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RESEARCH ARTICLE

Tonic–clonic seizures captured during ambulatory video-EEG are frequently unreported

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Abstract

Objective: Tonic–clonic seizures (TCSs) are widely regarded as clinically obvious, yet seizure counts used for treatment decisions and risk counseling often rely on patient or caregiver diaries. We sought to quantify the frequency of unreported TCSs during prolonged ambulatory video-EEG (vEEG) monitoring and examined associations with electrographic-onset subtype and patient characteristics.

Methods: We conducted a retrospective cohort study of routinely collected ambulatory vEEG from a single national Australian service (January 2018–June 2024). Studies were eligible if the patient had epilepsy and at least one objectively captured TCSs. Reporting status was derived from diary entries and post-study questioning, and classified as reported vs unreported. The primary descriptive outcome was patient-level reporting status across captured TCSs: all captured TCSs reported, some captured TCSs reported, or no captured TCSs reported. Event-level reporting status was used for seizure-level descriptive summaries and patient-clustered analyses. Event-level associations were examined using patient-clustered generalized estimating equations, and patient-level subgroup comparisons used nonparametric and categorical tests.

Results: Among 130 patients with objectively captured TCSs, 69 of 130 (53.1%) reported all captured TCSs, 41 of 130 (31.5%) reported some but not all captured TCSs, and 20 of 130 (15.4%) reported no TCSs during monitoring. Overall, 61 of 130 patients (46.9%) had at least one unreported TCS. At the event level, 340 of 754 captured TCSs (45.1%) were unreported and identified only on review. Nineteen of 130 patients (14.6%; 95% confidence interval [CI] 9.0–21.9) had no documented prior TCS history in available service records and reported no TCSs during monitoring. Unreported event proportions were similar across focal-onset and generalized-onset TCSs, whereas sleep was associated with higher odds of underreporting.

Significance: In this selected ambulatory vEEG cohort, nearly half of patients with captured TCSs had at least one unreported TCS, including 15.4% who reported none during monitoring. These findings indicate that diary-based histories may underestimate convulsive seizure burden in some monitored patients, with implications for safety decisions, therapeutic escalation, and sudden unexpected death in epilepsy (SUDEP) counseling.

KEYWORDS
convulsive events, home monitoring, nocturnal events, seizure diaries, underreporting

1 | INTRODUCTION

Tonic–clonic seizures (TCSs) are widely regarded as the most overt and clinically evident seizure types. They are associated with injury, psychosocial morbidity, and increased mortality, including sudden unexpected death in epilepsy (SUDEP).[1,2] In clinical practice, the presence or absence of TCSs is frequently determined by patient or caregiver reporting, and seizure counts obtained from diaries are used to inform treatment decisions, eligibility for driving, and risk counseling.

Although it has long been recognized that nonconvulsive seizures are underreported, convulsive seizures are commonly assumed to be reliably identified.[3,4] However, impaired awareness during seizures and postictal amnesia may contribute to inaccurate self-reporting, and seizures occurring during sleep or in the absence of witnesses may never come to medical attention. Thus, even events considered clinically pronounced may be incompletely captured in routine history.[3,4]

Prior studies comparing patient-reported seizures with objective recording have demonstrated substantial underreporting, including for motor and tonic–clonic seizures. However, much of this evidence derives from inpatient epilepsy monitoring units,[4–9] where reporting may be influenced by admission context, medication changes, staff observation, caregiver presence, and active prompting. The extent to which these findings generalize to prolonged home ambulatory video-electroencephalography (vEEG), where seizures occur in a more naturalistic environment, remains uncertain.

This study examines the frequency of unreported TCSs during prolonged home ambulatory vEEG monitoring in a cohort in whom convulsive seizures were objectively recorded. The aims were to quantify the extent of TCS underreporting, determine whether reporting varies by electrographic-onset subtype, and identify patient characteristics associated with complete failure of reporting.

Key points

- Twenty of 130 patients reported none of their captured tonic–clonic seizures (TCSs), and 41 of 130 reported some but not all captured TCSs.
- Unreported events were more likely during sleep, with no clear onset-type association.
- In 14.6% of patients, there was no documented prior TCSs in service records and none reported during monitoring.
- Diary-based counts may underestimate burden, affecting safety, treatment, and sudden unexpected death in epilepsy (SUDEP) counseling.

