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The Rehabilitation of Younger Stroke Patients

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Abstract

The young stroke population represents a significant rehabilitation challenge. Young patients are more often employed, caring for dependants, and rely on work-related income. Although much less common than in older patients, stroke in young adults has an annual incidence rate from 6 to 20 per 100,000 individuals annually (Leys et al. 2002). For every 5 individuals who experience a stroke, 1 is under the age of 65 and 5% of all stroke patients have been found to be younger than 45 years old. This represents a significant amount of patients with a degree of unique rehabilitation needs (Dixon et al. 2007; Stone 2007). This chapter reviews current research pertaining to incidence, risk, etiology, rehabilitation, recovery and prognosis of stroke in younger patients. Additional topics relevant to the young stroke population are also featured: Return to work, family stress, institutionalization, patient perceptions of care, and future needs.

Key Points

- Strokes in young people are uncommon.
- Young stroke patients have higher rates of undetermined etiology.
- Common young hemorrhagic stroke etiologies are arteriovenous malformation, ruptured aneurysm or hypertension. These causes are not mutually exclusive.
- Common young ischemic stroke etiologies are cardiac embolism or advanced atherosclerosis. These causes are not mutually exclusive.
- Both modifiable and non-modifiable risk factors are significant in young stroke. The most common risk factors are smoking, hypertension, hyperlipidemia, alcohol abuse, race (in black patients), and migraines (in female patients).
- Uncommon risk factors are mitral valve prolapse, moderate alcohol consumption, previous stroke, and drug use.
- Young stroke patients make better neurological recoveries.
- Young stroke rehabilitation differs in terms of better likelihood of neurological recovery and unique social issues.
- Improved recovery proves to be less stress on caregivers.
- Institutionalization is required infrequently in young stroke patients.
- Vocational issues are often neglected in young stroke patient rehabilitation.
- Vocational issues for young stroke patients are influenced by education, job type, and stroke severity.
- Young patients post-stroke have unique psychosocial and supportive needs, rather than specific health concerns.

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22. The Rehabilitation of Younger Stroke Patients

Stroke is generally considered to be a condition that occurs in elderly individuals (Teasell et al. 2000). The mean age for acute stroke is 75 years in industrialized countries. Stroke also occurs in younger adults with an incidence rate from 6 to 20 per 100,000 individuals annually (Leys et al. 2002). Moreover, stroke incidence for patients under 75 years old has increased (Johansson et al. 2000). For every 5 individuals who experience a stroke, 1 is under the age of 65, and 5% of all stroke patients have been found to be younger than 45 years of age. Rutten-Jacobs (2011) reports that up to 12% of all strokes occur in patients aged 18-50. This represents a significant amount of patients with unique rehabilitation needs (Dixon et al. 2007; Stone 2007).

Both physical and cognitive skills are impacted by stroke, which in turn affects a young individual's quality of life (Keppel & Crowe 2000; O'Connor et al. 2005; Röding 2009). Younger stroke survivors are at a stage in their life when employment is important. As well, they are more likely to be caring for children. Therefore, rehabilitation strategies for elderly patients are not always applicable for younger patients (Stone 2005). Few studies have assessed the specific needs of young stroke patients (Low et al. 2003) and young stroke survivors' viewpoints on the recovery process are lacking (Dixon et al. 2007; Low et al. 2003; Stone 2005). Consequently, the needs of young stroke patients are not being addressed within the context of inpatient rehabilitation which tends to focus on older stroke patients (Röding et al. 2003; Stone 2005).

Stroke in younger patients has become a major socioeconomic issue (Bjorkdahl & Sunnerhagen 2007; Mehndiratta et al. 2004), as survivors have a longer time to live with their physical impairments. The cost of stroke in young people exceeds that of stroke in older people due to a loss in productivity and more psychosocial complications (Jacobs et al. 2002; Nayak et al. 1997). These complications include stress in the family, institutionalization, return to work and future needs (Teasell et al. 2000). The rehabilitation of young stroke patients presents distinct challenges in achieving the best possible outcomes.

22.1 Incidence of Stroke in Young Patients

The incidence of stroke in young individuals is significantly less than in older individuals (Ghandehari & Moud 2006). Incidence rates for age ranges below the age of 50, have spanned from 3/100,000 to 44.3/100,000 (Bonita et al. 1984; Cabral et al. 2009; Corso et al. 2009; Ghandehari & Moud 2006; Harmsen et al. 2009; Jacobs et al. 2002; Marini et al. 2001; Rasura et al. 2006). A recent review by Marini et al. (2010) found incidence rates of stroke in young, standardized to the 2000 European population, range from 6.14/100 000 to 48.51/100 000 per year, or 8.70/100 000 to 21.10/100 000 per year once outliers had been removed. For individuals between the ages of 50 and 64 years, stroke occurs at a rate of approximately 3/1,000 persons; between the ages of 65 and 74 years, the incidence is approximately 12/1,000 and doubles to approximately 25/1,000 for persons 80 years and over (Abu-Zeid et al. 1975; Bonita 1992; Bonita et al. 1984; M & H 1981; Mayo et al. 1991; Shah & Bain 1989). Table 22.1 summarizes studies investigating the incidence rates of stroke in young patients.

Table 22.1 Studies Evaluating the Incidence of Stroke for Younger Individuals

Author, Year Country PEDro Score	Methods	Outcomes
Abu-Zeid et al. (1975) Canada No Score	1367 stroke cases in the Manitoba area were included in this study over an 18-month period.	The incidence rate of ischemic stroke (IS) and hemorrhagic stroke for patients under 50 years of age was similar for men and women. With age, the incidence of IS increased more rapidly than did hemorrhagic stroke.
Bonita et al. (1984) New Zealand No Score	All stroke patients over the age of 15 in the area of Central Auckland were included in this study.	Men on average had higher age-specific event rates compared to women, except in the oldest age-group (>85 years). Incidence rates of stroke for the various age-groups were as follows: 15-24 years of age, 6.4/100 000; 25-34, 9.0/100 000; 35-44, 44.3/100 000; 45-54, 114.3/100 000; 55-64, 262.8/100 000; 65-74, 682.5/100 000; 75-84, 2081.3/100 000; and 85+ years of age, 3034.3/100 000.
Nencini et al. (1988) Italy No Score	47 patients with a first-ever stroke, ages of 15 to 44 years, from Florence were followed over a 3-year period.	The incidence rate for all annual stroke events per 100 000 was 8.7 (95% C. I. 5.5-13.9) for women and 9.0 (95% C.I. 5.8-13.4) for men. Stroke subtype annual incidence rates were as follows: 3.4 for cerebral infarction, 3.2 for subarachnoid hemorrhage and 1.9 for intracerebral hemorrhage.
Koul et al. (1990) India No Score	Stroke patients in the rural North-west India area were included in this survey study.	Ninety-one patients from a surveyed population of 63,645 people. The crude prevalence of stroke was 143/100 000. Ten stroke patients were between the ages of 15-39, giving a prevalence rate of 41/100 000.
Mayo et al. (1991) Canada No Score	Stroke patients in the province of Quebec were included.	From 1981 to 1988 incidence rates of intracerebral hemorrhagic stroke for men aged 50-64 and 65-79 significantly increased by about 50%, and for men aged over 50 it increased by about 128%. Whereas the incidence rate for intracerebral hemorrhage in women increased in only the 2 older age groups (ages 65-79 years, 38%; aged >80 years, 84%). The annual incidence rates for other intracranial hemorrhagic strokes increased significantly by 40% for men aged 65-79 and 204% for men over 80 years old. Incidence rates for occlusion of the precerebral arteries decreased significantly for men in the two youngest aged groups but a significant increase was noted in the two oldest age groups.

Kittner et al. (1993) USA No Score	The total population of stroke patients aged 15 to 44 years was 117 from the Baltimore area in 1988.	Ischemic stroke incidence rates for a population of 100 000 were 10.3 for white men, 22.8 for black men, 10.8 for white women, and 20.7 for black women. Intracerebral hemorrhage incidence rates for a population of 100 000 were 4.6 for white men, 14.2 for black men, 1.5 for white women and 4.8 for black women.
Rozenthul-Sorokin et al. (1996) Israel No Score	253 first stroke victims (ages 17-49) was the number of people admitted to all hospitals in Israel over the course of 1 year.	The incidence rate for young stroke patients per 100 000 population was 10.36 after age-and sex-adjustments. The incidence of stroke in females was almost half that of males.
Johansson et al. (2000) Sweden No Score	2316 patients with first-ever stroke (median age of 76.3 years) from the University Hospital of Lund were included.	After age- and sex- adjustments the stroke incidence rate for patients under the age of 75 years was 94/100 000 person-years in 1983-1985. The incidence rate increased to 117/100 000 person-years in 1993-1995. The incidence rate for stroke patients over the age of 75 years was 1477/100 000 person-years in 1983-1985, which increased to 1560/100 000 person-years in 1993-1995.
Marini et al. (2001) Italy No Score	89 patients of a population of 4353 patients, younger than 45 years of age with first-ever stroke, were included in this 5-year study.	The crude annual incidence rate for stroke in young patients was 10.18/100 000 (95% CI, 8.14 to 12.57). With increasing age, stroke incidence rates greatly increased. Thirty percent of strokes occurred in patients under the age of 35 years. The crude annual incidence of stroke for the various stroke types was as follows: subarachnoid hemorrhage, 2.29/100,000; intracerebral hemorrhage, 2.06/100,000; and cerebral infarction 5.83/100,000.
Jacobs et al. (2002) USA No Score	74 patients with first stroke, aged 20 to 44 years old were included.	The incidence rate for stroke in young adults was 23/100 000.
Naess et al. (2002) Norwary No Score	A retrospective review was performed on 232 patients, ages 15-49, diagnosed with first-ever cerebral infarction during 1988-1997 in Hordaland County, Norway.	The average annual incidence rate was 11.4/100 000. For men, the average annual incidence rate was 12.9/100 000 and for women it was 9.7/100 000.
Di Carlo et al. (2003) Italy No Score	Residents of the province of Vibo Valentia that experienced a first-ever stroke were followed and the incidence evaluated.	Crude incidence rate of total stroke per 1000 inhabitants per year in adults aged 0-44 was 0.10, in adults 45-54 was 0.69, and in adults 55-64 it was 1.49. Up to age 85, with every 10 years the frequency of first-ever stroke approximately doubled.
Medin et al. (2004) Sweden No Score	Patients between the ages of 30-65 discharged from a public hospital in Sweden with the diagnosis of first-ever stroke from 1989 until 2000 were included in this study (n=43389).	Crude total incidence was 117.1/100 000 for men and 63.8/100 000 for women. It was found that, between 1989 and 2000, age-standardized stroke incidence increased in both men and women that were 30-65 years of age.
Rasura et al. (2006) Italy No Score	394 ischemic stroke patients aged 14-47 years were included. Incidence of cerebral ischemia and risk factors in young adults were evaluated.	The crude annual incidence rate for stroke in young patients was 8.8/100 000.
Ghandehari &	124 young adult ischemic stroke patients aged 15–	The incidence of ischemic stroke for young

Izadi-Mood. (2006) Iran No Score	45 years were registered in Southern Khorasan stroke data bank over a 5-year period.	stroke patients 8/100 000.
Bejotet al. (2008) France No Score	715 patients with lacunar strokes were examined over a period of 17 years. Participants were stratified according to age, gender, and etiology.	The incidence of lacunar stroke for patients below the age of 65 was 8.4 per 100 000.
Cabral et al. (2009) Brazil No Score	All stroke cases (1323 registered; 759 were first every strokes) within one year occurring in Joinville, Brazil were prospectively ascertained.	Crude incidence rates of first ever stroke for patients of various age groups were as follows: 25-34 years of age, 9.2/100,000; 35-44, 26.8/100,000; and 45-54, 123/100,000.
Harmsen et al. (2009) Sweden No Score	Patients with first stroke were detected during the period of 1987-2006 through the National Hospital Discharge Register and the Cause of Death Register in Gothenburg, Sweden. Incidence and mortality rates were evaluated.	The incidence rate for male patients ages 20-44 during a one year period for various stroke types were as follows: all stroke, 12/100,000; intracerebral hemorrhage, 5/100,000; and ischemic stroke, 5/100,000. The incidence rate for female patients ages 20-44 during a one year period for various stroke types were as follows: all stroke, 16/100,000; intracerebral hemorrhage, 2/100,000; and ischemic stroke, 10/100,000. Stroke incidence has not significantly changed since 1987.
Lewsey et al. (2009) Scotland No Score	All 213,358 individuals who experienced a stroke during 1986 to 2005 in Scotland were identified and incidence rates were evaluated.	In 2005, 13.6% and 9.3% of all strokes occurred in men and women, respectively, below 55 years of age. This was an increase in rates from 1986.
Onwuchekwa et al. (2009) Nigeria No Score	Stroke patients between the ages of 18-45 who were admitted to the medical wards of the University of Port Harcourt Teaching Hospital between 2003 and 2008 were identified through retrospective review of medical records.	Young stroke patients were 8.8% (54 individuals) of the total stroke population (611 individuals).There was no significant difference in incidence rates between males and females. Of the young stroke patients, 64.8% were identified as having a cerebral infarction and 24.1% identified as having an intracerebral hemorrhage.
Vega et al. (2009) Spain No Score	Episodes of stroke in patients 14 years and older were recorded by 3 Spanish health sentinel networks in 2005 (n=201,025).	Incidence of acute episodes of stroke for patients 15-54 years of age were 9.6 per 100,000 individuals for women and 15 per 100,000 for men. Total incidence rate was 12 per 100,000.
Corso et al. (2009) Italy No Score	Residents from the Valley of Aosta region in Italy with stroke onset during 2004 and 2008 were included (n=1024).	Incidence rates of stroke for various age-groups per year were as follows: 0-14 years of age, 3/100,000; 15-24, 14/100,000; 25-34, 14/100, 000; 35-44, 40/100,000; 45-54, 58/100,000; and 55-64, 166/100,000.
Putaala et al. (2009) Finland No Score	Medical records of 1008 first ever ischemic stroke patients between the ages of 15-49 during 1994 to 2007 were evaluated.	Average annual occurrence rates were 10.8/100,000 overall, 13.3/100,000 for males, and 7.8/100,000 for females. There was an overall male preponderance but the females were significantly younger.
Sridharan et al. (2009) India No Score	The incidence of first-ever ischemic stroke was found for patients in a South Indian community using a standardized questionnaire about stroke events as well as using multiple overlapping supplementary methods (n=541).	Incidence rates of stroke per 100 000 inhabitants per year for the urban community were 1.6 for ages 15-24, 10.1 for ages 25-34, 29.9 for ages 35-44 and 94.9 for ages 45-54. Rates in the rural community were 0 for ages

		15-24, 7.4 for ages 25-34, 26.6 for ages 35-44 and 141.0 for ages 45-54.
Zhao et al. (2010) China No Score	Data from 81,298 patients, all older than 18 years of age, from the City Staff Medical Insurance Registry in Lhasa between October 2006 and October 2008 was used.	Crude average incidence rate per 100 000 per year (95% CI) for various age groups were as follows: 20-29, 4.199 (3.376-5.022); 30-39, 14.081 (12.488-15.674); 40-49, 41.001 (13.44-68.558); and 50-59, 116.088 (100.138-232.041).
Kulesh et al. (2010) Belarus No Score	Using multiple sources of ascertainment, information regarding 2069 patients of all ages who had first-ever stroke between January 2001 and December 2003 was used.	Incidence rates per 100 000 person per year (95% CI) for various age groups were as follows: <25, 1 (0.2-3); 25-34, 8 (4-14); 35-44, 37 (28-48); 45-54, 236 (210-264).
Kang et al. (2011) South Korea No Score	Male and female stroke patients aged 45 to 54 with or without prior stroke. Results were derived from the national epidemiologic data of the Korean Health Disease study.	The prevalence of stroke in the studies general male population was 0.68% and 0.47% in females. The risk of new-onset stroke in the study among people without prior stroke was 176/100,000 in males and 113/100,000 in females. The number of stroke cases (incidence of stroke in general population) was 214/100,000 in males and 135/100,000 in females.

Conclusions Regarding Incidence of Stroke for Younger Individuals

The incidence of stroke in young patients is significantly less than in older patients. Variable incident rates have been reported, ranging from 3/100, 000 to 44.3/100, 000 and 3/1, 000 to 25/1, 000 for younger versus older individuals, respectively.

The incidence rate of young stroke patients varies considerably due to different age ranges, races and population denominations surveyed.

Strokes in young people are uncommon.

22.2 Stroke Etiology

Stroke in younger populations tend to have a wider variety of etiology than older stroke cohorts. Unique to young patients is the higher percentage of stroke which is of undetermined causes (Guercini et al. 2008). Among cohorts of young strokes (defined as less than 55) uncommon etiology is more prevalent in those <35 years of age, whereas those between 35-55 years of age are more likely to be diagnosed with early onset of an etiology more common to older patients (Jacobs et al. 2002). As well, hemorrhagic strokes occur more frequently in younger populations (Ruiz-Sandoval et al. 2006). While male and female stroke patients tend to have some etiological similarities, they are not identical (Martínez Sánchez et al. 2011; Zhang et al. 2011). Studies investigating the etiology of stroke in young people are summarized in Table 22.2.

Table 22.2 Studies Evaluating Stroke Etiologies of Young Stroke Patients

Author, Year Country PEDro Score	Methods	Outcomes
Snyder & Ramirez-Lassepas	A retrospective study of 61 patients ages 16-49 (38 men and 23 women), with cerebral infarction. Mean follow-	Premature atherosclerosis was the cause of stroke in 29 patients. Patients with

(1980) USA No Score	up 2.4 years.	atherosclerosis tended to have high frequency of risk factors, mortality rate of 23.9%, recurrence rate of cerebrovascular disease of 41.6% and tended to be male. Seven women were taking hormonal contraceptives at the time of cerebral infarction. Cardiac embolism was the cause of stroke for seven patients and five had "other causes" of stroke. Etiology remained unknown for 13 patients at follow-up.
Adams et al. (1986) USA No Score	144 patients aged 15-45 with cerebral infarction.	10 patients were dead within 30 days of stroke onset. 38 had atherosclerosis. Risk factors for atherosclerosis included: hypertension in 22, smoking in 21, diabetes mellitus in 15, transient ischemic attack in 14, coronary heart disease in 2 and leg claudication in 3 patients. Mitral valve prolapse was determined to not be a cause of cerebral infarction. The study found over 40 possible causes of cerebral infarction.
Ferro & Crespo (1988) Portugal No Score	A retrospective study of 254 young stroke patients between 15 and 50 years old.	Eight etiological categories were identified. Stroke was the result of cerebral atherosclerosis for 89 (35.0%) patients, cardiac emboli for 78 (30.7%), intracerebral hemorrhage for 21 (8.3%), vasospasm for 14 (5.5%), hematogolic diseases for 5 (2.0%), occurring during puerperium or pregnancy or during the use of oral contraceptives for 9 (3.5%), nonatherosclerotic cerebral vasculopathy for 8 (3.1%), and unknown etiology for 39 (15.4%). Most common cause of stroke for patients <40 yrs old was cardiac embolism and for 41-50 yrs old was atherosclerosis.
Federico et al. (1990) Italy No Score	56 acute ischemic stroke patients included between the ages of 17 to 45 years old.	Of 56 stroke patients, etiologies or predisposing factors were as follows: 21 had juvenile atherosclerosis, 13 had cerebral embolism, 4 had secondary coagulopathies, 6 had non atherosclerotic vasculopatheies, 3 had traumas of the skull and neck, 2 had migraines, 1 used oral contraceptive and 6 were unknown.
Love & Biller (1990) USA No Score	Prospective registry of cerebral infarction in young adults in an Iowa university hospital studied 286 patients between the ages of 15-45 years.	Atherosclerotic etiology was implicated in 26.9%, a nonatherosclerotic vasculopathy in 23.1%, cardioembolic cause in 21.7%, hematologic etiology in 12.2% and undetermined causes in 16.1%. Atherosclerosis was a more common etiology. Difference may be attributable to greater predominance of atherosclerosis in patients between the ages of 40-45 years as atherosclerotic stroke increases almost exponentially with increasing age.
Bevan et al. (1990) USA No Score	113 young stroke patients between the ages of 15-45, admitted to a Vermont hospital were included.	Intracerebral hemorrhage accounted for 41% (n=46) of young strokes; these had a variety of etiologies. Subarachnoid hemorrhage was the cause of stroke in 17% (n=14), while cerebral infarctions accounted for 42% (n=48), which was

		attributed to cardiac emboli and premature atherosclerosis for the majority of cases. Mitral valve prolapse, use of oral contraceptives, alcohol drinking and migraines were uncommon causes of cerebral infarction when other risk factors were not present.
Awada (1994) Saudi Arabia No Score	Etiologies for 120 patients with stroke between the ages of 15 and 45 years old were evaluated.	Cerebral infarction accounted for 58.5% of strokes and the remaining were hemorrhagic stroke, 41.5%. Main causes of cerebral infarction included atherosclerosis in 28%, cardiac embolism in 19.5, "other causes" in 34.5% and unknown causes in 18%. Distribution of risk factors was: hypertension, 32%; Diabetes, 16%; smoking, 26%; cardiac disorders, 17%; previous TIA or stroke, 6%; and cervical bruit, 1%.
Ferro & Crespo (1994) Portugal No Score	215 patients under the age of 45 years with long-term follow-up, mean of 43.1 months.	Etiologies that were more commonly identified were: cardioembolic (19%), large-vessel atheromatous disease (15%), single-perforator disease (10%), multiple causes (3%), dissection (7%), arteritis (5%), hematologic disorder (1%) and other rare conditions (7%).
Adams et al. (1995) USA No Score	Causes of stroke from 329 patients ages 15-45 were evaluated during a 15.5 year period.	A total of 60 different potential causes were identified. When classified according to the author's own criteria, proportions of causes of stroke were as follows: large-artery atherosclerosis, 21.6%; Cardioembolism, 19.5%; small-artery occlusion, 8.2%, hematologic disorder, 5.8%; other causes, 30.4%; undetermined, 14.6%. When classified according to the TOAST criteria, etiology was as follows: large-artery atherosclerosis, 9.7%: cardioembolism, 17.6%; small artery occlusion, 7.9%; other causes, 30.4%; and undetermined causes, 34.3%.
Barinagarre-menteria et al. (1996) Mexico No Score	300 consecutive patients younger than 40 years with cerebral infarction (<3 months post-stroke) were included.	Etiologies were: cryptogenic (unknown) in 32%, nonatherosclerotic vasculopathy in 27%, cardioembolism in 24%, hematological disturbance in 10%, migraine in 3% and premature atherosclerosis in 3%. Authors reported atherosclerosis was an uncommon cause of cerebral infarction in patients < 40 yrs.
Siqueira Neto et al. (1996) Brazil No Score	106 stroke patients between ages of 15 to 40 years subdivided into 2 age groups (15 to 29 years and 30 to 40 years). Etiology classification from trial of ORG 10172 in acute stroke treatment (TOAST) was used.	9 (8.5%) had large-artery atherosclerosis, 13 (12.3%) had small-vessel occlusion or lacunes, 30 (28.3%) had cardioembolism, 37 (34.9%) had other determined causes and 17 (16%) had undetermined causes of stroke.
You et al. (1997) Australia No Score	201 first-onset stroke patients between ages of 15 to 55 years were included. Stroke patients were matched for age and sex with individuals in their neighbourhoods (controls).	Patients with diabetes, hypertension, heart disease, long-term heavy alcohol consumption and current smokers were at a significantly increased risk of stroke. 52% of cases were thromboembolic; however, 14% had unknown etiology of cerebral infarctions.
Kristensen et al.	88 first-ever ischemic stroke patients (<3 months post-	79% patients had a cause for their stroke

