

# AT WHAT COST

## THE ECONOMIC IMPACT OF STROKE IN EUROPE

- A summary -



Research Authors

**Ramon Luengo-Fernandez, Paolo Candio, Mara Violato,  
Jose Leal**

Health Economics Research Centre, Nuffield Department  
of Population Health, University of Oxford.

Editors

Joe Korner, Gary Randall, Sandra Jackson

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This report was commissioned by the Stroke Alliance for Europe (SAFE), a non-profit-making organisation that represents a range of stroke patient groups from across Europe whose mutual goal is to drive stroke prevention and care up the European and national political agendas, prevent the incidence of stroke through education and support stroke care and patient centred research. SAFE aims to raise awareness of the major impact stroke has on individuals and on the health and economy of Europe.

## FOREWARD

Since the research contained in this report was carried out, the world has been transformed by the COVID-19 pandemic. Across Europe it has impacted on every aspect of life and has, understandably, diverted attention from other pressing health issues, such as stroke.

At the height of the pandemic all attention was focussed on preventing the spread of the virus and treating those infected. A recent World Health Organization survey<sup>1</sup> highlighted the impact of the pandemic on the disruption of services and predicted an increase in mortality and morbidity from causes other than COVID-19.

*“ COVID-19 should be a lesson to all countries that health is not an ‘either or’ equation. We must better prepare for emergencies but also keep investing in health systems that fully respond to people’s needs throughout the life course.”*

*Dr Tedros Adhanom Ghebreyesus*

Hanne Christensen of the University of Copenhagen and Francesca Romana Pezzella of the San Camillo Forlanini Hospital in Rome, wrote in the European Stroke Organisation’s blog<sup>2</sup> at the end of March 2020,

*“ Before the pandemic, during and after, stroke remains. Stroke is a serious sometimes lethal, sometimes ‘just’ life-changing condition, which can be prevented and treated. Stroke is an old threat that we have always lived with – but what is new is that we have the means to fight it.”*

Many stroke support organisations throughout Europe have reported that an immediate impact of the pandemic was a reluctance of people to report their stroke symptoms, or to attend already over-burdened hospitals. Some reported that dedicated stroke units were used to treat other patients at the height of the pandemic, that stroke patients were discharged early, without appropriate support and that outpatient visits and much rehabilitation were halted. In some places stroke audits were halted and stroke clinicians were concerned that both the momentum to improve stroke care and its priority, may be permanently diminished.

<sup>1</sup> [https://www.who.int/publications/i/item/WHO-2019-nCoV-EHS\\_continuity-survey-2020.1](https://www.who.int/publications/i/item/WHO-2019-nCoV-EHS_continuity-survey-2020.1)

<sup>2</sup> <https://eso-stroke.org/stroke-still-matters/>

At the time of writing, it is not clear what the causes of non-COVID-19 excess deaths are, but it seems likely that stroke mortality rates have been affected.

It is vital that the urgent need to improve stroke prevention and care is not forgotten as in addition to the impact on stroke care, it appears from several research papers that COVID-19 is associated with an increased risk of stroke.<sup>3</sup>

In 2017, the European Stroke Organisation and SAFE collaborated to produce the Stroke Action Plan for Europe 2018-2030,<sup>4</sup> and, together, launched SAFE's Burden of Stroke in Europe report.<sup>5</sup> With the addition of this report, we now have a comprehensive understanding of the extent and impact of stroke across Europe and, crucially, a blueprint to transform stroke service provision.

So it is vital that this important groundwork is not undermined by the COVID-19 crisis.

The projections in this report of the future cost of stroke should be a wake-up call to health planners and officials across Europe. And the research into the benefits and costs of new treatments demonstrates that actively pursuing the latest, sometimes seemingly expensive interventions, can improve outcomes and, in some instances, save substantial amounts of money.

The response to the pandemic has shown that very rapid system change and adaptation is possible across a variety of different health systems. This should hearten all of us who work to transform stroke care – and this report provides more evidence for why it is now time to do so.



**Jon Barrick**  
SAFE President,

A handwritten signature in black ink that reads "Jon Barrick". The signature is written in a cursive style and is underlined with two parallel lines.

<sup>3</sup> Risk of Ischemic Stroke in Patients with Coronavirus Disease 2019 (COVID-19) vs Patients With Influenza. JAMA Neurol. Published online July 2, 2020. DOI:10.1001/jamaneurol.2020.2730, Large-Vessel Stroke as a Presenting Feature of Covid-19 in the Young. New

<sup>4</sup> Stroke Action Plan for Europe 2018-2030, <https://www.safestroke.eu/stroke-action-plan>

<sup>5</sup> The Burden of Stroke in Europe report, May 2017 <https://www.safestroke.eu/burden-of-stroke>

## INTRODUCTION

In 2017, SAFE published the Burden of Stroke in Europe report<sup>6</sup> which revealed the extent of stroke across the continent and the disparities in provision for stroke between regions and countries. In this report we build on that research, to provide, for the first time, a picture of the economic impact of stroke in 2017, and also over the next 20 years. We then look at three interventions which are in the latest stroke guidelines from the European Stroke Organisation. We estimate the impact they have on the costs of stroke and on the number of years of life in good health that they save.

This research provides details on the costs of different parts of the stroke care pathway, the costs of informal care and the productivity losses due to disability or death from stroke for all of the countries of the European Union (EU), plus Iceland, Israel, Norway, Switzerland and the United Kingdom (UK).

To the best of our knowledge, this is the first study to quantify the current and future projected costs of stroke and identify the impact of investing in promising cost-effective interventions to prevent, treat and help stroke patients in their rehabilitation across the 32 European countries. We believe that our study will be of essential use to policy makers when assessing whether or not to make substantial cost commitments in stroke care.

**The total cost of stroke in these 32 countries was €60 billion in 2017:**

**€27 BILLION  
ON  
HEALTHCARE**



**€16 BILLION ON  
INFORMAL,  
UNPAID CARE**



**€5 BILLION  
ON SOCIAL  
CARE**



**€12 BILLION  
ON LOST  
PRODUCTIVITY**



6 The Burden of Stroke in Europe report, May 2017 <https://www.safestroke.eu/burden-of-stroke>

These figures are almost certainly an underestimate. For example, we did not include social care costs such as provision of meals at home, social work support, or home adaptations and home help costs because this data is simply not available.

The research reveals big disparities in costs between countries. On average, in Europe, 60% of the total healthcare costs for stroke are due to hospitalisation costs, but this varies considerably between countries, from 11% in Cyprus to 86% in Switzerland.

This disparity, which mirrors the findings about stroke care from the Burden of Stroke in Europe report, has implications for planning and developing improved stroke services over the coming years and decades. The priorities for investing in improved stroke prevention and care may be different for each country.

Our research shows marked differences between the wealthy and less wealthy countries of Europe. Just five countries (France, Germany, Italy, Spain and the UK - the top five in terms of population) accounted for 71% of all stroke-related healthcare expenditure in Europe. And yet the less wealthy countries spent, on average, a much bigger proportion of their healthcare budgets on stroke. As a proportion of the countries' overall health expenditure, the European average was 1.7%.

But Eastern European countries such as Hungary spent 3.42% and Estonia spent 4.34%. This contrasts with wealthier Western European countries - Denmark spends 0.58% of its health budget on stroke and Switzerland spends 0.75%.



Over the next 50 years, Europe will see decreasing birth rates, an ageing population, and, for many countries, a reduction in the total population, particularly of working age.

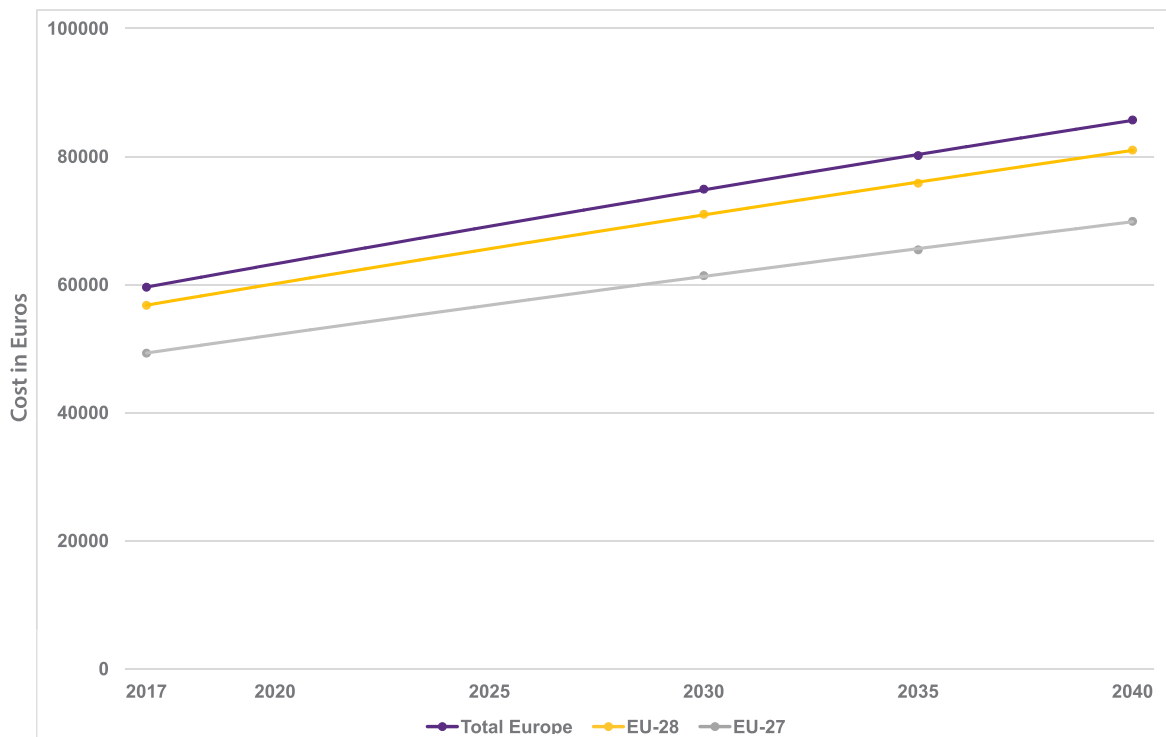
Therefore, the number of people having, living with and dying from stroke will be very likely to increase, and with it, the economic costs associated with stroke.

