
SUMMARY OF STROKE STUDY
WHAT IS BEST AND AT WHAT COST?
OECD STUDY ON CROSS-NATIONAL DIFFERENCES OF AGEING-RELATED DISEASES:
CONCLUDING WORKSHOP

To be held at the International Conference Centre, 19 Avenue Kléber, 75016 Paris from 20 to 21 June 2002, starting at 9h30 on the first day

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SUMMARY OF RESULTS FROM STROKE DISEASE STUDY

1. The burden from stroke in OECD countries is large, both in terms of disease burden and health system costs. Stroke deaths accounted for 10% of all deaths worldwide in 1999. We also know that the disability burden from stroke is substantial. It has been estimated that, in the low mortality regions of the world which include the majority of countries participating in the ARD study, between 3 and 11% of the total disease burden (deaths and disability) is attributed to stroke (WHO 2000). Because of the large burden from stroke in terms of deaths and disability, the health system costs resulting from stroke are high, with estimates ranging between 2 and 4% of total health system expenditures. Significant costs also accrue outside the health system, largely due to the significant disability associated with stroke.

2. This analysis of the treatment, costs and outcomes from stroke care in 17 countries largely focuses on a sub-type of stroke — ischaemic stroke — although other types are discussed in some sections. This summary is based on the full report of the stroke study, which contains further details particularly in relation to specific results obtained from the country reports that formed the basis of the study (Moon et al. 2002). This summary has six sections:
   - a section outlining the main policies, incentives and regulations impacting stroke treatment
   - a brief overview of the epidemiological data on stroke
   - the key results from our comparison of stroke treatments between countries
   - the main findings in relation to health outcomes
   - an overview of available data in relation to the economic aspects of stroke treatment
   - a discussion section outlining the main policy issues, and exploring some of the relationships between treatments, costs and outcomes.

1. Policies, incentives and regulations

3. Policies, incentives and regulations influence stroke treatment in two main ways: through demand-side and supply-side effects. The key effects are summarised below.

1.1 Demand-side

4. The majority of countries in our survey have universal health insurance coverage, meaning few limitations on access to medically necessary health care exist. Acute care is generally well covered, however, this may be less the case for some ambulatory care treatments, including drugs for primary and secondary prevention, or follow-up treatment.
5. In general, the availability of private health insurance does not have a significant impact on access for most stroke care services, though it may play a significant role in providing coverage for some of these services in Mexico, the Netherlands, Switzerland and the United States. In addition, it may be used to cover services left out of the public health insurance programme such as outpatient drugs, to cover (or partly cover) the co-payment required when a person decides to be admitted as a private patient, or to allow choice of doctor.

6. Cost sharing for ambulatory care drugs is much more prevalent than for non-drug related treatments for stroke. In fact, apart from exemptions for various identified population groups within a country, cost sharing is an integral part of insurance coverage for ambulatory care drugs in all the countries included in our study. Thus, the potential impact on the financial burden to patients prescribed ambulatory care drugs for stroke is greater than for non-drug related treatments, especially for the treatment of related risk factors such as hypertension.

1.2 Supply-side

7. Two important supply-side incentives for which we have data are the size of the medical workforce, and the supply of machines used for diagnostic tests.

Medical workforce

8. In relation to the supply of doctors, our analysis included a comparison of the number of neurologists in our participating countries. Italy has by far the largest number of neurologists with 10.4 per 100,000 population, but these may include many non-practising physicians and neurologists who are in reality practising as general practitioners. Excluding Italy, Denmark has the largest number of neurologists per 100,000 (4.6) in 1999, with the Netherlands being the only other country with greater than 4.0 neurologists per 100,000 population. Hungary and the United Kingdom have the lowest number of neurologists, 0.4 per 100,000 population, likely reflecting the lower spending on health care of these two countries. These figures need to be treated with caution since the definitions of neurologists varies significantly across countries.

Machines for diagnostic tests

9. Computed tomography is the older of the two technologies we examined in this study that are used in stroke diagnosis. Japan (71.8), Australia (23.9) and Korea (22.1) are the only countries with more than 20 scanners per 1,000,000 population. Waiting for CT scans was not identified as a problem in any of these countries, which is expected given the number of scanners relative to other countries. Mexico had the fewest number of CT scanners per 1,000,000 population (2.0), which is likely a reflection of its lower per capita income.

10. MRI is a newer diagnostic technology. The countries with the greatest number of MRI scanners per 1,000,000 population are Japan (18.8), Sweden (8.0), United States (7.6) and Switzerland (6.9). The US and Switzerland are the richest countries in the study in terms of per capita income, so they may be early adopters of this relatively new technology which may help to explain why they have more machines than most other countries (TECH 2001). However, this is not a satisfactory explanation why Japan or Sweden, two countries with much lower per capita incomes have more MRIs per capita than the US or Switzerland. Nor does it explain why Canada, with the fourth highest per capita income respectively of the countries included, has the fourth lowest number of MRIs per capita. However, it was reported in this study that waiting times for MRIs in Canada is a significant problem.
2. Epidemiological background

11. Information is presented here on stroke incidence, mortality and risk factors. This is to assess whether there is variation in the level of stroke between countries, which would be an important contextual factor in our comparison of treatment variations between countries.

