

# Sexual activity and cardiovascular risk

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For the majority of patients, sexual activity in a familiar and monogamous setting poses a very modest coronary risk; in fact, some epidemiological studies suggest longevity benefits for sexually active persons. Although the relative risk for myocardial infarction is increased during and within 2 h after sex, the absolute risk remains minuscule. The metabolic and haemodynamic demands of sexual activity, as well as any cardiac rhythm disturbances observed during sex, are generally consistent with those of daily activities, although there is considerable inter-individual variation in energy requirements. Risk for myocardial infarction during sex can be reduced through exercise training, and exercise testing plays a central role in determining the risks associated with sexual activity and treatment for erectile dysfunction. Consensus guidelines have

been released to assist the clinician in risk-stratifying patients with concomitant cardiovascular disease and erectile dysfunction, determining the advisability of resuming sexual activity or treatment for erectile insufficiency, and otherwise counselling the cardiac rehabilitation patient. Phosphodiesterase type 5 inhibitors can potentiate the blood pressure lowering effects of nitrates and nitric oxide donors; concomitant administration of these agents with sildenafil citrate and likely other phosphodiesterase type 5 inhibitors is contraindicated.

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## Introduction

With the recent advent and expanding use of potency-enhancing treatments, including phosphodiesterase (PDE) type 5 inhibitors, attention has focused on the potential health hazards of sexual activity<sup>[1]</sup>. Interest in this issue was heightened by reports of acute myocardial infarction (MI) allegedly associated with the use of the PDE5 inhibitor sildenafil citrate (Viagra®; Pfizer Inc., New York, U.S.A.)<sup>[2]</sup>. However, a subsequent British prescription event monitoring study found no evidence for a higher incidence of fatal MI or coronary heart disease (CHD) among more than 5600 men taking sildenafil<sup>[3]</sup>. Nevertheless, a U.S. panel of cardiologists released a consensus statement establishing clinical recommendations for the use of sildenafil in patients with cardiovascular disease (CVD)<sup>[4]</sup>.

Irrespective of their erectile dysfunction (ED) treatment regimens, patients with CVD incur a distinct, albeit slight, risk for sudden death during sexual activity<sup>[1]</sup>. The present review considers epidemiological evidence regarding the health risks (and benefits) of sexual activity in men, as well as guidelines for recognizing and managing these risks in clinical practice.

## Erectile dysfunction in perspective

Nearly 35% of men between 40 and 70 years of age suffer from a moderate or severe (complete) inability to achieve or maintain an erection that is adequate for sexual activity<sup>[5]</sup>. The prevalence of this condition, termed 'erectile dysfunction', increases with age and may reach 75% in men aged 80 years<sup>[6]</sup>. An increasingly well recognized and treated clinical entity, erectile dysfunction may be particularly likely in men with emotional problems or stress, declining income and/or health problems<sup>[7]</sup>. Among these health problems, CVD may be particularly relevant. Not only do erectile dysfunction and heart disease share many of the same risk factors (e.g. smoking, dyslipidaemia)<sup>[5]</sup> but, conversely, the emergence of erectile dysfunction in a man without prior symptoms may be a marker for occult CHD<sup>[8,9]</sup> or disease progression in overt cases<sup>[10]</sup>.

## Sexual activity: promoter of good health or disease risk factor?

### *Sexual activity as a promoter of health*

Sexuality is an essential aspect of normal human function, well-being and quality of life. In fact, several longitudinal

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studies of varying duration have demonstrated an inverse relationship between sexual activity and risk for death, although their trial designs did not enable determination of the direction of causality. The Duke First Longitudinal Study of Aging, a 25-year trial involving 270 men and women aged 60–94 (median 70) years at study outset, found that the frequency of sexual intercourse was a significant predictor of longevity in men<sup>[11]</sup>. Conversely, a Swedish study involving 128 married men aged 70 years who were followed for 5 years showed that early cessation of sexual intercourse (i.e. before age 70 years) was associated with an increased risk for death as compared with continuing sexual relations<sup>[12]</sup>.

