The Mortality of Status Epilepticus

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Summary

Generalised Convulsive Status Epilepticus (SE), traditionally defined as a persistent generalised seizure lasting longer or intermittent generalised seizures with incomplete recovery of consciousness in between seizures of duration longer than 30 minutes, is associated with significant morbidity and mortality. In this review we examine the factors associated with high mortality and poor prognosis, in particular discuss prognosis associated with the major aetiologies of SE as well as the relative impact of other prognostic factors such as age and duration of SE. We also discuss whether the prognosis and associated mortality of SE has changed over time, particularly in the last 20 years in light of improved treatment options and the increasing advocacy of earlier and more aggressive treatment in the context of prolonged seizures.

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Key words: Status epilepticus, mortality, epidemiology

Mortalité chez l'état de mal

L'état de mal épileptique (SE) généralisé convulsif, traditionellement défini par la persistence de crises généralisées ou la reprise incomplète de conscience pendant plus de 30 minutes est associé avec une morbidité et mortalité significative. Dans cette revue, nous examinons les facteurs associés avec une mortalité élévée et un mauvais pronostic, avec une emphase particulière sur les causes principales d'état de mal épileptique et également l'impact relatif d'autres facteurs comme l'âge et la durée de l'épisode. Nous discuterons également si le pronostic et la mortalité associée à l'état de mal se sont modifiés avec le temps, plus particulièrement dans les derniers 20 ans, au vu du nombre croissant d'options de traitement et de l'identification plus précoce ainsi que du traitement plus aggressif de crises prolongées.

Mots clés : État de mal épileptique, mortalité, épidemiologie

Sterblichkeit bei Status epilepticus

Der Status epilepticus convulsivus (SE), traditionell definiert als ein Persistieren von generalisierten Anfällen oder unterbrochenen, generalisierten Anfällen mit inkomplettem Wiedererlangen des Bewusstseins für länger als 30 Minuten, ist assoziiert mit einer signifikant erhöhten Mortalität und Morbidität. In diesem Review untersuchen wir die Ursachen, die in Verbindung mit einer hohen Sterblichkeit und einer schlechten Prognose stehen, wobei der Schwerpunkt bei den Hauptursachen des SE und dem Einfluss anderer Faktoren wie Alter der Patienten und Dauer des SE liegt. Wir diskutieren ebenfalls, ob sich die Prognose und die dem Status epilepticus assoziierte Sterblichkeit im Laufe der Zeit verändert haben, insbesondere innerhalb der vergangenen 20 Jahre, auf dem Hintergrund der zunehmenden therapeutischen Möglichkeiten und dem rascheren Erkennen sowie der aggressiveren Behandlung von prolongierten Anfällen.

Schlüsselwörter: Status epilepticus convulsivus, Mortalität, Epidemiologie

Introduction

Generalised Convulsive Status Epilepticus (SE), traditionally defined as a persistent generalised seizure lasting longer or intermittent generalised seizures with incomplete recovery of consciousness in between seizures of duration longer than 30 minutes, is associated with significant morbidity and mortality [1, 2].

Despite the fact that SE has been recognised at least since 700-600CE [1], it took until the early 1990s before the first staged treatment protocol for the management of SE appeared [3]. This is perhaps for a long time, whilst the high associated mortality of SE was well known, that SE was a rare event, typically only seen in people with chronic epilepsy in long-term institutions

or asylums and often in the context of anti-epileptic drug (AED) withdrawal [1, 2]. Moreover, it was only in the mid- to late 1990s that the first population cross-sectional studies were published, permitting an accurate estimation for the incidence rate of SE for the first time (**Table 1**). In addition, such studies provided a more accurate estimation of the associated mortality of SE as given the prospective nature of the studies, they were less prone to selection bias.

Any discussion on SE needs to be centred on three fundamental questions which will form the basis of the reminder of this review: 1) What is the overall mortality rate associated with SE? This is typically defined in terms of the 30-day case fatality rate or the proportional mortality rate. 2) What factors determine the prognosis of SE and by extension the mortality rate? 3) Has the mortality rate associated with SE changed over time and if so why?