However, the number of people of working age is projected to fall between 2017 and 2040. As a result, the costs of lost productivity due to deaths and disability are set to go down by €200,000 by 2040 – a 4% reduction due to deaths and 1% reduction due to disability.

Nevertheless, over the same period, the number of people aged 65 or over is projected to increase by 45% and the number aged 85 or over by 89%. As a result, the projected number of people living with stroke will increase by 35%, from nine million in 2017 to 12 million in 2040.

We estimate the costs of stroke will increase from €60 billion in 2017 to €75 billion in 2030, €80 billion in 2035 and €86 billion in 2040. This means that, in just 13 years, the costs of stroke are projected to increase by 26%, and by 44% in 23 years' time.

The graph below shows the increases in total stroke costs between 2017 and 2040 across Europe.





The rising costs of stroke will put strain on already stretched health and social care budgets. European countries need to invest in stroke interventions that are cost-effective, not just to improve outcomes for people who have a stroke but also to halt this increase in costs and overall burden.

Our study evaluated investments in three different interventions across the stroke pathway:

- prevention - to reduce the likelihood of people suffering a stroke in the first place;
- acute treatment in order to minimise stroke damage to the brain and reduce the likelihood of disability;
- rehabilitation to improve the quality of life of stroke survivors.

We looked at:

- routinely treating people who have atrial fibrillation (an uneven heartbeat) with either warfarin or new anticoagulant therapies;
- using mechanical thrombectomy (removing blood clots in the brain) to acutely treat people with ischaemic stroke;
- providing rehabilitation in a community setting once stroke patients were discharged from hospital.

All three interventions were shown to be cost effective and very good value for money at the European level. All of them would increase the number of extra years of good health across the population (known as the quality-adjusted life expectancy).

Treating atrial fibrillation with warfarin, having mechanical thrombectomy routinely available, and providing community-based rehabilitation would all make cost savings. The new oral anticoagulants increase quality-adjusted life expectancy and are cost effective, but they are also more expensive.

The costs of stroke in the 32 countries we studied will rise by 44% between 2017 and 2040, with some countries seeing rises in stroke-related costs of nearly 100%. Policy makers and health planners need to act. Health and social care systems need to be improved and the increasing burden on informal carers (who will have to take even greater responsibility for the care of stroke survivors), needs to be acknowledged and acted upon. European countries need to put interventions and policies in place to try and mitigate these cost increases, whilst also maximising the health outcomes and quality of life for stroke survivors.

## RECOMMENDATIONS

SAFE believes that all countries studied in this report should urgently recognise the increasing economic impact that stroke will have on their health and social care budgets and services over the next 20 years. We urge all countries to take immediate steps to reduce this burden. We also feel strongly that the European Commission must use these findings to prioritise stroke.

This report provides evidence that cost savings can be made by providing better treatment and care for stroke patients. The Organisation for Economic Co-operation and Development (OECD) and the European Commission recently published *Health at a Glance: Europe*<sup>7</sup> which presents comparative analyses of the health status of EU citizens and the performance of the health systems of the 28 EU member states, five candidate countries and three European Free Trade Association countries. It highlighted that reducing wasteful spending and making health systems more effective and resilient is a key priority.

In addition, in 2019, the European Commission published its proposals for country specific recommendations as part of the EU's yearly European semester cycle, which monitors the EU member states' economic and fiscal progress. Seventeen countries were tasked with making improvements, including investing in their healthcare systems and making them more cost-effective.

We call upon all individual countries to take the following actions:

- Adopt and implement a national stroke plan, including the recommendations of the Stroke Action Plan for Europe,<sup>8</sup> and a clear cost-effectiveness framework so that they can properly evaluate their expenditure decisions thus making stroke a national political priority with aligned ambitions and countries pledging themselves to commonly agreed goals.
- Invest in stroke prevention, service provision and research in line with the recommendations in the Stroke Action Plan for Europe.<sup>8</sup> In addition, the evidence in this report demonstrated that the three investigated interventions are at the least cost effective and in most cases would save money. We call on all of the countries studied to:
  - routinely treat patients with known atrial fibrillation with

7 OECD/EU (2018), *Health at a Glance: Europe 2018: State of Health in the EU Cycle*, OECD Publishing, Paris. [https://doi.org/10.1787/health\\_glance\\_eur-2018-en](https://doi.org/10.1787/health_glance_eur-2018-en)

8 Stroke Action Plan for Europe 2018-2030, <https://www.safestroke.eu/stroke-action-plan>

warfarin or the new anticoagulant therapies;

- acutely treat non-minor ischaemic stroke patients with mechanical thrombectomy;

- provide rehabilitation in a community setting once stroke patients are discharged from hospital.

- Accurately collect comparable data in order to help in understanding the impact of public health interventions, social care and provision for people living with stroke.

In addition, as an Alliance, we call for:

- Members of the European Parliament to adopt a Resolution calling on Member States to implement the recommendations of the Stroke Action Plan for Europe<sup>8</sup> and, together with the European Commission, to approve a pilot project to support the international implementation of the Stroke Action Plan for Europe<sup>8</sup> as outlined by SAFE and European Stroke Organisation in 2018.<sup>7</sup>

- DG SANTE should support the creation of a stroke-specific subgroup in the Steering Group on Health Promotion, Disease Prevention and Management of non-communicable diseases and help facilitate discussions about creating national plans for stroke, encompassing the entire chain of care from primary prevention through to life after stroke, in order to better manage and reduce the societal and economic burden of stroke in Europe.

- The European Commission must include research into stroke as a key priority in Horizon Europe, the research and innovation programme which will succeed Horizon 2020.

SAFE also commits to seek funding to carry out further research so that we have a better understanding of the reasons for the differences in the costs of stroke between countries, and to provide further evidence to why, across Europe, we need to increase disease prevention and improve access to care.

# HOW MUCH DOES STROKE COST NOW?

In order to find out what economic impact stroke has, we need to know:

- how many people have a stroke;
- how many live with the long-term effects of stroke;
- the cost of treating someone with a stroke;
- the cost of caring for someone after they leave hospital – including the unpaid, informal care provided by loved ones;
- the impact that people dying or being disabled from stroke has on their economic productivity.

We looked at the 2017 data on the number of new strokes; the number of people living with stroke; the number of people who die as a result of their stroke; hospital admissions for stroke; disease related costs; and other health related indicators.

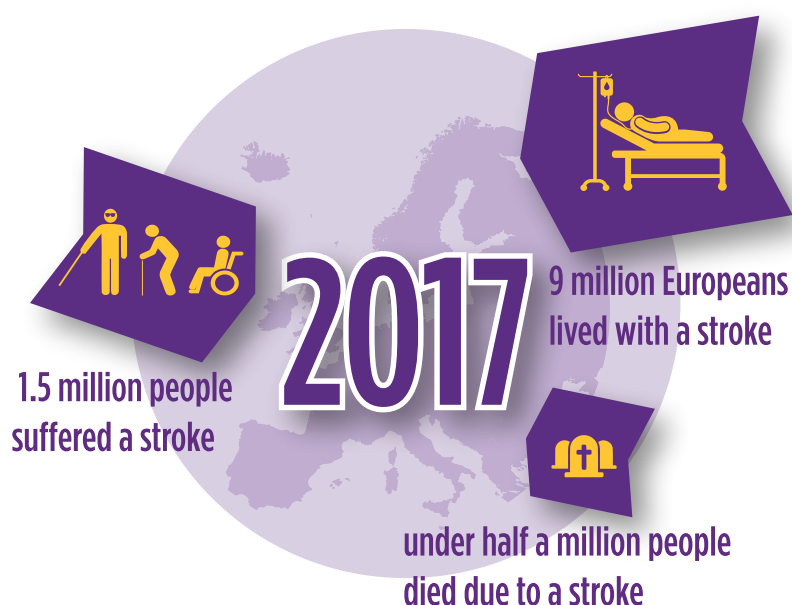
Among the sources consulted included the World Health Organization (WHO), the OECD, the Statistical Office of the European Communities (EUROSTAT), the World Bank Group, national ministries of health, national statistical institutes and large cohort studies. Where there was little data on a particular country, projections based on similar countries (including healthcare costs, life expectancy and geography) were used. The framework used was based upon similar work carried out on cardiovascular disease and dementia.

We looked at the health costs and also the costs to society per year:

- Health costs covered: primary care, accident and emergency care, hospital inpatient care (including day cases), outpatient care and medications.
- Social care costs covered: nursing and residential care homes but not things such as home care, provision of meals, and social carer visits because of the lack of data about these areas of provision. This means that suggested costs of social care in this report are almost certainly underestimated.

- The costs of informal care (most often provided by loved ones): the informal care costs of people who were severely affected by stroke or who were terminally ill, using country-specific data from the Global Burden of Disease and data from SHARE (Survey of Health, Ageing and Retirement in Europe) to assess the informal care needs of stroke patients.
- The impact of stroke on productivity: the costs of stroke survivors having to take sickness leave from work; being too disabled to get employment; or dying from their stroke at an employable age.

In 2017, nearly 1.5 million people suffered a stroke in the 32 European countries under study, nine million Europeans were living with stroke, and almost half a million people died due to a stroke.



The table below shows, for each of the countries studied:

- the number of new strokes (incidence);
- the number of people who have had a stroke (prevalence);
- the number of people who died from a stroke (deaths);
- the number of years of healthy life lost to stroke (DALYs- Disability- Adjusted Life Years).

