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Editorial

Implantable Device Prescription in 2004: A Complex Business?

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Implantable devices are now used to treat patients with congestive heart failure (CHF) with electromechanical dyssynchrony.\textsuperscript{1-4} The proven benefits include improvement in cardiovascular functional state such as better exercise capacity, 6 min-hallwalk distance, New York Heart Association Class and quality of life. There is also measurable structural change in reverse left ventricular (LV) remodelling.\textsuperscript{5} These lead to combined clinical benefit of reduced hospitalisation and possibly reduced mortality. On the other hand, patients with CHF has a high risk of concomitant arrhythmias, and sudden cardiac death is an important cause of mortality in these patients.\textsuperscript{6} Prophylactic implantable cardioverter defibrillator (ICD) has been shown to improve survival over best medical therapy when implanted either for primary or secondary prevention.\textsuperscript{7,8} Thus when a device is prescribed for any patients, one must consider these therapeutic options so that the patient can derive the maximum benefit from an optional device. Upgrading a device is not only costly, but can be difficult because of access issues and complexity of multiple leads.

Congestive Heart Failure

In patients with a QRS >120 ms and poor ejection fraction (EF, <35%), cardiac resynchronisation therapy (CRT) is now a Class IIa indication for pacing. The main argument here is whether to use a CRT or a CRT with ICD backup (CRT-D) in the CHF population with high risk of SCD.\textsuperscript{9} The pros would advocate a one-off device treatment which is evidenced based\textsuperscript{8-9} both for ischaemic and non-ischaemic cardiomyopathy. In addition, most benefits of ICD are in patients with wide an underlying QRS complex. The antagonist would argue the relative small benefit of ICD over drug therapy (e.g. 106 vs 97 deaths in the drug vs ICD arms in MADIT 2). In addition, many CHF patients have significant co-morbidities that would limit the lifespan of these individuals, and CRT alone would give good clinical relief and reduce hospitalisation. Cost is an important issue in all countries. In patients with narrow QRS complex, underlying LV dyssynchrony may be present, and these patients may also benefit from CRT, although we do not yet have trial data.

Bradycardia Pacing

Existing studies with the exception of a proportion of patients in MUSTIC\textsuperscript{1} do not include a group of patients with right ventricular (RV) pacing, which induces a wide QRS complex. Whether one can extrapolate existing short to intermediate term data to these patients remain controversial.
particularly for patients – who are not symptomatic of heart failure. For patients with sick sinus syndrome, it may be fair to apply the current indication for CRT in these patients if concomitant LBBB and CHF are present. In patients with complete atrioventricular (AV) block, the situation is a little more complex. A LV based pacing system after AV nodal ablation gives a better acute haemodynamic results compared to RV pacing. There is less mitral regurgitation and better ejection fraction after LV pacing compared to RV pacing. The data also suggest similar benefit in patients with either preserved or impaired EF. These data have implication of the use of CRT rather than RV pacing after AVN ablation. There is as yet no data for idopathic AV block. Whether one should implant a CRT device in AV block remains controversial and it is uncertain if a CRT-D should be used in those with poor EF. RV apical pacing is associated with long term impairment of LV function and regional perfusion defects, and RV septal pacing may be an alternative way to preserve LV function.

Conclusion

We are now at a crossroad when prescribing a device for a patient with combination of brady or tachyarrhythmias with poor LV function. For most patients, a single, most sophisticated device that fits all purpose is clearly appealing, but there are issues in risk of procedure, cost and complexity in programming. We clearly need data to best tailor therapy for the individual patient to minimize the need for system change, and yet medically, socially, and economically acceptable.

References

Two Cases of Long-term Coronary Sinus Pacing by Medtronic Model 6992 Lead

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NAKAZATO and NAKATA: Two Cases of Long-term Coronary Sinus Pacing by Medtronic Model 6992 Lead. In late '70s, coronary sinus (CS) pacing was clinically performed by using several specifically designed lead systems. However, there is scant long-term follow-up data covering periods more than 15 years. We report two patients with sick sinus syndrome in whom CS pacing with Medtronic model 6992 lead system was successfully applied for 17 and 21 years, respectively. (J HK Coll Cardiol 2004;12:3-6)

Left atrial pacing, pacing lead, prognosis, sick sinus syndrome

Introduction

Coronary sinus (CS) is an optional site for atrial pacing if an optimal site cannot be found in the right atrium. Although lead dislodgement and/or threshold rise were observed in limited cases, the long-term feasibility of the CS pacing method by standard or specifically designed lead systems has been reported.1,2 However, no follow-up data over 15 years using Medtronic model 6992 CS lead has been reported. We have experienced two patients with sick sinus syndrome (SSS) in whom CS pacing by this system was successfully implanted at late '70 and applied for 17 and 21 years, respectively.

Case Reports

Case 1

The patient was a 77-year-old male with SSS. At the age of 55, he was implanted with an AAI mode pacemaker using a Medtronic model 6992 CS lead (Figures 1a & 1b). Unipolar pacing was performed because of better thresholds than bipolar pacing. The voltage (V) and current (mA) thresholds measured with a pulse width of 0.6 msec were 2.4 V and 7.9 mA respectively at the time of implantation. P-wave amplitude was 2.1 mV and pacing impedance was 304 ohms. Although two generator changes were performed at 8 and 12 years following initial implant,
these parameters remained stable (Table 1). Thereafter, CS pacing was successfully performed for 17 years until lead fracture was found at the vicinity of puncture site. We abandoned the CS lead and implanted a new pacing system from the opposite site. ECG during CS pacing has not changed and no progression to atrioventricular block was noted (Figure 1c).

