

# NEUROLOGIC COMPLICATIONS OF CARDIOVASCULAR DISEASES

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**Neurocardiology considers the interrelationships between the circulatory and nervous systems. An appreciation of the anatomic relationship preceded the concept of the clinical relationship of the two systems. Epidemiologic studies link risk factors of the cardiovascular and nervous systems. Neurologic signs and symptoms are often the presenting indication of cardiovascular disease. Neurologic complications occur during the natural history of cardiovascular disease, during diagnostic evaluation, and in the treatment process. A knowledge of potential complications as well as their frequency will help the physician make ethical and valid recommendations to patients concerning their management. This article highlights some of the potential complications that may be encountered in the management of patients with cardiovascular diseases.**

The circulatory and nervous systems should be considered as an integrated neurovascular unit because they develop symbiotically. Functionally, the heart and vessels depend on the nervous system for rhythm, rate, and the normal progression of cardiac impulse and the maintenance of vascular tone; the nervous system relies on the cardiovascular system for nourishment. The brain has enough reserve for energy production for fewer than five minutes of blood supply loss.

The anatomic relationship between the vascular and nervous systems has captured attention since the infancy of medical science. The appreciation of the clinical relationship was recognized much later. In one of the first publications devoted to this relationship, Burrows<sup>1</sup> is cited as quoting a contemporary to refute the intrinsic and interdependent relationships of the neural and vascular systems. Cardiovascular disease and cerebrovascular disease are linked by common risks.<sup>2-6</sup>

Recent advances in technology provide for a more accurate assessment of physiologic parameters related to clinical events. This gives the clinician the capacity to manipulate some of the autonomic functions of the heart, program cardiovascular activities, replace cardiovascular parts, and more accurately diagnose and functionally assess the dysfunction of cardiovascular parts. These capabilities are associated with complications.

Neurologic signs and symptoms are often the presenting indication of cardiovascular dysfunction.<sup>7,8</sup> Some neurologic complications occur in the natural course of cardiovascular disease; others occur in patients who have congenital defects in both systems (Table 1).<sup>8-10</sup> Some complications occur in the process of diagnosis<sup>11-13</sup> and management of cardiovascular disabilities. A knowledge of the potential complications as well as their frequency may assist the physician in risk management. Such knowledge is essential to make valid and ethical recommendations to patients in the evaluation of risks and benefits of the diagnostic and therapeutic modalities.

An assortment of cardiovascular diseases masquerade as neurologic problems. Cardiac dysrhythmias, mitral valve prolapse, and endocarditis are frequently treated as syncope, seizure, or transient ischemic attacks. About 25% of the patients with congenital heart disease will have neurologic involvement of various types.<sup>10,11</sup>

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**TABLE 1. CARDIOVASCULAR DISEASES WITH RISKS OF NEUROLOGIC COMPLICATIONS**


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Congenital heart disease  
 Cardiac dysrhythmia  
 Coronary artery disease  
 Cardiomyopathy  
 Valvular heart disease  
 Arteritis  
 Coarctation  
 Atherosclerosis

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Patients with cardiac defects that allow for the direct passage of the blood from venous to arterial vessels are at risk for cerebral abscess. A high incidence of syncope is experienced in patients with the tetralogy of Fallot, usually precipitated by exercise and associated with dyspnea.<sup>12</sup> An important and well documented extra-cardiac anomaly associated with coarctation of the aorta is berry aneurysm at the circle of Willis, the rupture of which causes syndromes of intracranial bleeding.<sup>13</sup>

Recurrent loss of consciousness may be due to cardiac arrhythmia and a typical stroke may be caused by embolism of cardiac origin. A careful history and physical examination supplemented by appropriate laboratory evaluation will enable the physician to correctly identify the etiology.

## COMPLICATIONS

Nonvascular atrial fibrillation is the most common source of cardio-embolic infarction even in the absence of valvular disease.<sup>14,15</sup> More than 70% of cerebral infarcts occurring in patients with nonvalvular atrial fibrillation are embolic. The risk of infarction in these patients is calculated to be six times that of the general population. If valvular disease coexists the risk is increased seventeen times. About 20% of patients with rheumatic heart disease experience clinical cerebral embolization, and mitral stenosis is the anomaly frequently encountered during evaluation. Recurrent embolization occurs in about 50% of the cases and 15% of these occur within the first two weeks of the initial episode.<sup>16</sup>

Mitral valve prolapse, linked to embolic stroke in young adults,<sup>17</sup> is estimated to have a yearly incidence of 1%. Continuing investigation suggests that the frequency is not as high as originally assumed.<sup>18</sup> Mitral annulus calcification as a cause of brain embolism continues to be debated without a clear cut impression of the relationship.<sup>19,20</sup>

**TABLE 2. CARDIAC CATHETERIZATION MORBIDITY FACTORS**


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Age  
 Disability classification  
 Left ventricle dysfunction  
 Site of coronary pathology  
 Coronary and valvular pathology  
 Severe noncardiac disease

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About one third of the patients with bacterial endocarditis have neurologic complications, with embolic cerebral infarction the most common.<sup>21</sup> The middle cerebral artery is the most common site of lodgment, and multiple emboli to the small intracerebral branches may produce either diffuse encephalopathy or focal neurologic signs. Mycotic aneurysms, susceptible to rupture, may develop as a result of intramural septic emboli. Nonbacterial thrombotic endocarditis may present as an embolic infarct.<sup>22</sup> Disseminated intravascular coagulopathy may be an associated syndrome with accompanying neurologic complications. The rapidly evolving acquired immune deficiency syndrome will provide neurologic syndromes with uncommon agents infesting the heart.<sup>23</sup> Other sources of emboli include atrial myxoma,<sup>22,24</sup> diffuse cardiomyopathy,<sup>25</sup> and paradoxical emboli.<sup>26</sup> Lacunar infarctions, intracerebral hemorrhage, and encephalopathy are some of the neurologic sequelae associated with hypertension.