	INCIDENCE	PREVALENCE	DEATHS	DALYS
AUSTRIA	23,698	154,877	5,246	68,833
BELGIUM	28,085	192,320	6,943	116,340
BULGARIA	38,368	205,683	21,513	327,622
CROATIA	20,469	98,358	7,487	118,848
CYPRUS	1,573	11,079	374	7,522
CZECH REPUBLIC	38,959	216,547	9,630	165,197
DENMARK	12,540	92,553	3,392	60,016
ESTONIA	4,610	32,633	853	23,179
FINLAND	17,429	133,952	4,300	75,047
FRANCE	131,416	942,293	32,271	548,745
GERMANY	242,497	1,685,144	57,082	926,146
GREECE	34,149	212,536	14,445	200,543
HUNGARY	40,003	237,789	12,500	232,778
IRELAND	7,462	56,931	1,920	31,653
ITALY	166,015	778,199	61,783	641,405
LATVIA	12,188	68,840	5,117	73,098
LITHUANIA	15,035	83,143	5,680	77,217
LUXEMBOURG	1,074	8,273	234	4,966
MALTA	892	6,646	287	4,105
NETHERLANDS	35,385	254,094	9,679	162,107
POLAND	124,540	690,591	30,475	653,330
PORTUGAL	27,447	191,120	11,776	187,018
ROMANIA	103,102	489,826	44,251	776,798
SLOVAKIA	20,560	103,365	5,488	95,249
SLOVENIA	6,204	38,875	1,983	27,499
SPAIN	101,845	550,941	28,434	389,291
SWEDEN	24,807	166,065	6,154	103,126
<b>TOTAL EU-27</b>	<b>1,280,353</b>	<b>7,702,671</b>	<b>389,297</b>	<b>6,097,675</b>
UK	134,979	992,413	40,054	667,392
<b>TOTAL EU-28</b>	<b>1,415,332</b>	<b>8,695,085</b>	<b>429,351</b>	<b>6,765,066</b>
ICELAND	603	4,167	154	2,342
ISRAEL	11,390	82,396	2,454	45,122
NORWAY	12,254	81,671	2,623	43,207
SWITZERLAND	19,766	135,329	3,642	63,410
<b>TOTAL EUROPE</b>	<b>1,459,345</b>	<b>8,998,648</b>	<b>438,224</b>	<b>6,919,147</b>

For the 32 countries studied, the total healthcare system costs were calculated from the following **stroke-related health and social care resources**:



<b>GP visits</b>	<b>97,674,000</b>	<b>€3.3B</b>
<b>outpatient visits</b>	<b>62,606,000</b>	<b>€4.7B</b>
<b>emergency care</b>	<b>6,202,000</b>	<b>€919M</b>
<b>hospital days</b>	<b>25,581,000</b>	<b>€16.4B</b>
<b>nursing/ residential care</b>	<b>43,168,000</b>	<b>€4.7B</b>

The next table shows the 2017 costs (in millions of euros) of the six areas of healthcare:

### **PRIMARY CARE**

With over 98 million visits to the GP due to stroke in the 32 countries the overall cost was €3.3 billion. About half of this amount is accounted for by just two countries – Germany and Spain.

### **OUTPATIENT CARE**

The 63 million visits to outpatient consultants cost the healthcare systems of the 32 countries €4.7 billion. Germany (€1.4 billion), the UK (€0.5 billion) and Italy (€0.4 billion) accounted for approximately half of outpatient care costs in Europe.

## **EMERGENCY CARE**

There were 6.2 million visits to Accident and Emergency departments across Europe, costing €919 million overall. While Spain and France had the highest number of visits, accounting for 31% of total visits in Europe, Spain and the UK accounted for 53% of emergency care costs in Europe.

## **HOSPITAL CARE**

Across Europe the 26 million days spent in hospital due to stroke in 2017 resulted in a total cost of €16.4 billion for the 32 countries. Countries spending the most in terms of inpatient care for stroke included: Germany (€6.4 billion); Italy (€2.2 billion); the UK (€1.6 billion) and France (€1.2 billion), with these four countries accounting for approximately 70% of European healthcare spend on inpatient care for stroke patients.

## **PHARMACEUTICALS**

In 2017, the European spend on pharmaceuticals used to prevent and treat stroke was €1.3 billion. The highest spend on stroke medications was in France (€199 million), followed by Spain (€175 million), the Netherlands (€169 million), Germany (€143 million) and Italy (€115 million). These five countries accounted for 61% of total European pharmaceutical expenditure on stroke medications.

## **NURSING HOME/RESIDENTIAL CARE EXPENDITURE**

43 million days were spent in nursing/residential care home by stroke survivors in 2017. This resulted in a total cost for European social care systems of €4.7 billion and €4.2 billion for the EU. Countries spending the most in terms of social care for stroke included: Germany (€866 million); the UK (€767 million), France (€630 million), Italy (€375 million) and Belgium (€328 million).

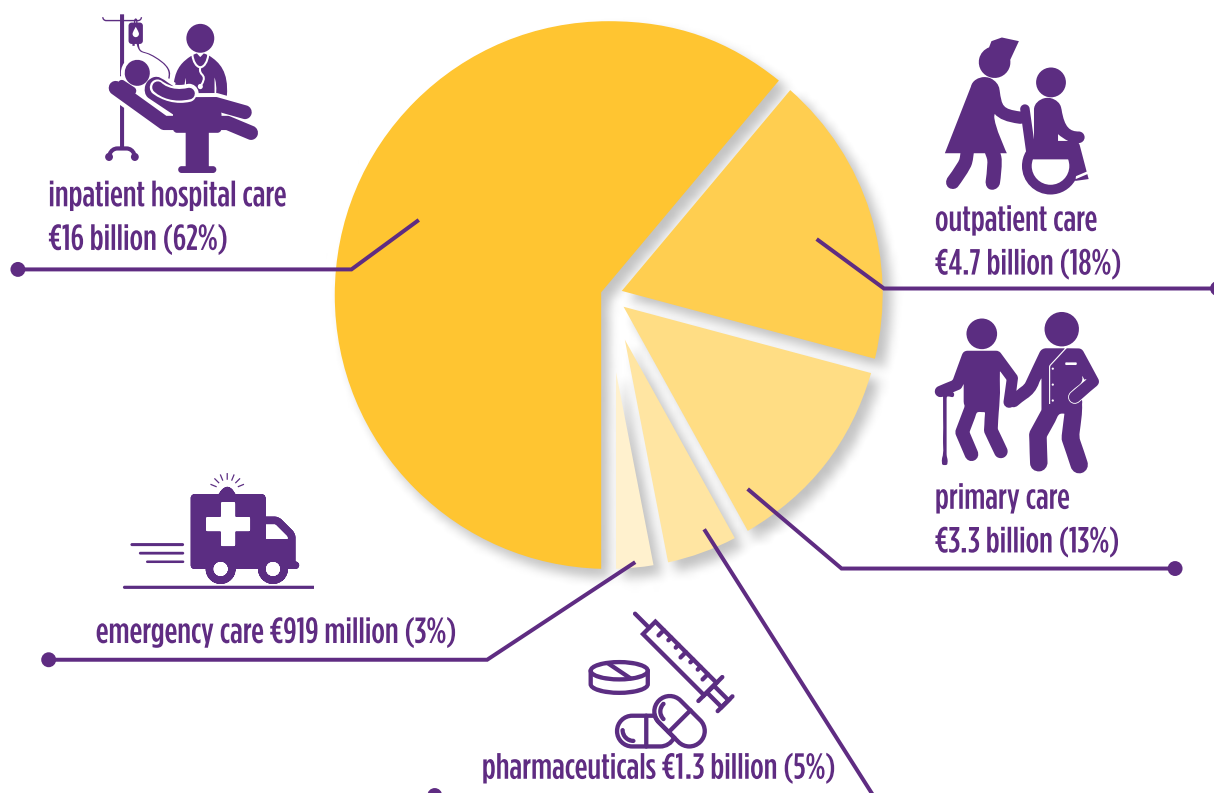


AT WHAT COST – The Economic Impact of Stroke in Europe - A summary

	PRIMARY CARE	OUTPATIENT CARE	EMERGENCY CARE	HOSPITAL CARE	PHARMA	HEALTHCARE	TOTAL HEALTHCARE	SOCIAL CARE
AUSTRIA	155	127	30	504	29		845	106
BELGIUM	39	38	7	411	31		524	328
BULGARIA	11	12	2	31	15		70	8
CROATIA	10	6	8	22	5		50	2
CYPRUS	1	6	2	1	1		11	2
CZECH REPUBLIC	25	64	3	280	18		390	24
DENMARK	20	19	6	114	7		166	155
ESTONIA	9	15	2	33	1		61	3
FINLAND	19	161	29	421	10		640	133
FRANCE	292	401	87	1,165	199		2,143	630
GERMANY	1,155	1,359	24	6,408	143		9,089	866
GREECE	6	11	17	209	41		284	36
HUNGARY	20	37	6	196	28		286	13
IRELAND	27	26	23	83	14		172	17
ITALY	250	418	188	2,160	115		3,131	375
LATVIA	4	8	1	13	3		30	3
LITHUANIA	13	14	1	32	2		62	5
LUXEMBOURG	2	5	0	21	2		29	19
MALTA	1	1	0	7	1		10	2
NETHERLANDS	83	217	12	450	169		932	210
POLAND	45	261	9	253	67		636	89
PORTUGAL	37	60	44	91	24		257	15
ROMANIA	19	61	4	88	26		198	33
SLOVAKIA	32	78	3	55	8		177	11
SLOVENIA	10	8	2	25	4		48	9
SPAIN	427	336	178	569	175		1,685	133
SWEDEN	121	289	55	311	12		788	231
<b>TOTAL EU-27</b>	<b>2,832</b>	<b>4,038</b>	<b>743</b>	<b>13,955</b>	<b>1,146</b>		<b>22,715</b>	<b>3,459</b>
UK	399	516	123	1,636	101		2,775	767
<b>TOTAL EU-28</b>	<b>3,231</b>	<b>4,554</b>	<b>866</b>	<b>15,590</b>	<b>1,247</b>		<b>25,489</b>	<b>4,226</b>
ICELAND	8	6	1	11	1		27	6
ISRAEL	20	49	36	84	12		201	22
NORWAY	43	46	8	211	8		316	186
SWITZERLAND	23	13	8	482	33		558	307
<b>TOTAL EUROPE</b>	<b>3,324</b>	<b>4,669</b>	<b>919</b>	<b>16,378</b>	<b>1,301</b>		<b>26,592</b>	<b>4,748</b>

## TOTAL HEALTHCARE EXPENDITURE

In total, in 2017 stroke cost the healthcare systems of the 32 countries under study €27 billion. Of this, €16 billion (62%) was due to inpatient hospital care, followed by outpatient care (€4.7 billion, 18%), primary care (€3.3 billion, 13%), pharmaceuticals (€1.3 billion, 5%) and emergency care (€919 million, 3%).



