The safety of UK video telemetry units: Results of a national service evaluation

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Purpose: To assess patient safety during seizures occurring on UK video telemetry units and identify factors in unit infrastructure which may improve safety with the intention of producing national guidelines.
Methods: A prospective multicentre national service evaluation of the occurrence of adverse events and level of nurse attendance during seizures occurring on video telemetry units was performed. Data from 272 seizures from 27 video telemetry units across the UK were analysed.
Results: Adverse events occurred in 12% of seizures: 7% were physical events such as falls or respiratory compromise and 5% were unnoticeninness seizures. Nursing staff did not attend the patients in 44% of seizures and attendance was delayed beyond 30 s in a further 28%. Only 27% of seizures were attended by a Healthcare Professional within half a minute. The most important factor shown to improve timely attendance of patients during seizures was the presence of a nurse dedicated to the telemetry bed(s). The site of the telemetry bed (bay or cubicle) and method of observation (direct or indirect) was less important. An optimal nurse-to-patient ratio was difficult to identify but the study suggests that a ratio of at least 1 nurse to 4 patients is appropriate.
Conclusion: The results provide an evidence base for the production of national standards and guidelines for surveillance of patients during video telemetry to improve patient safety.

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1. Introduction

Long term video EEG recording is increasingly used to differentiate epileptic from non-epileptic attacks, to classify epileptic seizure types and to identify seizure foci in patients being assessed for a possible surgical treatment for intractable epilepsy. To meet increasing demand, video telemetry (VT) units are expanding across the UK. Success of the investigation depends on recording the patients’ habitual seizure type and anti-epileptic medication may be withdrawn to improve the likelihood of recording a seizure. During seizures patients are at risk of complications including injury and sudden unexpected death in epilepsy (SUDEP).1-5 Patients with psychogenic nonepileptic seizures are also at risk of harm.6 Adverse events need to be anticipated and prevented to ensure patient safety and effective patient surveillance during seizures is of paramount importance. Although there are published surveys detailing the incidence of adverse events in video telemetry units, specific guidelines for safety in video telemetry units are lacking. The few published guidelines available6-9 concentrate on electrical safety and availability of resuscitation equipment with limited recommendations specifically addressing the level and type of staffing required in a VT unit to ensure safety. This study aims to investigate the optimal requirement for healthcare professional (HCP) surveillance of patients in VT units through a national service evaluation.

2. Methods

The aim of the study was to assess how often seizures occurring in patients on UK telemetry units were attended by healthcare professionals and to measure the length of any delay to professional care being given. We aimed to identify variables in VT unit infrastructure which may aid prompt attendance during seizures to help formulate national recommendations for patient safety. There is no published guideline suggesting a minimum time from seizure onset to attendance by a healthcare professional to ensure patient safety. For the purpose of the study, after
consultation with expert colleagues, an attendance within 30 s of seizure onset was deemed to be satisfactory for patient safety. The primary outcome measure was taken as attendance by a HCP within 30 s of seizure onset. Secondary outcome measures were any attendance by a HCP, absolute delay to attendance by a HCP and occurrence of adverse events.

Questionnaires were sent to 63 departments of Clinical Neurophysiology who had expressed an interest via the professional societies (British Society for Clinical Neurophysiology and Association of Neurophysiological Scientists) in participating in national audit studies. Not all of the 63 centres had video telemetry facilities but replies were received from 31 centres (Appendix). We believe this to be over 80% of the UK units.

The questionnaire consisted of two parts (Appendix). The first part obtained data on unit infrastructure for each department focusing on patient surveillance. The second part of the questionnaire was filled out prospectively on consecutive patients admitted for video telemetry between 1st November 2011 and 31st December 2011. The Clinical Physiologists were asked to fill out one form for each seizure to a maximum of five seizures per patient. Each unit was asked to contribute up to 5 patients over this time period. Information regarding attendance of healthcare professionals during the seizure was obtained.

The full questionnaire can be viewed in the Appendix but for clarity definitions of some of the terms used in the questionnaire and in the results are stated here.

