Evidence-based Clinical Practice Guidelines on Seeking Referral for Preoperative Cardiac Evaluation for Elective Noncardiac Surgery

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EXECUTIVE SUMMARY

The Philippine Council for Health Research and Development - Department of Science and Technology (PCHRD-DOST), and the Philippine College of Surgeons (PCS) signed a Memorandum of Agreement on 1 June 1999, whereby both agreed to support the formation of Evidence-Based Clinical Practice Guidelines (EBCPGs) on specific areas of surgical care in the Philippines. The areas were to be specified by the PCS, and those areas should have a reasonably large potential of improving the quality of patient care throughout the country, and can be implemented nationwide in both government and private health facilities.

The first clinical area selected was on when to refer for preoperative cardiac evaluation for elective noncardiac surgery, and when would the intraoperative presence of a cardiologist be beneficial. A Technical Working Group (TWG) was appointed, which: 1) searched and appraised the evidence; 2) prepared a first draft EBCPG; 3) presented the evidence to a Panel of Experts; 4) supervised the panel using the nominal group technique (6 November 1999 - PCS Building); and 5) prepared the second draft EBCPG based on the consensus recommendations of the panel. All processes strictly conformed to the methods of evidence-based guidelines formation specified by evidence-based medicine texts.

The second draft EBCPG was presented on 11 December 1999 during the 55th Clinical Congress of the PCS, and the final draft approved by the PCS Board of Regents on 29 January 2000.

Literature search was conducted through the MEDLINE, COCHRANE Library and the HERDIN Database. A total of 2,156 titles, 427 abstracts and 77 full text articles were appraised. Data from 23 prospective cohort studies were encoded into the software COCHRANE Review Manager (RevMan), Version 3.0 for Windows (updated October 7, 1996). Tables were generated which contained authors, outcome rates, relative risks, and the 95% confidence intervals of the relative risks. Three perioperative outcomes were identified - cardiac morbidity, cardiac death, and overall cardiac events.

The 3 clinical questions addressed were:

1. What are the predictors of adverse perioperative cardiac events in patients undergoing elective noncardiac surgery?
2. In patients who are to undergo noncardiac surgery, when will a referral to a cardiologist be beneficial?
3. When is the intraoperative presence of a cardiologist beneficial for patients undergoing elective noncardiac surgery?

LEVELS OF EVIDENCE

I Evidence from at least one properly designed randomized controlled trial, meta-analysis, or prospective cohort study.

II Evidence from at least one well-designed clinical trial without proper randomization, from retrospective cohort or case-controlled analytic studies (preferably from one center), from multiple time-series studies, or from dramatic results in uncontrolled experiments.

III Evidence from opinions of respected authorities on the basis of clinical experience, descriptive studies, or reports of expert committees.

CATEGORIES OF RECOMMENDATIONS

Category A: Recommendations that were approved by consensus (75% of the multisectoral expert panel).

Category B: Recommendations that were somewhat controversial and did not meet consensus.

Category C: Recommendations that caused real disagreements among members of the panel.

Question No 1. What are the predictors of adverse perioperative cardiac events in patients undergoing elective noncardiac surgery?

Table 27 shows the risk factors for overall cardiac events reported from univariate analysis. Tables 28 and 29 show the significant risk factors from multivariate analysis (Level I, Category A).

Question No. 2: In patients who are to undergo noncardiac surgery, when would referral to an internist/cardiologist for preoperative cardiac evaluation be beneficial?

Preoperative referral to an internist/cardiologist for cardiac evaluation will be beneficial for patients undergoing elective noncardiac surgery in the following situations:

I. History

1. Age > 70 years (Level I, Category A)
2. CAD and prior MI (Level I, Category A)
3. CHF (Level I, Category A)
4. Significant valvular heart disease (Level I, Category A)
5. Uncontrolled, insulin dependent diabetes (Level III, Category A)
6. Severe, uncontrolled hypertension (Level III, Category A)
7. Chronic heavy smoking (Level III, Category A)
8. COPD (Level III, Category A)
9. Cerebrovascular disease (Level I, Category A)
10. Severe systemic disease (Level I, Category A)
11. Peripheral vascular disease and claudication (Level I, Category A)
12. Poor functional capacity (< 4 mets) (Level III, Category A)

II. PE

1. Clinical findings of CHF (Level I, Category A) (S3, neck vein engorgement, rales, edema)

III. Laboratory Findings

1. ECG abnormalities (Level I, Category A)
   (ischemia, arrhythmia, left ventricular hypertrophy)

IV. Surgery

1. Major vascular, aneurysm, and peripheral vascular surgery (Level I, Category A)
2. Anticipated large intraoperative volume shifts/blood loss (Level III, Category A)
3. Anticipated operative technical difficulty (Level III, Category A)

Question No. 3: When is the intraoperative presence of a cardiologist/internist beneficial for patients undergoing elective noncardiac surgery?

The intraoperative presence of a cardiologist/internist will be beneficial when,
1. risk factors are identified after proper preoperative evaluation, and
2. the surgeon, anesthesiologist, and internist/cardiologist agree that it is needed for optimum care. (Level III, Category A)

Technical Working Group

1. Manuel Francisco T. Roxas, M.D. - *Project Leader/Surgery*
2. Antonio L. Dans, M.D. - *Consultant Supervisor/Internal Medicine-Cardiology*
3. Adriano V. Laudico, M.D. - *Consultant Supervisor/Surgery*
4. Benjamin Daniel S. Valera, M.D. - *Consultant Supervisor/Anesthesia*
5. Romeo R. Gutierrez, M.D. - *Consultant Appraiser/Surgery*
6. Ma. Concepcion L. Cruz, M.D. - *Consultant Appraiser/Anesthesia*
7. Ms. Ma. Leonila R. de Luna - *Research Assistant*

Panel of Experts

1. Francisco Y. Arcellana, M.D. (PCS)
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12. Edgardo T. Orlina, M.D. (Philippine Association of Plastic, Reconstructive and Aesthetic Surgery)
13. Mariano Lopez, M.D. (Philippine Heart Association)

Rapporteurs

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Background

It is generally agreed that Philippine medical practice is greatly influenced by what is perceived to be current practice in developed countries, particularly the United States. Unfortunately, many of these practices perceived to be "state of the art" and strongly embedded in Philippine medical practice are in fact now being seriously challenged, or even discarded, in developed countries. The engine that drives this global rethinking and reshaping of traditional medical practices towards true improvement of patient care is Evidence-Based Medicine (EBM).

