Disclosure

- Consultant for AtriCure, Medtronic
- Research and educational grants over the last 2 years:
  - AtriCure
  - Edwards
Postoperative Atrial Fibrillation

- Remains the most common complication following cardiac surgery, the incidence is unchanged despite decades of basic and clinical research.

- Significant cause of morbidity leading to increased utilization of healthcare resources.
Incidence

- Meta-analysis of 24 randomized controlled trials found an incidence of 26%

- Higher incidence after valve surgery and combined valve surgery and coronary artery bypass grafting
  - Lowest rates seen after transplantation

- The incidence at Washington University has been 30% over the last 20 years.
  - No change in incidence despite widespread use of beta blockers and statins
The persistent problem of new-onset postoperative atrial fibrillation: A single-institution experience over two decades

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Objective: Postoperative atrial fibrillation is the most common complication after cardiac surgery. A variety of postoperative atrial fibrillation risk factors have been reported, but study results have been inconsistent or contradictory, particularly in patients with preexisting atrial fibrillation. The incidence of postoperative atrial fibrillation was evaluated in a group of 10,390 patients undergoing cardiac surgery among a comprehensive range of risk factors to identify reliable predictors of postoperative atrial fibrillation.

Methods: This 20-year retrospective study examined the relationship between postoperative atrial fibrillation and demographic factors, preoperative health conditions and medications, operative procedures, and postoperative complications. Multivariate logistic regression models were used to evaluate potential predictors of postoperative atrial fibrillation.

Results: Increasing age, mitral valve surgery (odds ratio = 1.91), left ventricular aneurysm repair (odds ratio = 1.57), aortic valve surgery (odds ratio = 1.52), race (Caucasian) (odds ratio = 1.51), use of cardioplegia (odds ratio = 1.36), use of an intraaortic balloon pump (odds ratio = 1.28), previous congestive heart failure (odds ratio = 1.28), and hypertension (odds ratio = 1.15) were significantly associated with postoperative atrial fibrillation. The non-linear relationship between age and postoperative atrial fibrillation revealed the acceleration of postoperative atrial fibrillation risk in patients aged 55 years or more. In patients undergoing coronary artery bypass grafting, increasing age and previous congestive heart failure were the only factors associated with a higher risk of postoperative atrial fibrillation. There was no trend in incidence of postoperative atrial fibrillation over time. No protective factors against postoperative atrial fibrillation were detected, including commonly prescribed categories of medications.

Conclusions: The persistence of the problem of postoperative atrial fibrillation and the modest predictability using common risk factors suggest that limited progress has been made in understanding its cause and treatment. (J Thorac Cardiovasc Surg 2011;141:559-70)
Pathophysiology

- The underlying pathophysiology of postoperative atrial fibrillation remains poorly defined.

- Various factors have been implicated.
  - Inflammation
  - Autonomic dysfunction
  - Ventricular dysfunction
  - Cardioplegia
  - Atrial swelling or stretch
  - Renin-angiotensin-aldosterone system
Inflammation

- The degree of atrial inflammation has been shown by our group to be associated with a proportional increase in the inhomogeneity of atrial conduction and AF duration in an animal model.

- This may be a factor in the pathogenesis of early postoperative AF.

- Anti-inflammatory therapy may have the potential to decrease the incidence of AF after cardiac surgery.

Activation Map of Lateral RA

- **Anesthesia**
  - Homogeneously

- **Pericardiotomy**
  - Mildly inhomogeneous

- **Atriotomy**
  - Greater inhomogeneity

- **Atriotomy+Steroids**
  - Homogeneously parallel to atrial incision

Role of Inflammation in Postoperative AF

Ishii, et al
Circulation 2005;111:2881-2888
AF Inducibility

\[ \text{Pr}[\text{AF}] \% \]

\[ p = 0.012 \]

MPO (DELTA OD/min/mg protein)

Pr [AF] %
Predictors of Postoperative AF

- Numerous risk factors have been identified for the development of atrial fibrillation.
  - Age ( >70, OR=5.6)
  - Male gender
  - Race (OR=1.6)
  - Hypertension (OR=1.2)
  - History of previous AF
  - Redo surgery
  - Congestive heart failure (OR=1.3)
  - Valvular heart disease (AoV OR=1.5, MitV OR=1.9)
  - Left atrial enlargement
Age and Incidence of Postoperative AF

