

# The Lasting impact of the COVID-19 pandemic on outpatient neurology consultations

Sean YW Tan ,<sup>1,2</sup> Nushan Gunawardana,<sup>1</sup> Rhys C Roberts<sup>1</sup>

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## ABSTRACT

**Background** The COVID-19 pandemic prompted rapid changes in outpatient neurology services and there remain unanswered questions regarding its long-term impact. First, what are the lasting changes of the pandemic on demographics and outcomes of new referrals and patients reviewed at outpatient neurology clinics? Safety concerns about virtual consultations during the initial stages of the pandemic were also raised. Has the continual adoption of virtual consultations led to negative outcomes for patients?

**Methods** New referrals and first clinic appointments in 2019 (prepandemic baseline) and 2022 (postpandemic) in a tertiary referral centre were compared retrospectively. 7294 referrals (4946 clinic appointments) in 2019 and 6989 referrals (3976 clinic appointments) in 2022 were assessed. Outcomes investigated were rates of referrals accepted, time to clinic consultation, number of outpatient investigations per appointment, rates of discharge and the risk of reassessment.

**Results** There was a change in triaging practice postpandemic, with more patients being offered virtual assessments. Virtual appointments were offered to a specific suitable cohort of patients. This resulted in a faster time to consultation, fewer investigations, higher rates of discharge, with a reduced risk of reassessment compared with prepandemic patients, and patients postpandemic who were seen face to face.

**Conclusion** Outpatient neurology services have adapted postpandemic by effectively triaging referrals and allocating new patients appropriately to face-to-face or virtual clinics, improving patient outcomes and safety.

## WHAT IS ALREADY KNOWN ABOUT THIS TOPIC

⇒ The COVID-19 pandemic prompted rapid changes in outpatient neurology services, including an increase in virtual consultations. The long-term impact of these changes on the outcomes and safety of new clinic patients are unknown.

## WHAT THIS STUDY ADDS

⇒ Outpatient neurology services have adapted since the pandemic, effectively triaging new patients to virtual or face to face consultations, improving clinical care.

## HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study provides evidence for the utility and safety of virtual consultations for new referrals in the outpatient setting in the context of appropriate triaging practices. Younger patients with conditions more reliant on history taking (eg, headaches, seizures, epilepsy) were preferentially assessed in virtual clinics.

## INTRODUCTION

The COVID-19 pandemic has dramatically altered the delivery of outpatient neurology services. Most prominently, there has been a mandated widespread adoption of remote telemedicine systems to maintain safe healthcare provision. Subsequent studies examining the impact of this change have focused on the implementation,<sup>1-4</sup> feasibility,<sup>5,6</sup> cost-effectiveness<sup>7</sup> and acceptability of virtual consultations by telemedicine, encompassing both video and telephone appointments.<sup>8,9</sup> However, there are other important and unanswered questions regarding the pandemic's lasting impact on outpatient neurology services.

It is unclear whether referral patterns from primary care have changed, either as a result of the pandemic, or as a response to virtual clinics. Furthermore, it is unknown if triaging practices have changed in accordance with this. The lack of direct physical examination during virtual appointments might also affect outcomes from clinics, for example by increasing the number of outpatient investigations, as well as increasing the risk of reassessment as suggested by Watila *et al*<sup>10</sup> in their study during the early stages of the pandemic. As we move into a postpandemic era, are these concerns still valid?

This study aims to identify the lasting impact of the COVID-19 pandemic on new referrals and novel consultations reviewed in outpatient neurology services. Referrals and first clinic appointments in 2019 (prepandemic) and 2022 (postpandemic) were compared retrospectively. We show that, although demographics were similar between years, patients reviewed in outpatient clinics postpandemic



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<sup>1</sup>Department of Neurology, Addenbrooke's Hospital, Cambridge, UK

<sup>2</sup>Department of Clinical Neurosciences, University of Cambridge, Cambridge, UK

## Correspondence to

Dr Sean YW Tan;  
st822@cam.ac.uk

had fewer investigations with a reduced risk of reassessment despite an increase in virtual appointments. This is likely due to a change in triaging practices where younger patients with conditions more reliant on history taking (such as headaches, epilepsy and seizures) are streamed appropriately to be reviewed virtually. Conversely, older patients and those with conditions requiring a physical examination were allocated to an in-person review.