It is not surprising that the United States, a country from which Philippine physicians have borrowed many practices, some of which have subsequently been proven to be ineffective, inefficient, and sometime even harmful, is now one of the leading players in the new paradigm of EBM. It is doubly important for developing countries like ours to partake of, and benefit from the best available evidence, with as little lag time as possible. We must use EBM to maximize dwindling resources, and benefit a population that is already overburdened by problems other than illness.

The cost benefit of not performing ineffective or unnecessary tests and procedures is quite evident. What is not as evident is ordering these tests or performing these procedures anyhow, notwithstanding their lack of utility, simply "because the patient can afford it". This will over time create a public perception that they are in fact beneficial, and are not done for the poor because of purely economic reasons. Such a perception results in serious social, political and legal consequences.

Two such practices are that of the "cardiac clearance" prior to elective noncardiac surgery, and that of intraoperative "cardiac monitoring" by cardiologists/internists.

A survey of 134 Filipino surgeons who attended a symposium on surgical critical care in Phuket, Thailand on 29-30 July 1999 revealed some information regarding the presence of policies/practices on preoperative "cardiac clearance" in the hospitals where they practiced (Laudico 1999), some of which were: (Appendix 1)

1. Mandatory cardiac clearance was practiced (72%).
2. Requirements were set mainly by the Departments of Anesthesia (58%), Medicine (54%), and Surgery (57%).
3. Patient age as a criterion was used in 99%; age 40 years and above at 49%, age 35 years and above, 25%.
4. Surgeons agreed completely (44%); disagreed in some cases (52%).
5. Medicolegal implications were an important factor in deciding when to refer (81%).

A prospective and analytical survey of 1,119 consecutive operations done in 6 tertiary care centers in Metro Manila during a one-month period in 1996 showed interesting data on

intraoperative cardiac monitoring by internists (Villacin 1997), some of which were: (Appendix 2)

1. Eight per cent of operations underwent cardiac monitoring.
2. The most frequent indications were hypertension (33%), arrhythmias (14%), age (6%), and COPD (5%).
3. Some of the independent predictors included admission as a paying patient, and admission to certain hospitals.

There are some widely used classification methods for predicting risks of operative mortality and morbidity. The American Society of Anesthesiology (ASA) Clinical Classification (Dripps 1961) is widely used and validated by several reports (Goldman 1961, Banocnoc 1993, Lette, 1992, Singson 1987, Mangano 1990, Warner, 1993). However, the ASA classification is too general and gives no idea as to how to establish the presence or absence of systemic disease which is the main predictor in this classification.

A landmark prospective cohort study of major noncardiac operations in 1,001 patients over 40 years of age reported 19 (1.9%) cardiac deaths, and 39 (3.9%) patients with life-threatening but nonlethal cardiac morbidity. Discriminant analysis showed 9 independent predictors which included jugular vein distention, arrhythmias , certain operations (intraperitoneal, intrathoracic, aortic), age older than 70 years, emergency surgery and poor general condition. The authors devised a scoring system, now known as the Goldman Cardiac Risk Index, that stratified cardiac risk into 4 categories, and which has also been validated by subsequent reports (Goldman 1977, Banocnoc 1993, Gerson 1990, Fleisher 1991, Lette 1992, Singson 1987). In the original report, the distribution of cardiac deaths according to category were: I=1 (0.2%); II=5 (1.6%); III=3 (2.3%); IV=10 (55.6%) (Goldman 1977).

Both the ASA Classification and the Goldman Cardiac Risk Index showed some degree of validation in a retrospective cohort analysis of 500 patients who underwent noncardiac surgery between 1988 to 1992 at the Philippine General Hospital (Samar-Sy 1992, Samar-Sy 1995).

A prospective cohort of 100 patients who underwent noncardiac surgery at the Manila Central University - Filemon D. Tanchongco Memorial Foundation Hospital agreed with previous reports on the ASA classification and the Goldman Cardiac Risk Index. Four significant predictors of perioperative myocardial infarction were: 1) age over 70 years; 2) presence of heart failure; 3) ECG evidence of ischemia; and 4) atrial fibrillation (Banocnoc 1993).

Meanwhile, the American College of Cardiology (ACC) and the American Heart Association (AHA), after a long and methodical process came up with their "ACC/AHA Guidelines for Perioperative Cardiovascular Evaluation for Noncardiac Surgery" (ACC/AHA 1996). The target physicians were cardiologists/internists to whom a referral for preoperative cardiac evaluation had been made. There are several sections of the guidelines which clearly expressed the current philosophy and feelings of these 2 organizations, and we quote some of them:

1. "The overriding theme of this document is that intervention is rarely necessary simply to lower the risk of surgery unless such intervention is indicated irrespective of the preoperative context."
2. "The goal of the task force is the rational use of testing in an era of cost containment."

3. “Preoperative testing should be limited to circumstances in which the results will affect patient treatment and outcome.”
4. “To reiterate, it is important to emphasize that the concept of ‘medical clearance’ is shortsighted. The real issue is to perform an evaluation of the patient’s current medical status, make recommendations concerning the risk of a cardiac problem over the entire perioperative and postoperative period, and provide a clinical risk profile that the patient, anesthesiologist and surgeon can use to make management decisions.”

