

## ORIGINAL ARTICLE

# Stroke in centenarians

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**Aim:** Reports on centenarians with stroke have thus far been casuistic. We present clinical characteristics and 1-month mortality in 39 centenarians admitted to Danish hospitals with acute stroke within 2000–2010.

**Methods:** A Danish stroke registry (2000–2010) contains information about 61 935 acute stroke patients among which 39 patients were centenarians. Data included age, sex, civil and housing status, stroke severity (Scandinavian Stroke Scale [SSS], 0 worst to 58 best), computed tomography scan, cardiovascular risk factors and death within 1 month after stroke. Data in centenarians were compared with similar data in stroke patients aged 40–69 years ( $n = 25\,023$ ), 70–79 years ( $n = 16\,048$ ), 80–89 years ( $n = 16\,274$ ) and 90–99 years ( $n = 3379$ ).

**Results:** Of the 39 centenarians, 87% were women, 82% were living alone and 64% were living in their own home before the stroke. In general, the prevalence of cardiovascular risk factors was lower in centenarians, particularly with regard to previous myocardial infarction, previous stroke and diabetes mellitus. Strokes were significantly more severe (SSS 25.4), and 1-month mortality (38.5%) was significantly higher in centenarians when compared with other age groups.

**Conclusion:** Centenarians with stroke are from a cardiovascular standpoint healthier than their younger counterparts. Yet, strokes in centenarians are more severe and associated with very high mortality. *Geriatr Gerontol Int* 2013; ●●: ●●–●●.

**Keywords:** age, centenarian, mortality, risk factors, stroke.

## Introduction

The oldest-old is the fastest growing segment of the elderly population.<sup>1</sup> Because the incidence of stroke is steeply increasing with age,<sup>2</sup> the elderly are expected to constitute an increasingly large proportion of the stroke population.<sup>1</sup> Centenarian stroke patients occur only rarely in stroke units, and reports on centenarian stroke patients have thus far been casuistic.<sup>3,4</sup> By the midcentury, centenarians are expected to comprise nearly 1% of the population in the most developed countries.<sup>1</sup> Hence, in coming years, centenarians, although few in number, will not be rarities in a stroke unit.

The aim of this study was to present data on stroke severity, cardiovascular risk factor profile and 1-month mortality in centenarians admitted to Danish hospitals with acute stroke within 2000–2010, comparing these patients with patients in other age groups admitted with acute stroke in the same period.

## Methods

The present study was based on data from the Danish National Indicator Project (NIP) described in detail elsewhere.<sup>5,6</sup> All Danish hospitals are committed to reporting a predefined set of data into the NIP database on all patients admitted to hospital with acute stroke. Data include age, sex, civil status, stroke severity measured by the Scandinavian Stroke Scale (SSS),<sup>7</sup> stroke subtype and a predefined cardiovascular profile.

SSS is a validated neurological stroke scale evaluating stroke severity on a score from 0 (worst) to 58 (best).<sup>7</sup> SSS and the National Institute of Health Stroke Scale (NIHSS)<sup>8</sup> can be converted by using the equation  $SSS = 50 - 2 \times NIHSS$ .<sup>9</sup> Stroke subtype (hemorrhage/infarct) is determined after computed tomography (CT)/magnetic resonance imaging (MRI) scan. The cardiovascular risk profile includes information on: alcohol consumption ( $\leq 14/21$  or  $>14/21$  drinks per week for women and men respectively representing under/over the limit set by the Danish National Board of Health), current daily smoking, diabetes mellitus (DM), atrial fibrillation (AF; chronic or paroxysmal), arterial hypertension, previous myocardial infarction (MI), previous stroke and intermittent arterial claudication. Diagnosis

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of DM, AF, arterial hypertension, previous MI, previous stroke and intermittent arterial claudication is made following current Danish standards,<sup>6</sup> and is either known before onset of stroke or diagnosed during hospitalization. Stroke is defined according to the WHO criteria<sup>10</sup>.

Patients with transient ischemic attacks and patients aged <18 years were excluded from the study, as well as patients in whom CT/MRI scan was not carried out (0.4%) or unavailable (0.7%). Time origin for the analysis was the date of hospital admission.

Inclusion started on 8 May 2000 and ended on 20 June 2010. Information of death was obtained through the Danish Central Person Registry, with information on vital status, including date of death within 1 month (30 days) or emigration. Less than 0.2% of the patients were lost to follow up. NIP registry coverage was by professional consensus estimated to be at least 80% of all stroke admissions in Denmark.<sup>11</sup> A very high proportion of stroke patients are admitted to hospital (90%) in Denmark.<sup>2</sup>

Among 61 935 acute stroke patients registered in the NIP database, just 39 were centenarians. Because of this limitation in statistical power, only stroke severity (*t*-test) and 1-month mortality ( $\chi^2$ -test) were evaluated statistically.

