National Audit of Hyperventilation and Intermittent Photic Stimulation (2024-2025)

Molly Williams (Clinical Physiologist)

Dr May Nwe (Consultant Neurophysiologist)

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Summary

- Aim
- Objectives
- Methodology
- ANS/BSCN guidelines overview on IPS and hyperventilation
- Literature review and definitions of photosensitivity
- Results

Aims

- Assess how many UK Neurophysiology departments perform Hyperventilation (HV) and Intermittent Photic Stimulation (IPS) during routine EEGs
- Determine **whether local protocols/SOPs** are in place
- Evaluate **departmental adherence** to BSCN guidelines

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Study Objectives:

- Assess how many UK Neurophysiology departments perform **hyperventilation (HV)** as part of routine EEGs, and whether they follow local protocols or standard operating procedures (SOPs)
- Assess how many departments perform **intermittent photic stimulation (IPS)** during routine EEGs, and whether local protocols/SOPs are in place
- Determine how many departments have conducted **internal audits**; if not, explore the reasons why
- Compare departmental protocols against **British Society for Clinical Neurophysiology (BSCN)** guidelines

Standard Use

- ANS/BSCN Guidelines for Photic Stimulation & Hyperventilation during EEG recordings.

Methodology

- Questionnaire developed using **Mentimeter**
https://www.menti.com/alnrzpdo28ab

- Distributed to UK Neurophysiology departments by the **ANS Audit Team** via email nationally.(Scotland, NI, England)
- Responses collected and compiled into a **Microsoft Excel** spreadsheet
- Data analyzed using **Microsoft Excel**

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ANS/BSCN Guidelines for Hyperventilation During EEG Recording

Standard 1: HV Procedure & Consent

- Perform **3–5 mins** of HV at **20–30 breaths/min** in **room air**
- **Informed consent** required
- EEG continues **≥3 mins post-HV**
- Patient can **stop HV anytime**
- **Guideline:** Repeat HV if clinically indicated (e.g., absence seizures)

Standard 2: HV Effort Assessment

- Assess HV effort **qualitatively** (e.g., poor, moderate, good)
- Modify for **age/ability**
- **Guideline:** Use **quantitative** assessment (e.g., plethysmography)

Standard 3: Document Effects

- **Document EEG changes** and any clinical events (e.g., seizures, non-epileptic attacks)
- **Prepare to manage** any clinical event

Standard 4: ECG Monitoring

- **Record ECG** during HV
- **Stop HV** if chest pain, arrhythmias, or ECG changes

Standard 5: Contraindications

- **Absolute contraindications:** Recent stroke/MI (≤12 months), unstable heart/lung disease, sickle cell, moyamoya disease
- **Guideline:** Weigh risk vs. benefit for relative contraindications (e.g., asthma)

ANS/BSCN Guidelines for Photic Stimulation during EEG Recordings

Standard 1: Consent for PS

- PS performed with consent in all age groups referred for suspected epilepsy or NEAD
- Exceptions: Generalised tonic-clonic seizures earlier in EEG

Standard 2: Clinical History

- Physiologist collects seizure history and triggers, including family history

Standard 3: Pre-Consent Info

- Patients/carers informed of the purpose, value, and seizure risks of PS

Standard 4: Informed Consent

- Consent must be documented and stored
- Carers may leave room unless needed; risks documented if they stay

Standard 5: Timing

- PS starts ≥3 minutes after hyperventilation ends

Standard 6: Protocol

- Include ≤5 Hz flashes for suspected progressive myoclonic epilepsy

Standard 7: Eye Closure

- Eye closure attempted during each flash rate; aids used in young patients

Standard 8: Low-Frequency Use in Children

- ≤5 Hz flashes included when progressive myoclonic epilepsy suspected

Standard 9: Reproducibility

- Show reproducibility with minimum necessary stimulus
- No need to repeat flashes for sustained responses

Standard 10: Seizure Management Protocol

- Department has a predefined seizure response plan

Standard 11: Documentation

- Reason documented if PS not performed
- If epileptiform activity appears, describe its type/distribution

Standard 12: Patient Autonomy

- PS is stopped immediately upon patient or carer request

How Hyperventilation produced Seizures

•Neuronal Excitability:

