler characterization of ventricular diastole is beyond the scope of this manuscript (see Naqvi et al.17), some general observations are pertinent for this discussion.

1) Heartsofpatiencswithsystolicdysfunction have prolonged myocardial relaxation and decreased compliance and therefore uniformly have diastolic dysfunction (substrate).
2) The specific Doppler pattern of mitral inflow observed in patients with systolic dysfunction is influenced by a number of factors, including left atrial pressure and the crossover pressure between the left atrium and left ventricle at the onset of mitral valve opening (stimulus).
3) Correlacing symptoms (reaction) to isolated and serial transrnitral Doppler assessments of patients with syscolic dysfunction has helped define our understanding of the interaction between substrate and stimulus.

In general, three patterns of micral inflow have been observed (Figure 2), and each correlates with che clinical spectrum of systolic heart failure. Relevant investigations have assigned risk by segregacing pacients into groups with either the presence or absence of the restrictive filling pattern (RFP) or the ability to reverse the RFP. The generally accepted definition of RFP is that the ratio of early (E) to atrial (A) wave be greater than 2.0 and the deceleration time (OT) of che mitral E wave be less than 140 ms.

Static measurement of rnitral inflow among patients with systolic dysfunction have demonstrated that the presence of a RFP predicts worse NYHA functional class[17] and exercise capacity[18] despite similar demographics, LV diascolic dimension, fractional shonening and right heart catheterization data. Xie at al. extended these observations and found that the presence of RFP among ambulacory patients with LVEF < 40% was the single best discriminator of mortality, conferring event rates of 5% vs. 19% p<0.05 at one year and 5% vs. 51% p<0.01 at two years (RFP