## METHODOLOGY

### Study design and participants

We retrospectively evaluated new referrals and patients seen in the outpatient neurology clinic at Addenbrooke's Hospital, located in Cambridge. Addenbrooke's hospital is a tertiary centre receiving neurology referrals (general and specialist) from the entire east of England (EoE) region, with a fully integrated electronic healthcare record system (EPIC systems). The EoE region is a large area extending from Suffolk and Essex to Hertfordshire and Bedfordshire, and to Cambridgeshire and Norfolk, with a population of approximately 6.4 million people. These factors make Addenbrooke's a suitable centre to conduct our analysis.

Referrals and patients reviewed at first clinic appointments from the periods of January to December 2019 and January to December 2022 were compared in this study. Participants in 2019 were used as the prepandemic cohort, given that it was the last year before the COVID-19 pandemic affected the UK in 2020. Participants in 2022 were used as the postpandemic cohort. The term 'post-pandemic' in this article is used to indicate a timeframe where healthcare services have had sufficient time to adapt to COVID-19, resulting in stable and longer-term changes to medical practice. Hence, the year 2022 was used instead of 2020 or 2021, when hospitals were still adjusting to the difficulties of the pandemic.

Within the postpandemic cohort, new face-to-face (F2F) and virtual consultations were compared. Virtual clinics (ie. non-F2F clinics) included both telephone and video appointments. Patients who attended video clinic appointments used the Attend Anywhere software. A link was sent to patients, which they could use to join using a desktop computer, laptop, tablet or smartphone. The patient connected in from their own homes or chosen location without a trained assistant to help with the examination.

Exclusion criteria for referrals/patients were (1) referrals for outpatient procedures—namely lumbar punctures; (2) referrals/patients with errors in data entry; (3) referrals/patients with >20% of missing data and (4) any follow-up patients. Duplicated data points were identified and removed. The initial sample consisted of 7482 referrals in 2019 and 7481 referrals in 2022. After applying the above criteria, the sample used for analysis consisted of 7294 referrals (4946 clinic appointments) in 2019 and 6989 referrals (3976 clinic appointments) in 2022 (figure 1).

### Data collection and definitions

Data were gathered from electronic health records stored on EPIC. Demographic variables included age and gender. When comparing referrals in 2019–2022, the number of referrals, referral modality and percentage of referrals accepted and converted to an outpatient appointment were assessed. For the first clinic appointments, data points evaluated included: time to consultation, modality of clinic appointment, the percentage of patients discharged after a first clinic appointment, diagnosis at appointment, number of investigations ordered per appointment and the risk of reassessment after being discharged. Reassessment was defined as the need for a patient who was discharged after their first appointment to reattend or be re-referred to the neurology clinic for any reason within a 1-year period.

Appointment diagnoses were established at first clinic appointments. Fifteen diagnostic categories were used based on a modification of Watila *et al's* and Chapman *et al's* systems<sup>10 11</sup> to allow for comparison to the existing literature. The types of investigations ordered after a first clinic appointment examined in this study included blood tests, electroencephalograms (EEGs), electromyographs (EMGs), CT and MRI scans.