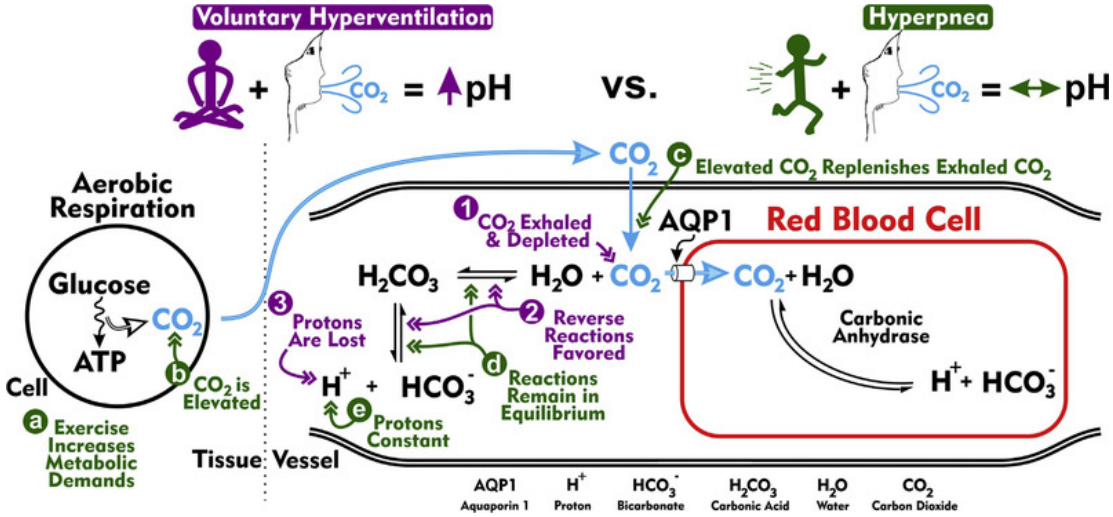
•Elevated pH and reduced cerebral blood flow can destabilize neuronal membranes, making them more prone to electrical activity and spontaneous discharges.

Thalamic Involvement:

Some studies suggest that the thalamus, a region involved in relaying sensory information and regulating sleep-wake cycles, may be particularly sensitive to these changes and may be involved in hyperventilation-induced seizures

pH-sensitive neurons:

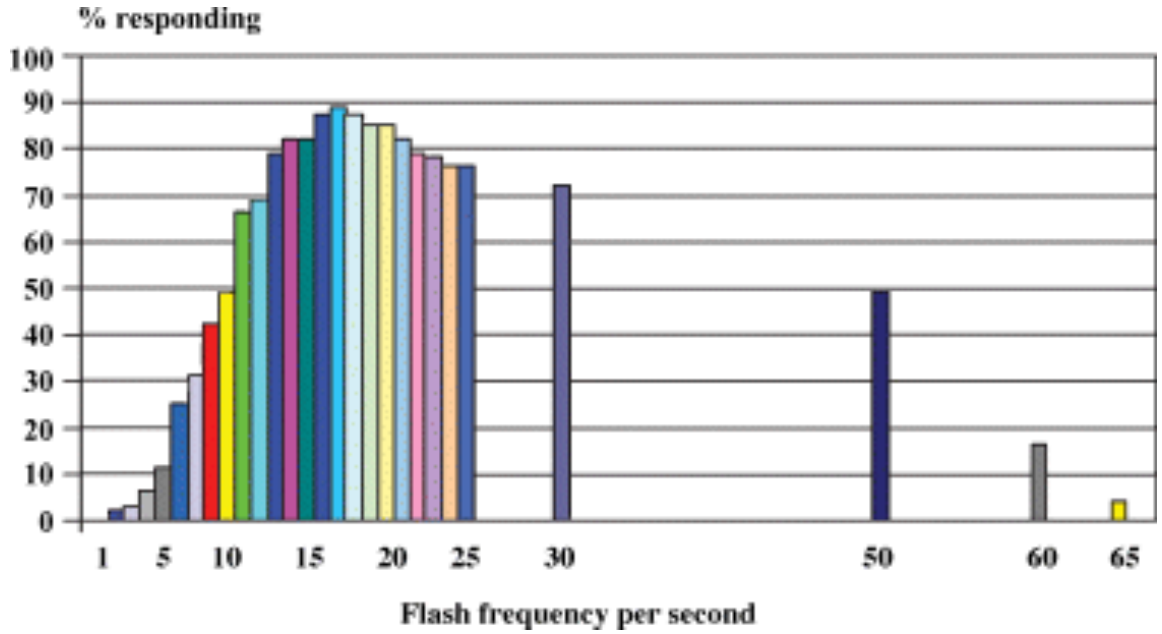
Research suggests that neurons in the intralaminar nuclei of the thalamus, a region linked to seizure generation, are sensitive to pH changes and may be activated by hyperventilation, leading to seizures