2.1 Incidence

12. Incidence is the number of new cases of ‘stroke’ for a given year, presented here as the number per 100,000 population. Due to the difficulties involved in collected incidence data, we only have information on a relatively small number of the countries included in this study, which may not be generalisable to the other countries in this study. The data we do have shows that there is variation in stroke incidence between countries. For ischaemic stroke, incidence rates in Sweden for males and females were around 2.5 times those in Australia.

13. In general terms among the countries with data included in our study, Sweden has the highest incidence rates, followed by Norway, Italy, Denmark and Japan. The UK and Australia have the lowest incidence rates among these countries. As expected, the incidence of stroke increases with age, with the largest incidence rates occurring in the 75+ age group.

14. Recent studies have demonstrated declining stroke incidence in some centres, though the decline has sometimes been small and not statistically significant (Thorvaldsen et al. 1997). Using age-standardised trends in ischaemic stroke incidence (for persons aged 40 years and over) where available, we found that one country demonstrates declining incidence (Australia), two countries increasing incidence (Denmark and Norway) and the remaining two having relatively stable incidence (Italy and Sweden).

2.2 Mortality

Figure 1: Ischaemic stroke age-standardised\(^{(a)}\) mortality rates, 1997

(per 100 000 aged 40 and over)

<table>
<thead>
<tr>
<th>Country</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA (NHDS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA (Med.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switzerland</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td></td>
<td></td>
</tr>
<tr>
<td>United Kingdom</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hungary</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(a) Age-standardised to the European standard population.

Source: ARD stroke study, OECD.
15. Table 1 summarizes the trends in ischaemic stroke mortality for persons aged 40 years and over, showing two groups of countries. The first group includes those displaying decreasing trends in stroke mortality. For these countries, the male mortality rate has fallen to 70-100 per 100,000. For females, the rates have fallen to around 65-105 per 100,000. The second group includes the other countries: those with steady or increasing trends. For both males and females, the two countries with the lower rates (Denmark and Sweden) currently have rates at similar levels to those countries with decreasing trends. The main exception is Hungary, where the rate has remained high at around 200 per 100,000. The mortality rates in Japan have remained at levels between Hungary and the other countries. The identification of two distinct patterns in stroke mortality has also been identified in the research literature (Sarti et al. 2000).

Table 1: Trends in ischaemic stroke mortality rates
(per 100 000 population aged 40 and over, age-standardised to the European standard population)

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
<th></th>
<th></th>
<th>% decrease(a)</th>
<th>Fema1es</th>
<th></th>
<th></th>
<th>% decrease(a)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Decreasing trends</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United Kingdom</td>
<td>184</td>
<td>150</td>
<td>114</td>
<td>2.2</td>
<td>167</td>
<td>142</td>
<td>114</td>
<td>1.9</td>
</tr>
<tr>
<td>Switzerland</td>
<td>183</td>
<td>165</td>
<td>98</td>
<td>2.7</td>
<td>153</td>
<td>126</td>
<td>89</td>
<td>2.5</td>
</tr>
<tr>
<td>Italy</td>
<td>189</td>
<td>129</td>
<td>98</td>
<td>2.8</td>
<td>151</td>
<td>110</td>
<td>85</td>
<td>2.6</td>
</tr>
<tr>
<td>Netherlands</td>
<td>124</td>
<td>98</td>
<td>98</td>
<td>1.2</td>
<td>109</td>
<td>93</td>
<td>95</td>
<td>0.8</td>
</tr>
<tr>
<td>Australia</td>
<td>173</td>
<td>104</td>
<td>79</td>
<td>3.2</td>
<td>160</td>
<td>107</td>
<td>81</td>
<td>2.9</td>
</tr>
<tr>
<td>USA (NCHS)</td>
<td>92*</td>
<td>75</td>
<td></td>
<td></td>
<td>80*</td>
<td>77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA (Medic.)</td>
<td>78</td>
<td>67</td>
<td></td>
<td>2.0</td>
<td>73</td>
<td>69</td>
<td></td>
<td>0.8</td>
</tr>
<tr>
<td>Canada</td>
<td>113</td>
<td>80</td>
<td>70</td>
<td>2.2</td>
<td>94</td>
<td>70</td>
<td>66</td>
<td>1.8</td>
</tr>
<tr>
<td><strong>Stable or increasing trends</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hungary</td>
<td>237</td>
<td>256</td>
<td>239</td>
<td>0.0</td>
<td>175</td>
<td>185</td>
<td>171</td>
<td>0.1</td>
</tr>
<tr>
<td>Japan</td>
<td>151</td>
<td>117</td>
<td>156*</td>
<td>-0.2</td>
<td>150</td>
<td>127</td>
<td>167*</td>
<td>-0.7</td>
</tr>
<tr>
<td>Denmark</td>
<td>95</td>
<td>99</td>
<td>99</td>
<td>-0.2</td>
<td>77</td>
<td>86</td>
<td>94</td>
<td>-1.3</td>
</tr>
<tr>
<td>Sweden</td>
<td>68</td>
<td>81</td>
<td>83</td>
<td>-1.3</td>
<td>55</td>
<td>70</td>
<td>74</td>
<td>-2.0</td>
</tr>
</tbody>
</table>

\(a\) Average annual percentage decrease (over the period 1980-1997, except for the US where the period is only 1990-1997).
* Extrapolated for given year from available data for adjacent years.

