

# Stroke in decline?

*Bob Siegerink, PhD, Center for stroke research Berlin, Charité Universitätsmedizin, Berlin, Germany*

[Bob.siegerink@charite.de](mailto:Bob.siegerink@charite.de) | [Bobsiegerink.com](http://Bobsiegerink.com)

---

## Incidence of stroke throughout the years

A recent systematic review of 56 studies from all over the world show that the stroke incidence and early case fatality reported in these studies change over time. They indicate a fall in high-income countries by 42%, but an increase in low-middle income countries by as much as 100%.[2] This contrasting trend leads to the situation that the estimated overall incidence of stroke is currently higher in the in low-middle income countries compared to high-income countries. However, these aggregated data from studies with different methodologies do not show time trends within the same populations and we have to dive into the literature.

There are several studies that show incidence of stroke over the years, and they all confirm that the incidence of stroke is declining in western countries during the past decades.[3]–[10] For example, data from the UK OXVASC study show that the incidence of stroke is declining, from 2.27 / 1000 person-years in 1981 to 1.62 / 1000 person-years in 2004.[11] This decline continues after that time period, as was shown in a study on data from the General Practice Research Database which showed an overall stroke incidence rate of 1.04 / 1000 person-years in 2008.[12] Most remarkable result from these data is the stark drop in stroke incidence in the elderly age group, which is supported by the notion that stroke incidence might be on the rise for the young.[13] Data from the Erlangen stroke project corroborate these trends.[4] The crude absolute risk, as well as age and sex adjusted incidence rate ratios show a small but certain decline over the years. This decline is however different between men and women. Stroke incidence was 28% lower for men in 2009-2010 compared to 1995-1996 whereas the incidence in women was, if anything, only slightly decreased by 10%.

## A more detailed look at declining incidences

This difference shows that we need to consider not only the overall incidence, but also the incidence of particular patient groups and different types of stroke.

For example, the Erlangen also tells us that the decline amongst men is similar for all types of stroke, i.e. ischemic stroke, primary intracerebral hemorrhage and sub arachnoid hemorrhage. However, the decline differs among the subtypes of ischemic stroke. For example, the incidence of large artery has dropped by 73% in men. On the other hand, women showed a 2 fold increase in the incidence of small artery occlusion in women over time (Incidence rate ratio or IRR 2.33 95%CI 1.39-3.90).[4] The OXVASC study tells a similar story, albeit with different details: although there is no clear sex specific decline, the decline is less outspoken in women (IRR 0.76 95%CI 0.61–0.94) compared to men (0.66 95%CI 0.53–0.82). Different in these data is that there decline is different for the different types of stroke: IS

incidence dropped 27% (IRR 0.73, 95%CI 0.62-0.86) while ICH dropped more than half (IRR 0.47 95%CI 0.27-0.83) over the period of investigation.[11]

## Incidence vs prevalence

Assessing the stroke incidences is not sufficient to paint the complete picture about the stroke patient of the future, as we also have to consider matters like case fatality rate and stroke severity.

There is evidence that short term mortality of stroke, but also stroke recurrence, is in decline over time, especially for men.[3], [8], [9], [12], [14]–[16] This is reflected in stroke severity: severe strokes are in decline, leading to higher proportion of minor stroke.[11] However, these observations might not be true for all types of strokes, for example, intra cerebral hemorrhage incidence might have decreased, but here the case fatality and long-term mortality seem to be stable, suggesting that treatment and secondary prevention is not equally successful in all types of stroke.[5], [16]

With lower incidence and fatality, as well as an expected improved long term outcome through a decline of severe stroke does not necessarily mean less stroke patients. For Germany, the lifetime prevalence of stroke did not change in the last 12 years.[17] Other data show that the combination of low mortality and declining incidence can even lead to an increase in stroke prevalence over time up to 12.5% (from 6.4/1000 persons in 1999 to 7.2/1000 persons in 2008). [12]

## The stroke patient of the future

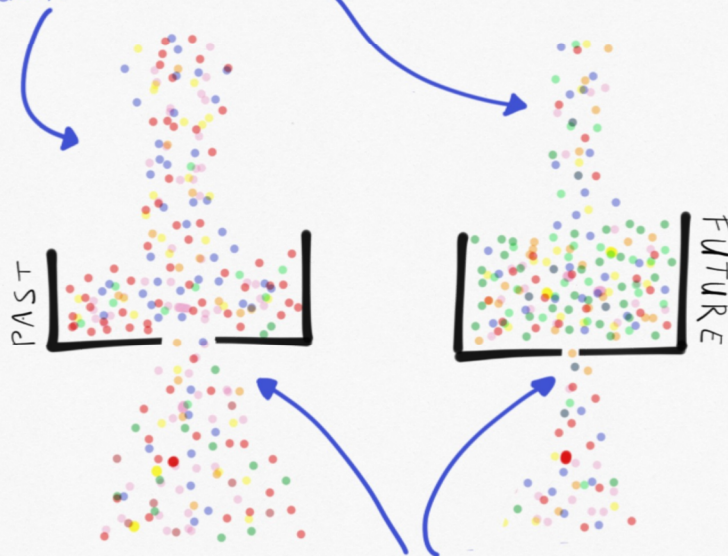
What lesson can we learn from all the evidence about time trends in stroke incidence and prevalence? To what extent can we extrapolate these data in order to obtain an idea about the type of patients that develop in the future?