2 | MATERIALS AND METHODS

2.1 | Study setting

This retrospective cohort study used routinely collected ambulatory vEEG clinical data from a single national Australian service (January 2018 to June 2024). The primary recordings were not available for the purposes of this research. The study was approved by the St Vincent's Hospital Melbourne Human Research Ethics Committee (042/18). Written informed consent was obtained from participants. This was not a clinical trial, and trial registration was not applicable. This report adheres to STROBE guidelines for observational studies.[10] The completed checklist is included in Supplementary Appendix.

2.2 | Study design and cohort

Patients were referred for diagnostic evaluation and/or reassessment of seizure diagnosis and management. vEEG recordings were initiated in clinic and completed in the home environment, with remote technical review during acquisition. EEG was recorded with full montage 10–20 EEG. All studies had concurrent video. Recording duration was requested by the referring clinician and reviewed by a senior neurologist from the ambulatory vEEG service. Longer recordings were generally used when capture of infrequent events or multiple event types was sought, provided the requested duration was considered clinically appropriate.

Studies were checked remotely twice a day by trained technicians to assess and log recording quality and troubleshoot technical issues. Technicians had access to live video and EEG, system status (i.e., memory usage, temperature), and impedance logs via a secure web interface. Patients and carers were asked to complete a seizure diary during monitoring using a mobile app (Seer Medical, Australia). Where this was not feasible,

patients were provided with a paper diary. When patients returned their EEG systems, they were further prompted by the technologists whether any events had occurred that needed to be included in the diary.[11] No adjustments were made to the patient's medications during the monitoring period.[12]

We included all neurologist-reported studies with recording duration between 3 h and 14 days, and restricted the analytic cohort to studies where the patient had a diagnosis of epilepsy (either before or after the vEEG).

2.3 | Variables and definitions

Patient- and study-level variables were extracted from the clinical cloud database, including age, self-reported sex, recording duration, referral indication, and anti-seizure medication (ASM) count.

TCS events were identified from report text and event metadata. For event-level analyses, TCSs were grouped by onset type (focal to bilateral vs generalized onset) and reporting status (reported vs unreported).[13] Sleep context (awake/asleep) and hour-of-day bins were used for event-context summaries. Onset type was derived from the clinical report assigned by the reporting neurologist and was not reclassified for this study. Sleep and wake classifications were made by trained technicians from video and EEG data during event review. Documented prior TCS history was derived from referral information and clinical history available to the ambulatory vEEG service. This variable therefore reflects whether prior TCSs were documented in available service records, rather than whether prior TCSs had occurred or were recorded elsewhere in the patient's broader medical record.

Captured TCS patients were defined as patients with at least one TCS event. The unrecognized subgroup was defined as captured TCS patients with no documented prior TCS history in available service records and no reported TCS during monitoring.

There were no missing data for age, sex, recording duration or ASM count. Patient histories were limited to the information provided during the patient referral process. Driving status was not documented in the available referral data and could not be assessed as a potential contributor to underreporting.

2.4 | Statistical analysis

Continuous variables are reported as median (interquartile range, [IQR]), and categorical variables as n (%). Patient comparisons used two-sided Mann–Whitney U tests for continuous variables and chi-square tests for categorical variables, with Fisher's exact tests for 2×2 tables when expected counts were small.[14]

Because multiple TCS events could be contributed by the same patient, primary event-level inferential analyses used patient-clustered generalized estimating equations (GEEs). We used GEEs with a binomial distribution and logit link, clustering on patient ID, with robust (sandwich) standard errors and an independence working correlation structure. The event-level outcome was unreported TCSs (discovered) vs reported TCSs. Univariable GEE models were fit for onset type (generalized vs focal onset), sleep state (asleep vs awake), and time-of-day category (00:00–05:59, 06:00–11:59, 12:00–17:59, 18:00–23:59). A multivariable GEE model included onset type, sleep state, and time-of-day simultaneously. Results are reported as odds ratios (ORs) with 95% confidence intervals (CIs); global Wald tests were used for multi-level predictors.

For 2×2 contrasts, ORs with CIs are reported. Exact binomial (Clopper-Pearson) 95% CIs were used for selected proportions.[15]

Statistical significance was set at $p<0.05$ (two-sided). Analyses were performed in Python 3.11.

2.5 | Data availability statement

De-identified data may be shared upon reasonable request to the corresponding author.

