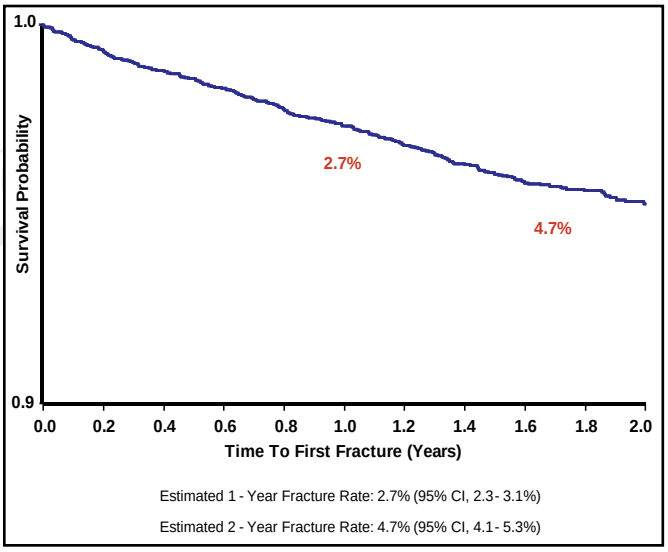
A comprehensive program that deals with the multiple aspects of chronic stroke recovery, including rehabilitation, transition, and community aspects, can improve cardiovascular function and endurance in survivors. Data indicate that patients who are released from postacute stroke rehabilitation programs experience impaired ambulation, decreased cardiovascular function, injuries from falls, and limited social participation. One study estimated that the 2-year fracture rates were 4.7% (95% CI, 4.1 to 5.3) for newly released stroke patients (Figure 2). Intermediate functional impairment conferred a higher fracture risk than mild or severe functional impairment [Whitson HE et al. *J Am Geriatr Soc* 2006].

Figure 2. 2-Year Fracture Rates for Newly Released Stroke Patients.



Almost 50% of the community-dwelling stroke population needed full-time and able-bodied caregivers at home. A large proportion of these patients also reported depression, a lack of meaningful activity, and worsening of function. Further, data suggest a number of secondary problems: fewer than 50% of individuals with stroke have their risk factors assessed, treated, or controlled; 90% of those who are evaluated as overweight at initial evaluation remain overweight; only 51% of individuals who are hypertensive have their blood pressure under control; smokers do not quit smoking; and few participate in a exercise program.

"Evidence exists that extended home-based rehabilitation programs and physiotherapy improve functional independence following stroke. We need to do a better job of enrolling more patients into these programs," concluded Pamela W. Duncan, PhD, Duke University, Durham, NC.

Multimodality Management of Cerebral Arteriovenous Malformations

The presence of cerebral arteriovenous malformations (AVM) confers considerable risk of intracerebral hemorrhage (ICH) and poor outcome. However, the best way to proceed in patients with unruptured AVMs, or whether to intervene at all, is hotly debated. William L. Young, MD, University of California, San Francisco, CA, reviewed 2 models for decision-making.

The decision of whether to treat should be based on a comparison of the estimated lifetime risk of harm without treatment, primarily from spontaneous hemorrhage, with the risks of interventional treatment. A common comparison is to cite an average annual risk of hemorrhage from an untreated AVM in the range of 2.4% to 4% per year. The risk is highest during the first 5 years after diagnosis and then decreases [Hernesniemi JA et al. *Neurosurgery* 2008; Kim H et al. *Stroke* 2007]. If the treatment risk is ~5%, there is quite a favorable risk benefit for intervention. However, actual risk for either approach is dependent on individual patient variables. In the case of surgical resection, for example, it is lesion size, any deep drainage and eloquence. Most (~71%) of the attributable risk of spontaneous hemorrhage after diagnosis can be accounted for by hemorrhagic AVM at presentation, deep AVM location, or exclusively deep venous drainage, according to one recent large study [Stapf C.et al. *Neurology* 2006]. This study pointed out that nearly half of patients are at low risk (~1% per year) hemorrhage rate.

"Functional outcome, rather than hemorrhage rate, is the meaningful endpoint," said Dr. Young. Using this assessment model for the cohort expected to bleed at 1% per year, he estimated the risk of serious morbidity as 0.4% per year for best medical management [van Beijnum J et al. *Brain* 2009]. If this natural history risk is weighed against more realistic estimates of interventional treatment complication rates, (ie, 5% to 15%), a much more conservative management approach would be warranted. Dr. Young recommends prospective studies that compare best medical management with an interventional treatment approach. Rational risk assessment requires knowing the model assumptions, patient risk factors, and whether functional outcome versus hemorrhage is the endpoint, he said. Further, he pointed out that the pace of biomedical discovery and innovation is tremendous; "best medical therapy" might be more constructively viewed as "deferred

treatment" in which treatment is deferred in anticipation of improved therapeutics and prognostics.