Mortality rates in status epilepticus

In discussing the mortality of SE we will primarily focus on the results of seven cross-sectional studies [4 - 10] published from Richmond, Virginia [4], Rochester, Minnesota [5], French-speaking Switzerland [6], Germany [7], Bologna, Italy [8], California [9], and North London [10]. The first of the population-based studies was from Richmond, Virginia in 1995, with the second highest reported mortality rate of 22% [4]. This high mortality may in part be explainable by the high proportion of African-Americans (20%) in this study, in whom the incidence of SE was three-fold that of white Americans [4]. This may have been in part due to socioeconomic factors and unequal access and quality of medical care for the different populations in this study. This finding of a higher incidence and higher associated mortality in African-Americans was replicated in the Californian study [9]. Of these studies, all but one was prospective in nature.

Overall the incidence of SE typically ranged from 10 - 20 cases per 100,000 person years although the re-

Table 1: Seven population-based studies of status epilepticus*

	Richmond Virginia USA[4]	Rochester, Minn, USA[5]	French speaking Switzerland[6]	Hessen, Germany[7]	Bologna, Italy[8]	California	London[10]
Year	1989-1991	1965-1984	1997-1998	1997-1999	1999-2000	1991-1998	2002-4
Population (denominator)	202,774	1,090,055	1,735,420	743,285	336,876	N/A	605230
Number of cases	166	199	172	150	44	19,491	226 total
Incidence of SE (per 100,000 per year)	41 (raw) 61 (adjusted)	18.3 (adjusted)	9.9 (raw) 10.3 (adjusted)	15.0	13.1	6.2 (4.9-8.5)	176 first-ever episode of SE
Female:male ratio of cases	1:1.21	1:1.92	1:1.72	1:1.93	1:0.742	1:1.1	17-23 (adjusted) 12.5-14 (adjusted; first-ever episode of SE)
History of prior epilepsy	42%	46%	42.4%	33%	39%	N/A	1:1.12
Case fatality	22.3%	19%	7.6%	9.3%	39%	10.7%	7%4
Inclusions/Exclusions	Patients one month of age or less were excluded	-	Patients with post anoxic encephalopathy were excluded	Only patients of 18 years of age or over were included	Only patients of 20 years of age or over were included	Only generalised convulsive SE cases were included	3%
Case ascertainment	Prospective hospital record review	Retrospective review using record linkage system	Prospective hospital record review	Prospective hospital record review	Prospective Active surveillance of hospital admissions	Prospective hospital discharge record review	Only convulsive SE was included;

1 = Raw data, 2 = Adjusted ratio, 3 = Adjusted figures, from the regions with the best case ascertainment (and least likely to selection bias), 4 = Excluding febrile seizures

*From reference [11].

ported incidence was significantly higher (41 - 61 per 100,000 person years) in the Richmond study [4]. The overall mortality rate (30-day case fatalities) ranged from 3% in the paediatric study from North London [10] to 39% in the small study from Bologna, Italy [8] which seems to represent a significant outlier. The earlier American studies reported higher mortality rates (22% [4] and 19% [5]) compared to the later Swiss (7.6%) [6] and German (9.3%) [7] studies, which probably provide a more accurate and representative estimate of the mortality of SE. Of note the EPISTAR study excluded people with SE and post-anoxic encephalopathy which has the highest associated mortality, thereby explaining the slightly lower mortality rate (7.6%) in this study [7]. Mortality in SE demonstrates a J-shape relationship with age, with very low mortality rates in children, with increasing mortality rates with increasing age, particularly after the age of 60. In the Richmond study, the mortality rate was only 3% in children, comparable to that seen in the North London SE in Childhood Surveillance Study (NLSTEPSS) [10], yet the mortality rate was 41% in those aged > 60 years [4]. This is in part mitigated by the fact that the aetiology of SE varies with age, with febrile SE (prolonged form of a febrile convulsion) making up about a third of cases of SE in children, which is associated with a very low mortality rate. In contrast post-anoxic SE, which is almost invariably fatal, is a significant cause of SE in the elderly [11].