- ‘Nurse’ and ‘Healthcare Professional’ applies to either qualified nurses or unqualified healthcare assistants.
- ‘Dedicated nurses’ refers to those nurses either on a dedicated VT unit or dedicated to the VT beds on a general ward.
- ‘Direct’ methods of patient observation included a HCP positioned in the patient’s room or the bed situated within sight of the nurses’ station. ‘Indirect’ methods of observation included a monitor at the nurses’ station, patient and/or software alarms, relatives staying in the room and nurses positioned outside the room.
- ‘Major motor’ seizures included generalised tonic–clonic, tonic and hyperton motor epileptic seizures as well as non-epileptic seizures involving the patient ‘thrashing’ around. All other seizure types were classed as ‘Minor motor’.
- Daytime seizures were those occurring between 8 am and 8 pm and night time seizures were those occurring between 8 pm and 8 am.
- ‘Missed’ seizures were deemed to be an adverse event and were those seizures that were only discovered on review of the VT recording by a Clinical Physiologist and were unnoticed at the time of occurrence. ‘Unattended’ seizures included the ‘missed’ seizures as well as those that were known to have occurred at the time but a HCP had not managed to attend before the seizure ended.

Patient data was anonymised but the video telemetry centre could be identified by use of the postcode. The study was approved by the Sheffield Teaching Hospitals NHS Foundation Trust Clinical Effectiveness Unit (project registration number 4476). Data was entered onto a Microsoft Access database and analysed using Microsoft Excel and Statistica (Statsoft Inc.).

3. Results

Data from 27 centres were analysed; incomplete data were returned by 4 centres and these were excluded from the analysis.

3.1. Survey of VT unit infrastructure

Detailed characteristics of the infrastructure of the VT units can be seen in the supplementary on-line file. Of the 27 units, 67% were staffed by nurses performing general ward duties as well as looking after the telemetry patients and 33% were staffed by nurses dedicated to the telemetry beds. Direct patient observation by nurses occurred in 26% of units with the remaining 74% using indirect methods including one or more of the following: a monitor at the nurses’ station (24), patient and/or software alarms (18), relatives staying in the room (17) and nurses positioned outside the room (8). The 27 units had a total of 60 beds (median 2; range 1–7 beds per unit). 78% of the beds were located in cubicles with 22% being in ward bays.

Intensity of HCP cover tended to be better in units staffed by dedicated nurses particularly during the night. In units with dedicated nursing the median ratio of nurse to patients was 1:2 (range 1:4 to 1:1) both during the day and during the night while in units with non-dedicated nursing the median ratio was 1:5 (range 1:14 to 1:75) during the day and 1:6 (range 1:16 to 1:75) during the night. 12 (44%) centres reported that the intensity of nursing on their VT unit was appropriate.

Although all units monitored the ECG continuously, it was only visible to nursing staff in 17 units. 21 units had a cot side policy suggesting cot sides up in 18, down in 2 and not stated in 1.

3.2. Prospective study of seizures

272 seizures occurred during the data collection period, 194 in adults and 78 in children. 177 were epileptic, 83 psychogenic non-epileptic seizures and 12 were ‘other’ non-epileptic seizures. 56% of seizures were attended by a HCP. Of the 44% that were not, a relative was present in 22% leaving 22% of seizures not attended by either a nurse or relative.

In the 153 seizures that were attended by a HCP, the range of time to attendance was 0 s to 56 min with a median of 32 s. In 48% of attended seizures (27% of all 272 seizures) a HCP was present within 30 s from onset of the clinical seizure. In 52% of attended seizures (29% of all 272 seizures) attendance by a HCP was delayed beyond 30 s.

Adverse events were noted in 33 (12%) seizures. 18 (7%) of these were ‘physical’ comprising falls (8), hitting head/limbs (2), status epilepticus (2), airway or respiratory compromise (3) and vomiting (3). The remaining 15 (5%) adverse events were unnoticed seizures of which 13 were epileptic, all involving motor features and including 2 generalised tonic–clonic seizures. 52% of the adverse events occurred during the night and 48% during the day. This represented an adverse event occurring in 9% (15/160) of daytime seizures and 16% (18/112) of night time seizures.