Definitions of Photosensitivity

- Photic-induced seizure: A seizure provoked by visualstimulation. The usual stimulus is a flashing light, but itcan be patterns of lines, gratings, checkerboards, or otherconfigurations.
- Photoparoxysmal response (PPR): An abnormal EEGresponse to light or pattern, consisting of spikes, spike–waves, or intermittent slow waves. To be classified as pho-toparoxysmal, the spikes should not be confined to occipital regions and should not be confused with the normal visual evoked response that is phase-locked to the flash.
- Photosensitivity: An abnormal response of the EEG to light or pattern stimulation, consisting of a PPR.
- Photomyoclonic response: Forehead and muscletwitching in response to light flash, disappearing with eyeopening. Photomyoclonic responses are most common insubjects with early alcohol withdrawal and in anxious pa-tients. A photomyoclonic response is considered to be amyogenic component of eye flutter and not an epilepti-form pattern. It is more frequently seen at low-frequencystimulation, and it disappears when the interval betweenstimuli is shorter than the eyelid reflex latency

Photic- and Pattern-induced Seizures: A Review for the Epilepsy Foundation of America Working Group



Epilepsia, Volume: 46, Issue: 9, Pages: 1426-1441, First published: 01 September 2005, DOI: (10.1111/j.1528-1167.2005.31405.x)

EPIDEMIOLOGY OF PHOTOSENSITIVITY

- Air Force studies show photoparoxysmal EEG responses in 0.35% to 2.4% of applicants. These studies likely underestimate general population prevalence due to selection bias and underrepresentation of females.
- In a review of 20,000 EEGs, 1.25% had abnormal responses to light. Light sensitivity in EEGs is higher among those with seizure history.
- 7.6% of normal children showed PPRs. In a 1997 Pokémon cartoon incident, ~1 in 10,000 children had a seizure. Photosensitivity more common in youth and may persist into adulthood.
- 50% of siblings with one photosensitive parent were also photosensitive. Higher prevalence in younger age groups, females, and certain ethnicities. PPISs occur in 1/4,000 aged 5–24 years.
- Female-to-male ratio for photosensitivity is 1.5 to 2.0. Racial differences exist: 2.5% of whites,0.9% of Africans show PPRs.
- Annual incidence: 1.2 per 100,000 (general); 5.7 per 100,000 (ages 7–19). Most occurred within 30 minutes of play.

classification of the photoparoxysmal response (PPR)

Waltz classification of the photoparoxysmal response (PPR)

Waltz type	Description
Type 1	Spikes limited to the occipital lobe and phase locked to stimulus frequency, non-self-sustaining
Type 2	Parieto-occipital spikes with a biphasic slow wave
Type 3	Spikes an slow waves propagating to frontal areas
Type 4	Generalized 2–5 Hz discharges with frontal and paracentral predominance

