**Epilepsy management in older people: Lessons from National Audit of Seizure management in Hospitals (NASH)**

**Purpose:**

Epilepsy is the third most common diagnosis in older people, however management in this group remains variable. National Audit of Seizure management in Hospitals (NASH) set out to assess care provided to patients attending hospitals in England following a seizure.

**Method:**

154 Emergency Departments (EDs) across the UK took part. 1256 patients aged 60 years or over were included for analysis (median age 74 years, 54% men). 51% were known to have epilepsy, 17% had history of previous seizure or blackout and 32% presented with a suspected first seizure.

**Results:**

14% of older patients with epilepsy were not on treatment, 59% were on monotherapy. Sodium valproate was the most commonly used antiepileptic, 28%. 35% of patients with epilepsy, aged 60 and over, had a CT during admission compared to only 17% of those under 60. 80% of patients aged 60 and over presenting with a likely first seizure were admitted to hospital, compared to 65% of those under 60.

34% of those with suspected first seizure were referred to a neurologist on discharge compared to 68% of patients under the age of 60. 52% of 60-69 year olds with a suspected first seizure were referred to neurology compared to 25% of patients aged 80-89.

**Conclusions:**

Older patients presenting with seizures are more likely to be admitted to hospital and have imaging. They are less likely to be referred to specialist services on discharge. There appears to be significant disparity in patient age and rate of referral.

**Introduction**

Epilepsy is the third most common neurological condition in older people, following dementia and stroke. (1-5) The annual incidence of epilepsy rises from 85.9 per 100 000 people in those aged over 65 to more than 135 per 100 000 people in those over 80. The true incidence rates are likely to be conservative, given that the diagnosis can often be challenging. (6,7) Approximately 30% of older patients diagnosed with epilepsy do not have this diagnosis, although the true extent of this remains unclear. (8)

Epilepsy accounts for a 2-3 fold increase in mortality in older people. (7, 9) The association of another condition with epilepsy also has substantial effects on morbidity and mortality, quality of life, demand on health services and consequently, financial costs. (10-12) Treatment of epilepsy in this group is challenging given the changes in pharmacokinetics and pharmacodynamics of anti-epileptic drugs (AED), making adverse effects more likely. (13)

The adverse consequences of a diagnosis of epilepsy are as important in older people as their younger cohorts. (14-16) Seizures can erode confidence and lead to social isolation. Driving restrictions can limit independence. Older people with epilepsy have a higher prevalence of anxiety and depression, as well as poor sleep; all of these factors lead to a poorer quality of life. (17, 18)

In spite of the public health need, there remains paucity of data concerning the management of older patients presenting with seizures. This study presents data of from the National Audit of Seizure management in Hospitals (NASH). (19) NASH collated data on patients presenting with seizures to emergency departments (EDs), and assessed the care they received prior to admission, management of the acute event and follow-up arrangements.

**Method**

**Study population**

NASH was coordinated from the University of Liverpool and overseen by a multidisciplinary steering committee consisting of representatives from neurology, emergency medicine, primary care, a patient charity, Information Systems and statistics. Patients presenting to ED, who were either admitted or discharged were selected, providing an index point and opportunity to identify first seizure, new epilepsy cases as well as established cases with uncontrolled seizures. Information was collected about acute, prior and onward care. In keeping with other published data, patients aged 60 and over were selected from the data set for the purposes of this study.

Initial diagnosis and management, was carried out by medical staff in ED, with onward referral and admission to hospital as clinically indicated. The following investigations were documented: AED levels, computed tomography (CT) head, electrocardiogram (ECG), electroencephalogram (EEG), glucose levels and magnetic resonance imaging (MRI) head.

The proforma captured the clinical care pathway for individual patients. The questions were based on the NICE and SIGN guidelines (20, 21) augmented by the practical experience of the steering committee. The clinical proforma was divided into sections covering the care antecedent to the presenting seizure, the care at hospital (in the ED and on medical wards) and the future plans for the patient. Recognising the constraints on data collectors, a limited range of items was collected. The proforma was piloted, with duplicate collections from 60 patients across 10 sites, and the questions amended and refined to reduce ambiguities and inconsistencies.