Source: ARD stroke study, OECD.

2.3 Risk factors

16. Tobacco smoking and hypertension are the main modifiable risk factors for stroke (Stegmayr et al. 1997). Other risk factors include high blood cholesterol, overweight, heavy alcohol consumption, low socio-economic status, and a number of medical conditions.

17. Countries included in this study differ substantially both in terms of current smoking rates, as well as those observed in the past. The proportion of the population aged 15 years and over who are daily smokers (Figure 2) ranged between about 18 and 35%, with the highest rates found in the Netherlands, Korea, Spain, Switzerland, Denmark and Norway. The lowest rates were in Portugal, Sweden, and the US.

18. Hypertension, or high blood pressure, is defined here as persons having systolic blood pressure\(>=140\)mmHg and diastolic blood pressure\(>=90\)mmHg. The proportion of the population with hypertension increases with age. For the countries with data available for our study, around 20-30% of
males and around 10-20% of females in their 40s were classified as having hypertension. But for people aged in their 70s, the proportions were between 30-60%.

Figure 2: Tobacco consumption, 1995-98


3. Treatments

19. Despite the increasingly global nature of information diffusion in the treatment of stroke, differences remain in the care received by stroke patients (Beech et al. 1996, Wolfe et al. 1999). These may relate to aspects such as underlying population differences in stroke types and severity, differences in practitioner preferences, or differences in health system characteristics. The continuum of care is important for stroke patients, as many receive both acute and longer-term care including rehabilitation and assistance with any resulting disabilities. While each phase in this continuum is important—including prevention, acute care, and ongoing care—data are available more commonly in relation to the acute phase.

3.1 Prevention

20. Prevention of strokes, as well as prevention of second or subsequent strokes, occur both at an individual level (usually care provided for a patient by a medical practitioner) and at a population level (such as public health programs aimed at particular risk factors). In relation to stroke, an important preventative measure aimed at individuals is the management of hypertension, often through drug treatment. Control of hypertension has been shown to be highly effective in reducing the risk of stroke for all age groups. Population-level preventive measures are aimed at groups of people, rather than individuals. Countries differ both in their involvement in and the approach taken for these population-level measures (see for example, WHO 2002).

3.2 Hospitalisations

21. The majority of ischaemic stroke patients who do not die at the time of the stroke event are admitted to hospital for treatment. This treatment may include assessment, diagnostic procedures, drug
treatment, early rehabilitation, and long-term planning to reduce the risk of further strokes and to provide support if some level of disability remains.

22. Figure 3 shows age-standardised hospitalisation rates for ischaemic stroke where available. There is considerable variation in these hospitalisation rates, with the highest rates observed in the Scandinavian countries, and the lowest rates in the United Kingdom. There is around a 4-fold difference between these two extremes.

![Figure 3: Stroke hospitalisation rates, 1997](Per 100 000 population aged 40 and over, age standardised to the European standard population)

Source: ARD stroke study, OECD.

23. Although not shown, trend data were also available for many of these countries. The hospitalisation rates at the country level in Australia, Canada and the United States appear to have declined in recent years, while the rates in the Netherlands, the UK (Oxford) and Sweden have remained largely unchanged. However, the rates in Greece and Italy show evidence of having increased over time.

3.3 Stroke units

24. Stroke units (organised, specialist inpatient stroke care) have been demonstrated to result in a positive outcome for stroke patients, both in terms of survival and disability (Cochrane Review 2002, Stroke Unit Trialists’ Collaboration 1997a). In addition, evidence is emerging suggesting that stroke units also have benefits in terms of cost-reduction (Jorgenson et al, 1995; Grieve et al, 2000). Stroke units have been shown to benefit a wide range of patients in a variety of ways (Indredavik et al, 1999; Jorgenson et al, 2000; Stroke Unit Trialists’ Collaboration 1997b).

25. The studies that have examined the benefits of stroke units have taken steps to use a clear definition of a stroke unit, however a standard definition across studies has not yet emerged. Aspects of the definitions used in some of these studies include multidisciplinary staffing, access to technology such as CT scanners, organised care in a dedicated unit with dedicated staff, and usually includes both acute and rehabilitation care.
26. Definitional aspects are an issue when comparing the use of stroke units in the data collection undertaken for this study. Nevertheless, it is still valuable to make general comparisons between the use of stroke units in the various countries with data available. Information is available on the use of stroke units in seven of the countries participating in this study, and is summarised in Table 2.

Table 2: Available information on the use of stroke units

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Stroke units (per 100 000)</th>
<th>Stroke unit beds (per 100 000)</th>
<th>% of patients care for in stroke unit</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>1998</td>
<td>0.93</td>
<td>10.4</td>
<td>49 hospitals with 550 beds</td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>2000</td>
<td>0.42</td>
<td>1.7</td>
<td>67 hospitals with 268 beds</td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>1999</td>
<td>0.23</td>
<td>1.8(a)</td>
<td>44 stroke units with defined beds</td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td>1998</td>
<td>0.78</td>
<td>5.8</td>
<td>70% SU at 70 of 84 hospitals, 518 beds, % patients cared for in SU rose from 54% to 70% between 1995 and 1998</td>
<td></td>
</tr>
<tr>
<td>Hungary</td>
<td>2000</td>
<td>0.15</td>
<td></td>
<td>Approx. 15%</td>
<td>4 SU in 1992, 15 in 2000</td>
</tr>
<tr>
<td>United Kingdom</td>
<td></td>
<td>26% at least ½ admission</td>
<td></td>
<td>1999, 45% of trusts had SU</td>
<td></td>
</tr>
<tr>
<td>Norway</td>
<td></td>
<td>Approx. 60%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(a) Estimated from survey data based on hospital size. 3.4 Diagnostic and surgical procedures