The study was approved by the board of the Danish National Indicator Project and the Danish Data Protection Agency.

## Results

Of the 61 935 acute stroke patients registered in the NIP database, 39 (0.06%) were centenarians (age range 100–107 years). Table 1 shows cardiovascular risk factors and demographics of the centenarians in comparison with the NIP stroke population stratified into age groups (40–69, 70–79, 80–89 and 90–99 years).

Of the centenarians, 87% were women, 82% were living alone and 64% were living in their own home before the stroke. The prevalence of cardiovascular risk factors generally appeared to be lower in centenarians, particularly with regard to myocardial infarction, previous stroke and diabetes. The prevalence of intermittent arterial claudication, smoking and alcohol consumption were also quite low among centenarian stroke patients, but the validity of the data was hampered by large amount of missing information. Nearly half of the centenarian stroke patients had hypertension.

Strokes were significantly more severe in centenarians (mean SSS 25.4; Fig. 1;  $P < 0.05$ ). The 1-month case fatality was also significantly higher in the centenarians (38.5%; Fig. 2;  $P < 0.05$ ).

## Discussion

Centenarians with stroke were characterized by a strikingly better cardiovascular risk factor profile than any other age groups in the NIP cohort. They were usually women, living alone and two-thirds were living in their own home before the stroke. Strokes were severe and 1-month case fatality was high (38.5%).

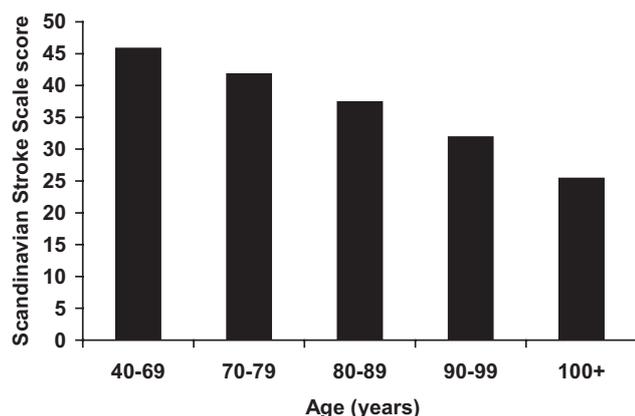
It is quite plausible that old age and an expectation of poor outcome kept some centenarians with stroke from hospitalization. Thus, in a Danish population-based study of 207 centenarians, just 34% were living in their own home in contrast to 64% in the present stroke cohort.<sup>12</sup> Centenarians suffering stroke whilst in nursing home might very well be cared for in the nursing home instead of being hospitalized. Therefore, the centenarians with stroke presented in the present study should be considered representative of centenarians with stroke in Danish hospitals rather than representing the centenarian stroke population. We are not aware of any other report on characterization of strokes among centenarians. Because numbers were small, data on the centenarians in comparison with other age groups are not suitable for statistical processing, and they should be interpreted with caution.

The traditional risk factors for stroke are all associated with excess mortality.<sup>13</sup> Therefore, mortality displacement (i.e. decrease in prevalence of the risk factor in the population due to excess mortality of individuals having the risk factor)<sup>14</sup> is the most likely explanation of the relatively low prevalence of stroke risk factors in centenarians than in the other age groups with stroke. This phenomenon finds expression as early as in the 70s, where the prevalence of most cardiovascular risk factors in stroke patients begins to decline.<sup>15</sup> Thus, a better risk factor profile appears to be involved in delaying the occurrence of stroke to a very old age. The relatively lower prevalence of traditional risk factors for stroke in centenarians (and in the oldest old as a whole) in the present study supports findings in the Leiden 85± study<sup>16</sup> that the relationship between traditional cardiovascular risk factors and cardiovascular events weakens in the oldest old, with other factors being important.

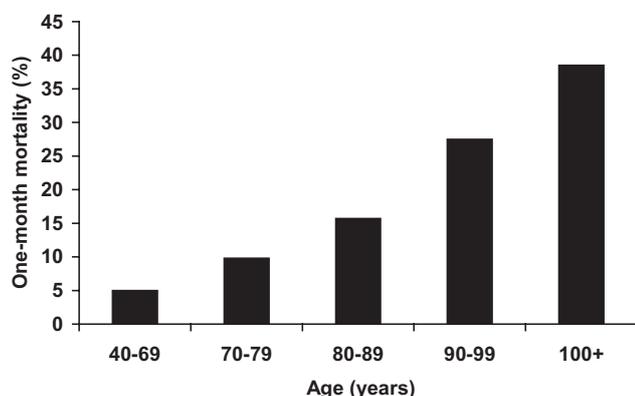
Stroke severity increases with age,<sup>17</sup> and strokes were also markedly more severe among centenarians in the NIP stroke cohort. Stroke severity and age are the two most important predictors of short-term, as well as long-term, survival in stroke.<sup>18</sup> Accordingly, mortality was also greatest in the centenarians in our cohort. In Scandinavia, the stroke hospitalization rate is high – 90% or more.<sup>2,19</sup> The rate of non-hospitalized stroke patients increases with increasing age.<sup>19,20</sup> In one study<sup>19</sup> the mean age was 89 years for patients who had primary care only compared with 76 years of in-hospital stroke patients. In the former, stroke was mostly severe, as 28-day mortality was 61% compared with 13% in

