



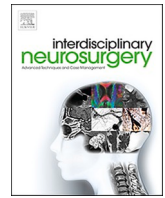
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Research Article

Neurosurgery in octogenarians during the COVID-19 pandemic: Results from a tertiary care trauma centre

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ABSTRACT

Background: In 2020, 6% of Scotland's adult population was ≥ 80 years. Advancements in care mean improved chances of survival at 6-months for older adults following injury to the brain or spine. The Covid-19 pandemic also resulted in local and national policies aimed at protecting the elderly. We sought to evaluate referral patterns and outcomes for patients ≥ 80 years referred to our institution during this period.

Objective: To evaluate referral patterns and outcomes for patients ≥ 80 years referred to our institution both before and during the coronavirus pandemic.

Design: Retrospective observational cohort study.

Setting: Tertiary care in a developing major trauma centre (Queen Elizabeth University Hospital, Glasgow).

Participants: All patients ≥ 80 years referred to the on-call neurosurgical service over two four-month periods before (2016–17; $n = 1573$) and after the onset of Covid-19 (2020; $n = 2014$).

Methods: Data on demographics, ASA, diagnosis and referral decision were collected. 30-day and 6-month mortality and functional independence were assessed.

Results: 246 (before) and 335 (during Covid-19) referred patients were ≥ 80 years. No gender bias. A significant increase (17%) in acute trauma was seen during the pandemic months. Fewer older adults were transferred (6% to 2% Covid-19) for specialist care, most commonly for chronic subdural haematoma. Most were alive, home and independent at 6 months (47% pre and 63% during Covid-19).

Conclusions: Octogenarians feature disproportionately in acute adult neurosurgical referrals. In our department, local and national responses to the Covid-19 pandemic did not appear to influence this. Robust evidence of neurosurgical outcomes in the older adult is required to fairly distribute resources for our ageing population, but decisions must not be based on age alone.

Key points

- People aged 80 and over made up 6% of the adult population of Scotland according to the most recent estimates.
- The recent coronavirus (Covid-19) pandemic has highlighted the stark contrast in outcomes for the older patient; illness in this group has a significant impact on the smooth function of the whole health service.
- During Covid-19, we observed a significant increase in the number of referrals for neurosurgical trauma in older adults.

- Admissions were almost exclusively for chronic subdural haematoma, with the majority making a meaningful recovery, alive and functionally independent at six months.

1. Introduction

The mid-year population estimate for Scotland in 2020 was 5.5 million, with fewer than one in five people (19.3%) aged 65 and over [1]. The population of one of the world's most economically advanced nations is ageing, with falling birth rates and improved life expectancy

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of the 'post-war' and 'baby boomer' generations suggested as possible explanations for this trend. Guidance from NICE (National Institute for Health and Care Excellence) [2], and the World Health Organisation (WHO) [3] define people aged over 65 years as 'older' (previously referred to as 'geriatric').

People aged 80 and over made up 6% of the adult population of Scotland, according to the most recent estimates [1]. Over the last two decades, people aged 75 years and over experienced the greatest percentage change by age group in Scotland (25%). Similar trends have been observed in the population referred to the neurosurgical service. In 1986, patients aged 65 years and over accounted for 15% of admissions for traumatic brain injury (TBI) in Scotland [4]. The King's fund in 2012 reported on differences in the average length of stay following any emergency admission in English hospitals. The report found patients over 65 were admitted for an average of nine days, compared to three days for patients under 65, with the highest rates of admission observed for those aged over 85 [5]. This average duration of acute hospital stay was not dissimilar to reports from 1983 when it was 8.8 days for the ≥ 65 compared to 2.7 days in the < 65 [4].

As the average age of patients referred to the neurosurgical service increases, perhaps it is appropriate to consider redefining who the 'older' patient is in order to improve planning of tomorrow's health service. In this paper, 'older' is defined as adults aged 80 years and over. A review of trauma care in Scotland [6] identified advancing age as a significant negative predictor for admission to a neurosurgical unit, with those over 70 years at reduced odds of being admitted to an intensive care following severe TBI.