Predicting outcome is particularly difficult in poor-grade aneurysmal subarachnoid hemorrhage (aSAH) patients. Sander Connolly Jr, MD, Columbia University, New York, NY, said that he would repair the aneurysm immediately in patients with *any* possibility of meaningful survival.

In a group of 104 aSAH patients who were treated by Dr. Connolly, 13.5% of patients had a favorable outcome at 14 days, 38.5% at 3 months, and 51% at 1 year ($p<0.0001$). Of 99 patients who were rated grade 4 to 5, 51% had good outcomes 1 year after intervention. Admission Glasgow Coma scores significantly correlated with outcome (Spearman rank test=0.472; $p<0.0001$) [Starke M et al. *J Clin Neurosci* 2009].

"If the decision to treat aSAH patients were based on outcome during the first 14 days, few physicians would opt for treatment." The aggressive approach increases the good outcome rate, without increasing the poor outcome rate, Dr. Connolly concluded.

Jan Hillman, MD, University Hospital, Linkoping, Sweden, suggested that it is time to take another look at the use of antifibrinolytic (AF) therapy to prevent early rebleeding after subarachnoid hemorrhage. Decreases in the time window for early surgical intervention suggest that a brief course of high-dose AF is safe, may be beneficial in diminishing the risk of rebleeding, and offers significant protection against aSAH death.

Dr. Hillman presented results of two randomized, prospective, multicenter studies that assessed the efficacy of short-term AF treatment in preventing rebleeding. There was a significant ($p<0.002$) decrease in rebleeding in AF-treated patients (2.7%) versus untreated patients (11.4%) and no difference in ischemic complications. Mortality also was significantly less in the treated patients at 12 months (RR, 3.8; $p<0.0001$) [Hillman J et al. *J Neurosurgery* 2002; Starke RM et al. *Stroke* 2008].

Michael N. Diringer, MD, Washington University School of Medicine, St. Louis, MO, revisited the issue of hypertension and hypervolemia for the treatment of cerebral vasospasm.

Current management of vasospasm involves intravascular volume expansion and hemodynamic augmentation with the goal of increasing cerebral blood flow (CBF). Despite data that suggest that intravascular volume depletion occurs after aSAH and that patients with normal blood volume are far less likely to experience cerebral ischemia even if vasospasm develops, a review of the clinical data indicated that hypervolemia offered no advantage over euvolemia, said Dr. Diringer. In contrast to hypertension, moderate hypervolemia rarely increased $P_{br}O_2$, and it carried a high complication rate, including hyponatremia, fluid overload, cardiac arrhythmia, and cerebral edema.

Impaired vascular reactivity after SAH, loss of autoregulation, and reduced CBF are associated with poor clinical grade, vasospasm, and poor outcome. Enhancing cardiac output and increasing CBF by induced hypertension may be beneficial. Moderate hypertension increased $P_{br}O_2$ in most cases with few complications. Increases in blood pressure (using phenylephrine and dobutamine) can reverse flow deficits better than hypervolemia. In a prospective, randomized study, prophylactic hypervolemic therapy had no effect on the frequency of delayed ischemic neurological deficits that were attributable to cerebral vasospasm between treated and untreated groups regarding vasospasm, CBF, and 1-year outcomes compared with euvolemic therapy.

Cardiac Dysfunction in Stroke

Ronald Freudenberger, MD, Center for Advanced Heart Failure, Allentown, PA, listed some of the similarities between the pathophysiology of heart failure (HF) and stroke.

In addition to having a history of diabetes mellitus and/or hypertension, cardiac patients also have a high rate of silent cerebral infarcts (SCI): approximately 15% of diagnostic and percutaneous coronary intervention patients [Segal AZ et al. *Neurology* 2001]; 17% of coronary artery bypass graft patients [Friday G et al. *Heart Surgery Forum* 2005]; and 34% of patients who are referred for transplantation [Siachos T et al. J *Card Fail* 2005] have been shown to have an SCI.

HF likely is a prothrombotic state. Plasma viscosity, serum P-selectin, von Willebrand factor, and fibrinogen are higher in HF patients [Gibbs CR et al. *Circulation* 2001], and there also is an increase in whole blood aggregation and platelet/EC adhesion molecules [Serebruany V et al. *Eur J Heart Fail* 2002].

"Heart failure and stroke are strongly related and often coexist in the same population. Both share common risk factors and characteristics, including activation of inflammatory and thrombotic systems," said Dr. Freudenberger (Table 1).