27. Stroke units are being implemented in many countries. However, the extent to which stroke units are used differs between countries. A crude measure of the supply of stroke units, the number per 100 000 population, shows variation from 0.15 in Hungary to 0.93 in Denmark. The percentage of stroke patients receiving care in a stroke unit also differed markedly between countries, ranging from 15% in Hungary to 70% in Sweden. From information supplied as part of this project, it also appears that the use of organised stroke units is tending to increase over time.

3.4 Diagnostic tests and surgical procedures

28. Diagnostic procedures are used to determine the stroke type and severity, which impact on treatment options. The main diagnostic procedures examined in this study were CT scans and MRI/MRA. The three main points apparent from this analysis on the use of diagnostic tests for ischaemic stroke and TIA patients are:

- Variation across countries: There is considerable variation in the use of these procedures, both in the percentage of patients receiving the test, as well as in which test is used most often.

- Increasing use: There is quite marked increase in the use of CT scans in some cases (such as in Sweden, Australia and Ontario). In addition, the use of MRI/MRA has increased substantially in Alberta.

- Age patterns: The use of CT scans is generally constant across the age groups. However, MRI/MRA are used more commonly in the younger age groups compared to the older age groups.
29. Carotid endarterectomy (CE) is used as a preventive measure in individuals at high risk of stroke or recurrent stroke. Currently, CEs are not a common procedure in most OECD countries. Of the countries with data available for this study, the US had the highest number of procedures per population at around 80 per 100,000, followed by Australia at around 60 per 100,000 and Canada with nearly 45 per 100,000. The procedure was used more moderately in Sweden, Norway, Hungary and the UK, while the procedure was used very rarely in the remaining countries with data available (Spain, Japan, Italy and Korea). Note that the measure used here is relatively crude, and does not take account of differing proportions of populations who are potential candidates for the procedure.

30. Time trends over 5 or more years are only available for three of these countries—Sweden, Australia and Canada (Ontario). From these data there is evidence of a gradual increase in the use of the procedure until about the mid 1990s, with the rates remaining stable or perhaps even declining after that. There is no evidence of any dramatic increases in the use of this procedure.

3.5 Drug treatment

31. Drug therapy is a significant component in the prevention and treatment of stroke. An important component of drug therapy relevant to stroke patients is the use of drugs to treat high blood pressure. The total use of anti-hypertension drugs (which includes antihypertensives, diuretics, peripheral vasodilators, beta blocking agents, calcium channel blockers, and ACE inhibitors) has been rising steadily in all the countries able to supply drug consumption data as part of this project (Figure 4). In Denmark, Norway and Australia, consumption of these drugs rose by between 12 and 15% between 1994 and 1998. In the Netherlands, consumption rose by around 20% during this period, but still remains below that of the other three countries. The largest increase during this period occurred in Greece with a 30% increase. In Italy, consumption rose by 5% between 1998 and 1999, and is now close to the highest rate along with Australia. Sweden (no trend data) and Denmark have the next highest consumption rates.

*Figure 4: Trends in the use of antihypertension drugs*  
*(DDD per 1,000 population per day)*

Source: ARD stroke study, OECD.
32. The percentage share each of these antihypertension drugs accounted for varied between countries. The drugs most commonly used were diuretics, calcium channel blockers and ACE inhibitors. Beta-blockers were also relatively frequently used. Countries fell into one of two groups depending on which class of antihypertensives were most commonly used. Denmark, Sweden, Switzerland and the Netherlands used diuretics more than any other class of these drugs. In Norway, Italy, Greece and Australia, ACE inhibitors were most commonly used.

4. Health outcomes

33. Health outcomes can be defined as ‘those changes in health status strictly attributable to the activities of the health system’ (Hurst 2002). However, available data can rarely disentangle the health system effects from other effects (such as those related to the natural course of the disease, housing, employment, or social services for example). The particular focus here is on outcomes that may be to some degree attributable to health care interventions and the quality of the interventions, or the lack of them. Ideally we would like to have outcome measures that cover the following: the risk of stroke (first and subsequent strokes), deaths from stroke, complications from stroke, and functioning levels and health-related quality of life after stroke.

34. As for most diseases, stroke outcome measures are not widely available on a country basis. The main outcome measures available for this study relate to death rates, measured as in-hospital or case fatality rates (the percentage of patients who died within certain time periods following admission).

4.1 In-hospital mortality

35. This section deals with the proportion of patients who died in hospital, information which is available for approximately half of the countries involved in this study. Here we present information on case-fatality rates which relate to a distinct period of time: 7 days. This provides a measure of the fatality rate in the very acute phase, and represents the number of deaths occurring in the first 7 days in hospital as a percentage of all stroke admissions.