The top five countries with the highest healthcare expenditure due to stroke also have the biggest populations. Germany (€9.1 billion), Italy (€3.1 billion), the UK (€2.8 billion), France (€2.1 billion) and Spain (€1.7 billion). Health expenditure due to stroke in these five countries accounted for 71% of all stroke-related healthcare expenditure in Europe.

The average costs of stroke as a proportion of the countries' overall health expenditure was 1.7%. But there was a very wide variation between countries, with less wealthy countries such as Hungary spending 3.42% and Estonia spending 4.34%. This contrasts with the wealthiest countries - Denmark spends 0.58% of its health budget on stroke and Switzerland spends 0.75%.

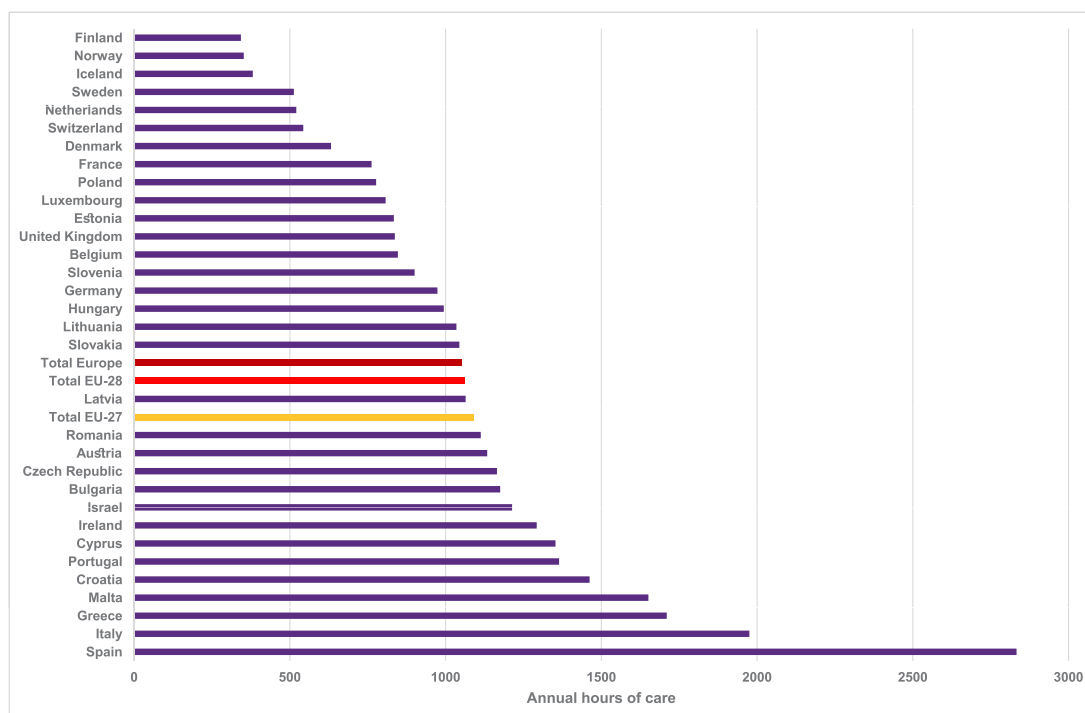
## THE COSTS OF INFORMAL CARE

On average, in 2017, friends and family provided 1,052 hours of informal care for each person with stroke who was severely limited in activities of daily living. This varied widely across Europe from 343 hours in Finland to 2,833 hours in Spain. Scandinavian countries tended to provide the least hours of informal care, whereas southern European countries provided the most.

Of the nine million people with stroke, 1.2 million were severely hampered in their activities of daily living. In total, they received 1.3 billion hours of care from friends and family. The most care took place in Germany with 271 million hours of care provided (21% of the total), followed by Italy with 170 million hours (13%) and Spain with 110 million hours (8%).

These 1.3 billion hours of informal care provided across Europe were valued at €16 billion for the year 2017. As with the total number of hours of care, Germany had the highest informal care costs across Europe (€5 billion – 32%), followed by Italy with costs of €2 billion (15%) and France (€1 billion – 8%).

The graph below shows the average number of hours per year of informal care that stroke survivors received in 2017.



## THE COSTS OF LOST PRODUCTIVITY DUE TO DEATH AND DISABILITY

In 2017, there was a total of 438,000 deaths due to stroke in the 32 European countries under analysis, amounting to 286,000 potential years of work lost. After discounting future losses (such as those losses incurred after the first year of death), premature mortality cost the 32 European countries under study a total of €6.2 billion. Germany, with productivity losses of €1.5 billion due to premature death, accounted for nearly a quarter of total mortality costs. A total of 38 million working days were lost due to permanent and temporary absence from work across Europe due to stroke. These losses were valued at €6.3 billion. In total, productivity losses due to death or disability caused by stroke amounted to €12.5 billion.

The next table shows the amount of informal care and lost productivity (in 1,000s), in the 32 countries studies in 2017.

	HOURS OF INFORMAL CARE	DEATHS	WORKING YEARS LOST DUE TO DEATH	WORKING DAYS LOST DUE TO ILLNESS
<b>AUSTRIA</b>	22,215	5	3	920
<b>BELGIUM</b>	21,128	7	3	770
<b>BULGARIA</b>	40,133	22	15	193
<b>CROATIA</b>	21,541	7	3	421
<b>CYPRUS</b>	1,255	0.4	0.3	54
<b>CZECH REPUBLIC</b>	35,784	10	7	507
<b>DENMARK</b>	5,099	3	3	297
<b>ESTONIA</b>	5,837	1	1	362
<b>FINLAND</b>	4,743	4	2	832
<b>FRANCE</b>	86,846	32	19	7,648
<b>GERMANY</b>	270,850	57	39	5,191
<b>GREECE</b>	21,982	14	5	889
<b>HUNGARY</b>	38,342	13	9	224
<b>IRELAND</b>	4,726	2	2	507
<b>ITALY</b>	169,878	62	21	3,199
<b>LATVIA</b>	12,571	5	4	299
<b>LITHUANIA</b>	14,738	6	6	620
<b>LUXEMBOURG</b>	828	0.2	0.1	16
<b>MALTA</b>	895	0.3	0.2	50
<b>NETHERLANDS</b>	27,764	10	7	548

	HOURS OF INFORMAL CARE	DEATHS	WORKING YEARS LOST DUE TO DEATH	WORKING DAYS LOST DUE TO ILLNESS
<b>POLAND</b>	90,924	30	33	604
<b>PORTUGAL</b>	44,808	12	9	905
<b>ROMANIA</b>	90,407	44	33	405
<b>SLOVAKIA</b>	17,075	5	5	359
<b>SLOVENIA</b>	5,071	2	1	111
<b>SPAIN</b>	110,152	28	13	2,804
<b>SWEDEN</b>	9,301	6	3	568
<b>TOTAL EU-27</b>	<b>1,174,893</b>	<b>389</b>	<b>245</b>	<b>29,303</b>
<b>UK</b>	116,847	40	34	5,705
<b>TOTAL EU-28</b>	<b>1,291,740</b>	<b>429</b>	<b>279</b>	<b>35,008</b>
<b>ICELAND</b>	158	0.2	0.2	22
<b>ISRAEL</b>	10,272	2	3	1,551
<b>NORWAY</b>	2,922	3	2	1,149
<b>SWITZERLAND</b>	6,157	4	3	267
<b>TOTAL EUROPE</b>	<b>1,311,249</b>	<b>438</b>	<b>286</b>	<b>37,997</b>

## THE TOTAL COST OF STROKE

Stroke cost the 32 European economies under study a total of €60 billion in 2017. For the EU this was just under €50 billion. Of that total, healthcare cost €27 billion, 45% of total costs; informal care cost €16 billion and loss of productivity due to disability and death about €12 billion. Nursing home and residential care (social care), costing €5 billion, made up 8% of the total cost.

**€27 billion**

**healthcare**

**€16 billion**

**informal care**

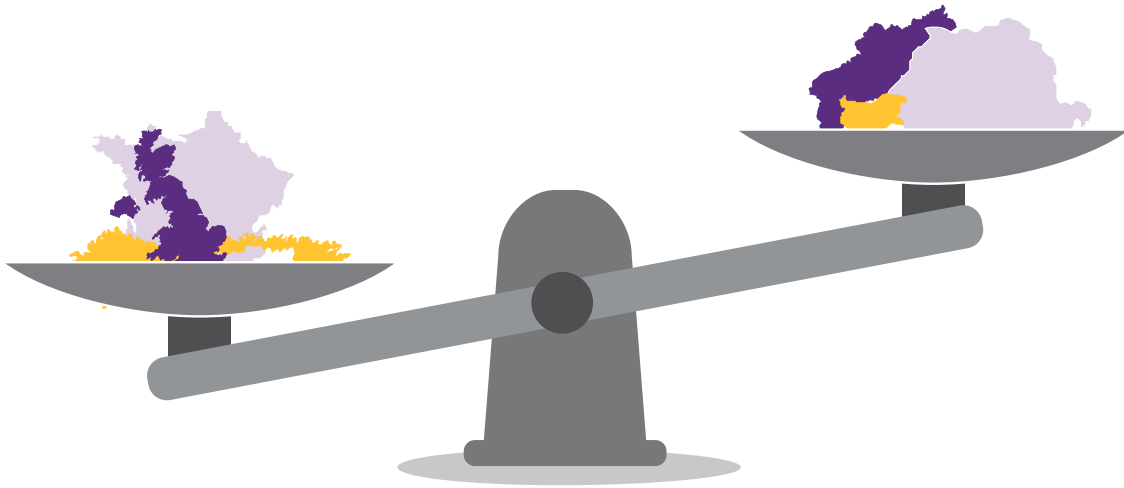
**€12 billion**

**loss of productivity**

**€5 billion**

**social care**

However, these proportions of spending varied widely between countries. In Luxembourg, for example, social care accounted for 25% (€19 million) of total costs of stroke, whereas in Croatia these costs accounted for less than 1% (€2 million) of total costs. As a proportion of total costs, productivity losses due to premature mortality were highest in Bulgaria, accounting for 31% (€88 million) of total costs, and lowest in Norway, where they accounted for 7% (€68 million) of total costs.



The table below shows all of the different areas of cost discussed above to provide the overall cost (in millions €) of stroke across the 32 countries.