(1997) Sweden No Score	stroke) aged 18 to 44 were included. Follow-up occurred at 4 and 12 months post-stroke onset.	identified. Most common etiology was cardioembolism (33%). Other probable causes included: patent foramen ovale or atrial septal aneurysm (28%), IgG anticardiolipin antibodies (4.7%), atherothrombotic vasculopthy (3.7%), oral contraceptives (7%) and migraine (1%).
Kittner et al. (1998) USA No Score	428 first stroke patients aged 15 to 44 years with primary or secondary diagnosis of cerebral infraction were included.	Sixty-one percent of the patients were black. A possible cause of stroke was determined in 212 (49.7%) patients. The distribution of etiologies for the 428 patients was as follows: cardiac embolism, 15.4%; lacunar, 9.8%; hematologic and other, 8.9%; non-atherosclerotic vasculopathy, 5.6%; illicit drug use, 4.7%; oral contraceptive use, 2.6%; large artery atherosclerosis, 1.9%; and migraine, 0.7%. 136 (31.8%) patients had unknown etiology. 69 stroke patients experienced a recurrent stroke.
Ruiz-Sandoval et al. (1999) Mexico No Score	200 consecutive patients with ICH (age 15-40). Patients classified by risk factors, haemorrhage location, etiology and prognosis.	High cholesterol, hypertension, tobacco and alcohol use were determined to be significant risk factors. Etiology was determined as arteriovenous malformation 33%, cavernous angioma 16%, unknown 15%, and hypertension in 11% of the sample.
Kittner et al. (1999) USA No Score	167 women with first-ever ischemic stroke between the ages of 15 to 44 were compared to 328 control subjects. Risk factor data and plasma homocysteine was measured.	Race did not affect median homocysteine levels. Homocysteine level was found to be an independent risk factor for stroke. 83 (50%) patients had one probable cause of stroke, 32 (29%) had no probable cause but at least 1 possible cause, and 52 (31%) had an unknown cause of stroke.
Gilon et al.(1999) USA No Score	213 consecutive ischemic stroke or TIA patients under the age of 45 years were compared to 263 control patients without heart disease.	Of 213 stroke patients, cause of stroke was determined in 142 cases and undetermined in 71 cases. 93 were a result of disease of the carotid or vertebral system and 49 were caused by a cardiac source of embolism. Only 4 (1.9%) had mitral-valve prolapse compared with 7 controls.
Camerlingo et al. (2000) Italy No Score	135 consecutive first-ever cerebral infarction patients, aged 16 to 45 years old, were evaluated and followed up a mean of 68.8 months.	Stroke type included 11.8% with atherothrombotic stroke, 20% with cardioembolic stroke, 10.4% with small vessel disease, 11.1% with haematological stroke, 25.2% with other causes, and 21.5% with unknown causes. Risk factors included 25.9% with hypertension, 5.2% with diabetes, 5.9% with hypercholesterolemia, 20.7% with migraine, 23.7% current smokers, 8.1% current drinkers, 26.6% of women using oral contraceptives, and 14.1% with cardiac valvular disease.
Kwon et al. (2000) Korea No Score	149 patients aged 15 to 44 years old with first-ever ischemic stroke.	Stroke subtype was as follows: large artery atherosclerosis, 20.8%; small artery occlusive disease, 17.4%, cardioembolism, 18.1%; other determined etiologies, 26.8%; and

		undetermined causes 16.8%. Risk factors include 38.8% of patients with hypertension, 10.1% with diabetes mellitus, 51.0% current cigarette smokers, 31.5% with high alcohol consumption and 8.1% with hyperlipidemia.
Chan et al. (2000) Canada No Score	Patients' records ages 15-45 years old with a diagnosis of ischemic stroke were retrospectively reviewed to determine the etiology of each stroke.	Strokes were classified according to a modified TOAST classification and patients were divided into two age groups. 47% of patients between the ages of 15-30 experienced strokes of an unknown cause, 23% of the stroke resulted from miscellaneous causes, 14% were cardioembolic, 13% were dissection of extracranial artery, 8% were small vessel disease, and 6% were large artery disease. Patients 31-45 years old had 43% unknown causes of stroke, 23% miscellaneous causes, 20% cardioembolic, 20% dissection of extracranial artery, and 1% large artery disease.
Wityk et al.(2000) USA No Score	110 women with first cerebral infarction aged 15 to 44 years were matched by age and geographic region of residence with 216 patients with no history of stroke (control). Serum & lipoprotein (a) testing was done.	Probable causes of stroke were found in 57 patients. Of these 57, identified etiologies were large artery atherosclerosis (9), cardioembolism (11), lacune (5), and other determined causes (32). 27 patients had at least one possible cause of which were large artery atherosclerosis (6), cardioembolism (15), lacune (1) and other determined causes (5). 26 strokes resulted from undetermined causes.
Lee et al. (2002) Taiwan No Score	264 stroke patients between 18 to 45 years old. Stroke risk factors and stroke subtype distribution were studied.	Stroke subtype was small-vessel occlusion (20.5%), large-artery atherosclerosis (7.2%), cardioembolism (17.8% of), other determined etiology (22.3%), and undetermined etiology (23.5%).There were 4 main stroke risk factors including hyperlipidemia (53.1%), smoking (49.8%), hypertension (45.8%), and family history of stroke (29.3%).
Jacobs et al. (2002) USA No Score	74 first stroke patients aged 20 to 44 years. Relative Risk (RR) of stroke was calculated for Hispanics and blacks compared to whites.	The distribution of stroke type in the young was 45% infarct, 31% intracerebral hemorrhage, and 24% subarachnoid hemorrhage. Risk factors for young stroke patients included: extracranial atherosclerosis (6%), intracranial atherosclerosis (9%), lacunar (18%), cardioembolism (6%), cryptogenic (55%) and other causes (6%). RR of young stroke patients was higher for black and Hispanics compared to whites.
Tan et al. (2002) Singapore No Score	109 consecutive first-ever ischemic stroke patients under the age of 50 and above age 88 and gender matched controls.	Hyperlipidemia, diabetes mellitus and hypertension were significantly more prevalent in strokes compared to controls. Strokes had a significantly higher serum homocysteine and significantly lower vitamin B_{12} level than controls. 48 patients had small-artery/lacunar stroke, 30 had large-artery stroke, 18 had either "other etiologies" or undetermined etiology, and 13 had cardioembolic stroke.

Anzini et al. (2004) Italy No Score	141 ischemic strokes (81 males) aged 18-46 paired with 192 sex/age matched controls. Blood samples were taken within 24 hours of stroke event to determine levels of IgA, IgG, IgM antibodies (associated with Chlamydia pneumonia infection). Other risk factors and etiologies were compared.	An association between stroke and IgG and IgA antibodies was found (2.2, 95% CI 1.5-3.9; 8.8, 95% CI 3.9-19.1). No difference in IgM level was found between cases and controls. Smoking was the most common risk factor (13.2% higher in patients).Persistent C. pneumoniae infection was associated with stroke and large-vessel atherothrombosis in young patients.
Mehndiratta et al. (2004) India No Score	127 stroke patients aged 15 to 40 years old.	Spontaneous intracranial hemorrhagic stroke accounted for 14.2% of patients, whereas ischemic stroke accounted for 85.5% of patients. For patients with cerebral infarction, stroke etiology was: cardioembolic, 29.4%; atherosclerotic occlusive disease, 22%; nonatherosclerotic vascular disease, 15.6%; metabolic etiology, 10.2%; and unknown etiology, 10.1%. 22 patients had no stroke risk factors and 35 patients had several stroke risk factors.
Bos et al. (2005) The Netherlands No Score	161 patients, aged 18 to 45 years, with cerebral infarction or TIA were included.	For young stroke patients homocysteine level was significantly associated with the risk of recurrent vascular events at the 95% confidence level. For patients with homocysteine levels ≤10.7, percentages of patients with presumed etiologies were as follows: large vessel disease, 12%; small vessel disease, 12%; cardio-embolism 10%; other determined causes, 23%; and undetermined, 43%. For patients with homocysteine levels between 10.7 and 13.7, percentages of patients with presumed etiologies were as follows: large vessel disease, 6%; small vessel disease, 16%; cardio-embolism 7%; other determined causes 22%; undetermined 49%. For patients with homocysteine levels ≥13.7, percentages of patients with presumed etiologies were as follows; large vessel disease, 17%; small vessel disease, 4%; cardio-embolism 5%; other determined causes 33%; undetermined 41%.
Carod-Artal et al. (2005) Brazil No score	130 young ischemic stroke patients (age 14-45, mean age 33.8) matched with 200 elderly ischemic stroke registry patients (mean age 61.5) to compare etiologies (using TOAST criteria) and prevalence of thrombophilia. Study conducted from 2002-2004 with consecutive patients.	Etiology in young patients was determined as unknown 69.2%, cardioembolism 14.6%, large artery atherosclerosis 7.7%, small vessel occlusion 3.8%, and other 4.6%. 16.1% of young patients were identified as presenting potential thrombophilic states as opposed to 13% of elderly patients.
Lai et al. (2005) Taiwan No Score	296 (224 male, 72 female) spontaneous intracerebral haemorrhage patients aged 15-45 were assessed between 2000 and 2001 to determine ICH location, etiology, and risk factors.	Determined causes of ICH were hypertension 46.6%, vascular anomaly 18.4%, coagulopathy 5.4%, tumour, 6.1% undetermined 10.1%, cryptogenic 4.4%, smoking/alcohol use 8.8%, and other 1.7%.
Rasura et al. (2006)	394 ischemic stroke patients aged 14-47 years. Incidence, etiology, and risk factors in young adults were	Risk factors of stroke patients included smoking (56%), migraine (26%), Diabetes Mellitus (2%),

Italy No Score	evaluated. Etiologic classification was based on the modified diagnostic Criteria from TOAST and Baltimore-Washington Cooperative Young Stroke Study.	hyperlipdaemia (15%), hypertension (23%), and oral contraceptives (38%). Etiology of stroke patients was: cardioembolism in 34%, atherothrombosis in 12%, non-atherosclerotic vasculopathies in 14%, other causes in 13%, lacunar stroke in 2.5%, migraine in 1%, and undetermined causes in 24%. Subdivision of subjects into 2 cohorts based on age (14-35 and 35-47 years) revealed that diabetes, hypertension, hyperlipidemia, smoking and alcohol abuse were significantly more common (P<0.05) in the older age group.
Ghandehari & Izadi-Mood (2006) Iran No Score	124 young adult ischemic stroke patients aged 15–45 years registered in Southern Khorasan stroke data bank over a 5-year period. Etiology classification used TOAST criteria.	Cardioembolic mechanism comprised 54% of stroke etiology in young adults. Rheumatic valvular disease (RVD) was present in 32% of the patients and caused 2.5 preventable stroke cases per 100,000 'young adults' per year. Atrial fibrillation was present in 29 patients (23%), all of whom had RVD or mechanical heart valve. Also, 8 (6.45%) patients had atherosclerosis, 3 (2.42%) patients had lacunar infarction and 35 (28.2%) had unknown etiology.
Piechowski-Jozwiak et al. (2007) Poland No Score	94 ischemic stroke patients <55 years of age were investigated for anti- Chlamydia pneumonia IgA and IgG antibodies and were divided into subgroups according to TOAST.	Etiology was determined for ischemic stroke patients. Cardioembolism occurred in 8.5%, large artery atherosclerosis in 13.8%, small vessel occlusion in 15.9%, other determined etiology in 15.9%, and 45.7% of the patients had unknown etiology.
Lipska et al. (2007) South India No Score	214 South Indian patients between the ages of 15-45 were enrolled in this case-control study determining risk factors for ischemic stroke. Stroke causes were categorized according to TOAST criteria.	25.2% of patients had cardioembolic stroke, 12.6% had large artery atherosclerosis and 7.5% had lacunar infarct. 11.2% of strokes were attributed to other determined etiologies and 43.5% were of "indeterminate origin".
Varona et al. (2007) Spain No Score	Longitudinal study of 272 first-ever ischemic stroke patients aged 15-45 (177 male and 95 female). Etiologic diagnosis made using TOAST criteria.	Ischemic stroke etiology was undetermined in 98 (36%) of cases, large artery atherosclerosis in 53 (19.5%), cardioembolism in 47 (17.5%), non-atherosclerotic vasculopathy in 45 (17%), lacunar stroke in 14 (5%), and cerebral venous thrombosis in 4 (1%).
Arnold et al. (2008) Switzerland No Score	1004 patients (137 of which were between the ages of 16 and 45) with first ever acute ischemic stroke were prospectively enrolled in this study.	Percentages of etiologies of ischemic stroke according to TOAST: large artery disease, 2%; cardioembolic, 37%; small artery disease, 3%; other determined etiology, 31%; and undetermined (despite complete examination), 27%. Percentages of etiologies of ischemic stroke according to the Oxfordshire Community Stroke Project criteria: total anterior circulation syndrome, 9%; partial anterior circulation syndrome, 53%; lacunar syndrome, 12%; and posterior circulation syndrome, 26%.
Jovanović et al. (2008) Serbia	865 patients between the ages of 15 and 45 who experienced first ever transitory ischemic attack were prospectively enrolled in a study to determine risk	Results showed: 14% of the strokes were from large artery atherosclerosis, 14% resulted from small artery disease, 20% resulted from

No Score	factors involved in ischemic attack. TOAST criteria were used to assign the most likely cause of ischemic stroke.	embolism, and 20% resulted from other determined causes. 32% of the patients' stroke had undetermined causes.
Putaala et al. (2009) Finland No Score	1008 patients aged 15-49 who experienced first-ever ischemic stroke were admitted to the study. Trends were analyzed.	According to the TOAST criteria, percentages of patients within each subgroup were as follows: large-artery atherosclerosis, 3.9%; cardioembolism, 21.9%; small-vessel disease, 7.5%; other determined etiology, 30.1%; multiple possible etiologies, 2.6%; undetermined etiology (extensive evaluation), 28.1%; and undetermined etiology (incomplete evaluation), 5.9%.
Samiullah et al. (2010) Hyderabad No Score	A prospective study was performed on 50 patients between the ages of 15 and 35 to determine the etiological pattern of strokes in young patients.	The most common cause of stroke was found to be infective meningitis which was found in 34% of the cases. Following that causes were cardio-embolism for 20% and hypertension for 14%. Other causes were related to pregnancy (12%), systemic lupus erythematosus (4%), nephritic syndrome (4%), and various other causes (12%).
Spengos & Vemmos (2010) Athens No Score	Patients 45 years old and younger who experienced first ever ischemic stroke In Athens between 1999 and 2008 were included. Etiology of stroke was classified according to TOAST criteria.	252 patients were included. 6.7% experienced a large artery atherosclerosis, 15.8% cardioembolism, 17.4% small-vessel disease, 26.5% had another determined etiology and 33.6% were undetermined.
Manobianca et al. (2010) Italy No Score	Over a 2 year study period, 127 patients that experienced first ever stroke were identified in order to determine age-specific incidence of stroke subtypes.	Incidence rates (per 100 000 per year) of cerebral infarction (CI), intracerebral haemorrhage (ICH), subarachnoid haemorrhage (SH) and undetermined stroke (US) were determined for different age groups. For ages 0-14, the rates for the different types were as follows: CI, 8; IH, 0; SH, 0; and US, 0. For ages 15-34 incidence rates were 0 for all four types. For ages 35-44: CI, 8; IH, 0; SH, 0; and US, 0.
Tan et al. (2010) Malaysia No Score	61 patients from Australia and 67 patients from Malaysia under the age of 50 who experienced first ever ischemic stroke were recruited.	In Australia, 9.8% of strokes are large-vessel atherosclerosis, 14.8% are small-vessel occlusion, 21.3% are cardioembolism, 22.9% are by another determined cause and 31.0% are of undetermined etiology. In Malaysia, 28.3% of strokes are large-vessel atherosclerosis, 32.8% are small-vessel occlusion, 12.6% are cardioembolism, 5% are by another determined cause and 21.0% are of undetermined etiology.
Balci et al. (2011) Turkey No Score	Ischemic stroke survivors 18-47 years of age were included in this study. A retrospective review occurred and 192 patients (4.7% of all ischemic strokes admitted to the department of neurology) were classified according to criteria based on modified version of the TOAST and Baltimore Classification systems.	An atherosclerotic vasculopathy was detected in 26.5% of the patients, non-atherosclerotic vasculopathy was detected in 13%, 6% were classified as having a lacunar infarction, 20% as having a cardiac embolism, 3.5% had a migrainous stroke, 10% had a determined cause other than the ones previously listed and 21% had an undetermined cause.
Dharmasaroja et al. (2011) Thailand	99 Ischemic stroke and transient ischemic attack survivors between the ages of 15 and 50 were included in this study. Authors looked at etiology by age and	Subtypes for ages 15-30 were as follows: transient ischemic attack (TIA), 8%; Other determined etiology, 33%; and undetermined

No Score	stroke subtypes were classified by the TOAST criteria.	etiology (UND), 58%. Subtypes for ages 31-40 were as follows: TIA, 8%; large artery atherosclerosis (LAA), 16%; small artery occlusion (SAO), 20%; cardioembolic (CE), 8%; other determined etiology, 28%; UND, 20%. Subtypes for ages 31-40 were as follows: TIA, 3%; LAA, 11%; SAO, 29%; CE, 18%; other determined etiology, 18%; and UND, 21%.
Fromm et al. (2011) Norway No Score	Patients with acute cerebral infarction were prospectively enrolled in the Bergen Stroke Study (100 patients out of 1217 involved in the study were <50 years old).	3% of the patients <50 experienced a stroke etiology of large-artery atherosclerosis, 21% cardiac embolism, 14% small vessel disease, 23% are other known causes, and 39% were from unknown causes.
Larrue et al. (2011) France No Score	Consecutive patients aged 16–54 years treated for acute ischemic stroke in a tertiary stroke unit were included in this retrospective analysis.	318 patients were included (195 men and 123 women); 131 patients were aged 16–44 years, and 187 were aged 45–54 years. A definite cause of stroke (ASCO [atherosclerosis, small-vessel disease, cardiac source, other cause] grade 1) could be identified in 145 patients (45.5%). An uncertain cause of stroke (ASCO grade 2) was found in 59 (18.5%) of patients. Most (130 of 145) definite causes were identified by initial evaluation. The 2 major causes of stroke were patent foramen ovale associated with atrial septal aneurysm (PFO-ASA) (20 of 131 or 15.3%) and dissection of the cervical or cerebral artery (19 of 131 or 14.5%) in patients aged 16–44 years and large-vessel atherosclerosis (37 of 187 or 19.8%) and PFO-ASA (23 of 187 or 12.3%) in patients aged 45–54 years.
Martínez-Sánchez et al. (2011) Spain No Score	A retrospective analysis of 310 patients up to age 50 who experienced first ever cerebral infarction was performed.	Of the women included in the study, 7.8% experienced an atherothrombotic stroke, 27.3% a cardioembolic stroke, 13.3% a lacunar stroke, 22.7% experienced a stroke of undetermined origin and 28.7% a stroke of unusual cause. Of the men included in the study, 15.9% experienced an atherothrombotic stroke, 21.4% a cardioembolic stroke, 20.3% a lacunar stroke, 16.5% experienced a stroke of undetermined origin and 25.3% a stroke of unusual cause.
Munshi et al. (2011) India No Score	525 ischemic stroke patients were included in this study. The control group consisted of 500 healthy individuals matched for sex and age (male:female = 351:149) and were recruited from the same demographic area.	Analyzed +488 G/A polymorphism in TNF-a gene and 1612 5A/6A polymorphism in MMP-3 gene. Allelic and genotypic frequencies of TNF-a G/A polymorphism differed significantly between patients and healthy controls ($p< 0.001$). A stepwise logistic regression analysis confirmed these findings ($p<0.001$). Evaluating the association of this polymorphism with stroke subtypes, found significant association with intracranial large artery atherosclerosis, extracranial large artery atherosclerosis, and stroke of undetermined etiology.