The conclusion is that it is difficult to draw a detailed conclusion from these studies, as there is a plethora of differences in methodology and patient populations. How can we for example draw solid conclusions from the comparison of the OXVASC and Erlangen Stroke project when ischaemic stroke subtype distribution is so different, with 19% of the strokes in the OXVASC study is of cardio embolic nature, whereas the Erlangen stroke project shows this number to be 27%.[4], [18]

However, the general picture is clear. Stroke incidence has been in decline during the last decades in high income countries, probably due to better primary prevention.[19] But this does not result in fewer stroke patients: a decline in stroke severity and mortality leads to more stroke survivors, which make it likely that stroke prevalence is likely to rise in coming decades.[8], [20] Given that the decline is different for the different subgroups, it also becomes clear that the type of stroke patient will change. Patients of the future might be younger at first manifestation, but with a wide age distribution for those who survive.[21] (see figure) This comes with an increase in patients who have multiple comorbidities, thus complicating treatment and care.[3], [21] The patient population of the future necessitates an open mind to different treatment options, and different care demands to handle the different clinical dilemmas in the future. It is up to us, stroke physicians, nurses and researchers, to rise up to this challenge.

# A changing stroke population

A change in overall incidence  
Including subtype distribution



A change in mortality rates

Figure 1 A changing stroke population: how lower incidence and different mortality rates can result in a different patient population in the future

## References

- [1] M. Hollander, P. J. Koudstaal, M. L. Bots, D. E. Grobbee, a Hofman, and M. M. B. Breteler, "Incidence, risk, and case fatality of first ever stroke in the elderly population. The Rotterdam Study.," *J. Neurol. Neurosurg. Psychiatry*, vol. 74, pp. 317–321, 2003.
- [2] V. L. Feigin, C. M. Lawes, D. a. Bennett, S. L. Barker-Collo, and V. Parag, "Worldwide stroke incidence and early case fatality reported in 56 population-based studies: a systematic review," *Lancet Neurol.*, vol. 8, no. 4, pp. 355–369, 2009.
- [3] B. Ovbiagele, D. Markovic, and A. Towfighi, "Recent age- and gender-specific trends in mortality during stroke hospitalization in the United States," *Int. J. Stroke*, vol. 6, no. October, pp. 379–387, 2011.
- [4] P. L. Kolominsky-Rabas, S. Wiedmann, M. Weingrätner, T. G. Liman, M. Endres, S. Schwab, M. Buchfelder, and P. U. Heuschmann, "Time Trends in Incidence of Pathological and Etiological Stroke Subtypes during 16 Years: The Erlangen Stroke Project," *Neuroepidemiology*, pp. 24–29, 2015.
- [5] D. B. Zahuranec, L. D. Lisabeth, B. N. Sánchez, M. a. Smith, D. L. Brown, N. M. Garcia, L. E. Skolarus, W. J. Meurer, J. F. Burke, E. E. Adelman, and L. B. Morgenstern, "Intracerebral hemorrhage mortality is not changing despite declining incidence," *Neurology*, vol. 82, pp. 2180–2186, 2014.
- [6] J. Sivenius, J. Tuomilehto, P. Immonen-Räihä, M. Kaarisalo, C. Sarti, J. Torppa, K. Kuulasmaa, M. Mähönen, A. Lehtonen, and V. Salomaa, "Continuous 15-Year Decrease in Incidence and Mortality of Stroke in Finland: The FINSTROKE Study," *Stroke*, vol. 35, pp. 420–425, 2004.
- [7] P. Pajunen, R. Pääkkönen, H. Hämäläinen, I. Keskimäki, T. Laatikainen, M. Niemi, H. Rintanen, and V. Salomaa, "Trends in fatal and nonfatal strokes among persons aged 35 to ≥85 years during 1991-2002 in Finland," *Stroke*, vol. 36, pp. 244–248, 2005.
- [8] I. Vaartjes, M. O'Flaherty, S. Capewell, J. Kappelle, and M. Bots, "Remarkable decline in ischemic stroke mortality is not matched by changes in incidence," *Stroke*, vol. 44, pp. 591–597, 2013.
- [9] R. Carandang, A. Beiser, M. Kelly-hayes, C. S. Kase, W. B. Kannel, and P. a Wolf, "of Stroke Over the Past 50 Years," vol. 296, no. 24, pp. 2939–2946, 2014.
- [10] V. L. Feigin, M. H. Forouzanfar, R. Krishnamurthi, G. A. Mensah, D. A. Bennett, A. E. Moran, R. L. Sacco, L. Anderson, M. O. Donnell, N. Venketasubramanian, S. Barker-collo, C. M. M. Lawes, W. Wang, Y. Shinohara, E. Witt, and M. Ezzati, "from the Global Burden of Disease Study 2010," vol. 383, no. 9913, pp. 245–254, 2014.
- [11] P. M. Rothwell, a J. Coull, M. F. Giles, S. C. Howard, L. E. Silver, L. M. Bull, S. a Gutnikov, P. Edwards, D. Mant, C. M. Sackley, a Farmer, P. a G. Sandercock, M. S. Dennis, C. P. Warlow, J. M. Bamford, and P. Anslow, "Change in stroke incidence, mortality, case-fatality, severity, and risk factors in Oxfordshire, UK from 1981 to 2004 (Oxford Vascular Study).," *Lancet*, vol. 363, no. 9425, pp. 1925–33, Jun. 2004.
- [12] S. Lee, a. C. E. Shafe, and M. R. Cowie, "UK stroke incidence, mortality and cardiovascular risk management 1999-2008: time-trend analysis from the General Practice Research Database," *BMJ Open*, vol. 1, pp. e000269–e000269, 2011.
- [13] B. M. Kissela, J. C. Khoury, K. Alwell, C. J. Moomaw, D. Woo, O. Adeoye, M. L. Flaherty, P. Khatri, S. Ferioli, F. De Los Rios La Rosa, J. P. Broderick, and D. O. Kleindorfer, "Age at stroke: Temporal trends in stroke incidence in a large, biracial population," *Neurology*, vol. 79, pp. 1781–1787, 2012.
- [14] A. Castermans and P. den Hollander, "omgaan met onzekerheid. Proportionele aansprakelijkheid, artikel 6:101 BW en de leer van de kansschade. Annotatie bij HR 14 december 2012, RvdW2013/37," *NTBR*, vol. 5, p. 185, 2013.
- [15] J. Lewsey, P. S. Jhund, M. Gillies, J. W. T. Chalmers, A. Redpath, A. Briggs, M. Walters,