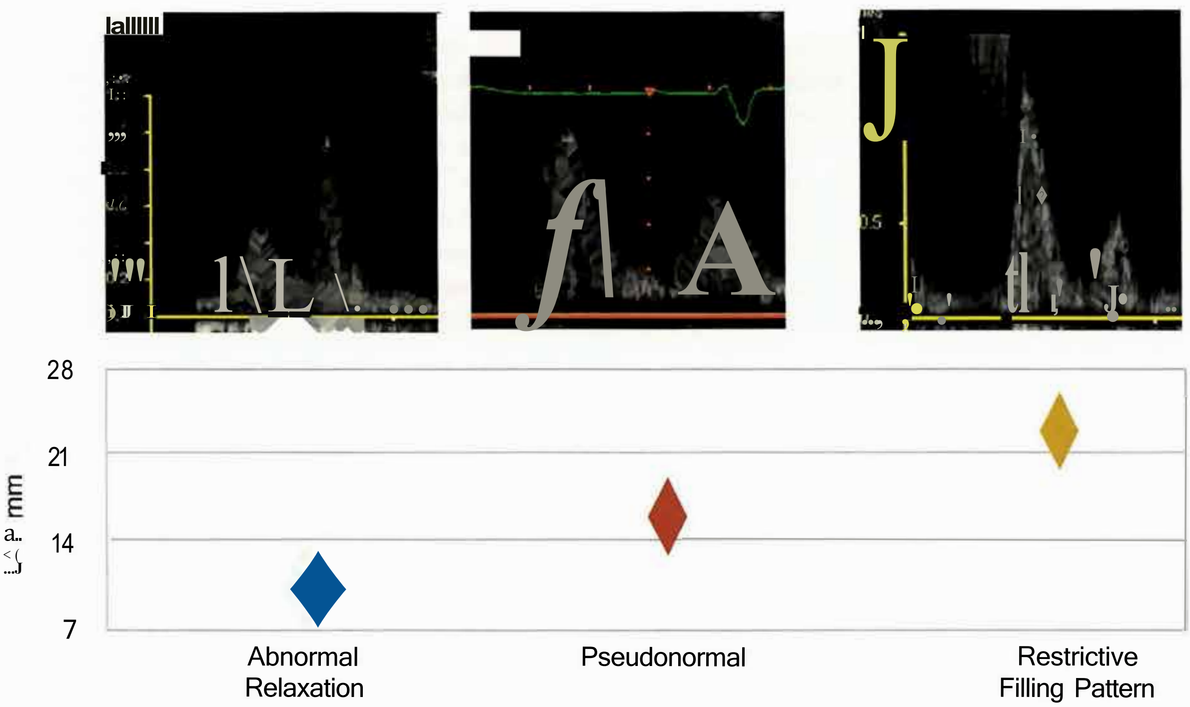

Figure 2. Doppler mitral inflow pattern in patients with systolic dysfunction (LVEF < 35%) and its relation to left atrial pressure.

vs. non-RFP respecrively).19 Further discriminacory power of the transmicral inflow pauern was documented among 311 patients being evaluated both for heart transplantation and for myocardial oxygen consumption (MVO2) values less than 14 ml/min/kg. The presence of a RFP added important prognostic information and was associated with a significantly higher morcalicy compared co patients with a non-RFP (48% vs. 20%). Not surprisingly, chose subjects wich MVO2 values greater than 14 ml/min/kg had a significantly better survival, although a RFP among these patients was associated with three rimes the mortality compared to those without a RFP (20% vs. 6%).20

Therapies chat reverse the RFP improve prognosis among patients with syscolic heart failure. As mentioned earlier, the Doppler micral inflow panem is strongly influenced by alceracion in preload, and the reversibility of RFP with medical or device-based therapy carries prognostic implications. For more than six months, Traversi et al. optimized medical treatment in 98 patients with initially RFP (E/A > 1 and OT < 130ms) and performed serial studies with echo-Doppler, cardiopulmonary testing and hemodynamic at six monchs.21 A highly significant reduction in pulmonary wedge pressure (from 25 +/- 7 mm Hg co 11 +/- 3 mm Hg) and an increase in exercise capacity was observed in 19 patients with initial RFP who reverted to non-RFP, while six patients who reverted to a RFP had marked deterioration of these parameters. More importantly, patients with persistent RFP after six months of medical therapy had a 35% event rate (mortality or transplantation) over the following year as opposed to chose who reverted to or remained in a non-RFP scare (5% and 4 % event rates, respectively).[21•22]

Concordant data published by Pinamonti et al. report chat a persistent RFP after three months of optimized medical therapy was associated with a 35% one-year mortality, while RFP

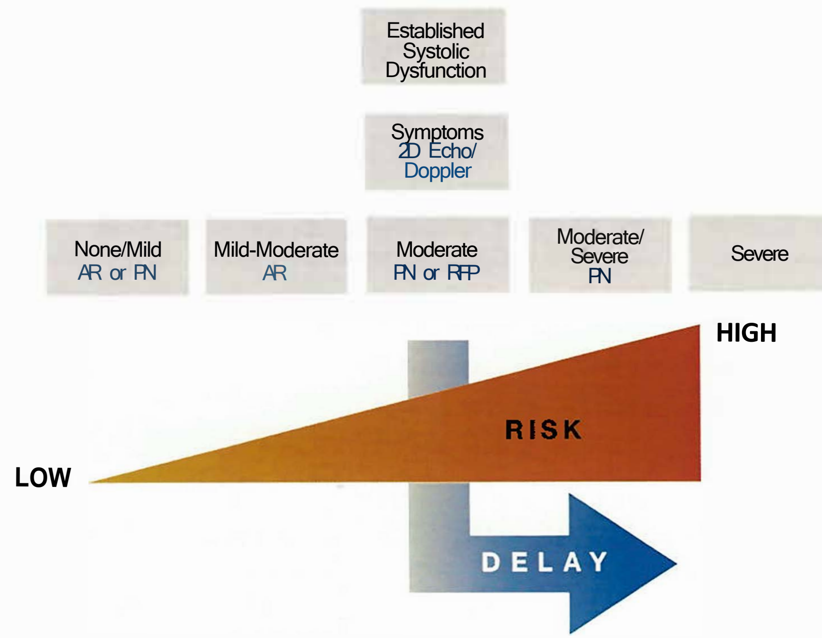

Figure 3. Algorithm incorporating Doppler indices to assign perioperative risk for cardiac events. Anticipated surgery is elective and noncardiac. This model does not account for other established perioperative risk factors.