## DIAGNOSES

The complications of cardiac diagnostic procedures are cerebral vascular insults, including hemorrhage, infarction, and transient ischemia.<sup>27-33</sup> Some complications involve peripheral neural structures that lie near the catheterized vessels<sup>34,35</sup>; a focal seizure may rarely occur. The risks of neurologic complications are related to the morbidity of cardiac catheterization in general (Table 2). Additional risks for neurologic complications are the presence of carotid bruits, decreased carotid pulses, and a history of a previous cerebral vascular accident (Table 3). Preventative measures such as the use of anticoagulants, catheter flushing, clean guide wires, and restricting the time of guide wire can reduce complications.<sup>35</sup> The electrophysiologic diagnostic studies carry the risk of cerebral emboli, especially with left chamber catheterization. The decision to perform diagnostic tests should be based on an informed knowledge of the risks and benefits of the diagnostic procedure.

**TABLE 3. INCREASED RISKS FOR CEREBRAL VASCULAR ACCIDENT IN CARDIAC CATHETERIZATION**

Previous cerebral vascular accident
Diminished carotid pulses
Carotid bruits
Anomalies of circle of Willis

**TABLE 4. NEUROLOGIC COMPLICATIONS OF OPEN HEART SURGERY—PREDISPOSING FACTORS**

Arrhythmia
Air embolism
Carotid artery trauma
Aortic atherosclerosis
Prolonged hypotension
Cardiopulmonary bypass

## THERAPY

The therapeutic armamentarium available for the management of cardiovascular diseases may cause neurologic complications despite proper precautions due to the inherent nature of the medication or procedures. Medical or surgical management is associated with the risk of neurologic complications. This article does not attempt to detail all of the reported complications of therapy but rather strives to alert health care providers to potential complications in patient management. Each of a number of pharmaceuticals used to manage hypertensive patients has specific side effects, mainly toxic and nonfocal. Focal symptoms may be the result of additional stress on an area of the brain already minimally functioning.<sup>36-43</sup> Subarachnoid and intracerebral hemorrhage are neurologic complications of anticoagulant therapy that can be minimized by careful monitoring.<sup>44,45</sup> Adverse neurologic complications of intravenous drugs may be related to overdose, rapid rates of infusion, and idiosyncratic reactions. Vasodilators mainly cause lightheadedness, postural hypotension, and occasionally syncope. These symptoms should be distinguished from seizures that may occur as a result of specific toxicity.<sup>42</sup> Psychiatric and neurologic manifestations may represent adverse reactions to medication, especially in the elderly.<sup>41,42,46-49</sup>

The surgical approach is important in the management of cardiovascular diseases. As the technical skills and experience of the surgeon increase, the overall morbidity and mortality decrease; however, ischemic brain damage continues to be a serious and frequent complication of open heart surgery.<sup>50,51</sup> Factors predisposing to complications are advanced age, previous cerebrovascular insults, duration of perfusion,<sup>52</sup> and postoperative cardiac dysrhythmias<sup>53</sup> (Table 4).

Diffuse encephalopathy as a complication is reported in 0.4% to 11.6% of cases depending on the diversity of the criteria.<sup>54-56</sup> Artificial heart valves and mechanical and biological prosthesis signify an advance in management of some cardiac patients. The mechanical prostheses reportedly have long-term durability and the bio-

logical prostheses have the advantage of lower thrombogenicity.<sup>56-58</sup> More than 60% of the clinically recognized emboli arising from artificial valves are cerebral.<sup>59</sup> Cardiac transplantation has a neurologic complication rate of about 50%.<sup>60</sup> These complications run the gamut from embolism and hemorrhage to infection, neoplasia, and metabolic encephalopathy.<sup>60-65</sup>

Since the introduction of catheter angioplasty in 1964,<sup>66</sup> the technique has been modified to treat smaller branches of the vascular tree. Improvements in imaging and contrast material have decreased morbidity and mortality.<sup>13,67</sup>

## CONCLUSION

Cerebrovascular episodes are often associated with cardiac dysrhythmia. Neurologic complications are frequently the presenting signs of cardiovascular disease. Many cardiac disorders have important neural components. More than twice as many patients with transient ischemic attacks die of myocardial infarction as compared with brain infarction. The zeal of the clinician for precise confirmed diagnosis must be tempered by a knowledge of the risks and benefits not only of the procedure but also of the potential management.

Medications frequently cause neurologic signs and symptoms, especially in the elderly, regardless of care and diligence in prescribing. Expert technical skill and judicious implementation of preventative techniques will effectively reduce the neurologic complication of surgical intervention. An awareness of neurologic signs and symptoms as signals of possible cardiovascular disease and a knowledge of the adverse reaction to management will provide the physician with an opportunity for early intervention. This may reduce the severity of neurologic disability. Medicine has made exceptional progress in the diagnosis and management of cardiovascular disease. A knowledge of the potential neurologic complications will enhance this progress by decreasing the morbidity and mortality.

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