Similarly, in a cohort study in Wales involving 918 men aged 45–59 years at initial evaluation, the age-adjusted odds ratio for 10-year all-cause mortality was significantly higher among men with a low frequency of orgasm (less than monthly) as compared with their counterparts who reported a high frequency (more than twice weekly)<sup>[13]</sup>. The authors of the Welsh study found a similar inverse association between orgasm frequency and CHD death, and evidence of a frequency–response relation was also seen among men with low, intermediate and high orgasm frequencies.

### *Sexual activity as a risk factor*

Despite the potential health benefits conferred by maintaining an active sex life, sexual activity can trigger MI, arrhythmia or sudden death in a small minority of patients. Studies have documented an association between sexual activity and coital death<sup>[1,14,15]</sup>.

The association between sexual activity and sudden death, as determined by forensic autopsies, was found to be low in three studies: one conducted in Japan (1962) and two in Germany (1972–1998). The proportions of individuals whose deaths were related to sexual activity ranged from 0.6% (34/5559)<sup>[14]</sup> to 1.7% (30/1722)<sup>[15]</sup>. The majority of those cases involved men who had extra-marital sexual activity. In the Japanese study, 82% (28/34) of persons who died during coitus were men, and 75% (21/28) had engaged in extra-marital sexual activity, in most cases with a younger partner, in an unfamiliar setting, and/or after excessive food and alcohol consumption. Cardiac conditions accounted for 18 (64%) of the 28 deaths among men, and cerebral haemorrhage for four of six deaths among women<sup>[14]</sup>.

In one German study that reviewed 26,901 autopsies over a 25-year period (1972–1998), 94% (45/48) of coital deaths were recorded in men, and 75% (36/48) of these individuals were involved in extra-marital relationships<sup>[1]</sup>. Average age at death was 60.6 years, and MI was the cause of death in 25 cases: 12 primary MIs and 13 reinfarctions. These findings are consistent with data from an earlier German study of death records<sup>[15]</sup>. In that report, 1722 autopsies included 28 men and 2 women (1.7%) who died suddenly during sexual activity. Of these 30 coital deaths, 23 (77%) occurred outside marriage.

## **Myocardial infarction triggered by sexual activity**

The risk for sexual activity triggering an MI is low and transient, as reported by two case-crossover studies<sup>[16,17]</sup>. In the Determinants of Myocardial Infarction Onset Study, which involved 1774 U.S. inpatients with MI (mean age 55 years), 858 patients were sexually active during the year before MI<sup>[16]</sup>. Of this sexually active group, 79 (9%) reported sexual activity occurring within 24 h before MI and 27 (3%) within 2 h before symptom onset.

The relative risk for experiencing MI during the 2 h following sexual activity was approximately 2.5 among all patients, but the relative risk was not higher among men with a history of MI as compared with their counterparts without prior CHD<sup>[16]</sup>. Sedentary men, who exercised to a minimum level of 6 METs (metabolic equivalents of oxygen consumption) once weekly or less, had a relative risk of 3.0. However, physically active individuals had a relative risk of 1.2.

Sexual activity was a contributing factor to MI in only 0.9% of all cases<sup>[16]</sup>. On the basis of Framingham estimates of a 1% annual absolute risk for MI for a 50-year-old non-smoking man without diabetes, weekly sexual activity increased the annual absolute risk of MI to 1.01% in men without a history of MI and to 1.10% in those with a positive MI history.

Although the relative risk for MI was increased by approximately twofold during the 2 h after sex, the absolute risk for infarction was only two chances per million per hour in a 50-year-old man without a history of MI<sup>[16]</sup>. The authors concluded that regular physical activity can sharply reduce the risk for sexual activity triggering an MI. Whereas the absolute risk for reinfarction or death within 2 h after sex is approximately 20 per million per hour in 50-year-old men with a prior MI, this value falls to less than 6 per million among men who can exercise to more than 7 METs without symptoms on an exercise stress test.