In 1987, Sam Galbraith, a Glasgow neurosurgeon, defined the issue facing elderly patients as one of reduced cerebral reserve to withstand even a minor injury [7]. This diminished neurological and physiological reserve reduces the likelihood of return to functional independence and is cited as the reason to decline higher clinical care to this age group [5–7]. Mortality following all-severity TBI was predicted to rise by 4% for each year beyond the age 35; approximately 100% for an 80-year-old admitted to the department of Neurosurgery in Glasgow in 1987 [7]. Today's prognostic models, although limited in their representation of the older patient, are more generous and predict 37–60% mortality at six months for the same octogenarian [8–10].

Older adults are not a monolithic group. With an increasing proportion of people living into their eighties with meaningful independence, and emerging acceptance that frailty and functional reserve are not entirely correlated with age, it is important to consider each patient referred as an individual. In order to improve neurosurgical care for tomorrow's older patient, surgeons and referrers must be able to balance the need for treatment with achievable patient and disease-specific outcomes.

To a large extent, outcomes following neurosurgical intervention in the elderly depend on the underlying disease process and are not uniformly poor. Microvascular decompression for trigeminal neuralgia has been reported to have significantly better long-term pain outcomes in patients 60 years-of-age and older compared to younger patients [11]. A 2005 prospective multicentre study of 295 patients found that the older patient required more inpatient rehabilitation but continued to improve after discharge following TBI [12].

Despite the above trends and disproportionately poor health outcomes, geriatric neurosurgery remains controversial. The recent coronavirus (Covid-19) pandemic has highlighted the stark contrast in outcomes for the older patient, as well as the significant impact that illness in this group has on the smooth function of the whole health service.

During the pandemic, our neurosurgical department was required to admit all patients with a TBI from the local emergency department as part of efforts to improve critical care bed availability. We hypothesised that an increase in the overall number of neurosurgical referrals for the elderly would result from this policy. To investigate this, we compared a four-month period during the Covid-19 pandemic to a similar period

four years before the pandemic to explore the differences in referral patterns and assess the impact on outcomes for the elderly.

2. Methods

2.1. Study design

We conducted a retrospective review of a prospectively collated database of young persons and adult patients referred to the neurosurgical service at the Queen Elizabeth University Hospital, Glasgow, in four representative months in 2016–17 (referred to as the pre-Covid period) and a similar period in 2020 (referred to as the Covid-19 period). We collected data from the months of April, June, August and December over each period. The records of consecutive patient referrals for emergency advice were manually assessed for data on patient demographics, diagnosis and referral decision. For admissions, we evaluated length of stay, discharge destination, functional independence and mortality at 30-days and 6-months. Admissions were considered if they took place within 10 days of the referral.

2.2. Inclusion criteria

Patients were included if they were aged over 16 years and had clinical follow-up of at least six months. All diagnoses or reasons for referrals were eligible for inclusion if listed on the archived database or related clinical notes.

2.3. Exclusion criteria

Entries were excluded if they were duplicated within a given month, but not across months, or if they did not satisfy the inclusion criteria.

2.4. Variables

The following exposure variables were collected: baseline demographics (age at referral, gender, performance status, American Society of Anaesthesiologists [ASA] score), details of diagnosis (degenerative spine, subdural haematoma, vascular, oncology, infection etc), severity of brain injury (indicated by Glasgow Coma Scale [GCS]), outcome of referral (inpatient or outpatient review or discharge) and, for those admitted, Glasgow Outcome Score Extended (GOSE; assessed from clinical letters at 30 days and six months following discharge).

2.5. Definition of diagnosis

The definition of the following was accepted for analysis: degenerative spine was defined as cervical, thoracic or lumbar canal stenosis, disc disease or chronic vertebral column instability. Spinal trauma included all fractures of the vertebral column from the occipital condyle to the sacrum. Acute TBI was any patient with a history of trauma and CT head showing contusions, skull fracture, intraventricular haemorrhage, subarachnoid haemorrhage, acute subdural haematoma or extradural haematoma. Severity was classified using GCS. Chronic subdural haematoma (CSDH) was accepted as a hypodense or mixed density extra-axial collection reported on CT head. Cerebrovascular class was accepted as all causes of ischaemic or haemorrhagic strokes, including subarachnoid haemorrhage, malignant evolution of ischaemic strokes, carotid or vertebral dissection, intracerebral haemorrhage and intraventricular haemorrhage. Vascular malformations including aneurysms, cavernoma, arteriovenous malformations were also included. Infection included meningitis, discitis, cranial or spinal epidural abscess. Cranial oncology included primary or secondary, benign or malignant neoplastic pathology; colloid cysts were included in this class. Spinal oncology included primary or secondary, benign or malignant neoplastic pathology of the vertebral column and neural axis. Cerebrospinal fluid (CSF) dynamics included all causes of hydrocephalus

including normal pressure hydrocephalus. Other included diagnoses that did not fit into the above (for example arachnoid cysts, Chiari malformation). Where multiple diagnosis classes were present in a single referral, it was assigned the most life-threatening diagnosis. Operative fitness was assessed using ASA grade with a score of III or less indicating a patient was considered a good candidate for surgery.