![Figure 1](image.png)

**Table 1. Change of measurements at the time of initial implantation and replacement in Case 1**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Initial implant (78)</th>
<th>1st (85)</th>
<th>2nd (90)</th>
<th>3rd (95)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage* (V)</td>
<td>2.4</td>
<td>3.2</td>
<td>2.2</td>
<td>fracture</td>
</tr>
<tr>
<td>Current* (mA)</td>
<td>7.9</td>
<td>9.6</td>
<td>5.6</td>
<td></td>
</tr>
<tr>
<td>P-wave (mV)</td>
<td>2.1</td>
<td>1.8</td>
<td>2.4</td>
<td>0.3</td>
</tr>
<tr>
<td>Impedance (Ω)</td>
<td>304</td>
<td>315</td>
<td>379</td>
<td>740</td>
</tr>
</tbody>
</table>

*Measured at pulse width of 0.6 ms
Case 2
The patient was a 68-year-old female with SSS. At the age of 48, she had recurrent syncope due to sinus arrest and CS pacing with a Medtronic 6992 lead was performed (Figures 2a & 2b). At the time of initial implantation, the voltage and current thresholds measured at a pulse width of 0.6 msec were 1.2 V and 2.8 mA respectively, and P-wave amplitude was 3.7 mV all in the unipolar configuration. Subsequently, the lead remained functional after one generator change with the last measured thresholds of 1.3 V and 2.9 mA at 0.6 ms, a P-wave amplitude of 2.6 mV and lead impedance of 540Ω. Stable CS pacing has been maintained for 21 years since the initial implantation. Voltage threshold during the follow-up period has ranged from 1.8 V to 2.2 V with a pulse width of 0.5 msec. The ECG has indicated constant AAI pacing and no progression to atrioventricular block is noted during the follow-up period (Figure 2b).

Discussion
Recent advances in pacing lead technology have made stable atrial pacing possible. The prevalent lead fixation sites are the right atrial free wall by screw-in leads or the right atrial appendage by J-shaped leads. CS is another optional site for atrial pacing and several specially designed CS leads were used before the development of above two lead systems.1,2 However, the CS lead has the concern of lead dislodgement and/or threshold rise and their clinical application was very limited.1,3

Figure 2. Chest X-ray and ECG in Case 2. (a & b) CS lead is clearly recognizable in the Postero-anterior and lateral projection. (c) ECG showed stable atrial pacing.
Moss and Rivers\textsuperscript{2} reported ten-year experience in 50 patients with CS pacing by Medtronic model 5818 and 6904 bipolar pacing lead. They had 11 electrode related malpacing events, or a rate of 10\% in the first pacing month, 1.1\% per paced month during the next six months, and 0.25\% per paced month thereafter. Within 7 months, they observed lead dislodgement and high thresholds as major problems. Effective atrial pacing was achieved in 76\% of the patients during a follow-up of more than five years. They concluded that long term atrial pacing from the CS was safe and effective.

Greenberg et al\textsuperscript{1} reported 66 patients with CS pacing by specifically designed leads. During an average follow-up of 14 months the failure rate was 14\% and they reported 4 cases of lead dislodgement and 4 cases of threshold rise.

In the present cases, we had a chance to use Medtronic 6992 leads for CS pacing. Until then, we had no means of atrial pacing for sic sinus syndrome. This lead has a straight tapered tip with bipolar electrodes for obtaining stable fixation. However, unipolar use with distal electrode provides superior thresholds as compared to bipolar use. This could be explained by the fact that proximal electrode more mobile and could not maintain good contact with surrounded CS tissues. Ideally, it had been better to fix the lead in optimal position for good thresholds. However, if this CS lead was once fixed, it could not be changed the position for preventing dislodgement. If the thresholds were not acceptable at this position, we might have abandoned it and obliged to chose ventricular pacing. In our 2nd case, voltage and current thresholds were 1.3 V and 2.9 mA respectively. These were similar to Greenberg et al's\textsuperscript{1} and Moss and Rivers's\textsuperscript{2} reports which stated an overall average threshold by unipolar and bipolar CS pacing as 2.3 mA in both series. Relatively high thresholds were obtained in our 1st case, but they were mostly stable. Thus, the thresholds during long-term follow-up periods were acceptable and lead dislodgement was not observed in either cases.

Recently, the indication of biatrial pacing is emphasized for the prevention of refractory atrial tachyarrhythmias.\textsuperscript{4} In such cases, CS pacing is a necessary site for left atrial pacing. Therefore, the long-term prognosis of CS leads is major concern. Rosenthal and Cook reported that significant adhesions to the coronary veins were found 12 years after placing a pacing lead in the posterolateral coronary vein.\textsuperscript{5} The results of their observation and the presented cases support that the long-term CS pacing is feasible with safety. It may encourage selecting the CS as a site for multisite pacing if it is needed.

References

Surgery for Cardiac Tumors (Primary and Secondary) – Clinical Experience and Surgical Results in 22 Patients: Queen Elizabeth Hospital

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LAM ET AL.: Surgery for Cardiac Tumors (Primary and Secondary) – Clinical Experience and Surgical Results in 22 Patients: Queen Elizabeth Hospital. Purpose: Retrospective review of surgical management of the 22 cardiac tumors resected in Queen Elizabeth Hospital during the period of March 1995-December 2002. Methods: Presenting symptoms, diagnostic data, anatomical findings, surgical techniques, morbidity and complications of surgery were recorded. Follow up data was retrieved from out-patient records. Results: There were 12 male (54.5%) and 10 female (45.4%) patients. Median age was 61.50% (11/22) of the cases were myxoma. Of the remaining cases, 27.3% (6/22) were various types of secondary metastastic tumor, 13.6% (3/22) were tumor of mediastinum with cardiac invasion, and 9.1% (2/23) were primary malignancy. Left sided masses were dominated by myxoma, which were sited either on the inter-atrial septum (81.8%) or left atrium (18.1%). All other tumor groups were found on the right side. Dyspnea (81.9%) was the most common presenting symptom, followed by chest pain (31.8%), embolic events (13.6%) and superior vena cava obstruction. All tumors were resected with cardiopulmonary bypass under moderate hypothermia, undertaken via either right atriotomy, superior septal and trans-septal with full thickness excision. The average cross-clamp time and bypass time were 48.6 minutes and 101.4 minutes respectively. The average blood loss was 813 ml. Post-operatively, 2 of the cases were complicated by junctional bradycardia and one of them required permanent pacing. Other complications including pericardial effusion, superior vena cava obstruction, pneumonia, secondary hemorrhage had been reported. The average follow up period was 40 months ranging from 3 months to 8 years. All patients with primary benign myxoma remained asymptomatic except one died 3 years after surgery. This patient had known co-existing history of breast cancer. She suffered from embolic complications and finally succumbed from multiple organ failure. All patients with secondary neoplasms died during the course of follow-up. One with germ cell tumor was loss to follow up. Survival for primary benign tumors and cardiac metastasis from secondary tumors, were 34 and 6 months respectively. The median survival of all tumors was 25 months. Surgical resection, when possible, is the treatment of choice for all patients with cardiac neoplasms. It is curative in benign tumors. On the other hand, palliative surgical procedures may be carried out for malignant tumors for relief of obstructive symptoms and allow time for adjuvant therapy. (J HK Coll Cardiol 2004;12:7-15)