**Site selection**

Letters to the Chief Executives and Heads of Clinical Audit, and emails to participants from NASH1, were sent in February 2013 to all Trusts/Health Boards in England, Scotland, Wales and Northern Ireland which had sites with EDs, representing 165 UK trusts. 132 trusts participated, with some Trusts having more than one site take part, resulting in data collection from 154 sites.

**Recruitment within sites**

Each site was asked to identify up to 30 consecutive adult patients who presented at the ED from 1st January 2013 with an episode thought to have been a seizure and where the seizure was the primary reason for their admission/attendance. Data was entered anonymously into a bespoke web-based audit system. Data entry took place from June to September 2013, when follow up information should have been available. If an individual attended more than once, each attendance was treated as a separate event.

**Statistical analysis**

For the purposes of analysis patients were divided into the following categories:

1. Those recorded as having known epilepsy prior to attendance. 60 and over (n=640; 51%) under 60 (n=2115; 65%).
2. Those known to have had previous seizures or blackouts, but not a diagnosis of epilepsy. 60 and over (n=209; 17%) under 60 (n=556, 17%).
3. Those with likely first seizure, with no previous seizures, blackouts or diagnosis of epilepsy. 60 and over (n= 405; 32%) under 60 (n=606, 18%).

In order to assess whether there was a difference in patient management according to age, management of patients aged 60 and over was compared to those under 60.

**Results**

**Patient characteristics**

Of the total 4531 patients , 1256 (28%) were aged 60 years or over and included for analysis (median age 74 years, IQR 66-82, 54% men). 87% (1088/1256) of the clinical information was entered by doctors, 8% (104/1256) by nurses, 5% (64/1256) by audit staff or other healthcare professionals. 2 patients could not be classified with regards to diagnosis and were excluded from analysis.

**Treatment prior to admission**

Forty-four percent (281/640) of patients with known epilepsy, and 41% (85/209) of patients with previous seizure or blackout had presented to ED with a seizure in the preceding 12 months.

Eighty-six percent (552/640) of patients with epilepsy were documented as taking AED treatment. 59% (377/640) were on monotherapy, 27% (175/640) were on two or more AEDs (i.e. polytherapy). (Table 1) Sodium valproate, was the most commonly used AED both as monotherapy 28% (181/640) and polytherapy 42% (267/640). 9% (56/640) of patients with epilepsy were on carbamazepine monotherapy, 8% (50/640) phenytoin monotherapy, 9% (40/640) on lamotrigine monotherapy and 9% (39/640) on levetiracetam monotherapy.

Twenty-eight percent (179/640) of those aged 60 and over with epilepsy had evidence of contact with an epilepsy specialist recorded in the year preceding their attendance, compared to 40% (842/2115) of patients under 60. Only 30% (189/640) of patients aged 60 and over with epilepsy had a written care plan in place.

**Assessment on arrival**

The majority of patients had their Glasgow Coma Scale (GCS) and temperature checked on arrival to ED. The figures were similar for those over and under 60. 43% (175/405) of patients presenting with a likely first seizure had plantar reflexes checked; fundoscopy was only carried out in 15% (60/405). (Table 1)

For those presenting with a likely first seizure, an eyewitness account was sought in 80% (323/405) of patients over 60 compared to 72% (436/606) in patients under 60.

Senior review or discussion with a senior in ED was carried out in 57% (229/405) of patients presenting with a likely first seizure and in 59% (377/640) of patients with epilepsy. These figures were comparable to those in the under 60s.

Documentation of alcohol intake was lower for patients over 60 compared to their younger cohorts. It was carried out in 31% (126/405) of patients presenting with a likely first seizure.

Rates of admission were higher in patients over 60 compared to those under 60. 80% (326/405) of patients aged 60 and over presenting with a likely first seizure were admitted to hospital, compared to 65% of those under 60. (Table 1)

**Inpatient management**

ECGs, a NICE guideline-recommended investigation, were documented in 91% (370/405) of patients presenting with a likely first seizure and 83% (534/640) of patients with epilepsy. (17) (Table 1)

CT head, was the primary imaging modality, with only 3-4% of patients having MRI. 71% (290/405) of patients with a likely first seizure had a CT scan during admission, compared to only 43% of those under the age of 60.

