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Primary intracerebral haemorrhage in the Jyväskylä region, Central Finland, 1985-89: incidence, case fatality rate, and functional outcome

R Fogelholm, M Nuutila, A-L Vuorela

Abstract

The age and sex specific incidence rates, the case fatality rates, and the functional outcome of patients with primary intracerebral haemorrhage occurring in a population of 116 000 during a period of four years four months are presented. A total of 158 patients were identified, the diagnosis was confirmed in 78% by CT, and in 22% by necropsy. The crude annual incidence rate was 31/100 000 population, the age specific rates increased from two to 222/ 100 000 from the age of 30–39 to over 80 years. Men had higher incidence rates between the ages of 40 and 79 years. The short term case fatality rate was high, 27% of patients dying during the first day after onset of symptoms, and 50% were dead at 30 days. After the first month the probability of survival did not differ from an age- and sex-matched average population. Large haematoma volume had an adverse effect on the short term, old age (> 70 years) on the long term survival. Ventricular extension, especially when combined with hydrocephalus was a bad omen for short term survival. Infratentorial and large basal ganglionic haematomas, and primary intraventricular haemorrhage carried a worse prognosis than haematomas of other locations. At the end of a median 32 month follow up 55 (35%) of the patients were alive, 51% of these were independent in activities of daily living, 45% were dependent on outside help, and 4% needed constant nursing care. Old age (> 70 years), but not the haematoma volume or location, was associated with a poor functional recovery.

Department of Neurology, Central Hospital of Central Finland, Jyväskylä, Finland
R Fogelholm

Provincial Office of Central Finland, Jyväskylä, Finland
M Nuutila

Department of Radiology, Central Hospital of Central Finland, Jyväskylä, Finland
A-L Vuorela

Correspondence to:
Dr Fogelholm, Department of Neurology, Central Hospital of Central Finland, 40620 Jyväskylä, Finland.

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The main interest of numerous epidemiological studies on stroke has been in ischaemic cerebrovascular disease, and haemorrhagic strokes, but scant attention has been given to primary intracerebral haemorrhage (PICH). Most of these studies pre-date CT. During the past decade CT has been increasingly applied in these studies and reliable data on the different pathological entities have been obtained.[1–9] The annual incidence rates of PICH have generally been from 11 to 20 per 100 000 population, and the diagnosis of PICH has been confirmed by CT in 37%–100% of the cases. The number of patients in most of these studies has, however, been too small to warrant firm conclusions regarding the case fatality rate and the functional outcome.

Since 1985 CT has been available in the Central Hospital of Central Finland and it has been included in the routine examination of stroke patients. On the other hand, because virtually all acute stroke patients from Jyväskylä and the surrounding communes, the Jyväskylä Region, are admitted to the Central Hospital, an epidemiological study on PICH seemed feasible. To make the study as comprehensive as possible, patients with the diagnosis made by necropsy were also included.

Patients and methods

The study included a population of 116 033 living in the Jyväskylä Region (figure 1). The age and sex distribution of the study population 31 December 1987 is shown in table 1 (Central Statistical Office of Finland). The study population was slightly younger than the Finnish population, the proportions of people aged 65 years or older were 11·5% and 12·9%, respectively.

The primary health care in Central Finland is provided by the Health Centres of the 32 communes, which have joined to form 11 larger Health Centre Districts. Because of a shortage of beds the Health Centres in the Jyväskylä Region send nearly all acute strokes to the Central Hospital. A survey performed in 1986 revealed that 92% of acute strokes occurring in this population were admitted to the Central Hospital, 2% died before arrival, and only 6% were treated in their Health Centres. After 1986 there has been no change in this situation.

Since 1982 nearly all stroke patients admitted to the Central Hospital were treated in the Department of Neurology. The exceptions are those patients with serious cardiac or metabolic problems who are first treated in the Department of Medicine. CT has been available since August 1985 in the hospital and this has enabled confirmation of pathological lesions causing stroke. The aim has been to perform CT on all acute stroke patients, preferably within the first few days after onset of symptoms. In 1989 90% of all stroke patients were examined with CT, and an additional 2–3% were diagnosed at necropsy.