Cardiac tumor, myxoma, superior septal approach, survival

摘要
目的：回顧性地分析從1995年3月至2002年12月間伊利沙伯醫院手術切除的22例心臟腫瘤病人的資料。方法：記錄臨床症狀、診斷資料、解剖發現、手術技術、病變狀況和手術併發症。並從門診記錄中獲取隨訪資料。結果：共有12位男性(54.5%)和10位女性(45.4%)病人，平均年齡為61歲。50%(11/22)的病例為粘液瘤。其他剩餘的病例中，27.3%(6/22)為各種類型的繼發性轉移腫瘤，13.6%(3/22)為縱隔腫瘤伴有心內膜侵犯，其他9.1%(2/23)為原發性惡性腫瘤。左側腫瘤皆為粘液瘤，部位或在房間隔內(81.8%)或在左心房(18.1%)。其他腫瘤則位於右側。呼吸困難(81.9%)是最常見的臨床症狀，其次為胸痛(31.8%)，栓塞事件(13.6%)和上腔靜脈阻塞。所有腫瘤均在適中的低溫下通過心肺轉
SURGERY FOR CARDIAC TUMORS (PRIMARY AND SECONDARY)

Introduction

Primary cardiac tumor is rare entities. Three quarters of tumors are benign and nearly half of the benign tumors are myxoma. Metastatic tumor component, on the other hand, is relatively frequent. It is generally located in the pericardium. Diagnosis is usually difficult since clinical manifestations varied and sometimes patients may be asymptomatic. Surgical results in patients with primary cardiac tumors depend upon the anatomical and histological type of tumors. Conduction disturbances and supra-ventricular arrhythmias are common complications following excision of left atrial myxomas. Superior-septal approach can injure sinus node function because incision interrupts the sinus node artery. Benign cardiac tumors are generally curable if surgically excised, and the prognosis is excellent. Aggressive surgery can palliate obstructive symptoms in malignant tumors and allow time for adjuvant therapy even though it may result in incomplete excision.

Patients and Methods

Cardiac tumors (primary and secondary) were resected from 22 patients in Queen Elizabeth Hospital between the period of March 1995-December 2002. There were 12 male (54.5%) and 10 female (45.5%) patients (age between 14-72). Median age was 61 and mean age was 56.7. Tumors were mainly divided into 3 groups: primary (benign and malignant), secondary (metastatic) and mediastinal tumor with cardiac invasion. Primary, benign cardiac tumor, myxoma (n=11), accounted for 50% of all cases. Primary malignant composed of 9% of all cases. One of them was angiosarcoma (n=1) and the other malignant fibrous histiocytoma (n=1). Of the secondary cardiac tumors, 3 were metastasis from carcinoma of lung (13.6%), including one large cell carcinoma and 2 non-small cell carcinoma. In the remaining cases, 2 were metastasis from the liver (hepatocellular carcinoma) and one from the bladder (transitional cell carcinoma). Lastly, the mediastinal group with cardiac invasion accounted for 13.6%, of which 2 were malignant thymoma (n=2) and one germ cell tumor (n=1) (Tables 1 & 2).

Presenting Symptom

The majority (81.8%) of patients presented with shortness of breath and chest pain (31.8%). Embolic events (including recurrent TIA and pulmonary embolus) were noted in 3 patients (13.6%). One of the pulmonary embolus was located in the right pulmonary artery with extension into the right ventricle. Three of the patients presented with Superior Vena Caval Obstruction (SVCO) syndrome. Various cardiopulmonary symptoms (including dizziness, cough, hemoptysis and fever) had been reported (Table 3).

Investigation

All patients had echocardiogram (transthoracic) as their diagnostic modalities. Transthoracic echocardiogram and CT thorax were performed in
Table 1. Results (primary cardiac tumor)

<table>
<thead>
<tr>
<th>Lesion</th>
<th>No</th>
<th>Sex (M/F)</th>
<th>Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myxoma (benign)</td>
<td>11</td>
<td>3/8</td>
<td>LA (2), interatrial septum (9)</td>
</tr>
<tr>
<td>Malignant fibrous histiocytoma</td>
<td>1</td>
<td>0/1</td>
<td>LA</td>
</tr>
<tr>
<td>Angiosarcoma (malignant)</td>
<td>1</td>
<td>1/0</td>
<td>RA</td>
</tr>
</tbody>
</table>

LA: left atrium; RA: right atrium

Table 2. Results (secondary / metastasis)

<table>
<thead>
<tr>
<th>Lesion</th>
<th>No</th>
<th>Sex (M/F)</th>
<th>Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mediastinal Thymoma / thymic CA</td>
<td>2</td>
<td>2/0</td>
<td>Thymus</td>
</tr>
<tr>
<td>Germ cell</td>
<td>1</td>
<td>1/0</td>
<td>Mediastinal with bilateral pleural extension, right bronchus and trachea</td>
</tr>
<tr>
<td>Secondary HCC</td>
<td>2</td>
<td>2/0</td>
<td>RV, IVC</td>
</tr>
<tr>
<td>TCC</td>
<td>1</td>
<td>1/0</td>
<td>RA</td>
</tr>
<tr>
<td>Lung CA</td>
<td>3</td>
<td>2/1</td>
<td>RV, LA, RVOT</td>
</tr>
</tbody>
</table>

CA: cancer; HCC: hepatocellular carcinoma; TCC: transitional cell carcinoma; RV: right ventricle; IVC: inferior vena cava; RA: right atrium, AV: atrio-ventricular; RVOT: right ventricular outflow tract