2.6 | Data access

The corresponding author had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

3 | RESULTS

Among 7347 patients classified as having epilepsy, 130 (1.8%) had at least 1 captured TCS event (Table 1) during vEEG. These 130 patients had a combined total of 754 TCS events. Median age was 23.0 years (IQR 15.0–37.0), 43 of 130 (33.1%) were younger than 18 years of age, and 70 of 130 (53.8%) were female. Median recording duration was 163.9 h (IQR 95.1–167.6), median ASM count was 1 (IQR 0–2), and median TCS events per EEG study was 2 (IQR 1–7).

At the patient level (Figure 1), all TCSs were reported by patients or carers in 69 of 130 (53.1%), there was a mix of reported and unreported in 41/130 (31.5%), and all TCSs were unreported (none reported) in 20 of 130 (15.4%). We found no association between prior TCS history and

reporting of TCS events during monitoring (Fisher exact $p = 1.000$, OR for no-reported TCS, history-no vs history-yes 1.90, 95% CI 0.23–15.73). Among studies with at least one unreported TCS, 29.5% had no diary entries of any type (18/61). Overall, 61 of 130 patients (46.9%) had at least one captured TCS that was not reported. TCS: Tonic-clonic seizure. ASM: Anti-seizure medication.

Referral indications were similar between patients with captured TCS and the remainder of the epilepsy cohort. Among the 130 patients with captured TCS, the primary referral indication was characterization/localization of epileptic seizures in 61 patients (46.9%), assessment of treatment response or suspected subclinical seizure burden in 58 (44.6%), and diagnosis of episodic neurological dysfunction in 11 (8.5%). In the remainder of the epilepsy cohort, the corresponding proportions were 3377 of 7217 (46.8%), 2865 of 7217 (39.7%), and 950 of 7217 (13.2%), respectively. There was no evidence of a difference in the overall distribution of primary referral indications between groups (Pearson chi-square $p = 0.336$), and no individual substantive referral category differed significantly in one-vs-rest Fisher exact tests after multiple-comparisons correction.

TABLE 1 Demographic and clinical summary of captured TCS patients.

Captured TCS patients, n	130
Age, years	23.0 [15.0, 37.0]
Child (<18), *n* (%)	43 (33.1%)
Sex: Female, *n* (%)	70 (53.8%)
Sex: Male, *n* (%)	56 (43.1%)
Sex: Other, *n* (%)	4 (3.1%)
Prior TCS history, *n* (%)	11 (8.5%)
No documented prior TCS history, *n* (%)	119 (91.5%)
No reported TCSs during monitoring, *n* (%)	20 (15.4%)
No documented prior TCS history and no reported TCSs, *n* (%)	19 (14.6%)
Recording duration, hours	163.9 [95.1, 167.6]
ASM count	1 [0, 2]
TCS events per study	2 [1, 7]

Note: Continuous variables are median [IQR]. Sex was self-reported.

A total of 393 of 7347 patients in the epilepsy cohort (5.3%) had referral information available to the ambulatory vEEG service documenting a prior TCS or suspected history of TCSs. This included 11 of 130 patients with TCSs captured during their study (8.5%) and 382 of 7217 patients without captured TCSs (5.3%). Patients with captured TCSs were not significantly more likely to have TCSs mentioned in their referral than the remainder of the epilepsy cohort (OR 1.65, 95% CI 0.88–3.09; Fisher exact $p = 0.114$). These findings suggest that the captured-TCS subgroup was not strongly enriched for patients with documented prior or suspected TCSs in the available referral/service records. In 20 of 130 (15.4%) patients with TCSs captured during monitoring, no TCSs were reported by the patient during monitoring (that is, their TCSs were found only during review of the study). Nineteen of 130 patients (14.6%; 95% CI 9.0–21.9) had no documented prior TCS history in available service records and no reported TCS during monitoring.

Descriptive event-level reporting patterns are shown in Figure 2. Unreported proportions were similar for focal-onset and generalized-onset seizures (44.0% vs 49.1%).