36. Where differences are observed at the aggregate level, it is not possible to determine the causes of these differences from this analysis. The major factor that has not been controlled for is the severity of cases being admitted. As the severity may differ between countries, as well as over time, it is not possible to determine any causal links between the treatment received and the outcome measure. In addition, differing admission practices between countries may also affect the relative comparisons between countries.

37. The percentage of ischaemic stroke patients admitted to hospital who died within the first 7 days of their stay is fairly consistent across the countries able to supply these data (Figure 5). However, the hospital fatality rates in the UK stand out as being higher for all age groups than in the other countries. Generally around 5% of these patients aged between 40 and 64 years died within the first week of their hospital stay. There was more variation in the hospital fatality rates in the oldest age group examined. Approximately 10% of these patients died within the first week.
4.2 Case fatality

38. The hospital fatality rates discussed in the previous section do not reflect the total continuum of care which includes care outside the hospital setting. To do that, we need to also account for non-hospital deaths by using case fatality rates. That is, during a specified period, the number of deaths as a percentage of the number of cases. Case fatality rates are presented here for the first year following initial treatment.

39. The same cautions in relation to attribution for these outcome measures apply as for the hospital fatality rates. That is, while health care does affect these outcome measures, there will be other influences
outside of the health care system. In addition, these outcome measures do not control for casemix or severity of the stroke, thus judgements cannot be made from these data on the relative quality of different health care systems in treating stroke patients.

40. Figure 6 displays the one year case fatality rates, using data from Canada (Alberta and Ontario), Denmark, Sweden, the UK (Oxford) and the US (for person aged 65 years and over). Around 10% of ischaemic stroke patients aged 40-64 years died within one year of their stroke, compared to around 30-40% of those in the oldest age group. This represents a risk 4 times higher in the oldest age groups compared to the youngest. Again, the UK rates fall outside these ranges demonstrating higher rates that in the other countries. Little difference is apparent between males and females.

5. Economic aspects of stroke care

5.1 Aggregate expenditure

41. The health care of stroke patients has significant economic impact in OECD countries. In 1995, the direct health care expenditure on cerebrovascular disease in the United States was over US$20 billion (Hodgson et al, 1999), which is equivalent to 3% of total health care expenditure. Similar information is available for three of the other countries in our study — Canada, the Netherlands and Australia — where between 2 and 4% of total health care expenditure was attributed to the care of stroke patients (Mathers and Penn, 1999; Moore et al, 1997; Evers et al, 1997).

42. For each of the four countries, the largest share of expenditure was on hospital and nursing home care combined, accounting for at least 70%, and generally between 80 and 90% of expenditure. Within this category, the US and Australia spent slightly more on hospitals than on nursing homes, while in the Netherlands nursing home care was almost double that of hospital care. This reflects high expenditure in long-term care provided in nursing homes in the Netherlands (OECD, 1999). The split between hospital and nursing home care expenditure in Canada is not available for cerebrovascular disease.

5.2 Length of stay in hospital

43. The length of a stroke patient’s stay in hospital is dependent on a number of factors, including the severity of the stroke, whether they die in hospital, and whether they received rehabilitation or long-term care whilst in the hospital. Therefore, within a particular health system, there is potential for considerable variation in the length of stay for stroke patients.

44. Whilst keeping in mind that direct comparisons of the absolute length of stay between countries needs to be undertaken with caution due to underlying differences in definitions, in general the majority of means and/or medians of length of stay were around 10-15 days for ischaemic stroke patients. The main country with length of stays longer than this is Japan, where the mean length of stay was around 90 days, which is related to the inclusion of some long-term care in the admission. The countries that are notable for lower lengths of stays are Denmark and the US (mean around 5-6 days). Over recent years, the length of stay for stroke patients has decreased in all countries with trend data available.

5.3 Relative unit expenditure on stroke admissions

45. Results from two main types of studies on the expenditure for stroke-related treatment are presented here, distinguished by their scope. The scope of information for the first group is ‘national’ or
The measure used here is mean expenditure per treatment bundle (‘unit expenditure’) expressed as a percentage of GDP per capita. This provides a measure of the unit expenditure relative to an indicator of average income per person. This is therefore a measure of relative expenditure, not absolute expenditure. The measure is referred to in this section as relative unit expenditure.

Information on the relative unit expenditure for ischaemic stroke admissions for four countries and two provinces in Canada is shown in the first panel of Figure 7. The relative unit expenditure estimates for ischaemic stroke admissions are relatively constant, ranging between 19% and 26% of GDP per capita. Two countries, Australia and Norway, were able to supply data separately for patients who died in hospital and for those who were discharged alive. In these two cases, little difference was found between the two groups of patients.

Figure 7: Relative unit expenditure for stroke admissions

Sources: ARD stroke study, OECD; and Grieve et al (2001).
48. The second panel in Figure 7 provides similar information sourced from studies with a smaller scope. The majority of these relate to one hospital with the exception of Japan where the data come from nine tertiary level hospitals. Due to these limitations, the data are not likely to be representative of the whole country. For the majority of cases here, the relative unit expenditure is within the same range as for the health system level result in the first panel.

49. At least some of the variation in the second panel is likely to be due to differences in the casemix in the different sites. For the five results from Grieve et al. (2001), we also show the predicted unit expenditure for a constant casemix — for treating a man aged over 74 years who was conscious and continent on admission. This adjustment for casemix reduces the variability from 13–32% to 7–16% of GDP per capita.