The ACC/AHA recommended clinical predictors of increased perioperative cardiovascular risk (Appendix 3) and cardiac risk stratification for noncardiac surgical procedures (Appendix 4).

The ACC/AHA Guidelines were mainly for physicians to whom a referral for preoperative cardiac evaluation had been made, and did not address the two issues of: 1) when such a referral should be made in the first place; and 2) when the intraoperative presence of a cardiologist/internist will be beneficial.

The three clinical questions that will be addressed by the guidelines are:

1. What are the predictors of adverse perioperative cardiac events in patients undergoing elective noncardiac surgery?
2. In patients who are to undergo noncardiac surgery, when will a referral to a cardiologist be beneficial?
3. When is the intraoperative presence of a cardiologist beneficial for patients undergoing elective noncardiac surgery?

Methods

A search of the English medical literature was done using the MEDLINE (no time limit), COCHRANE Library and HERDIN Databases. Mesh terms used were: perioperative, risk assessment, prognosis, diagnostic test and cost benefit.

Titles of all journals were printed, and all 6 members of the Technical Working Group (TWG) went over the list and checked the titles that they thought should have an abstract printed. Abstracts of all checked titles were printed.

The printed abstracts were divided into 3 groups, each group given to 2 members of the TWG, who independently read the abstracts and recommended which titles deserved a review of the full text (Appendix 5). If there was agreement between the 2 members, the title was included for full text retrieval. If there was disagreement, the issue was settled by a third member.

The full texts of selected titles were obtained mainly from the University of the Philippines Medical Library, and a few from the PCHRD.

The full texts were also divided into 3 groups and underwent an evaluation process similar to that used on the abstracts (Appendix 6). If there was agreement between 2 members, the full text was either included or excluded from the study. If there was disagreement, the issue was settled by a third member.

Only prospective cohort studies were chosen for data extraction and analysis. A Data Extraction Sheet (Appendix 7) was filled up by the Project Leader for each of these selected and retrieved articles. The data was encoded into the software COCHRANE Review Manager (RevMan), Version 3.0 for Windows (updated October 7, 1996).

The TWG then compiled, summarized and classified the evidence according to levels and to categories of recommendations, as follows:

LEVELS OF EVIDENCE

- **I** Evidence from at least one properly designed randomized controlled trial, meta-analysis, or prospective cohort study.
- **II** Evidence from at least one well-designed clinical trial without proper randomization, from retrospective cohort or case-controlled analytic studies (preferably from one center), from multiple time-series studies, or from dramatic results in uncontrolled experiments.
- **III** Evidence from opinions of respected authorities on the basis of clinical experience, descriptive studies, or reports of expert committees.

CATEGORIES OF RECOMMENDATIONS

- **Category A:** Recommendations that were approved by consensus (75% of the multisectoral expert panel).
- **Category B:** Recommendations that were somewhat controversial and did not meet consensus.
- **Category C:** Recommendations that caused real disagreements among members of the panel.

This first draft was presented to a Multisectoral Expert Panel (MEP) in an en banc meeting organized by the PCS on November 6, 1999. The MEP then ratified the evidence and formalized the recommendations, using the Nominal Group Technique (NGT), which assured unopposed generation of ideas from all participants, with the final decisions requiring at least a seventy five percent majority concurrence. The recommendations were incorporated into the first draft, and the TWG prepared the second draft. The second draft was presented in a Public Forum on 1 December 1999 during the Clinical Congress of the PCS. The guidelines were approved by the PCS Board of Regents on 29 January 2000.

Results

A total of 2,157 titles were printed, out of which 427 abstracts were reviewed. A total of 202 articles were deemed deserving of a reading of the full text. After a diligent effort by the Research Assistant, and considering time constraints, 125 articles were obtained. Appendix 8 lists the titles of the 77 articles for which the full texts were not obtained.

The 125 articles were also divided into 3 groups and underwent an evaluation process similar to that used for titles and abstracts. A total of 78 articles were used in the preparation of the first draft of the evidence-based clinical practice guidelines (EBCPG). From these articles, data from 23 prospective cohort studies were extracted and encoded into the software to come up with computations on the different predictors for adverse cardiac events. Appendix 9 lists the titles of 47 articles whose full texts were reviewed but not included.

Question No 1. What are the predictors of adverse perioperative cardiac events in patients undergoing elective noncardiac surgery?

Outcomes were classified into 3 categories: cardiac morbidity, cardiac death, overall cardiac events, and presented as event rates, per cent difference - either absolute rate increase (ARI) or absolute rate reduction (ARR), relative risk (RR), and 95% confidence interval of the relative risk (95% CI). Most of the cardiac events were ischemic events or myocardial infarction.

The risk factors were:

I. History: age, myocardial infarction, coronary artery disease (CAD), congestive heart failure (CHF), angina, cerebrovascular disease (CVD), claudication, hypertension, smoking, diabetes, orthopnea, dyspnea, and poor general medical condition.
II. Physical Examination: S3, neck vein engorgement, rales, systolic murmur (aortic stenosis).
III. Laboratory/Diagnostic Tests: ECG changes, cardiomegaly (chest x-ray), serum cholesterol.
IV. Surgical Procedures: emergency, abdominal, thoracic, vascular.

I. History

A. *Age: More than 70 years* (Table 1)

i. Cardiac Morbidity. Three reports (Goldman 1977, Hollenberg 1992, Steen 1978) involving 1,995 patients reported 15.3% and 10.4% occurrence among older and younger patients respectively, an ARI of 4.9% , and RR of 1.52 (95% CI 1.24, 1.88).
ii. Cardiac Death. Two reports (Boyd 1980, Goldman 1977) involving 1,358 patients reported 6.0% and 0.9% occurrence respectively, an ARI of 5.1%, and a RR of 6.14 (95% CI 2.87, 13.12).
iii. Overall Cardiac Events. Seven reports (Boyd 1980, Coley 1992, Goldman 1977, Hollenberg 1992, Raby 1989, Raby 1992, Steen 1978) involving 2,743 patients showed 15.6% and 10.8% occurrence respectively, an ARI of 4.8%, and a RR of 1.53 (95% CI 1.27, 1.84).