**Table 1** Cardiovascular risk factors and demographics in 61 935 acute stroke patients registered in the Danish National Indicator Project database related to age

Age (years)	40–69	70–79	80–89	90–99	100+
No. patients	25 023	16 048	16 274	3379	39
Infarct/hemorrhage (%)	92.2/7.8	90.7/9.3	91.3/8.7	92.5/7.5	92.3/7.7
Women (%)	36.3	47.6	60.0	72.8	87.2
Civil status (%)					
Living together	66.3	54.0	33.3	14.8	7.7
Single	28.3	40.2	58.3	71.9	82.1
Other	2.3	2.0	4.3	9.3	10.3
Missing	4.0	3.9	4.1	4.0	0
Housing (%)					
Own home	90.0	87.9	80.3	67.5	64.1
Nursing home	1.9	4.8	12.3	25.2	30.8
Other	2.3	1.9	2.3	2.4	5.1
Missing	5.8	5.4	5.1	5.0	0
Diabetes mellitus (%)					
Yes	13.9	14.5	12.1	8.4	2.6
No	82.2	80.4	82.2	83.3	84.6
Missing	4.0	5.1	5.7	8.4	12.8
Intermittent arterial claudication (%)					
Yes	3.3	4.2	3.4	1.9	0
No	87.0	81.7	78.9	74.5	74.4
Missing	9.8	14.1	17.7	23.6	25.6
Atrial fibrillation (%)					
Yes	7.3	16.3	26.9	31.3	20.5
No	88.0	78.10	66.7	60.6	66.7
Missing	4.7	85.6	6.40	8.0	12.8
Previous myocardial infarction (%)					
Yes	7.2	10.8	10.9	8.2	5.1
No	87.9	82.6	80.6	79.4	82.1
Missing	4.9	6.6	8.5	12.4	12.8
Previous stroke (%)					
Yes	17.4	23.7	23.7	19.0	12.8
No	78.5	71.0	69.3	70.5	74.4
Missing	4.1	5.3	6.9	10.5	12.8
Hypertension (%)					
Yes	44.9	51.0	49.0	42.4	39.5
No	49.8	42.4	42.3	44.7	42.1
Missing	5.4	6.7	8.7	11.10	18.4
Current daily smoking (%)					
Yes	48.8	30.9	16.5	8.3	5.1
No	39.8	51.3	56.7	54.5	53.9
Missing	11.5	17.8	26.9	37.2	41.0
Alcohol consumption (%)					
Over limit	12.8	5.0	1.8	1.0	0
Under limit	76.0	78.7	76.3	69.5	59.0
Missing	11.2	16.3	21.9	29.40	41.0



**Figure 1** Admission stroke severity related to age in 61 935 acute stroke patients registered in the Danish National Indicator Project database. Mean Scandinavian Stroke Scale score (0 worst to 58 best) in five age groups ( $P < 0.05$ ).



**Figure 2** One-month mortality related to age in 61 935 acute stroke patients registered in the Danish National Indicator Project database ( $P < 0.05$ ).

hospitalized patients. Therefore, we believe that some centenarians, especially those with severe stroke, refrain from hospitalization in the case of stroke. Hence, the high 38.5% 1-month case-fatality rate among centenarians in the present cohort hardly reflects the true 1-month stroke case-fatality in the centenarian stroke population, which is probably being much higher. Elderly patients with stroke in Denmark in particular, those over the age of 80 years, receive a lower quality of care than do younger patients.<sup>21</sup> However, age-related differences of processes of care do not appear to explain the higher mortality among elderly stroke patients in Denmark.<sup>21</sup> Advanced age might constitute a barrier to thrombolytic treatment, hence partly explaining higher in-hospital mortality among the oldest-old stroke patients. However, thrombolysis, although improving outcome, does not influence mortality.<sup>22</sup>

In conclusion, centenarians who are affected by stroke are, from a cardiovascular standpoint, healthier

than their younger counterparts. Yet, strokes in centenarians are more severe and associated with very high mortality.

## Disclosure statement

No potential conflicts of interest were disclosed.

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