6. Discussion

50. The primary goal of the ARD study is to determine whether there are treatment variations between countries, and whether these are related to differing policy approaches and economic incentives. A second focus is to examine the implications of any treatment variations in terms of costs and health outcomes. This section provides a discussion of the results of the stroke disease study in relation to these two goals.

51. Here we highlight the main policy-relevant relationships between treatments (interventions), costs and outcomes. The context of the discussion here is exploratory rather than conclusive. Within this section, a number of examples are given based on the data for males only, and at times for only a subset of the age groups included in the analyses. The use of examples based on a subset of the study data is undertaken simply to simplify the discussion.

52. The key issues identified through the stroke study are twofold. Firstly, the importance of a broad-based policy for stroke care, that includes a focus on prevention as well as the treatment phase, has been identified. And secondly, the organisation of care within the treatment phase is a significant component of high quality care, notably through the use of specialised stroke units. The policy implications of these themes are relevant to both public health policy (prevention) and the design and operation of the treatment phase. Both of these findings relate to the co-ordination and organisation of health systems over the whole continuum of care. This is in contrast to the main issues identified in the breast cancer and ischaemic heart disease components of the ARD study where use of technology in screening and treatment were dominant policy issues.

6.1 Policy perspective on treatment variations

Are there variations in stroke prevention and treatment?

53. This study has reported substantial variations in the treatment and care of stroke patients in the 17 countries included in the study. These variations occur over the whole continuum of care. Firstly, in the area of prevention, countries differ in their approaches, emphasis and success in reducing the risk of stroke through one of its major determinants — tobacco smoking. Secondly, the use of hospitalisation for stroke patients varies between countries, particularly in relation to Transient Ischaemic Attack (TIA) patients. Thirdly, the organisation of stroke care within the inpatient setting also varies, the main issue being the use of stroke units. Fourthly, there appears to be variation in the use of technology for stroke patients, demonstrated through the use of the surgical procedure carotid endarterectomy. And finally, drug treatment
for another key risk factor, high blood pressure, varies both in volume of use and in the types of antihypertensive drugs used.

54. The interpretation of these variations is not straightforward. Notably, levels of use are affected by the underlying rates of the disease, which determine the medical ‘need’ for treatment. Ideally, measures of incidence (new cases) or prevalence (all cases at a particular point in time) would provide a good indication of need in each country. However, consistent incidence or prevalence data were only available for approximately half of the countries in our study.

Management of risk factors

55. Tobacco smoking has been shown to account for a large proportion of the attributable burden for stroke. While it is acknowledged that countries with high proportions of smokers are likely to have a resulting effect on stroke incidence and prevalence rates, it is also useful to examine the success of countries in reducing the numbers of smokers in their populations.

56. As an indication of the recent success of countries in lowering population risk from smoking, countries were grouped based on the percentage reduction in the proportion of male and female smokers between 1990 and 1995 (the choice of years was largely determined by data availability). In general, Denmark and the US have been relatively more successful in reducing smoking, though smoking rates in Denmark are still quite high compared to other countries in this study. The other Nordic countries in the study (Norway and Sweden), Australia, Canada, the UK, and Switzerland have had moderate success in reducing smoking compared to other countries. The Mediterranean countries in the study (Greece, Portugal and Spain), the two Asian countries (Japan and Korea) and the Netherlands have had small reductions or even an increase. Combined with low reductions, high levels of smoking remain in Korea, Japan, Greece and the Netherlands, making this risk factor a significant policy issue in these countries.

Use of stroke units

57. A key policy issue for the care of stroke patients is the organisation of care, notably with the use of inpatient stroke units, with the general characteristic of specialised, multidisciplinary care in a dedicated setting. As indicated earlier, the availability of data on the use of stroke units in different countries is currently quite limited. Nevertheless, it is apparent that the use of stroke units varies between the countries in our study.

58. Despite their proven efficacy in treating stroke patients, few guidelines exist regarding the planning, establishment or utilisation of dedicated stroke units. Where guidelines do exist, they tend to be local guidelines, products of the efforts of health professionals who regularly treat stroke patients and realise the potential of stroke units in improving outcomes for stroke patients. Furthermore, for the most part stroke units are not yet considered an important component in the operation of acute care hospitals in the sense that coronary care units are in treating acute myocardial infarction.

59. If stroke units are as effective as studies indicate then why are they not a part of the regular organisation of hospitals? There are several possible explanations. Firstly, it may be a matter of definition. There is no standardised definition of what constitutes a stroke unit, apart from a common understanding that a stroke unit is a pool of dedicated human and technological resources used in the treatment of stroke. The definition of a stroke unit differs from country to country; even within countries different definitions are found. There are at least two consequences of not having a standard definition for a stroke unit. The first consequence may simply be that the number of stroke units are underestimated in most countries. The other consequence is that it complicates the planning process for creating stroke units. If a standard
definition of a stroke unit is not available, then it is likely that health care planners will be reticent about establishing stroke units.