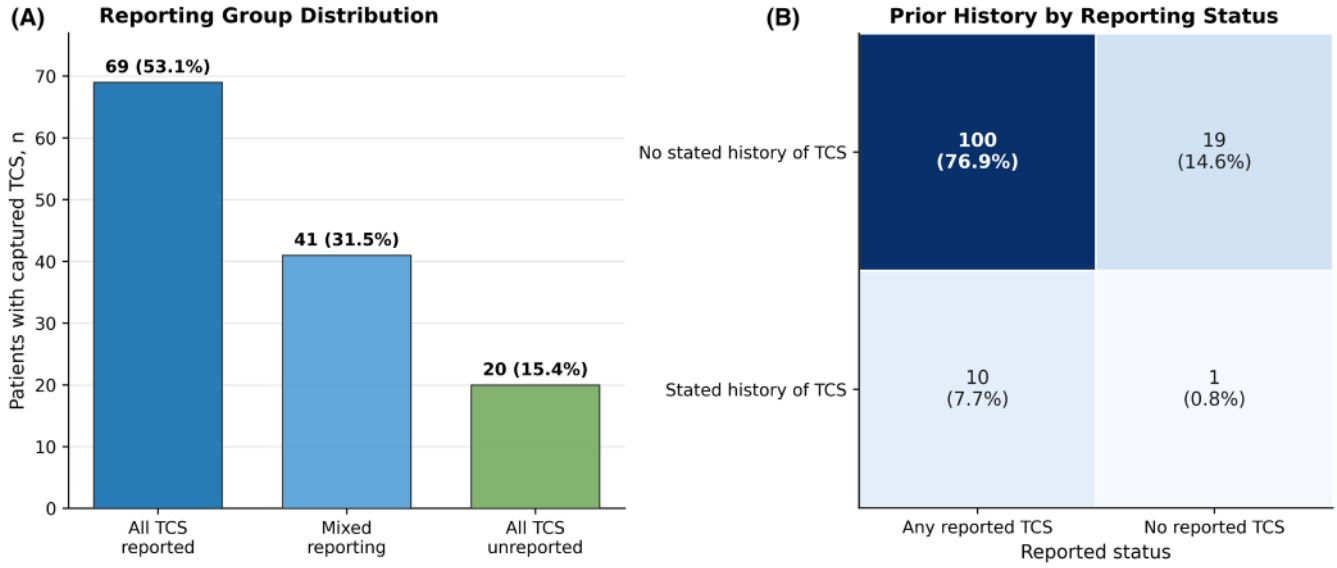

FIGURE 1 Patient-level reporting groups and prior-history and reporting contingency table among patients with captured TCS. (A) All-reported, mixed, and all-unreported groups. (B) Prior TCS history vs reporting status. TCS, Tonic-clonic seizure.

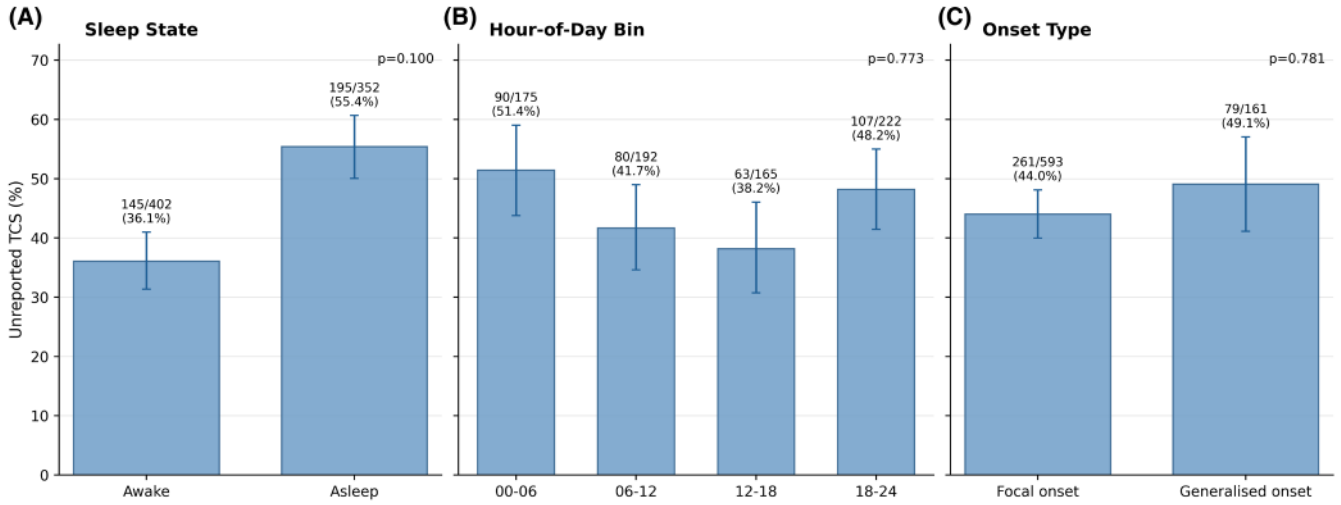

FIGURE 2 Proportion of TCS events that were unreported during ambulatory vEEG. Panels show unreported proportions with 95% confidence intervals by (A) sleep state, (B) time-of-day bin, and seizure-onset type.

