Encouragingly, overall stroke mortality steadily declined across the world during the 20th century.1 In fact, stroke was demoted from the third to the fourth leading cause of death in the US.2 Evaluating the reasons for this decline is critically important to characterize the progress we have made to date and guide our approaches to the challenges that lie ahead.

Many different facets of stroke care can affect stroke mortality. For example, declines in stroke mortality could be related to improvements in emergency, hospital, and rehabilitative care.3-5 If this were the reason, then we would also expect case-fatality (ie, death from any cause within a certain period of time, usually 30 days, after the stroke event) to also have declined. Declines in mortality could also be related to improved primary prevention. In this circumstance, one would expect a decline in stroke incidence (ie, occurrence of first-ever strokes); if less people are having stroke in the first place, then less people will die from stroke as well. Finally, mortality declines may be related to the notable advances in secondary prevention during the past 2 decades,6-9 in which case a decline in stroke recurrence should be seen. Declines in recurrent stroke events are not necessarily detected in studies of stroke incidence, as the typical convention is to limit stroke incidence to first-ever events.10,11

Overall stroke mortality rates can also be profoundly affected by biases and confounders related to their measurement. Most evaluations of stroke mortality use death certificate data. Physicians who fill out death certificates have minimal training regarding the documentation of the appropriate cause of death. Stroke is particularly susceptible to these kinds of errors, as death due to aspiration pneumonia, or sepsis from skin breakdown, may be many months later but are still primarily related to disability from a stroke event.12,13 Moreover, these causes of death are subsequently coded by nonmedical personnel, and the definitions for these codes are vague and have changed over the years. The sensitivity of death certificate data for detecting stroke deaths is only about 50%, when compared with physician medical record adjudication.14 Finally, methods of stroke diagnosis may change over the years, introducing detection bias. Better understanding of disease states and newer technologies may influence our classification of an event in a given time period. For example, if we begin to diagnose more strokes of mild severity, then stroke mortality rates will seem to decline.

If overall stroke mortality is truly declining (which most in the field believe is a substantiated phenomenon despite the reservations listed above), then what is the best way to determine the reasons and why? How do we determine if less people are having strokes in the first place, or more people are surviving for longer after their strokes? To answer this question, we require data spanning a substantial period of time within a stable population. Administrative data lend themselves well to this issue as they capture large numbers of cases often with both demographic and geographic diversity. However, potential drawbacks to administrative data include their coding by nonmedical personnel and their limited accuracy in identifying stroke cases. In addition, most administrative databases only capture data in the setting of hospitalization, and we know that nonhospitalized, nonfatal strokes represent up to 10% of stroke cases in the United States.15 Population-based data use medical professional review of patient charts, are therefore less likely to have errors in case/not a case ascertainment, and can potentially evaluate both inpatient and out-of-hospital cases. However, these studies are labor- and time-intensive and cannot possibly be done on a nationwide scale. Therefore, sampling is required for these kinds of studies, with extrapolation of the results to larger populations. Additionally, stable funding sources are required to reevaluate the same population over time. Given the strengths and weaknesses of administrative and population-based data, it is clear that both are needed to truly understand our public’s health.

The literature is mixed regarding whether the decline in stroke mortality is owing to stroke incidence, case fatality, stroke recurrence, or all 3. Several studies have reported declining incidence.10,16 whereas a few have reported stable or increasing incidence.17,18 We tend to believe that incidence rates have declined, as most larger population-based studies have reported declining incidence over time.11,19-21 Similarly, several studies have reported a stable case fatality, whereas others have noted small declines.19,20 On the basis of our review, the majority of studies favor stability in case fatality rates. Temporal trends of stroke recurrence are more challenging to summarize, owing to variations in the definitions of recurrent events.22 Of note, however, the far majority of epidemiological studies published in English are from well-developed countries and white populations.

In this issue of Stroke, Vaartjes et al23 evaluate temporal trends of both stroke incidence and case-fatality in the Netherlands using administrative data. In contrary to much of the literature, they conclude that stroke incidence was slightly increasing, and case fatality was dramatically decreasing from 1997 to 2005. We speculate that this may be related to methodology. Although the authors commendably attempted to include both hospitalized...
stroke cases and stroke deaths that were never hospitalized, their finding that 23% of all incident stroke events were ischemic stroke deaths that occurred without hospitalization (ie, deaths at home, in nursing homes, or in the ambulance before arrival at the hospital) seems extraordinarily high compared with prior studies. For example, in the Greater Cincinnati Northern Kentucky Stroke Study, which used population-based methods of chart review, only 0.1% of incident ischemic stroke events were deaths that were never hospitalized; these were ascertained by monitoring all of the region’s coroners’ offices and a sampling of nursing homes and physician offices.20 Given so many nonhospitalized cases in the current analysis, there is concern for a significant rate of misclassification of stroke subtype. Many of these cases were unlikely to have autopsies or imaging to verify an ischemic stroke. In fact, cases found dead at home are much more likely to be hemorrhagic strokes; ischemic strokes rarely cause sudden death. Additionally, the authors used an International Classification of Diseases-10 code (164) that includes hemorrhagic strokes, making it likely that several deaths were erroneously included. For these reasons and other limitations of administrative databases discussed previously, we question the current findings.

Detangling the mystery of the falling rates of stroke mortality is a daunting task, but well worth the effort. It is crucial for us to accurately measure our rates of stroke incidence, recurrence, and case fatality, to identify our priorities regarding primary prevention, secondary prevention, and treatment for the future. We believe that, despite the current findings, the weight of the evidence suggests that stroke mortality has declined in recent decades primarily owing to declining stroke incidence. However, this decline in stroke incidence in developed countries does not imply a decline in incidence worldwide. Stroke incidence in developing countries is likely to be sharply increasing and requires further study to plan appropriate interventions.24 Additionally, in developed countries, the total number of stroke events is likely to climb as their populations age.

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