	HEALTH AND SOCIAL CARE	INFORMAL CARE	MORTALITY LOSSES	MORBIDITY LOSSES	TOTAL
AUSTRIA	952	383	94	180	1,608
BELGIUM	853	354	118	159	1,484
BULGARIA	78	106	87	6	278
CROATIA	52	101	31	26	211
CYPRUS	13	13	5	6	37
CZECH REPUBLIC	414	206	79	32	730
DENMARK	322	148	124	83	677
ESTONIA	64	35	14	24	137
FINLAND	773	92	83	163	1,111
FRANCE	2,773	1,260	519	1,271	5,823
GERMANY	9,954	4,971	1,483	1,191	17,600
GREECE	320	160	82	89	650
HUNGARY	300	168	87	12	567
IRELAND	189	83	67	111	451
ITALY	3,507	2,355	543	501	6,905
LATVIA	32	59	36	16	144
LITHUANIA	67	59	47	29	203
LUXEMBOURG	48	17	6	4	75
MALTA	13	8	3	5	29
NETHERLANDS	1,142	484	247	117	1,991
POLAND	725	421	331	35	1,512
PORTUGAL	272	304	133	74	783
ROMANIA	231	333	234	17	815
SLOVAKIA	188	83	54	22	347
SLOVENIA	57	45	15	12	129
SPAIN	1,818	1,109	274	357	3,557
SWEDEN	1,019	193	122	122	1,455
<b>TOTAL EU-27</b>	<b>26,174</b>	<b>13,549</b>	<b>4,920</b>	<b>4,665</b>	<b>49,308</b>
UK	3,542	1,838	1,044	1,046	7,470
<b>TOTAL EU-28</b>	<b>29,716</b>	<b>15,387</b>	<b>5,964</b>	<b>5,711</b>	<b>56,778</b>
ICELAND	33	4	7	5	48
ISRAEL	223	123	57	195	597
NORWAY	501	78	68	277	926
SWITZERLAND	866	170	139	81	1,256
<b>TOTAL EUROPE</b>	<b>31,339</b>	<b>15,762</b>	<b>6,235</b>	<b>6,269</b>	<b>59,605</b>

## WHAT ARE THE FUTURE COSTS OF STROKE?

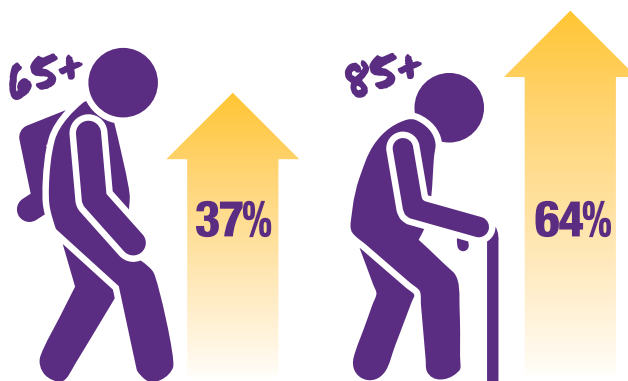
In 2017 the cost of stroke in the 32 European countries studied was €60 billion. In this chapter we predict the costs of stroke in 2030, 2035 and 2040. In order to do so, the first step was to estimate the future incidence and prevalence of stroke:

- incidence is the number of new strokes;
- prevalence is the number of people who have had a stroke.

The incidence of strokes has been declining over the last two decades. But recent data shows (after adjusting for age and gender related prevalence) an increase in strokes in younger people; and that the number of people with conditions that increase the risk of stroke, such as diabetes, obesity and atrial fibrillation is rising. This complicates assessments of future incidence. Our study is based upon 2017 data (from the Global Burden of Disease Study with projections on future population numbers from EUROSTAT and, for Israel, the OECD).

While there has been a welcome decrease in stroke related deaths, there is some evidence suggesting that the number of deaths within the first year after a stroke has not changed. Nor is it clear what impact this may have on the number of people living with the life changing, long-term impact of stroke. Therefore, the study assumes the same stroke mortality rates for 2030, 2035 and 2040 as in 2017.

The research used the country, age and sex-specific stroke prevalence data from 2017 and mapped this against projections of the future age and sex-specific populations of the 32 countries.



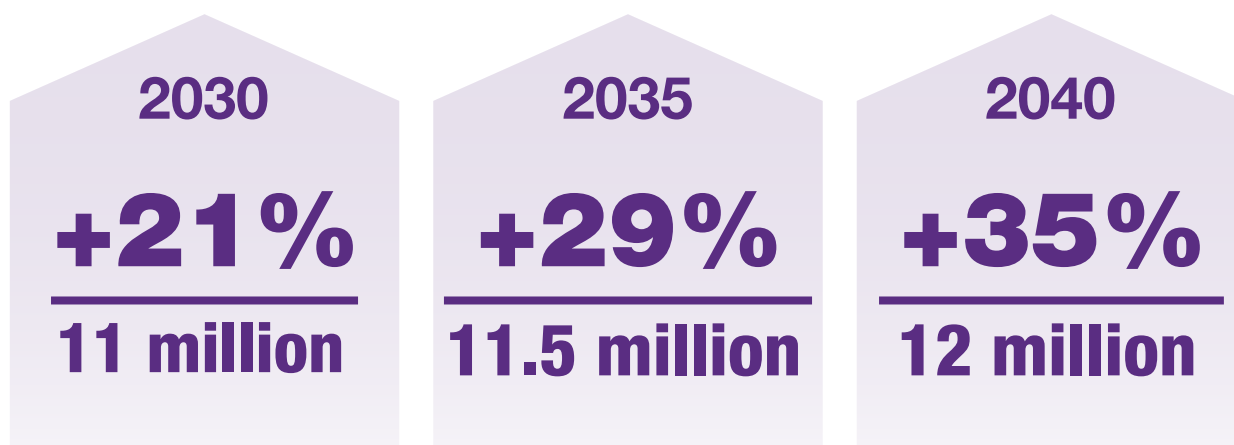
In 2030 the total population of the 32 countries is predicted to increase by 4%. But the number of people aged 65 and over is set to rise by 37% and, even more dramatically, there will be an estimated 64% increase in the number of people aged 85 and over.



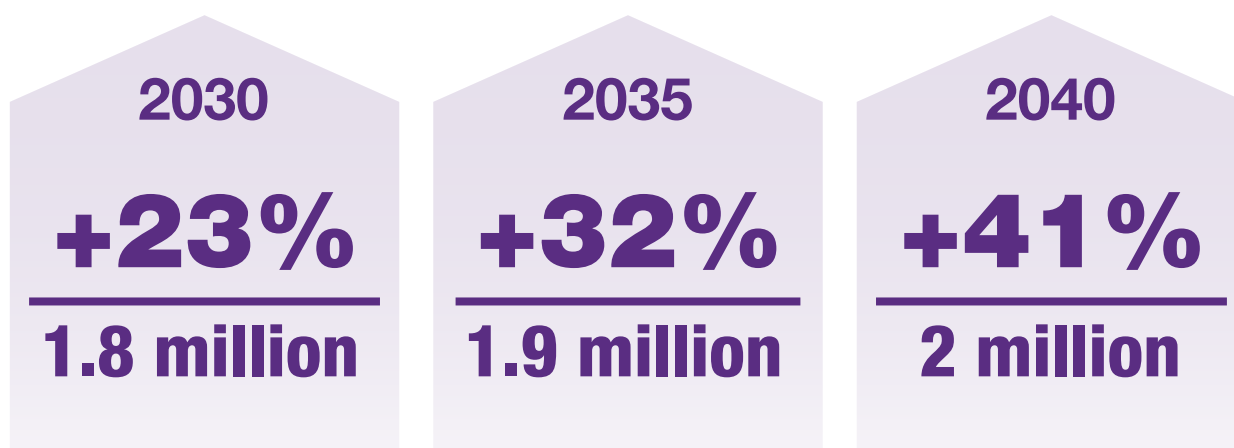
As age is the biggest, non-modifiable risk factor for stroke, we are set to see a considerable rise in the number of new strokes and the number of people living with stroke, concentrated in these older age groups.

The predicted increase in overall population compared to 2017 remains 4% for 2035 and 2040, but the increase in the number of older people means that stroke incidence is set to increase by 32% in 2035 and 41% in 2040.

The projected number of people living with stroke is projected to rise from nine million in 2017 to:



The number of people suffering a stroke for the first time is predicted to increase from 1.5 million in 2017 to:

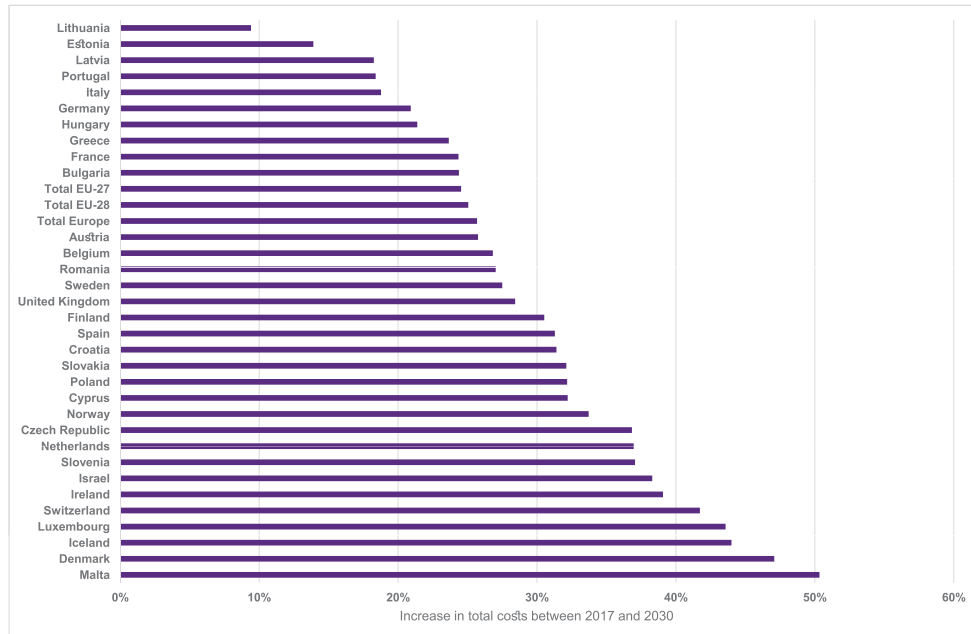


So, how will this projected rise in the number of people having a stroke and living with stroke in 2030, 2035 and 2040 impact on the cost of stroke?