Unreported events were more common during sleep than wakefulness (55.4% vs 36.1%).

Across patients, the median within-patient proportion of unreported TCS was 0.00 (IQR 0.00–0.625), indicating substantial between-patient heterogeneity despite an event-level unreported rate of 45.1%.

Of the patients we identified with TCSs, 10 of 130 (7.7%) reported a total of 25 events that had no EEG abnormality but were described by the patient to have TCS-like symptoms such as convulsions or other major motor manifestations. Eleven of 25 (44%) of these reported events from 4 of 10 patients (40%) were described as "typical events" by the patients or carers.

Of patients with focal epilepsy who had captured TCSs, 12 of 76 (15.8%) also had non-TCS seizures during monitoring. Among these 12 patients, the number of non-TCS seizures ranged from 1 to 21 events per patient. In total, there were 91 additional non-TCS epileptic seizures, of which 25 of 91 (27.5%) were reported and 66 of 91 (72.5%) were unreported.

Despite the perceived clinical importance of tongue-biting in the description of clinical events, exploratory analysis of the epilepsy dataset identified only 11 seizures across 8 studies in which tongue- or cheek-biting was confirmed during the event. Individual studies contributed between one and three seizures with confirmed tongue- or cheek-biting, none of which were tonic–clonic seizures.

In a multivariable patient-clustered GEE model (Table 2), sleep state was independently associated with event underreporting: TCSs occurring during sleep had higher odds of being unreported than awake events (adjusted OR 2.75, 95% CI 1.16–6.49; $p = 0.021$). By contrast, onset type was not independently associated with reporting status (generalized vs focal adjusted OR 1.56, 95% CI 0.35–6.98; $p = 0.561$), and time-of-day was not significant overall ($p = 0.651$).

TABLE 2 Multivariable patient-clustered GEE model of seizure-level reporting status.

Predictor	Adjusted OR	95% CI	*p*-value
Onset type (generalized vs focal)	1.56	0.35 to 6.98	0.56
Sleep state (asleep vs awake)	2.75	1.16 to 6.49	0.021
Hour bin (06–12 vs 00–06)	1.21	0.54 to 2.72	0.65
Hour bin (12–18 vs 00–06)	1.24	0.50 to 3.04	0.64
Hour bin (18–24 vs 00–06)	1.53	0.78 to 3.02	0.22
Hour bin (global test)	—	—	0.65

Note: Adjusted odds ratios (ORs), 95% confidence intervals (CIs), and two-sided *p*-values are from a binomial generalized estimating equation (logit link) with robust (sandwich) standard errors clustered by patient ($n = 130$ patients; $n = 754$ TCS events). Outcome: unreported vs reported TCSs. Covariates entered simultaneously: Onset type, sleep state, and time-of-day bin. Reference categories were focal onset, awake state, and 00:00–05:59. The time-of-day global *p*-value is a Wald test across the three non-reference time bins.

The unrecognized subgroup ($n = 19$) did not differ significantly in age, proportion of which were children, sex distribution, or recording duration (all p's > 0.05, Table 3) compared to other patients. The unrecognized subgroup had a lower ASM count (median 0 [IQR 0–1] vs 1 [IQR 0–2], $p = 0.040$) and fewer TCS events per patient (median 1 [IQR 1–2] vs 3 [IQR 1–8], $p = 0.018$).

TABLE 3 Clinical characteristics of unrecognized subgroup vs all other captured TCS patients.

Characteristic	Unrecognized subgroup	All other captured TCS patients	*p*-value
N patients	19	111	
Age, years	23.5 [13.2, 40.0]	22.0 [15.5, 36.5]	0.72
Child (<18), *n* (%)	7 (36.8%)	36 (32.4%)	0.71
Sex: Female, *n* (%)	12 (63.2%)	58 (52.3%)	0.50
Sex: Male, *n* (%)	6 (31.6%)	50 (45.0%)	
Sex: Other, *n* (%)	1 (5.3%)	3 (2.7%)	
Recording duration, hours	164.0 [92.6, 167.6]	163.8 [95.1, 167.6]	0.99
ASM count	0 [0, 1]	1 [0, 2]	**0.04**
TCS events per patient	1 [1, 2]	3 [1, 8]	**0.02**

Note: Unrecognized subgroup: No documented prior TCS history and no reported TCSs during monitoring. Continuous variables are median [IQR]. Bold *p*-values indicate statistical significance at $p < 0.05$.