Patella et al. (2011) Italy No Score	First ever ischemic stroke patients under the age of 45 were prospectively evaluated. All 94 patients' strokes were classified according to TOAST and Baltimore classification and Bamford criteria.	6.4% of patients experienced a stroke resulting from atherosclerotic vasculopathy, 21.3% from non-atherosclerotic vasculopathy (dissection or vasculitis), 3.2% from lacunar infarct, 34% from cardioembolism, 7.4% from other causes (anitiphospholipid antibody, lupus anticoagulant, polycythemia, and C&S protein deficiency) and 27.7% of patients had a stroke resulting from undetermined causes.
Wolff et al. (2011) France No Score	From October 2005 to September 2007, 48 consecutive patients younger than 45 years of age who were admitted to stroke unit for ischemic stroke. First-line screening was performed, including blood tests, cardiovascular investigations, and urine analysis for cannabinoids. If no etiology was found, 3D rotational angiography and cerebrospinal fluid analysis were performed. A control was planned through neurovascular imaging within 3 to 6 months.	The most common etiology was multifocal intracranal stenosis (N=11), followed by monoarterial intracranial stenosis (N=10), extracranial dissection (N=9), and finally cardioembolism (N=6).
Zhang et al. (2011) China No Score	669 Chinese patients between the ages of 18 and 45 years with cerebral infarction were retrospectively examined. Stroke subtypes were classified according to the TOAST system.	Of the women evaluated in the study, stroke subtypes were as follows: arteriosclerosis, 25%; lacunar, 42.3%; cardioembolic, 14.1%; other and undetermined, 18.6%. Of the men evaluated in the study, stroke subtypes were as follows: arteriosclerosis, 40.5%; lacunar, 41.9%; cardioembolic, 6.5%; other and undetermined, 11.4%.
Hankey et al. (2012) Australia No Score	A collaborative analysis of 57 prospective studies in which 894,576 adults were followed up for a mean of 13 years.	Individuals with a BMI of 30 kg/m² or more have double the incidence of ischemic and haemorrhagic stroke compared with individuals with a BMI of less than23 kg/m². Each unit increase in BMI is associated with an increase in the adjusted risk of stroke by about 6% (relative risk 6%, 95% CI 4–8). Among adults who are overweight or obese (BMI 25–50 kg/m²), each 5 kg/m² increase in BMI is associated with about 40% higher mortality from stroke (hazard ratio 1·39, 95% CI 1·31–1·48).
Nakagawa & Hoffmann (2013) USA No score	Prospective study conducted from September 2002 to December 2006. Consecutive collection of clinical, radiological, sonographic and laboratory data of patients with first ever stroke, aged 18-49 years, identified through a stroke registry. All patients were classified according to an expanded TOAST classification.	Stroke subtypes were similar between genders; specifically, small vessel disease (women 30/55; men 25/55, 0.09, P=NS), and large vessel cervical and intracranial disease (women 24/43; men 19/43, 0.19, P=NS). Cardioembolism was more frequent in men versus women (26/42 3.9 P=0.05). The remaining 29 patients had indeterminate etiologies as multiple etiological possibilities were found. Women had greater numbers of the subtype other (132/226, 6.8 P=0.01). A significant number of the young stroke patients (226/363) fell under the subtype of other. Men showed a greater etiology of substance abuse (26/41, 4.6, P=0.05). Whereas, women showed a greater ischemic stroke etiology of cerebral

		venous thrombosis (15/19, 12.4, P=0.001), vasculitis (8/12; 23.1, P=0.001), migraine (10/11, 6.6, P=0.02) and miscellaneous vasculopathy (38/52; 9.7, P=0.01). Intracerebral haemorrhage occurred more frequently in men and the leading causes in both men and women were arteriovenous malformations, aneurysms, substance abuse and hypertensive related.
Yesilot Barlas et al. (2013) Europe No Score	Observational, multi center, cross-sectional cohort study with involvement of 15 European stroke centers. The study was based on existing data collected in 1988-2010. Data from 3311 eligible patients aged 15-49 with first-ever ischemic stroke (IS) were analyzed. Stroke etiology was based on the TOAST criteria: Trial of Org in Acute Stroke Treatment (TOAST) criteria: large-artery atherosclerosis (LAA), cardioembolism (CE), small-vessel occlusion (SVO), other determined etiology, or undetermined etiology. CE was categorized into low- and high-risk sources. 'Other determined etiology' was divided into dissection and other non-dissection causes.	Based on TOAST criteria classification, 39.6% of IS were of undetermined etiology. Additional classifications reported were: other determined etiology (21.6%), CE (17%), SVO (12%), and LAA (9%). The most common known single etiology was cervical (carotid) artery dissection, (12.8%), followed by small-vessel occlusion (SVO)(12.2%). Amongst the 575 (17.3%) patients with CE, high-risk (8.6%; e.g., atrial fibrillation or flutter, and cardiomyopathy) and low-risk sources (8.6%) were equally common. Inherited thrombophilia and antiphospholipid antibodies were the most commonly reported non-dissection rare causes in the TOAST subgroup. In the age-specific comparison, LAA and SVO had an increasing frequency with age, whereas low-risk sources of CE and other non-dissection rare causes became less frequent with age. Low risk causes of CE and non-dissection causes were more common in females, whilst LAA, high-risk sources of CE, and SVO were more common in males.

22.2.1 Undetermined Etiology

Previous studies suggest that a cause for stroke cannot be determined for up to one-third of young stroke patients (Chancellor et al. 1989; Kittner et al. 1999; Kittner et al. 1998; Rasura et al. 2006; Wityk et al. 2000). However, variations in definition and classification of "unknown etiology" may affect this estimate (Guercini et al. 2008). For instance, Awada (1994) separated unknown causes from uncertain causes, while Varona et al. (2007) divided undetermined etiologies on the basis of complete versus incomplete evaluations. Moreover, Lai et al. (2005) included pre-examination mortality with unknown etiology, and designated cryptogenic etiology for patients without risk factors. A longitudinal study by Varona et al. (2007) suggests that the number of cryptogenic diagnoses from 1974-1988 compared to 1989-2002 decreased by 19%. The number of undetermined etiologies due to incomplete evaluation also decreased by 38% (Varona et al. 2007). These reductions were attributed to improved diagnostic tools and methods. Similarly, Balci et al. (2011) reported a decreased frequency of undetermined etiology when their population was compared to literature; this was believed to be a result of more extensive diagnostic evaluations.

Conclusions Regarding Unknown Etiology

Up to one third of strokes in young people are of unknown etiology. However, as diagnostic methods improve this proportion is decreasing.

22.2.2 Hemorrhagic Etiology

There is a large degree of etiological overlap between the sub-types of hemorrhagic stroke in young patients. Intracerebral hemorrhage (ICH) and subarachnoid hemorrhage (SAH) together constitute approximately 30-35% of all strokes in patients under the age of 50 (Awada 1994; Jacobs et al. 2002; Teasell et al. 2000). This appears to be significantly higher than the 15-20% incidence rate reported for patients over the age of 50 (Abu-Zeid et al. 1975; Awada 1994). Moreover, the majority of these young hemorrhagic stroke patients are aged between 30 and 50 (Lai et al. 2005; Mehndiratta et al. 2004; Ruiz-Sandoval et al. 2006). Meyer (1994) listed the following possible causes for ICH in young patients: arteriovenous malformations (AVM), aneurysm, hypertension (HTN), blood disorders, brain tumors, and inflammation of blood vessels and veins. Etiologies of hemorrhagic strokes are reported in table 22.2.1.

Table 22.2.1 "Etiologies of hemorrhagic stroke in young patients"

Author, Year	N	Most common etiologies (%)
Awada (1994)	120 (age 15-45)	1. HTN (27) 2. AVM (26.5)
Ruiz-Sandoval et al. (1999)	200 (age 15-40)	1. AVM (49) 2. HTN (11)
Mehndiratta et al. (2004)	127 (age 15-40)	1. Aneurysm (44.4) 2. AVM (22.2), HTN (22.2)
Lai et al. (2005)	296 (age 15-45)	1. HTN (46.7) 2. AVM (16.9)

When examining hypertension (HTN) as the etiology of ICH in young patients, race is a noted factor (Chong & Sacco 2005). Qureshi et al. (1995) found that 64% of black stroke patients had HTN-caused ICH; whereas, Ruiz-Sandoval et al. (2006) reported that only 11% of young Mexican stroke patients had ICH attributable to HTN-determined etiology (see also section 22.3.3 Non-Modifiable Risk Factors: Race). Hypertension is also more common among younger stroke patients than in persons over age 45 with ICH (Chong & Sacco 2005; Ruiz-Sandoval et al. 2006). This trend peaks significantly for those in the 35-45 age range (Lai et al. 2005). Similar to hypertension, AVM are commonly found to be causes for ICH in the second and third decade of life (Meyer et al. 1994).

As mentioned, the majority of SAH etiologies in young patients overlap with those of ICH. Additional etiologies are trauma and eclampsia (in young women)(Meyer et al. 1994). Mehndiratta et al. (2004) found the most common cause of SAH to be a ruptured aneurysm (66.6%), followed by AVM (33.3%; though this was only in 2 cases). Bevan et al. (1990) also found 41% of SAH in young people were caused by a ruptured aneurysm.

Conclusions Regarding Hemorrhagic Etiology

The most common causes for hemorrhagic stroke in young patients include hypertension, arteriovenous malformation, ruptured aneurysm, or a combination of these factors.

22.2.3 Ischemic Etiology

Overall, individuals under the age of 45 account for fewer than 5% of the total number of ischemic infarcts (Kristensen et al. 1997). However, ischemic cerebral infarctions are the predominant subtype of stroke for the younger population, with 47-85% of young stroke events recognized as ischemic (Awada

1994; Mehndiratta et al. 2004; Meyer et al. 1994). Between the ages of 40-49 there is a dramatic increase in the number of strokes. This can be accounted for, in part, by an increase in advanced atherosclerosis (Ferro & Crespo 1988; Siqueira Neto et al. 1996; Williams et al. 1997).

A study of 300 consecutive stroke patients with cerebral infarction under the age of 40 found that premature atherosclerosis accounted for only 3% of the strokes (Barinagarrementeria et al. 1996). However, Love and Biller (1990) in their prospective study of 286 patients, ages 15-45 who had suffered a cerebral infarction, found that an atherosclerotic etiology was implicated in 26.9% of cases. Finally, in a retrospective study of 254 young stroke patients (≤50 years of age), Ferro and Crespo (1988) found that 35% of all strokes could be attributed to atherosclerosis. For patients younger than 40 years of age, cardiac embolism was the most common cause of ischemic stroke (Ferro & Crespo 1988; Hart & Miller 1983).

The etiology of ischemic stroke in the young patient population is characterized by diversity. Cardioembolism, advanced atherosclerosis, dissection of the carotid and vertebral arteries, hypercoagulable states, vasculitis, migraines, cerebral artery occlusion, non-atheroclerotic vasculopathy, plasma homocysteine level, drug and alcohol abuse, hematological disorders, stroke associated with postpartum state, L-aspariginase, and infective meningitis are all recognized as possible causes (Bendixen et al. 2001; Bos et al. 2005; Hart & Miller 1983; Hillbom et al. 1995; Kittner et al. 1999; Kristensen et al. 1997; Mehndiratta et al. 2004; Samiullah et al. 2010; Westover et al. 2007; Wityk et al. 2000).

Conclusions Regarding Ischemic Stroke

The majority of strokes in young patients are Ischemic. Cardiac embolism is a frequent cause for patients younger than 40, while advanced atherosclerosis is a common etiology in patients aged 40-49.

22.2.4 Uncommon Etiologies

Strokes are uncommon in individuals under the age of 45, and are even more uncommon under the age of 30. Stroke etiology in individuals under the age of 30 is generally related to unknown or unusual causes. Hematological disorders, developmental cardiac difficulties, chronic systemic inflammation and hypercoagulable state are all documented possibilities (Bevan et al. 1990; Ha et al. 2009; You et al. 1997). Some uncommon etiologies are also recognized as risk factors for stroke in young patients: migraines, non-atheroclerotic vasculopathy, plasma homocysteine level, drug abuse, alcohol abuse, mitral valve prolapse, oral contraceptives, stroke, multifocal intracranial stenosis, monoarterial intracranial stenosis, extracranial dissection, cardioembolism, cardiac disease, polymorphism, and BMI associated with postpartum state (Bendixen et al. 2001; Bos et al. 2005; Hankey 2012; Hillbom et al. 1995; Kittner et al. 1999; Kristensen et al. 1997; Munshi et al. 2011; Vassilopoulou et al. 2011; Westover et al. 2007; Wityk et al. 2000; Wolff et al. 2011). See also section 22.3: Risk Factors.

Conclusions Regarding Uncommon Etiologies

Uncommon etiologies are likely in stroke patients under 30. There are many uncommon etiologies that have been recognized as risk factors for stroke in young patients, including but not limited to, migraines, non-atheroclerioticvasculopathy, plasma homocysteine level, drug abuse, alcohol abuse, mitral valve prolapse, oral contraceptives, stroke, multifocal intracranial stenosis, monoarterial

intracranial stenosis, extracranial dissection, cardioembolism, cardiac disease, polymorphism, and BMI associated with postpartum state.

22.2.5 Summary

Stroke among young adults is uncommon; however, this population does experience more frequent unknown or cryptogenic etiology (Jacobs et al. 2002). Diagnosis of "undetermined causes" accounts for up to one third of strokes in individuals under the age of 45 (Awada 1994; Rasura et al. 2006) and up to almost 40% in patients up to 49 years of age with first-ever ischemic stroke (Yesilot Barlas et al. 2013).

Hemorrhagic stroke (including intracerebral and subarachnoid hemorrhage) is also more common in people under the age of 50 (Lai et al. 2005; Mehndiratta et al. 2004; Ruiz-Sandoval et al. 2006). Typical etiologies for hemorrhagic stroke include arteriovenous malformation, ruptured aneurysm, hypertension, or a combination of these factors.

The majority of strokes in young people are cerebral infarctions (Awada 1994; Mehndiratta et al. 2004; Meyer et al. 1994), which are often caused by cardiac embolism for patients younger than 40 (Ferro & Crespo 1988; Hart & Miller 1983). Advanced atherosclerosis is a common cerebral infarction etiology in patients aged 40-49 (Ferro & Crespo 1988; Siqueira Neto et al. 1996; Williams et al. 1997). Uncommon etiologies are likely in stroke patients under 30 (Bendixen et al. 2001; Varona et al. 2007). However, many are recognized as both possible etiologies and risk factors.

Young stroke patients have higher rates of undetermined etiology which account for 30-40% of cases.

Common young hemorrhagic stroke etiologies are arteriovenous malformation, ruptured aneurysm or hypertension. These causes are not mutually exclusive.

Common young ischemic stroke etiologies are cardiac embolism or advanced atherosclerosis. These causes are not mutually exclusive.

22.3 Risk Factors

Even though stroke in the young population is rare, the odds of a stroke event may increase if patients exhibit one or more risk factors. Risk factors can be categorized as modifiable or non-modifiable. The modifiable risk factors discussed are smoking, alcohol, drug use, cocaine, use of oral contraceptives, hyperlipidemia, plasma homocysteine level, migraine, diabetes mellitus, Chlamydiapneumoniae and hypertension. Non-modifiable risk factors listed are family history, previous stroke, mitral valve prolapse, patent foramen ovale, pregnancy & postpartum, gender, and race. Studies listing the prevalence and level of influence of these risk factors in young stroke patients are described in Tables 22.3.1 to 22.3.9. Studies were only included if the sample population used mixed gender and race (unless otherwise described), and only if author(s) included data clearly denoted as 'risk factors'. The percentage of young stroke patients in the study who had a particular risk factor is provided.

22.3.1 Modifiable Risk Factors

Smoking

Smoking is reported to be a significant risk factor for stroke among younger populations (Lu et al. 2008; Rasura et al. 2006; Ruiz-Sandoval et al. 2006; Spengos & Vemmos 2010; You et al. 1997). In fact, recent studies showed that smoking is the most common risk factor, seen in approximately half of the studied population (Chatzikonstantinou et al. 2012; Putaala et al. 2012; Von Sarnowski et al. 2013). In western populations, smoking was listed as a risk factor in both young female and young male stroke patients (Kristensen et al. 1997; Ruiz-Sandoval et al. 2006). In contrast, Lee et al. (2002) and Kwon et al. (2000) found smoking to be dramatically higher (>50%) in young male stroke patients as opposed to young female stroke patients living in Asia. When compared to an older population, Fromm et al. (2011) found a significantly higher percentage of the young stroke had current smoking as a risk factor. See also chapter 8: Secondary Prevention of Stroke (8.7.3, Smoking).

Table 22.3.1 Smoking Prevalence in Young Strokes

Author, Year	N (age)	Stroke Type	Percentage with Risk Factor
Adams et al. (1986)	144 (15-45)	Ischemic 100%	21%
Awada (1994)	120 (15-45)	Hemorrhagic 41.5%, Ischemic 58.5%	26%
Barinagarrementeria et al. (1996)	300 (<40)	Ischemic 100%	24%
You et al. (1997)	201 (15-55)	Ischemic 100%	56%
Nayak et al. (1997)	177 (15-45)	Ischemic 100%	47%
Ruiz-Sandoval et al. (1999)	200 (15-40)	Hemorrhagic 100%	20.5%
Kwon et al. (2000)	149 (15-44)	Ischemic 100%	51%
Lee et al. (2002)	264 (18-45)	Ischemic 100%	49.8%
Schwaag et al. (2003)	160 (15-45)	Ischemic 88.7%, TIA 11.3%	54%
Musolino et al. (2003)	60 (17-45)	Ischemic 92%, TIA 8 %	46.7%
Mehndiratta et al. (2004)	127 (15-40)	Hemorrhagic 14.5%, Ischemic 85.5%	15.9%
Nedeltchev et al. (2005)	203 (16-45)	Ischemic 100%	46%
Carod-Artal et al. (2005)	130 (15-45)	Ischemic 100%	24.6%
Lai et al. (2005)	296 (15-45)	Hemorrhagic 100%	38%
Rasura et al. (2006)	394 (14-47)	Ischemic 100%	56%
Ruiz-Sandoval et al. (2006)	35 (18-40)	Hemorrhagic 100%	14%
Lipska et al. (2007)	214 (15-45)	Ischemic 100%	37%
Varona et al. (2007)	272 (15-45)	Ischemic 100%	49%
Rallidis et al. (2008)	135 (≤35)	Ischemic 100%	94.8%
Jovanović et al. (2008)	865 (15-45)	Ischemic 100%	37%
Arnold et al. (2008)	137 (<45)	Ischemic 100%	39%
Onwuchekwa et al. (2009)	54 (18-45)	Hemorrhagic 35.2%, Ischemic 64.8%	11.1%
Putaala et al. (2009)	1008 (15-49)	Ischemic 100%	44.2%
Bi et al. (2010)	1988 (35-45)	Hemorrhagic 95.7%, Ischemic 94.3%	38.8%
Spengos and Vemmos (2010)	253 (≤45)	Ischemic 100%	59.3%
Tan et al. (2010)	67 (>50)	Ischemic 100%	22.4%
	61 (>50)	Ischemic 100%	44.2%
Balci et al. (2011)	192 (18-47)	Ischemic 100%	37%
Dharmasaroja et al. (2011)	12 (15-30)	Ischemic and TIA 100%	25%
	25 (31-40)	Ischemic and TIA 100%	56%

	62 (41-50)	Ischemic and TIA 100%	42%
Fromm et al. (2011)	100 (<50)	Ischemic 100%	41%
Janssen et al. (2011)	95 (<50)	Ischemic 51%, TIA 49%	40%
Patella et al. (2011)	98 (14-45)	Ischemic 100%	47.9%
De Los Rios et al. (2012)	501 (18-54)	Ischemic 69%, hemorrhagic 22%, unknown 9%	36% (in 18-34y.o) 55% (in 35-44y.o) 53% (in 45-54y.o)
Putaala et al. (2012)	3944 (18-49)	First ever ischemic 100%	49%
Chatzikonstantinou et al. (2012)	104 (19-45)	Ischemic stroke 100%	55.2%
Von Sarnowski et al. (2013)	4467 (18-55)	Ischemic stroke / TIA	55.5%

Hypertension

Hypertension (HTN) is common as both a cause and risk factor in young stroke patients (Lai et al. 2005). Within the young stroke population, males between the ages of 30-45 have the highest rate of HTN (Barinagarrementeria et al. 1996; Lai et al. 2005; Nayak et al. 1997; Varona et al. 2007). This is particularly true of males living in Asian populations (Lai et al. 2005; Lee et al. 2002; You et al. 1997). Unfortunately, young people may not be fully aware of the risks of hypertension or always be compliant with the provided treatment (Bi et al. 2010; Spengos & Vemmos 2010).See also chapter 8: Secondary Prevention of Stroke (8.3, Hypertension).

Table 22.3.2 Hypertension Prevalence in Young Stroke Patients

Author, Year	N (age)	Stroke Type	Percentage with Risk Factor
Adams et al. (1986)	144 (15-45)	Ischemic 100%	22%
Awada (1994)	120 (15-45)	Hemorrhagic 41.5%, Ischemic 58.5%	32%
Barinagarrementeria et al. (1996)	300 (<40)	Ischemic 100%	7%
Nayak et al. (1997)	177 (15-45)	Ischemic 100%	18%
You et al. (1997)	201 (15-55)	Ischemic 100%	49%
Ruiz-Sandoval et al. (1999)	200 (15-40)	Hemorrhagic 100%	13%
Kwon et al. (2000)	149 (15-44)	Ischemic 100%	38.3%
Lee et al. (2002)	264 (18-45)	Ischemic 100%	45.8%
Musolino et al. (2003)	60 (17-45)	Ischemic 92%, TIA 8 %	21.7%
Schwaag et al. (2003)	160 (15-45)	Ischemic 88.7%, TIA 11.3%	28.8%
Mehndiratta et al. (2004)	127 (15-40)	Hemorrhagic 14.5%, Ischemic 85.5%	14.8%
Carod-Artal et al. (2005)	130 (15-45)	Ischemic 100%	34.6%
Nedeltchev et al. (2005)	203 (16-45)	Ischemic 100%	19%
Lai et al. (2005)	296 (15-45)	Hemorrhagic 100%	48.7%
Panagiotakos et al. 2006	100 (<35)	Ischemic 100%	96%
Rasura et al. (2006)	394 (14-47)	Ischemic 100%	23%
Lipska et al. (2007)	214 (15-45)	Ischemic 100%	36%
Varona et al. (2007)	272 (15-45)	Ischemic 100%	22%
Jovanović et al. (2008)	865 (15-45)	Ischemic 100%	35%
Arnold et al. (2008)	137 (< 45)	Ischemic 100%	19%
Onwuchekwa et al. (2009)	54 (18-45)	Hemorrhagic 35.2%, Ischemic 64.8%	77.8%
Putaala et al. (2009)	1008 (15-49)	Ischemic 100%	39.1%
De Silva et al. (2009)	38 (15-45)	Ischemic 100%	21%

Samiullah et al. (2010)	50 (15-35)	Hemorrhagic 14%, Ischemic 86%	14%
Bi et al. (2010)	1988 (35-45)	Hemorrhagic 95.7%, Ischemic 94.3%	41.0%
Spengos and Vemmos (2010)	253 (≤45)	Ischemic 100%	22.1%
Tan et al. (2010)	67 (>50)	Ischemic 100%	65%
	61 (>50)	Ischemic 100%	23%
Balci et al. (2011)	192 (18-47)	Ischemic 100%	45%
Dharmasaroja et al. (2011)	12 (15-30)	Ischemic and TIA 100%	—
	25 (31-40)	Ischemic and TIA 100%	24%
	62 (41-50)	Ischemic and TIA 100%	36%
Fromm et al. (2011)	100 (<50)	Ischemic 100%	27%
Janssen et al. (2011)	94 (<50)	Ischemic 51%, TIA 49%	56.4%
Patella et al. (2011)	98 (14-45)	Ischemic 100%	34%
Chatzikonstantinou et al. (2012)	104 (19-45)	Ischemic stroke 100%	31.4%
Von Sarnowski et al. (2013)	4467 (18-55)	Ischemic stroke and TIA 100%	46.6%

Alcohol

Alcohol-related stroke events in young patients are relative to the amount consumed. Light to moderate alcohol intake reduces risk of stroke whereas high intake, or alcohol abuse, increases the risk of stroke (particularly hemorrhagic) (Bruno 2003; Hillbom et al. 1995; Lu et al. 2008). A review of alcohol-related stroke in young patients found ischemic stroke was reduced by up to 40% in those who consumed 1-2 alcoholic beverages daily (Bruno 2003). Risk of hemorrhagic stroke was found to increase 1.9-4.6 times if patients consumed >1 alcoholic beverage (40g) daily. This is likely due to increased blood pressure associated with heavy drinking (Gillman et al. 1995). Similar results were reported from an 11-year prospective cohort study of 45,449 women under the age of 60 (Lu et al. 2008) . Compared with non-drinkers, women who consumed alcohol had a decreased risk of stroke, regardless of the beverage type (Lu et al. 2008). See also chapter 8: Secondary Prevention of Stroke (8.7.4, Alcohol).