Jeavons and Harding Classification

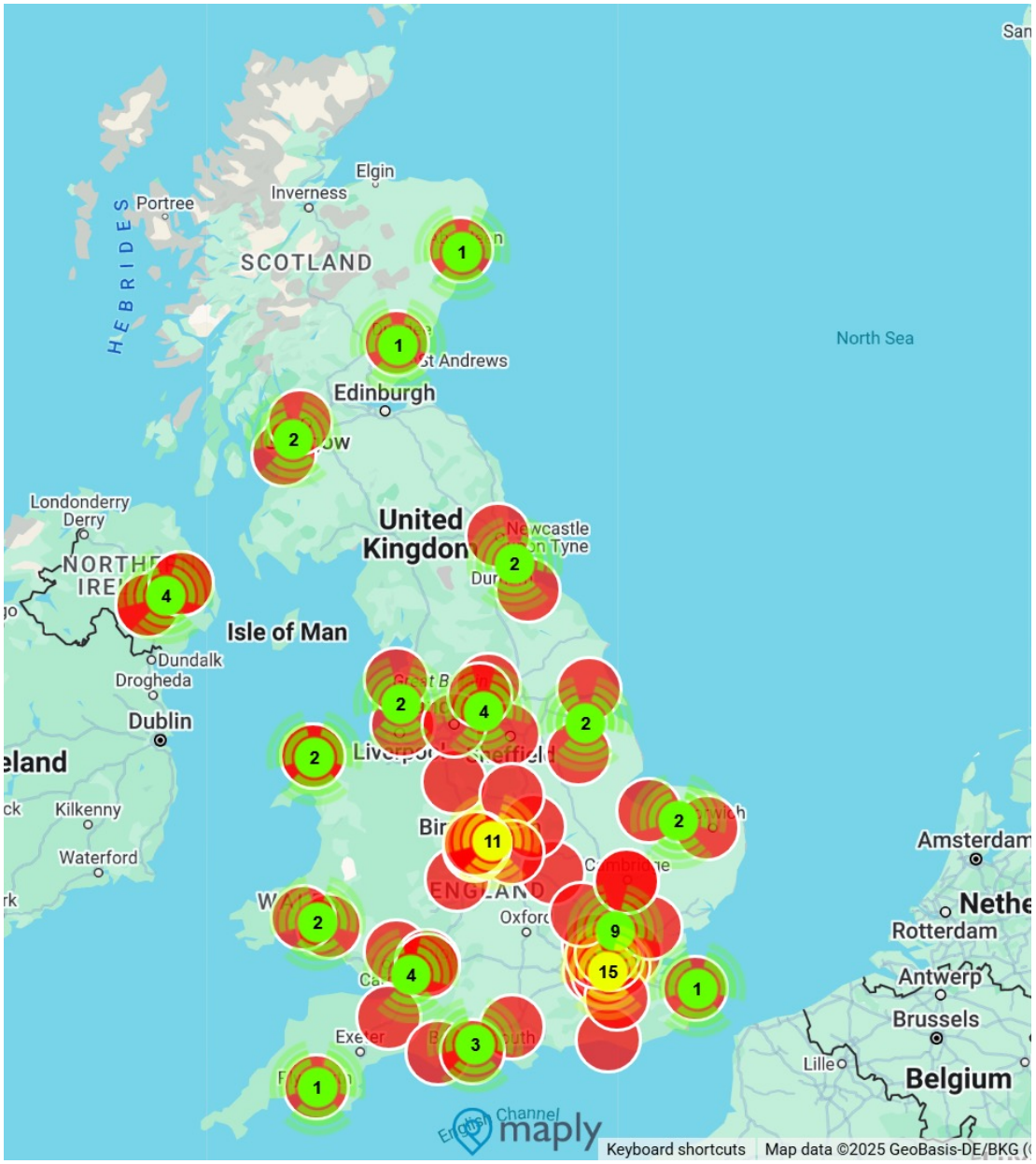
- 1Responses seen only in the anterior regions (photomyoclonic);
- 2Responses seen only in the posterior region (photic driving, visual evoked potentials, occipital spikes); and
- 3Widespread, anterior and posterior, bilateral response (photoconvulsive).
  - 1Spike–wave bursts, usually around three per second
  - 2Spike–waves at 4–7 (theta) frequencies
  - 3Polyspikes or polyspikes–wave
  - 4Spikes coinciding with the flash, but extending widely
  - 5Spike–waves at 3/s, lasting ≥5 s, and associated with a clinical absence
  - 6Bilateral, diffuse high-amplitude slow waves

Previous Audit results
Hyperventilation Audit (2011-2012)

- Very few departments (20%) use published guidelines for the safety of hyperventilation and of these, only 1 was referenced
- Most departments (84%) have safety protocols focusing on areas such as age limitations, contraindications and consent
- Where age limitations are mentioned, a limit of 65 years is the one most commonly enforced (42%)
- The most frequent contraindications mentioned are cerebrovascular disease, cardiovascular disease and respiratory disease
- Only 1 memory from the vast experience across the departments over the years suggests a truly adverse event