4 | DISCUSSION

In this selected ambulatory vEEG cohort, patient/caregiver reporting did not capture all objectively recorded TCSs. At the patient level, 61 of 130 patients (46.9%) with captured TCSs had at least one unreported TCS, including 20 of 130 (15.4%) who reported no TCSs during monitoring despite objective capture. At the event level, 45.1% of captured TCSs were unreported. These findings show that failure to report objectively captured TCSs was not limited to isolated events and challenge the assumption that convulsive seizures are reliably documented in routine care.

The results presented in this work should be interpreted in the context of earlier inpatient vEEG studies showing that seizure awareness is heterogeneous and may vary by seizure type, epilepsy syndrome, and seizure-onset localization.[4–7] Blum et al. found that seizure awareness differed by epilepsy type, with lower awareness in temporal lobe epilepsy and greater awareness of tonic–clonic seizures in primarily generalized epilepsy than in secondarily generalized focal seizures. Hoppe et al. similarly reported poor documentation of seizures in an inpatient focal epilepsy cohort, including incomplete reporting of secondarily generalized tonic–clonic seizures, and found that documentation failures were not corrected by daily reminders. Kerling et al. also studied patients undergoing inpatient presurgical vEEG monitoring and identified substantial unrecognized seizure burden. Poochikian-Sarkissian et al. further demonstrated low patient awareness of seizures documented in the epilepsy monitoring unit. Velez et al., although focused on wrist accelerometer detection, also used vEEG as the reference standard in an epilepsy monitoring unit and found marked discrepancy between patient/caregiver reporting and objective detection for recorded seizures. Together, these studies indicate that awareness of tonic–clonic seizures is not uniform. However, they were conducted in inpatient monitoring or presurgical settings, whereas the present cohort was monitored in the home environment. The present data therefore extend prior inpatient observations by demonstrating that underreporting of TCSs is also frequently observed during ambulatory vEEG, in the absence of medication withdrawal and other seizure provocation, and was not clearly confined to focal-to-bilateral tonic–clonic seizures.

At the event level, 45.1% of TCSs were identified only on review rather than through patient or caregiver report. Convulsive seizures are generally regarded as dramatic and unmistakable; however, this study shows that a large proportion of captured events were not reported.[16] Several mechanisms are likely to contribute. Postictal confusion may impair recall, and seizures occurring during sleep or early morning transitions may be unwitnessed. Individuals who live alone may have no external corroboration. Infrequent seizures may reduce vigilance or lead to misattribution of postictal symptoms to other causes. The absence of injury or prolonged functional impairment may further reduce the likelihood that an event is recognized as epileptic. There may also be reporting gaps due to patient education. Although clinicians are often highly aware of the clinical implications of convulsive seizures, patients and their caregivers are likely to be far less aware of their potential consequences. In this selected ambulatory vEEG cohort enriched for captured TCSs, the magnitude of underreporting suggests that diary-based histories can substantially underestimate convulsive seizure burden.

At the patient level, 15.4% reported no TCSs during monitoring despite objective capture. More strikingly, 14.6% had neither documented prior TCS history in the available service records nor any reported events during the monitoring interval. In these individuals, the presence of convulsive seizures might have remained clinically unrecognized without objective recording. The implications

are considerable. The presence of TCSs influences decisions regarding driving, occupational safety clearance, ASM escalation, surgical candidacy, and counseling about SUDEP risk. If convulsive seizures remain unrecognized, risk stratification may be fundamentally flawed, and treatment decisions may be based on incomplete information.

Approximately 30% of patients with unreported TCSs made no diary entries during the monitoring period. It is unclear to what extent this is due to non-compliance with the diary, or whether this represents a genuine lack of awareness of seizure events. Future studies should include the driving status of patients in their analysis, as patients may deliberately mis-report or under-report events if they believe this may allow them to retain driving privileges.

We did not detect a clear association between electrographic-onset subtype and reporting status after accounting for within-patient clustering. Descriptively, the proportions of unreported TCSs were similar in focal-onset and generalized-onset seizures. Underreporting therefore does not appear confined to focal to bilateral tonic–clonic seizures. Even primary generalized convulsions frequently escaped documentation. This suggests that impaired consciousness and postictal amnesia intrinsic to the convulsive event are sufficient to obscure reporting, regardless of electrographic-onset mechanism. In this cohort, electrographic-onset subtype was not clearly associated with reporting status.