This study included all PICH patients who were: a) permanently living in the Jyväskylä Region; b) for whom the onset of ICH occurred during the study period from 1 September 1985 to 31 December 1989, and c) in whom the diagnosis was confirmed by CT and/or necropsy. We excluded patients with traumatic haematomas as well as those with

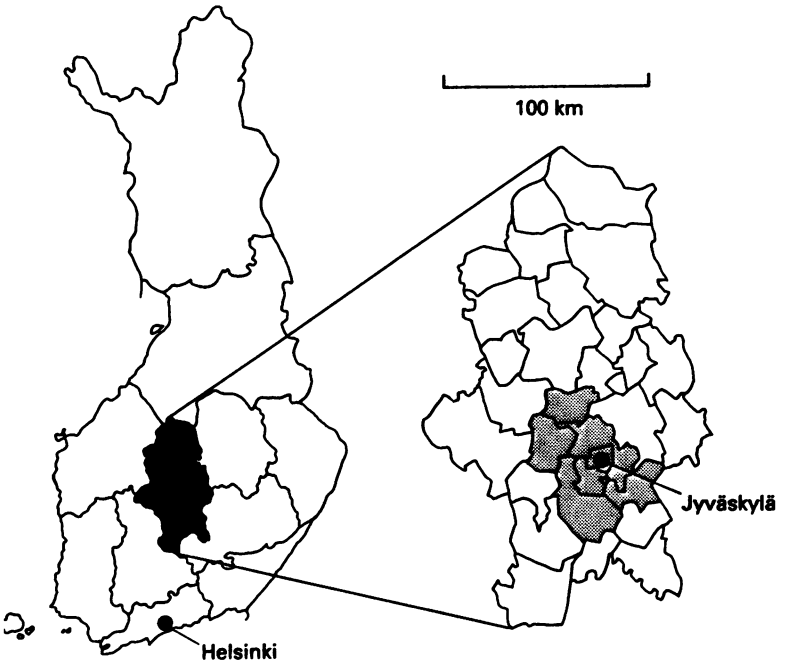

Figure 1 Map of Central Finland. The communes included in the Jyväskylä Region are hatched.

arterio-venous malformation, arterial aneurysm or neoplasm as the source of bleeding.

The patients in the present study were traced from: a) the files of the Department of Neurology; b) the discharge lists of the Central Hospital, the Health Centres of the Jyväskylä Region, and the Department of Neurosurgery, University of Kuopio, which is responsible for the neurosurgical treatment of our patients; c) the lists of death certificates of Central Finland; d) the necropsy reports of the Department of Pathology, and e) the medico-legal necropsies of Central Finland. The medical records (the Central Hospital and the Health Centres) of all patients with the diagnosis of ICH (ICD-8,ICD-9 code 431) were reviewed and from these relevant data were collected.

The patients were followed up to 31 August 1990. At the end of follow up all patients who had been discharged alive were contacted by telephone—in case of severe handicap or death the carer or a near relative was interviewed. Missing data concerning earlier health and living habits were completed, the possible occurrence of new strokes and the degree of independence in activities of daily living (ADL) was assessed applying the Rankin grading method.[10 11] The best functional grade achieved in ADL was also assessed in case of hospital death, provided the patient survived for 10 days or longer. In addition to the telephone interview, the medical records of all survivors were assessed to confirm the presence or absence, and pathology of recurrent strokes. The cause of death was determined on the basis of the death certificates and all relevant data in the hospital and necropsy records.

Table 1 The population of Jyväskylä and the surrounding communes 31 December 1987

Age (years)	*Men*	*Women*	*Total*
0–29	24 921	23 941	48 862
30–39	10 355	10 087	20 442
40–49	8 175	8 165	16 340
50–59	5 488	6 059	11 547
60–69	4 073	5 938	10 011
70–79	2 308	4 231	6 539
80+	646	1 646	2 292
Total	55 966	60 067	116 033

The CT scans were checked and the haematomas were located using the CT atlas of Kretschmann and Weinrich.[12] Large haematomas were classified according to the lobe most affected. In the region of the basal ganglia (when the origin of the bleed could not be identified) they were named "basal ganglia" haematoma. The same principles were applied in haematomas diagnosed at necropsy. Carotid angiography was used to exclude bleeds from an arterial aneurysm in the frontal and temporal lobe haematomas adjacent to the interhaemispheric or the Sylvian fissure.