### Statistical analysis

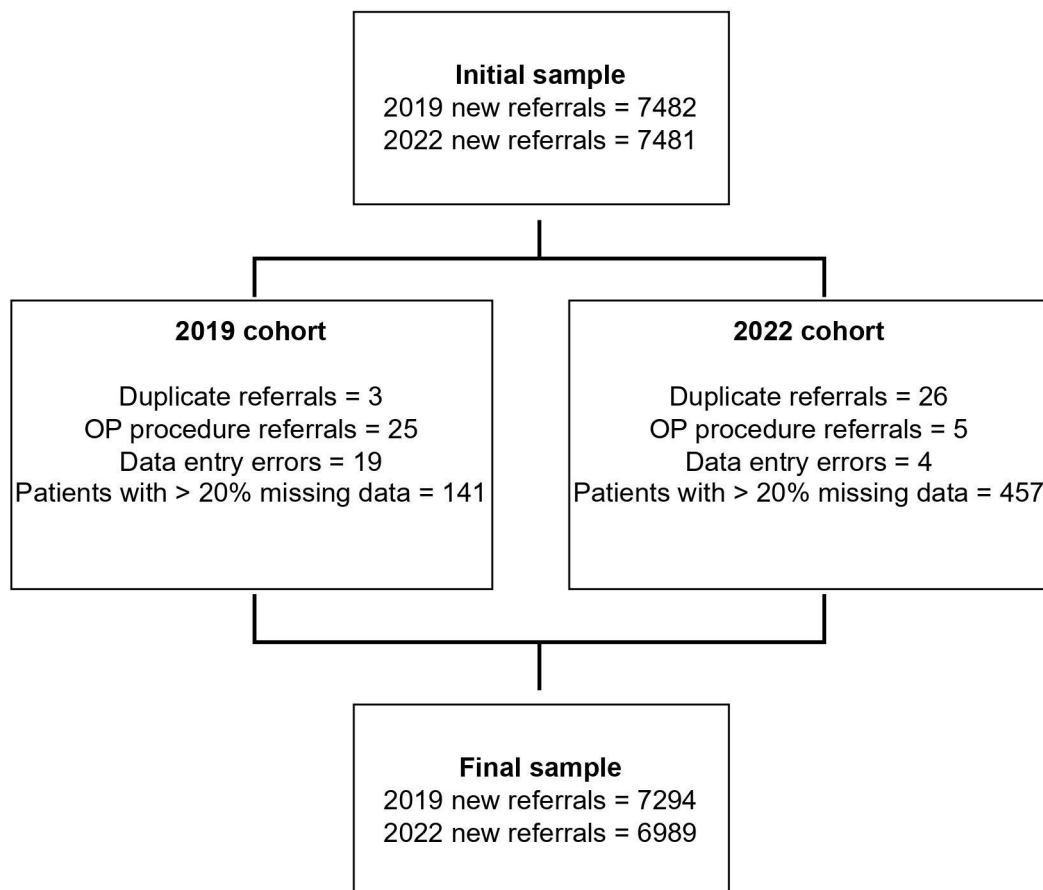
All data processing and analysis were conducted in R V.4.2.1. For continuous data, when assumptions of normality were met, unpaired t-tests were used to compare groups. For non-parametric data Mann-Whitney U tests were used to assess if distributions were similar. Mood's median test was used to directly compare medians as well.  $\chi^2$  tests were used for categorical data. Percentages or proportions were compared with a z-test of proportions (no statistics were run for ratios >1). Results were considered statistically significant at  $p < 0.05$ . Where appropriate the Bonferroni correction procedure was used to control for multiple comparisons. The risk of reassessment was tabulated in a univariate analysis reporting the relative risk (RR) with the corresponding p-value and 95% CI.

## RESULTS

### Comparing referrals and first clinic appointments prepandemic and postpandemic

#### Demographics, referral pathways and time to consultation similar between years

Our sample consisted of 7294 referrals in 2019 (prepandemic) and 6989 referrals in 2022 (postpandemic) (table 1). For first clinic appointments, 4946 appointments in 2019 and 3976 appointments in 2022 were analysed (table 1). The modality of clinic appointments altered significantly between years (table 1), with more appointments being telephone and video consultations in 2022 (telephone=852, video=72, F2F=3052) compared with 2019 (telephone=34, video=0, F2F=4912). We investigated if this shift to virtual working was associated with



**Figure 1** Flow chart showing exclusion criteria being applied to the initial dataset, leading to the final sample carried forward for analysis. OP, outpatient.

changes in the characteristics of referrals or patients reviewed in clinics.

The demographics of patients referred and referral pathways were similar between years (table 1). Patient cohorts reviewed at first clinic appointments were also comparable in gender and age (table 1). The distribution of diagnosis made at clinic appointments is displayed in figure 2. It is similar for both years, where the predominant diagnoses were headaches and facial pains (21.9% in 2019, 20.1% in 2022), non-specific neurological symptoms (18.1% in 2019, 17.4% in 2022), delirium and neurodegenerative disorders (10.5% in 2019, 12.4% in 2022) and movement disorders (8.8% in 2019, 9.2% in 2022). There was no significant difference between median time to consultation (median=73 days, IQR=61 days, for both years) (table 1).

This showed that while significantly more patients were being seen virtually in 2022, the patterns of referrals and types of patients being reviewed in clinics were similar, as was the time to appointment. A total of 210 (4.24%) patients in 2019 and 207 (5.20%) patients in 2022 did not attend their clinic appointments. Although the z-test of proportions comparing these percentages was statistically significant ( $\chi^2=4.34$ ,  $p=0.03$ ), the effect size is small with the 95% CI of difference in percentages being 0.05%–1.87%. As our sample size was large, smaller effect sizes

can reach the significance threshold more easily. Moreover, given that the actual difference in percentage is minimal, we believe that the cohorts remain comparable.