60. A second possible explanation is that the use of stroke units is still evolving, with some countries further along in the standard use of stroke units compared to others. In the 1970s it was recognised that organised stroke care, from acute care to rehabilitation could result in beneficial outcomes for stroke patients (Indredavik 1999). Since then the development of stroke units has been slow to take root. It is only within the last few years, as evidence continues to mount supporting the efficacy of stroke units, that we have witnessed a significant growth in stroke units, particularly in the Scandinavian countries. It is likely that the number of stroke units will continue to grow as the evidence base regarding their efficacy continues to grow.

61. A third possible explanation is the lack of an established “evidence base” (Wolfe 2001). Wolfe states that practice in the United Kingdom, focuses on “evidence from clinical trials and meta-analysis,” which is in contrast to mainland Europe which puts more emphasis on “physiological observation and so called “common sense.”” If the proliferation of stroke units in the UK has been retarded by a lack of trial evidence, and this applies to other countries as well, than this may possibly explain the lack of stroke units. However, as evidence appears to be mounting supporting the efficacy of stroke units (for example Cochrane Review 2002), this explanation is likely to be less of an issue in the future.

62. From the information provided as part of this study, variation in the level of use of stroke units does exist between countries. It appears that the adoption of this approach for the care of stroke patients has occurred earlier and faster in countries with more “integrated” models for delivery of hospital care, notably the Scandinavian countries. These countries tended to have integrated models for delivery of all hospital care, in contrast to some countries that have integrated care for public hospitals and contracted care in private hospitals, and others that have contracted care for all hospital services. It is possible that the integrated approach facilitates earlier adoption of different models of care, of which stroke units are an example. This theory needs to be validated with more data from a wider range of countries before a definitive observation can be made.

The decision to hospitalise

63. Also relevant to the organisation of care is the use of hospitalisation in relation to stroke. We found that there appears to be quite a strong link between hospitalisation for ischaemic stroke and the corresponding incidence rate. However, we expect that there may be more of a discretionary element around the decision to admit patients with TIA (a ‘temporary’ stroke event) to hospital. Therefore it is likely that different approaches in relation to hospitalising TIA patients may reflect differing policies and incentives between countries.

64. The ARD stroke study has found evidence of variations in hospitalisation for TIA patients which appears to be related to differing incentives and policies. To illustrate this point, data are presented in Figure 8 showing the relationship between hospitalisation rates for ischaemic stroke compared to those for TIA. If there was no variation due to the discretionary element in the decision to admit TIA patients, we would expect to see a direct relationship between the two hospitalisation rates. Countries with higher relative incidence of stroke (and thus higher hospitalisation for ischaemic stroke) would be expected to have relatively high incidence of TIA. This expected relationship appears to exist fairly well for younger patients (aged 40-64 years), but not for older patients (aged 75+ years). This suggests that some countries

1. Integrated models are defined in OECD (1994) as those where the same body asks as both purchased and provider, in contrast to contracted models.
are more likely than others to admit TIA patients to hospital. That is, they have more TIA admissions per stroke admission compared to other countries. These countries are represented on the graph as those above the estimated regression lines.

**Figure 8: Hospitalisations for ischaemic stroke and TIA**

*Note:* Although the relationship between the two variables is weak in the second panel, the regression line is included to indicate those countries with higher rates of TIA admission to ischaemic stroke admissions (those countries ‘above the line’).

*Source:* ARD stroke study, OECD.

65. In both age group graphs, the countries with higher TIA hospitalisation rates relative to their ischaemic stroke hospitalisation rates are also those with less constraints on hospital financing. These countries ‘above the line’ for the younger age group are Italy, Switzerland and Australia. These countries also appear ‘above the line’ for the older age group, also joined by the US. Countries ‘below the line’ include the UK, Netherlands and Spain, countries with stronger constraints on hospital payments. This link
between supply-side constraints and utilisation rates has also been demonstrated in the IHD component of the ARD study.

**Use of technology**

66. Carotid endarterectomy (CE) is a surgical procedure used for only a very small proportion of stroke patients. The measure of CE use reported in this study is the number of procedures per 100,000 population aged 40 years and over. Hence, this measure does not control for the relative levels of the disease, which we know does vary between countries, thus resulting in differing levels of medical ‘need’ for the procedure. Therefore, it is surprising that the countries that have the highest usage of the procedure — the US, Australia and Canada — are also the countries with relatively low incidence rates. The study has not found a link between the existence of specific guidelines/policies and the variations in the use of the procedure, partly due to lack of information. However, the existence of variation in guidelines for the use of CE suggests that there is again a discretionary element in the use of the procedure. The variation in use of the procedure does not appear to be related to either medical ‘need’ or economic incentives. It could be that practice variation exists between countries, with physicians in some countries more likely than those in other countries to use surgical intervention.

**6.2 Link between treatment variations, health outcomes and costs**

**Health outcomes and policies**

67. Using the health outcome measures collected in this study—hospital and case fatality rates for ischaemic stroke patients—the 11 countries can be qualitatively grouped as follows:

- Low fatality rates: Denmark, Sweden, Switzerland, Japan
- Medium fatality rates: Norway, US, Australia, Canada, Italy, Spain
- High fatality rates: UK

68. Data were not available for the following countries:

- Portugal, Hungary, Korea, Mexico, Netherlands, Greece.

69. As the health outcomes measures do account for differing incidence and prevalence rates by reporting the proportion of the patients who died, they can therefore be viewed as general measures of effectiveness. Importantly however, these measures do not account for differences in the severity of stroke cases. Thus, if the casemix for any country is more severe than in others, this is not controlled for in the results presented here.