The haematoma volumes were calculated by a computer program. The area of the haematoma was measured planimetrically and it was multiplied by the thickness of the corresponding slice. The total volume was calculated by summing these subvolumes. The shift of the midline structures, pineal body and/or the third ventricle, was measured, and the presence of intraventricular blood and hydrocephalic dilatation of the cerebral ventricles was recorded.

The confidence intervals for incidence rates were calculated using the Schoenberg tables,[13] for medians according to Campbell and Gardner,[14] and for proportions according to Gardner and Altman.[15] Life-tables were constructed as described by Colton.[16] The crude incidence rates were adjusted to the age distribution of the Finnish population 1980[17] by the direct method.[16] The chi-square test was applied in the comparison of proportions, and the *t* test in the comparison of means.

Results

During the study period 1 September 1985 to 31 December 1989 a total of 158 patients resident in the Jyväskylä Region were traced (table 2). The diagnosis was confirmed in 123 patients with CT, and in the other 35 by necropsy (fig 2), a total of 31 of the patients having both CT and necropsy. Eight (5% of all patients) of the 35 patients with necropsy confirmation were found dead and had a medico-legal autopsy. The time interval between onset of symptoms and admission to the emergency room of the Central Hospital was short, the median delay was 2 hours, and 75% were admitted within 6 hours. Cerebral CT was performed within the first 24 hours after onset in 43%, and within 72 hours in 90% of cases. The distribution of the location of the haematomas is shown in table 3.

The prevalence of various cardiovascular diseases was as follows: hypertension 46%, coronary heart disease 22%, atrial fibrillation 20%, and ischaemic brain infarction 17%. Twenty six (16%) of the patients were on anticoagulation at the onset of PICH.

Table 2 Age and sex distribution of the patients

Sex	Age 30–39	40–49	50–59	60–69	70–79	80+	Total
Men	1	11	12	19	32	3	78
Women	1	3	8	21	28	19	80
Total	2	14	20	40	60	22	158

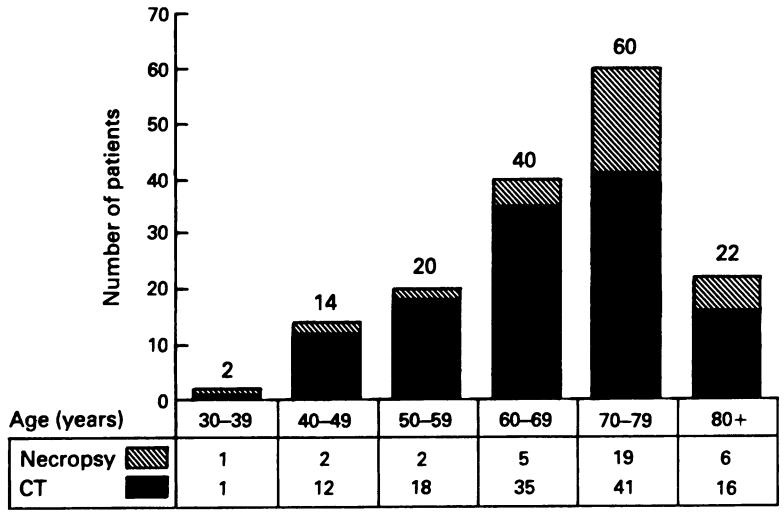

Figure 2 Numbers of patients with the diagnosis confirmed by either CT or necropsy, by age.

The crude incidence rate was 31/100 000/year, the age and sex specific annual incidence rates per 100 000 population are shown in table 4. The rate increased steeply by age, from 2/100 000 in the age 30–39 years to 222/100 000 over the age of 80 years. The incidence rates for men were higher between the ages 40–79 years, but the 95% confidence intervals were overlapping, though only marginally in the age group 70–79 years.

All except eleven patients, including 8 lobar and 1 cerebellar haematomas who had neurosurgical evacuation of the clot, had medical treatment. At the end of a median 32 month follow up, range 8 to 60 months, 103 (65%) of the 158 patients had died, and of these 66 (64%) had necropsy. The death rate immediately after onset of ICH was extremely high with 27% of the patients dying within 24 hours, and 50% were dead at 30 days (fig 3). Life table analysis showed that the long-term prognosis up to five years for those surviving the first month was fair (fig 4) and did not differ from that of the average 1985 Finnish population.[18] Six (4%) of the patients alive 10 days or longer after the first haemorrhage had a recurrent ICH diagnosed by CT or necropsy, and another five had recurrent ischaemic or non-defined acute stroke. The recurrent ICHs occurred from 36 to 1210 days (median 304 days) after the first bleed.