IPS (2013-2014)**Summary**

- Around half the departments use published guidelines
- All have a departmental protocol
- Variability exists in respects of the procedure, age groups and consent
- Safety: around half the departments have experienced GTCS but no real other adverse events. Only two thirds have protocols for dealing with seizures



Response Breakdown:

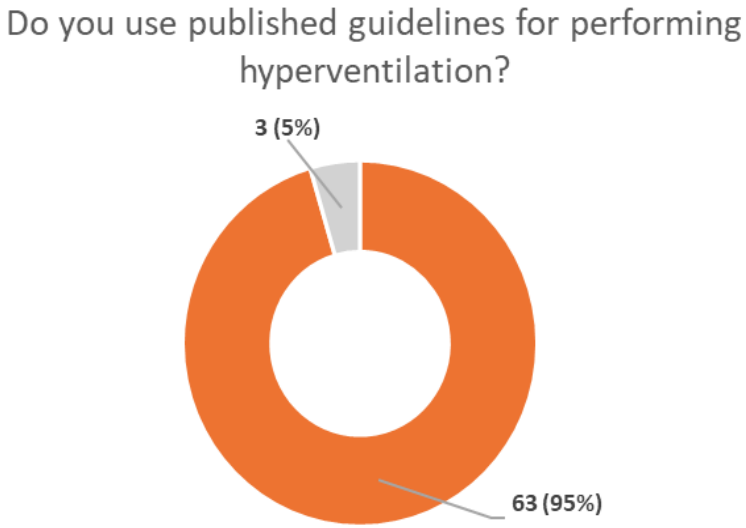
- **Total responses received:** 74
- **Excluded due to missing postcode:** 3 → *71 remaining*
- **Excluded due to incomplete responses (postcode only):** 3 → *68 remaining*
- **Excluded due to absence of departmental guidelines:** 2 → *66 valid responses for analysis*

Data Processing and Analysis

- Menti responses **collated into Microsoft Excel**
- **Exclusions applied** (see previous slide)
- Data **filtered and sorted** using Excel's automated tools, with manual checks to minimise errors
- Responses **converted to percentages** for comparative analysis
- Data **visualized using pie charts**

Hyperventilation

All departments perform hyperventilation as part of routine EEGs



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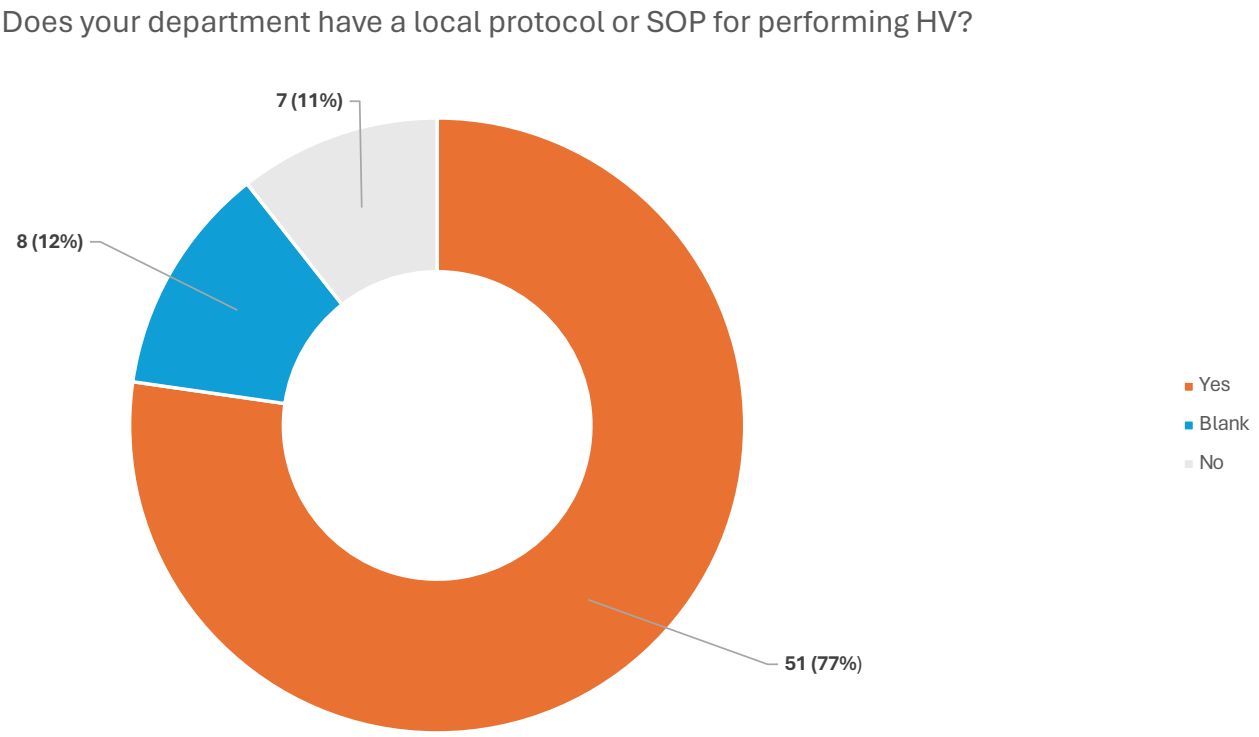
Hyperventilation continued