Between 2017 and 2030 overall costs of stroke are projected to rise by €25 per citizen. This goes up by €33 per citizen from 2017 to 2035 and €42 per citizen from 2017 to 2040. However, there was great variation between countries, with Finland experiencing the biggest increase in costs per citizen in all three years and Cyprus showing the lowest increase in 2035 and 2040.

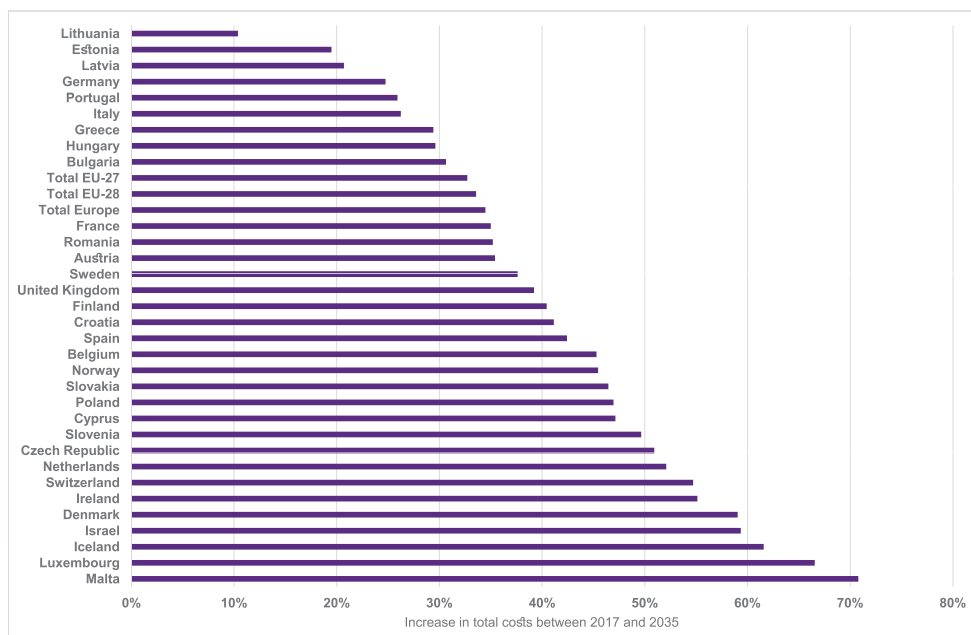
## COSTS OF STROKE IN 2030

Stroke is projected to cost the 32 European economies under study a total of €75 billion in 2030 with healthcare costs projected to be €33 billion in 2030, ranging from a lower value of €24 billion to a higher value of €45 billion. This graph shows the increase in total stroke costs between 2017 and 2030.



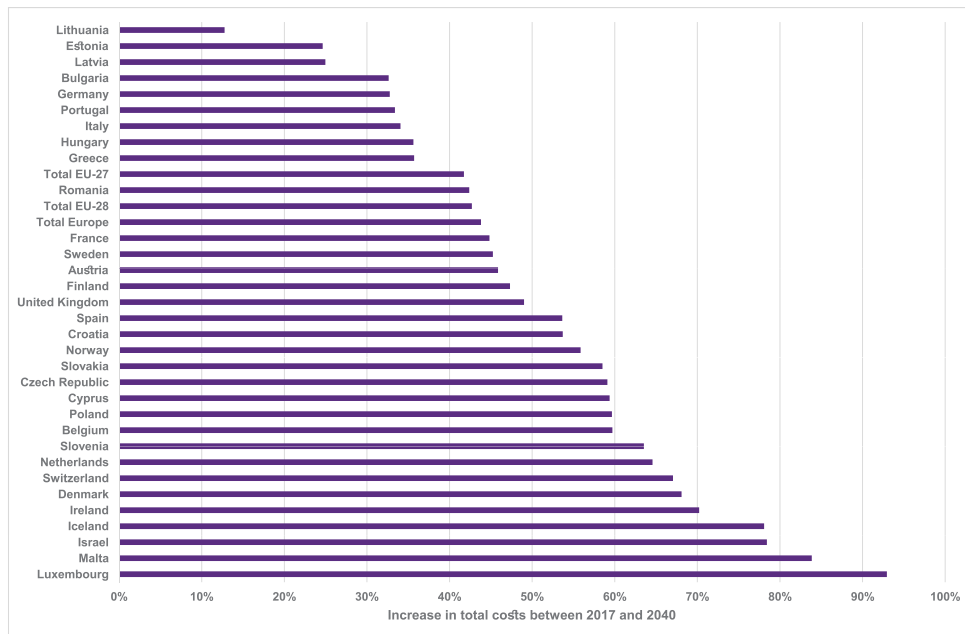
## COSTS OF STROKE IN 2035

Stroke is projected to cost the 32 European economies under study a total of €80 billion in 2035 with healthcare costs projected to be €35 billion, ranging from a lower value of €26 billion to a higher value of €48 billion. This graph shows the increase in total stroke costs between 2017 and 2035.



## COSTS OF STROKE IN 2040

Stroke is projected to cost the 32 European economies under study a total of €86 billion in 2040 and healthcare systems costs are projected to be €37 billion in 2040, ranging from a lower value of €27 billion to a higher value of €51 billion. This graph shows the increase in total stroke costs between 2017 and 2040.



# INVESTING IN STROKE CARE: ECONOMIC IMPACT

We looked at the impact three different interventions in stroke care and prevention would have on the economic burden of stroke. The numbers of people having a stroke, the severity of their stroke, and their recovery from stroke all influence the overall economic impact of stroke.

- **The first intervention** was tackling atrial fibrillation (uneven heartbeat) through the use of warfarin, or new oral anti-coagulation drugs instead of aspirin;
- **The second** was rolling out routine use of thrombectomy (the mechanical removal of blood clots in ischaemic stroke);
- **The third** was provision of rehabilitation services and support as outlined in stroke guidelines.

For each of these three interventions the study makes projections of costs over a five-year period, starting from the baseline of 2017.

We have used the concept of Quality Adjusted Life Years (QALYs) to work out the cost effectiveness of the interventions as well as comparing the number of cases, healthcare costs, informal care costs and productivity losses associated with implementing the intervention versus current practice/standard care.

England and Wales's National Institute for Health and Care Excellence (NICE), defines QALYs as: "A measure of the state of health of a person or group in which the benefits, in terms of length of life, are adjusted to reflect the quality of life. One QALY is equal to one year of life in perfect health. QALYs are calculated by estimating the years of life remaining for a patient following a particular treatment or intervention and weighting each year with a quality-of-life score (on a 0 to 1 scale). It is often measured in terms of the person's ability to carry out the activities of daily life, and freedom from pain and mental disturbance. NICE also determines a financial threshold of €22,727 per QALY gained (£20,000, exchange rate: €1 = £0.88) above which an intervention is deemed to not be cost effective. The WHO also provides guidance on cost effectiveness.

The model we used to determine the costs of these three interventions simulated costs, survival and (quality adjusted) life expectancy following the onset of stroke. It is based on six levels of stroke-related disability at three months following the stroke using the modified Rankin Scale (mRS) .

Following a stroke, patients might die or, at three months, have:

- 0** | No symptoms
- 1** | No significant disability (able to carry out all usual activities despite some symptoms)
- 2** | Slight disability (able to look after own affairs without assistance, but unable to carry out all previous activities)
- 3** | Moderate disability (requires some help, but able to walk unassisted)
- 4** | Moderate severe disability (unable to attend to own bodily needs without assistance and unable to walk unassisted)
- 5** | Severe disability (requiring constant nursing care and attention, bedridden and incontinent)

Anticoagulant therapy was modelled around the potential reduction in the incidence of ischaemic stroke on the one hand and a potential increase in major bleeding events in the atrial fibrillation population on the other, both compared to current practice. Both mechanical thrombectomy and community-based rehabilitation were modelled via a potential change in severity of stroke-induced disability and death at three months after stroke onset compared to standard care.

Atrial fibrillation is a major risk factor for stroke. Treatment with anti-coagulant drugs reduces the risk of blood clots forming which can travel through the vascular system to the brain, causing a blockage - an ischaemic stroke.

There is evidence that a large proportion of people with atrial fibrillation who have an ischaemic stroke were not being treated with anti-coagulant drugs at the time of their stroke. We evaluated the impact of routine use of anticoagulants in atrial fibrillation patients.

A range of anticoagulants are currently licensed and used throughout Europe. These include warfarin and new oral anticoagulants (NOACs: apixaban, dabigatran, edoxaban and rivaroxaban).

**Warfarin** has been available since the 1950s and its costs are low, therefore potentially decreasing the barriers to rapid uptake across Europe. 28 tablets of warfarin 1mg cost €0.48.

**NOACs**, on the other hand, are more costly, but have broadly shown to be more effective at reducing the risk of ischaemic stroke, major bleeding events and all-cause mortality, than warfarin.

Anticoagulants are not suitable for all people with atrial fibrillation because the risk of bleeding, compared to just giving aspirin, can be higher. A scoring system to assess the risk of major bleeding for people using anticoagulants has been developed, called HAS-BLED.



In this study, we assumed that patients with HAS-BLED scores higher than 2 would not be eligible to receive any anticoagulant, and thus would continue to be treated with aspirin.

Using population-based evidence, we assumed this to be 15% of the atrial fibrillation population, irrespective of age. Atrial fibrillation is very rarely found in people under 30, so we restricted our target population to those with atrial fibrillation aged over 30 years.

We defined “current practice” by assuming that on average 25% of the eligible atrial fibrillation population would be already on warfarin (this proportion varied with age), and that the rest would be on daily antiplatelet therapy with aspirin 150mg. We then compared routine use of warfarin and NOACs to current practice. Given that there are currently four classes of NOACs, we modelled that of the 60% of patients receiving a NOAC, 25% of them would receive apixaban (5mg twice daily), 25% dabigatran (150mg twice daily), 25% edoxaban (60mg once daily), and the remaining 25% would receive rivaroxaban (20mg once daily).