The RR of younger patients in having a cardiac morbidity was 0.6 (Steen 1978). The RR of younger patients in dying from cardiac complications following colon resection (elective and emergency) was 0.3 (Boyd 1980). The RR of younger patients in having an MI was 0.09, and in a cardiac death was 0.5 (Goldman 1978).

Summary of Evidence:

1. Age over 70 years increases the risk of perioperative cardiac morbidity, cardiac death, and overall cardiac events (Level I, Category A).
2. Age less than 70 years lowers the risk (Level I, Category A).

B. ***Myocardial Infarction (MI)***

a) *MI More than 6 Months* (Table 2)

i. Cardiac Morbidity. Eight reports (Eichelberger 1993, Foster 1986, Goldman 1978, Hollenberg 1992, Rao 1983, Steen 1978, Tarhan 1972, Von Knorring 1981) involving 49,934 patients showed 8.1% cardiac morbidity versus 0.7% for those without a history of MI, an ARI of 7.4 %, and a RR of 1.70 (95% CI 1.47, 1.98).

ii. Cardiac death. Five reports (Foster 1986, Goldman 1978, Steen 1978, Tarhan 1972, von Knorring 1981) involving 48,719 patients showed rates of 2.4% and 0.2% respectively, an ARI of 2.2%, and a RR of 1.69 (95% CI 1.27, 2.25).

iii. Overall cardiac events. Thirteen reports (Brown 1993, Coley 1992, Eichelberger 1993, Foster 1986, Goldman 1978, Hollenberg 1992, Lette 1992, Mangano 1990, Raby 1992, Rao 1983, Steen 1978, Tarhan 1972, Von Knorring 1981) involving 51,229 patients showed rates of 10.8% and 0.99%, an ARI of 9.81%, and a RR of 1.72 (95% CI 1.53, 1.95).

b) *MI Less than 6 Months* (Table 3)

i. Cardiac morbidity. Seven reports (Banocnoc 1993, Foster 1986, Goldman 1978, Hollenberg 1992, , Rao 1983, Steen 1978, von Knorring 1981) involving 4,534 patients showed rates of 10.8% and 9.2%, an ARI of 1.6%, and a RR of 2.29 (95% CI 1.60, 3.27).

ii. Cardiac death. Five reports (Banocnoc 1993, Foster 1986, Goldman 1978, Steen 1978, von Knorring 1981) involving 3,404 patients gave rates of 14.6% and 1.7%, an ARI of 12.9%, and a RR of 6.22 (95% CI 3.54, 10.91).

iii Overall cardiac events. Ten reports (Banocnoc 1993, Coley 1992, Foster 1986, Goldman 1978, Hollenberg 1992, Lette 1992, Raby 1989, Rao 1983, Steen 1978, von Knorring 1981) involving 5,170 patients gave rates of 16.1% and 10.5%, an ARI of 5.6%, and a RR of 2.10 (95% CI 1.63, 2.71).

Summary of Evidence:

3. A history of MI more than 6 months prior to surgery increases the risk of perioperative cardiac death, morbidity and overall cardiac events (Level I, Category A).
4. A history of MI less than 6 months prior to surgery significantly increases the risk of cardiac morbidity, death and overall cardiac events (Level I, Category A).

C. ***Coronary Artery Disease*** **(CAD)** (Table 4)

i. Cardiac morbidity. Two reports (Ashton 1993, Hollenberg 1992) involving 1,894 patients reported rates of 17.0% and 7.5%, an ARI of 9.5%, and a RR of 1.93 (95% CI 1.55, 2.40).
ii. Cardiac death. Three reports (Ashton 1993, Foster 1986, Roger 1989) involving 2,475 patients gave rates of 4.3% and 0.8%, an ARI of 3.5%, and a RR of 4.27 (95% CI 2.37, 7.70).
iii Overall cardiac events. Eight reports (Ashton 1993, Foster 1986, Hollenberg 1992, Lette 1992, Mangano 1990, Raby 1989, Raby 1992, Roger 1989,) involving 4,007 patients gave rates of 13.6% and 7.4%, an ARI of 6.2%, and a RR of 1.97 (95% CI 1.65, 2.35).

Summary of Evidence:

5. A history of CAD increases the risk of perioperative cardiac morbidity, cardiac death, and overall cardiac events (Level I, Category A).

D. ***Angina*** (Table 5)

i. Cardiac morbidity. Five reports (Goldman 1978, Hollenberg 1992, Rao 1983, Steen 1978, von Knorring 1981,) involving 2,919 patients gave rates of 13.7% and 8.3%, an ARI of 5.4%, and a RR of 1.27 (95% CI 0.99, 1.61).
ii. Cardiac death. One report (Goldman 1978) involving 1,001 patients gave rates of 4.3% and 1.7%, an ARI of 2.6%, and a RR of 2.49 (95% CI 0.74, 8.35).
iii Overall cardiac events. Ten reports (Brown 1993, Coley 1992, Goldman 1978, Hollenberg 1992, Lette 1992, Raby 1989, Raby 1992, Rao 1983, Steen 1978, Von knorring 1981) involving 3,894 patients gave rates of 12.8% and 9.2%, an ARI of 3.6%, and a RR of 1.26(95% CI 1.03, 1.55).