#### Change in triaging of referrals

We then asked whether referrals were being triaged differently. Referral outcomes differed significantly with less referrals being accepted and converted to appointments in 2022 (56.89%) compared with 2019 (67.80%) (table 1). As diagnoses and demographics at appointment were similar, this suggested that triaging was not biased towards accepting any specific type of patient, but rather that this change was due to a different triaging practice being employed. Indeed, in the postpandemic period the centre altered how referrals from the region were vetted. During the prepandemic timeframe, primary care practitioners were able to use a booking system to arrange for outpatient neurology consultations. In the postpandemic period, this system was removed and all referrals were vetted by neurology consultants.

#### Fewer investigations requested per appointment postpandemic

The total number of investigations and blood tests ordered per appointment was lower in 2022 (table 2). For all other investigations ordered per appointment (EMGs, EEGs, CTs, MRIs) there were no significant differences

**Table 1** Number, demographics and outcomes of new referrals and patients seen in clinics in the prepandemic and postpandemic setting

|   |  | Prepandemic (January–December 2019)   | Postpandemic (January–December 2022)  | Test statistic/p value                |
|---|--|---|---|---------------------------------------|
| New referrals                                 | Number of referrals                                  | n=7294  | n=6989  | –                                     |
|   | Gender   | 42 % M/58% FM   | 41% M/59% FM  | $\chi^2=1.11/p=0.291$                 |
|   | Age (years)  |   |   |                                       |
|   | Mean±SD  | 51.72±19.06   | 52.34±19.71   | t=–1.96/p=0.051                       |
|   | Referral modality                                    | Electronic order=762 (10.45%)<br>Email=237 (3.25%)<br>eReferral=5117 (70.15%)<br>Fax=13 (0.12%)<br>Letter=1151 (15.78%)<br>Telephone=14 (0.12%) | Electronic order=768 (10.99%)<br>Email=164 (2.35%)<br>eReferral=4884 (69.88%)<br>Fax=1 (0.01%)<br>Letter=1171 (16.75%)<br>Telephone=0 | –                                     |
|   | Number of clinic appointments given (% of referrals) | 4946 (67.80%)   | 3976 (56.89%)   | $\chi^2=180.75/p<2.2 \times 10^{-6*}$ |
| First clinic appointments                     | Gender   | 43 % M/57% FM   | 43 % M/ 57% FM  | $\chi^2=0.0002/p=0.988$               |
|   | Age (years)  |   |   |                                       |
|   | Mean±SD  | 51.56±18.74   | 52.95±19.38   | t=–3.42/p=0.00062*                    |
|   | Time to consultation (days)                          |   |   |                                       |
|   | Median (IQR)   | 73 (61)   | 73 (61)   | Z=1.3217/p=0.1863                     |
|   | Modality of clinic appointment                       | F2F=4912 (99.31%)<br>Telephone=34 (0.69%)<br>Video=0  | F2F=3052 (76.76%)<br>Telephone=852 (21.43%)<br>Video=72 (1.81%)   | $\chi^2=1170/p<2.2 \times 10^{-6*}$   |
| Discharged after first clinic appointment (%) | 54.71%   | 45.52%  | $\chi^2=75.42/p<2.2 \times 10^{-6*}$  |                                       |

\*Denotes statistical significance at  $p<0.05$ .

F, Female; F2F, face-to-face ; M, Male; t, t-test statistic; Z, Mood's median test statistic.

between years. Overall, this was surprising as we expected virtual consultations to result in more investigations being requested.

### Reduced risk of reassessment postpandemic

We examined whether the reduced acceptance rate for referrals and reduction in outpatient investigations resulted in an increased risk to patients. After being discharged from a first clinic appointment, the risk of reassessment in the postpandemic period was lower (RR=0.27, 95% CI=0.18 to 0.38,  $p=3.49 \times 10^{-15}$ ), suggesting a lower risk of patients returning to the outpatient setting.

Hence, although patient demographics were similar, referrals postpandemic were less likely to be accepted, had a higher chance of being seen virtually, with fewer investigations and a reduced risk of reassessment. We proceeded to compare F2F and virtual appointments directly within 2022 to investigate whether these differences were consistent within rather than across cohorts.