For NOACs, we assumed that 15% of the population would remain on antiplatelet therapy (aspirin) due to high HAS-BLED scores, 25% would still be taking warfarin because they are perceived to be at risk of missing dosages of the medication.

If a dose of warfarin is missed, re-starting treatment with warfarin would still be effective. In contrast, NOACs are shorter acting than warfarin, so if a dose of NOAC is missed, patients can quickly lose the anticoagulation effect and increase their risk of a blood clot. The remaining 60% of patients would receive a NOAC.



The dose of warfarin will vary between individuals depending on how long it takes to form a blood clot (known as the international normalised ratio or INR). We followed general guidance and assumed that patients would be on a daily dosage of 10mg during the first day of treatment, and 2mg thereafter.

For NOACs, we assumed that patients would receive dosages as recommended in the British National Formulary.

The table below shows that there are almost seven million people with atrial fibrillation in the 32 countries under study, with almost six million of them having the potential to benefit from anticoagulation therapy. Country, age, and gender-specific numbers of cases with atrial fibrillation were derived from the Global Burden of Disease study.

	NUMBER OF AF PATIENTS	AF PATIENTS ELIGIBLE FOR ANTICOAGULANT THERAPY
AUSTRIA	142,603	121,212
BELGIUM	137,448	116,831
BULGARIA	88,079	74,867
CROATIA	43,670	37,119
CYPRUS	10,161	8,636
CZECH REPUBLIC	135,868	115,488
DENMARK	74,597	63,408
ESTONIA	16,619	14,126
FINLAND	87,422	74,309
FRANCE	820,312	697,265
GERMANY	1,201,402	1,021,191
GREECE	139,047	118,190
HUNGARY	125,060	106,301
IRELAND	42,228	35,893
ITALY	847,845	720,668
LATVIA	26,232	22,297

	NUMBER OF AF PATIENTS	AF PATIENTS ELIGIBLE FOR ANTICOAGULANT THERAPY
LITHUANIA	36,884	31,351
LUXEMBOURG	7,582	6,445
MALTA	5,583	4,745
NETHERLANDS	197,572	167,936
POLAND	495,314	421,017
PORTUGAL	102,488	87,115
ROMANIA	196,967	167,422
SLOVAKIA	61,154	51,981
SLOVENIA	31,271	26,580
SPAIN	588,301	500,056
SWEDEN	174,243	148,107
<b>TOTAL EU-27</b>	<b>5,835,950</b>	<b>4,960,557</b>
UNITED KINGDOM	934,851	794,623
<b>TOTAL EU-28</b>	<b>6,770,801</b>	<b>5,755,181</b>
ICELAND	3,399	2,889
ISRAEL	61,750	52,488
NORWAY	69,017	58,665
SWITZERLAND	80,875	68,743
<b>TOTAL 32 COUNTRIES</b>	<b>6,985,842</b>	<b>5,937,966</b>

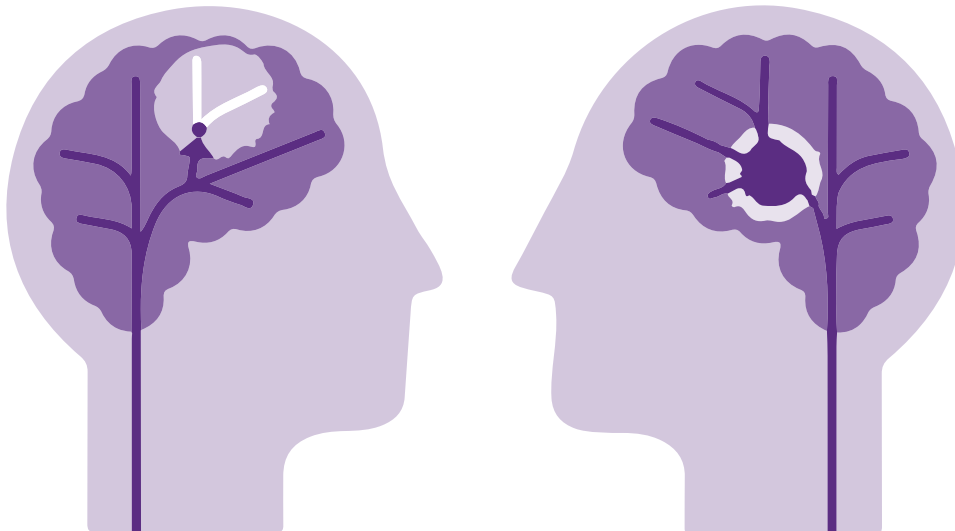
To generate a picture of the economic costs of treating or not treating atrial fibrillation with either warfarin or a NOAC, we used the following model following a one-year cycle:

- someone with atrial fibrillation (who has not already had a stroke) could have an ischaemic stroke;
- they could have a major bleed requiring hospital treatment;
- they could die as a result of both.

For people who have an ischaemic stroke, their condition was further divided into six levels, depending on the severity of the long-term impact of the stroke (measured at three months using the mRS which assesses the level of disability that someone is left with after stroke). During the one-year cycle, there may be no change; or they could have a major bleed; or they could die. For those who were already taking warfarin at the time of their ischaemic stroke, we assumed they would continue to take it unless or until they then had a major bleeding event.



People with non-fatal major bleeds may either recover completely or be disabled. They could also have an ischaemic stroke and they could die. We assumed that those on warfarin would stop taking it following a major bleed and be given aspirin instead.



Using the daily costs of aspirin, warfarin and NOAC from the British National Formulary, our analysis is based upon the following:

- **aspirin** (1250mg) costs €0.07 per day. A packet of 75mg tablets cost €0.794, therefore daily cost was  $€0.94 / 28 \times 2 = €0.07$ ;
- **warfarin** costs €0.04 per day. A packet of 28 tablets of 1mg cost €0.62, therefore daily cost was  $€0.62 / 28 \times 2 = €0.04$  (plus an initial cost for the higher first dose on day one of €0.05);
- **apixaban** (5mg twice daily) costs €2.16 per day: a packet of 56 tablets of 5mg costs €60.45 therefore,  $€60.45 / 56 \times 2 = €2.16$ ;
- **dabigatran** (150 mg twice daily) costs €1.93 per day: a packet of 60 tablets of 150mg costs €57.95 therefore,  $€57.95 / 60 \times 2 = €1.93$ ;
- **edoxaban** (60mg once daily) costs €1.99 per day: a packet of 28 tablets of 60mg costs €55.68 therefore,  $€55.68 / 28 = €1.99$ ;
- **rivaroxaban** (20mg once daily) costs €2.04 per day: a packet of 28 tablets of 20mg costs €57.27 therefore,  $€57.27 / 28 = €2.04$ ;

We assessed the difference in costs and QALYs for each intervention compared to aspirin. Where the intervention was more costly but also more effective, or was less costly but less effective, we evaluated the “incremental cost-effectiveness ratio” (ICER), estimated by dividing the difference in costs by the difference in QALYs.

We used two thresholds in order to judge the cost-effectiveness of the interventions being evaluated:

- The cost-effectiveness threshold decided by England's NICE of €22,727 per QALY gained (£20,000, exchange rate: €1 = £0.88);
- Using the country's per capita gross domestic product (GDP) for 2017, as recommended by the WHO.

## Warfarin

On average patients treated with warfarin would gain 2.21 quality-adjusted life years over five years, compared to 2.19 with those just treated with aspirin – that is a QALY gain of 0.019 per patient.

With warfarin, the average QALYs over five years were 2.21 per patient treated compared with 2.19 QALYs under current practice - a QALY gain of 0.019 per atrial fibrillation patient.

At the population level, the total QALYs across the 32 European countries were 15.4 million with routine use of warfarin and 15.3 million with current practice, an increase of 0.14 million QALYs.

Across the 32 countries, the average cost of therapy per patient was:

- **€51.4** for those treated with routine use of warfarin
- **€64.9** for patients receiving current therapy (aspirin only).

This translates as costs of €359 million compared to €453 million with current practice.

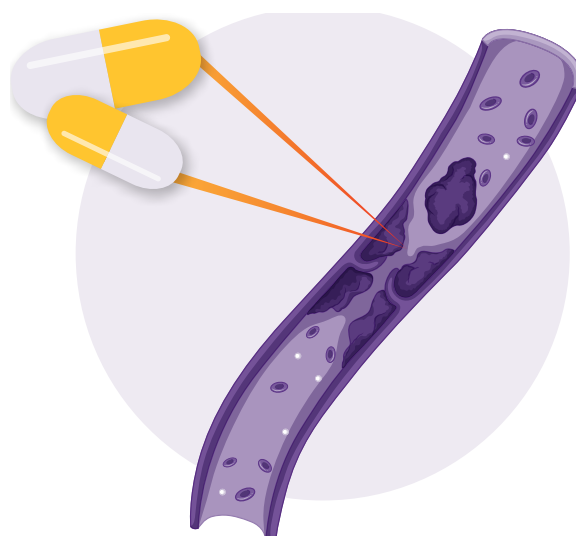
Health and social care costs were also lower for routine use of warfarin (€8.7 billion vs. €14.8 billion), even though costs associated with treatment of major bleeding were higher in the routine warfarin scenario. So, treating eligible atrial fibrillation patients with warfarin would generate cost-savings to the health and social care budget across Europe of €6.1 billion. When we include the overall societal costs, savings of around €7 billion could be made over five years in the 32 countries under study.

So, overall, routine use of warfarin would add just over 136,000 QALYs years over five years and would save €7 billion.

## New oral anticoagulants

With routine use of NOACs the average QALYs over five years were 2.24 per patient treated compared with 2.19 QALYs under current practice- a QALY gain of 0.044 per atrial fibrillation patient.

At the population level, the total QALYs across the 32 countries were 15.6 million for NOACs and 15.3 million with current practice, an increase of around 0.3 million QALYs. For all countries NOACs generated additional QALYs, compared to current practice.



The five-year average therapy cost of NOACs per patient with atrial fibrillation was €1,344 compared with €64.90 for current practice (€9.4 billion as opposed to €453 million at the population level).

However, subsequent health and social care costs were lower than current practice (€7.5 billion vs. €14 billion, respectively).