Table22.3.3 Studies included in Bruno (2003)

Ischemic stroke	Hemorrhagic stroke		
Stampfer et al. (1988) Gillman et al. (1995) Djousse et al. (2002)	Donahue et al. (1986) Calandre et al. (1986) Klatsky et al. (1989) Monforte et al. (1990)	Longstreth et al. (1992) Juvela et al. (1993) Juvela et al. (1995) Gillman et al. (1995)	Teunissen et al. (1996) Thrift et al. (1999) Klatsky et al. (2002)

Table 22.3.4 Alcohol Abuse Prevalence in Young Stroke Patients

Study	N (age)	Stroke Type	Percentage with Risk Factor
Hillbom et al. (1983)	100 (15-55)	Ischemic 100%	40%
Hillbom et al. (1995)	75 (16-40)	Ischemic 100%	28%
Barinagarrementeria et al. (1996)	300 (<40)	Ischemic 100%	20%
Nayak et al. (1997)	177 (15-45)	Ischemic 100%	22%
You et al. (1997)	201 (15-55)	Ischemic 100%	59%
Ruiz-Sandoval et al. (1999)	200(15-40)	Hemorrhagic 100%	9.5%
Kwon et al. (2000)	149 (15-44)	Ischemic 100%	31.5%
Lee et al. (2002)	264 (18-45)	Ischemic 100%	19.2%
Musolino et al. (2003)	60 (17-45)	Ischemic 92%, TIA 8 %	3.3%

Mehndiratta et al. (2004)	127 (15-40)	Hemorrhagic 14.5%, Ischemic 85.5%	2.3%
Lai et al. (2005)	296 (15-45)	Hemorrhagic 100%	6.3%
Carod-Artal et al. (2005)	130 (15-45)	Ischemic 100%	5.4%
Ruiz-Sandoval et al. (2006)	35(18-40)	Hemorrhagic 100%	29%
Rasura et al. (2006)	394(14-47)	Ischemic 100%	5%
Varona et al. (2007)	272 (15-45)	Ischemic 100%	31%
Onwuchekwa et al. (2009)	54 (18-45)	Hemorrhagic 35.2%, Ischemic 64.8%	27.8%
Putaala et al. (2009)	1008 (15-49)	Ischemic 100%	14.2%
Bi et al. (2010)	1988 (35-45)	Hemorrhagic 95.7%, Ischemic 94.3%	38.2%
Spengos and Vemmos (2010)	253 (≤45)	Ischemic 100%	13.8%
Balci et al. (2011)	192 (18-47)	Ischemic 100%	9%
Patella et al. (2011)	98 (14-45)	Ischemic 100%	0%
De Los Rios et al. (2012)	501 (18-54)	Ischemic 69%, hemorrhagic 22%, unknown 9%	15%
Von Sarnowski et al. (2013)	4467 (18-55)	Ischemic stroke and TIA 100%	33%

Drug Abuse

Stroke related to drug abuse is more common in younger patients even when other etiology is usually absent (Bruno 2003). Stroke risk related to drug use varies among young populations; however, important variables are the patient's sex, type of drug, and the amount taken. Petitti et al. (1998) found that catecholamine use in young women was associated with a 3.8 times greater risk for stroke. Bruno (2003) found young women using drugs containing phenylpropanolamine (PPA) were at a 2 times higher risk of hemorrhagic stroke. In particular, appetite suppressants containing PPA increased hemorrhagic stroke risk by 16.6 times. However, PPA use among men is considerably lower and is not associated with increased risk of hemorrhagic stroke (Bruno 2003).

Westover et al. (2007) found amphetamine abuse to be associated with twice the risk of hemorrhagic stroke and mortality compared with cocaine abuse. In contrast, amphetamine abuse was not found to increase risk of ischemic stroke. The same authors found a risk of 1.36 and 1.76 (95% CI, 0.90-2.71) for cannabis use related to hemorrhagic and ischemic stroke, respectively.

Young patients who use ecstasy (Methylenedioxymethamphetamine) were found to have lower cerebral blood vessel volume. This suggests vasoconstriction which may cause stroke (Bruno 2003). Similarly, Wolff et al. (2011) found a highly significant association between cannabis use and multifocal intracranial stenosis. No variation was found with regard to race and drug-related stroke in young patients (Westover et al. 2007).

de Los Rios et al (2012) investigated the trend of substance abuse preceding stroke among young adults age 18-54 and found an alarming trend since 1993-1994 to 2005. In 2005, 19.8% of young stroke patients admitted to illicit drug use compared to 3.8% in 1993-1994. The highest percentage of patients who had documented illicit drug use were those aged younger than 35 years old, compared to those aged 35 to 54 years.

Cocaine

Cocaine use is a risk factor more unique to the young population. In patients with an absence of other known vascular risk factors, cocaine use is associated with at least 6.5 times higher risk of stroke (Broderick et al. 2003; Bruno 2003; Petitti et al. 1998). Research concerning cocaine-induced stroke has demonstrated roughly equal proportions of ischemic and hemorrhagic events (Bruno 2003). Potential

mechanisms involved in cocaine-induced stroke include vasospasm, cerebral vasculitis, enhanced platelet aggregation, cardioembolism, and hypertensive surges associated with altered cerebral autoregulation and cerebral blood flow (Treadwell & Robinson 2007). Men are more commonly exposed to cocaine but women are more likely to become dependent (O'Brien 1998). Petitti et al. (1998) found 4.7% of adolescent male cocaine users to be dependent, compared with 17.5% of female adolescents. However, there is no research as to whether this results in a higher mortality rate for cocaine-induced stroke in young women.

Oral Contraceptives

The role of oral contraceptives (OC) relating to stroke has been controversial (Kristensen et al. 1997). When 28 young female ischemic stroke patients were compared with 50 group-matched controls OC use was found to be 11% higher in the young stroke patients (Hillbom et al. 1995). Federico et al. (1990) found 4 out of 18 young ischemic stroke patients were using OC; although, use of OC was considered as the probable cause of stroke in only one case. Camerlingo et al. (2000) found no OC etiologies but considered it a risk factor for 26% of young stroke patients. Similarly, although 38% of women used OC in a study by Rasura et al. (2006), no young OC-determined stroke etiologies were found and Mehndiratta et al. (2004) found only 1 out of 109 patients to have an OC determined etiology. The conflicting evidence may be attributed to developments in OC and variations in doses. In a study of 295 young female stroke patients, low-dose OC did not play a significant role in increasing stroke risk (Petitti et al. 1996). The strongest increase-of-risk relationship involving low-dose OC was when it was accompanied by cigarette smoking (Buring 1996). In conclusion, OC appears to play a minor role in young stroke etiology, but remains a risk factor particularly when paired with other factors.

Hyperlipidemia

Hyperlipidemia and hypercholesterolemia are noted risk factors in the young stroke population. They are particularly prevalent among males aged 35-50 (Barinagarrementeria et al. 1996; Dharmasaroja et al. 2011; Rasura et al. 2006); although Carod-Artal et al. (2005) found hyperlipidemia to be 19% more common in stroke patients over 50 years of age. In studies of young stroke, hyperlipidemia and hypercholesterolemia were consistently ranked as the 4th or 5th most common risk factor (Barinagarrementeria et al. 1996; Carod-Artal et al. 2005; Rasura et al. 2006; You et al. 1997). The exception is a comparison study by Tan et al. (2002) which found hyperlipidemia to be the most common risk factor (80.7%) in stroke patients aged 20-50. This high figure may have been confounded by a generally high level of hyperlipidemia within the study population. Among controls, hyperlipidemia was also the highest risk factor (44.3% prevalence). See also chapter 8: Secondary Prevention of Stroke (8.5, Hyperlipidemia).

Table 22.3.5 Hyperlipidemia Prevalence in Young Stroke Patients

Study	N (age)	Stroke Type	Percentage with Risk Factor
Barinagarrementeria et al. (1996)	300 (<40)	Ischemic 100%	6%
You et al. (1997)	201 (15-55)	Ischemic 100%	23%
Kwon et al. (2000)	149 (15-44)	Ischemic 100%	8.1%
Lee et al. (2002)	264 (18-45)	Ischemic 100%	53.1%
Schwaag et al. (2003)	160 (15-45)	Ischemic 88.7%, TIA 11.3%	30%
Carod-Artal et al. (2005)	130 (15-45)	Ischemic 100%	11.5%
Nedeltchev et al. (2005)	203 (16-45)	Ischemic 100%	39%
Lai et al. (2005)	296 (15-45)	Hemorrhagic 100%	36.3%
Rasura et al. (2006)	394(14-47)	Ischemic 100%	15%

Bi et al. (2010)	1988 (35-45)	Hemorrhagic 95.7%, Ischemic 94.3%	4.2%
Balci et al. (2011)	192 (18-47)	Ischemic 100%	35.4%
Dharmasaroja et al. (2011)	12 (15-30)	Ischemic and TIA 100%	42%
	25 (31-40)	Ischemic and TIA 100%	76%
	62 (41-50)	Ischemic and TIA 100%	53%
Putaala et al. (2012)	3944 (18-49)	First ever ischemic 100%	46%
Chatzikonstantinou et al. (2012)	104 (19-45)	Ischemic stroke 100%	27.6%
Von Sarnowski et al. (2013)	4467 (18-55)	Ischemic stroke and TIA 100%	34.9%

Plasma Homocysteine

Elevated plasma homocysteine level has been found to increase risk of stroke. Bos et al. (2005) investigated the effect that plasma homocysteine level had on recurrent vascular events. They reported a significant association between the risk of experiencing a recurrent vascular event and homocysteine level for cerebral infarct and TIA patients. Tan et al. (2002) found hyperhomocystemia to be associated with cerebral infarction, independent of conventional risk factors. They also reported risk of stroke may increase as a result of a proatherogenic effect based on the association found between homocysteinemia and large-artery strokes. See also chapter 8: Secondary Prevention of Stroke (8.7.2.2, Homocysteine).

Migraine

Migraine has been studied as both a risk factor and an etiology for young stroke. Kristensen et al. (1997) found only 1 in 107 ischemic strokes to be migraine-induced. However, 18% of men and 35% of women in that study had history of migraines. Federico et al. (1990) found similar results: 18% of young patients suffered from migraine, but considered migraine as a probable cause in only 2 of 45 recorded stroke events. In a larger study of 300 young ischemic stroke patients, Barinagarrementeria et al. (1996) reported migraine to be the etiology in 10 patients (3%) and to be a risk factor in 27 patients (12%). Schwaag et al. (2003) found migraine to be associated with a risk of 2.11 (CI 1.16-3.82) in young stroke patients. Finally, Rasura et al. (2006) found migraine to be a risk factor for 26% of young stroke patients but to be the actual cause of stroke in none. These findings suggest that migraine is a common risk factor and an uncommon etiology. Each of these studies noted a higher incidence rate of migraine among women.

MacClellan et al. (2007) further examined the role of gender in migraine-related stroke. These authors studied 386 female ischemic stroke patients aged 15 to 49. Compared with 614 matched controls, no significant difference was found in migraine prevalence between the groups. However, migraine with aura was found to be 9% higher in patients with an associated stoke-risk increase of 1.5 (95% CI, 1.1-2.0) (MacClellan et al. 2007). In a mixed gender study (53% male), Schwaag et al. (2003) found no difference between the patient and control groups in regards to migraine with aura. Despite these results, the authors do acknowledge migraine as not only a significant, but also an independent, risk factor for young women. More recently in a study by Camerlingo et al. (2010) migraine was found to be associated with stroke in patients aged 16-44, though this association was not statistically significant in men. The greatest risk was to women who experienced migraine with aura. Migraine without aura was not significantly different between stroke patients and controls. In contrast, despite finding that young patients who experienced migraine with aura had a two-fold risk of ischemic stroke when compared with stroke patients without migraine, Pezzini et al. (2011) suggest that migraine itself is not a risk factor. The authors promote the idea that migraine can only be a risk factor when acting synergistically with other nonproatherosclerotic factors (Pezzini et al. 2011).

Dietary Patterns

Lifestyle factors link stroke to dietary factors. Decreased stroke rates are related to high intakes of fish, whole grains and fruits and vegetables, whereas increased rates of stroke can be associated with factors such as alcohol consumption (Agnoli et al. 2011). In the presence of the EPICOR study, Agnoli et al. (2011) investigated the association between stroke and adherence to 4 a priori-defined dietary patterns: Healthy Eating Index 2005 (HEI-2005), Dietary Approaches to Stop Hypertension (DASH), Greek Mediterranean Index, and Italian Mediterranean Index. The study included 40,681 patients, with a mean follow-up of 7.9 years. There were 178 diagnosed stroke cases reported (100 ischemic and 47 hemorrhagic)(Agnoli et al. 2011). All dietary patterns, other than the Healthy Eating Index, were inversely associated with risk of stroke, with Italian Mediterranean Index showing the strongest association (HR=0.47 95% CI,0.30-0.75)(Agnoli et al. 2011). Ischemic stroke showed significant inverse associations with all patterns included in the study except the Greek Index and the Italian Index (HR = 0.37 95%CI 0.19– 0.70). Hemorrhagic stroke was only associated with the Italian Index (HR = 0.51(95%CI = 0.22–1.20); P = 0.07). The Italian Index features high intakes of typical foods (such as pasta, typical Italian vegetables, fruit, legumes, olive oil and fish) and low intakes of alcohol and non-typical foods (such as soft drinks, butter, red meat and potatoes). These findings suggest that adherence to one specific dietary pattern was protective against one type of stroke, with the Italian Index being the dietary pattern associated with the largest reduction in risk for stroke (Agnoli et al. 2011).

Another study that looked at the effect of nutrition on stroke etiology states both malnutrition and over nutrition can have an effect on stroke prevalence (Hankey 2012). An association of poor growth in the first 2 years of life, due to malnutrition, with an increased risk of stroke in adulthood (p=0.004) was reported (Hankey 2012). Over nutrition and the effects of specific nutrients was also found to be associated with increased risk of stroke; specifically, salt supplementation by 5 g per day was associated with a 23% (95% CI 6-43) increased risk of stroke, whereas potassium supplementation by 1 g per day was associated with an 11% (95% CI 3-17) reduction in the risk of stroke (Hankey 2012).

Diabetes Mellitus

In patients under the age of 30, diabetes mellitus is not an important risk factor for stroke (Mehndiratta et al. 2004). When compared with older patients, Awada et al. (1994) found diabetes to be 29% less common in stroke patients under the age of 45. Ruiz-Sandoval et al. (2006) found 16% less cases of diabetes in patients <40 years of age. Further, it has been reported that 13% of young stroke patients aged 30-40 had diabetes versus 4.2% of patients aged 15-30 (Mehndiratta et al. 2004). This data suggests diabetes mellitus is a less common risk factor for young stroke patients. Voorend et al. (2004) found no mean difference in *C. pneumoniae* levels in young stroke patients with atherosclerotic-determined etiology and controls. A large scale prospective study is necessary to confirm the validity of C. pneumonia as a risk for stroke in young patients (Anzini et al. 2004; Bandaru et al. 2009; Piechowski-Jozwiak et al. 2007; Voorend et al. 2004). See also Chapter 8: Secondary Prevention of Stroke (8.6, Infection).

22.3.2 Summary

The most common risk factors for young stroke patients are modifiable (Broderick et al. 2003). Hypertension and smoking are consistently major risk factors for ischemic and hemorrhagic stroke in young populations (Awada 1994; Mehndiratta et al. 2004; Varona et al. 2007; Waje-Andreassen et al. 2007). Uncommon and minor risk factors include *C.pneumoniae* infection and low-dose oral contraceptives (Petitti et al. 1996; Piechowski-Jozwiak et al. 2007). Diabetes, hypercholesterolemia, hyperlipidemia, and elevated homocysteine levels are more prevalent in young stroke patients aged 35-50 rather than those under 35 (Barinagarrementeria et al. 1996; Bos et al. 2005; Rasura et al. 2006; Ruiz-

Sandoval et al. 2006). Modifiable risk factors which tend to be unique to the young population are oral contraceptives, drug use, and cocaine use (Broderick et al. 2003; Bruno 2003; Hillbom et al. 1995).

Conclusions Regarding Modifiable Risk Factors

Smoking is the most significant risk factor for stroke in the young population.

Hypertension is a common risk factor for young stroke.

Hyperlipidemia, diabetes mellitus, and elevated plasma homocysteine level are stroke risk factors particularly for those aged >35.

Alcohol-related stroke events in young patients are relative to the amount consumed. 1-2 alcoholic beverages daily reduces the risk of ischemic stroke.

Drug use is an uncommon risk factor for stroke in the young population; however, drug abuse and cocaine use can cause both ischemic stroke and hemorrhage in young people.

Oral contraceptives play a minor role in stroke risk when paired with other factors. Low-dose oral contraceptives do not appear to be an independent risk factor for stroke in young people.

Adherence to specific dietary patterns, such as the Greek Mediterranean Index, can reduce the risk of stroke in a young population. High intake of salt can increase risk of stroke, whereas high intake of potassium can reduce the risk of stroke.

Migraine is a risk factor for young stroke. Young women in particular are at an elevated risk.

Further study is required to determine the validity of Chlamydia pneumonia as a risk factor for young stroke.

22.3.3 Non-Modifiable Risk Factors

Family History

Family history of stroke as a risk factor for young patients requires further research (Schwaag et al. 2003). The small amount of available data appears conflicting and inconclusive. Mehndiratta et al. (2004) found family history of stroke to be present in only 2.7% of young ischemic stroke patients. In contrast, Rasura et al. (2006) and Patella (2011) found it to be the most common risk factor (present in 63% and 74.5% of young patients, respectively). In a case-control study the prevalence of family history of vascular events was the same in both young stroke patients and a group of age/gender matched controls (Schwaag et al. 2003). The odds ratio of having a family history of subarachnoid haemorrhage for patients 15-49 years of age was 1.92, which was not significantly different between age groups (Bor et al. 2008). Differences between studies may be due to the varying definitions of 'family history' used. For example, Lai et al. (2005) used a family history of stroke if "patients had no obvious risk factors", whereas Rasura et al. (2006) and Patella et al. (2011) listed family history as a "history of cardio- and cerebrovascular disease in first degree relatives."

Table 22.3.6 Family History of Stroke Prevalence

Author, Year	N (age)	Stroke Type	Percentage with Risk Factor
Nayak et al. (1997)	177 (15-45)	Ischemic 100%	6%
Lee et al. (2002)	264 (18-45)	Ischemic 100%	29.3%
Mehndiratta et al. (2004)	127 (15-40)	Hemorrhagic 14.5%, Ischemic 85.5%	1.6%
Schwaag et al. (2003)	160 (15-45)	Ischemic 88.7%, TIA 11.3%	15%
Lai et al. (2005)	296 (15-45)	Hemorrhagic 100%	6.7%
Rasura et al. (2006)	394 (14-47)	Ischemic 100%	63%
Jovanović et al. (2008)	865 (15-45)	Ischemic 100%	9%
De Silva et al. (2009)	38 (15-45)	Ischemic 100%	18%
Spengos and Vemmos (2010)	253 (≤45)	Ischemic 100%	12.6%
Balci et al. (2011)	192 (18-47)	Ischemic 100%	18%
Janssen et al. (2011)	90 (<50)	Ischemic 51%, TIA 49%	44.4%
Patella et al. (2011)	98 (14-45)	Ischemic 100%	74.5%

Gender

Studies report conflicting results regarding the incidence of stroke in young males and females and which sex is more likely to experience stroke while young (Table 22.3.7). Despite varying results, a recent report by Towfighi et al. (2011) found women aged 35-64 were more likely than men to report previous stroke. This is likely resulting from the fact that stroke patients under the age of 30 are more likely to be female than male (Putaala et al. 2009; Rozenthul-Sorokin et al. 1996). Similarly, Spengos and Vemmos (2010) found that, below the age of 30, females outnumbered males, while above the age of 30 this pattern was reversed and males outnumbered females. Putaala et al. (2012) also found that females outnumbered males in those aged <34, with male: female 0.7. In the age group >34, the male: female ratio linearly increased, and reached 1.7 in patients aged between 45 to 49 years. It has been suggested that this large female population of very young stroke survivors is due to the association that age and gender have with other risk factors such as oral contraceptive use and migraines (Carolei et al. 1993; Kwon et al. 2000). Despite these findings, other studies suggest the female stroke population is decreasing (Naess et al. 2011).While Martínez-Sánchez et al. (2011) found no difference in the gender of stroke survivors, but found that females experienced more severe strokes than men.