2.6. Data sources

All data on patient demographics, symptom ascertainment, management and response of symptoms were jointly obtained from electronic medical records by three authors (SB, LAS, AAO). Radiological information was obtained from electronic reports of scans and cross-checked by author KA.

2.7. Data analysis

Baseline demographics were summarised using descriptive statistics. Potential associations between age over 80 and management decision were explored using Chi-square test. Significant associations were further evaluated using multivariate binary logistic regression. Non-parametric variables such as ASA and GOSE were assessed using the Fisher’s Exact test. Across different groups, median age at diagnosis was compared using the Mann-Whitney U test. Data were analysed using Microsoft Excel (version 16.50) and SPSS (version 24.0, IBM SPSS Inc, Chicago, IL, USA). A p value of <0.05 was used to determine statistical significance.

3. Results

3.1. Demographics

The pre-Covid-19 period (2016–17) included 1573 referrals with a male to female ratio (M:F) of 1:1. Median age was 60 years (interquartile range [IQR] 45–74), 42% of patients were aged ≥65 years and 16% aged ≥80 years. 2014 referrals were included for a similar period with Covid-19 restrictions in place (2020). An even gender divide was observed (M:F 1:1), the median age was 61 years (IQR 46–75) and a similar proportion of referrals were aged ≥65 years (43%) and ≥80 years (17%). The distribution of ages at referral for both periods is summarised in Fig. 1.

Comparing time periods, patients appeared significantly less likely to be admitted to the neurosurgical department during the ‘Covid-19’ study period (14%) compared to ‘pre-Covid-19’ (19%) (odds ratio [OR] 0.69; 95% confidence interval [95% CI] 0.58–0.83); p<.0001). There was no significant gender predilection regards to the likelihood of admission for all patients during either period (OR 0.92 versus 1.01).

For patients aged ≥80 years, fewer were admitted during the pandemic compared to before Covid-19 (2% vs 6%, OR 0.37; 0.16–0.90, p=.027, χ^2 , p=.02). Male gender appeared to be associated with an increased likelihood of admission for patients aged ≥80 across both time

periods, albeit not significant (pre-Covid OR 2.73, p=.094, Covid OR 4.16, p=.081).

3.2. Reason for referral

Overall, most adult referrals before Covid-19 were for cerebrovascular advice (24%), degenerative spine (20%), acute TBI (19%), and cranial tumours (14%). During the Covid-19 period, significant changes in the percentage of referrals for acute TBI (16%, χ^2 p=.036), cerebrovascular pathology (21%, χ^2 p=.016) and degenerative spine (25%, χ^2 p=.001), but a similar proportion of cranial tumours was observed (14%, p=.506). These results are summarised in Fig. 2.

Among patients aged ≥80, the most common reasons for referral were cerebrovascular (pre vs during Covid-19, χ^2 ; 26% vs 19%, p=.038), acute TBI (24% vs 32%, p=.047), CSDH (14% vs 9%, p=.046), spine trauma (6% to 15%, χ^2 , p=.001), cranial oncology (11% to 8%, p=.176) and degenerative spine (11% to 8%, p=.176).

3.3. Variables associated with admission

In the pre-Covid period, age ≥80 appeared to be significantly associated with a reduced likelihood of admission when compared to younger patients (OR 0.25; 0.14–0.44, p<.001). This was also the case during Covid-19 (OR 0.13; CI 0.06–0.26, p<.001).