reversion was associated with a 0% event **rate.**[23] Simply evaluating mitral filling pattern prior to discharge in patients admined for decompensated heart failure (n= 115) reveals that the presence of a RFP (n 27) is associated with a 38% all-cause mortality and 41% CHF rehospitalizacion rate at one year compared to 17.4% morcality and 15.4% CHF re-hospitalization for patients with no RFP.[24]

The mitral filling pattern is one measure for optimizing patients with advanced heart failure; patients who either develop or persist to have a RFP even with an apparent compensated clinical state should undergo further pharmacologic optimization. In particular, carvedolol therapy optimized among a subset of heart failure subjects with RFP successfully reverse chis pattern in 72% of those treated.[25] The clinical implications of diastolic filling among patients with systolic heart failure are established.17 To dace there are no clinical investigations establishing che role that diastolic filling may play in evaluating perioperative risk among patients with systolic heart failure undergoing noncardiac surgery. The absence of data is fertile ground for speculation from clinical observation, hypothesis generation and subsequent testing.

If diastolic filling among patients with chronic systolic heart failure has significant clinical implications with regard to symptoms, functional capacity and correlation with central hemodynamics, then evaluation with preoperative 20 echocardiogram and Doppler may allow further risk stratification among patients with known systolic heart failure. Currently, the Methodist OeBakey Heart Center is conducting a retrospective chart review among patients who underwent deceive major noncardiac surgery with syscolic heart failure. Information will be used to estimate risk and subsequent sample size calculations so as to conduct a larger prospective clinical investigation. The algorithm provided serves as the basis of an ongoing clinical investigation bur may help co manage individuals with established systolic heart failure.

We have employed a protocol incorporating echocardiographic measures of hemodynamics to optimize cardiac risk. Among systolic hearr failure patients being evaluated for major noncardiac surgery, a detailed history identifies current symptoms while a fullow-up echocardiogram with Doppler is used to estimate central hemodynamics emphasizing left ventricular filling pressure. If sympcoms are greater than moderate with concomitant elevated filling pressures, we delay elective surgery and initiate medical therapy to reverse the RFP. While prospective validation of this paradigm has not been compared with the current standard of care, overwhelming data from patients with chronic heart failure provides adequate impetus for this approach. If major noncardiac surgical intervention is deemed urgent, we advocate placement of a perioperative Swan-Ganz catheter and titration of appropriate medical (vasodilarors, beta-blockers, diuretics, etc.) or mechanical therapy (intra-aortic balloon councerpulsation) to normalize pulmonary wedge pressure. Anecdotally, patients undergoing mechanical therapy have had lower complication rates and improved 30-day post-operative survival.

CONCLUSION

Established paradigms for identifying and managing patients with systolic heart failure undergoing major noncardiac surgery are lacking. Information from retrospective data indicates high cardiac complication rates among individuals with an antecedent diagnosis of CHF. Signs and symptoms are late manifestations of heart failure, carry significant intra-observer variability and have low reproducibility. Objective measuring of cardiac function correlating with symptoms, central hemodynamics and prognosis may be ideal for estimating cardiac risk. In this regard, simple Doppler echocardiography can be incorporated into a clinical risk assessment model to define risk and manage patients with heart failure.

Clearly, future investigations utilizing focused clinical evaluation along with cardiac imaging and relevant biomarkers are needed. Consensus statements and guidelines rely on a clinical compendium of data to endorse a creatmem or diagnostic strategy. At chis stage, whatever statements can be made regarding the evaluation and management of perioperative risk among patients with systolic heart failure would carry a "C" level of evidence.

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