Shen J et al
J Thorac Cardiovasc Surg 2011;141:559-570
Influence of LA Volume and Age on the Incidence of Postoperative AF

Osranek M, et al
J Am Coll Cardiol 2006;48:779-798

P<0.00001
Numerous other preoperative risk factors have been identified for the development of atrial fibrillation including:

- Chronic obstructive pulmonary disease (OR=1.4)
- Peripheral vascular disease (OR=1.3)
- Renal insufficiency (OR=1.3)
- Obesity
- Left ventricular hypertrophy
- Right coronary disease
Postoperative Predictors of AF

- In addition to preoperative risk factors, complications following cardiac surgery have been shown to increase the risk of postoperative AF.
  - Myocardial infarction
  - Persistent congestive heart failure
  - Respiratory failure
  - Infection
  - Renal failure
  - Cardiac arrest

Timing of Postoperative AF

- Atrial fibrillation was most common on postoperative day 2
- Recurrence was most common on postoperative day 3
  - More than 60% of initial recurrence occurring within 2 days of first onset
  - Only 22% of patients (326/1503) experienced more than 2 episodes.

Postoperative Atrial Fibrillation: Morbidity and Mortality

- Often thought of as a benign arrhythmia, however, this is not true.
  - Studies have shown increased early and late mortality, stroke, and prolonged hospital length of stay.

- Increased hospital and healthcare costs
Postoperative AF: Morbidity and Mortality

- 6475 patients undergoing CABG
- In-hospital mortality was increased in pts. with POAF from 3.4 to 7.4% (p=.0007)
- POAF was an independent predictor of late mortality (OR 3.4, p=.0018, case-matched group)
- Stroke was increased in pts. with POAF from 1.7 to 5.2% (p<.0001)

Preventing Postoperative AF

- Many studies have been conducted examining effective preventative strategies for AF.
  - A meta-analysis demonstrated that prophylactic treatment to decrease postoperative AF reduced hospital stay and cost, but had no effect on stroke or mortality.

- Numerous drugs studied
  - Beta-blockers, Amiodarone, Sotalol, Magnesium
  - Other non-antiarrhythmics
    - Statins, N-3 polyunsaturated fatty acids, anti-inflammatory drugs
Beta-blockers

- Meta-analyses have shown positive effect.
  - Reduced the incidence of postoperative AF from 33% to 19%.

- Added benefit of reducing perioperative mortality

- Current AHA guidelines strongly recommend preoperative and postoperative beta-blocker therapy for patients undergoing coronary artery bypass grafting to prevent atrial fibrillation.
Amiodarone

- Largest trial of amiodarone prophylaxis showed that it was effective and safe, and had a benefit over the use of beta-blockers alone.

- Benefit of combined oral and intravenous amiodarone versus placebo alone (22% vs. 39% of patients) demonstrated in AFIST II trial

- Only drug shown to have effect on reducing incidence of postoperative stroke
Amiodarone

- Well studied in multiple meta-analyses
  - Effective despite a wide variation in dosing, scheduling, and route.

- No significant difference found between high and low dose regimens, or between preoperative and postoperative initiation of treatment
Numerous other treatments have been tested for the prevention of postoperative AF.

- Include sotalol, magnesium, statins, N-3 polyunsaturated fatty acids, anti-inflammatory drugs, temporary pacing.

- None of these treatments have been proven to be effective with the same robustness of amiodarone or beta-blockers and the data have been sometimes conflicting.
Management of Postoperative Atrial Fibrillation

Goals

- Assess for hemodynamic instability
- Differentiate atrial fibrillation from atrial flutter
- Rate versus rhythm control
Hemodynamically Unstable Patients

- Electrical cardioversion is the mainstay of treatment
  - Semi-elective cardioversion protocol at Washington University
    - Contact the critical care physician or electrophysiologist
    - NPO for 4-6 hours
    - Consider IV midazolam or anesthetic agent
    - Check $K^+$, $Mg^{2+}$, digoxin levels
Atrial Flutter

- Diagnosis of atrial flutter is best made by obtaining an atrial electrogram.
Atrial epicardial pacing wires
Atrial Flutter
Atrial Flutter

- In patients that have atrial flutter, consider rapid atrial pacing.
  - Begin burst pacing at twice diastolic threshold and a rate 10% above the flutter cycle length. Increase in increments of 10% until flutter is terminated.