Thirty-five percent (226/640) of patients with epilepsy, aged 60 and over, had a CT during admission compared to only 17% of those under 60. 32% (128/396) of patients aged 60 and over with known epilepsy, and GCS of 13-15 on admission, went on to have a CT. This figure is much higher than for those under 60 where only 15% (249/1621) with a GCS of 13-15 went on to have a CT. The number of CTs carried out did not differ between age groups.

**Care following admission**

Patients who died during admission were excluded from analysis of follow-up arrangements (Table 2-3)

1. Those recorded as having known epilepsy prior to attendance. 60 and over (n=622), under 60 (n=2114).
2. Those known to have had previous seizures or blackouts, but not a diagnosis of epilepsy. 60 and over (n=208), under 60 (n=554).
3. Those with likely first seizure, with no previous seizures, blackouts or diagnosis of epilepsy. 60 and over (n= 390), under 60 (n=603).

Seizure was quoted as the cause of death in only one patient with known epilepsy (1/18) and in one presenting with likely first seizure (1/15).

Only 22% (90/390) of patients presenting with a likely first seizure were given advice on what to do should they go on to have further seizures. The percentage of patients with a likely first seizure, or previous seizure or blackout who were given advice increased by age group, with similar figures in those under 60. (Table 2, 3)

Thirty-four percent (131/390) of patients 60 and over, presenting with a likely first seizure were referred by ED, or asked to be referred by their GP, for an epilepsy outpatient review compared to 68% (411/603) of those under 60. (Table 2)

There was a downward trend in referral rate by age group. 42% (105/252) of 60-69 year olds with epilepsy were referred on discharge compared to 24% (35/157) of those 80-89. 52% (57/110) of 60-69 year olds presenting with a likely first seizure were referred compared to 25% (29/116) of patients aged 80-89. (Table 3)

Fifty-three percent (94/176) of patients with epilepsy, who had contact with neurology services in the preceding 12 months, were referred back to epilepsy services on discharge, compared to 25% (112/445) of patients with epilepsy who had not been seen.

**Discussion**

NASH retrospectively assessed the management of patients aged 60 and over presenting to ED with seizures. Sodium valproate was the most commonly prescribed AED in this study both as monotherapy and polytherapy. This is likely to reflect the broad therapeutic spectrum and straightforward dosing schedule of this drug. (22-24)

Focal epilepsy is more likely to be refractory to treatment and there is evidence that sodium valproate is not the best first AED to achieve seizure freedom. (6, 25-27) A multi-centre double blind trial, comparing carbamazepine to sodium valproate, found that carbamazepine was more effective in the treatment of focal seizures, the two being equally effective for secondary generalised tonic–clonic seizures. Carbamazepine had fewer long term adverse effects than sodium valproate. (25)

Sodium valproate has also been implicated in reduction of bone density in the older people increasing the risk of fractures in this group. (13, 28-29) There is also a higher rate of Parkinsonism in patients treated with sodium valproate. (30) The continued use of sodium valproate reflects outdated practice and is likely to be a consequence of management of these patients in primary care or by non-specialist services.

To date only five randomised controlled trials of AED monotherapy in older patients with newly diagnosed epilepsy have been carried out. (26, 31-34) Four of the trials have shown comparable efficacy, in terms of time to first seizure, or seizure freedom between carbamazepine and lamotrigine. (26, 31, 33, 34) Retention rates were higher for lamotrigine than carbamazepine in these trials, mainly due to better tolerability with lamotrigine. The only prospective randomised, double-blind trial comparing levetiracetam, lamotrigine and carbamazepine controlled release in older patients with newly diagnosed epilepsy showed similar efficacy of levetiraceteam monotherapy compared to carbamazepine controlled release. Tolerability was superior in levetiracetam leading to increased effectiveness in terms of retention rates. (32) These findings do not seem to be reflected in clinical practice judging by the results of NASH where, by comparison, only a small percentage of patients were on lamotrigine, carbamazepine or levetiracetam monotherapy.