Summary of Evidence:

6. A history of angina increases the risk of overall cardiac events (Level I, Category A).

E. ***Congestive Heart Failure (CHF)*** *(Table 6)*

i. Cardiac morbidity. Seven reports (Ashton 1993, Banocnoc 1993, Foster 1986, Goldman 1978, Hollenberg 1992, , Raby 1989, Rao 1983) involving 5,504 patients gave rates of 13.4% and 7.0%, an ARI of 6.4%, and a RR of 1.88 (95% CI 1.49, 2.36).
ii. Cardiac death. Two reports (Foster 1986, Goldman 1978) involving 2,601 patients gave rates of 3.3% and 1.3%, an ARI of 2%, and a RR of 2.52 (95% CI 1.19, 5.33).
iii. Overall cardiac events. 13 reports (Ashton 1993, Banocnoc 1993, Boyd 1980, Brown 1993, Coley 1992, Foster 1986, Goldman 1978, Hollenberger 1992, Lette 1992, Mangano 1990, Raby 1989, Raby 1992, Rao 1983) involving 6,769 patients gave rates of 18.7% and 7.9%, an ARI of 10.8%, and a RR of 2.14 (95 CI 1.79, 2.56)

Summary of Evidence:

7. A history of CHF increases the risk of perioperative cardiac morbidity, cardiac death, and overall cardiac events (Level I, Category A).

F. ***Cerebrovascular Disease (CVD) or Stroke*** *(Table 7)*

i. Cardiac morbidity. One report (Ashton 1993) involving 1,487 patients gave rates of 2.8% and 0.8%, an ARI of 2.0% and a RR of 3.39 (95% CI 1.09, 10.51)
ii. Overall cardiac events. Three reports (Ashton 1993, Brown 1993, Lette 1992) involving 2,070 patients gave rates of 5.9% and 2.3%, an ARI of 3.6%, and a RR of 1.81(95% CI 1.01, 3.25).

Summary of evidence:

8. A history of CVD increases the risk of perioperative overall cardiac morbidity and overall cardiac events (Level I, Category A).

G. ***Hypertension*** *(Table 8)*

i. Cardiac morbidity. Eight reports (Ashton 1993, Eichelberger 1993, Foster 1986, Goldman 1978, Hollenberg 1992, Rao 1983, Steen 1978, von Knorring 1981) involving 5,779 patients gave rates of 8.5% and 6.4%, an ARI of 2.1%, and a RR of 1.31 (95% CI 1.08, 1.58).
ii. Cardiac death. Two reports (Foster 1986, Goldman 1978) involving 2,601 patients gave rates of 1.9% and 1.3%, an ARI of 0.6%, and a RR of 1.49 (95% CI 0.79, 2.83).
iii. Overall cardiac events. Thirteen reports (Ashton 1993, Brown 1993, Carliner 1985, Eichelberger 1993, Foster 1986, Goldman 1977, Hollenberg 1992, Lette 1992, Raby 1989, Raby 1992, Rao, 1983, Steen 1978, von Knorring 1981) involving 7,077 patients gave rates of 8.8% and 6.2%, an ARI of 2.6, and a RR of 1.37(95% CI 1.16, 1.62).

Summary of Evidence:

9. A history of hypertension increases the risk of perioperative cardiac morbidity and overall cardiac events. (Level I, Category A)

H. ***Diabetes*** *(Table 9)*

i. Cardiac morbidity. Six reports (Ashton 1993, Eichelberger 1993, Foster 1986, Hollenberg 1992, Steen 1978, von Knorring 1981) involving 4,370 patients gave rates of 15.2% and 8.9%, an ARI of 6.3%, and a RR of 1.79 (95% CI 1.48, 2.17)
ii. Cardiac death. One report (Foster 1986) involving 1,600 patients gave rates of 1.6% and 1.2%, an ARI of 0.4, and a RR of 1.34 (95% CI 0.40, 4.53).
iii. Overall cardiac events. Twelve reports (Ashton 1993, Brown 1993, Coley 1992, Eichelberger 1993, Foster 1986, Hollenberg 1992, Lette 1992, Mangano 1990, Raby 1989, Raby 1992, Steen 1978, von Knorring 1981) involving 5,919 patients gave rates of 16.7 % and 9.5%, an ARI of 7.2%, and a RR of 1.8 (95% CI 1.53, 2.11).

Summary of Evidence:

10. A history of diabetes increases the risk of perioperative cardiac morbidity and overall cardiac events, (Level I, Category A).

I. ***Smoking*** *(Table 10)*

i. Cardiac morbidity. Four reports (Ashton 1993, Eichelberger 1993, Foster 1986, Hollenberg 1992) involving 3,569 patients gave rates of 9.4% and 10.1%, an ARR of 0.7%, and a RR of 1.19 (95% CI 0.98, 1.44).
ii. Cardiac death. One report (Foster 1986) involving 1,600 patients gave rates of 1.3% and 1.2%, an ARI of 0.1%, and a RR of 1.03 (95% CI 0.41, 2.57).
iii. Overall cardiac events. Eight reports (Ashton 1993, Brown 1993, Eichelberger 1993, Foster 1986, Hollenberg 1992, Lette 1992, Raby 1989, Raby 1992) involving 4,445 patients gave rates of 9.8% and 10.1%. , an ARR of 0.3%, and a RR of 1.21 (95% CI 1.01, 1.44)

Summary of Evidence:

11. A history of smoking does not increase the risk of perioperative cardiac morbidity, cardiac death and overall cardiac events (Level I, Category A).

J. ***Claudication*** *(Table 11)*

i. Cardiac morbidity. One report (Ashton 1993) involving 1,487 patients gave rates of 2.5% and 0.7%, an ARI of 1.8%, and a RR of 3.71 (95% CI 1.36, 10.14).
ii. Overall cardiac events. Two reports (Ashton 1993, Mangano 1990) involving 1,961 patients gave rates of 11.3% and 3.2%, an ARI of 8.1%, and a RR of 2.37 (95% CI 1.66, 3.39).

Summary of Evidence:

12. A history of claudication increases the risk of perioperative cardiac morbidity and overall cardiac events (Level I, Category A).