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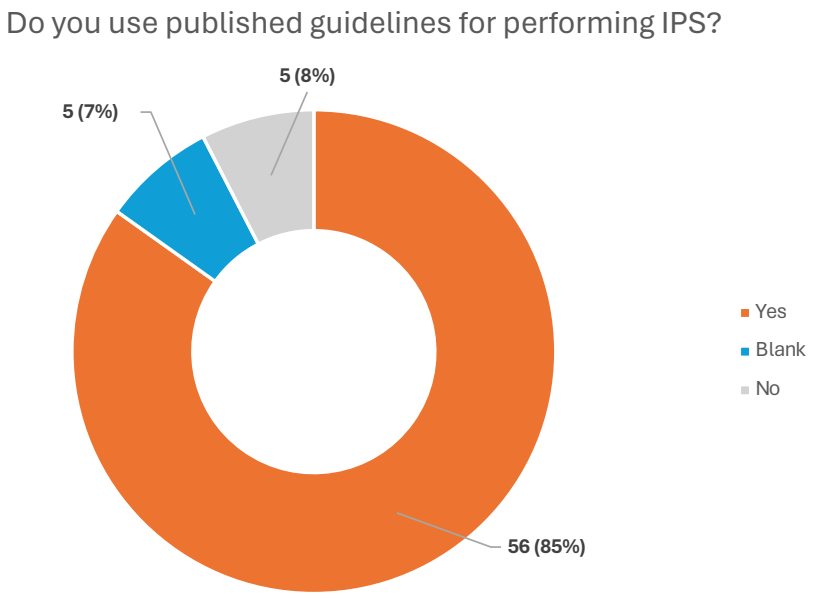
Intermittent photic stimulation (IPS)

62 departments routinely perform IPS during routine EEGs.

4 departments (6.45%) did not answer this question.



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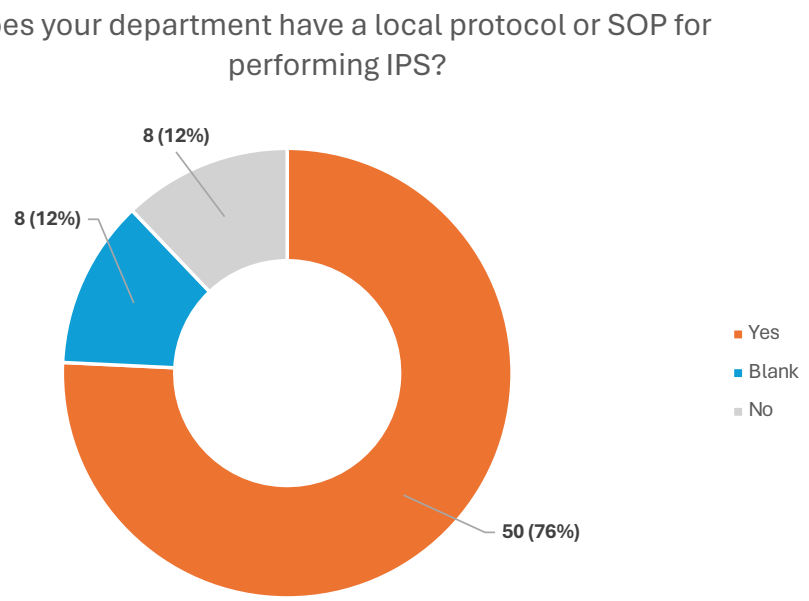
Intermittent photic stimulation (IPS) continued