The person reviewing the VT recording was asked to give a subjective opinion as to whether the presence of a HCP or relative during the seizure had prevented an adverse event. In 33 patients it was felt that an adverse event (e.g. falls, injury or hypoxia) was prevented during a seizure by the presence of a nurse in 26 and a parent in 7. The median time to nurse attendance in this group was 18 s.

The video telemetry recordings were reviewed by neuropsychology staff within 24 h in the majority of seizures but there was a delay in data review of between 2 days and 4 weeks after the seizure had occurred in 12% of seizures. Within this group were 2 generalised tonic–clonic seizures reviewed at 4 weeks.

Univariate analyses of factors influencing the primary outcome measure of attendance within 30 s are shown in Table 1. Univariate analyses of secondary outcome measures are shown in Table 2 (any attendance by a HCP), Table 3 (absolute delay to HCP attendance) and Table 4 (occurrence of adverse events).
the presence of dedicated nursing, the seizure involving major motor phenomena, the use of direct observation, the absence of a relative and the patient being adult. The absolute delay to nurse attendance in seizures was significantly reduced in patients nursed by dedicated staff and to a lesser extent by those occurring in cubicles. The occurrence of adverse events was more likely to occur in seizures involving major motor features but there was no association with any particular VT unit characteristic. In view of the interrelating nature of many of these variables a multivariate analysis of the primary outcome measure was performed the results of which are shown in Table 5. Only nursing type and timing of the event during the day/night remained significantly predictive of attendance by a HCP within 30 s. The standard was more likely to be met during the daytime and in the presence of dedicated nursing staff.

The multivariate analysis did not identify nurse-to-patient ratio as an independent factor influencing timely attendance. However, analysing the effect of nurse-to-patient ratio is complex due to the wide variation in staffing levels. Grouping the nurse-to-patient ratios into low (<1:5, 96 events), moderate (1:5 to 1:2.5, 141 events) and high (>1:2.5, 35 events) a non-significant trend towards better attendance with higher intensity nursing can be seen: attendance in 30 s in 21% of low, 29% of moderate and 37% of high intensity staffing levels. Similarly there was a non-significant trend to faster nurse attendance with increasing nurse-to-patient ratios (Fig. 1).

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Table 5
Multivariate analysis of possible factors affecting HCP attendance to seizures within 30 s.

<table>
<thead>
<tr>
<th>Predictors of non-attendance within 30 s</th>
<th>Estimate</th>
<th>p-Value</th>
</tr>
</thead>
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<tr>
<td>Intercept</td>
<td>1.34495</td>
<td>0.000995</td>
</tr>
<tr>
<td>Seizure occurrence during night</td>
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<td>0.014396</td>
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<td>Dedicated nursing</td>
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<td>Room-type cubicle</td>
<td>-0.30666</td>
<td>0.231972</td>
</tr>
<tr>
<td>Indirect observation</td>
<td>-0.10627</td>
<td>0.557301</td>
</tr>
<tr>
<td>Major motor seizure</td>
<td>-0.28639</td>
<td>0.025157</td>
</tr>
<tr>
<td>Nurse-to-patient ratio at time of seizure</td>
<td>-0.28715</td>
<td>0.830854</td>
</tr>
</tbody>
</table>

Fig. 1. Time to attendance of seizures by HCP in relation to nurse to patient ratio.

4. Discussion

As video telemetry becomes more commonly available as an investigative technique, concerns about its safety are increasing. Recent cases of SUDEP in video telemetry units have raised awareness of the potential dangers of seizures occurring (sometimes provoked by anti-epileptic drug withdrawal) in VT units. A recent death in a British paediatric unit stimulated the British Paediatric Neurology Association to survey paediatric VT units with a view to producing safety guidelines, a European survey of VT units is at present ongoing and another European study (MORTEMUS) is specifically investigating death and near death cardiac phenomena on VT units. The BSCN and ANS National Audit Group intend to produce evidence based guidelines to improve safety in VT units in the UK. This study is a first step towards this goal.