Unreported TCSs were significantly more likely during sleep. Time of day was not independently associated with underreporting after adjustment, although descriptively the highest unreported proportions were in the evening and early morning bins. This is broadly consistent with results reported by Zhang et al. with use of wearable-detected tonic–clonic seizures, although the present cohort showed relatively more TCSs in the early morning. This difference may reflect imperfect sensitivity and specificity of wearable detection or differences in cohort characteristics between the studies.[17,18] Furthermore, the higher likelihood of unreported TCSs during sleep has potential implications for SUDEP and corresponding patient counseling.

The subgroup of patients with entirely unreported convulsive seizures did not differ from the remainder of the cohort in age, sex distribution, or monitoring duration. However, they had lower ASM exposure and fewer TCS during the recording period. This pattern suggests that individuals with lower apparent disease burden may be particularly vulnerable to the consequences of unrecognized convulsive events. Infrequent seizures may not generate sustained vigilance in patients or caregivers, and a single nocturnal convulsion in a person without established convulsive history may not be recognized. Underreporting, therefore, is not restricted to severe or refractory epilepsy. It may preferentially affect patients who are considered relatively stable.

The observed underreporting of captured TCSs highlights the potential clinical utility of objective monitoring systems, including wearable and implantable devices.[19–21] Contemporary wearable systems may employ combinations of accelerometry, heart rate variability, electrodermal activity, and other physiological signals to detect tonic–clonic motor patterns and associated autonomic changes. For patients whose convulsions are unwitnessed or unreported, these devices may help reduce systematic underestimation of seizure burden, although device-derived seizure counts require cautious interpretation.[9] Continuous monitoring may support objective event detection, delineation of temporal patterns, and characterization of seizure clustering across the circadian cycle.[17,18,22] In addition, real-time alert systems may notify caregivers during nocturnal events, potentially reducing delay in assistance and improving safety.[23] However, wearable devices remain vulnerable to false-positive detections from non-epileptic movements, physiological artifact, and non-seizure autonomic changes, particularly when events cannot be verified with concurrent video or EEG.[8] Monitoring devices should therefore be viewed as potentially complementary to, rather than a replacement for, contextual clinical assessment, corroborative history, patient and caregiver education, and vEEG for TCS assessment.[19] Implantable and subscalp devices may provide longer-term electrographic confirmation, but their use is potentially limited by cost, availability, need for implantation, and the clinical infrastructure required to review large volumes of data.

The broader implications extend to research. Clinical trials frequently rely on patient-reported TCS frequency as a primary endpoint. If substantial proportions of convulsive seizures are unreported, treatment effects may be misestimated and responder classifications distorted. Accurate detection is central to both clinical decision-making and mechanistic investigation.

The strengths of this study include objective seizure confirmation using ambulatory vEEG and event-level analysis accounting for within-patient clustering, together with a relatively large number of patients and seizures in the analysis cohort.

This study has several limitations. First, it is a retrospective analysis from a single ambulatory vEEG service, and referral patterns, monitoring workflows, and patient mix will limit generalizability. Future studies should assess the frequency of TCS underreporting in broader and less-selected epilepsy populations. Second, "reported" events were derived from diary entries and post-study questioning by technologists; incomplete diary engagement, variability in caregiver availability,

and differences in how events were elicited or documented could have contributed to misclassification, and the study cannot fully separate non-adherence from true lack of awareness. It is unknown from this dataset whether patients lived with others or had carers, which may significantly influence the nature of their seizure reporting.[16] By design, the TCS cohort was restricted to patients with at least one objectively captured TCS during ambulatory vEEG. This creates an event-enriched cohort and means the observed seizure frequency should not be interpreted as the expected TCS frequency in the broader epilepsy population, or even among all patients referred for ambulatory vEEG. Rather, the study addresses a conditional question: among patients in whom TCSs were objectively captured during ambulatory home monitoring, how often were those events reported by patients or caregivers? The high event yield therefore reflects the ascertainment strategy, prolonged recording duration, and referral context. Nevertheless, the finding that many captured TCSs were unreported remains clinically relevant because it demonstrates that even overt convulsive seizures may escape self-reporting in a naturalistic ambulatory setting. Finally, important contextual factors that are likely to influence reporting, such as whether seizures were witnessed, living situation, injury, nocturnal supervision, and comorbid sleep disorders, were not consistently available in the clinical dataset and could not be examined. Furthermore, the history of TCS was only derived from the provided clinical history, and not prospectively or systematically collected; nor was it sought from other medical records. Similarly, important background information such as driving status and whether patients had refractory epilepsy was not available in this analysis. The data used in this study only considered what was documented in the vEEG reports, and the primary recordings were not independently re-reviewed. No attempt was made to lateralize or determine specific seizure foci and how these contribute to TCS seizure reporting; however, other investigators have found some associations with seizure foci and reporting.[24,25] Future prospective studies are needed to better quantify the underreporting of TCS.