Table 3. Clinical presentations

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Myxoma</th>
<th>Primary malignant</th>
<th>Secondary malignant</th>
<th>Mediastinal tumor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dyspnea</td>
<td>8/11 (72.7%)</td>
<td>2/2 (100%)</td>
<td>5/6 (83.3%)</td>
<td>3/3 (100%)</td>
</tr>
<tr>
<td>CHF</td>
<td>4/11 (36.3%)</td>
<td>1/2 (50%)</td>
<td>1/6 (16.7%)</td>
<td>0</td>
</tr>
<tr>
<td>Chest pain</td>
<td>5/11 (45.4%)</td>
<td>1/2 (50%)</td>
<td>1/6 (16.7%)</td>
<td>0</td>
</tr>
<tr>
<td>Syncope</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Embolism Cerebral</td>
<td>1/11 (9.09%)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Embolism Peripheral</td>
<td>0</td>
<td>0</td>
<td>2/6 (33.3%)</td>
<td>0</td>
</tr>
<tr>
<td>Embolism Coronary</td>
<td>1/11 (9.09%)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Embolism AII 3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Constiutional manifestation</td>
<td>3/11 (27.2%)</td>
<td>1 (hemoptyis)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SVCO</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3/3 (100%)</td>
</tr>
</tbody>
</table>

CHF: congestive heart failure; SVCO: superior vena caval obstruction

selected patients. One patient with history of ischemic heart disease also had coronary angiogram as part of the preoperative investigation (Figure 1).

Tumor size range from 2.5 x 5 cm to 7-8 cm x 5.5 cm in size. Of all the atrial myxoma, 4 had narrow stalk and one was pedicled. Two had broad sessile base. For the non-myxomatous tumor group, only one of them had narrow stalk. One patient had tumor arising from the pulmonary valve annulus (Figures 2 & 3).

In each case, tumor was excised during total cardiopulmonary bypass under moderate hypothermia. The average cross-clamp time and bypass time were 48.6 minutes and 101.4 minutes respectively. The average blood loss was 813 ml.
Surgical approaches were mainly accessed via the right atrium (right atriotomy). Amongst these 17 cases, superior-septal approach was employed in 6 of the cases. Trans-septal approach was used in 3 cases. One of them required the extension of incision into the left atrium. Another required incision into pulmonary artery because of the extent of the tumor mass.

Tumor excision was performed in 17 cases and the remaining 5 were performed as palliative procedures (Figures 4 & 5).

Excision of the atrial tumor with an adequate margin was generally performed in each of these cases. Atrial septal defect (ASD) was created in 5 of these cases, in which 2 of them required patch repair. Primary closure (of ASD) was performed in the remaining case. One patient also had co-existing mitral valve replacement (Figure 6 & Table 4).
Figure 3. Site and distribution of tumor.

Figure 4. Surgical procedures.

Figure 5. Surgical approaches.
Early Deaths

Early deaths were defined as death within 30 days of operation which occurred in 3 of our patients. One of them (with secondary metastasis from transitional cell carcinoma) died of complications as a result of tumor obstruction to the right ventricular outflow tract. The second patient (carcinoma of unknown origin, ? lung) died of gastrointestinal bleeding. The third patient with angiosarcoma died of multi-organ failure and sepsis (due to the rapid progression of the disease) (Table 5).

Recurrence had been reported in 2 patients. One with malignant fibrous histiocytoma and large cell carcinoma (lung), in which both received cycles of chemotherapy. The tumor size were large and in conjunction with its aggressive nature and rapid growth, debulking surgery had been performed for palliative purposes.

Follow up

All 12 survivors (10 myxoma, 1 thymic carcinoma and 1 malignant thymoma) remained asymptomatic during the time of follow-up of up to 7 years. One patient with germ cell tumor was lost to follow-up.

Discussion

Tumors of the heart remain a rare occurrence. The incidence of primary cardiac neoplasia ranges from 0.001% to 0.03% in autopsy report. In adult, approximately 75% of such tumors

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Table 4. Early morbidity

<table>
<thead>
<tr>
<th>Cardiac complications</th>
<th>Respiratory complications</th>
<th>Thoracic complications</th>
<th>Systemic complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junctional bradycardia</td>
<td>Pneumonia</td>
<td>SVC obstruction</td>
<td>Secondary hemorrhage</td>
</tr>
<tr>
<td>Pericardial effusion</td>
<td></td>
<td>Bilateral diaphragmatic paralysis</td>
<td>Wound infection</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sepsis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>GI bleeding</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hypoxic brain damage</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Multi-organ failure/DIC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Embolic events</td>
</tr>
</tbody>
</table>
are benign and 25% are malignant.5 Eleven of 22 (50%) tumors in this surgical series were benign tumor and all were myxoma. Two (9.1%) were primary malignant tumors (Figure 1). In the remaining 8 cases were metastatic tumor (arising from lung, liver and bladder). 3/22 (13.6%) were mediastinal tumor with cardiac invasion (Figure 2).

Myxoma is the most common primary tumor of the heart (30-50% of all cases). They may affect patients of all ages, predominantly women. They are gelatinous masses (myxomatous), lobulated, attached to the endocardium via a variable sized pedicle or by a wide base that project toward the interior of the cavity without infiltrating the underlying tissue. 75-80% are found in the left atrium, especially associated to the fossa ovalis.3

Sarcoma accounted for almost all these malignant tumors, they have a rapid and fatal evolution. Surgical statistics show that the most frequent malignant tumors are angiosarcoma (35-40%), most of which (80%) are located in the right atrium.1 They are invasive tumor masses, with areas of necrosis and hemorrhage affecting the myocardium, and may protrude into the atrial cavity. Because of its unique location, they can manifest as right heart failure. Pericardial effusion (usually hemorrhagic in nature with or without tamponade) as well as systemic manifestation (e.g. fever, weight loss) had also been reported in the literature.1

The only patient with angiosarcoma (primary malignant) in our series, the tumor was also sited in the right atrium. He presented acutely with marked shortness of breath and hemoptysis. His condition deteriorated rapidly despite palliative surgical resection of the tumor. He went on to develop multi-organ failure, septicaemic shock and eventfully died the next day after surgery.

Secondary cardiac neoplasms are 20-40 times more common compared with primary malignancies.3 Metastases can reach the heart via blood stream and coronary arteries (e.g. melanoma, sarcoma and bronchogenic carcinoma). Other routes include the lymphatic channels or direct invasion of tumor from adjacent lung, breast, oesophagus and thymus. Pericardium is the most frequently involved structure through direct invasion by various thoracic tumors.