### Comparing F2F and virtual clinics postpandemic

#### Demographics and time to consultation differed: selective triaging

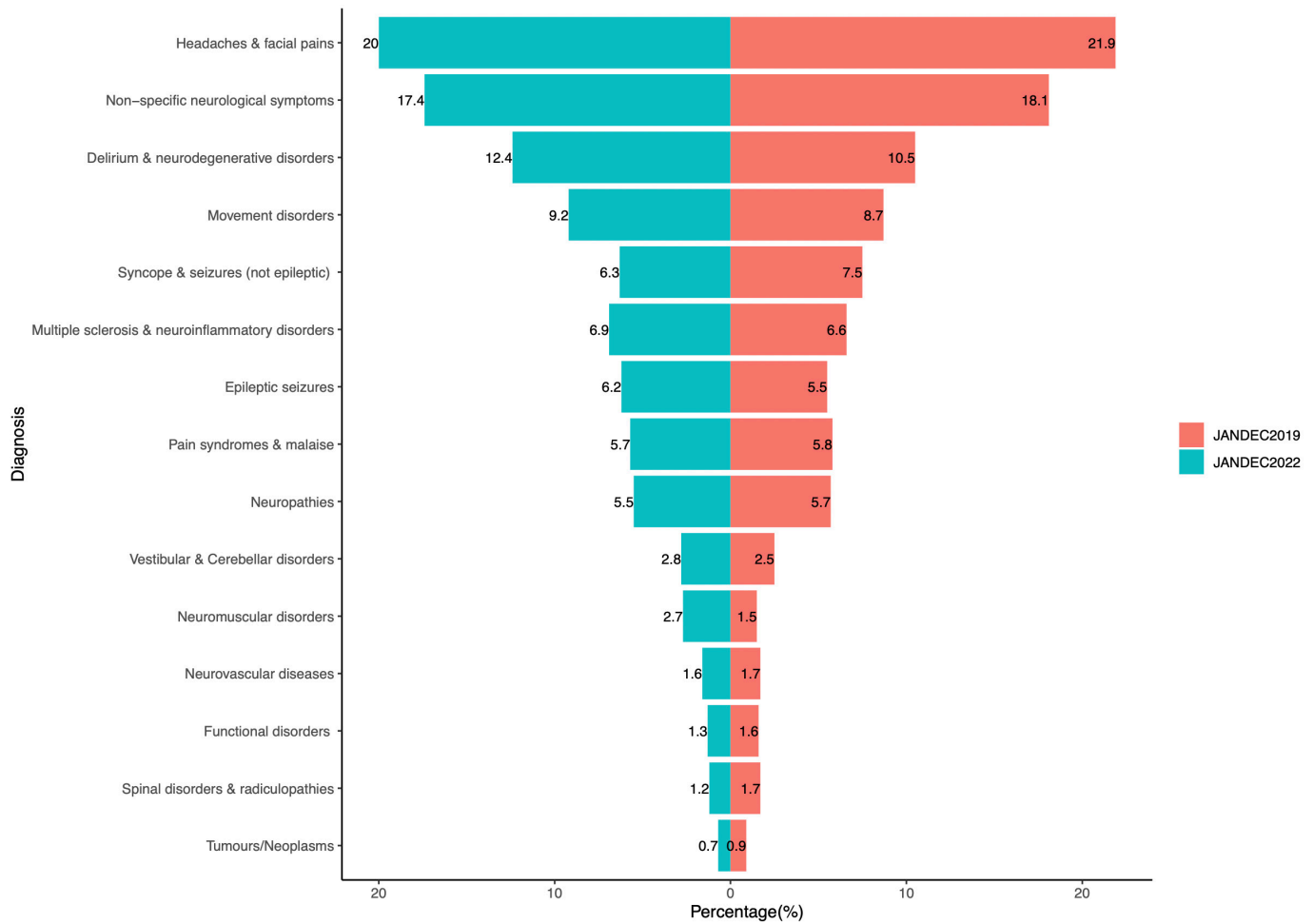
Of the 3976 appointments in 2022, 3052 were F2F (76.76%) and 924 (23.24%) were virtual (table 3). While more female patients attended both clinics, patients

seen in virtual clinics were younger than those in F2F clinics. An asymmetrical distribution of diagnosis for the different clinic modalities was found (figure 3). Virtual clinics were mostly attended by patients with headaches and facial pains (40.2%), syncope and seizures (18.9%), epileptic seizures (14.4%) and non-specific neurological symptoms (12%). F2F clinics more commonly reviewed individuals with non-specific neurological symptoms (19.1%), delirium and neurodegenerative disorders (15.9%), headaches and facial pains (13.6%), movement disorders (11.1%) and multiple sclerosis and neuroinflammatory disorders (8.6%). Time to consultation was significantly shorter for virtual clinics (median=66 days, IQR=55 days) compared with F2F clinics (median=74 days, IQR=63 days) (table 3).