II. Physical Examination

a) ***S3 Heart Sound*** *(Table 12)*

i. Cardiac morbidity. Four reports (Banocnoc 1993, Foster 1986, Gerson 1990, Goldman 1977) involving 2,878 patients gave rates of 22.7% and 7.5%, an ARI of 15.2%, and a RR of 2.98 (95% CI 2.06, 4.31).
ii. Cardiac death. Two reports (Foster 1986, Goldman 1977) involving 2,601 patients gave rates of 9.9% and 1.2%, an ARI of 8.7%, and a RR of 8.27 (95% CI 4.05, 16.9).

iii. Overall cardiac events. Five reports (Banocnoc 1993, Coley 1992, Foster 1986, Gerson 1990, Goldman 1977) involving 2,978 patients gave rates of 31.1% and 8.5%, an ARI of 22.6%, and a RR of 3.68 (95% CI 2.72, 4.96).

Summary of Evidence:

13. The presence of an S3 heart sound increases the risk of perioperative cardiac morbidity, cardiac death, and overall cardiac events (Level I, Category A).

b) ***Neck Vein Engorgement*** *(Table 13)*

i. Cardiac morbidity. Two reports (Banocnoc 1993, Goldman 1977) involving 1,101 patients gave rates of 17.1% and 3.3%, an ARI of 13.8%, and a RR of 5.37 (95% CI 2.48, 11.61).
ii. Cardiac death. One report (Goldman 1977) involving 1,001 patients gave rates of 20% and 1.2% , an ARI of 18.8%, and a RR of 16.1 (95% CI 6.75, 38.39).
iii. Overall cardiac events. Two reports (Banocnoc 1993, Goldman 1977) involving 1,101 patients gave rates of 34.1% and 4.4%, an ARI of 29.7%, and a RR of 8.07 (95% CI 4.82, 13.51).

Summary of Evidence:

14. The presence of neck vein engorgement increases the risk of perioperative cardiac morbidity, cardiac death and overall cardiac events (Level I, Category A).

c) ***Rales*** *(indicative of CHF) (Table 14)*

i. Cardiac morbidity. One report (Goldman 1978) involving 1,001 patients gave rates of 1.7% and 1.8%, an ARR of 0.1%, and a RR of 0.94 (95% CI 0.27, 3.20).
ii. Cardiac death. One report (Goldman 1978) involving 1,001 patients gave rates of 5.1% and 1.2%, an ARI of 3.9%, and a RR of 4.22 (95% CI 1.74, 10.23).
iii. Overall cardiac events. One report (Goldman 1978) involving 1,001 patients gave rates of 6.8% and 3.0%, an ARI of 3.8%, and a RR of 2.25 (95% CI 1.15, 4.39).

Summary of Evidence:

15. The presence of rales indicative of CHF increases the risk of perioperative cardiac mortality and overall cardiac events (Level I, Category A).

d) ***Aortic Stenosis*** *(AS) (Table 15)*

One report (Goldman 1977) involving 1,001 patients established AS by the presence of a systolic ejection murmur of at least Grade 2 (of 6) accompanied by carotid and cardiac examination consistent with aortic stenosis.

i. Cardiac morbidity. Rates were 4.3%and 3.9%, an ARI of 0.4%, and a RR of 1.12 (95% CI 0.16-7.80).
ii. Cardiac death. Rates were 13.0% and 1.6%, an ARI of 11.4%, and a RR of 7.97 (95% CI 2.49-25.48).
iii. Overall cardiac events. Rates were 17.4% and 5.5%, an ARI of 11.9%, and a RR of 3.15 (95% CI 1.25, 7.96).

Summary of Evidence:

16. The presence of AS increases the risk of perioperative cardiac death and overall cardiac events (Level I, Category A).

III. **Laboratory/Diagnostic Tests**

1. *ECG findings*

a) *Ischemia* (Table 16)

i. Cardiac morbidity. Two reports (Goldman 1978, von Knorring 1981) involving 13,655 patients gave rates of 5.2% and a 0.4%, an ARI of 4.8%, and a RR of 4.56 (95% CI 2.60, 8.01).
ii. Cardiac death. Two reports (Goldman 1978, von Knorring 1981) involving 13,655 patients gave rates of 4.2% and 0.2%, an ARI of 4.0%, and a RR of 4.57 (95% CI 2.05, 10.20).
iii. Overall cardiac events. Five reports (Brown 1993, Coley 1992, Fleisher 1991, Goldman 1978, Von Knorring 1981) involving 14,058 patients gave rates of 10.9% and 0.6%, an ARI of 10.3%, and a RR of 4.44 (95% CI 3.00, 6.58).

Summary of Evidence:

17. The presence of ECG findings of ischemia increases the risk of perioperative cardiac morbidity, cardiac death and overall cardiac events (Level I, Category A).

b) *ST Changes (Table 17)*

i. Cardiac morbidity. One report (von Knorring 1981) involving 12,654 patients gave rates of 22.8% and 0.3%, an ARI of 22.5%, and a RR of 77.65 (95% CI 43.66, 138.11).
ii. Cardiac death. One report (von Knorring 1981) involving 12,654 patients gave rates of 12.3% and 0.1%, an ARI of 12.2%, and a RR of 171.89 (95% CI 66.29, 445.73).
iii. Overall cardiac events. Three reports (Brown 1993, Lette 1992, von Knorring 1981) involving 13,228 patients gave rates of 17.3% and 0.5%, an ARI of 16.8%, and a RR of 4.88 (95% CI 3.32, 7.19).