Möller *et al.*, writing for the Stockholm Heart Epidemiology Programme (SHEEP), reported similar findings and reached similar conclusions regarding the low absolute risk for MI for cardiac patients and the benefits of regular physical exercise in further reducing this risk<sup>[17]</sup>. The Swedish group examined sexual activity among 699 MI patients aged 45–70 (mean 59) years. A total of 560 (80%) of those patients were sexually active. As in the U.S. study, sedentary patients had a higher relative risk for MI than did those who were physically active (4.4 versus 0.7).

Plausible biological mechanisms by which sexual activity might trigger MI include the following: rupture of vulnerable atherosclerotic plaque; coronary artery vasoconstriction in the presence of endothelial dysfunction, which may occur during emotional or physical stress and reduce myocardial oxygen supply; onset of a pro-thrombotic state, including platelet activation, and declines in fibrinolytic activity and prostacyclin release, which may be induced by exercise in CHD patients; and increased myocardial oxygen demand due to a combination of physical and emotional stress.

## Arrhythmia triggered by sexual activity

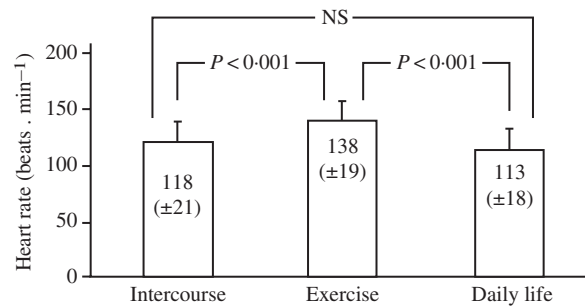
Sexual intercourse can also induce cardiac rhythm disturbances, probably as a consequence of physical and emotional stress (and presumably via sympathetic activation). However, my colleagues and I previously reported that arrhythmia was not exacerbated during intercourse in most patients, on the basis of ambulatory ECG monitoring in 88 men with stable CHD ranging in age from 36 to 66 (mean 52) years<sup>[18]</sup>. Ventricular ectopic activity was detected in 49 (56%) patients during intercourse as compared with 38 (43%) during exercise. Of these 49 patients, 27 (55%) also had arrhythmia during exercise testing; conversely, out of 38 patients who experienced arrhythmia during near-maximal exercise testing, 27 (71%) also exhibited ectopic activity during sexual activity.

Although all patients with either onset or exacerbation of arrhythmias during sex showed complex ventricular ectopic activity, there was not a single life-threatening arrhythmia<sup>[18]</sup>. Most patients with arrhythmias related to sex showed simple ectopic activity that was similar to disturbances typical of daily activities. About half of these CHD patients were completely free of rhythm disturbances.

## Energy requirements and heart rate during sexual activity

Oxygen requirements during sexual activity are generally recognized to be moderate<sup>[19,20]</sup>, and heart rates during intercourse are consistent with those during other activities of daily living. In an outpatient cardiac rehabilitation setting, heart rate during sexual activity was  $118 \pm 21$  beats  $\cdot$  min<sup>-1</sup> as compared with  $113 \pm 18$  beats  $\cdot$  min<sup>-1</sup> for daily activities – a non-significant difference (Fig. 1)<sup>[21]</sup>. Although the mean peak heart rate during intercourse ranged from 150 to 185 beats  $\cdot$  min<sup>-1</sup> in 11% of these patients with stable CHD, the mean peak heart rate was considerably higher during exercise than during sexual activity. Patients without ischaemia had significantly ( $P < 0.001$ ) lower mean peak heart rates during intercourse ( $117 \pm 21$  beats  $\cdot$  min<sup>-1</sup>) than during exercise ( $150 \pm 13$  beats  $\cdot$  min<sup>-1</sup>). Similar, significant trends toward lower heart rates during intercourse were also evident for all patients, as well as those with exercise-induced ischaemia only. Patients who had silent ischaemia during both exercise and intercourse also had lower mean peak heart rates during sexual activity ( $131 \pm 17$  beats  $\cdot$  min<sup>-1</sup>) than during exercise ( $144 \pm 13$  beats  $\cdot$  min<sup>-1</sup>), although this trend was not statistically significant.