Table 3 Location of the haematomas

Location	No of patients (%)	
Lobar		53 (34)
frontal	13	
temporal	19	
parietal	14	
occipital	7	
Basal ganglionic		68 (43)
caudate nucleus	3	
putamen/pallidum	11	
thalamus	28	
internal/external capsule	9	
"basal ganglia"	17	
Cerebellum and brain stem		28 (18)
cerebellum	17	
brain stem	11	
Intraventricular		9 (5)
Total		158 (100)

Eighty three (81%) of all 103 deaths were due to the first ICH and 84% of these occurred during the first week after onset, and an additional 4 (4%) patients died of a recurrence. Heart disease, pneumonia and recurrent ischaemic or non-defined stroke were the cause of death in 12 (12%) cases, and four patients died from miscellaneous causes. Age had no impact on the case fatality rate during the first month after onset but younger patients had a better long-term prognosis; 45% of patients younger than 70 years, 27% of those aged 70–79 years, and 23% of the patients older than 80 years were alive at the end of follow up.

The cumulative frequencies of the volumes of supratentorial haematomas are shown in fig 5. The curves of patients dead or alive at the end of follow up overlap up to 20 ml which is explained by the small haematomas of patients dying from causes other than PICH; 15 out of 18 had haematomas < 20 ml. The volume distribution of patients dying of PICH was markedly different from that of survivors, and the difference was further exaggerated when the deaths during 30 days, and especially 7 days after onset were analysed separately. The median volumes of the patient groups were as follows: survivors 23 ml (95% CI 13–37 ml), ICH deaths 63 ml (95% CI 50–76 ml), deaths within 30 days 69 ml (95% CI 50–80 ml), and within 7 days 74 ml (95% CI 56–86 ml).

The 30 day case fatality rate was strongly associated with the supratentorial haematoma volume ($X^2 = 26{\cdot}2$ df = 5 $p < 0{\cdot}0005$), and no critical haematoma volume was observed (fig 6). Sixteen per cent (95% CI 6–26%) of patients with haematomas smaller than 20 ml died, the corresponding figure was 82% (95% CI 60-100%) for patients with haematomas larger than 100 ml. The number of infratentorial haematomas with CT examination was only 16 and this precludes detailed analysis. However, there was a clear difference between those dying within 30 days, and those surviving for longer—the median volumes being 18·5 ml (95% CI 15–28 ml) and 2 ml (95% CI 1–8 ml), respectively.

The displacement of midline structures in supratentorial haematomas measured from the CTs was 8·8 mm (SE 0·8) in patients dying within 30 days, and 2·4 mm (SE 0·3) in those surviving for longer than 30 days, a highly significant difference ($t = 8{\cdot}3$ df = 102 $p < 0{\cdot}0001$). The displacement was, however, strongly correlated with haematoma size ($r = 0{\cdot}73$ $p < 0{\cdot}0001$), thus reflecting the adverse prognostic effect of large haematomas. Ventricular extension and hydrocephalus were coded as present or absent without any quantification. In the 104 supratentorial haematomas the 30 day case fatality rate was 11% if neither

Table 4 Age and sex specific annual incidence rates (95% confidence interval) per 100 000 population of primary intracerebral haemorrhage in Jyväskylä and surrounding communities, Central Finland, 1985–89

	Men		Women		Total	
Age	N	Rate	N	Rate	N	Rate
-39	1	2 (0-12)	1	2 (0-13)	2	2 (0-8)
40-49	11	31 (16-56)	3	9 (2-25)	14	20 (11-33)
50-59	12	51 (26-88)	8	31 (13-60)	20	40 (24-62)
60-69	19	108 (65-168)	21	82 (51-125)	40	92 (66-125)
70-79	32	320 (219-451)	28	153 (102-221)	60	212 (162-273)
80+	3	107 (22-317)	19	266 (158-421)	22	222 (137-339)
Total	78	32 (25-40)	80	31 (24-38)	158	31 (27-37)

was present, 36% in cases of ventricular extension, and 78% when both ventricular extension and hydrocephalus were present. This trend was highly significant (chi-square = 33·0 df = 2 $p < 0·0005$). The median volumes of the haematomas of patients dying within 30 days with either ventricular extension alone or combined with hydrocephalus was twice the size of patients without these signs on CT (table 5). Conversely, those surviving for more than 30 days had small haematoma volumes (10 to 19 ml) in all three patient categories, which again stresses the importance of the haematoma volume as a decisive factor of the prognosis.