A significant number of patients with known epilepsy are having imaging following a seizure. Whilst there appears to be some correlation between this and the GCS score, the same cannot be said when comparing the over and under 60s. This may be due to longer resolution of post-ictal confusion, Todd’s paresis or aphasia, thereby necessitating imaging in this group. (35) Given the retrospective nature of NASH it is difficult to explore this further, however the need for imaging is likely to lead to longer admission times and perhaps unnecessary scans in this group of patients.

Older patients presenting with seizures are also more likely to be admitted to hospital. Their other comorbidities and also safety concerns if they live alone, are factors which will influence admission. Advice on what to do in the event of further seizures is generally poor. It might be helpful for ED departments to have information leaflets available to give to patients on discharge.

Patients with epilepsy who had been seen in the previous 12 months were twice as likely to be referred back to epilepsy services on discharge. This is in line with previous published data. (36) Equitable access to specialist epilepsy services is important, particularly in older people where diagnosis can be more challenging. A study assessing this in Sheffield and Rotherham found that older patients with epilepsy were less likely to be referred to specialist neurology services than their younger counterparts, raising the possibility of age discrimination. (37) These findings are supported by the national data collated in this study.

The same group in Sheffield and Rotherham explored possible reasons for non-referral, and identified a number of factors which may explain lower referral rates, including difficulty accessing hospital, patient reluctance to attend clinics, unclear referral pathway, complex differential diagnosis, referrer knowledge and time since onset. (38) When older patients were surveyed on the same questions many directly disagreed with these views. This data suggests that healthcare professionals may make assumptions about older people in terms of their willingness and ability to attend hospital appointments. (39) The sample size of professionals and patients was small and therefore further studies are needed to assess healthcare professionals’ attitudes.

Other reasons for non-referral to specialist services include referral to another medical speciality, such as elderly care medicine. NASH was not set up to assess referral to other specialties, which is a limitation for the purposes of this analysis and may account, in part, for the lower referral rates to epilepsy services in this group. A more integrated approach between primary care, general physicians and epilepsy specialists would be helpful in management. If there is diagnostic uncertainty early involvement of physicians with an interest in epilepsy should improve this.

As a retrospective audit, data in NASH could only be derived through information documented in the medical notes. Some of the missing data may be due to variability of recording, or availability of the information at the time of data collection. Patients were divided into 3 groups, one of which comprised those who may have had a seizure or blackout. In the latter the diagnosis of epilepsy was not clear from the medical records and they were therefore reported separately given that a retrospective diagnosis would not have been possible. A group of patients without a known diagnosis of epilepsy were on anti-epileptic medication. The nature of data collection did not allow retrospective review to ascertain whether this was in error or whether these drugs had been prescribed for different indications.

**Conclusion**

There is considerable variation in the documented care of patients with seizures attending hospital and this is evident throughout the care pathway. Better management of these patients in the community would lead to lower admission rates in hospital. With a rapidly expanding ageing population, we have to be even more inclusive of the healthcare needs of this group of individuals, which can fundamentally improve their quality of life as well reducing unnecessary investigations and thereby longer hospital admissions.

Although review of these patients within epilepsy services is ideal, this may not be feasible for every patient. A stronger network between epilepsy specialists, primary care and general physicians is needed to improve management, lower admission rates, bringing about large cost savings.