<table>
<thead>
<tr>
<th>Tumor type</th>
<th>Sex/age</th>
<th>Time from presentation till death</th>
<th>Evidence of recurrence</th>
<th>Cause of death</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large cell carcinoma</td>
<td>M/58</td>
<td>5 months</td>
<td>Malignant pleural effusion</td>
<td>Large cell CA</td>
</tr>
<tr>
<td>HCC</td>
<td>M/62</td>
<td>6 months</td>
<td>(FU PWH)</td>
<td>Palliative resection of tumor (RVOTO) Progression of RHF</td>
</tr>
<tr>
<td>HCC</td>
<td>M/62</td>
<td>6 months</td>
<td>Palliative resection of tumor</td>
<td>HCC, RHF</td>
</tr>
<tr>
<td>MFH</td>
<td>F/64</td>
<td>2 years</td>
<td>Yes (LA wall with obstruction to MV valve prosthesis)</td>
<td>Progression of CHF Disseminated CA</td>
</tr>
<tr>
<td>Secondary cell carcinoma (lung)</td>
<td>M/59</td>
<td>3 years</td>
<td>Intraperitoneal metastatic spread</td>
<td>CA lung</td>
</tr>
<tr>
<td>Myxoma (background history of CA breast)</td>
<td>F/59</td>
<td>3 years</td>
<td>Emboli (recurrent TIA, popliteal and femoral artery thrombosis) septic encephalopathy</td>
<td>Sepsis, MOF</td>
</tr>
</tbody>
</table>

Clinical symptoms were commonly reported to be found in 10% of these patients\(^6\) Pericardial effusion or cardiac tamponade was the most common symptom. Three of our patients (with mediastinal tumor) presented with symptoms of superior vena cava obstruction.

Abdominal and pelvic tumors may grow in a cephalad direction via the inferior vena cava to reach the right atrium. Up to ~10% of cases of renal cell carcinoma behave in this manner and nearly 40% of these reach the right atrium.\(^3\)

**Surgical Approaches**

Various approaches had been described in the literature, depending on the site and extent of tumor involvement. The superior-septal approach (SS) had been adopted in the majority of the cases, however, trans-septal approach (TS) had also been used depending on the location of the tumor.

The proposed advantages of TS include only one atrial incision, adequate exposure for evaluation of the mitral valve, low recurrence rates and its long term efficacy.\(^7\) The SS, on the other hand, provides an excellent exposure for en bloc removal of the tumor with simultaneous visualization of both sides (right and left) of the inter-atrial septum. It is associated with a lower risk of damaging the mass and thus tumor embolisation.

Supra-ventricular arrhythmias and conduction disturbances were commonly reported following this approach, as the sinus nodal artery is often interrupted during the incision and thus sinus nodal function.\(^2\)

In our series, 3 cases of post-operative arrhythmia had been reported. Two of them were junctional bradycardia and the SS approach had been adopted in these cases. One required temporary pacing which subsequently self-reverted to sinus rhythm. The third patient had complete heart block prior to operation (likely relating to tumor invasion of the conduction system), she sustained such rhythm post-operatively, which lately required permanent pacing for treatment of her condition. The prognosis for resection of atrial myxoma, as repetitively reported in the literature, has been excellent. The optimal operative approach lacks uniformity. There is still considerable controversy concerning the extent of surgical resection necessary to prevent recurrence.\(^5\)

The rate of recurrence had been reported to be between 4-7% in different series.\(^5,8\) In our series, only one patient with myxoma died 3 years after surgical treatment. She suffered from complications (including septic encephalopathy and multi-organ failure) likely relating to her past history of breast cancer. During the course of her follow-up, there had been no evidence of recurrence of myxoma.

Post-operative echocardiogram had been generally recommended to detect recurrence. Except for those patients with multiple, atypical or familial myxoma, few trans-thoracic echocardiogram at 5-year intervals throughout life should be adequate if there has been recurrence in the first few years.\(^9\)

On the other hand, prognosis is generally poor in those with primary malignant or secondary neoplasms. Surgical treatment is directed at providing symptomatic relief with minimal patient discomfort and hospital stay.\(^3\) All patients with secondary neoplasms died after a period of follow-up ranging between 3 months to 3 years.

In conclusion, surgical resection, when possible, is the treatment of choice for all patients with cardiac neoplasms. It is curative in benign tumors. Palliative procedures, on the other hand, may be carried out for malignant tumors for relief of obstructive symptoms. It may prolong life and allow time for effective adjuvant therapy, but this would depend on the histological type (thus natural behavior of the tumor) and the location of the lesion.

**References**

4. Frota Filho JD, Lucchese FA, Leaes P, et al. Primary cardiac


Impact of a Multidisciplinary Heart Failure Management Programme on Clinical Outcomes and Hospital Admissions

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LEUNG ET AL.: Impact of a Multidisciplinary Heart Failure Management Programme on Clinical Outcomes and Hospital Admissions. Objectives: Heart failure is associated with significant morbidity and high admission rate. We evaluated the impact of a multidisciplinary heart failure management programme in a regional hospital.

Methods: From March 2001 to January 2003, fourteen patients with heart failure and history of ≥1 hospitalization for heart failure in the previous 6 months were recruited. Patients attended the programme twice per week for 3 months. Patients were cared by a multidisciplinary team including cardiologist, geriatrician, registered nurse, physiotherapist, occupational therapist and dietitian. All patients were counseled on different aspects about heart failure and received exercise training. Medications for heart failure were optimized. Knowledge of the disease, drug compliance, functional class, exercise capacity and quality of life were assessed before and after the programme. Number of heart failure hospitalization and the cost of care within the 6 months before enrolment were compared to that within the 6 months after enrolment. Results: The number of hospitalization for heart failure was reduced significantly from 28 to 6 (a reduction of 78.6%, p<0.001). Knowledge score, drug compliance score, New York Heart Association (NYHA) class, 6-minute walk and quality of life scores all improved significantly. An estimated cost saving of HK$11,340 per patient was achieved over a 6-month time frame (reduction of in-patient costs by HK$35,880 per patient and an increase in outpatient costs by HK$24,540 per patient). Conclusions: Multidisciplinary heart failure management programme is feasible in our locality. It can improve clinical outcomes; reduce heart failure hospitalizations and the high cost burden of this condition. (J HK Coll Cardiol 2004;12:16-22)