The case fatality rate, all patients included, varied according to the location of the haematoma and the proportions of deaths during the first 30 days was as follows: lobar 43% (23/53), deep basal ganglionic 47% (32/68), cerebellum and brain stem 64% (18/28), and primary intraventricular 78% (7/9). The difference between supratentorial, infratentorial and primary intraventricular haemorrhage was statistically significant (chi-square = 6·0 df = 2 $p < 0·05$).

At the end of the follow up 55 patients were still alive. Twenty eight (51%) of them were independent in the ADL (Rankin grades 1 and 2), 25 (45%) were in need of outside help (Rankin grades 3 and 4), and 2 (4%) were in institutions for the chronically ill needing constant nursing care (Rankin grade 5). The functional outcome of all patients surviving for 10 days or longer was age-dependent (fig 7), the proportion of patients needing outside help in the ADL (Rankin grades 3–5) was much higher in the oldest age group than in the younger (chi-square= 18·8 $p < 0·0005$).

At the end of the follow up most of the severely handicapped patients had died but the adverse effect of old age was obvious (chi-square = 10·0 $p < 0·005$). Neither the location nor the volume of the haematoma had any predictive value on the functional recovery. Figure 8 depicts a summary of the fate of all 158 patients included in the study during the follow up of median 32 months.

Discussion

There are not many population based studies on PICH with CT or necropsy confirmation in a large proportion of the cases. The most important non-oriental studies[1-9] with more than twenty patients are given in table 6. The crude annual incidence rates have varied between 11–20/100 000 population, with one exception from Söderhamn, Sweden,[4] giving a rate of 38/100 000 population. The low incidence rates in two studies[7 8] may be explained by incomplete case ascertainment, for example, patients treated by neurosurgeons were not included, and the high rate from Söderhamn may be due to the older age structure of the study population. To make the incidence rates comparable, five of the earlier studies where the data were available[1 2 4 6 9] were adjusted by age to the 1980 population of Finland. In two of the studies the rates changed markedly reflecting the young[2] and older[4] age structure of the study population. After the adjustment the incidence rate 32/100 000 of our study was the highest, but the 95% confidence interval (27-37/100 000) overlapped with those of the Libyan[2] and Söderhamn[4] studies, 18–31/100 000 and

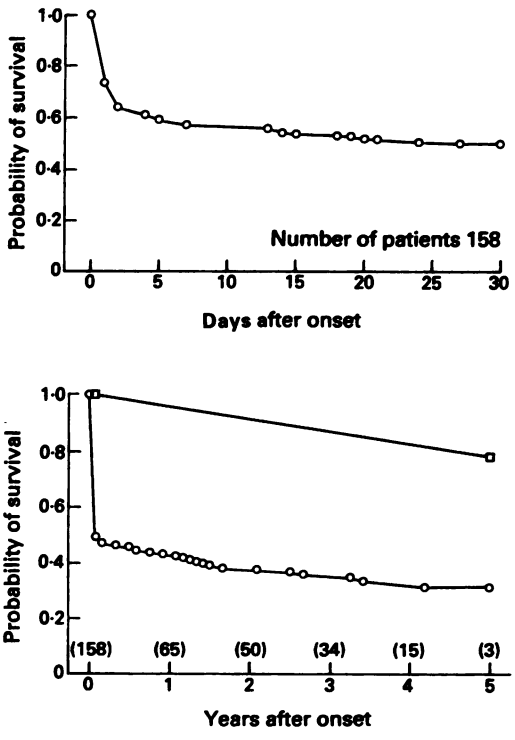

Figure 3 Probability of surviving the first 30 days after onset of primary intracerebral haemorrhage.

Figure 4 Probability of surviving five years after onset of primary intracerebral haemorrhage. Life table analysis, number of patients in brackets. The upper curve represents an average Finnish population of same age and sex distribution.