70. A recent multi-centre study that examined stroke outcomes (mortality and disability) in 12 sites and 7 European countries reports results relevant to our discussion (Wolfe et al 1999). The first aspect to note is that the ranking of health outcomes measures in Wolfe et al match those found in the ARD study (for the overlapping countries). Further, the study was also able to adjust for casemix (severity) differences. It was found that there were significant differences in severity between centres, though it is not

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For a subset of tertiary-level hospitals only.
apparent whether this was due to differing hospital admission practices, or other factors. From their analysis, the authors conclude that there are true differences in outcomes after controlling for severity, but that the aspects of care that need to be altered in order to realise the residual potential for health gain are not clear.

71. The final issue in relation to health outcomes is their relationship to treatment variations in the use of stroke units and technology. Given the demonstrated importance in the research literature of the organisation of stroke care through the use of stroke units, it would have been of interest to be able to compare the use of stroke units to our health outcome measures. However, this was not possible as part of this study, due to the small amount of available data on stroke units. In addition, again due to limitations in the data, the analytical component of this study was not able to investigate the relationship between technology use and health outcomes.

Costs and outcomes

72. It has been demonstrated that for stroke, there is a strong relationship between length of stay in hospital and total expenditure for the hospital admission (Jorgenson et al 1997). This is due to the fact that, for ischaemic stroke patients in particular, use of high technology is not a large component of the care, resulting in total costs being largely driven by staff costs. Therefore, by using length of stay as a proxy for expenditure, we have data for almost all the countries in our study. The strong relationship between length of stay and expenditure may not always hold (for example there are large differences in unit costs between countries), but nevertheless this proxy can be used as a general indicator of expenditure.

73. The critical relationship we wish to examine is between expenditure and health outcomes. Figure 9 displays this relationship using length of stay against 7-day and 30-day hospital fatality rates. From these graphs there appears to be a weak relationship between these two variables, with increasing length of stay being associated to some degree with lower fatality rates. The UK is the very prominent exception, having much higher fatality rates given the level of expenditure proxied by length of stay. Even if the actual expenditure levels in the UK were much lower than proxied by length of stay, the UK would still be well above the other countries, indicating relatively high fatality rates per unit expenditure.

74. Another perspective on the relationship between costs and outcomes comes from a multi-country European study undertaken by Grieve et al (2001). This study used health outcome measures taking into account both the death and disability components. In this study it was found that the rankings of countries based on health outcome results, after controlling for severity and differing input costs, matched that of the country rankings for costs in most cases. Thus, in most cases increasing costs were associated with better health outcomes. The main exception to the observed relationship was again in the UK. The authors concluded that spending more on stroke care does not necessarily improve outcomes, but instead careful consideration needs to be given to using the resources in a cost-effective way.
Figure 9: Length of stay and hospital fatality rates

7 day hospital fatality: males

30 day hospital fatality: males

Source: ARD stroke study, OECD.

75. The general conclusion that can be drawn from evidence both in the literature and coming from the ARD study is that there appears to be some relationship between use of resources and health outcomes. However, while there is general evidence to support this, there are a number of important exceptions. This implies that it is not only how much is spent on stroke care that is important, but also how the money is spent. Further research is required to determine which are the most cost-effective treatments for stroke patients.
REFERENCES


COCHRANE REVIEW. 2002

EVERS, S., G. ENGEL AND A. AMENT (1997),

GRIEVE, R., V. PORSDAL, J. HUTTON AND C. WOLFE (2000),

GRIEVE, R. ET AL. (2001),

HODGSON, T. AND A. COHEN (1999),
“Medical care expenditures for selected circulatory diseases”, Medical Care, Vol. 37:10, pp. 994-1012.

HURST, J (2002)

INDREDAVIK, B., F. BAKKE, S. SLORDAHL, R. ROKSETH AND L. HAHEIM (1999),
"Treatment in a combined acute and rehabilitation stroke unit: which aspects are most important?", Stroke, Vol. 30, pp. 917-923.


JORGENSEN, H., J NAKAYAMA, H. RAASCHOU AND T. OLSEN (1997),

JORGENSEN, H. et al (2000),

MATHERS, C. AND R. PENM (1999),

MOORE, R., Y. MAO, J. ZHANG AND K. CLARKE (1997),

OECD (1994),

OECD (1999),

SARTI C, RASTENYTE D, CEPAITIS Z AND TUOMILEDHTO J (2000),
STEGMAYR B, ASPLUND K, KUULASMAA K ET AL. (1997)

STROKE UNIT TRIALISTS' COLLABORATION (1997a),

STROKE UNIT TRIALISTS' COLLABORATION (1997b),

TECH RESEARCH NETWORK (2001)
"Technological change around the world: evidence from heart attack care”. Health Aff (Millwood) May-Jun; 20(3):25-42.

THORVALDSEN, P. et al. (1997)

WOLFE C, TILLING K, BEECH R et al. (1999)

WOLFE, C. (2001)

WORLD HEALTH ORGANISATION (WHO) (2000)

WORLD HEALTH ORGANISATION (WHO) (2002)
The European report on tobacco control policy. WHO Europe: Copenhagen.