Cardiac rehabilitation, exercise, heart failure, multidisciplinary approach

Background

Heart failure is a growing public health problem in Hong Kong and in many other countries. Both the incidence and the prevalence of chronic heart failure are increasing. Heart failure is associated with poor
prognosis, reduced quality of life and is one the most significant causes of hospital admissions. In the United States, the incidence of heart failure approaches 10% per 1,000 population after age 65.1 Heart failure accounts for 5 to 10% of all hospitalizations in the United States annually, and is the leading cause of hospitalization in individuals older than 65 years of age. Hospital discharges for heart failure increased for more than three times from 1979 to 1997. Readmission rate for congestive heart failure is very high, with half of the patients readmitted within 6 months.2,3 In Hong Kong, heart failure is also an important cause of hospital admissions.4 The overall incidence was 0.7 per 1,000 population, whereas in the older than 85-year age group, the incidence was 20 per 1,000 women and 14 per 1,000 men.5 Cost of care for heart failure is very substantial because of the high hospitalization and rehospitalization rate. In the United States, heart failure costs about US$38 billion annually, of which approximately two-thirds of this amount are spent on hospitalizations.6,7

Non-compliance to optimal pharmacological, dietary or physical activity regimens is a major cause for heart failure decompensation.8 It has been shown that early re-hospitalization in patients with heart failure may be preventable in up to 50% of cases.2,9,10 These preventable negative factors include noncompliance with medications or diet, inadequate discharge planning or follow-up, and failure to seek medical attention promptly when symptoms recur. Recent studies have shown that multidisciplinary heart failure disease management programme can improve the clinical outcomes and quality of life of patients with heart failure, and reduce hospital admissions and resources utilization.11-18

We designed and implemented a multi-disciplinary management programme for heart failure patients in our hospital to determine whether this kind of programme is feasible and beneficial in our locality. The objectives of the programme were to optimize the medications; to improve the quality of life, compliance, symptoms, and functional status of patients with heart failure; to decrease the hospital admissions and cost of care for heart failure through multidisciplinary management approach.

Methods

Patient Selection

From March 2001 to January 2003, patients admitted to Pamela Youde Nethersole Eastern Hospital with a primary diagnosis of congestive heart failure were screened for enrolment. The inclusion criteria were: age >18; moderate to severe symptomatic heart failure (NYHA Class II to IV); history of 1 or more than 1 hospitalization for heart failure in the previous 6 months.

The criteria for exclusion from the study included: acute myocardial infarction within 4 weeks of entry; unstable coronary artery disease, acute myocarditis, constrictive pericarditis and other significant co-morbid conditions such as dementia or malignancy that likely to limit compliance or survival.

Baseline Evaluation and Outcome Measurement

Baseline evaluation included a history and physical examination performed by a cardiologist. Echocardiography was performed to assess the left ventricular function if it had not been performed in the previous six months.

Each patient was his/her own control and a comparison was made before and after the intervention. Data were obtained at entry to the study and at the end of the programme. Assessments included knowledge of the disease; drug compliance; sodium intake; New York Heart Association Class; exercise capacity measured by 6-minute walk test; quality of life using the Minnesota Living with Heart Failure Questionnaire.19 Sodium intake was assessed using a food frequency questionnaire. Each participant was interviewed by a dietitian with respect to food portion size, intake of food containing sodium, frequency of intake per week and month. Hospital diet was used as a reference to sodium level of seasoning. Average daily sodium intake was calculated based on the nutrient database of Nutritional Five (First DataBank Inc., 1998) and commercial food labeling. Knowledge of the disease was assessed by a set of 21 questions designed by our team, regarding the symptoms and worsening symptoms of heart failure;
the proper diet and physical activities. Drug compliance was assessed by asking the patients 6 questions regarding the name, dosage, frequency, route of administration and side effects of the medications for heart failure.

Number of heart failure hospitalization within the 6 months before enrolment was compared to that within the 6 months after enrolment. Death and other significant morbidity were also recorded.

Medications usage and dose were recorded at baseline and at end of the programme. Angiotensin converting enzyme inhibitors (ACE-I) were grouped and ranked according to dose: 'low dose' ≤10 mg/day of lisinopril or equivalent, 'medium dose' 10 to <20 mg/day lisinopril or equivalent; and 'high dose' ≥20 mg/day lisinopril or equivalent. Similarly, beta-blockers were also ranked according to dose: 'low dose' ≤12.5 mg/day carvedilol or equivalent; 'medium dose' 12.5 to <50 mg/day carvedilol or equivalent; 'high dose' ≥50 mg/day carvedilol or equivalent.

Multidisciplinary Management Programme

Patients attended the programme twice per week for about 3 months which took place at the Day Hospital of the Pamela Youde Nethersole Eastern Hospital. Patients were cared by a multidisciplinary team. The team included a cardiologist, a geriatrician, a registered nurse, a physiotherapist, an occupational therapist and a dietitian.

Each patient received an initial consultation with the cardiologist or the geriatrician. This was a comprehensive assessment of the patient's heart failure status. A monthly conference was held to discuss the progress of the patients. Follow-up review by physician would be arranged if required.

Medications for heart failure, especially angiotensin converting enzyme inhibitors and beta-blockers were optimized according to the ACC/AHA heart failure management guideline. The side effect and the importance of drug treatment were emphasized. Instructions on the use of a flexible diuretic regimen and dosage adjustment in response to worsening symptoms and weight change were given.

All patients were counseled by the registered nurse on different aspects of heart failure with emphasis on warning symptoms and signs of deterioration; and the importance of daily weighing. Each patient also received an educational booklet on heart failure. Patients and their caretaker received advice from the dietitian regarding diet, fluid and sodium management. Energy conservation technique, work simplification advice and relaxation practice were given by the occupational therapist.

All patients were assessed individually by the physiotherapist and received exercise training designed for heart failure patients. The exercise programme lasted for 3 months, two times per week. It included a combined programme of treadmill exercise, static bike riding and upper limb ergometer training. Patients were exercised to a heart rate of 50-60% of maximum predicted for age and a Borg rating of 9-12 for perceived exertion. Patients were encouraged to maintain a home programme of daily walking for a total period of exercise 30-minute per day, 5-7 days per week.

Statistical Method

The baseline demographic data were expressed as mean and standard deviation. The changes between the data obtained before and after the programme were analyzed using paired t-test. A p-value less than 0.05 was considered to be statistically significant. Analyses were performed using SPSS (version 10.0).