Our findings suggest that in the postpandemic period different cohorts of patients from accepted referrals were being selectively triaged to be reviewed in either F2F or virtual clinics. We examined if this change in practice was associated with alterations in clinic outcomes.

#### Fewer investigations requested per appointment for virtual consultations

The total number of investigations and blood tests ordered per appointment were lower for virtual



**Figure 2** Pattern of diagnosis from clinic appointments in the prepandemic (January to December 2019) and postpandemic (January to December 2022) settings, expressed as percentages.

clinics (table 4). Significantly lower numbers of MRIs and EMGs were ordered per virtual appointment. No significant difference was found for CTs ordered per appointment. More EEGs were ordered per appointment for virtual clinics compared with F2F clinics. The higher numbers of EEGs and lower numbers of EMGs for virtual clinics are not surprising given that virtual clinics reviewed more seizure-related

presentations and fewer neuromuscular conditions. However, the lower number of MRIs for virtual clinics given the predominance of headaches and facial pains was surprising. Further analysis of patients with headaches and facial pains revealed that 0.36 MRIs were requested per patient for F2F consultations compared with 0.19 MRIs for virtual clinics ( $\chi^2=24.55$ ,  $p=7.24 \times 10^{-7}$ ).

**Table 2** Number and types of investigations ordered per appointment in the prepandemic and postpandemic clinic settings

| Investigations | Number per appointment              |                                      | Test statistic/p value (corrected) |
|----------------|-------------------------------------|--------------------------------------|------------------------------------|
|                | Prepandemic (January–December 2019) | Postpandemic (January–December 2022) |                                    |
| All            | 1.98                                | 1.53                                 | –                                  |
| Blood tests    | 1.43                                | 0.98                                 | –                                  |
| CT scans       | 0.074                               | 0.071                                | $\chi^2=0.21/p=1.000$              |
| MRI scans      | 0.35                                | 0.37                                 | $\chi^2=5.62/p=0.148$              |
| EMGs           | 0.078                               | 0.068                                | $\chi^2=2.75/p=0.403$              |
| EEGs           | 0.043                               | 0.044                                | $\chi^2=0.006/p=1.000$             |

Z-tests of proportions were not run for proportions >1.  
EEGs, electroencephalograms; EMGs, electromyographs.



**Table 3** Number, demographics and outcomes of patients seen in F2F and virtual clinics in the postpandemic period

|   | F2F            | Virtual                            | Test statistic/p value                    |
|---|----------------|------------------------------------|---|
| Number of clinic appointments                 |                |                                    |   |
| Modality                                      | n=3052         | n=924<br>Video=72<br>Telephone=852 | –   |
| Gender  | 44% M/56% FM   | 40% M/60% FM                       | $\chi^2=4.65/p=0.031^*$                   |
| Age (years)                                   |                |                                    |   |
| Mean $\pm$ SD                                 | 55.35 $\pm$ 19 | 45.01 $\pm$ 18.47                  | t=14.817/p<2.2 $\times$ 10 <sup>-6*</sup> |
| Time to consultation (days)                   |                |                                    |   |
| Median (IQR)                                  | 74(63)         | 66(55)                             | Z=4.97/p=6.77 $\times$ 10 <sup>-7*</sup>  |
| Discharged after first clinic appointment (%) | 44.06%         | 50.32%                             | $\chi^2=11.19/p=0.0008^*$                 |

\*Denotes statistical significance at p<0.05.

F, Female; F2F, face-to-face ; M, Male; t, t-test statistic; Z, Mood's median test statistic.