Quantifying the risk attached to VT has been difficult although several retrospective studies have tried to address the issue. A retrospective study of 752 seizures in 149 patients from a single unit showed adverse events occurring in 7% of patients. Interestingly although status epilepticus, post ictal psychosis, serious ECG abnormalities and vertebral fractures during a generalised tonic–clonic seizure occurred there were no reports of falls, lacerations or dental injuries. An explanation for the absence of preventable injuries may be that the unit had 24 h surveillance by a technician and specially trained nurses with a minimum nurse-to-patient ratio of 1:4.

A retrospective study of 5090 events from 507 patients in a single unit showed adverse events occurring in 9% of seizures consisting of post ictal psychosis in 3%, injuries in 3% and status epilepticus in 2%. These adverse events occurred with equal frequency during the day and night.

A further retrospective study was commissioned by the American Epilepsy Society to address concerns over the lack of consensus regarding patient care on VT units. 70 US centres reported adverse events over the course of a year. 69% of centres experienced falls, 63% status epilepticus, 54% post ictal psychosis, 6% fractures, 7% cardiac arrest and 3% death.

The results from our study showed adverse events occurred in 12% of seizures (7% being physical) which is comparable with results from previous studies as were the types of adverse events themselves i.e. falls, injuries and status epilepticus. No post ictal psychoses occurred in our group but the reporting period was relatively brief at 2 months and may have been too short for all types of adverse events to have occurred. We also confirm that adverse events are equally probable during the day and night and additionally that night time seizures are less likely to be attended promptly, suggesting that surveillance levels should be similar throughout the 24 h monitoring period. 5% of seizures including 2 generalised tonic–clonic seizures were missed during the recording and only noticed at review which was sometimes delayed to a maximum of 4 weeks. This is a risk factor which could be diminished by prompt review of recordings.

Previous studies conclude that standardised guidelines for monitoring and safety are required. The ILAE produced some revised recommendations on the methods to achieve the requirements for long term EEG recordings. The document discusses electrical safety and availability of life support equipment but makes no recommendations regarding patient surveillance and staffing of VT units. Guidelines adopted by the National Association of Epilepsy Centres in the United States specifically addressed the issue of personnel and facilities in specialised epilepsy centres. Recommendations for VT units included protocols for seizure emergencies, resuscitation equipment and ITU care. Recommendations regarding personnel included educational programmes for nurses, nursing protocols for patient safety and a higher than standard nurse-to-patient ratio although the ratio was not stipulated. An American Epilepsy Society symposium presented results from a survey of physicians and nurses from the United States showing that nurse supervision in epilepsy monitoring units was variable with 49–61% of units having constant nurse supervision. Their recommendations were for continuous supervision by EEG technologists or epilepsy staff nurses supported when appropriate by monitoring technologists or automated seizure detection programmes. These guidelines have remained unpublished.

A recent study of 971 VT admissions investigated whether introducing a safety protocol to the epilepsy monitoring unit diminished adverse events such as falls and missed seizures. The protocol included introducing an education programme for staff. Additionally, they replaced the existing surveillance arrangements consisting of EEG technologists during the day and nurse assistants at night and weekends with surveillance by technologists at all times. Although there was a significant reduction in missed seizures, there was no reduction in the frequency of falls. It is not surprising that an EEG technologist would be more capable of recognising seizures as they are able to analyse the EEG as well as the video information. The failure to reduce the incidence of falls suggests that the type of staff used for patient surveillance is not an important factor in this respect.

An older survey performed in 2000 set out to identify a minimum set of requirements for the provision of VT units. 42 units including 13 from Europe responded. Many aspects of VT monitoring were considered; of interest for comparison with our present study is the fact that 52% of units had dedicated nurses, and 38% had alarm bells. Our survey showed fewer units with dedicated nurses (33%) but more with alarms (66%). This may reflect the financial constraints in the UK manifesting in a greater reliance on monitoring methods not involving staff costs. Surprisingly only 64% of units had continuous ECG monitoring.
compared to 100% in our study. Possible reasons for this could include improved technology or a heightened awareness of SUDEP and serious ictal cardiac arrhythmias.