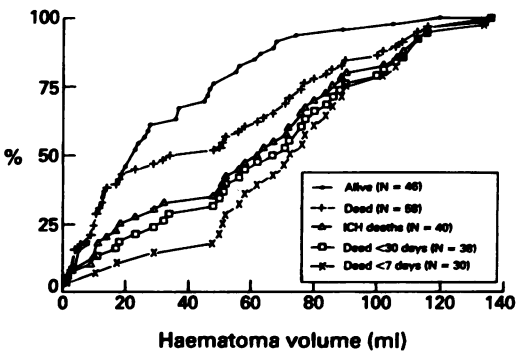

Figure 5 Cumulative distribution of supratentorial haematoma volumes of patients alive at the end of follow up, dead of any cause, and dead due to primary intracerebral haemorrhage. Of the latter, the deaths within 30 and seven days are separated.

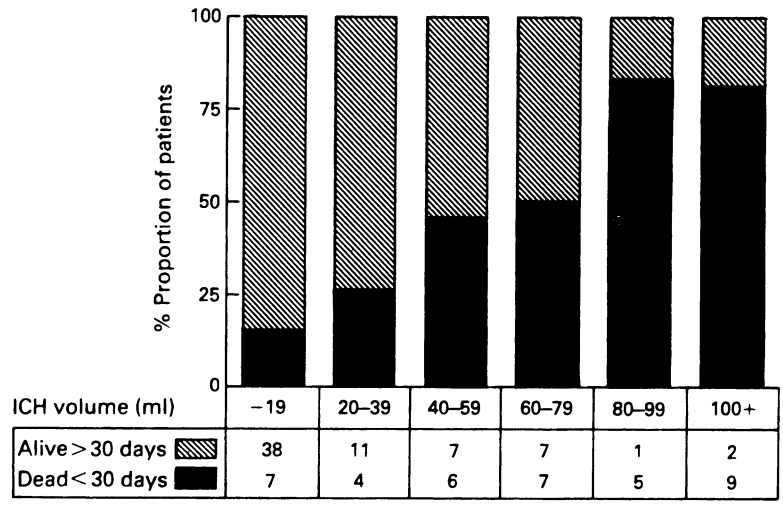

Figure 6 Proportion of patients dead within the first 30 days of onset, by supratentorial haematoma volume.

Table 5 Median volumes (ml) of supratentorial haematomas, by intraventricular extension, presence of hydrocephalus, and survival

	Dead < = 30 days			Alive > 30 days		
	N	Median	(95% CI)	N	Median	(95% CI)
ivblood hydrocephalus	5	34 ml		40	14 ml	(10–24 ml)
ivblood + hydrocephalus	11	67 ml	(58–89 ml)	20	19 ml	(12–56 ml)
ivblood + hydrocephalus +	21	71 ml	(48–113 ml)	6	10 ml	(4–46 ml)

ivblood = intraventricular extension
95% CI = 95% confidence interval

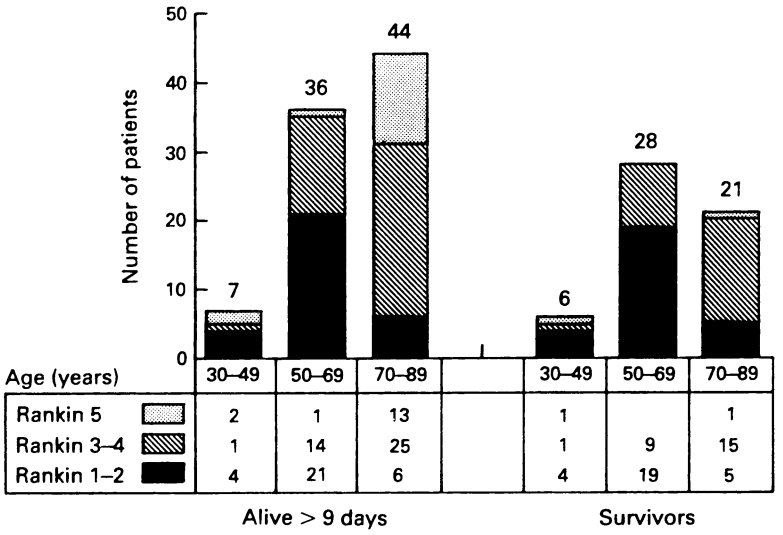

Figure 7 Distribution of the functional status of patients alive 10 days or longer after onset of symptoms, and of those alive at the end of median 32 month follow up, by age. Rankin 1–2 = independent, Rankin 3–4 = needs some outside help in the ADL, Rankin 5 = needs continuous nursing care.