Results

Patient Population

From March 2001 to January 2003, fourteen patients with heart failure and history of ≥1 hospitalization for heart failure in the previous 6 months were recruited. The mean age was 71.9±5.9 (range 61-84). The male to female ratio was 1:1. The mean ejection fraction was 38.5±15.0%. Most patients were in NYHA Class III (71.4%), 21.4% of patients in Class II and 7.1% in Class IV. The etiology of heart failure were: ischemic cardiomyopathy (50%), dilated cardiomyopathy (14.2%), hypertensive heart disease (21.4%) and valvular heart disease (14.2%). All
patients completed the programme. No patient died during follow-up up to 6 months.

Hospitalizations (Figure 1)

Hospitalizations were significantly reduced. In the 6 months prior to the start of the programme, the total number of hospitalizations for heart failure was 28. The mean number of hospitalizations for heart failure per patient was 2.0. In the 6 months after enrollment to the programme, the total number of hospitalizations for heart failure was 6. The mean number of hospitalizations per patient was 0.43. Hospitalization for heart failure was reduced by 78.5% (p<0.001). Bed days were significantly reduced from a total of 362 days (of which 177 were acute bed days, 185 were convalescent bed days) to 165 days following the programme (of which 15 were acute bed days and 150 were convalescent bed days) (p<0.001). Outpatient clinic attendance also reduced from 34 to 24 following the programme.

Drug Therapies

At baseline, 71.4% of patients were receiving ACE-I or angiotensin receptor blocker (ARB), 70% of them were receiving high dose. At the end of the programme, 78.8% were receiving ACE-I or ARB and 21.4% of patients had a dose increment from their baseline dose. Regarding beta-blockers, 35.7% of patients were taking them at baseline: 60% were on low dose; 40% on medium dose; and none on high dose. At follow-up, 50% of patients were on beta-blockers of whom 14.3% were on low dose; 57.1% were on medium dose and 28.6% were on high dose and 35.7% of study patients had a dose increment.

Functional Status and Quality of Life (Table 1)

A significant improvement in symptoms and functional status was found. The NYHA Class improved from 2.9±0.6 at baseline to 1.7±0.4 at follow-up (p<0.001). Exercise capacity as measured by 6-min walk test also improved from a mean of 289.3±67.5 meters to 339.1±67.8 meters (p=0.005). Quality of life improved significantly after the programme. The Minnesota Living with Heart Failure Questionnaires improved from a score of 39.4±7.6 to 16.4±10.4 following the programme (p=0.001).

Knowledge, Drug Compliance and Sodium Intake (Table 1)

Both the knowledge of the disease and drug compliance improved after the programme. The knowledge score improved from 19.9±1.5 at baseline...
to 22.8±1.6 (p<0.001) at follow-up. The drug compliance score improved from 3.9±0.2 to 5.7±0.5 (p=0.001). The estimated daily sodium intake was 3.4 g and 3.3 g before and after the programme respectively (p: n.s.).

**Costs (Table 2)**

The cost of care for different modalities were calculated by the finance department of our hospital, using the specialty costing exercise model and taking into account of the labour cost of different disciplines, cost for drugs and equipment. The average cost per bed day for acute bed was HK$2,662 and for convalescent bed was HK$2,031. The average cost per out-patient clinic attendance was HK$1,024 and per visit to the programme (Day Hospital visit) was HK$1,404. Comparing the cost of care in the 6 months prior the programme with that spent in the 6 months following enrolment, there was a reduction of inpatient costs by HK$35,880 per patient and an increase in outpatient costs by HK$24,540 per patient. An estimated cost saving of HK$11,340 per patient over a 6-month time frame was achieved.

**Discussion**

There is growing evidence in supporting a multidisciplinary management approach to patients with chronic heart failure. Increasing input into outpatient care can reduce expensive hospital readmissions. Based on available evidence, it is appropriate to recommend widespread development and application of multidisciplinary heart failure disease management. Our study, although involved only a small number of patients, demonstrated that multidisciplinary heart failure disease program is effective in reducing hospital admissions, hospital days and cost of care; enhancing patient knowledge and compliance with medications; improving functional capacity and quality of life. The only non-significant finding in our study was the estimated daily salt intake before and after the intervention.

Drug therapies, especially ACE-I and beta-blockers, have been shown to improve survival and reduce hospitalizations in patients with heart failure. Optimization of drug therapies was one of the objectives of our programme. We observed that by the end of the

| Table 1. Summary of the effects of the multidisciplinary heart failure programme |
|---------------------------------------------|-----------------|-----------------|----------|
| NYHA Class | Pre-programme | Post-programme | p-value  |
| 2.9±0.6 | 1.7±0.4 | <0.001 |
| 6-minute walk (meters) | 289.3±67.5 | 339.1±67.8 | 0.005 |
| Quality of life (Minnesoita HF questionnaire 0-105) | 39.4±17.6 | 16.4±10.4 | 0.001 |
| Knowledge score (0-21) | 19.9±1.5 | 22.8±1.6 | <0.001 |
| Drug compliance score (0-6) | 3.9±0.2 | 5.7±0.5 | 0.001 |
| Estimated daily sodium intake (gram) | 3.4 | 3.3 | n.s. |

| Table 2. Comparison of resource utilizations and cost of care per patient in the 6 months before and after the programme |
|---------------------------------------------|-----------------|-----------------|----------|
| Pre-programme number / Post programme number / Cost savings |
| Cost (HK$) | Cost (HK$) | (HK$)  |
| Acute bed days | 177 / 33,655 | 15 / 2,852 | 30,803 |
| Convalescent bed days | 185 / 26,838 | 150 / 21,761 | 5,077 |
| Outpatient clinic visit | 34 / 2,487 | 24 / 1,755 | 732 |
| Day hospital visit | 2 / 201 | 254 / 25,473 | -25,272 |
| Cost savings (Total) | ----- | ----- | 11,340 |

(p<0.001)
study, the usage of ACE-I and beta-blockers were improved. We believed that the improvement in various parameters after intervention in our study could be partly contributed by a better medical regimen. However, the improvement was unlikely to be related entirely to the introduction and up-titration of medical treatment, because patients who could not tolerate beta-blocker still demonstrated no hospitalizations in the follow-up period.