The impact of aetiology on the prognosis

The number of causes that predominate in epidemiological studies of SE is surprisingly small, with 7 - 8 major aetiologies typically identified [11]. In contrast, in a recent review of uncommon cause of SE, which were pragmatically defined as a single cause accounting for < 1% of all cases documented in the major pop-

Table 2: Major aetiologies of SE[1]

	Richmond[4]	Rochester[5]	Switzerland[6]	Hessen[7]	Bologna[8]	California[9]	London[10]
Low AEDs	21%(P)/34% (A)	1%	8.1%[3]	8.7%	-	3.9%	0.5%
CNS Infections	52%(P)/5% (A)	8.5%	-	0%	-	0.6%	10.2%
Febrile	-	8%	14.9%[4]	0%	-	2.5%	32%
CVA	10%(P)/22%(A)	19.1%	30.5%[5]	66.7%[1]	41%	12.4%[2]	0.5%
Alcohol	13% (A)	-	-	8.7%	7%	8.1%	0%
Trauma	3% (A)	4.5%	-	7.3%	10%	0.4%	1.5%
CNS Tumours	7% (A)	-	-	12%	5%	1.8%	-
Metabolic disturbance	5% (P)/15%(A)	3.5%	-	8.7%	24%[6]	8.7%	3%
Degenerative brain disease/CNS anomalies	38%(P)/25%(A)	5.5%	-	26.7%[2]	10%	13.3%[3]	32%
Medication induced/ overdose	2% (P)/3% (A)	2%	-	10.7%	-	-	1%
Anoxia/Hypoxia	5% (A) (anoxia) 5%(P)/13% (A) (hypoxia)	10%	Excluded	-	9.1%	8%	0.5%
Cryptogenic	5%(P)/3%(A)	13.5%	8.7%	8.7%	-	-	7%

A = adults; P = paediatric (from reference [11]), [1] Some studies only give percentages for some aetiologies, [2] In the Richmond study, aetiologies were separately given for the paediatric and adult populations [4], [3] Percentage of total cohort. (Low AEDs was the cause of SE in 18.9% of patients with epilepsy), [4] Patients with epilepsy only

[5] Non-epileptic patients, [6] Combination of systematic metabolic disorders and postanoxic encephalopathy

Table 3: Approximate frequency and mortality of SE in different aetiologies

Aetiology	Proportion of cases of SE	Associated acute mortality in patients with SE
Drug reduction/withdrawal, poor compliance or low AED levels	10-20%	0-10%
Cerebrovascular Disease	10-40%	20-60%
Metabolic Disorders	5-15%	10-40%
Acute CNS Infections	1-12%	0-33%
Anoxia-Hypoxia	5-12%	60-80%
Alcohol	5-15%	0-10%
Head Trauma	0-10%	0-25%
Brain Tumours	0-10%	0-20%
Cryptogenic/Idiopathic	5-15%	5-20%

Amalgamated figure [11]

ulation studies (**Table 1**), identified 181 different uncommon causes of SE [12]. Inevitably rare causes, once identified will become increasingly recognised. This is particularly true of the autoimmune encephalopathies such as anti-NMDA receptor encephalitis, which nevertheless overall remain a rare cause of SE, although is a more prevalent cause of refractory and supra-refractory SE. The major aetiologies and their relative frequency in the population studies are shown in **Table 2**.

Specific Aetiologies of Status Epilepticus and Mortality

Stroke and status epilepticus

Stroke is a significant cause of SE in people aged > 60 years particularly in those with no prior history of seizures (**Table 2**).

In a comprehensive study of the frequency of SE post-stroke, 3,205 people with a first time stroke(s) were identifed over an 8 year period. Of these, 159 had first time post-stroke seizures and SE was recognised in 31 cases, and was the first presentation of epilepsy in 17, occurring within 14 days of the stroke. In four cases the stroke occurred simultaneously with SE, and in the remaining 10 cases, SE developed after one or more seizures. After follow-up of 47 months, 48.3% (15) had died, of which five deaths were directly attributable to SE. Additional seizures occurred in over half (8) of the initial SE cases and all 14 patients with SE occurring after one or more seizures. The study concluded that SE in stroke has a poor prognosis but that inital SE as a first epileptic symptom was not predictive of developing subsequent seizures [13].

In the US Nationwide Inpatient Sample study covering an eight year period, 718,531 hospitalisations with acute ischaemic stroke (AIS) were identified of whom generalised convulsive SE (GCSE) developed in

1,415 (0.2%). 102,763 were admitted with intra-cranial haemorrhage (ICH) of whom GCSE developed in 266 (0.3%). In-hospital mortality was significantly higher in those with GCSE and AIS or ICH, particularily if analysis was restricted to patients with length of stay greater then one day (AIS: 28.4% vs 9.2%, p<.01; ICH: 30.1% vs 24.3%, p=0.03). Other markers of morbidity like pneumonia, need for mechanical ventilation, tracheotomy and length of stay > seven days were all statistically associated with concomittant SE [14].