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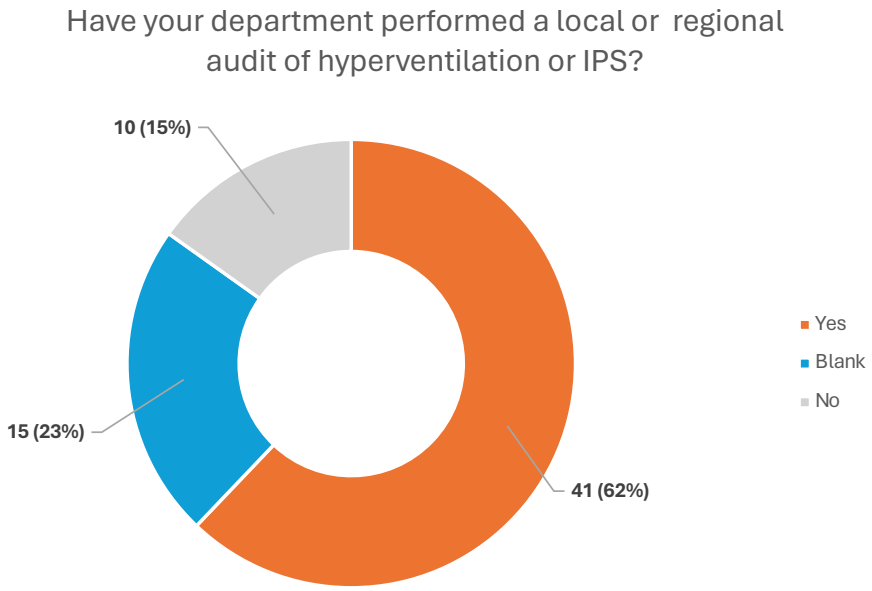
Internal audits



Local/regional audit findings:

Departmental audit to analyze the frequency and reasons documented on factual [reports] when HV was not performed and if it matched protocol criteria"

"Did stopping HV during the pandemic decrease the yield of EEG? Small sample but no EEG abnormalities would have been missed by omitting HV."

"[Departmental staff follow protocols for activation]"

"[…] IPS [audit] as part of a PTP student dissertation project"

"HV audit: compliance to national guidelines generally very good however respiratory rate needed to be improved"

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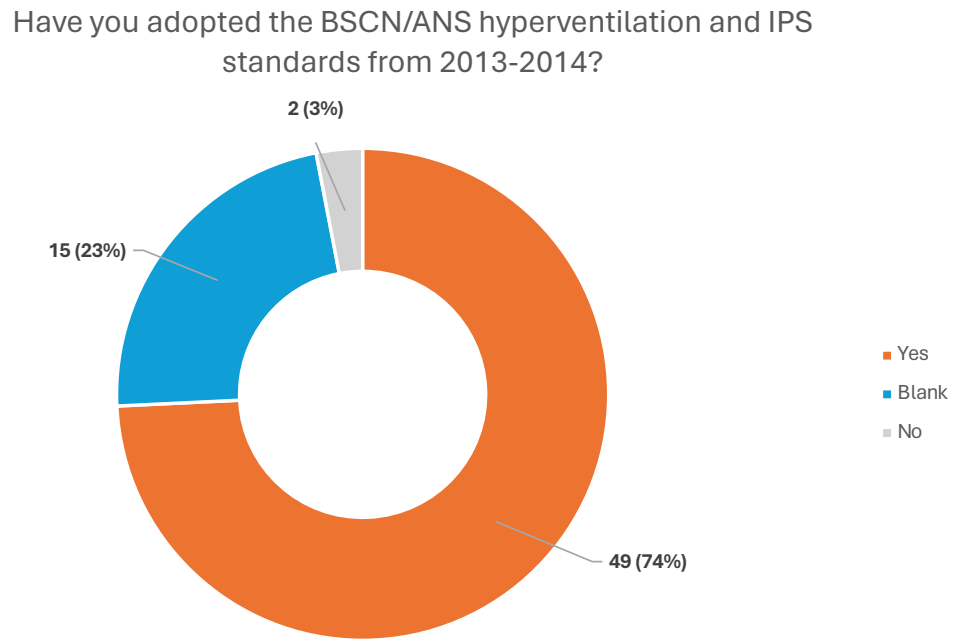
Using BSCN/ANS 2013-2014 standards in departmental EEGs