Most published trials were done at academic centre in other countries while non-academic centres may lack the necessary facilities and personnel to assemble an effective heart failure management team. Our study demonstrated that this kind of multidisciplinary programme is feasible in our locality and could be implemented in a regional hospital. It is necessary, before implementing the programme, to consider a variety of disease management models, to select and modify the model most suited to a given practice environment because a single, unified approach is unlikely to be applicable to different practice settings.

**Limitations**

Several limitations of the study should be noted. First, this study was a non-randomized trial, and that the before-after comparison with respect to readmissions for heart failure may overestimate the reduction in hospital readmissions and the subsequent cost benefit. An appropriate way of evaluating heart failure admissions is to compare the observed readmission frequency with the expected readmission frequency during the 6 months of follow-up. A more appropriate method to confirm the true benefit of the programme is to incorporate a control group for comparison, e.g. patients who refuse to participate into the programme but with similar disease severity.

Second, it was a relatively small study. Although few patients were involved in the study, it demonstrated that this kind of programme is feasible in our locality and is potentially beneficial. Larger studies involving more patients are needed to confirm the efficacy and to identify which patient groups will benefit the most from multidisciplinary programme.

Lastly, the programme was multidisciplinary and the relative contributions of its various components could not be assessed. Future studies are needed to determine the relative merits of each component of the programme.

**Conclusions**

This is one of the first studies to assess a comprehensive multidisciplinary management programme specific to heart failure in our locality. Our study showed that a multidisciplinary approach with intensive outpatient care improves patient outcomes, reduces heart failure admissions and the high cost burden of this disease. Such management could be implemented in our locality and may become the standard care for heart failure patients, especially those with high risk of admission.

**References**

Letter to the Editor

Electron Beam Computed Tomography

Dear Editor,

The ability of Electron Beam Computer Tomography (EBT) to detect presence of coronary calcification in asymptomatic patients has fueled much debate regarding the appropriate use of this new imaging modality.

It is apparent that the extent of calcification, in terms of both an absolute volume and an age related percentile score, is predictive of relative risk of coronary artery events. It has also been demonstrated that risk stratification by Coronary Calcium Scoring has incremental value over "traditional risk assessment". As Dr. Rumberger correctly points out: certain basic epidemiological characteristics of EBT have been defined (there is a low absolute risk of coronary artery disease (CAD) with a zero coronary calcium score, increased relative risk of events and increased likelihood of angiographically significant CAD occurs with high scores).

The source of the real debate is not these issues, but rather whether and how this test should be incorporated into routine clinical cardiology practice. Firstly, should the test be used as a non-invasive test in selected populations with intermediate risk of CAD or as a screening test for the early detection of atherosclerosis in unselected populations?

There are numerous factors regarding clinical application of coronary calcium scoring that remain undefined:

1. How should the results of EBT influence the level of aggressiveness of medical therapy in asymptomatic patients? For instance:

   a) Should a patient with a zero score continue with standard primary prevention risk factor modification? Are we doing these people an injustice by providing false reassurance with a "zero" score?
   b) Does presence of any coronary calcium in an asymptomatic patient indicate the need to move to aggressive (secondary style) risk factor modification? Should these patients be prescribed aspirin?
   c) What is the evidence that asymptomatic patients with coronary calcium scores >75% for age actually benefit from further investigations such as stress testing? Although higher scores may be associated with increased atherosclerotic burden, what percentage of these patients actually have inducible ischemia at stress testing? Preliminary reports would suggest this percentage is low unless the total calcium burden (Agatson score) is greater than 400.1

2. What is the utility of serial coronary artery calcium testing, particularly after initiation of medical therapy? What do you say to a patient who has been compliant with statin therapy but has multiple new calcified lesions at follow up?

3. Is there a role for EBT in patients with prior revascularization?

4. Where should EBT be placed in the testing algorithm for symptomatic patients? Given that the risk of acute events relates to unstable plaque, and risk stratification in the presence of known coronary artery disease has been shown to relate to the extent of inducible ischemia and left ventricular function is knowledge of the coronary calcium burden additive or simply redundant information?

5. Numerous characteristics of plaque that has been shown to relate to risk of plaque rupture cannot be assessed by electronic beam computer tomography

Opinions expressed are views of the authors and not necessarily the view of the editorial board or the Hong Kong College of Cardiology.
LETTER TO THE EDITOR

(i.e. plaque ulceration and surface contour, fibrous cap, lipid content etc.). Given that a relatively small amount of the total atherosclerotic plaque burden is calcified plaque, the relationship between coronary calcium scores and risk of acute events must be more variable than Dr. Rumberger suggests. Testing for plaque stability is the ideal approach and should be incorporated into plaque imaging.

6. Most importantly, there is no information available to date regarding the cost implications of coronary artery calcium assessment in testing strategies for symptomatic or asymptomatic patients in low or intermediate risk groups. Calcium scoring has the potential to generate considerable downstream costs from non-invasive and invasive evaluations, or from altered medical management strategies.

We agree with Dr. Rumberger that an extensive literature exists validating that physiologically the presence of coronary calcium has meaning. We also agree that "coronary artery disease" can be defined today either as the presence of a significant epicardial stenosis (a traditional angiographic definition) or as the presence of atherosclerosis as demonstrated by detection of coronary artery plaque with or without associated calcification. As pointed out by Dr. Rumberger, electronic beam computer tomography is far superior for identification of calcified plaque than for the detection of patients with angiographically significant stenosis.

Hence, as alluded to by Dr. Rumberger, despite early claims that EBT would serve as a test to replace conventional stress imaging, in light of its performance characteristics this is unlikely to be the case. Rather, EBT is one of a number of tests currently available to clinicians for identification of the presence of preclinical atherosclerosis (e.g. EBT, Intimal Medial Thickening, Ankle Brachial Index). In addition, there are an increasing number of biochemical markers (such as high sensitivity C-reactive Protein) gaining acceptance for their ability to identify asymptomatic patients at risk of adverse cardiac events.

The questions facing cardiologists today are which combination of tests should be obtained in clinical practice to identify those asymptomatic patients at risk of events secondary to premature atherosclerosis. And in the event of symptoms, which combination of tests most accurately and efficiently leads to diagnosis, risk stratification and formulation of a management plan. EBT may well play an important role as a component of an algorithm in the future. However, this will only be the case after more extensive data is collected validating its performance characteristics both individually and as part of a testing algorithm.

Reference


Yours sincerely,

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