Summary of Evidence:

18. The presence of ST changes on ECG increases the risk of perioperative cardiac morbidity, cardiac mortality and overall cardiac events (Level I, Category A).

c) *Arrythmia* (Table 18)

i. Cardiac morbidity. Five reports (Foster 1986, Gerson 1990, Goldman 1977, Hollenberg 1992, O'Kelly 1992) inovolving 3,415 patients gave rates of 18.1% and 10.8%, an ARI of 7.3%, and a RR of 1.71 (95% CI 1.39, 2.09).
ii. Cardiac death. Three reports (Foster 1986, Goldman 1977, O'Kelly 1992) involving 2,831 patients gave rates of 3.2% and 1.2%, an ARI of 2.0%, and a RR of 2.66 (95% CI 1.39, 5.09).

iii. Overall cardiac events. Eight reports (Coley 1992, Foster 1986, Gerson 1990, Goldman 1977, Hollenberg 1992, Lette 1992, Mangano 1990, O'Kelly 1992) involving 4,309 patients gave rates of 23.9% and11.5%, an ARI of 12.4%, and a RR of 2.05 (95% CI 1.74, 2.41).

Summary of Evidence:

19. The presence of arrythmia in the ECG increases the risk of perioperative cardiac morbidity, cardiac death, and overall cardiac events (Level I, Category A).

d). *More than 5 premature ventricular contractions (PVC) (Table 19)*

i. Cardiac morbidity. Two reports (Gerson 1990, Goldman 1977) involving 1,178 patients gave rates of 20.3% and 4.6%, an ARI of 15.7%, and a RR of 3.63 (95% CI 2.09, 6.32).
ii. Cardiac death. One report (Goldman 1977) involving 1,001 patients gave rates of 13.6% and 1.4%, an ARI of 12.2%, and a RR of 10.04 (95% CI 4.00, 25.16).
iii. Overall cardiac events. Two reports (Gerson 1990, Goldman 1977) involving 1,178 patients gave rates of 30.5% and 5.8%, an ARI of 24.7% and a RR of 4.63 (95% CI 2.97, 7.23).

Summary of Evidence:

20. The presence of more than 5 PVC's in the ECG increases the risk of perioperative cardiac morbidity, cardiac death and overall cardiac events (Level I, Category A).

e) *Left Ventricular Hypertrophy (LVH) (Table 20)*

i. Cardiac morbidity. One report (Hollenberg 1992) involving 407 patients gave rates of 78.3% and 38.8%, an ARI of 39.5%, and a RR of 2.02 (95% CI 1.57, 2.59).
ii. Overall cardiac events. Two reports (Hollenberg 1992, Lette 1992) involving 762 patients gave rates of 33.3% and 25.0%, an ARI of 8.3%, and a RR of 1.95 (95% CI 1.47, 2.58).

Summary of Evidence:

21. The presence of LVH in the ECG increases the risk of perioperative cardiac morbidity and overall cardiac events (Level I, Category A).

2. *Cardiomegaly in Chest X-ray* (Table 21)

i. Cardiac morbidity. Three reports (Banocnoc 1993, Foster 1986, Goldman 1978) involving 2,701 patients gave rates of 11.5% and 6.3%, an ARI of 5.2%, and a RR of 1.81 (95% CI 1.29, 2.53).
ii. Cardiac death. Two reports (Foster 1986, Goldman 1978) involving 2,601 patients gave rates of 2.6% and 1.4%, an ARI of 1.2%, and a RR of 1.94 (95% CI 0.90, 4.17).

iii. Overall cardiac events. Three reports (Banocnoc 1993, Foster 1986, Goldman 1978) involving 2,701 patients gave rates of 14.1% and 7.6%, an ARI of 6.5%, and a RR of 1.83 (95% CI 1.35, 2.48).

Summary of Evidence:

22. The presence of cardiomegaly in the chest x-ray increases the risk of perioperative cardiac morbidity and overall cardiac events.

3. ***Hypercholesterolemia*** (Table 22)

i. Cardiac morbidity. One report (Hollenberg 1992) involving 407 patients gave rates of 63.6% and 39.7%, an ARI of 23.9%, and a RR of 1.60 (95% CI 1.14, 2.25).
ii. Cardiac death. One report (Brown 1993) involving 224 patients gave rates of 4.3% and 6.1%, an ARR of 1.8%, and a RR of 0.72 (95% CI 0.22, 2.31)
iii. Overall cardiac events. Four reports (Brown 1993, Hollenberg 1992, Raby 1989, Raby 1992) involving 929 patients gave rates of 14.3% and 29.5%, an ARR of 15.2%, and a RR of 0.89 (95% CI 0.66, 1.21).

Summary of Evidence:

23. An elevated serum cholesterol increases the risk of perioperative cardiac morbidity but not of cardiac death and overall cardiac events (Level I, Category A).

IV. Surgical Procedures

1. ***Emergency Surgery*** (Table 23)

i. Cardiac morbidity. Two reports (Goldman 1977, Rao 1983) involving 1,734 patients gave rates of 5.4% and 2.3%, an ARI of 3.1%, and a RR of 2.63 (95% CI 1.55, 4.48)
ii. Cardiac death. Two reports (Boyd 1980, Goldman 1977) involving 1,358 patients gave rates of 6.5% and 1.5%, an ARI of 5.0%, and a RR of 4.96 (95% CI 2.49, 9.86).
iii. Overall cardiac events. Three reports (Boyd 1980, Goldman 1977, Rao 1983) involving 2,092 patients gave rates of 8.3% and 2.9%, an ARI of 5.4% and a RR of 3.27 (95% CI 2.17, 4.93).

Summary of Evidence:

24. Emergency surgery increases the risk of perioperative cardiac morbidity, cardiac death and overall cardiac events (Level I, Category A).

2. ***Vascular Surgery*** (Table 24)

i. Cardiac morbidity. Three reports (Ashton 1993, Roger 1989, Steen 1978) involving 2,192 patients gave rates of 7.9% and 2.2%, an ARI of 5.7%, and a RR 0f 3.61 (95% CI 2.30, 5.85).

ii. Overall cardiac events. Six reports (Ashton 1993, Fleisher 1991, Lette 1992, Mangano 1990, Roger 1989, Steen 1978) involving 3,093 patients gave rates of 12.3% and 4.2%, an ARI of 8.1%, and a RR of 2.33 (95% CI 1.8, 3.02).