- P. Langhorne, S. Capewell, J. J. V McMurray, and K. MacIntyre, "Temporal trends in hospitalisation for stroke recurrence following incident hospitalisation for stroke in Scotland.," *BMC Med.*, vol. 8, p. 23, 2010.
- [16] S. Koton, A. L. C. Schneider, W. D. Rosamond, E. Shahar, Y. Sang, R. F. Gottesman, and J. Coresh, "Stroke Incidence and Mortality Trends in US Communities, 1987 to 2011," *Jama*, vol. 312, no. 3, p. 259, 2014.
- [17] M. a. Busch, a. Schienkiewitz, E. Nowossadeck, and a. Gößwald, "Prävalenz des Schlaganfalls bei Erwachsenen im Alter von 40 bis 79 Jahren in Deutschland," *Bundesgesundheitsblatt - Gesundheitsforsch. - Gesundheitsschutz*, vol. 56, pp. 656–660, 2013.
- [18] U. G. R. Schulz and P. M. Rothwell, "Differences in vascular risk factors between etiological subtypes of ischemic stroke: importance of population-based studies.," *Stroke.*, vol. 34, no. 8, pp. 2050–9, Aug. 2003.
- [19] D. T. Lackland, E. J. Roccella, A. F. Deutsch, M. Fornage, M. G. George, G. Howard, B. M. Kissela, S. J. Kittner, J. H. Lichtman, L. D. Lisabeth, L. H. Schwamm, E. E. Smith, and A. Towfighi, "Factors influencing the decline in stroke mortality a statement from the american heart association/american stroke association," *Stroke*, vol. 45, pp. 315–353, 2014.
- [20] D. a. Bennett, R. V. Krishnamurthi, S. Barker-Collo, M. H. Forouzanfar, M. Naghavi, M. Connor, C. M. M. Lawes, A. E. Moran, L. M. Anderson, G. a. Roth, G. a. Mensah, M. Ezzati, C. J. L. Murray, and V. L. Feigin, "The Global Burden of Ischemic Stroke," *Glob. Heart*, vol. 9, no. 1, pp. 107–112, 2014.
- [21] M. Schmidt, J. B. Jacobsen, S. P. Johnsen, H. E. Bøtker, and H. T. Sørensen, "Eighteen-year trends in stroke mortality and the prognostic influence of comorbidity," *Neurology*, vol. 82, pp. 340–350, 2014.
- [22] G. National and C. Gnc, "The German National Cohort: aims, study design and organization.," *Eur. J. Epidemiol.*, vol. 29, pp. 371–82, 2014.
- [23] D. O'Neill, F. Horgan, A. Hickey, and H. McGee, "Long term outcome of stroke: Stroke is a chronic disease with acute events.," *BMJ (Clinical research ed.)*, vol. 336. p. 461, 2008.