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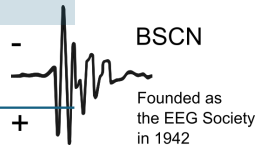
Comparison of HV to BSCN standards

NB:
Blanks ignored, if answered no previously did not continue with survey.
Total now 50

Comparison	Yes	No
Is informed consent taken from the patient or parent/carer?	49	1
Is HV performed for 3-5 minutes in room air with respiratory rate of approximately 20-30 breaths for minutes?	48	2
Is the EEG recording continued for 3 minutes or more after cessation of HV?	50	0
Is HV repeated or prolonged if clinically indicated?	47	3
Is the patient's effort qualitatively assessed?	50	0
Is the patient's effort quantitively assessed?	2	48
Are any effects of HV on the EEG and any clinical events documented and described?	50	0
Is a simultaneous single lead ECG recorded?	50	0



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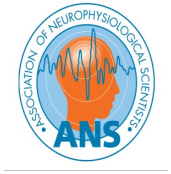
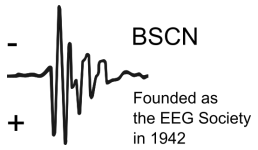
Additional HV comments

"We only obtain written consent in those patients over 16 years of age."

"No HV for patient who is above 70 years and patients who are contraindicated to do HV."





Comparison of IPS to BSCN standards

Comparison	Yes	No	Blank
Is IPS performed with consent in all age groups referred with a provisional diagnosis of epilepsy or non-epileptic attack disorder?	47	3	
Does the recording clinician obtain a clinical history from the patient and/or from their accompanying carer, friend or relative?	50	0	
Does the information given to the patient/carer before consent is obtained, state the value/likelihood of a positive response/risk to IPS?	45	5	
Is IPS performed at least 3 minutes after the cessation of hyperventilation?	47	3	
Is your IPS protocol based on the methodology outlined in the 'IPS procedure on the basic level?	35	15	
In all age groups, is eye closure attempted during each flash rate?	44	6	
In children suspected of progressive myoclonic epilepsies, do they undergo ≤5Hz flash frequencies?	43	6	1
Is the reproducibility of the response demonstrated with the minimum stimulus necessary?	48	2	
Does your department have a protocol for dealing with seizures?	46	4	
If IPS is not performed, it is clearly stated why it was not done?	48	2	
If there is an epileptiform change, does the report state whether it is generalised/describe distribution? Are clinical events documented?	50	0	
At the patient's or carer's request, is IPS stopped at any point during the procedure?	50	0	

Additional IPS comment

- **Not performed in patients over 40-years, unless specified in triage**
- **If PPR present, reproduce and find and a sensitivity range**.
- Adult only service – paediatric questions “no”
- Alternative frequencies – “2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 25, 30, 40, 50 and 60 Hz”, “1,2,4,6,8,10,12,14,16,18,20,25,30,40,50,60Hz” and “16, 18, 20, 25, 50, 12, 8, 5, 1 Hz”
- Adapted based upon patients' ability and/or age
- Not performed on pregnant patients
- Performed before HV

Further Recommendation

- Use a metronome to assess hyperventilation effectiveness
- Use standard criteria for PPR distribution to ensure consistent reporting
- Follow ANS/BSCN guidelines if no local protocol exists
- Standardise PPR reproducibility to reduce side effects (e.g., seizures)
  - Example: If generalised discharges are seen at 8 Hz and 15 Hz, classify as PPR
- Provide further staff education:
  - Consent procedures
  - Importance of performing hyperventilation after PPR

Conclusion

- Strong compliance with HV and IPS protocols across departments
- Most departments have local SOPs aligned with BSCN guidelines
- Common deviations include age-related adjustments and consent practices
- Opportunities exist to further standardize practices, particularly regarding consent documentation and HV effort assessment.

References

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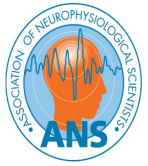

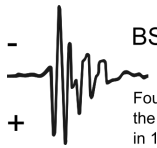

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