18–36/100 000 respectively. Thus the high incidence rate obtained from the Jyväskylä Region does not mean a real difference compared with the other studies and may be explained by a more detailed case finding which resulted from the tradition in Finland to treat all strokes in hospital; the high (92%) admission rate from the Jyväskylä Region to the Department of Neurology (almost all stroke patients admitted had a CT); and the access to all medical and medico-legal necropsy records of the study population.

The medico-legal necropsies revealed that 5% of the patients died a sudden death which constitutes an important aspect of PICH as it occurs in the population. The high incidence rate in this study may be an underestimate because there may have been some PICH patients who did not have CT or necropsy. However, some patients with secondary, intra-infarct haematomas[19] may be included in the study. We did not see such cases, perhaps because the CT examinations were seldom performed during the first few hours after onset of symptoms, and the examination was only occasionally repeated in spite of worsening of symptoms in case the initial CT was normal or suggested brain infarction. We believe that such secondary haematomas in ischaemic brain infarctions must be rare, which seems to be the case in the Stroke Data Bank with less than 1% of PICHs having a normal first CT and an ICH in repeat examination.[20]

The early case fatality rate (CFR) was high with 27% dying during the first day, and 50% (95% CI 42–58%) dying within 30 days (fig 3), almost exclusively due to the first PICH. In earlier population based studies[2 5 7 9 21] the 30 day (one study 21 days) CFRs have varied between 25% and 72%, with a weighted mean of 48% (95% CI 42–54%), which corresponds well with our results. In studies based on hospital materials[20 22 28] CFRs have been from 27%–54% with a weighted mean of 35% (95% CI 32–38%). In three of the studies the data were given for days 14, 16 and 60. The figures from hospital based studies are much lower than ours and may be explained by the numerous cases diagnosed by necropsy included in our study.

The most important determinant of death during the first 30 days in our study was haematoma volume, concerning both supra- and infratentorial haematomas. The same has been shown in earlier studies[8 22 24 26 34] regardless of method used in assessment of the volume. The method we used gives a fairly reliable quantitative measure of the volume, and we found that the risk of early death increased almost linearly with the haematoma volume. Because the measurement was based on one single examination, the possibility of a later increase of the volume,[35 36] may distort the results. The resolving of the haematomas[37] was not a problem due to the early timing of the CT examination.

The lateral shift of the midline structures in supratentorial haematomas correlated closely with the haematoma volume and does not have any predictive value in itself. Ventricular extension of the haematoma tripled the early CFR, and when hydrocephalus was also present the rate was sevenfold. The haematoma volumes in these cases were, however, three times larger than in patients without these signs. The median haematoma volumes of survivors, with or without ventricular extension or hydrocephalus, were small and of similar size, between 10 ml and 20 ml. Ventricular extension has

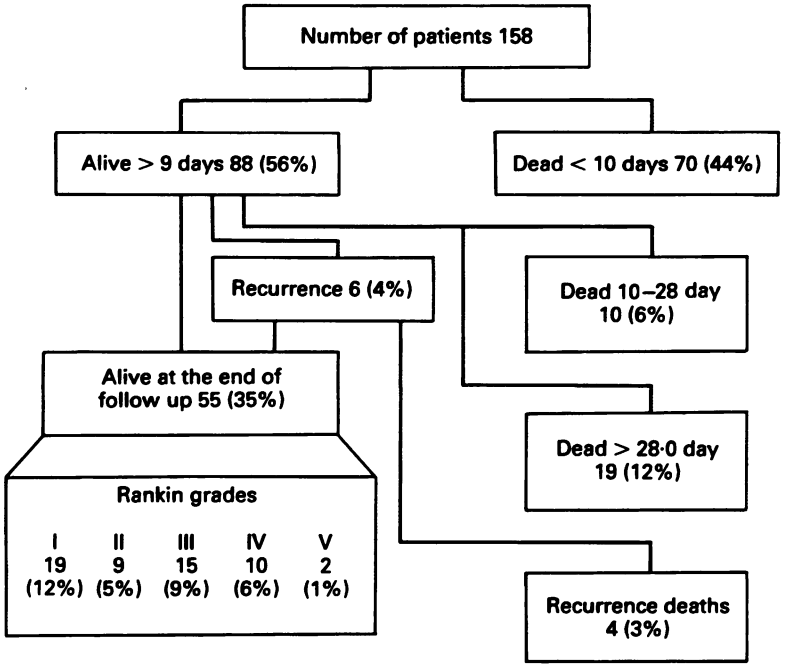

Figure 8 The fate during the median follow up of 32 months of all 158 patients included in the study. The percentages refer to the initial 158 patients.