The preponderance of the literature regarding sexual activity both in healthy volunteers and in patients with CHD suggests that mean peak heart rate during sex ranges from approximately 104 to 131 beats  $\cdot$  min<sup>-1</sup><sup>[19,22–28]</sup>, peak systolic blood pressure from 150 to 180 mmHg, and metabolic expenditure from 2 METs (before orgasm) to 5 or 6 METs (during orgasm). Despite these generalizations, there is substantial variation in haemodynamic and metabolic parameters both among healthy individuals and among different sexual activities, according to one study<sup>[22]</sup>. These activities included coitus with the man prone; coitus with the



**Figure 1** Mean peak heart rate during sexual intercourse as compared with exercise test and daily activities. In 11% of patients peak heart rate during intercourse was 150–185 beats  $\cdot$  min<sup>-1</sup>. (Data from Drory *et al.*<sup>[21]</sup>.)

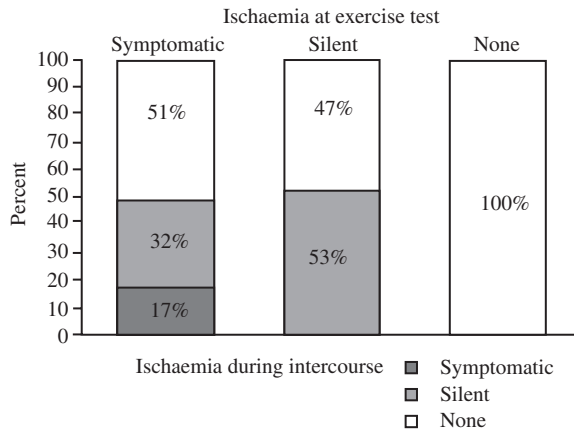
women supine; non-coital stimulation of the man by the women (supine); and self-stimulation by the man (supine).

In a trial involving 10 healthy married couples aged 25–43 (mean 33) years, peak values for heart rate, rate–pressure product (RPP) and oxygen uptake ( $\text{VO}_2$ ) were reached during the brief interval of orgasm (10–16 s) and then rapidly approached baseline levels during the resolution phase<sup>[22]</sup>. Although the highest values occurred during orgasm, foreplay also elicited significant increases above baseline with respect to heart rate, RPP and  $\text{VO}_2$ . For instance, average heart rate rose by 4–8 beats  $\cdot$  min<sup>-1</sup> (8–13%) from baseline, with a further increase from foreplay to stimulation of 11 beats  $\cdot$  min<sup>-1</sup> (16%) for partner stimulation and 28 beats  $\cdot$  min<sup>-1</sup> (40%) for man-on-top coitus. Average heart rate, RPP and  $\text{VO}_2$  were highest for man-on-top coitus during orgasm, including values of  $127 \pm 23$  beats  $\cdot$  min<sup>-1</sup> for heart rate,  $21,200 \pm 6,100$  beats  $\cdot$  min<sup>-1</sup>  $\cdot$  mmHg for RPP, and 3.3 METs (22% of maximum) for metabolic expenditure. However, although coitus is generally associated with higher cardiac and metabolic expenditures than partner stimulation or self-stimulation, man-on-top coitus was associated with marked disparities in energy expenditures from one individual to another. For instance,  $\text{VO}_2$  during man-on-top orgasm ranged from 2.0 METs for one male volunteer to 5.4 METs for another.