In our study it was clear that centres were concerned about the safety of their patients during VT with less than half of centres reporting satisfaction with intensity of nursing levels. Despite these concerns in only 17 of the 27 centres monitoring ECG continuously was the trace made visible to nursing staff. This is an area which could clearly be improved by simple means.

The perception that staffing was inadequate was supported by the demonstration that only a quarter of seizures were attended by a healthcare professional within 30 s and nearly half were not attended by a HCP at all. Some partial seizures are subtle and genuinely unnoticeable to monitoring staff. Whilst we showed that minor seizures were less likely to be attended by nurses, seizures involving major motor semiology were not attended faster than the minor seizures that were noticed.

The one controllable factor that significantly influenced whether patients received attention during their seizure was the type of nurse staffing the unit. Nurses dedicated to the telemetry beds whether they were in a dedicated telemetry unit or on a general ward were more likely to attend seizures and attend them more rapidly than nurses who looked after the VT patients as well as performing general nursing duties. There was some improvement in early attendance if supervision of the patients was made by direct rather than indirect means but the direct observation did not improve rapid attendance and it seemed that nursing in a cubicle was better than in a ward bay for ensuring prompt attendance. However observation type and bed type were closely correlated with nursing type and in multivariate analysis the presence of dedicated nursing was the dominant factor influencing prompt nurse attendance. It is worthy of note that even with dedicated nursing one third of seizures were unattended. In these cases other factors must influence whether the HCP has the facility to attend the seizure and intuitively the number of other patients the nurse is responsible for would seem relevant.

Nevertheless it is difficult to recommend an appropriate nurse-to-patient ratio as it has not been possible to prove a strong association between nurse-to-patient ratio and seizure attendance. However, the dedicated nurses were generally provided in greater numbers than the general nurses and no unit with dedicated nurses had a nurse-to-patient ratio of less than 1:4. It seems sensible, therefore, in the absence of better data to recommend a ratio of no less than 1:4.

It appears that the presence of a relative negatively influences the probability of attendance by a healthcare professional during seizures. This may be because the patient’s family are used to dealing with seizures and do not feel the need to summon professional assistance. Whilst the presence of a relative is undoubtedly valuable, in a hospital setting reliance on relatives cannot represent the best option of care. The family should be encouraged to stay but instructed to alert HCPs to all seizures during the VT admission.

5. Conclusion

The aim of this multicentre prospective study was to provide a UK evidence base on which to produce national guidelines. Our findings suggest that all VT beds should have 24 h surveillance by healthcare professionals with similar staffing throughout the monitoring period. Direct observation of the patient may improve nurse attendance but other methods of observation such as the use of video monitors and nurse alarms are acceptable. It is important that the healthcare professionals in charge of patient surveillance should be dedicated to the VT unit and not be expected to perform other duties even if telemetry beds are situated on a general ward. It is not possible to specify the optimum nurse-to-patient ratio for a video telemetry unit but a ratio of not less than 1:4 is suggested as appropriate. HCPs should be trained to recognise seizures and major disturbances of cardiac rhythms. The patient’s heart rate should be clearly displayed to the monitoring HCP usually by ECG or alternatively by pulse oximetry to allow prompt intervention during instances of serious ictal cardiac arrhythmias. VT studies should be reviewed by Neurophysiology staff within 24 h to reduce consequences of unnoticed seizures. Whilst the presence of a relative may be beneficial to patient safety, accompanying relatives should be encouraged to alert HCPs to all seizures occurring in the VT unit.

Guidelines and standards should also include reference to factors outside the scope of this study such as risk assessment of room layout, protocols for antiepileptic drug withdrawal and facilities for emergency treatment for status epilepticus.

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Appendix. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.seizure.2013.08.001.

References