Two separate FS algorithms were developed under supervision of a clinical neurologist, Kevin F. Haas, MD, PhD (KFH), to reduce bias during algorithm development and chart review. The primary algorithm was used to identify FS patients without concurrent epilepsy (Figure 2, Table 1). The secondary algorithm identified FS patients without exclusions for epilepsy (Figure 3, Table 2).47 The primary algorithm was validated by unblinded manual chart review of 50 algorithm-identified cases.



**Figure 2.** Algorithm for detecting FS cases and controls within the VUMC EHR. All VUMC EHR patients were initially included, then anyone with a generalized or focal epilepsy ICD code was excluded. Patients without convulsion or conversion disorder ICD codes were considered controls, while anyone with both a FS keyword in their chart and the presence of the keyword EEG was included as a FS case.



**Figure 3**. Flow chart of algorithm used to identify FS patients irrespective of their epilepsy case/control status.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **FS inclusion keywords ( >= 1)** | **Inclusion ICD codes ( >= 1)** | **Inclusion CPT codes ( >= 1)** | **Additional inclusion criteria** | **Exclusion Epilepsy ICD codes in group ( >= 1)** |
| “Psychogenic non-epileptic”  *(or nonepileptic or non epileptic)* | 300.11 – conversion disorder | Group 95812-95830: Routine Electroencephalography (EEG) Procedures | Genotyping data available | 345.1 |
| “Pseudoseizure” | 780.39 – other convulsions | Group 95950-95967: Special EEG Testing Procedures | Presence of keyword “EEG” in chart | 345.10 |
| “Psychogenic seizure” | R56.9 – unspecified convulsions | .. | .. | 345.4 |
| “Non-epileptic seizure”  *(or nonepileptic or non epileptic)* | F44.5 – conversion disorder with seizures or convulsions | .. | .. | 345.40 |
| “ PNES " | .. | .. | .. | 345.5 |
| .. | .. | .. | .. | 345.50 |
| .. | .. | .. | .. | G40.20 |
| .. | .. | .. | .. | G40.30 |
| .. | .. | .. | .. | G40.00 |
| .. | .. | .. | .. | G40.10 |

**Table 1.** Criteria for algorithm to identify FS patients, excluding those who have concurrent epilepsy. Inclusion ICD codes, inclusion keywords and other criteria, and exclusion ICD codes are all listed.

|  |  |  |  |
| --- | --- | --- | --- |
| **FS inclusion keywords ( >= 1)** | **Inclusion ICD codes ( >= 1)** | **Inclusion CPT codes ( >= 1)** | **Additional inclusion criteria** |
| “Psychogenic non-epileptic”  *(or nonepileptic or non epileptic)* | 300.11 – conversion disorder | Group 95812-95830: Routine Electroencephalography (EEG) Procedures | Genotyping data available |
| “Pseudoseizure” | 780.39 – other convulsions | Group 95950-95967: Special EEG Testing Procedures | Presence of keyword “EEG” in chart |
| “Psychogenic seizure” | R56.9 – unspecified convulsions | .. | .. |
| “Non-epileptic seizure”  *(or nonepileptic or non epileptic)* | F44.5 – conversion disorder with seizures or convulsions | .. | .. |
| “ PNES " | .. | .. | .. |

**Table 2**. Criteria for algorithm to identify FS patients regardless of epilepsy status. Inclusion ICD codes, inclusion keywords and other inclusion criteria are all listed.

Both algorithms were created by filtering criteria joined with Boolean operators. First, we required one or more convulsion or conversion disorder (ICD9 codes 300.11 OR 780.39 OR ICD10 codes R56.9 OR F44.5)47 AND the presence of regular expressions indicating FS-related keywords in charts (“pseudoseizure,” “psychogenic seizure,” “nonepileptic seizure”, or “ pnes ”). Although FS can present as syncopal events, we have not included this phrase in our algorithm because in patient charts such as the ones we mined, this would be a nonspecific symptom and would add noise to our algorithm. Next, we required the presence of both the keyword “EEG” AND one or more EEG CPT code (Group 95812-95830: Routine Electroencephalography (EEG) Procedures and Group 95950-95967: Special EEG Testing Procedures) to ensure that patients had an EEG performed at VUMC. Eighty-two percent of potential FS cases with an “EEG” keyword also had an EEG procedure CPT code present in their chart.

Fifty charts were randomly selected from the FS algorithm identified cases and were reviewed by one rater (SBG), who was trained by a clinical neurologist (KFH).

The charts were reviewed for positive clinical diagnosis of FS based on a publication by LaFrance et al describing the minimum requirements for the diagnosis of FS.4 Positive predictive values (PPVs) were calculated for two groups based on this paper: (a) documented, clinically established, or probable FS; and (b) possible FS. Based on this paper, the first criteria for a positive diagnosis of documented, clinically established, or probable FS was defined as having chart history characteristics consistent with FS. The second criteria was having a seizure witnessed by a clinician who either 1) reviewed the video EEG recording and found the semiology typical of FS, or 2) is experienced in diagnosis of seizure disorders and found the seizure to show semiology typical of FS, regardless of whether or not it was on v-EEG. The third criteria was that there was no epileptiform activity in routine or sleep-deprived interictal EEG, in routine or ambulatory ictal EEG during a typical event, or immediately before, during or after ictus captured on ictal video EEG. A positive diagnosis for possible FS was defined as having a history consistent with FS, event matched FS semiology by witness report or self-report/description, and that there was no epileptiform activity in routine or sleep-deprived interictal EEG.4 KFH was consulted as needed to adjudicate.

Prior to review of these 50 charts, SG reviewed 100 charts, and KH also reviewed 37 of these charts. The goal of this first round of chart review was to train the reviewer (SG) to identify key phrases and language used by VUMC neurologists to interpret video EEG and to confirm diagnoses. SG, KH, and LKD sat in conference for approximately 4 hours to discuss the levels of evidence observed and the certainty of diagnosis given video EEG results.