The wide inter-individual variation in physiological responses to sexual activity suggests that equating energy expenditures during coitus with ‘climbing two flights of stairs’ is a potentially misleading oversimplification. Although it is safe to say that the physiological cost of monogamous sexual activity is similar to that for activities of daily living among most physically active middle-aged men, physical and emotional stresses (and autonomic responses) associated with sexual activity can augment cardiac risk in certain patients.

## Role of the exercise test in the assessment of cardiac risk

Identifying patients with increased cardiac risk during sexual activity can be facilitated by exercise testing. A pivotal finding from a study involving outpatients with



**Figure 2** Ischaemia during intercourse in patients with and without ischaemia at exercise test. (Data from Drory *et al.*<sup>[21]</sup>.)

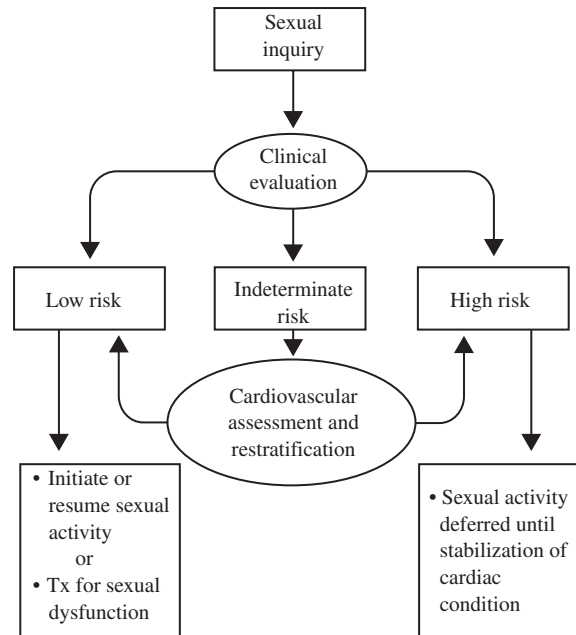
stable CHD was that all 34 men with no evidence of myocardial ischaemia (ST-segment depression  $\geq 2$  mm) during bicycle ergometry also had no ischaemia during sexual activity (Fig. 2)<sup>[21]</sup>. If a patient can achieve an energy expenditure of 5–6 METs without demonstrating ischaemia during exercise testing, then the risk for ischemia during sexual activity is very low, provided that the patient is with the usual sexual partner in a familiar setting, and without the added stress of a heavy meal and/or alcohol consumption.

### Clinical management of sexual dysfunction in patients with CVD: the Princeton Guidelines

Of special concern to clinicians are patients with erectile dysfunction and overt or covert CVD who resume drug-facilitated sexual activity after prolonged abstinence. These patients may be more likely to perform sexual activity at high cardiac and metabolic expenditures. Also of potential concern are persons whose cardiovascular conditions are sufficiently severe to place them at relatively high risk during sexual activity.

In order to address these and other issues, an international consensus conference working group on sexual activity and cardiac risk met, under the auspices of the University of Medicine and Dentistry of New Jersey, at Princeton University on June 4–5 1999<sup>[8]</sup>. Recommendations of this working group included an elegant risk-stratification algorithm (Fig. 3) for clinical management of patients with sexual dysfunction and concomitant CVD or cardiovascular risk factors.

According to the Princeton Guidelines, patients can be grouped into one of three categories at the time of their initial assessment, according to cardiovascular status (Table 1)<sup>[8]</sup>: low risk; intermediate or indeterminate risk; and high risk. Most patients meet criteria for the low risk category. These patients may be asymptomatic, with fewer than three CHD



**Figure 3** Sexual activity and cardiac risk: a simplified algorithm. (From DeBusk *et al.*<sup>[8]</sup>.)

risk factors, or may have any of the following: controlled hypertension; mild, stable angina; mild congestive heart failure according to New York Heart Association (NYHA) criteria (class I); mild valvular disease; a history of successful revascularization; or uncomplicated MI with a more than 6- to 8-week history of negative post-MI stress tests. For patients in the low risk group, sexual activity is not associated with significantly elevated cardiac risk, and no special cardiac tests or other assessments are required before recommending that sexual activity be resumed or that therapy for sexual dysfunction be undertaken. Follow-up at 6- to 12-month intervals is recommended.