- If unsuccessful, treat according to atrial fibrillation protocol.
Atrial Fibrillation
Atrial Fibrillation Treatment Guidelines

- In the hemodynamically stable patient, there is no urgency or reason to electrically cardiovert.
  - Ensure $S_pO_2 > 92\%$
  - Correct profound anemia
  - Supplement $K^+ , Mg^{2+}$

- First goal is to control the heart rate.
  - Goal to decrease the heart rate below 100
Atrial Fibrillation Rate Control

- For patients with preserved EF (>30%)
  - Diltiazem 5mg IV test dose
  - If tolerated, give 0.25mg/kg IV over 3 minutes
  - If effective, begin 5-10mg/hr IV infusion
    - May increase in 5mg/hr increments up to 20mg/hr

- For patients with poor EF (<30%)
  - Digoxin load
    - 0.5mg IV, followed by 0.25mg IV q4h x 2 doses
  - Maintenance dose based on renal function
  - Consider early cardioversion
Rhythm Control

- For patients that persist in AF for greater than one hour despite adequate rate control, consider initiation of rhythm control.

- Amiodarone load
  - For patients able to take po or absorb via NG
    - 400mg po t.i.d loading dose x 5 days
    - Reassess for maintenance dose
  - For patients unable to utilize their GI tract
    - 150mg IV over 10 minutes, then 1mg/min infusion x 6 hours, followed by 0.5mg/min

- Monitoring
  - Initial assessment of LFT’s, and TFT’s
  - Follow QT interval
Contraindications to Amiodarone

- Contraindications
  - Allergy
  - History of toxicity
  - Severe pulmonary disease
  - 2\textsuperscript{nd} degree Type 2 or 3rd degree heart block
  - Junctional rhythm
  - Severe bradycardia
  - Untreated/uncontrolled thyroid disease
  - Pregnancy
Amiodarone

- Precautions
  - Decrease (halve) digoxin dose
  - Decrease (halve) warfarin dose
  - Beware additive bradycardia and AV block with beta-blockers and calcium channel blockers
Persistent Atrial Fibrillation

- For patients that persist in AF >8 hours despite amiodarone therapy, consideration must be given to anticoagulation to prevent the complication of stroke.
  - Continue oral amiodarone

- Anticoagulation
  - Coumadin therapy with intravenous heparin bridge
  - Goal INR 2.0-3.0
Ensure SpO₂ > 92% with supplemental O₂
Check K⁺ and Mg²⁺. Supplement if necessary.

Is the HR > 100 bpm?
  Yes
  Is ejection fraction > 30%?
    Yes
    Rate Control for EF > 30
    Diltiazem load and maintenance
    Yes
    Is treatment effective?
      Yes
      Contact Surgical MD + Intensivist.
      No
      Is atrial fibrillation present for >8 hrs?
        Yes
        Continue amiodarone PO. Consider anticoagulation (target INR 2.0-3.0)
        No
        Continue amiodarone PO at the discretion of the attending MD.
    No
    Rate Control for EF < 30
    Digoxin load and maintenance
    No
    Is the arrhythmia persisting for 1 hour or recurrent?
      No
      Consider initiation or increase in beta blocker therapy.
      Yes
      Amiodarone load and maintenance
  No
  No

Consider initiation or increase in beta blocker therapy.
Postoperative AF 1976-2010:
A persistent problem

72 studies Total n=55,885
Persistent Incidence Despite Treatment

New onset AF in 39% of 275 CABG patients despite high rates of beta-blocker and statin use.

No statistical difference between patients with postoperative AF with and without drug treatment

"It's fine to discover cures, but, remember, chronic conditions are our bread and butter."
Postoperative Atrial Fibrillation: Conclusions

- Postoperative atrial fibrillation is a common complication following cardiac surgery.
- Postoperative atrial fibrillation is associated with significant morbidity and mortality.
- Prevention of postoperative atrial fibrillation is difficult despite multiple positive clinical trials with a variety of drugs.
Postoperative Atrial Fibrillation: Conclusions

- Successful treatment of postoperative atrial fibrillation requires both rate and rhythm control.

- Further research is needed to define the mechanism of postoperative atrial fibrillation to more effectively prevent it.
Drug Trials to Prevent Postoperative AF

62 Studies n=123,659
Type II Atrial Flutter