Table 22.3.7 Proportion of Males and Female Young Stroke Patients

Author, Year	N	Stroke Type	% F : M
Hillbom et al. (1983)	100 (15-55)	Ischemic 100%	33: 67
Carolei et al. (1993)	333 (15-44)	Ischemic 100%	48: 52
Awada et al. (1994)	120 (15-45)	Hemorrhagic 41.5%, Ischemic 58.5%	36.7: 63.3
Carolei et al. (1996)	308 (15-44)	Ischemic 100%	47: 53
Rozenthul-Sorokin et al. (1996)	253 (17-49)	Hemorrhagic 17.8%, Ischemic 80.6%, Unspecified 1.6%	37.2: 62.8
Kwon et al. (2000)	149 (15-44)	Ischemic 100%	24.8: 75.2
Lee et al. (2002)	264 (18-45)	Ischemic 100%	28.8: 71.2
Naess et al. (2002)	23 (15-29)	Ischemic 100%	70: 30
	209 (30-49)		62: 38
Jacobs et al. (2002)	74 (20-45)	Hemorrhagic 55%, Ischemic 45%	47: 53
Broderick et al. (2003)	312 (18-49)	Hemorrhagic 100%	61: 39
Musolino et al. (2003)	60 (17-45)	Ischemic 100%	56.7: 43.3

Naess et al. (2004)	232 (15-49)	Ischemic 100%	41: 59
Varona et al. (2004)	272 (15-45)	Ischemic 100%	35: 65
Onwuchekwa et al. (2009)	54 (18-45)	Hemorrhagic 29.6%, Ischemic 64.8%, Unclassified 5.6%	51.9: 48.1
Putaala et al. (2009)	731 (15-49)	Ischemic 100%	37.2: 62.8
Bi et al. (2010)	1988 (35-45)	Hemorrhagic 95.7%, Ischemic 94.3%	27: 73
Camerlingo et al. (2010)	314 (16-34)	Ischemic 100%	52.2: 47.8
Spengos and Vemmos (2010)	253 (≤ 45)	Ischemic 100%	43.5: 56.5
Fromm et al. (2011)	100 (< 50)	Ischemic 100%	28: 72
Kang et al. (2011)	214/100,000 (45-54)	Ischemic 68%	47: 68
Martínez-Sánchez et al. (2011)	310 (≤ 50)	Ischemic 100%	41.3: 58.7
Naess et al. (2011)	23 (16-30)	Ischemic 100%	69.6: 31.4
	13 (16-30)	Ischemic 100%	0: 100
Zhang et al. (2011)	669 (18-45)	Ischemic 100%	32.9: 67.1
Putaala et al. (2012)	3944(18-49)	Ischemic 100%	43.4: 56.6

Race

Race appears to be an important factor in the risk for stroke. Kittner et al. (1993) studied stroke patients aged 15 to 44 and found a significantly higher risk for cerebral infarction and intracerebral hemorrhage existed for young black individuals compared with young white individuals. Qureshiet al. (1995) studied all stroke inpatients between the ages of 15 to 94 over a 4.5 year period at an Atlanta hospital. Of the 248 eligible young patients, 219 were black. Hypertension was noted to be associated with stroke in blacks much more commonly than in non-black patients (55% vs. 24%, p=0.03), with hypertensive intracerebral hemorrhage (64%) being the most common subtype of stroke recorded among young black patients. Rohr et al. (1996) studied 296 cases of ischemic stroke among black and white adults aged 18 to 44 years compared to 1220 controls. Diabetes mellitus, hypertension, and current cigarette smoking were found to be important risk factors, with the latter two factors particularly important risk factors for young blacks (Rohr et al. 1996).

Previous Stroke

Previous stroke in young patients is an uncommon and poorly studied risk factor (Barinagarrementeria et al. 1996). Ruiz-Sandoval et al. (2006) found previous stroke to be 4% less common in young patients than in a matched population over 40 years of age. Contrary to this, Jovanović et al. (2008) found a history of transient ischemic attack (TIA) or stroke in 23% of young patients.

Table 22.3.8 Previous Stroke Prevalence in Young Stroke Patients

Author, Year	N	Stroke Type	Percentage with Risk Factor
Adams et al. (1986)	144 (15-45)	Ischemic 100%	14%*
Awada (1994)	120 (15-45)	Hemorrhagic 41.5%, Ischemic 58.5%	6%
Barinagarrementeria et al. (1996)	300 (<40)	Ischemic 100%	11.7%
Nayak et al. (1997)	177 (15-45)	Ischemic 100%	13%
Lee et al. (2002)	264 (18-45)	Ischemic 100%	22. 7%
Carod-Artal et al. (2005)	130 (15-45)	Ischemic 100%	7.7%
Ruiz-Sandoval et al. (2006)	35 (18-40)	Hemorrhagic 100%	9%

Jovanović et al. (2008)	865 (15-45)	Ischemic 100%	23%
Bi et al. (2010)	1988 (35-45)	Hemorrhagic 95.7%, Ischemic 94.3%	14.9%
Fromm et al. (2011)	100 (<50)	Ischemic 100%	4%

*Transient ischemic attacks only

Mitral Valve Prolapse

Mitral valve prolapse (MVP) occurs in approximately 3-6% of the young adult population (Adams et al. 1986; Gilon et al. 1999). MVP as a cause of stroke is controversial. Among young stroke patients, it is considered a minimal risk factor and an infrequent sole etiology (Adams et al. 1986; Bevan et al. 1990; Gilon et al. 1999; Mehndiratta et al. 2004). In contrast, Bogousslavsky and Regli (1987) conducted a study with 41 patients under the age of 40 and reported 30% had MVP etiology. The authors attribute this finding to the use of echocardiography during assessment; however, echocardiography has been used by several researchers (Adams et al. 1986; Bevan et al. 1990; Gilon et al. 1999; Mehndiratta et al. 2004). Reported discrepancies may be due to changing diagnostic criteria or a range of risk factors accompanying the MVP (Gilon et al. 1999).

Patent Foramen Ovale

Patent foramen ovale (PFO) or atrial septal defect (ASD) in the general population is a relatively common cardiac abnormality (Guercini et al. 2008). In young stroke patients, particularly those with cryptogenic etiology, PFO is found with increased frequency (Cramer 2005). In a meta-analysis by Cramer et al., (2005) PFO was found to be significantly associated with ischemic stroke in patients under the age of 55. The odds ratio (using fixed effect) was 6.00 (95% CI, 3.72-9.68). However, despite this high occurrence rate in young cryptogenic stroke patients, the exact role of PFO in stroke pathogenesis is unknown (Cramer 2005). This complicates secondary stroke prevention in young stroke patients with a PFO. Rodés-Cabau et al. (2009) performed a prospective study on patients <55 years of age that had been diagnosed with cryptogenic stroke and found that patients with PFO had lower atherosclerotic burden when compared to those without PFO. The authors concluded that an atherosclerotic-mediated mechanism is not likely to be involved in stroke that occurs in the presence of PFO. See also chapter 8: Secondary Prevention of Stroke (8.10, Cardiac Abnormalities).

Pregnancy and Postpartum Stroke

There have been no definitive studies evaluating the incidence and types of pregnancy-related stroke, however there have been retrospective studies (Davie & O'Brien 2008; Feske 2007) to determine trends in epidemiology, etiology, risk factors, and prognosis.

The approximate incidence rate of pregnancy-related stroke is between 11 and 34 deliveries per 100,000 (Davie & O'Brien 2008; Egido & Alonso de 2007). Approximately, 90% of the stroke events occurred in the last trimester, and were twice as likely to occur in women over the age of 35 (Davie & O'Brien 2008; Egido & Alonso de 2007; Feske 2007; Pathan & Kittner 2003). The estimated mortality rate following pregnancy-related stroke ranges from 10-17.8% (Davie & O'Brien 2008; Feske 2007).

Table 22.3.9 Studies included in Feske (2007) and Davie & O'Brien (2008)

Retrospective studies	Inpatient registries
Wiebers and Whisnat (1985) Sharsharet al. (1995) Awadaet al. (1995) Kittneret al. (1996) Witlinet al. (1997) Lanskaet al. (2000) Jaigobin and Silver (2000)	Roset al. (2001) Jenget al. (2004) James et al. (2005) Ling et al. (2006)

Risk factors for stroke during pregnancy or postpartum include hypertension, diabetes, sickle cell disease, thrombophilia, smoking and heart disease, alcohol and substance abuse, strenuous labour, multiparity, caesarean section, increased

gestational age, increased maternal age, pre-eclampsia, eclampsia, anemia, a history of migraines and aneurysmal rupture (Davie & O'Brien 2008; Feske 2007; James et al. 2005). In particular, pre-eclampsia or eclampsia is found in 25-45% of pregnant stroke patients (Davie & O'Brien 2008; Feske 2007). Feske (2007) found patients with a history of pre-eclampsia to have up to a 60% greater risk of recurring stroke outside of pregnancy. In addition, Kajantie et al. (2009) found that the offspring of women who had pre-eclampsia were more likely to have a stroke than those born to normotensive mothers. Recurring stroke during pregnancy occurs in about 1-2% of patients (Pathan & Kittner 2003).

22.3.4 Summary

Young populations have both conventional and unique non-modifiable risk factors for stroke (Ning & Furie 2004). Factors such as family history and race seem to play a similar role in older stroke patients. Although the data regarding family history is conflicting, some studies have found it does play a significant role in stroke risk (Lee et al. 2002; Rasura et al. 2006; Schwaag et al. 2003). Race also appears to play a significant role in stroke risk and etiology. This is particularly true of hypertensive stroke in young black patients (Kittner et al. 1993). A unique non-modifiable risk factor to young female populations is pregnancy and postpartum. Stroke during these periods is uncommon, and usually attributed to preeclampsia or eclampsia (Feske 2007).

Conclusions Regarding Non-Modifiable Risk Factors

The significance of family history and patent foramen ovale as risk factors for stroke in young populations is unclear.
There is a gender preponderance related to age of onset of stroke. Young stroke patients under the age of 35 are more likely to be females and above 35 years of age are more likely to be males.

Race appears to be an important risk factor for stroke in young populations. Risk appears to be elevated particularly for young black patients.

Previous stroke in young patients is less common than in older patients.

Mitral valve prolapse appears to be a minimal risk factor and an infrequent sole etiology in young stroke events.

Pregnancy and postpartum state are unique periods of elevated stroke risk in young females. This is likely due to elevated blood pressure.

Both modifiable and non-modifiable factors are significant in young stroke risk. Most common are smoking, hypertension, hyperlipidemia, alcohol abuse, race (in black patients), and migraine (in female patients).

Uncommon risk factors are mitral valve prolapse, moderate alcohol consumption, previous stroke, and drug use.

22.4 Recovery and Prognosis

It is well known that young stroke patients demonstrate greater neurological and functional recovery and hence have a better prognosis compared to older stroke patients (Adunsky et al. 1992; Hindfelt &

Nilsson 1977; Marini et al. 2001; Nedeltchev et al. 2005). However, 11 years following an ischemic stroke, a substantial number of young stroke survivors are found to cope with permanent cognitive deficits (Schaapsmeerders et al. 2013). Compared to age matched controls who have not experienced a stroke, young ischemic stroke survivors, with seemingly excellent functional outcome, are found to have a worse prognosis regarding memory, anxiety and depression (Waje-Andreassen et al. 2013).

Table 22.4.1 Studies included in Black-Schaffer and Winston (2004)

Heinemann et al. (1987)
Granger et al. (1992)
Falconer et al. (1994)
Alexander et al. (1994)
Nakayama et al. (1994)
Colantonio et al. (1996)
Macciocchi et al. (1998)
Giaquinto et al. (1999)
Sze et al. (2000)
Ergeletzis et al. (2002)
Bagg et al. (2002)
Weimar e al. (2002)
Paolucci et al. (2003)

Unfortunately, data is not entirely conclusive in determining which stroke subtype(s) and severity levels will see the most (or least) improvement (Black-Schaffer & Winston 2004). Yet recently, Vibo and colleagues (2012) found that increasing age (45 to 54 vs. 0-44) and hemorrhagic stroke subtype were associated with lower long-term survival rates.

In general, age is associated with poorer rehabilitation outcomes, particularly for the oldest patients (Falconer et al. 1994). More favourable functional outcomes are found for young stroke patients. In a review study examining 979 stroke patients (including ischemic and intracerebral hemorrhage stoke types; see Table 22.4.1) a negative relationship was found between age and change in FIM score during stay at the hospital (Black-Schaffer & Winston 2004). Younger patients with a higher FIM were 30% more likely to return home. In general, younger patient's hospital stay was an average of 23 days longer. Of note, longer stays may be due to the increased likelihood of older patients being discharged directly to nursing homes (Black-Schaffer & Winston 2004; Falconer et al. 1994).

Some research has shown that young stroke patients benefit more from intravenous tPA compared to older stroke patients (Poppe et al. 2009; Toni et al. 2012), however it may be that the lack of significant medical comorbidities cause younger patients to fare better and not just their age (Poppe et al. 2009). Several studies have investigated the recovery and prognosis of younger stroke patients. Please see Table 22.4.2 for an outline of each study and their outcomes.

Table 22.4.2 Studies Evaluating Recovery and Prognosis in Young Strokes

Author, Year Country PEDro Score	Methods	Outcomes
Hindfelt and Nilsson (1977) Sweden No Score	Included 60 young adults (age 16-40 years, mean age at stroke onset was 30.85 years) who suffered an acute ischemic stroke. Patients were followed an average of 51 months.	In total eight patients died, two as a direct result of stroke, and six from other causes. At follow-up information of the neurological deficits was available for only 52 patients, 20 of whom had no deficits, 24 had minor to moderate deficits and 8 had major deficits. Four patients experienced re-infarctions.
Coughlan and Humphreys (1982) UK No Score	The spouses of 170 surviving stroke patients 3 to 8 years after having suffered a stroke completed postal questionnaires. All patients were under the age of 65 at stroke onset.	About half the patients reported at least one mobility problem and used mobility aids such as a wheelchair, walking frame or stick. Women had significantly more mobility problems than men ($P<0.05$). Assistance with self-care was necessary for approximately 2/3rds of patients. Hemiplegics reported many mobility and self-

		care problems, whereas non-hemiplegics reported few.
Ferro & Crespo (1988) Portugal No Score	254 young stroke patients between the ages of 15 and 50 were included.	About 30% of young aphasic stroke patients made a full recovery, 33% showed improvement, and 33% remained significantly "unresolved" in their language impairment. 5% of patients had a recurrent stroke. The younger stroke population had better recovery than reported for the aphasia population where age was not selected. In contrast to older stroke patients, this young stroke population showed complete recovery and significant improvement 6-month following stroke onset.
Bogousslavsky and Regli (1987) Switzerland No Score	41 ischemic stroke patients under 30 years of age included. Mean follow-up was 46 months post stroke.	3 patients died acutely. Annual incidence of death was 0.7% and that of recurrent stroke was 0.7%. One patient who survived the acute phase died during follow-up. This patient died of renal failure due to systemic lupus erythematosus, 48 months after stroke. One patient with intracerebral arteritis suffered another stroke 10 months after the initial event. The authors noted that subacute prognosis was good.
Chancellor et al. (1989) New Zealand No Score	66 young patients (<40 years old) with acute nonhemorrhagic cerebral infarction (n=63) or transient ischemic attack (n=3) included. Follow-up was a mean of 3 years following the initial presentation.	Follow-up information was available for patients. 3 patients died, 46 (78%) patients made a full recovery or had minor disabilities, whereas 10 patients had a moderate disability. All long-term survivors were able to perform ADLs without assistance from others.
Adunskyet al. (1992) Israel No Score	35 young stroke patients aged 18 to 40 years old admitted to an Israeli rehabilitation facility were included.	Mean time to admission was almost 1 month and patients remained in rehabilitation an average of almost 3 months. Nevertheless, a significant difference between ADL scores at admission and discharge was noted ($p<0.01$), but not between discharge and follow-up. Young stroke patients significantly improved in standing, sitting, transfer and walking abilities ($p<0.02$) during hospitalization. At follow-up significant improvements remained for standing and walking ability ($p<0.01$). There were no deaths during the study period.
Hindfelt and Nilsson (1992) Sweden No Score	74 young ischemic stroke patients between the ages of 16 and 40 (>1 month post stroke) included. Follow up ranged from 13-26 years following stroke onset.	12 patients were dead at follow-up. Death of 3 patients was unrelated to ischemic stroke. Of the 62 patients remaining, 7 patients who had risk factors for cerebrovascular disease at stroke onset suffered from recurrent ischemic events. Young stroke patients were found to have a favourable long-term prognosis.
Lindberg et al. (1992) USA No Score	324 consecutive long-term survivors of subarachnoid hemorrhage (SAH) included.	31% had motor and/or language deficits. Ninety-one percent of patients were independent in personal ADL. Of these only 14% needed ADL assistance from relatives and/or home-help (9%). 66% of the patients were unimpaired and/or had no ADL disability.

Falconer et al. (1994) USA No Score	260 patients with acute stroke (<120 days) admitted to inpatient stroke rehabilitation with LOS more than 7 days included. Patients categorized into 3 groups: 1) <65 years old (n=100), 2) 65-74 years old (n=75) or 3) ≥75 years old (n=85).	Older patients had significantly earlier admission times and poorer motor function compared to the younger stroke patient groups. At discharge older stroke patients continued to have poorer motor function and they were institutionalized more often than the younger stroke patient groups.
Ferro & Crespo (1994) Portugal No Score	215 patients under the age of 45 described their functional and vocational positions after a long-term follow up, a mean of 43.1 months.	88% patients completely recovered at the end of follow-up, 21 patients were handicapped. Disability was significantly more common among patients with major strokes compared to minor strokes (P<0.0001). 4 patients died at follow-up, all had a major stroke.
Kappelle et al. (1994) Sweden No Score	296 ischemic stroke patients between the ages of 15 to 45 years who had been referred to a tertiary medical center underwent a follow-up assessment.	The calculated annual mortality from vascular death was 1.7% during follow-up. Young patients, especially those with small-vessel stroke or stroke of unknown etiology, did significantly better than those older or who had large-vessel strokes of known etiology. On the GOS scale 76% of patients were found to have minimal or no problems, 17% had minor handicaps, and 16% had major handicaps.
Barinagarrementeria et al. (1996) Mexico No Score	300 consecutive patients younger than 40 years with the cerebral infarction (<3 months post-stroke) included. The Glascow Outcome Scale (GOS) measure was used for measuring handicap and outcome overall.	In this study 25% of patients made a full recovery, 47% made a partial but non-disabling recovery, 26% had a disabling stroke after a partial recovery and 1% died. 85% of the patients were followed for at least 3 months.13 patients (4%) suffered from recurrent cerebral infarctions.
Rozenthul-Sorokin et al. (1996) Israel No Score	253 first stroke victims (ages 17-49) were admitted to hospitals in Israel over 1 year. A questionnaire containing 88 questions was used for evaluation of the patients.	25 stroke patients died. The case-fatality rate for all stroke types within the first 4 weeks post stroke was 9.9%, with the rate for hemorrhagic strokes being much greater than ischemic strokes. Of the young stroke survivors, 7 gained complete recovery, 15 had minimal deficits, which did not prevent them from returning to all their pre-stroke activities, 96 had minor deficits, 38 had moderate deficits and 38 had severe deficits.
Neau et al. (1998) France No Score	71 young adults 15 to 45 years old experienced a cerebral infarction. Follow-up was done by interview and with neurological examination for 65 of the patients a mean of 31.7 months.	At follow-up 2 patients were dead, 7 experienced post-stroke seizures and 4 patients had recurrent strokes. 69.8% reported no problems, however 11.1% had a moderate disability and about 1/5 had a major disability.
Marini et al. (1999) Italy No Score	333 patients with first-ever transient ischemic attack or ischemic stroke aged 15 to 44 years were prospectively followed up.	96 months was the average follow-up period for 330 patients. Patients with TIA at entry were more likely to survive than patients with stroke on entry. During the follow-up period a total of 26 did not survive, and 10 had a recurrent stroke. 16% of surviving patients remained dependent at follow-up.
Camerlingo et al. (2000)	135 consecutive first-ever cerebral infarction patients, aged 16 to 45 years old, were evaluated and followed	At 12 months 8 patients were dead, 40 had mild to moderate handicaps, and 4 were completely

Italy No Score	up a mean of 68.8 months.	disabled. 83 patients were working and active and 15 experienced recurrent stroke 3 to 76 months following the first stroke.
Marini et al. (2001) Italy No Score	89 patients of a population of 4353 patients younger than 45 years of age with first-ever stroke were included.	Stroke classification for patients included 57.3% with cerebral infarction, 22 .5% with subarachnoid haemorrhage and 20.2% with intracerebral haemorrhage. Patients with the highest proportion of severe disability (47%), mortality (44%) and good recovery (60%) were patients suffering from cerebral infarction, intracerebral haemorrhage and subarachnoid haemorrhage respectively. Thirty days post-stroke 10 patients died. Patients under 45 years of age had a better chance of long-term survival compared to patients over 45 years of age (P<0.0001).
Kersten et al. (2002) UK No Score	639 Southampton Needs Assessment Questionnaires were distributed to people with stroke for 2 age groups (18-45 years; 46-65 years) suffering from chronic stroke.	Good levels of mobility (able to walk 10 meters independently inside and unaided outside) were reported in 60% of patients. 23% of patients could not walk 10-meters independently indoors or outdoors and 13% of patients could walk 10-meters independently indoors but not outdoors
Leys et al. (2002) France No Score	287 ischemic stroke patients aged 15 to 45 years old were included to determine the 3-year outcome.	After a 3-year period 22 patients were dead, 10 experienced recurrent stroke, 2 had myocardial infarction and 19 experienced seizures. 209 of the 265 survivors were independent at follow-up.
Black-Schaffer and Winston (2004) USA	979 new stroke patients were assessed using the Functional Independence Measure (FIM) at admission and discharge. Age, length of stay, severity of stroke, and amount returning home post-discharge were measured.	Younger stroke patients (<50 years of age) had greater increase in FIM scores from admission to discharge. Younger patients were also more likely to be discharged home. There was no difference in FIM between younger and older cohort in those with high admission FIM scores (>80). Younger patients stayed an average of 23 days longer in hospital, but this may be due to the likelihood of older patients being discharged to nursing homes. Overall, age was negatively related to functional outcome.
Varona et al. (2004) Spain No Score	272 young stroke patients with ischemic stroke were reviewed over 27 years to identify potential predictors of mortality, reoccurrence of stroke and poor functional recovery.	During follow-up 12% (30) of patients died and information on long-term functional handicaps was obtained from 88% (240) of patients at follow-up. 90% were independent following stroke, 26% had no disability and 11% had major deficits. 95% of patients could walk without aid from another person at follow-up. Cardiovascular risk factors and artery atherosclerosis in the carotid artery were predictors of negative long-term outcome.
Naess et al.(2004) Norway No Score	232 patients who experienced a first-ever cerebral infarction that were between the ages of 15 and 49 were included in this study.	After a mean time to follow-up of 5.7 years, 23 (9.9%) patients had died, 23 (9.9%) experienced recurrence of cerebral infarction, 24 (10.5%) developed post-stroke seizures, and 77.9% of all patients had a favourable functional outcome