### No increased risk of re-assessment and more discharges for virtual appointments

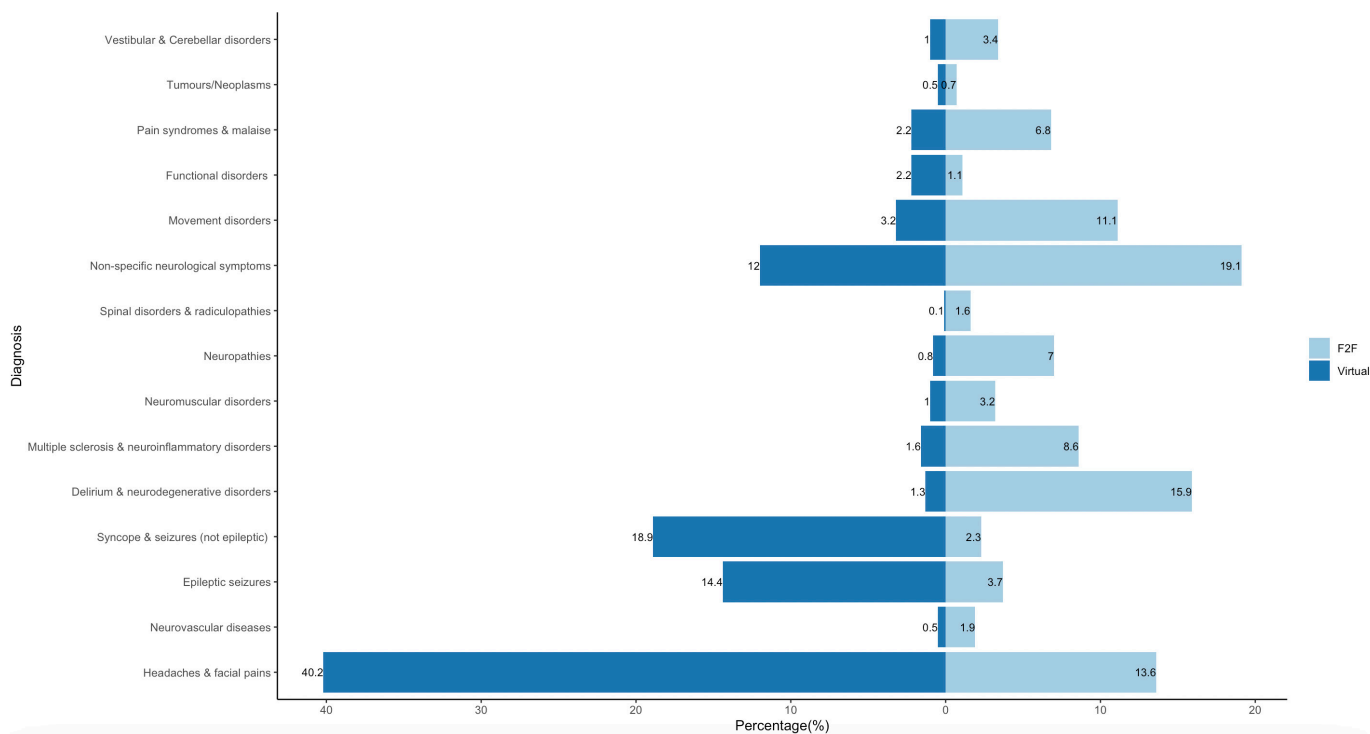
More patients were discharged after a virtual clinic review (50.32%) as opposed to a F2F appointment (44.06%) (table 3). There was no statistically significant increased risk of reassessment after being discharged from a virtual clinic (RR=1.21, 95% CI=0.58 to 2.50, p=0.61).

Overall, patients reviewed in virtual clinics were seen more quickly, discharged more frequently and had lower numbers of investigations without an increased risk of reassessment. Interestingly, different cohorts of patients were being reviewed in F2F and virtual clinics. This suggests that the overall effect seen when comparing the

prepandemic and postpandemic groups, may in part be due to patients being triaged effectively to be seen in an appropriate clinic modality in 2022.

### DISCUSSION

This study aimed to investigate the lasting impact of the COVID-19 pandemic on referrals and new patients reviewed in outpatient neurology clinics. While the demographics of referrals and referral pathways were similar, a lower percentage of referrals were converted to clinic appointments postpandemic. Characteristics of patients reviewed at first clinic appointments did not



**Figure 3** Pattern of diagnosis from F2F and virtual clinic appointments within 2022 expressed as percentages. F2F, face-to-face.