In the Hessen study [7], long-term mortality rate in patients with a first episode of cerebrovascular-related SE was 57% compared to 48% in people with acute stroke without SE, suggesting a synergistic effect between SE and stroke resulting in greater morbidity and mortality. Multivariate analysis indicated that patients with status epilepticus had, after 6 months, twice the risk of death compared with patients with stroke without SE (hazard ratio of 2.12, CI 1.04-4.32, p=0.0392) [7].

This potential synergistic effect between cerbrovascular disease and SE was investigated in a prospective cohort study of 83 patients with SE and stroke (44 with acute and 39 with remote stroke) and compared them to 159 controls (acute stroke only). Acute stroke and SE had a mortality of 39%, representing an almost threefold increase compared to those with acute stroke only (14%) or those with SE and remote stroke (5%), ($p < 0.001$). In addition there was almost an eight-fold difference in mortality between the acute stroke and SE group and the remote stroke and SE group. This difference was not accounted for by age, sex or radiographic lesion size. Logistic regression analysis demonstrated a statistically significant synergistic effect of combined injuries of cerebral vascular ischaemia and SE [15].

In a large US study on mortality rates in SE using hospital admission and discharge coding data, cerebrovascular disease was a predictor of in-hospital mortality with an odds ratio of 2.08 (CI 1.13-3.82) and a mortality rate of 22% ($p < 0.0001$) and also for the need for mechanical ventilation ($p < 0.0001$) [16].

The relative frequencies of the major aetiologies and their associated mortality rates are shown in **Table 3**.

SE and antiepileptic drug reduction or withdrawal or low antiepileptic drug levels

In patients with a prior diagnosis of epilepsy, noncompliance with anti-epileptic medication (AEDs) is often postulated as being the most common cause of SE. Whilst this may be true in adults, it is not the case in children. In the NLSTEPSS [10], only one case of SE was attributable to low antiepileptic drug concentrations, although low serum levels of AEDs were the cause in 21% of cases in children in the Richmond study [4].

In a retrospective review of all admissions with status epilepticus to a single institution in San Franscico in the 1980s, 25% of cases of status epileptius identified were related to withdrawal of AEDs, with 90% of patients having a good outcome (defined as unchanged from baseline, or mild neurologic deficits that allowed independent living) such that the authors conclude "... that patients with a history of epilepsy who develop SE because of anti-convulsant drug withdrawal or break-through seizures can be expected to respond well to acute anticonvulsants." [17].

In a study of 83 episodes of SE from Berlin, low levels of AEDs were the primary cause of the SE in 27.7% of the non-refractory cases but no refractory cases ($p < 0.001$) allowing the authors to conclude that "SE caused by insufficient levels of AEDs is usually not refractory" [18].

Alcohol, substance abuse and drug-induced SE

Alcohol abuse (intoxication or withdrawal) has been found to be a common cause of SE in many population-based and hospital-based studies,with a reported range of 8.1-25%, although alcohol was not reported to be a major cause in some studies such as the Minnesota [5] and EPISTAR [6] studies. Cases of alcohol-related SE are generally associated with a favorable outcome with most studies reporting a mortality rate of 0 - 10% (9.6% in the California study) [9].

In a study of all 249 cases of GCSE in adults admitted to a single centre over a 12 year period, 27 cases (10.8%) were identified in whom alcohol abuse was the only identifiable precipitating cause. In 12 (44%), SE was the initial presentation of alcohol-related seizures. 22 (81.5%) had returned to baseline at the time of discharge although time to gross recovery of mental status was ≥ 12 hours in 24 of the 27 patients. Four (14.8%) had new neurological deficits at the time of discharge. The only death (3.7%) occurred in a 60 year old in whom status epilepticus continued despite four hours of treatment [19].

Drug toxicity or abuse is generally a more common cause of SE in hospital-based studies compared to population-based studies, and the relative frequency and mortality rate varies markedly between different studies, with reported rates of 2 - 14% of cases. Cocaine (43%) and theophylline (21%) were the most commonly implicated drugs in the San Francisco study [17].

Severe acute cerebral anoxia/hypoxia and SE

Anoxia, usually after cardiac arrest in adults, can result in deep coma with myoclonic jerking, and this is assumed by some authorities, but not all, to be a form of "SE" [1]. This dichothomy of opinion is evident by the fact that post-anoxic SE cases were excluded from the EPISTAR study [6]. In the population based studies,

hypoxia is the cause of SE in 8 - 13% of cases with an associated mortality typically in the range of 60 - 80% but others have reported mortality rates of up to 100% albeit in small sample studies.