For the pre-Covid-19 cohort, 43% of referrals for CSF handling issues, 34% for CSDH, 20% cerebrovascular, 20% degenerative spine and 15% acute TBI were admitted for specialist management. Compared to this baseline, we observed a reduction in the proportion of admissions following referrals for CSF handling complaints (21%, χ^2 p=.008), CSDH (31%, χ^2 p=.751), cerebrovascular (16%, χ^2 p=.198), degenerative spine (16%, χ^2 p=.090) and acute TBI (9%, χ^2 p=.022) over the pandemic months.

For patients aged ≥80 years, 31% of referrals for CSDH, 7% of degenerative spine referrals, 2% of referrals for cerebrovascular and acute TBI were admitted for further management during the pre-covid months. We observed a reduction in admissions for referrals for CSDH (7%, OR 0.16; 0.03–0.77, p=.013), degenerative spine (4%, OR 0.5; 0.4–5.9), cerebrovascular (0%) but not for acute TBI (3%, OR 1.7; 0.17–16.7) during the pandemic months sampled.

For a pooled population of all patients referred ≥80 years before and during COVID-19, referrals for CSDH (OR 12.65; 5.29–30.27, p<.001) or male (OR 3.41; 1.3–8.8, p=.011) patients were most likely to result in admission to the neurosurgical department on univariate analysis. However, on multivariate analysis only CSDH remained significant (OR 10.8; 4.5–26.3, p<.001), male gender was no longer significantly associated (OR 2.45, p=.073).

3.4. Severity of TBI and ASA class in the older patients

Approximately 88% of referrals for traumatic brain injury in the older patients, including CSDH, remained mild in severity (GCS ≥13)

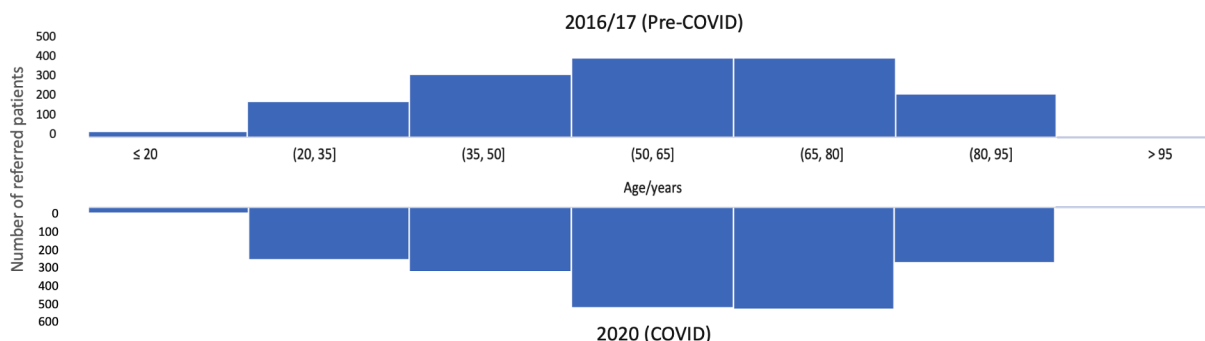


Fig. 1. Distribution of age for all referrals made during both periods.

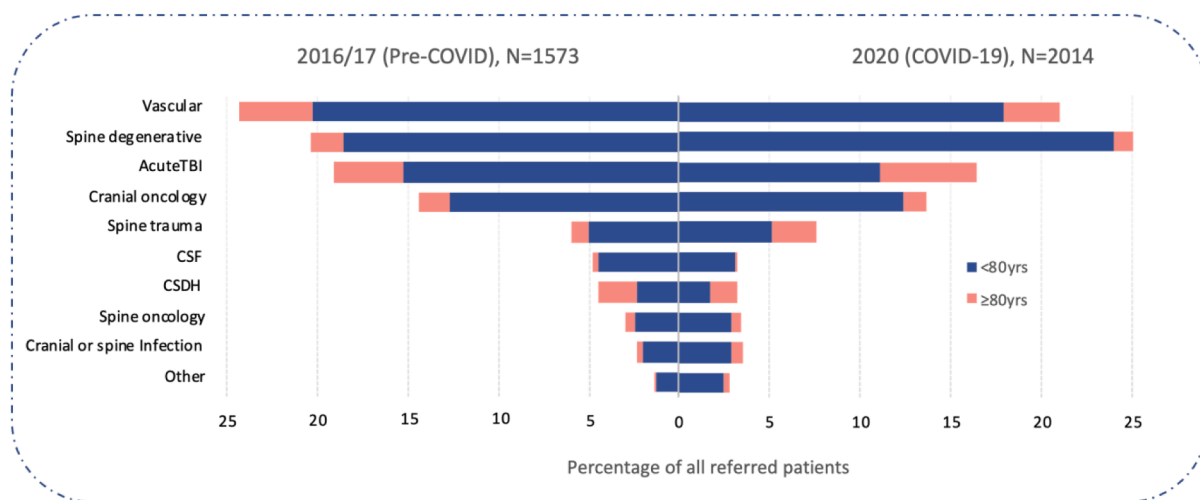


Fig. 2. Distribution of diagnosis class at referral before and during the Covid-19 pandemic.