Table 1. Treatment prior to admission, assessment on arrival and inpatient management – Comparison between 60 and over and under 60s.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Patient with diagnosis of epilepsy | Patients with known seizure/blackout but no diagnosis of epilepsy | Patient with likely first seizure with no diagnosis of epilepsy, seizure/blackout |
|  | 60 and over% (n=640) | Under 60% (n=2115) | 60 and over% (n=209) | Under 60% (n=556) | 60 and over% (n=405) | Under 60% (n=606) |
| No AEDs | 14% (88) | 19% (410) | 71% (148) | 84% (466) | 95% (383) | 95% (577) |
| Monotherapy | 59% (377) | 45% (950) | 26% (55) | 14% (78) | 5% (19) | 4% (26) |
| Two or more AEDs | 27% (175) | 36% (755) | 3% (6) | 2% (12) | 1% (3) | 0% (3) |
| Specialist review in the past 12 months | 28% (179) | 40% (842) | 25% (52) | 32% (176) | 7% (27) | 2% (43) |
| GCS Score | 88% (561) | 89% (1892) | 90% (189) | 92% (514) | 91% (369) | 90% (544) |
| Temperature | 92% (587) | 92% (1953) | 94% (198) | 94% (520) | 90% (367) | 92% (557) |
| Fundoscopy  | 12% (74) | 13% (272) | 17% (35) | 15% (84) | 15% (60) | 21% (127) |
| Plantar reflex | 33% (213) | 29% (615) | 40% (85) | 34% (190) | 43% (175) | 41% (247) |
| Eyewitness account | 73% (464) | 64% (1361) | 81% (170) | 65% (360) | 80% (323) | 72% (436) |
| Review by senior ED doctor | 59% (377) | 57% (1206) | 61%(127) | 58% (325) | 57% (229) | 60% (363) |
| Documented alcohol intake | 27% (174) | 40% (851) | 42% (87) | 59% (326) | 31% (126) | 59% (359) |
| CT | 35% (226) | 17% (369) | 44% (91) | 28% (153) | 71% (290) | 43% (259) |
| CT GCS 3-8  | 44% (31/70) | 46% (49/107) | 65% (13/20) | 25% (3/12) | 87% (45/52) | 81% (13/16) |
| CT GCS 9-12 | 45% (43/95) | 27% (43/162) | 38% (8/21) | 48% (14/29) | 73% (29/40) | 63% (19/30) |
| CT GCS 13-15 | 32% (128/396) | 15% (249/1621) | 43% (63/148) | 27% (128/472) | 69% (192/277) | 42% (207/496) |
| MRI | 3% (17) | 2% (41) | 4% (8) | 3% (17) | 8% (33) | 7% (43) |
| ECG | 83% (534) | 64% (1359) | 86% (180) | 77% (427) | 91% (370) | 84% (508) |
| Glucose | 86% (550) | 80% (1696) | 86% (180) | 82% (456) | 87% (352) | 86% (523) |
| Admission | 74% (474) | 50% (1065) | 62% (131) | 47% (263) | 80% (326) | 55% (331) |
| Advice or review by neurology | 22% (143) | 21% (435) | 20% (42) | 18% (100) | 21% (87) | 17% (101) |

AED, anti-epileptic drug treatment GCS, Glasgow coma score. ED, Emergency department. CT, computed tomography. MRI, magnetic resonance imaging. ECG, electrocardiogram.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Patient with diagnosis of epilepsy | Patient with previous seizures/blackouts but no epilepsy  | Patient with no diagnosis of epilepsy, seizures/blackouts  |
|  | 60 and over% (n=622) | Under 60 % (n=2114) | 60 and over % (n=208) | Under 60% (n=554) | 60 and over% (n=390) | Under 60% (n=603) |
| Seizure management  | 27% (172) | 28% (592) | 25% (53) | 27% (150) | 22% (90) | 29% (175) |
| Epilepsy specialist referral as outpatient | 33% (206) | 46% (982) | 42% (87) | 65% (360) | 34% (131) | 68% (411) |

Table 2. Future seizure management and specialist outpatient referral

Table 3. Future seizure management by age group

|  |  |  |  |
| --- | --- | --- | --- |
|  | Patient with diagnosis of epilepsy % (n=622) | Patient with previous seizures/blackouts but no epilepsy % (n=208) | Patient with no diagnosis of epilepsy, seizures/blackouts % (n=390) |
| Seizure management by age group |
| 60-69 | 28% (71/252) | 21% (16/76) | 20% (22/110) |
| 70-79 | 29% (55/189) | 25% (17/67) | 23% (30/130) |
| 80-89 | 26% (41/157) | 30% (14/47) | 25% (29/116) |
| > 90 | 22% (5/23) | 35% (6/17) | 30% (9/30) |
| Referral by age group |  |  |  |
| 60-69 | 42% (105/252)  | 59% (45/76)  | 52% (57/110)  |
| 70-79 | 33% (62/189)  | 44% (30/68)  | 32% (42/130)  |
| 80-89 | 24% (37/157)  | 21% (10/47)  | 25% (29/116)  |
| >90 | 13% (3/23)  | 12% (2/17)  | 10% (3/30)  |