In a study of 166 postanoxic survivors of cardiac arrest treated with hypothermia, postanoxic SE was present in 24% with a mortality rate of 80% compared to the overall mortality rate of 71% ($p < 0.001$). Post-anoxic SE was associated with a higher mortality regardless of the type of acute cardiac rhythm or hypothermia treatment [20].

In the large US study of mortality in convulsive SE hypoxia-ischaemic brain injury-associated SE was the strongest predictor of mortality with an odds ratio of 9.85 (CI 6.63-14.6) and a mortality rate of 69% and was a significant risk factor for the need for mechanical ventilation ($p < 0.0001$) [16].

CNS infections, encephalitis and status epilepticus

Acute CNS infections and encephalitis are an important cause of SE particularly in chidren, typically accounting for about 1 - 12% of all cases in various series from the developed world. In the California study, acute CNS infection was the cause of SE in 0.6% of cases with a median age of 42 years and a mortality rate of 32.6% [9]. In the NLSTEPSS [10] 6% (11) of children had acute bacterial meningitis and 4% (7) a viral CNS infection. Moreover 3 of the 7 children who died had acute bacterial meningitis.

In a retrospective study of all admissions to a paediatric ICU in Montréal over a 10-year period, there were 147 admissions with SE of which 20 (13.6%) were due to bacterial meningitis and 20 (13.6%) due to encephalitis, both of which were associated with high morbidity and mortality [16].

Population-based studies tend to show a rather more favorable outcome, with a lower frequency of refractory cases. In the California Encephalitis Project (CEP), a project aimed at determining the cause of encephalitis, all patients identified with encephalitis were subdivided into 3 categories: refractory SE (defined as SE requiring anesthetic coma for management (Group I); Non-refractory SE (Group II); and patients without seizures (Group III). 4% had refractory SE, 40% non-refractory SE and 56% no seizures. Cases of refractory SE associated with encephalitis tended to be younger (median age = 10) and had a poor outcome with 28% dying within 2 years and 56% neurologically impaired or undergoing rehabilitation [22].

Other causes of status epilepticus

Brain tumours are an uncommon cause of SE, representing 2 - 5% of cases in most studies although 12% of cases of SE in the Hessen study. The associated mortality rates are 0 - 36%.

Trauma is also an uncommon cause of SE, typically accounting for between 0 - 10% of cases in the major studies with an associated mortality of up to 20% (**Table 3**).

Metabolic disorders are the cause of status epilepticus in 2 -15% of cases in reported series with an associated mortality rate of up to 31%. In the San Fransisco Study [17], 4% of cases were due to metabolic causes, 50% of whom failed to respond to 1st-line treatments and were associated with poor outcome (severe neurologic deficit requiring full supportive care or death) in 65%. Acute metabolic disturbance (electrolyteimbalance, hypoglycaemia, hypocalcaemia) was the aetiology of SE in approximately 3% of children in NLSTEPSS [10].

Moreover patients with metabolic disorders in the US hospital mortality study, presenting with GCSE were significantly more likely to require mechanical ventilation ($p < 0.0001$) with a 3-fold increase in mortality for those requiring mechanical ventilation compared to those who did not (7.43% vs 2.22%, odds ratio 2.79) [16].

Cryptogenic SE/Non-onset refractory SE

Despite investigations, the aetiology of SE remains undetermined in many cases. In the Richmond study [4], approximately 5% of cases were classified as idiopathic with a mortality rate of 22%. In the Minnesota study [5] 17.5% of cases of SE were classified as idiopathic/cryptogenic while the aetiology of SE was unknown in 13 (8.7%), one (7.7%) of whom died in the Hessen study [7].

In a retrospective review of all cases of unprovoked seizure and status epilepticus in Richmond over a 30 year period, 291 people with a first brief unprovoked seizure and 16 with SE, there were 5 deaths (all aged > 65) in those with SE. Compared with people with seizure, the adjusted relative risk for death in those with SE was 2.4 over 10 years. This risk was more marked among those aged > 65 years (RR=5.1, CI 1.6-15.7) and for those with SE who later developed epilepsy (5/16, 31.3%) (RR=6.3, CI 1.5-26.0). The standardised mortality ratio (SMR) for SE was 2.6 (CI 0.8-5.3) [23].