Summary of Evidence:

25. Vascular surgery has a higher risk of cardiac morbidity and overall cardiac events compared to nonvascular surgery (Level I, Category A).

3. ***Abdominal Surgery*** (Table 25)

i. Cardiac morbidity. One report (Steen 1978) involving 587 patients gave rates of 8.3% and 5.8%, an ARI of 2.5%, and a RR of 1.45 (95% CI 0.65, 3.19).
ii. Overall cardiac events. Two reports (Brown 1993, Steen 1978) involving 809 patients gave rates of 7.5% and 5.7%, an ARI of 1.8%, and a RR of 1.32 (95% CI 0.63, 2.75).

Summary of Evidence:

26. Abdominal surgery does not have a significantly higher risk of cardiac morbidity nor perioperative cardiac events compared to non-abdominal surgery (Level I, Category A).

4. ***Thoracic Surgery*** (Table 26)

i. Cardiac morbidity. One report (Steen 1978) involving 587 patients gave rates of 12.5% and 5.9%, an ARI of 6.6%, and a RR of 2.13 (95% CI 0.70, 6.47).
ii. Overall cardiac events. Two reports (Brown 1993, Steen 1978) involving 811 patients gave rates of 10.3% and 5.7%, an ARI of 4.6%, and a RR of 2.0 (95% CI 0.72, 5.59).

Summary of Evidence:

27. Thoracic surgery does not have an increased risk of cardiac morbidity and overall cardiac events compared to non-thoracic surgery (Level I, Category A)

Table 27 shows risk factors for overall cardiac events that were reported from univariate analysis showing relative risk and 95% CI of the relative risk.

Combinations of Predictors (Multivariate Analysis)

There were 10 reports in which multivariate analysis was done. In 2 reports, cardiac morbidity was the outcome, 2 reports on cardiac death, and in 6 reports overall cardiac events was the outcome. Tables 28 and 29 summarize these reports by providing a list of the outcomes with their significant predictors and the number of reports in which they were included and the corresponding authors.

The following predictors were included in at least 2 multivariate reports:

History: 1) age more than 70 years; 2) congestive heart failure; 3) diabetes; 5) coronary artery disease ; 6) digoxin use for CHF.

Laboratory/Diagnostic Tests: 1) ECG changes (ischemia, arrhythmia, LVH); 2) increased left ventricular ejection fraction score.

The following were included in only 1 multivariate report:

History: 1) MI < 6 months; 2) hypertension; 3) smoking; 4) male sex; 5) nitrite use; 6) calcium channel blocker use; 7) dyspnea on exertion; 8) orthopnea; 9) poor medical condition.

Physical Examination: 1) clinical CHF: S3, neck vein engorgement, rales, edema; 2) aortic stenosis.

Laboratory/Diagnostic Tests: 1) > 5 PVCs on ECG.

Surgery: 1) emergency surgery; 2) thoracic surgery; 3) vascular surgery.

The following predictors identified in univariate analysis did not come out as significant predictors in multivariate analysis:

History: 1) angina; 2) MI more than 6 months; 3) claudication.

Laboratory/Diagnostic Tests: 1) cardiomegaly on chest x-ray; 2) hypercholesterolemia.

FUNCTIONAL CAPACITY

Aside from 1) a focused history taking and physical examination aimed at identifying risk factors for perioperative cardiac events, and the rational use of laboratory /diagnostic tests whose results may change the planned surgical management, and 2) consideration of the physiological stresses involved in the planned surgical procedure, a third major factor is the current functional capacity of the patient. Functional capacity can range from an athlete who has just finished a triathlon to a sedentary executive who has difficulty climbing a flight of stairs. Functional capacity has to be actively assessed. Appendix 10 shows the ACC/AHA recommended method of estimating energy requirements for various activities, adapted from the Duke Activity Status Index (Hlatky 1988) and the AHA Exercise Standards (Fletcher 1995).

Question No. 2: In patients who are to undergo noncardiac surgery, when would referral to an internist/cardiologist for preoperative cardiac evaluation be beneficial?

Preoperative referral to an internist/cardiologist for cardiac evaluation will be beneficial for patients undergoing elective noncardiac surgery in the following situations:

I. History

1. Age > 70 years (Level I, Category A)
2. CAD and prior MI (Level I, Category A)
3. CHF (Level I, Category A)
4. Significant valvular heart disease (Level I, Category A)
5. Uncontrolled, insulin dependent diabetes (Level III, Category A)
6. Severe, uncontrolled hypertension (Level III, Category A)
7. Chronic heavy smoking (Level III, Category A)
8. COPD (Level III, Category A)
9. Cerebrovascular disease (Level I, Category A)
10. Severe systemic disease (Level I, Category A)
11. Peripheral vascular disease and claudication (Level I, Category A)
12. Poor functional capacity (< 4 mets) (Level III, Category A)

II. PE

1. Clinical findings of CHF (S3, neck vein engorgement, rales, edema) (Level I, Category A)

III. Laboratory findings

1. ECG abnormalities (ischemia, arrhythmia, left ventricular hypertrophy) (Level I, Category A)

IV. Surgery

1. Major vascular, aneurysm and peripheral vascular surgery (Level I, Category A)
2. Anticipated large intraoperative volume shifts/blood loss (Level III, Category A)
3. Anticipated operative technical difficulty (Level III, Category A)

Question No.3: When is the intraoperative presence of a cardiologist/internist beneficial for patients undergoing elective noncardiac surgery?

The intraoperative presence of a cardiologist/internist will be beneficial when,

1. Risk factors are identified after proper preoperative evaluation, and
2. When the surgeon, anesthesiologist and internist/cardiologist agree that it is needed for optimum care. (Level III, Category A)

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