both before and during Covid-19 periods.

A similar proportion of patients were assessed as ‘fit’ for surgery at referral, as determined by ASA class III or less, over the Covid-19 months (63%) compared to before (61% OR 0.49; 0.17–1.4).

The proportion of admitted patients classed as ASA III or less appeared to be independent to the referred patients (for pre-Covid cohort; 60% vs 63%, Fisher’s exact, $p=0.78$). There was a trend towards admitting fitter patients during the pandemic (OR 1.91; 0.38–9.) than before (OR 0.87; 0.3–2.54). The results for patients aged 80 years and over are summarised in Table 1.

3.5. Outcome

Of the 15 patients aged 80 years and over transferred for specialist care over the pre-Covid period, eleven (73%) underwent operative

Table 1
Pattern of referrals, severity of brain injury, and ASA class for patients ≥ 80-year-old.

	Pre-COVID-19		COVID-19 policy	
	Referral	Admission	Referral	Admission
Number	246	15	335	8
Age	86	85	86	83
M:F	1:1	11:4	3:4	7:1
Diagnosis				
Cerebrovascular	64	1	63	0
Acute TBI	60	1	107	3
CSDH	35	11	30	2
Cranial oncology	28	0	27	0
Spine oncology	7	0	10	0
Spine trauma	14	0	50	1
Spine degenerative	28	2	27	1
Infection c/spine	5	0	12	1
CSF hydrodynamics	4	0	3	0
Other	1	0	6	0
TBI severity				
Mild (GCS 13–15)	83	11	122	5
Moderate (GCS 9–12)	3	1	7	0
Severe (GCS 3–8)	9	0	8	0
ASA class				
I	0	0	0	0
II	9	2	24	0
III	146	7	182	6
IV	90	6	127	2
V	1	0	1	0
Oncology				
Benign	10	0	15	0
Malignant	25	0	22	0

management. Their average length of stay in the neurosurgical department was 9.7 days, with 27% discharged directly to their home.

Eight patients were admitted during the pandemic months, five (63%) patients underwent operative intervention, average length of stay was eight days, with 75% of patients discharged directly to their home. Surprisingly, there were no deaths in the older adult group at 6 months following admission during the Covid-19 months studied. Fig. 3 summarises the proportion of patients that were independent at home and outside as assessed by the GOSE for both periods.

4. Discussion

Older persons make up less than 10% of the population in Scotland, however, this age group was disproportionately represented in referrals for acute neurosurgical advice before and during the Covid-19 pandemic. An even smaller proportion of older patients were accepted for acute inpatient neurosurgical management. For the small percentage of patients transferred, this was almost exclusively for CSDH with the majority making a meaningful recovery, alive and functionally independent at six months. This may reflect careful patient selection.

In the first year of the Covid-19 pandemic, the local contingency was to admit all patients with acute TBI who arrived at the on-site emergency department to a neurosurgical ward. However, this policy did not affect the proportion of elderly patients referred. The implementation of a national strategy to manage the spread of the coronavirus in the older adult population may have contributed to the changes in referral patterns in this group seen during the Covid-19 period.

An earlier analysis of emergency neurosurgical referrals concludes that they have continued to rise in the west of Scotland at a rate exceeding the population growth [13]. The increase in overall referrals observed in the sampled pandemic months was consistent with this pattern. In contrast to the decline in referrals for trauma observed in patients under 80 years during the pandemic months, significantly more referrals for acute trauma (brain and spine) but fewer for oncology and degenerative spine were received for the older patient compared to pre-Covid-19.

Overall, despite admitting fewer patients for neurosurgical management during the pandemic months, improvements in the general fitness, length of stay and the quality of recovery of those admitted were noted when compared to the pre-pandemic periods.