generally been considered as an adverse prognostic sign, and several studies have demonstrated higher CFRs when ventricular blood has been present;[22 24 27–30 33 34 38] in some of the studies[27 30 38] this has been associated with large haematoma size. No generally accepted explanation of the adverse effects of ventricular extension has been proposed but we think it only reflects the large haematoma volume. The adverse effects of hydrocephalus on outcome has been observed in a few studies[33 34] but no explanation for this has been proposed. Profuse intraventricular bleed blocking the CSF circulation and causing hydrocephalus increasing the intracranial pressure which further worsens the condition seems to us plausible, although it has not been accepted as the sole explanation.[34] In our study, age had no role in predicting the CFR during the first month.

Haematoma location had some effects on the acute survival, patients with large basal ganglia haematomas, infratentorial haematomas, and primary intraventricular haemorrhages had higher CFRs than patients with haematomas of other locations.

If the patient survived the first month the probability of surviving five years was similar to an average Finnish population of the same age and sex distribution. After a mean follow up of 32 months, 35% of the patients were alive. In none of the earlier epidemiological studies has the follow up been longer than 12 months. Three of the hospital series[23 27 30] give data on 2·5 to five year survival, 21% to 60% of patients being alive. The most frequent causes of death after the first month were cardiac disease, pneumonia and recurrent strokes. Old age > 70 years was associated with a poor long term survival.

The functional outcome was assessed in patients alive 10 days or longer after onset. Old age was strongly associated with severe handicap during the first weeks and months after stroke (fig 5). During follow up the most seriously disabled patients died, and 51% of the 55 patients alive at the end of follow up were independent, 45% needed outside help in the ADL, and only 4% were in need of constant nursing care. In the Oxfordshire study[6] applying the Rankin grading system, 68% of the one year survivors were functionally independent, the corresponding figure in one hospital based study[26] with CT confirmation of the diagnosis was 75%. The difference in our results may be explained by selection factors, the most ill patients perhaps not being admitted to the highly specialised hospitals.

Our results show that PICH is more common than earlier studies have suggested. Every fourth patient is either found dead or dies within the first day, often during the first hours after onset of symptoms. Only primary preventive measures, for example, antihypertensive treatment, and the avoidance of excessive amounts of alcohol[39 40] would decrease the number of patients in this category. If the patient lives long enough to have the diagnosis confirmed medical treatment aimed at decreasing the intracranial pressure and preventing complications must be given, and surgical treatment contemplated in spite of lacking consensus about the indications.[41 42] The results of our study stress the importance of primary preventive measures but after the catastrophe has occurred, we need better therapeutic tools than those available today to improve the probability of survival, and the functional outcome of the survivors.

Table 6 Previous non-oriental studies on the incidence of spontaneous intracerebral haemorrhage. Place and years of study, study population, number of patients, annual crude and adjusted incidence rates (per 100 000 population), and percentages with CT confirmation

Place	Year	Population	No	Rate		CT (%)	Comments
				Crude	adj*		
Lehigh Valley/USA[1]	1982–83	580 000	83	18	16	?	"haemorrhagic strokes"
Benghazi/Libya[2]	1983–84	519 000	63	12	24	80	"haemorrhagic strokes"
Cincinnati/USA[3]	1982	1 400 000	131	14	—	100	whites only included
Söderhamn/Sweden[4]	1983–86	31 000	35	38	26	37	aged population
Rochester/USA[5]	1975–84	60 000	80	14	—	70	CT performed in 25–85%
Oxfordshire/UK[6]	1981–86	105 000	66	16	16	59	necropsy in 29%
Lund/Sweden[7]	1986–87	153 000	28	11	—	86	cases missing
Giessen/Germany[8]	1987	235 000	27	12	—	100	cases missing
Tilburg/Netherlands[9]	1978–80	151 000	54	18	19	56	CT + isotope scan
Present study	1985–89	116 000	158	31	32	78	necropsy in 22%

*) Adjusted to the age distribution of the Finnish 1980 population

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