5 | CONCLUSION

This study demonstrates that, in a selected ambulatory vEEG cohort with objectively captured TCS, convulsive epilepsy may include an unreported component that is neither rare nor restricted to specific subtypes. Underreporting in this cohort was more likely in sleep and was not fully explained by measured clinical characteristics. Convulsive seizures cannot be assumed to be reliably identified through history alone. Objective detection technologies, including wearable or implantable devices, may help to reveal and quantify this hidden burden, with direct consequences for safety, therapeutic strategy, and risk assessment.

AUTHOR CONTRIBUTIONS

Conceptualization: E.S.N., J.F., and M.C.; Data curation: E.S.N. and V.W.; Formal Analysis: E.S.N., J.F., V.W., and M.C.; Software: E.S.N.; Writing – original draft: E.S.N. and M.C.; Writing – review & editing: E.S.N., J.F., V.W., and M.C.

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CONFLICT OF INTEREST STATEMENT

E.N. and M.C. were previously employees and shareholders of Seer Medical Proprietary Limited., but had no employment or shareholdings during the preparation of this work. M.C. is an employee and shareholder of Epiminder. V.W. has no conflicts to declare. J.F. receives salary support from the Epilepsy Foundation and from Epilepsy Study Consortium for consulting work and/or attending Scientific Advisory Boards for Acadia Pharmaceuticals, Access Industries, Acuta Capital Partners, AFASCI Incorporated, Agrithera, Inc, Alterity Therapeutics Limited, Angelini Pharma Società per Azioni, Autifony Therapeutics Limited, Axonis Therapeutics, Bain Capital, Beacon Biosignals, Inc., Biogen, Biohaven Pharmaceuticals, Bloom Science Inc., Bright Minds Biosciences, Inc., Capsida Biotherapeutics, Cerebral Therapeutics, Cerecin Inc., Cerevel, Ceribell, Cognizance Biomarkers, Cowen and Company Limited Liability Company, Crossject, EcoR1 Capital, EG 427, Eisai, Encoded Therapeutics, Engrail, EpiMinder, Epitel Inc., Grin Therapeutics, Harmony/Epygenix, Ionis Pharmaceuticals, iQure Pharma Inc., IQVIA Research and Development Solutions Incorporated, Janssen Pharmaceutica, Jazz Pharmaceuticals, Leal Therapeutics Inc., LivaNova, London Research & Pharmaceuticals, Longboard Pharmaceuticals, Maplight Therapeutics, Marinus, Medscape/Web MD, Modulight.bio, Mosaica Therapeutics, Neumirna Therapeutics, Neurelis, Neurocrine, Neurona Therapeutics, NeuroPace, Inc., NeuroPro Therapeutics, Neuroventis, Neurvati, Noema Pharma, Ono Pharmaceutical Company, Otsuka Pharmaceutical Development, Ovid Therapeutics Inc.,

Praxis, PureTech LTY Inc., Rapport Therapeutics, Inc., Receptor Holdings Inc., Rivervest Venture Partners, Sage Therapeutics, Inc., SK Life Sciences, Stoke, Stream Neuroscience, Supernus, Takeda, Taysha Gene Therapies, UCB Incorporated, uniQure, Ventus Therapeutics, Vida Ventures Management, and Xenon. J.F. has also received research support from the Epilepsy Study Consortium (funded by Eisai and UCB), Epilepsy Study Consortium/Epilepsy Foundation (funded by UCB), GW Pharmaceuticals/Finding A Cure for Epilepsy and Seizures/One8 Foundation, National Institute of Neurological Disorders and Stroke, and Praxis.

DATA AVAILABILITY STATEMENT

All data used in the preparation of this manuscript are available upon reasonable request to the corresponding author.

ETHICS STATEMENT

Ethics approval was provided by the St. Vincent's Hospital Melbourne Human Research Ethics Committee, approval number 042/18. We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

PATIENT CONSENT STATEMENT

All patients, or guardians, provided written informed consent.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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