		(mRS ≤2).
Naess et al. (2005) Norway No Score	192 patients aged 15 to 49 years old experienced cerebral infarction and 212 controls were interviewed.	53% of stroke patients and 31% of controls reported fatigue (P<0.001). There were significant associations between fatigue and poor functional outcome (P=0.001), and fatigue and depression (P<0.001).
Naess et al. (2005) Norway No Score	232 patients aged 15 to 49 years old with first-ever ischemic stroke were included.	There were 8 patients who died during hospital stay and 15 who died following hospital discharge. 21 (9.4%) patients experienced recurrent stroke and 10 (9.4%) had a myocardial infarction.
Nedeltchev et al. (2005) Switzerland No Score	Information on 203 consecutive ischemic stroke patients (aged 16-45) was collected prospectively. Outcomes were assessed three months after admission. Risk factors and stroke etiology were determined, and the Modified Rankin Scale (mRS) was used to classify recovery.	68% of patients had a favourable outcome (mRS 0-1), 29% unfavourable (mRS 2-5), and 3% died (mRS 6). Diabetes mellitus was associated an unfavourable clinical outcome. The annual risk of stroke recurrence was 3% for all patients and 11.7% for patients with a history of TIA. Most common risk factors included smoking (46%), hypercholesterolemia (39%), and hypertension (19%).
Naess et al. (2006) Norway No Score	232 patients aged 15 to 49 years with first-ever cerebral infarction and 215 control subjects were included.	The stroke patients had significantly lower scores on the HRQoL for physical functioning, general health and social functioning in comparison to the control subjects (P<0.001). Also, stroke patient who were depressed, unemployed or fatigued had significantly reduced score for all the items of the SF-36.
Cabral et al. (2009) Brazil No Score	All stroke cases (1323 registered 759 were first every strokes) within one year occurring in Joinville, Brazil were prospectively ascertained.	Crude mortality rates for men who suffered a stroke during 2005 and 2006 per 100,000 were as follows: <24 years, 0; 25-34 years, 0; 35-44 years, 6.6;4 45-54 years, 6.7; 55-64, 71.1. Crude mortality rates for women who suffered a stroke during 2005 and 2006 per 100,000 were as follows: <24 years, 0; 25-34 years, 1.1; 35-44 years, 9.1;4 45-54 years, 27.9; 55-64, 35.0.
Putaala et al. (2009) Finland No Score	Patients with first-ever ischemic stroke, aged 15-49, were registered in the Helsinki Young Stroke Registry and followed using the mortality registry of Statistics Finland.	Cumulative morality risk for one-year was 4.7%, and for 5-years was 10.7%.Factors most likely to predict death in the long-term were malignancy, heart failure, large artery atherosclerosis, peripheral arterial disease, heavy drinking preceding infection and being over the age of 45.
Naess et al. (2009) Norway No Score	Patients between the ages of 15-49 who suffered from first ever ischemic stroke during 1988-1997 were reviewed to evaluate aphasia among young patients.	On long-term follow up, relatively few patients had clinically significant aphasia. Patients with aphasia were more likely to have neurological deficits on admission than those without.
Röding et al. (2009) Sweden No Score	A questionnaire was sent out to patients 18–55 years of age with first-ever stroke containing questions about their physical and cognitive abilities before and after the stroke. 1068 patients returned the questionnaire 8-36 months post-stroke.	Young stroke patients that are can independently perform personal activities of daily living still experience cognitive and physical difficulties 1-2 years after a stroke. Patients were also worried about the effect of physical exertion following a stroke. Women were found to suffer from significantly more deterioration in

		both physical and cognitive functions than men.
Röding et al. (2010) Sweden No Score	Patients registered in the Swedish National Quality Register for Stroke Care, between the ages of 18-55, were sent a questionnaire to describe their satisfaction with life following a stroke. It was returned by 1068 participants.	97% of the participants were living at home.53% were unsatisfied with their life as a whole following stroke. Percentages of participants who were not satisfied with specific categories were as follows: personal activities of daily living, 21%; leisure situation, 48%; vocational situation, 66%; financial situation, 63%; sexual life, 68%; partnership relation, 42%; family life, 35%; contact with friends/acquaintances, 41%.The most important factor for not being satisfied with life as a whole for women was a diagnosis of haemorrhagic stroke and for men was living with a significant other.
Ellis (2010) USA No Score	Using a national data set (the Nationwide Inpatient Sample), 41 587 patients between the ages of 18-44 were identified (5% of all stroke patients).Discharge disposition and type of stroke was recorded.	Percentage of the total ischemic stroke survivor population for each discharge disposition that were young stroke were as follows, 2.3% of the deaths, 5.6% that had routine discharge, 6.1% of those that had another short term hospital stay, 1.9% of those discharged to a rehabilitation enter or nursing home, 2.1% of those that had home health, and 1.5% of those that had a disposition not included above. Percentage of the total subarachnoid hemorrhage survivor population for each discharge disposition that were young stroke were as follows, 12.1% of the deaths, 28.9% that had routine discharge, 15.0% of those that had another short term hospital stay, 13.8% of those discharged to a rehabilitation enter or nursing home, 12.2% of those that had home health, and 50.5% of those that had a disposition not included above. Percentage of the total intracerebral hemorrhage stroke survivor population for each discharge disposition that were young stroke were as follows, 5.0% of the deaths, 14.1% that had routine discharge, 11.5% of those that had another short term hospital stay, 4.6% of those discharged to a rehabilitation enter or nursing home, 5.0% of those that had home health, and 23.0% of those that had a disposition not included above.
Putaala et al. (2010) Finland No Score	807 patients registered in the Helenski Young Stroke Registry comprised of first ever ischemic stroke survivors between the ages of 15 and 49 were included in the analysis. Rates of recurrence stroke were examined.	Of the 807 patient, 17.9% died during follow up period (5 years) and 10.9% had at least 1 arterial event. Patients with a stroke subtype of large artery atherosclerosis had an increased risk of ischemic stroke and composite endpoint when compared to other etiologies.
Spengos and Vemmos (2010) Greece No Score	253 ischemic stroke patients were prospectively enrolled in the Athens Young Stroke Registry. Patients were 45 years of age or younger.	Overall probability of ten year survival following stroke was 86.3% (95% CI: 79.1-93.6).Stroke subtype did not result in a significant difference in survival rate. At the end of the follow-up period (mean follow-up period being 52.4

		months), 86.2% of all patients were independent (mRs score 0-2) and 6.7% of all patients were significantly disabled.
Greisenegger et al. (2011) Vienna No Score	677 patients who endured ischemic stroke or transient ischemic attack between the ages of 18 and 59 were identified in the Vienna Stroke Registry.	Cumulative mortality rates are as follows: 1-year, 2.4%; 5-year, 7.8%; overall (mean follow-up period of 6.5 years), 12%.The most frequent cause of death was cardioaortic causes, followed by malignancies and recurrent stroke.
Knoflach et al. (2012) Austria No Score	14, 256 adult actue ischemic stroke patients, functionally independent before stroke, recorded in the Austrian Stroke Unit Registry with 3-month follow-up data.	Good outcome scores (modified Rankin Scale score ≤2) was more common among young stroke patients (92.1% and 88.2% in the age ranges 18-45 and 18-55 years). Up to age 75, the probability of good outcome decreased by 3.1%-4.2% for each 10-year increase in chronological age. After age 75 the probability for good functional outcome declined ~ 10% per 10-year increment in age.
Palmcrantz et al. (2012) Sweden No Score	A 1 year prospective longitudinal study including 192 stroke patients [63 younger stroke patients (< 65 years)] with 12-month follow-up data.	Younger stoke patients spent a significantly greater number of days in stroke unit care, rehabilitation unit care, and hospital out-patient care compared to older stroke patients. Younger stroke patients rated less disability (via the Stroke Impact Scale) compared to their older counterparts in terms of strength, self-care and domestic life, and mobility.
Toni et al. (2012) Italy No Score	A post-hoc analysis to evaluate the clinical course and factors associated with intravenous thrombolysis. The study included stroke patients aged 18-50 years (n=3246) and 51-80 (n=24425), from the Safe Implementation of Thrombolysis in Stroke-International Stroke Thrombolysis Register (SITS-ISTR).	Younger patients had a lower symptomatic intracranial hemorrhage (SICH) rate, lower fatality, and higher functional independence, at 3-months compared to older patients. Among the young patients, several significant predictors of SICH, mortality, and functional independence were found using multivariable analysis (e.g., NIH stroke scale score, independence before stroke).
Vibo et al. (2012) Estonia No Score	A prospective population study including 1206 young (≤ 55 years) first ever stroke patients, investigating long-term survival rates.	Increasing age (0-44 years versus 45-54 years) and hemorrhagic stroke subtype were associated with lower long-term survival rates.
Waje-Andreassen et al. (2013) Norway No Score	A retrospective longitudinal study, investigating prognosis and mortality in 232 young ischemic stroke patients (≤ 49 years), compared to age and sex matched controls.	In comparison to the controls, stroke survivors had more memory, anxiety, depression, sleeping problems, and epilepsy, 12 years post-stroke. The mortality rate of stroke patients was 19% compared to 2% for controls 12 years post-stroke.
Schaapsmeerders et al. (2013) Netherlands No Score	A cohort study investigating long-term cognitive performance in 277 first-ever young ischemic stroke survivors against 146 age, sex, and level of education matched stroke-free controls.	Mean duration of follow-up was 11.0 years (SD 8.2). Patients with ischemic stroke had a worse cognitive performance on 6 cognitive domains (processing speed, working memory, immediate memory, delayed memory, attention, and executive functioning), compared with controls. In the stroke patients, longer follow-up duration was associated with lower immediate memory, delayed memory, and executive functioning.

Discussion

Younger patients are likely to have a better prognosis and long-term survival rate compared to older stroke patients (Nedeltchev et al. 2005). Young stroke patients were also more likely to return home after stroke, with moderate (40-80) FIM scores at admission to rehabilitation associated with the most dramatic recovery (Black-Schaffer & Winston 2004). The younger stroke population had relatively high scores for functional ability (measured by ADLs and independent ambulation), with a high percentage (68%) of young stroke patients found to have no significant disability upon discharge and an overall low (6%) risk of recurrent stroke (Nedeltchev et al. 2005). The neuroplasticity associated with being younger has a significant positive effect on the prognosis and recovery of these patients. Nevertheless, long-term follow-up of young stroke patients indicates these individuals are at increased risk for experiencing reductions in cognitive performance compared to stroke-free age and sex matched controls.

Conclusions Regarding Recovery and Prognosis for Young Stroke Patients

Young stroke patients make better neurological recoveries with less disability.

Young stroke patients make better neurological recoveries.

22.5 Rehabilitation of Younger Stroke Patients

Traditional rehabilitation is generally the same for younger and older stroke patients (Teasell et al. 2000). The major difference between the rehabilitation of the two groups lies in the differing nature of neurological recovery and associated social issues. The nature of family supports, the presence of young dependents, marital stress, and return to work are all issues generally associated with younger stroke rehabilitation (Dixon et al. 2007). Further, rehabilitation for young stroke survivors should emphasize participation in fitness activities (high-demand leisure activities) as these are the activities given up following a stroke (Wolf et al. 2012). Common rehabilitation regimes include some combination of physiotherapy, speech language therapy, occupational therapy, and pharmacological therapy (Stein 2004; Young & Forster 2007). Strategies to improve motor recovery in young stroke patients include: Constraint-induced movement therapy, robot-aided rehabilitation, virtual reality training, EMG-biofeedback, functional electrical stimulation, increased exercise intensity, and acupuncture (Stein 2004). For detailed information see chapter 6: The Elements of Stroke Rehabilitation.

A major difference in the rehabilitation of young stroke patients is that, on average, they will have longer to live with residual disability (O'Connor et al. 2005). Without appropriate rehabilitation, this longer period of time with the disability can result in large dependency costs. O'Connor et al. (2011) looked at the economic benefit of rehabilitation for working aged adults and found that it would require 21 weeks of inpatient rehabilitation in order for the rehabilitation to offset the cost of dependency. Furthermore, young patients will likely have seen less natural age-related deterioration of their cognitive and physical functions. Terént et al. (2009) found that young stroke patients receive greater relative benefits from stroke unit care than elderly stroke patients. For information on age-related rehabilitation outcomes see chapter 4: Managing the Stroke Rehabilitation Triage Process (4.4.2, Younger Stroke Patients).

22.5.1 Perceptions of Care

Young stroke patients often come from a different life situation compared to older patients (Stone 2005). Their needs may be different and this may affect their outlook on the rehabilitation process (Dixon et al. 2007). In a study of neurologically disabled young adults (n=24, 8 stroke patients), Dixon et

al. (2007) found patients had established 2 perspectives on rehabilitation: 'Recovery' and 'adaptation' (Table 22.5.1).

Table 22.5.1 Patient Perspectives on Rehabilitation (Dixon et al. 2007)

Recovery model (33% of participants)
• More common early in rehabilitation process • May be due to unfamiliarity and uncertainty environment • Found to be unrelated to duration of impairment • May cause difficulties in patients' psychological adjustment to living with neurological impairments • May lack willingness to participate in adaptive behaviours
Adaptation model (42% of participants)*
• More consistent with professionals' aims for rehabilitation • May require time to adjust to this approach • Patients recognized value of rehabilitation despite underlying impairment
** The remaining 25% of participants subscribes to both models*

The recovery model defines rehabilitation as a process to return back to their pre-morbid state, where as the adaptation model defines rehabilitation as a transitional adaptation and making the most of one's abilities (Dixon et al. 2007). Hartke and Brashler (1994) reported on a questionnaire administered to 100 young stroke survivors pertaining to what programs they felt would be most helpful during inpatient rehabilitation. Results are shown in Table 22.5.2. Although regarded as generally important, patients rated exercise/fitness programs as far more important than physicians. Physicians prioritized sexual adjustment counselling more than patients (Hartke & Brashler 1994).

Table 22.5.2 Patient versus physician rating of program importance in young stroke rehabilitation (Hartke & Brashler 1994).

Patient's rating
1) exercise/fitness programs 2) education/information programs 3) individual counselling 4) stress management programs 5) recreation/social programs.
Physician's rating
1) education/information programs 2) individual counselling 3) sexual adjustment counselling 4) vocational counselling and 5) family counselling.

"The *programs most frequently valued did not necessarily parallel development issues prescribed to be pertinent to a younger age group. Only vocational counselling was frequently chosen as valuable among the high-functioning survivors. Interventions concerning sexual functioning, parenting, and dating/interpersonal relationships were chosen relatively less frequently, although they might be assumed to be developmentally salient at a younger age*" (Hartke & Brashler 1994). The programs most highly valued might be viewed as age-nonspecific (Hartke & Brashler 1994).

The same authors noted that, "*In comparing the high- and low-functioning respondents, it is not surprising to observe the high-functioning survivors more frequently valuing vocational counselling and low-functioning survivors ranking family counselling higher. The high-functioning subgroup might be in pursuit of ambitions to return to work. In contrast, the low-functioning subgroups may have been expressing greater concern over family strain due to their dependence*" (Hartke & Brashler 1994).

Stroke patients expressed the need for more information following their stroke as essential, specifically about their disease and prognosis (Dixon et al. 2007; Low et al. 2003; Röding et al. 2003). They sensed that people had trouble comprehending them, and had concerns about others perception of their constant fatigue (Stone 2007).

Not enough attention has been paid to patients' cognitive impairments and how they affect their disability (Malm et al. 1998). This cognitive impairment, as a result of stroke, can complicate a young stroke patient's reintegration back into the community and return to work. Hommel et al. (2009) found that 70% of young stroke patients had complained of at least one significant disability in work and social functioning due to cognitive impairment post-stroke. Several studies investigating the rehabilitation of young stroke patients are summarized in Table 22.5.3.

Table 22.5.3 Studies Evaluating the Rehabilitation of Younger Stroke Patients

Author, Year Country PEDro Score	Methods	Outcome
Hindfelt and Nilsson (1992) No Score	74 young adults (age 16-40 years, mean age at stroke onset was 29.5 years) suffered a chronic ischemic stroke. Patients were followed for 13-26 years.	7 of the surviving 62 young patients were depressed. 3 of them had suffered a depression prior to the onset of their stroke.4 of them manifested overt depressive illnesses without a preceding history of similar symptomatology prior to their strokes. One patient's depression was associated with psychotic traits. 3 patients suffered from alcoholism.
Kappelle et al. (1994) Sweden No Score	212 ischemic stroke patients (aged 15-45 years) received quality of life scores obtained after a mean follow-up of 6 years.	Physical therapy was given to 40% of the patients and 94% indicated that the treatment was useful. Ninety-two percent of patients who judged speech therapy and 89% of patients who judged occupational therapy reported the treatments as beneficial. The subtype of stroke had no influence of patients' opinion in regards to rehabilitation. About 50% of patients reported residual problems with their physical or social functioning. Over 1/4 of the patients rated quality of life poor in these spheres. Almost half were diagnosed as depressed.
Hartke & Brashler (1994) USA No Score	These patients were on average 44 years (range 21-57) of age and 4 years post-stroke onset (range 1-21 years).	The majority (78%) of the survivors lived with another person, usually a spouse or other family member, while 22% lived alone. Eighty-nine percent reported a substantial level of ambulation while 71% were independent in self-care. Seventy-four percent reported making daily trips into the community while 27% were driving a car. Twenty-seven percent indicated they were engaged in some form of school attendance, employment, or job training.
Neau et al. (1998) France No Score	Return to work, post-stroke depression and quality of life was assessed for 71 young adults aged 15 to 45 years old with cerebral infarction.	Post-stroke depression occurred in 48.3% of patients and it was found to be significantly associated with severe disability and a bad general outcome.
Kersten et al.	639 Southampton Needs Assessment Questionnaires	38% (119) saw physiotherapists, 23% (74) were

(2002) UK No Score	were distributed to people with stroke for 2 age groups (18-45 years; 46-65 years) suffering from chronic stroke. Patients reported services they received 12-months prior to the survey.	treated by a nurse, 19% (60) saw an occupational therapist, 18% (58) saw a dietician, 15% (47) saw a speech-language therapist and 15% (47) saw a social worker.
Low et al.(2003) UK	200 Southampton Needs Assessment Questionnaires were distributed to young stroke patients and 135 (65%) were returned.	Unmet needs included intellectual fulfillment for 44 (34%) of patients, physiotherapy for 43 (33%), and help with activities of non-care in 43 (33%).
Röding et al. (2003) Sweden No Score	A qualitative interview of 2 women and 3 men from age 37 to 54 years who suffered from stroke.	Fatigue interfered with the ability to participate in daily activities. Informants reported a lack of participation during their hospital stay and rehabilitation program. They felt as though they were walking alongside the process. The patients wanted more information regarding the goal of rehabilitation. They also found that rehabilitation was focused on older patients. They expressed a desire to have age-adapted rehabilitation programs.
Dixon et al. (2007) UK No Score	Interviews conducted with 24 adults with neurologic disabilities regarding experiences in inpatient rehabilitation. 8 stroke patients were included, mean age of all participants was 38.1 (range 17-59). Interviews examined by 3 reviewers and 11 themes identified.	Themes identified include self-reliance, independence, importance of determination, working in partnership with the multidisciplinary team, patient's information needs, goal setting, value of vicarious experiences of other inpatients, self-recognition of progress, and necessity of external reassurance. Rehabilitation difficulties were identified with self-efficacy and time structuring. Two perspectives on rehabilitation were 'recovery' and 'adaptation'.
Hama et al. (2007) Japan No Score	452 stroke patients were examined for effect of sitting balance on activities of daily living (ADL). Sample was divided to compare young patients (<65) with older patients (≥65). Depression relating to sitting balance was also evaluated.	Young patients made up 39.6% of the sample. 24.5% of those needing assistance maintaining a 10-minute sitting position were young. 81.6% of those young patients needing assistance had improved at discharge, compared to only 56.4% of elderly patients who improved. Older patients generally were associated with higher incidence of physical impairment and functional disability, poorer outcomes, more occurrences of depression, and longer hospitalization.

Discussion

Though the rehabilitation offered to young stroke patients is similar to that of older patients, younger patients present many unique problems after stroke (Teasell et al. 2000). Their life situation and neurological recovery are often different than that of older patients. Consideration should be given to their unique struggle, and should be met with greater focus on psychosocial issues (Teasell et al. 2000). Röding et al. (2003) noted that medical doctors and rehabilitation therapists often ignore cognitive deficits in young patients and focus rather on regaining functional ability. Studies have noted that almost half of young stroke patients are diagnosed with some degree of depression (Kappelle et al. 1994; Neau et al. 1998), which is associated with a bad general outcome following stroke rehabilitation (Neau et al. 1998). Therefore advanced understanding of cognitive deficits is required for a more effective rehabilitation program (Röding et al. 2003). Röding et al. (2003) also reported young stroke patients' desire for age-adapted rehabilitation programs. Young stroke patients expressed a need for communication with other stroke patients their age that had been affected by similar experiences

(Dixon et al. 2007; Röding et al. 2003). Overall however, younger stroke patients appear to be generally pleased with the traditional stroke rehabilitation programs (Dixon et al. 2007; Kappelle et al. 1994).

Conclusions Regarding the Rehabilitation of Young Stroke Patients

Rehabilitation of young stroke patients is similar to the rehabilitation of older stroke patients with the main differences being the nature of neurological recovery and associated social issues.

Stroke rehabilitation programs should be aware of age-related needs.

Young stroke rehabilitation differs in terms of better likelihood of neurological recovery and unique social issues.

Young stroke patients have special rehabilitation needs.

22.6 Family Stress

Stroke can affect all members of a family system. In particular, spouses, children, and parents of patients often have to make large adjustments to deal with their relative's disability (Visser-Meily et al. 2005). With younger stroke patients, it would be anticipated that the need for a caregiver would be less because of the tendency to make a more complete neurological and functional recovery (Hindfelt & Nilsson 1992). However, despite whether a fulltime caregiver is necessary, other family members often assume new responsibilities to cope with the disability of the stroke patient (Teasell et al. 2000). For stroke patients, apart from the primary caregiver, other family members generally play only minor roles (Horowitz 1985; Tobin & Kulys 1981). Primary caregivers for younger stroke patients may also be more readily available as spouses or parents are more likely to be alive, local, and able to assist.