**Table 4** Number and types of investigations ordered per appointment in F2F versus virtual clinics

| Investigations | Number per appointment |         | Test statistic/p value (corrected)      |
|----------------|------------------------|---------|---|
|                | F2F                    | Virtual |   |
| All            | 1.78                   | 0.71    | –                                       |
| Blood tests    | 1.18                   | 0.30    | –                                       |
| CT scans       | 0.08                   | 0.05    | $\chi^2=5.57/p=0.07$                    |
| MRI scans      | 0.41                   | 0.24    | $\chi^2=90.75/p=6.51 \times 10^{-21*}$  |
| EMGs           | 0.087                  | 0.008   | $\chi^2=69.87/p=2.52 \times 10^{-16*}$  |
| EEGs           | 0.02                   | 0.11    | $\chi^2=148.59/p=1.41 \times 10^{-33*}$ |

Z-tests of proportions were not run for proportions >1.  
 \*Denotes statistical significance at  $p<0.05$ .  
 EEGs, electroencephalograms; EMGs, electromyographs; F2F, face-to-face.

alter between years, but a lower percentage of patients were discharged in 2022. These findings suggest a change in triaging practice: namely that stricter thresholds of appointment conversion are being enforced postpandemic, and patients reviewed in clinic are the ones who require follow-up. In other words, referrals are being triaged more selectively postpandemic. This aligns with the postpandemic shift to consultant-led vetting of referrals.

Importantly, our findings suggest that patients reviewed in virtual clinics are being seen quickly and discharged safely without excessive investigations due to a lack of physical examination. We found a reduced risk of reassessment after being discharged from a first clinic appointment in the postpandemic cohort with less investigations, even with larger numbers of virtual appointments in 2022. Further analysis within the postpandemic group revealed a higher percentage of patients were discharged after a virtual review without a significantly increased risk of reassessment. We also identified a reduced number of investigations ordered per appointment for virtual clinics (except EEGs, presumably due to the higher percentage of patients with suspected epilepsy and seizures) with a shorter median time to consultation.

How do we reconcile our results with the safety concerns of virtual clinics identified during the earlier stages of the pandemic? Virtual clinics in 2022 were attended by younger patients, who mostly suffered from headaches, epilepsy or seizures. Prior studies have demonstrated that patients with epilepsy and headache disorders can be managed safely with virtual clinics.<sup>12 13</sup> Additionally, Watila *et al* identified that younger individuals and patients with these diagnoses were groups that could be diagnosed safely using virtual consultations.<sup>10</sup> These conditions are more reliant on patient and collateral history taking, making them more suitable for virtual assessments as well.<sup>14 15</sup> Comparatively, patients attending F2F clinics postpandemic were older, with diagnoses that would benefit from an in-person review such as neurodegenerative disorders or multiple sclerosis. Hence, patients in the postpandemic setting seem to be appropriately triaged and allocated to be reviewed in either F2F

or virtual appointments, minimising the risk of reassessment and avoiding the need for excessive investigations. Another factor may be that clinicians over the course of the pandemic have become more adept at virtual consultations, improving outcomes in the postpandemic phase. Using the cohort of patients presenting with headaches and facial pains as an example, even for patients within the same diagnostic category, those selected for virtual reviews have reduced numbers of investigations. Perhaps patients with more reassuring features in their presentations are streamed to virtual clinics, whereas those with more concerning aspects who require further investigations are allocated to F2F reviews.

In summary, the pandemic did not have a lasting impact on the demographics of new referrals or patients seen at first clinic appointments. However, it seems that outpatient neurology services have adapted over the course of the pandemic, and are now able to effectively triage referrals, ensure the correct population of patients are reviewed in F2F or virtual clinics, discharge patients appropriately and avoid excessive investigations for patients reviewed remotely. These results demonstrate the safety and utility of remote assessments, which is encouraging for the continual adoption of virtual clinics in the outpatient setting. Certainly, the appropriate allocation of patients to virtual neurological consultations is dependent on its selective use for specific referrals.

Our findings should be interpreted in the context of the following limitations: (1) the retrospective nature of this study; (2) we focused our study on the risk of reassessment in the outpatient neurology clinic, but did not investigate other risks for example, the risk of hospital admission due to a neurological cause; (3) not all investigation subtypes were investigated for example, nerve conduction studies; (4) this study was carried out in one centre instead of multiple locations; (5) some patients may have represented outside the follow-up period; (6) we were unable to assess changes in patient or referrer satisfaction.

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**Competing interests** None declared.

**Patient consent for publication** Not applicable.

**Ethics approval** The project was registered with the Cambridge University Hospitals NHS trust Audit Team. Being a retrospective study, the data extraction and analysis did not require ethics approval. All data were retrieved, processed and analysed according to ethical standards.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data are available upon reasonable request.

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#### ORCID iD

Sean YW Tan <http://orcid.org/0000-0002-3150-6069>

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