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**References**

1. Orimo H, Ito H, Suzuki T et al. Reviewing the definition of elderly. *Geriatr Gerontol Int* 2006; 6:149–158.
2. Wallace H, Shorvon S, Tallis R. Age-specific incidence and prevalence rates of treated epilepsy in an unselected population of 2 052 922 and age-specific fertility rates of women with epilepsy. *Lancet* 1998; 352:1790-3.
3. Beghi E, Addressing the burden of epilepsy. Many unmet needs. *Pharmacological Research* 2016; 107: 79–84.
4. Hauser AW, Annegers JF Kurland L et al. Incidence of epilepsy and unprovoked seizures in Rochester, Minnesota: 1935–1984, *Epilepsia* 1993; 34: 453–468.
5. Tallis R., Hall G ,Craig I et al. How common are epileptic seizures in old age? *Age Ageing* 1991; 20: 442–448.
6. Stephen LS, Brodie MJ. Epilepsy in elderly people. *Lancet* 2000; 355: 1441-6.
7. Brodie MJ, Elder AT, Kwan P. Epilepsy in later life, *Lancet Neurol* 2009; 8: 1019–1030.
8. Ramsay RE, Rowan AJ, Pryor FM. Special considerations in treating the elderly patient with epilepsy. *Neurology* 2004; 62: S24–29.
9. Lhatoo SD, Johnson AL, Goodridge DH et al. Mortality in epilepsy in the first 11–14 years after diagnosis: multivariate analysis of a long-term prospective, population-based cohort. *Ann Neurol* 2001; 49: 336–344.
10. Feinstein A.R., The pre-therapeutic classification of co-morbidity in chronic disease. *J Chronic Dis* 1970; 23: 455–468.
11. Ferlazzo E, Sueri C, Gasparin S, et al. Challenges in the pharmacological management of epilepsy and its causes in the elderly. *Pharmacological Research* 2016; 106: 21–26.
12. Beghi E, Frigeni B, Beghi M, et al. A review of the costs of managing childhood epilepsy. *Pharmacoeconomics* 2005; 23: 27–4.
13. Gilliam FG, Fessler AJ, Baker G, et al. Systematic screening allows reduction of adverse antiepileptic drug effects: a randomized trial. *Neurology* 2004; 62:23–27.
14. Baker GA, Jacoby A, Buck D, Brooks J, Potts P, Chadwick DW. The quality of life of older people with epilepsy: findings from a UK community study. *Seizure* 2001; 10: 92–99.
15. Martin R, Vogtle L, Gilliam F, Faught E. Health-related quality of life in senior adults with epilepsy: what we know from randomized clinical trials and suggestions for future research. *Epilepsy Behav* 2003; 4: 626–34.
16. McLaughlin DP, Pachana NA, McFarland K. Stigma, seizure frequency and quality of life: the impact of epilepsy in late adulthood. *Seizure* 2008; 17: 281–87.
17. Haut S, Katz M, Majur J, Lipton RB. Seizures in the elderly: impact on mental status, mood and sleep. *Epilepsy Behav* 2009; 14: 540–44.
18. Laccheo I, Ablah E, Heinrichs R, Sadler T, Baade L, How K. Assessment of quality of life among the elderly with epilepsy. *Epilepsy Behav* 2008; 12: 257–64.
19. Dixon PA, Kirkham JJ, Marson AG, Pearson MG. National Audit of Seizure management in Hospitals (NASH): results of the national audit of adult epilepsy in the UK. *BMJ Open* 2015; 5: e007325.
20. National Institute for Health and Clinical Excellence. Epilepsies: Diagnosis and management. NICE Clinical Guideline 137. London. National Institute for Health and Clinical Excellence. 2012.
21. Diagnosis and management of epilepsy in adults: A national clinical guidelines Scottish Intercollegiate Guidelines Network Royal College of Physicians of Edinburgh, 2003.