There has been an attempt in recent years to define a new syndrome, NORSE (new-onset refractor which is nevertheless of questionable clinical utility. All cases described occured in young adults in previous good health with an antecedent febrile illness. In a recent retrospective review of 130 cases of new onset refractory status epilepticus from 13 academic US centres, 52% (67) remained cryptogenic with the common iden-

tified aetiologies being autoimmune (19%) and paraneoplastic (18%) encephalitis. Overall 77 (62% of 125) had a poor outcome of whom 28 (22%) died [24].

Other prognostic factors

In addition to aetiology, other prognostic factors include age, duration of SE at presentation, level of consciousness, EEG findings, type of SE, prior history of epilepsy and comorbidities. Apart from aetiology, increasing age and longer duration of SE are associated with a higher mortality rate [25] although the negative predictive effect of the duration of SE appears to lessen the longer it persists (> 10 hours) [26]. This in turn reflects the poorer prognosis with the later stages of SE, in particular refractory status epilepticus (requiring anaesthetic intervention) and super refractory status epilepticus (SE of > 24 hours duration despite anaesthetic drugs). A combination of the above factors is used in the two most widely utilised SE prognostic scales: the SE severity score (STESS) (level of consciousness, type of SE, age and past history of epilepsy) [27] and the Epidemiology-Based Mortality Score in SE (EMSE) (aetiology, age, comorbidities and EEG findings) [28].

Has status epilepticus mortality changed over time?

With the advent of increasing treatment options, establishment of treatment protocols for the acute management of SE and the advocacy of earlier and more aggressive intervention in the management of prolonged seizures (which is the rationale for the recently proposed definition of SE [29], raises the important question whether the mortality rate of SE has changed over time. There are however a very limited number of studies that allow for such an analysis.

In the Californian study [9] the incidence and mortality of SE was examined from 1991 through to 1998 using a state-wide database of all people with a hospital diagnosis of SE [7]. The overall case fatality was 10.7%, but with a much lower rate of 3.5% for those admitted with a primary diagnosis of generalised convulsive SE. Whilst the overall mortality for SE remained stable over the period of observation, the mortality of those admitted with a primary diagnosis of SE decreased from 4.7 to 3,2%. At the same time the annual incidence of SE decreased by 42% between 1991 and 1998 from 8.5 to 4.9/100,000 ($p < 0.001$) possibly suggesting more efficient and aggressive treatment of out of hospital prolonged seizures and SE [9].

Two more recent studies have looked at trends in SE-related hospital admissions and mortality in the United States, using representative samples of hospitals from national databases [30, 31]. In one study data from the US National Hospital Discharge Survey was used to identify hospital discharges with SE between 1979 and 2010 [30]. In total 760,117 discharges with SE were identified over the 32 years. In that time the incidence of SE increased from 3.5/100,000/year in 1979 to 12.5/100,000/year in 2010, representing an overall increase of 12.5% per year, with the most significant increase occurring between 1979 and 1991 (17.7% annual increase). There was a subsequent decrease in the incidence of SE in the 1990s before a further increase in the 2000s. The corresponding cumulative in-hospital mortality was 9.2% (95% CI 9.1,9.2) with no significant observed variation over the 32 years.

The second study utilised the Healthcare Cost and Utilisation Project Nationwide Inpatient Sample data to identify SE hospital admissions and SE associated mortality between 1999 and 2010 [31]. When considered as the primary cause of death, the age-adjusted mortality rate for SE increased by 5.6% between 1999 and 2010 from 0.179 per 100,000 to 0.189 per 100,000, with a corresponding increase of 56.4% in age-standardised SE hospital admissions from 8.86 per 100000 in 1999 to 13.86 per 100,000 in 2010 [31].

A more recent study looked at SE (and epilepsy) mortality rates in England and Wales between 2001 and 2013, which suggested a fall in SE mortality rates by 44% over the period of observation although such a finding needs to be cautiously interpreted as the mortality rates were presented without the corresponding SE incidence rates [32].

Conclusions

Whilst SE accounts for only about 10% of epilepsy rated deaths, it is nevertheless associated with significant morbidity and mortality. The overall mortality rate is about 10% with the SE aetiology being the primary prognostic factor, whilst age, SE duration, SE type and EEG findings are also of importance. There is conflicting evidence as to whether SE mortality rates have changed over time and this merits further study.

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