Our results highlight the pattern of referrals in the elderly and provide a framework to direct improvements in the service for this age group. In the absence of extra resources to manage the increased proportion of elderly patients referred for acute neurosurgical advice, the quality of the service provided is likely to suffer. It is reassuring to

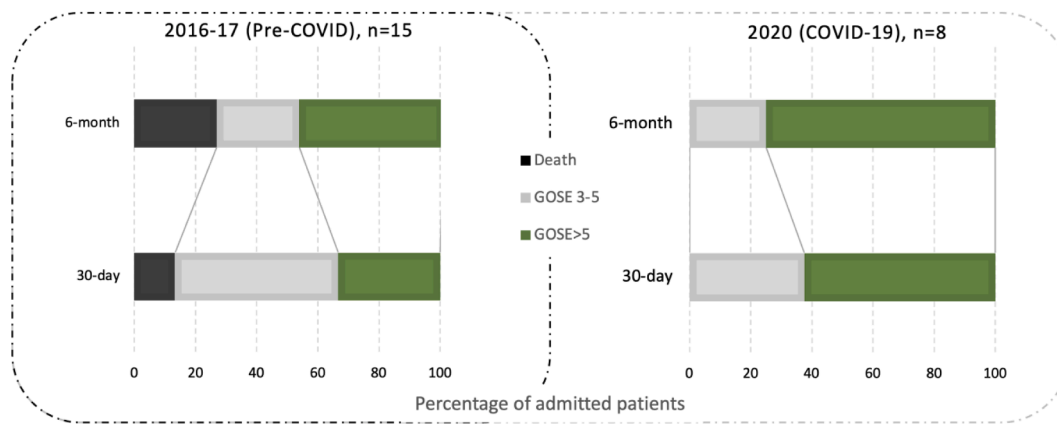


Fig. 3. GOSE of elderly patients admitted before and during COVID.

observe that a good proportion of patients aged 80 years and over transferred for acute neurosurgical care were alive and independent at 6 months, even with a policy to admit all acute TBI during the Covid-19 pandemic.

In our sample, the apparent absence of a significant relationship between the ASA of the patients accepted and those referred for acute neurosurgical care highlights potential arbitrary selection of older adult patients for treatment. A narrower selection of patients for transfer at our department, particularly during the Covid-19 period, is likely to explain the improvements in outcomes compared to historical data.

Studies evaluating the use of targeted assessment and multidisciplinary intervention have found that they improve outcomes of older people at risk of deteriorating health [14]. A meta-analysis of comprehensive geriatric assessments (CGA) reported a decrease in the likelihood that patients will be admitted to a nursing home at 3 to 12 months follow-up, but at a slight increase in the cost per life year living at home (LYLAH) gained [15]. An integrated, multi-disciplinary geriatric neurosurgical service with geriatricians, specialist nurses and anaesthetists would better co-ordinate care of the older patient referred for neurosurgical advice. Guidance from such a strategy, aimed at optimising patient autonomy and independent living, could be published for different neurosurgical conditions to aid referrers and patients in decision making whilst curtailing referrals for emergent advice. Ultimately, society must decide on how best to distribute health services, including for the elderly. Lessons from the pandemic provide an opportunity to revisit this age-old problem.

5. Conclusion

Referrals for octogenarians to the acute neurosurgical service continue to exceed what is expected for their share of the population at Scotland's largest regional centre.

Our local pandemic experience has shown that relaxing the admission criteria for traumatic brain injury did not have a negative impact on outcomes. This more liberal approach to TBI admission was however matched by a wider societal policy to keep the older adult shielded. Nevertheless, the elderly benefit from neurosurgical intervention in the right circumstances. The challenge is ensuring that treatment is provided for those who will benefit, regardless of age.

We recommend a focus on disease-specific geriatric assessments to guide referrers to the acute neurosurgical service. In our region, chronic subdural haematoma would appear to be the condition with the greatest likelihood of acceptance for neurosurgical care and for which treatment leads to a high proportion of older patients living independently at home. Focused assessments would reduce acute referrals but also provide a structured assessment of the needs of patient to optimise their independent living.

Robust research into the impact of advanced age on outcomes in

neurosurgery is required to help clinicians manage referrals for this group and maintain the quality of the neurosurgical service.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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