22. Stephen LJ. Drug treatment of epilepsy in elderly people: focus on valproic acid. *Drugs Aging* 2003; 20: 141–52.
23. Perucca E, Aldenkamp A, Tallis R, Kramer G. Role of valproate across the ages. Treatment of epilepsy in the elderly. *Acta Neurol Scand Suppl* 2006; 184: 28–37.
24. Huber DP, Griener R, Trinka E. Antiepileptic drug use in Austrian nursing home residents. *Seizure* 2013; 22: 24–7.
25. Arain AM, Abou-Khalil BW. Management of new-onset epilepsy in the elderly. *Nat Rev Neurol* 2009; 5: 363–71.
26. Rowan AJ, et al. New onset geriatric epilepsy: a randomized study of gabapentin, lamotrigine, and carbamazepine. *Neurology* 2005; 64:1868–1873.
27. Marson, A. G. et al. The SANAD study of effectiveness of carbamazepine, gabapentin, lamotrigine, oxcarbazepine, or topiramate for treatment of partial epilepsy: an unblended randomised controlled trial. *Lancet* 2007;369: 1000–1015
28. Ensrud KE, Blackwell T, Mangione CM et al. Central nervous system active medications and risk for fractures in older women. *Arch Int Med* 2003; 163: 949–957.
29. Verrotti A, Coppola G, Parisi P et al. Bone and calcium metabolism and antiepileptic drugs. *Clin Neuro Neurosurg* 2010; 112: 1–10
30. Jamora D, Lim S-H, Pan A et al. Valproate-induced Parkinsonism in epilepsy patients. *Mov. Disord.* 2007; 22: 130–133.
31. Brodie, M. J., Overstall, P. w. & Giorgi, L. Multicentre, double-blind, randomised comparison between lamotrigine and carbamazepine in elderly patients withnewly diagnosed epilepsy. The UK Lamotrigine elderly study Group. *Epilepsy Res* 1999; 37: 81–87.
32. Werhahn KJ, Trinka E, Dobesberger J, Unterberger I, Baum P, Deckert-Schmitz M, et al. A randomized, double-blind comparison of antiepileptic drug treatment in the elderly with new-onset focal epilepsy. *Epilepsia* 2015; 56: 450–9.
33. Nieto-Barrera M, Brozmanova M, Capovilla G, Christe W, Pedersen B, Kane K, et al. A comparison of monotherapy with lamotrigine or carbamazepine in patients with newly diagnosed partial epilepsy. *Epilepsy Res* 2001; 46: 145–55.
34. Saetre E, Perucca E, Isojarvi J, Gjerstad L. An international multicentre randomized double-blind controlled trial of lamotrigine and sustained release carbamazepine in the treatment of newly diagnosed epilepsy in the elderly. *Epilepsia* 2007;48:1292–302
35. Sheth RD, Drazkowski JF, Sirven JI, et al., Protracted ictal confusion in elderly patients. *Arch Neurol* 2006; 63:529–532.
36. Grainger R, Pearson M, Dixon P, et al. Referral patterns after a seizure admission in an English region: an opportunity for effective intervention? An observational study of routine hospital data. *BMJ Open* 2016; 6:e010100. doi:10.1136/bmjopen-2015- 010100.
37. Reuber M, Torane P, Mack C. Do older adults have equitable access to specialist epilepsy services? *Epilepsia* 2010; 51: 2341–3.
38. Blank L, Baxter S, Baird W, Reuber M. Understanding referral patterns to an epilepsy clinic: professional perceptions of factors influencing the referral of older adults. *Seizure* 2013; 22: 698–702.
39. Blank L, Baird W, Reuber M. Patient perceptions of the referral of older adults to an epilepsy clinic: Do patients and professionals agree who should be referred to a specialist? *Epilepsy Behav* 2014; 34; 120-123.