The intermediate or indeterminate risk classification is assigned to patients with three or more risk factors for CHD (apart from male sex)<sup>[8]</sup>: moderate, stable angina; a recent (>2 week and <6 week) history of MI; NYHA class II congestive heart failure; and non-cardiac consequences of atherosclerotic disease, including stroke and peripheral vascular disease. For these patients, specialized cardiac testing or evaluation should be undertaken before sexual activity is resumed or therapy for erectile dysfunction is undertaken. Following assessment, patients are reclassified into the high or low risk subgroup.

Patients in the high-risk group have unstable/refractory angina; uncontrolled hypertension; NYHA class III or IV congestive heart failure; MI occurring within the prior 2 weeks; high risk arrhythmias; hypertrophic obstructive (or other) cardiomyopathies; and moderate-to-severe valvular disease<sup>[8]</sup>. Referral for specialized cardiovascular evaluation and treatment is a clinical priority for these patients. Both resumption of sexual activity and management of erectile dysfunction are not recommended until after the patient's condition has been stabilized.

**Table 1 Management recommendations based on graded cardiovascular risk assessment**

Grade of risk	Categories of cardiovascular disease	Management recommendations
Low	Asymptomatic, <3 major risk factors for CHD Controlled hypertension Mild, stable angina Post-successful coronary revascularization Uncomplicated past MI (>6–8 weeks) Mild valvular disease LVD/CHF (NYHA class I)	Primary care management Consider all first-line therapies Reassess at regular intervals (6–12 months)
Intermediate	≥3 major risk factors for CHD, other than male sex Moderate, stable angina Recent MI (> 2 and < 6 weeks) LVD/CHF (NYHA class II) Non-cardiac sequelae of atherosclerotic disease (e.g. CVA, peripheral vascular disease)	Specialized cardiovascular testing (e.g. exercise tolerance test, echocardiography) Restratification into high risk or low risk based on cardiovascular assessment results
High	Unstable or refractory angina Uncontrolled hypertension LVD/CHF (NYHA class III/IV) Very recent (<2 weeks) MI, CVA High-risk arrhythmias Hypertrophic obstructive and other cardiomyopathies Moderate-to-severe valvular disease	Priority referral for specialized cardiovascular management Treatment for sexual dysfunction deferred until cardiac condition stabilized and specialist recommendations given

CHD=coronary heart disease; CHF=congestive heart failure; CVA=cerebrovascular accident (stroke); LVD=left ventricular dysfunction; MI=myocardial infarction; NYHA=New York Heart Association. (Adapted from From DeBusk *et al.*<sup>[8]</sup>.)

According to the algorithm established by the Princeton Guidelines (Fig. 3), sexual function should be assessed in all patients at the initial visit<sup>[8]</sup>. According to the findings of further evaluations, consisting of a medical history, physical examination and selected laboratory tests, patients can then be stratified into one of the three risk categories. Additional cardiovascular work-up is warranted in patients with intermediate or indeterminate risk, after which these individuals can be restratified into either low- or high-risk categories.