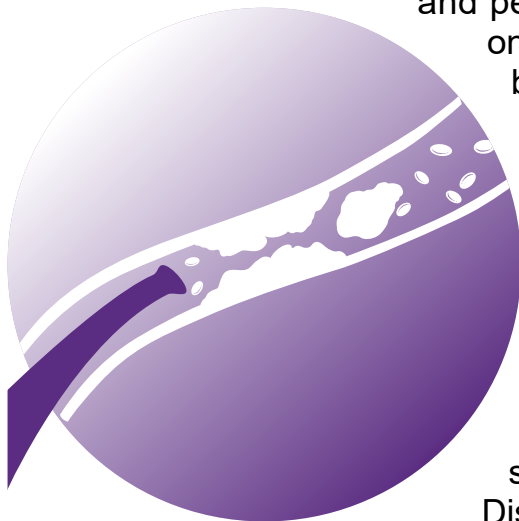
So, compared with current practice over a five-year period, the incremental health and social care costs of routine use of NOACs would be €2.5 billion across Europe. At a country level the intervention would generate health and social care cost savings in Belgium, Finland, Germany, Iceland, Luxembourg, Norway and Switzerland. When we include health, social and informal care costs and productivity losses, the overall costs were estimated to be €20 billion with routine use of NOACs compared with €18 billion for current practice.

Overall, routine use of NOACs would generate around 310,000 extra QALYs at an extra societal cost of €2 billion.

However, for some countries (Bulgaria, Croatia, Hungary, Latvia, Lithuania, Poland, Romania and Slovakia) the decision on whether the intervention is good value for money was dependent on which cost-effectiveness threshold was applied. Routine anticoagulation therapy to reducing stroke risk would deliver significant gains in QALYs. While the NOACs are more costly than warfarin, they deliver more QALYs per patient treated. In the wealthiest countries of Europe, NOACs do also deliver cost savings, but for less wealthy Eastern European countries, decisions about their cost effectiveness may make warfarin use more attractive. What is true for all of the 32 countries is that greater efforts to diagnose and treat atrial fibrillation will deliver financial and health benefits.

## Mechanical thrombectomy

One of the most recent advances in the treatment of acute stroke has been the development of mechanical thrombectomy (MT). MT is a treatment that removes blood clots blocking large blood vessels in the brain with a procedure using an angiogram or a catheterisation and a device that grabs the clot, removes it, and then re-establishes blood flow to the brain. It is most often performed after intravenous thrombolysis (IVT) with alteplase



and performed within six hours from symptoms onset. We compared MT with the use of IVT by itself, except for patients over the age of 80, where IVT is typically not administered, where we compared MT on its own with non-thrombolytic treatment.

For people who survived their stroke, we used the assessment of level of disability caused by their stroke at three months - levels 0 to 5 on the mRS. Country, age, and gender-specific numbers of new ischaemic strokes came from the Global Burden of Disease.

In 2017, across Europe, just over one million people aged 20 years and over suffered an ischaemic stroke. Of these, 27% (267,514) were eligible for MT.

The average QALY gain over five years was 2.00 for patients treated with MT, compared with 1.62 for those undergoing standard care. At the population level, the total QALYs gained across the 32 European countries was 534,430 with MT and 433,103 with standard care, with MT generating an additional 101,327 QALYs.

Over the five years, treating all eligible patients with MT generated health and social care costs of €11 billion compared with €12 billion for standard. The countries with the biggest savings were Germany, with five-year savings of €435 million, followed by the UK (savings of €80 million), Switzerland (savings of €61 million) and Italy (savings of €59 million). However, MT did not generate cost savings when compared to standard care for all countries, including Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Greece, Hungary, Israel, Latvia, Lithuania, Poland, Portugal, Romania, Slovakia and Spain.

When productivity losses were included, overall societal costs were €12.2 billion with routine use of MT compared with €13.7 billion for standard care -savings of €1.5 billion over a five-year period. As with the health and social care perspective, MT did not generate cost savings when compared to standard care for all countries. For Bulgaria, Croatia, Cyprus, Estonia,

Hungary, Latvia, Lithuania, Poland, Portugal, Romania and Slovakia, the additional costs of providing MT were not offset by subsequent savings.

For countries in which MT generated additional costs compared to standard care, we estimated the incremental cost per QALY gained to assess the cost-effectiveness of MT. For all countries MT was cost-effective using a €22,727 cost per QALY threshold. Only for Bulgaria, was MT judged not cost-effective when using annual GDP estimates as the cost-effectiveness threshold.

### Community-based rehabilitation following stroke



In 2017, across Europe, just over 1.4 million people aged 20 years or over suffered an ischaemic or haemorrhagic stroke. Of these, 855,083 (59%) stroke patients were eligible for community-based (CB) rehabilitation. Evidence and best-practice guidelines now recommend that stroke patients discharged from hospital should continue to have access to specialised CB rehabilitation services.

Therefore, in our study we compared CB rehabilitation for stroke patients discharged from hospital to current practice which we defined as inpatient care followed by some level of stroke rehabilitation delivered in either out-patient clinics or day hospital.

The target population of CB rehabilitation was defined as:

- stroke survivors who had a confirmed diagnosis (intracerebral haemorrhages, ischaemic strokes and strokes of unknown type);
- were aged over 20 years old;
- were admitted to hospital after stroke onset.

To work out the costs of CB rehabilitation, our model included all types of stroke cases: intracerebral haemorrhages, ischaemic strokes and strokes of unknown type over a one-year cycle. Following stroke, individuals could die from stroke or move to one of six degrees of stroke-disability at three months (i.e. the mRS 0 to 5). Country, age, and gender-specific numbers of incident stroke cases were derived from the Global Burden of Disease.

We assessed the effectiveness of CB compared to current practise based on evidence from differences in the Barthel Index (an assessment of functional independence in stroke patients) scores of patients undergoing community, as opposed to hospital, based therapy.

For those undergoing CB rehabilitation, the average QALY gain over five years was 1.82, compared with 1.75 for those undergoing current practice. As a result, at the population level, the total QALYs projected for the 32 countries was 1.6 million with CB rehabilitation and 1.5 million with current practice, an increase of 61,890 QALYs. For all countries, CB rehabilitation generated more QALYs than current practice.

On average the costs were €1,270 per patient receiving CB rehabilitation compared with €762 for those in current practice. This translated into costs across Europe of €1,086 million as opposed to € 652 million.

However, inpatient costs following the intervention were lower after CB rehabilitation compared to current practice (€18.8 billion vs. €19.4 billion, respectively). Over the five years, CB rehabilitation was associated with overall health and social care costs of €31.6 billion compared with €31.8 billion for standard rehabilitation.

With informal care costs and productivity losses included, overall costs were €43.6 billion with CB compared with €43.9 billion for current rehabilitation care. Therefore, from a societal perspective, CB rehabilitation for eligible stroke patients would generate savings across the 32 countries of €295 million over a five-year period.



While CB rehabilitation did not generate cost savings in all countries, we found it to be cost-effective both when using NICE's and WHO's systems of determining cost effectiveness.

## CONCLUSION

Accurate predictions about the future are notoriously difficult to make. But our research provides very strong indicators of the overall future costs of stroke and of the component parts of stroke care. We are confident that our findings are actually underestimates of the future cost of stroke, simply because there were areas of expenditure for which there is too little data. And we made sure that the assumptions we had to make in order to provide indicators of future costs were conservative. Those assumptions are fully documented in the full version of this report and in published and soon to be published research papers.

It is clear that the economic burden of stroke across the 32 countries we studied is huge.

The total cost of stroke in these 32 countries was €60 billion in 2017.



And the costs will rise over the next 20 years. Between 2017 and 2030 overall costs of stroke are projected to rise by €25 per citizen. This goes up by €33 per citizen from 2017 to 2035 and €42 per citizen from 2017 to 2040. The costs of stroke in the 32 countries under study are projected to increase by 44% between 2017 and 2040, with some countries seeing rises in stroke-related costs of nearly 100%.

These projected increases will undoubtedly place a burden in already stretched health and social care systems, but also in the overall economy, with informal carers having to take greater responsibility for the care of stroke survivors. As a result, European countries will have to put interventions and policies in place to try and mitigate these cost increases, whilst also maximising the health outcomes and quality of life for stroke survivors.



The results show that the amount of stroke-related health and social care costs in individual countries were significantly associated with that country's wealth – the richer the country the more it spent on stroke.

But even for countries with the same levels of national income, health and social care expenditure on stroke varied widely. More research is needed so we can better understand the reasons for this. What is clear, however, is that the cost effectiveness of different interventions is key. Careful evaluation of expenditure decisions, within a clear cost-effectiveness framework, similar to that employed by NICE, could improve value-for-money and strengthen moves towards stronger evidence-based care across the Europe.

We studied the economic impact of three specific interventions which already have a strong evidence base for their clinical effectiveness. All three – treating known AF patients with anti-coagulation, providing mechanical thrombectomy in acute ischaemic stroke and providing community-based rehabilitation – would increase the number of extra years of good health across the population and have been shown to be cost effective in our study.

In most cases they would save money. Clearly there is no good reason not to prioritise adopting these three interventions.

Based upon our findings for these three interventions, SAFE believes that improving stroke care at all stages of the pathway, from prevention to life after stroke, would not only improve outcomes for people, but would also reduce the overall economic burden of stroke. Risk factors for stroke, such as high blood pressure and diabetes, are too often undetected; many stroke patients across Europe are still not getting access to acute stroke units, (let alone mechanical thrombectomy); and the economic impact of stroke on individuals and families can be devastating.



We call on all countries across Europe to invest in better stroke care, believing this will not just improve outcomes, but will be cost effective and will reduce the economic burden of stroke.



## ABOUT SAFE

The Stroke Alliance for Europe (SAFE) an international non-profit-making organisation formed in 2004 in Brussels, Belgium. It is the voice of stroke patients in Europe, representing a range of stroke support organisation from more than 30 European countries.

SAFE's goal is to decrease the number of strokes in Europe by advocating for better prevention, access to adequate treatment, post-stroke care and rehabilitation.

For more information about SAFE, please visit [www.safestroke.eu](http://www.safestroke.eu).

Registered office

Rue Washington 40, Brussels 1050, Belgium,

Registered non-profit association (Association Sans But Lucrative)

ASBL 0661.651.450

[www.safestroke.eu](http://www.safestroke.eu)

© SAFE 2020

[info@safestroke.eu](mailto:info@safestroke.eu)

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