Table 22.6.1 Stress causing stages of stroke for the patient and spouse or partner

Stage	Stroke patient	Spouse or partner
Initial Crisis	The stroke event, seeking assistance	The stroke event, seeking assistance or receiving bad news
Treatment and realization	• Admission to hospital • Inpatient stay • Coming home • Coping with change	• Coping with crisis • Hospital visiting, work, family • The homecoming
Adjustment	• Impact on relationships	• Impact on relationships

*adapted from Banks and Pearson (2004)

Family members providing care for stroke survivors face their own adjustment problems, as their own personal needs are often sacrificed to meet the needs of the individual being cared for. Visser-Meily et al. (2005) found a correlation between the amount of strain and the level of depression in spouses of younger stroke patients. Partner strain was often due to emotional distress in children having difficulty coping. The same authors found spousal depression and quality of marital relationship levels one year post-stroke to be relative to their original measured levels. Teasell et al. (2000) found 38% of young stroke patients experienced conflict with their spouse during inpatient rehabilitation (as reported by hospital staff). In addition, 1 in 7 couples separated within 3 months of the stroke (Teasell et al. 2000). Gender of the healthy spouse does not appear to be significant in relation to these trends (Visser-Meily et al. 2005). Buschenfeld et al. (2009) found caregivers could be both positively and negatively impacted by a partner's stroke. Caregivers found adjustment had to occur and they coped by managing emotions, drawing from previous experiences,

comparing themselves to others, and depending on or finding social support (Buschenfeld et al. 2009). In a study comparing experiences of young stroke survivors and their partners or spouses, Banks and Pearson (2004) found both survivors and carers experience the initial crisis, treatment and realization as well as adjustment, but they experience different types of stress at each of these stages (Table 22.6.1).

Children's behavioural outcomes one year post-stroke could often be predicted by their behaviours at the start of rehabilitation process (Visser-Meily et al. 2005). During inpatient rehabilitation, 22% of young stoke patient appeared to experience conflict with their children (Teasell et al. 2000). The health status of the spouse and children was not affected by the severity of stroke (Visser-Meily et al. 2005). However, Visser-Meily et al. (2005) speculates that severity of stroke has an impact on the amount of support a family received from the hospital rehabilitation staff. Some stroke survivors have reported that the inherent responsibilities of being a parent impedes or conflicts with their time to focus on recovering from their stroke (Martinsen et al. 2012). Longer hospitalization appeared to correlate with the amount of attention rehabilitation staff gave children of young stroke patients; although, inpatient rehabilitation staff did not pay more attention to children with adjustment problems (Visser-Meily et al. 2005).

With severe stroke, Silverstone and Horowitz (1987) noted that families often find themselves in a position of having to provide skilled nursing care for which they are not experienced and for which they have received no formal training. They often have no choice but to learn the tasks by trial and error. With older stroke patients, family roles often become reversed, as other family members struggle to fill the void left by the stroke survivor (Teasell et al. 2000). In the case of young stroke patients, this role reversal is less apparent. In contrast, old roles were sometimes re-assumed, in particular when a parent must care again for a previously independent child (Teasell et al. 2000). See also chapter 19: Community Reintegration (19.2, Family and Stroke). Table 22.6.2 presents the results of several studies evaluating the effect stroke has on family stress.

Table 22.6.2 Studies Evaluating Family Stress

Author, Year Country PEDro Score	Methods	Outcomes
Hindfelt and Nilsson (1977) Sweden No Score	60 young adults (age 16-40 years, mean age at stroke onset was 30.85 years) with acute ischemic stroke were included. Patients were followed for an average of 51 months.	Of the 44 young stroke patients who returned to work, none required assistance from another person and there was limited need for special devices to help with everyday living. No social complications existed amongst family relations and only one patient experienced divorce as a consequence of the stroke.
MacKay and Nias (1979) UK No Score	90 stroke patients under the age of 65 years included.	28 of the 90 patients returned home to be cared for by their relatives. Of the 28 relatives (19 wives, 3 husbands, 4 daughters, 1 sister, 1 brother) 8 had to abandon their jobs to care for the patient, 2 had to work reduced hours and 2 others were unable to work normal hours; the remaining 16 relatives were not working previously. 25 of the 28 relatives had to spend most or all of their time at home. 2 had to move into alternative housing to accommodate the patient. 12 abandoned their usual summer

		holiday. 8 of the relatives were reported to be feeling emotionally depressed.
Coughlan and Humphreys (1982) UK No Score	The spouses of 170 surviving stroke patients 3 to 8 years after having suffered a stroke completed postal questionnaires. All patients were under the age of 65 at the time of their stroke.	Before stroke, 29 wives of the stroke patients were working full-time, 37 were working part-time, and 37 were housewives. At follow-up 12 wives were working full-time and 31 were working part-time. 18 wives stopped working after their husbands' stroke. Before the stroke, all but 5 husbands (7%) of the stroke patients were working full-time. Following stroke 44 (66%) husbands remained in paid employment.
Hindfelt and Nilsson (1992) Sweden No Score	74 young adults (age 16-40 years, mean age at stroke onset was 29.5 years) suffered a chronic ischemic stroke. Patients were followed for 13-26 years.	7 patients required constant help for their everyday activities from another person. Although, most of these patients had minor needs and only one of them was institutionalized. Children were born in 16 of the families directly affected by stroke. 3 women were pregnant at the time of stroke and 5 patients become pregnant after. 8 men had children following stroke. Only one patient divorced as a consequence of stroke.
Teasell et al. (2000) Canada No Score	83 consecutive stroke patients younger than 30 and admitted to a Canadian tertiary-care hospital rehabilitation unit were included.	The main caregivers were spouses of 53% of the patients. Fourteen of the patients younger then 28 years old were cared for mainly by parents or grandparents. Primary caregivers were parents for 24% of the cases and in two cases a 15-year-old daughter became the primary caregiver. In addition, 7 relatives other than spouse or parents were acknowledged to be the primary caregivers. In cases of elderly stroke patients often family roles are switched as children become primary caregiver's to their parents.
Lackey and Gates (2001) USA No Score	51 adults, ages 19 to 68 years, who were 3 to 19 years when their parent(s) suffered from a disability or disease including stroke were included in a retrospective study investigating the effects that caregiving has on younger children and how it has affected them as adults.	5 patients were stroke patients. Caregivers reported that caregivers brought their family closer together. Caregivers reported that personal care was the most difficult and home tasks took up the most time. Areas of a caregiver's life most affected were school, family life and time with friends. Children often helped in caregiving as long as they were not the sole caregiver.
Leys et al. (2002) France No Score	287 ischemic stroke patients aged 15 to 45 years were included to determine 3-year relationship outcomes.	At follow-up 20 (7%) patients reported divorce as a result of stroke.
Kersten et al. (2002) UK No Score	639 Southampton Needs Assessment Questionnaires were distributed to people with stroke for 2 age groups (18-45 years; 46-65 years) suffering from chronic stroke.	Difficulties in sex life were reported in 64% of the patients who thought questions about the changes in their sex life were appropriate.
Röding et al. (2003) Sweden No Score	A qualitative interview for 2 women and 3 men from age 37 to 54 years who suffered from stroke.	Fatigue interfered with the ability to participate in daily activities. In women, fatigue hindered their ability to provide and care for their children's needs. Since the women had always handled household duties and the needs of their

		family they felt that expectations were too high and too much to handle. The men, who had been previously responsible for the families' economic needs, considered economic factors in rehabilitation were most important. There is a need for specific gender modified rehabilitation.
Rodriguez et al. (2004) Spain No Score	111 patients (15-55 years) discharged from a Hospital with a cerebrovascular diagnosis included.	Of the 111 patients, 22.5% had to deal with loss of friends after stroke, and most of these patients had significantly poorer functional recovery. A total of 57% were unable to stay involved in previous recreational activities. In most cases, marital status stayed the same.
Visser-Meily et al. (2005) The Netherlands No Score	77 children, 18 years and younger were admitted to an inpatient rehabilitation unit. The amount of support provided by rehabilitation teams for children whose parent(s) had experienced a stroke was investigated.	Children with parents who had suffered a more severe stroke received the most support, but health and behavioral problems that presented in a child were disregarded. 54% of the children showed clinical or subclinical problems. This was in response to the strain put on the spouse of their parent with stroke, as determined 2 months after discharge. Support is needed for children based on the experience the children have with stroke patient.
Visser-Meily et al. (2005) The Netherlands	82 children (4-18 years of age) and their parents were interviewed to determine change in mood, behaviour problems, and health status over a 1 year period.	Children's outcome after 1 year could be predicted by their functioning at the start of the rehabilitation process. Spousal depression and marital relationships were also related to their pre-rehabilitation states. Depression in parents was an important factor in children's adjustment to life with a post-stroke parent. The severity of stroke appeared to have minor importance on final health outcomes in children and spouse.
Cameron et al. (2011) Canada No Score	A longitudinal cohort study was conducted of patients who have survived their first stroke and their caregivers. Stroke Survivors (SS)/caregiver dyads participated (n=399). This study examined the results of caregivers.	Patients completed standardized measures by telephone interviews at 1, 3, 6, and 12 months post-stroke. A subsample completed additional assessments 18 and 24 months post-stroke. Overall, caregivers reported more emotional distress when caring for SSs exhibiting more depressive symptoms and more cognitive impairment and when caregivers were younger, female, in poorer physical health, experienced more lifestyle interference, and reported less mastery. SSs' physical disability, stroke severity, and comorbidity were not significant. The set of significant predictors remained consistent when examined in the subsample followed for 2 years (except SS cognitive impairment).
Martinsen et al. (2012) Norway No Score	A qualitative study was conducted with patients who had survived a stroke. Stroke survivors (SS; n=22) were divided into three social groups: (1) young non-established participants, (2) participants living together/caring for children, with or without a partner, and (3) participants without children at home, with or	SS completed an in-depth interview focusing the on experiences of living a life after stroke and interpreted using a three-step hermeneutic phenomenological analysis. The challenges the SS experienced could be summarized in two main themes: (1) struggling to re-enter the

	without a partner. Time since stroke ranged from 6 months to 9 years.	family and (2) screaming for acceptance.
Jones & Morris (2013) United Kingdom No Score	A qualitative study was conducted with patients who survived a stroke and identified their parents as their carer at some point since stroke. SS/caregiver dyads (n=17; 6 adults stroke survivors, 6 mothers and 5 fathers). This study explored SS', mothers', and fathers' experiences separately. Time since stroke ranged from 1y 7m to 7y 6m.	A high degree of concordance was found between the SS and caregiver responses, which were grouped into four broad superordinate themes, (1) emotional turmoil, (2) significance of parents, (2) negotiating independence versus dependence, and (4) changed relationships.

Discussion

Caregivers of stroke survivors are known to suffer from higher rates of depression and greater rates of deterioration in their own health (Kinsella & Duffy 1979). Cameron et al. (2011) conveyed that caregivers reported more emotional distress when caring for individuals with stroke who were exhibiting more depressive symptoms and cognitive impairment, and when caregivers were younger, female, in poorer physical health, experienced more lifestyle interference, and reported less mastery. In the case of younger strokes, where the primary caregiver was the spouse, there are often the added responsibilities of caring for children (Visser-Meily et al. 2005). The relationship between parents post-stroke and their children is complex and the stroke event can add stress to the family environment.

Conclusions Regarding Family Stress

Young stroke patients tend to achieve higher levels of functional recovery and independence than elderly stroke patients. This improved outcome commonly puts less stress on caregivers and close relations.

Children's previous behaviours are more a predictor of adjustment issues post-stroke, rather than the stroke event itself.

Caregivers reported more emotional distress when caring for patients exhibiting more depressive symptoms and more cognitive impairment.

Individuals with stroke, physical disability, stroke severity, and comorbidity were not significant factors in the level of emotional distress reported by the caregiver.

Improved recovery proves to be less stress on caregivers.

22.7 Institutionalization

For stroke patients with significant disabilities and insufficient social supports, institutionalization becomes an important consideration. Teasell et al. (2000) reported institutionalization following formal rehabilitation occurred in approximately 5% of patients under the age of 50. Placement of an individual into a chronic care facility most often occurs when severe stroke is matched with lack of a supportive caregiver (Teasell et al. 2000). Where a caregiver is present, institutionalization occurs more often because of deterioration in the caregiver's health or an inability to cope with the continuous stress caused by increased care requirements (Boxall & McKercher 1990; Churchill 1993; Colerick & George 1986; Horowitz 1985). Fortunately, institutionalization is required infrequently in young stroke patients.

Young severe stroke patients often had longer hospitalizations than older cohorts (Black-Schaffer & Winston 2004). They concluded this was because older severe stroke patients are recognized as having less of a chance of functional recovery and are more promptly discharged to nursing homes or institutionalized care. Whereas, a longer hospital visit for younger patients may result in greater rehabilitation gains and a greater likelihood of returning home. In addition, nursing homes are often reluctant to accept younger adults (Black-Schaffer & Winston 2004). Table 22.7 presents the results of several studies evaluating institutionalization of young stroke patients.

Table 22.7 Studies Evaluating Institutionalization of Young Stroke Patients

Author, Year Country PEDro Score	Methods	Outcomes
MacKay and Nias (1979) UK No Score	90 stroke patients under the age of 65 were included.	At six months 27 of 90 patients had died. Of the 63 survivors, only 2 had to be institutionalized. Twenty-eight returned home to be cared for by their relatives.
Hindfelt and Nilsson (1992) Sweden No Score	74 young adults (age 16-40 years, mean age at stroke onset was 29.5 years) suffered a chronic ischemic stroke. Patients were followed for 13-26 years.	Most of these patients had minor needs. Only one of them was institutionalized.
Adunskyet al. (1992) Israel No Score	35 young stroke patients 18 to 40 years old admitted to an Israeli rehabilitation facility were included.	All patients went home, although their average length of stay was very long (87 ± 17 days). These patients achieved relatively high levels of functional independence at discharge when compared to elderly stroke patients. The former was attributed to the relative absence of previous and coexisting medical problems and "organic intellectual impairment."
Lindberg et al. (1992) USA No Score	324 consecutive long-term survivors of subarachnoid hemorrhage (SAH) were included.	10 (3%) were institutionalized to a long-term care facility. Of these 10 patients, all had motor impairment and all were dependent for personal ADLs. Aphasia was present in 7 of the 10 patients institutionalized. Ninety-four percent (296) of patients were not institutionalized.
Falconer et al. (1994) USA No Score	260 patients with acute stroke (<120 days) admitted to inpatient stroke rehabilitation with a length of stay more than 7 days were included. Patients were categorized into 3 groups: 1) <65 years old (n=100), 2) 65-74 years old (n=75) or 3) ≥75 years old (n=85).	Older patients had significantly earlier admission times and poorer motor function compared to the younger stroke patient groups. At discharge older stroke patients continued to have poorer motor function and were institutionalized more often than the younger stroke patient groups.
Teasell et al. (2000) Canada No Score	83 consecutive stroke patients younger than 30 and admitted to rehabilitation in a Canadian tertiary-care hospital were included.	Institutionalization following formal rehabilitation occurred in 4 (5%) of 83 patients less than 50 years of age. The common feature to each of these four cases was a severe disabling stroke(s) occurring in association with poor social supports.

Conclusions Regarding Institutionalization

Institutionalization is required infrequently in young stroke patients as a result of better prognosis and greater availability of caregivers.

Institutionalization is required infrequently in young stroke patients.

22.8 Return to Work

Vocational issues are a facet of rehabilitation unique to the young stroke population. Patients <55 years of age are the most likely to return to work (Howard et al. 1985). Elderly patients rarely have a vocational engagement prior to the stroke, occupational retraining is therefore uncommon. However, younger stroke patients view vocational issues as a primary concern for rehabilitation (Teasell et al. 2000). On this topic, Monga (1997)notes:

"The rehabilitation community has devoted only limited effort to the task of defining what is meant by the phrase return to work, to develop measures of vocational function, to applying these measures to patient populations, and to tracking return to work as a measure of rehabilitation outcome. In the published studies, the investigators do not all mean the same thing by 'work'; for example, some include homemaking and study but others only competitive employment, and some restrict it to former employment but others do not specify it at all. The age ranges of groups studied differ widely, with some studies including persons 65 years old and older and others considering only patients younger than 30 or 45 years of age".

There is also variability in the reported rates of return to work. Some studies show that few young stroke patients are able to return to previous or any full-time employment one year post-stroke, even if physical deficits are minimal (Glozier et al. 2008). Problems including headache, cognitive and memory problems, fatigue, anxiety, and irritation have accounted for reasons that individuals have not resumed a regular work schedule (Malm et al. 1998). Other research has found a relatively high rate (75%) of return to work for young individuals within one year post-stroke, most within 2-3 months (Hackett et al. 2012). Table 22.8.1 includes a full list of the studies examining the return to work of stroke patients. Also see Chapter 19: Community Reintegration (19.6, Return to Work).

Table 22.8.1 Studies Evaluating Return to Work for Young Stroke Patients

Author, Year Country PEDro Score	Methods	Outcomes
Isaacs et al. (1976) UK No Score	29 stroke patients admitted to a stroke rehabilitation ward were followed at home for a period of 3 years, or until death.	Of the 18 patients that survived the 3-year study most of them were younger stroke patients. Eleven patients had full time employment and 8 had full household duties prior to the stroke. Following discharge, no patients returned to any form of employment while 1 returned to full and 2 to partial household duties.
Hindfelt and Nilsson (1977) Sweden No Score	60 young adults (age 16-40 years, mean age at stroke onset was 30.85 years) who suffered an acute ischemic stroke included. Patients were followed an average of 51 months.	Over a period of 5-months 35 of the 52 surviving patients were able to return to work. Nine young stroke patients found part-time employment, 5 of these patients received training to overcome their handicaps at work. Only 8 patients were unable to return to work.
MacKay and Nias (1979) UK No Score	90 stroke patients under the age of 65 years included.	45 of the 90 patients were working at the time of their stroke. However, only 17 had returned to work within 6 months post-stroke and of these there was a mean loss of 111 working

		days per patient. At 6 months, 27 of the patients had died.
Coughlan and Humphreys (1982) UK No Score	The spouses of 170 surviving stroke patients 3 to 8 years post-stroke completed postal questionnaires. All patients were under the age of 65 at the time of their stroke.	Of those men still under 65 years of age at follow-up, only 30% (21) returned to paid employment, and 11 of these patients had reduced their number of hours worked or had changed the nature of their work. Of those 42 women under 60 years of age at the time of follow-up, only 17% were in paid employment. Patients without hemiplegia were employed significantly more often (11 of 18, 61%) than those with left hemiplegia (9 of 32, 28%) or right hemiplegia (2 of 37, 5%).
Sjogren (1982) Sweden No Score	51 stroke patients with hemiplegia younger than 65 years of age were consecutively admitted to the department of physical medicine and rehabilitation.	47 of the 51 stroke patients were occupationally active until the day of their stroke. However, following stroke only 17% of patients had returned to gainful employment and all of these had only "part-time" work. Approximately 75% of all patients' frequency of leisure time was reduced following stroke.
Bogousslavsky and Regli (1987) Switzerland No Score	41 ischemic stroke patients under 30 years of age were included. Mean follow-up was 46 months post-stroke.	Only 7 of the 37 patients (18.9%) remained disabled by severe neurological deficits, with an inability to resume their previous activities. However, 30 patients (81.8%) did well; 11 had no disability and 19 had returned to work and were fully employed despite a persisting mild neurological deficit.
Black-Schaffer and Osberg (1990) USA No Score	79 first-ever stroke patients aged 21 to 65 years, employed at the time of stroke, discharged from rehabilitation at least 6 months before follow-up and available for a telephone questionnaire were included. Work was defined as full-time and part-time competitive employment, homemaking, and full-time university studies.	39 (49%) patients returned to work by the time of follow-up, a mean of 3.1 months after discharge. Factors which had a negative impact upon success of return to work included aphasia, a longer rehabilitation stay, a decreased Barthel index and prior alcohol consumption. Of those returning to work, data was available on 34 patients indicating only 11 had returned to work the same number of hours as before their stroke while 23 had returned to work a reduced number of hours with an average reduction of 17.4 hours per week. However, 16 patients still maintained full-time work with the discrepancy indicating at least 5 had to cut back on the number of hours worked despite working full-time.
Hindfelt and Nilsson (1992) Sweden No Score	74 young ischemic stroke patients between the ages of 16 and 40 (>1 month post stroke) were included in this study. Follow up ranged from 13-26 years following stroke onset.	61% (39/62) returned to full-time hours, 11% (7/62) returned to part-time employment and 27% (17/62) retired following stroke. Of the retired patients, 8 had moderate to severe neurological impairments.
Lindberg et al. (1992) USA No Score	324 consecutive long-term survivors of subarachnoid hemorrhage (SAH) included.	87% of patients were employed prior to stroke onset. Of these, 57% were able to return to work and 40% received pensions for disability. Significantly fewer patients who returned to work reported impairments compared to

		patients who were unable to return to work. In 48% (143) a decrease in leisure activities was noted, mainly outdoor activities.
Saeki et al. (1993) Japan No Score	230 first-ever stroke patients younger than 65 years of age and working as a student, housewife or employed at the time of stroke included. Mean follow-up length was 43 months.	58% (134) of patients returned to work at the time of follow-up. Factors associated with return to work included: education, occupation, previous hypertension, prior alcohol drinking, maximum weakness, diagnosed side of hemiplegia, higher cortical functions, urinary and bowel incontinence and ADLs. The study found that patients with severe muscle weakness were 4 to 6 times less likely to return to work compared to patients with normal muscle strength, patients with apraxia were 4 to 5 times less likely to return to work in comparison to patients without apraxia and blue-collar workers were 3 times less likely to return to work compared to white-collar.
Ferro & Crespo (1994) Portugal No Score	215 patients under the age of 45 years to describe their functional and vocational positions after a long-term follow up, a mean of 43.1 months.	73% of the survivors had returned to work (including all housewives, students, and full or part-time workers) and 18% retired. Therefore, most of the patients returned to an active working life. Patients who drank alcohol (more than 60 g/d), who were disabled at follow-up, who had a major stroke or who were male were significantly more likely to retire.
Kappelle et al. (1994) Sweden No Score	296 ischemic stroke patients between the ages of 15 to 45 years had been referred to a tertiary medical center.	42% of patients had a job and of these 23% required an occupational adjustment. Sixty-one percent of the unemployed patients were unable to return to work due to a disability.
Saeki et al. (1995) Japan	A retrospective study was conducted on patients younger than 65 years who experienced first-ever stroke and were working at the time of the stroke. The longitudinal trends of patients returning to work after stroke as well as predictors for return to work were evaluated.	It was found that the curve of proportion of return to work was nonlinear. Two steep slopes emerged, one during the first six months and the other from 12 to 18 months. It was also found that patients were more likely to return to work if they had less impaired muscle strength, no apraxia, and if they worked at a white collar job.
Malm et al. (1998) Sweden No Score	24 patients (12 women and 12 men) between the ages of 18 and 44 years with a brainstem or cerebellar infarction included. Follow-up was completed at 4 and 12 months.	Outcomes were favorable for 22 (92%) of the patients at 4 and 12 months follow-up as seen from the Modified Rankin Scale. At 4 months post-stroke 12 (52%) patients were on sick leave regardless of residual functional deficits. By 12 months follow-up the corresponding figure moved to 10 (43%) patients. One year following stroke 57% of patients were working full-time. Headache, tiredness, anxiety, irritation and memory problems prevented the remaining patients from returning to previous employment in spite of adjustments made to their previous job credited. These symptoms were aggravated by functional or cognitive activities and were often ignored by medical doctors and therapists.