### Patient counselling implications and cardiac rehabilitation

Most patients at low risk according to the foregoing guidelines may be permitted to engage in or resume sexual activity, and/or receive treatment for erectile dysfunction, provided that this does not include sildenafil use in the presence of concomitant nitrate regimens. Clinicians should reassure low risk cardiac patients that the stress on the heart during intercourse is no greater than that during normal working activities or moderate exercise. Such reassurance may be particularly useful, and may potentially reinforce healthy sexual function and enhance quality of life among middle-aged men with 'ego infarction'<sup>[6]</sup>, who have played the role of protector and provider and now feel personally diminished and concerned about the perceived danger of sex. Sexual activity should be resumed gradually and when the patient is rested and relaxed. Maintaining a moderate room temperature, as well as avoiding intercourse after a heavy meal, heavy drinking or a bath, can contribute to a relaxing sexual encounter.

If the patient is taking a PDE5 inhibitor for erectile dysfunction, then he should not take a nitrate if angina occurs during sexual intercourse; therefore, no nitrates should be kept in the bedroom. In the event that angina occurs during intercourse, the patient should be advised to stop the activity, sit at the end of the bed and then stand up. No further sexual activity should be undertaken until the patient has had an adequate medical evaluation.

All of the currently recommended therapeutic methods aimed at reducing cardiac risk in general may also be effective in minimizing cardiac risks associated with sexual activity in particular. These include the following: medications (e.g. beta-blockers, calcium channel blockers, angiotensin-converting enzyme inhibitors, antiplatelet agents and statins); revascularization procedures (coronary artery bypass surgery and percutaneous coronary intervention); aggressive risk factor management; and cardiac rehabilitation. Certain medications can decrease sympathetic tone and reduce heart rate and blood pressure responses to sexual activity. Others increase myocardial blood supply or decrease the risk for cardiac events by stabilizing atherosclerotic plaques and/or improving endothelial function.

Finally, cardiac rehabilitation is an important but under-used component of comprehensive care. Phase I rehabilitation occurs during hospitalization, and phase II continues after patients have been discharged. In Europe, only about 15% of cardiac centres provide cardiac rehabilitation. However, such programmes offer a number of potential benefits in both the physiological and psychological realms: from improving exercise tolerance and attenuating myocardial oxygen demand for a given submaximal effort to promoting well-being and reducing stress and anxiety.

Cardiac and sexual rehabilitation programmes feature exercise, nutritional counselling, smoking cessation and weight management, along with other forms of support<sup>[6]</sup>. Finally, appropriate monitoring of blood pressure, heart rate and medication side effects can confer an additional measure of confidence to cardiac patients and physicians alike. Such confidence can be reinforced through graded exercise tolerance testing in the context of the Princeton Guidelines<sup>[8]</sup>.

Patients should also be advised to report to their physicians any angina, prolonged palpitations or dizziness, or intense and sustained fatigue experienced during sexual activity. Such symptoms may indicate a need to reappraise the safety of sexual activity. Improvements in exercise tolerance and symptoms resulting from cardiac and sexual rehabilitation can reduce the need for nitrate use and enhance the potential for effective treatment with PDE5 inhibitors or other agents. Sexual counselling should be provided to all cardiac patients and their partners on the basis of sexual histories, individual preferences and the results of exercise testing.

## Conclusions

The physiological cost of sexual activity is generally similar to that associated with daily activities or mild-to-moderate exercise for most middle-aged men, with or without CHD. Oxygen requirements during intercourse are generally moderate, and heart rates tend to be similar to those during other daily activities. The risks for triggering MI or arrhythmia are considered to be modest if sexual intercourse is performed with a steady partner in a familiar setting, and without the added stress of a heavy meal and/or excessive alcohol consumption. Regular physical activity can also markedly reduce the relative risk for sexual activity triggering MI.

The exercise tolerance test is a sound index of cardiac risk during sexual activity, and the 1999 Princeton Guidelines provide a rational risk stratification algorithm for the management of sexual dysfunction in patients with CVD<sup>[8]</sup>. On the basis of these guidelines and other consensus recommendations<sup>[4]</sup>, clinicians can provide appropriate counselling for resumption of sexual activity and erectile dysfunction therapy in low-risk patients.

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