Neau et al. (1998) France No Score	Return to work was assessed for 71 young adults aged 15 to 45 years old with cerebral infarction. Follow-up was done by interview and with neurological examination for 65 of the patients a mean of 31.7 months post-stroke.	46 (73%) patients returned to previous employment, however, 12 (26.1%) required occupational adjustments.
Marini et al. (1999) Italy No Score	333 patients with first-ever transient ischemic attack or ischemic stroke aged 15 to 44 years were prospectively followed up.	At follow-up, 169 (55.6%) returned to previous employment, and 86 (28.3%) remained unemployed in spite of recovery.
Teasell et al. (2000) Canada No Score	83 consecutive stroke patients younger than 30 were admitted to Canadian tertiary-care hospital rehabilitation.	64 (77%) of the patients had a previous job or were a student before the onset of stroke. 3 months following discharge 13 (20%) of them went back to being a student or returned to work. Only 2 of the 7 students returned to school, and 1 started working part-time. Only 5 of the 53 patients who were working full-time prior to stroke returned to full-time work.
Kersten et al. (2002) UK No Score	639 Southampton Needs Assessment Questionnaires were distributed to 2 age groups (18-45 years; 46-65 years) suffering from chronic stroke.	315 returned the questionnaire, of which 65% had to give up their prior job and 14% required an adjustment in the number of hours they worked. Patients unable to return to work had significantly more unmet needs than patients with reduced hours, and those patients had significantly more unmet needs than patients who returned to their previous employment with unchanged working hours.
Leys et al. (2002) France No Score	287 ischemic stroke patients aged 15 to 45 years old were included.	After 3 years, 12 (4.2%) lost their job regardless of the fact that their mRS score was ≤1.22. Almost 8% of patients died at follow-up, and of those 265 surviving patient 8 (3%) did not return to work because of personal reasons. 142 (49.5%) returned to their previous job, with 10 of them needing work adjustments. Thirty (10.5%) of the patients obtained a new job, social insurance deemed 43 (15%) unable to return to work due to medical conditions, 42 patients were unable to find employment and 12 patients lost their job post-stroke.
Musolino et al. (2003) Italy No Score	60 patients (ages 17 to 45 years old) suffering from either ischemic stroke (n=55) or TIA 24 hours before admission to the hospital (n=5) included. A follow-up was done a year after discharge from the hospital.	37 (68.5%) patients had returned to work, however adjustments to amount of time worked and type of job were necessary for 10 (27%) of the patients.
Vestling et al. (2003) Sweden	In a retrospective study, data was collected regarding return to work for patients 60 years or younger following a stroke. Medical records and postal questionnaires were used for data collection. Mean follow-up time was 2.7 years.	41% of patients returned to work following stroke, a greater proportion of that number being males. Sixty-one percent of those who returned to work had decreased their hours. Those who returned to work reported being more satisfied with life.
Röding et al. (2003) Sweden No Score	A qualitative interview for 2 women and 3 men from 37 to 54 years old who suffered from stroke.	Participants felt that the most difficult stroke deficit they had to endure was fatigue. It was overwhelming and they felt they had no control over their fatigue; rather it affected their entire being. Fatigue hindered these individuals return to full-time employment and had a negative

		effect on family and social situations. Women felt it was difficult to keep up with housework with cognitive deficits. The consequences of fatigue accounted for the reason that they were not able to resume a full time job.
Rodriguez et al. (2004) Spain No Score	111 patients (15-55 years) discharged from a Hospital with a cerebrovascular diagnosis included.	Nearly 80% of all patients were employed prior to stroke, but only 50.2% returned to work post-stroke. Patients who had no vascular risk factors and those that suffered from an ischemic stroke had a better functional recovery and were more likely to return to work. Statistical significance was seen with the Barthel Index and Modified Rankin Scale scores for patients that returned to work in comparison with patients who did not.
Varona et al. (2004) Spain No Score	272 young stroke patients with ischemic stroke were reviewed over 27 years to identify potential predictors of mortality, reoccurrence of stroke and poor functional recovery.	128 (53%) were able to return to work. Occupational adjustments (hours worked or another job) were necessary for 23% of those who returned to work. Eighty-four patients (35%) received a permanent retirement pensions because they were medically incapable of working despite the fact that only 77% of patients were not performing work activities following stroke. The 28 (12%) patients did not work pre-stroke and therefore were ineligible for a pension.
Hofgren et al. (2007) Sweden No Score	Information about vocational status before and after first ever stroke of 58 patients below the age of 65 was gathered.	Fifty-five patients were recorded as working prior to their stroke. One year following rehabilitation, 7% of these patients had returned to work. Three years following rehabilitation, 20% of patients were working. Patients with aphasia had a much lower rate of return to work.
Glozier et al. (2008) New Zealand No Score	210 younger stroke patients (mean age 55) were interviewed regarding previous paid employment, income, psychiatric history, hospitalization, medical history, and severity of disability at 6 months follow-up. Part of ARCOS community stroke study.	Non-white ethnicity, part-time employment prior to stroke, increased stroke severity, psychiatric morbidity were all independently associated with a lower likelihood of returning to work post stroke. Patients who completed a general health questionnaire were associated with shorter hospitalization, less inpatient rehabilitation, and more likely to be discharged home.
Gabriele & Renate (2009) Germany No Score	70 stroke survivors younger than 65 that were employed prior to their stroke were examined regarding their employment. Patients were examined a year following the first interview.	26.7% of the patients had returned to work. The patient's perceived functional ability was found to be the best predictor of return to work. Females and patients with higher income jobs were more likely to return to work. In addition, admission Barthel indices were higher for those who returned to work than those who did not. Localisation, primary education and white vs. blue-collar occupation groups were not significantly different.
Lindström et al. (2009)	1068 patients between the ages of 18-55 years who experienced first ever stroke were contacted to gain	82% were working at the time of their stroke and 65% returned to work post-stroke, with no

Sweden No Score	information about their life following stroke.	significant difference between males and females or age groups. Those who were self-employed were more likely to return to work than those in private or public employment. Higher socioeconomic status and the belief that the patient would not be a burden on others were also associated with a greater rate of return to work.
Saeki &Toyonaga (2010) Japan No Score	In a prospective cohort study, data from patients 15-64 years of age after first ever stroke who had an active employment status at the time of stroke were collected.	55% of patients reported successful return to work by 18 months after stroke onset. 50% of those returned within 100 days from onset. Function of the hand and leg with hemiplegia, an ability to perform ADLs independently and gender all impacted early return to work. Males were 3 times more likely to return early.
Graham et al. (2011) Canada No Score	This review reports the rate of successful return to work (RTW) for younger stroke survivors with aphasia. Nine studies were identified (aphasia N=415, total N=1612).	Younger survivors with aphasia were less likely to return to work post stroke than those without. The average rate of successful RTW for young survivors with aphasia was 28.4% compared to 44.7% for all young stroke survivors.
Hackett et al. (2012) Australia No Score	A prospective cohort study, with data from 271 stroke survivors (72% male; mean age 51 ± 10 years) who were in full-time or part-time paid employment immediately before stroke. First ever stroke survivors (N=109) were matched by age, sex, and functional impairment with injured individuals (N=429).	75% of patients returned to part-time or full-time paid work during the first year. Key variables identifying those most likely to return to work within 12 months following stroke included independent ADLs at 28 days after stroke, having health insurance, age (younger), male, and female without prior activity restricting illness.
Peters et al. (2013) Nigeria No Score	A Prospective cohort study, including 101 community dwelling stroke survivors (56% male; mean age of 47.2 ±12.3 years) who had been in paid employment before their stroke and not suffering from any clinically diagnosed ailment that limits their ability to work.	More than half (55%) of patients returned to work after the stroke event. Overall, functional status (no significant disability or mild disability) and post-stroke duration (3-12 months) were significant predictors of return to work.
McAllister et al. (2013) New Zealand No Score	A comparative cohort study, between people unable to work (on no-fault Accident Compensation Corporation) due to stroke versus another illness.	The odds of returning to work were significantly lower for participants in the stroke group compared to the injury group. The odds were still reduced when taking into account possible confounding factor (e.g., cognitive impairment) and 'Low' or 'High' personal income at baseline.

Discussion

Several factors have been identified as significant predictors of return to work for stroke survivors such as age, sex, functional status, absence of psychiatric illness, and education level (Bergmann et al. 1991; Glozier et al. 2008; Howard et al. 1985; Peters et al. 2013). Howard et al. (1985) reported that age, occupation, degree of disability, race, and lesion location were significant factors influencing return to work potential. They also found that those in managerial positions were most likely to return to work. Similarly, Saeki et al. (Saeki et al. 1993; 2010) reported that stroke survivors were more likely to return to work if they had limited residual muscle weakness, no apraxia, and white collar occupations. Adaptations made during ones return to work include a reduction in the number and/or complexity of tasks performed, and changes to the work schedule (Black-Schaffer & Osberg 1990; Hackett et al. 2012). Black-Schaffer and Lemieux (1994) found that of the 35 young stroke patients who returned to work

post-stroke, most went back to secretarial/clerical (15 patients) or professional/technical (17 patients) positions. They attributed the higher success rate for white collar positions to better education, work conditions, pay and less physically demanding tasks. The same authors also noted that these jobs were also more attractive, that workers had more work autonomy, and that fellow coworkers were more likely to accommodate the individual's acquired disability at work (Black-Schaffer & Lemieux 1994).

The side of hemiplegia or weakness has not been consistently associated with the ability to return to work in young stroke patients (Black-Schaffer & Osberg 1990; Heinemann et al. 1987; Howard et al. 1985; Kotila et al. 1984; Weisbroth et al. 1971). Weisbroth et al. (1971) found that among left hemiplegics, those with better upper extremity use, ambulation, and abstract reasoning were more likely to return to work. Right hemiplegics with milder communication and cognitive deficits also had better vocational outcomes. A distinct negative correlation between aphasia and return to work has also been demonstrated (Black-Schaffer & Osberg 1990).

Cognitive deficits following a stroke are recognized as an important factor in determining return to work. Unfortunately, many of these cognitive deficits are subtle or not readily apparent on general examination (Black-Schaffer & Lemieux 1994). In such cases, neuropsychological testing may be required in order to accurately delineate the extent of cognitive problems and determine how they might impact the patient's eventual return to work (Lindberg et al. 1992; Ljunggren et al. 1985). Memory deficits, indifference, anosognosia, depression, emotional lability and aphasia have been shown to reduce the likelihood of returning to work post stroke (Graham et al. 2011).

Other studies have shown that stroke survivors tend to not return to their previous employment (Brooks et al. 1987; Coughlan & Humphrey 1982; Howard et al. 1985; Isaacs et al. 1976). Recently, Glozier et al. (2008) found that 53% of young stoke patients returned to full-time employment after their first stroke event. The inability to return to work frequently leads to emotional and financial hardships for stroke survivors and their families (Churchill 1993). To address this issue, The Stroke Association & Different Strokes published Getting Back to Work after Stroke (Barker 2006). Their recommendations for assisting young stroke patients return to work are detailed in Table 22.8.2.

Table 22.8.2 Summary of *Getting Back to Work after Stroke* (Barker 2006)

Prospective Goals
• Full implementation of the proposals in the National Service Framework for long-term conditions for local rehabilitation services and specialist vocational rehabilitation services. • More early supported discharge services in hospitals to help support stroke survivors in getting back home and into the community. • More take-up by Primary Care Trusts and local authorities of the support services offered by voluntary organizations. • Access to a comprehensive rehabilitation service that is staffed by a multidisciplinary team including physiotherapists, occupational therapists, speech and language therapists, and psychologists.
Recommendations
• Health and social care professionals have more education on the impact of stroke on people of working age and the subsequent needs of this group. • Greater coordination and integration between health and social services and other agencies in the planning and delivery of services. • Personalized care plans that aim to get the stroke survivor fit for work should be in place before the stroke survivor leaves the hospital. • Rehabilitation should go further than a minimal functional level and continue as long as it is benefiting the stroke survivor. • Rehabilitation should provide more emotional and psychological support.

- Stroke survivors and their families are to be informed of all the support that is available to them, both statutory and voluntary.
- Rehabilitation staff should be designated to deal with vocational/work related issues.
- There should be greater liaison between health/social care professionals and employers.
- There should be more vocational rehabilitation services specifically designed to meet the needs of people with long-term neurological conditions.

Conclusions Regarding Return to Work for Young Stroke Patients

Vocational issues are important for young stroke patients.

Work-related outcomes post-stroke are influenced by educational level, hemiplegia, cognitive deficits, and functional performance.

Reported rates of return to work one year post-stroke range from 7% to 75%.

Vocational issues are often neglected in young stroke patient rehabilitation.

Vocational issues in young stroke patients are influenced by education, job type, and stroke severity.

22.9 Future Needs

The unique needs of young survivors post-stroke are understudied (Dixon et al. 2007). Differences in a young patient's life situation compared to their older cohorts would assume greater focus should be given to psychosocial issues (Teasell et al. 2000). The impact that the stroke has had on a young individual may not be as obvious. This invisible disability can lead to both subtle and major social issues, including post-stroke patients doubting the validity of their own disability (Stone 2005). Employers and professionals within the community should try to focus on meeting the needs of stroke survivors and their families in order to facilitate participation and independence for stroke patients (Kersten et al. 2002). Table 22.9 presents several studies which investigated the future needs of young stroke patients.

Table 22.9 Studies Evaluating Future Needs for Young Stroke Patients

Author, Year Country PEDro Score	Methods	Outcomes
Röding et al. (2003) Sweden No Score	Qualitative interviews from 2 women and 3 men, ages 37-54, who suffered from a stroke.	Fatigue interfered with the ability to participate in daily activities. Informants reported a lack of participation during their hospital stay and rehabilitation program. They felt as though they were walking alongside the process. The patients wanted more information regarding what rehabilitation was supposed to accomplish. They also found that rehabilitation was focused on older patients. They expressed a desire to have age-adapted rehabilitation programs.

Stone (2005) Canada	22 female hemorrhagic stroke survivors, aged 19-57, were interviewed. Content was analyzed for common issues and themes.	Stroke events ranged from 3-30 years ago. Concerns were expressed regarding others view of their 'invisible disability.' Participants found it difficult to cope with society's view of stroke as an ailment of the elderly They also found that physical disabilities are more quickly understood and adapted to, than post-stroke cognitive disabilities.
Naess et al. (2005) Norway	196 patients (aged 15-49) were studied after their first stroke (mean follow-up time 6 years) for post-stroke depression (PSD), etiology, and risk factors.	PSD appeared to be a milder in young stroke patients compared with older patients. Gender had no effect on PSD. Participants with a history of depression, excessive alcohol consumption, or severe neurological deficits upon hospital admission were considered at risk for developing PSD.
Stone (2007) Canada No Score	83 narratives were drawn from a stroke survivor internet site. Content analysis was performed to determine themes.	71% of the writers were women. Majority were <48 years of age (96% of females and 79% of males). The majority of writers were <10 years post-stroke. Themes identified included symptoms, doctors and hospitals, rehabilitation and recovery, disabilities, and misc. reflections. Overall, narrators show a need to share and discuss their experiences with other survivors.
Snögren et al. (2009) Sweden	71 patients between the ages of 22 and 64 were interviewed and filled out a questionnaire to help identify disabilities following stroke. An average of 22 months had passed since stroke onset.	Only one patient had no symptoms at all, 24% had no significant disabilities, 24% had slight disability, 21% had moderate disability, 24% had moderately severe disability and one person had a severe disability.15% had impaired communication, 62% presented with muscle weakness, 40% were walking impaired and 25% had depression. The most difficult issues were activities that were physically demanding. Environmental factors seen as barriers to accomplishing tasks were sound, societal attitudes and community members.

Discussion

The improved outcomes seen by young people post-stroke often reflect less of a need for continuous primary care. However, prevention of a second stroke is necessary and treatment is similar to that of older cohorts (Hindfelt & Nilsson 1977). In a long term follow-up study, Hindfelt and Nilsson (1992) followed 74 young adults for 13-26 years post-ischemic stroke. Common health concerns included post-apoplectic epilepsy (12.9%), depression (11.3%), muscular pain (9.6%), back pain (8.1%), and HTN (8.1%). Further, a long-term follow up study by Naess et al. (2004) found young stroke patients had a high number of modifiable risk factors and highlighted the need for increased efforts towards secondary prevention.

Post-stroke fatigue (PSF) is known to be related with higher mortality rates, depression, and lower functional outcomes in older patients (Naess et al. 2005). In young survivors, PSF is relatively unstudied. Naess et al. (2005) suggests that PSF in young adults can negatively affect scholastic, vocational, and social pursuits. Patients with PSF were independently associated with unfavourable functional outcomes and unemployment at follow-up (mean: 6 years).

In addition to fatigue, depression can occur post-stroke. Research has shown post-stroke depression (PSD) to be present in 26.9% of patients aged 15-44 (Naess et al. 2005). In addition, compared to older cohorts, there were no differences in incidence of depression but rather in severity (Naess et al. 2005). Mild depression was found in 25.0% of patients, compared to 15% in older post-stroke patients. Alcoholism, pre-stroke depressive symptoms, and severe neurological deficits upon admission were associated with a higher risk of PSD (Naess et al. 2005). Overall, no association was found between gender and PSD or between PSD and loss of employment (Naess et al. 2005). See chapter 18: Post-Stroke Depression.

A stroke and the rehabilitation process are consistently acknowledged as traumatic events (Dixon et al. 2007; Röding et al. 2003; Stone 2005). Post-rehabilitation, young stroke patients are interested in connecting with others who share similar experiences (Stone 2007). In a series of qualitative studies, it was reported that young stroke survivors required time to come to terms with having a stroke. They also required time to cope with changed physical abilities, work, family, and social life (Stone 2005, 2007).

Conclusions Regarding Future Needs of Younger Stroke Patients

Future health concerns in young post-stroke populations are luckily minimal. Young patients need to be aware of possible long-term health consequences.

Post-stroke depression and post-stroke fatigue can occur in young patients. Young survivors need access to age and stage related treatments.

Young stroke patients need to be connected with support organizations and those who share similar experiences.

Young patients post-stroke have unique psychosocial and supportive needs rather than specific health concerns.

22.10 Summary

1. ***The incidence of stroke in young patients is significantly less than in older patients.***
2. ***The incidence rate of young stroke patients varies considerably due to different age ranges, races and population denominations surveyed.***
3. ***Up to one third of strokes in young people are of unknown etiology. However, as diagnostic methods improve this proportion is decreasing.***
4. ***The most common causes for hemorrhagic stroke in young patients include hypertension, arteriovenous malformation, ruptured aneurysm, or a combination of these factors.***
5. ***The majority of strokes in young patients is Ischemic. Cardiac embolism is a frequent cause for patients younger than 40, while advanced atherosclerosis is a common etiology in patients aged 40-49.***
6. ***Uncommon etiology is likely in stroke patients under 30. Many uncommon etiologies are recognized risk factors for stroke in young patients.***
7. ***Smoking is a significant risk factor for stroke in young individuals.***
8. ***Alcohol-related stroke events in young patients are relative to the amount consumed. 1-2 alcoholic beverages daily reduces the risk of ischemic stroke.***
9. ***Drug use is an uncommon risk factor for stroke in the young population. Drug abuse and cocaine can cause both ischemic stroke and hemorrhage in young people.***
10. ***Oral contraceptives play a minor role in stroke risk when paired with other factors. Low-dose oral contraceptives do not appear to be an independent risk factor for stroke in young people.***
11. ***Hyperlipidemia, diabetes mellitus, elevated plasma homocysteine level and dietary patterns are stroke risk factors particularly for those aged >35.***
12. ***Migraine is a risk factor for young stroke. Young women in particular are at an elevated risk.***
13. ***Further study is required to determine the validity of Chlamydia pneumoniae as a risk factor for young stroke.***
14. ***Hypertension is a common risk factor for young stroke.***
15. ***The significance of family history as a risk factor for stroke and patent foramen ovale in young populations is unclear.***

16. ***Previous stroke in young patients is less common than in older patients.***

17. ***Mitral valve prolapse appears to be a minimal risk factor and an infrequent sole etiology in young stroke events.***

18. ***Pregnancy and postpartum state are unique periods of elevated stroke risk in young females. This is likely due to elevated blood pressure.***

19. ***Race appears an important risk factor for stroke in young populations. Risk appears to be elevated particularly for young black patients.***

20. ***Young males appear to be more likely to experience a stroke then young females.***

21. ***Young stroke patients make better neurological recoveries with less disability.***

22. ***Rehabilitation of young stroke patients is similar to the rehabilitation of older stroke patients with the main differences being the nature of neurological recovery and associated social issues.***

23. ***Stroke rehabilitation programs should be aware of age-related needs.***

24. ***Young stroke patients tend to achieve higher levels of functional recovery and independence than elderly stroke patients. This improved outcome commonly puts less stress on caregivers and close relations.***

25. ***Children's previous behaviours are more a predictor of adjustment issues post-stroke, rather than the stroke event itself.***

26. ***Institutionalization is required infrequently in young stroke patients as a result of better prognosis and greater availability of caregivers.***

27. ***Vocational issues are important for young stroke patients.***

28. ***Work-related outcomes post-stroke are influenced by educational level, hemiplegia, cognitive deficits, and functional performance.***

29. ***Future health concerns in young post-stroke populations are luckily minimal. Young patients need to be aware of possible long-term health consequences.***

30. ***Post-stroke depression and post-stroke fatigue can occur in young patients. Young survivors need access to age and stage related treatments.***

31. ***Young stroke patients need to be connected with support organizations and those who share similar experiences.***

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