Joseph Buford Pennybacker CBE MD FRCS (1907-1983): Continuing Sir Hugh Cairns' Oxford Legacy and Pioneer of the Modern Management of Cerebral Abscesses

Introduction

This essay examines the life and contribution of Joseph Buford Pennybacker, Sir Hugh Cairns' protégée, to British neurosurgery and the modern management of cerebral abscesses.

Pennybacker's inspirational journey began with him aspiring to Ephraim McDowell. It saw him cross the Atlantic, learn medicine at Edinburgh, train in neurology at Queen Square in London and learn neurosurgery under Sir Hugh Cairns in Oxford. He navigated a successful career through World War Two and together with Cairns established the Radcliffe Infirmary in Oxford as a highly esteemed neurosurgical unit.

By increasing the operative tempo yet uncompromising the meticulousness of his operative technique, Pennybacker challenged the Halstedian and Cushing traditions. The pioneering Pennybacker system of managing cerebral abscesses stood the test of time and the ethos of pre-operative imaging, intervention and post-operative monitoring - clinically, biochemically and with imaging results remains today.

Not only did he contribute significantly to British neurosurgery and the training of both home-grown and international neurosurgeons, he was a remarkably kind-hearted and calm person. These qualities inspired many of his contemporaries and junior colleagues and we hope will continue to do so for generations to come.

Early Life

Joseph ("Joe") Pennybacker was born in Somerset, Kentucky, USA, the home of his maternal grandparents, on the 23rd August 1907. The Dutch family Pannebacker were originally from Gorkum (modern day Gorinchem), in the Netherlands and moved as war refugees to Flomborn in Lower Palatinate, Germany. Its American descendants were from Heinrich Pannebacker, who was born in Flomborn in 1674[1]. Heinrich emigrated before 1699 and helped found Germantown, Pennsylvania. In fact, he became surveyor to William Penn and laid out most of the roads in Philadelphia. He went on to found a large influential family contributing 145 men - the largest contribution in manpower of any American family - to the War of Independence [1]. Joe's second name, Buford, was derived through his maternal grandfather, John Buford Mershon, a blacksmith who Pennybacker would later recall with great admiration [1].

Joe was the only son of Claude Pennybacker, a telegrapher and later train dispatcher for Southern Railway. His paternal Pennybacker grandparents owned a hotel in King's Mountain. However, after his family had moved, aged three years old he returned to his maternal Buford grandparents' home in Somerset, up the line to Danville [1]. In Danville, the Pennybackers lived at the bottom of the hill on

Fourth Street. When Joe was 12 years old, the Pennybackers relocated to Knoxville, Tennessee, where his mother and eldest sister remained for the rest of their lives [1].

He was raised as a Presbyterian and educated at Knoxville High School, Tennessee and graduated from the University of Tennessee with a Bachelor of Arts degree in 1926 (summa cum laude)[2]. Pennybacker had early surgical aspirations, desiring to follow in the footsteps of the pioneer ovariotomist Ephraim McDowell. McDowell's monument stands in Danville, their mutual hometown and had studied in Edinburgh[3]. Money was raised for Pennybacker to realise his dream and he travelled to Edinburgh to undertake his medical studies. At this time there existed the colonial tradition of going from the American South to study medicine in Edinburgh[2]. Pennybacker spent the next four years as a poor but happy Edinburgh medical student – sometimes reading at night by an Aladdin lamp[1]. He qualified in medicine in 1930 from Edinburgh with honours (M.B.,Ch.B.) and the Allen Prize in Surgery[2].

London - early aspirations

Pennybacker spent a short period as a general practitioner before his appointment as house physician at the Edinburgh Royal Infirmary and later as house surgeon to Sir John Fraser (1930-32)[2,4]. Upon deciding to pursue a career in surgery, he was appointed Resident Surgical Officer at Grimsby and District Hospital (1932-33)[2,4]. Subsequently, he passed his FRCS in 1934 and became Resident Medical Officer at the National Hospital for Nervous Diseases, Queen Square (1933-36)[2,4]. Here he learned to talk to distinguished neurologists "in their own language", his own modest reflection of being a highly competent neurologist despite becoming a neurosurgeon[5]. This firm grounding in neurology further distinguished him from his surgical contemporaries, earning him the admiration of his fellow physicians for being such a superb clinical neurologist as well as an outstanding surgeon[3].

Pennybacker's training at Queen Square cemented his decision to pursue a career in neurosurgery and he was appointed Resident Surgical Officer at the neurosurgical department, London Hospital[4]**.** This proved to be pivotal in his career for it was here he met his future colleague and life-long friend, Sir Hugh Cairns. He was made a Fellow of the Royal College of Surgeons of England in 1934[4] and appointed First Assistant to Hugh Cairns at the London Hospital in 1935[2]**.** Cairns had returned to England following his time as Harvey Cushing's pupil at the Peter Bent Brigham Hospital in Boston in 1928[1]. Here, Cushing's department of neurosurgery was at the time widely regarded as the best training unit in the world. However, Cairns was frustrated at the resistance he faced in establishing a specialist department at the London in the tradition of Cushing[5]**.** When Cairns moved to Oxford two years later where he had been appointed the first Nuffield Professor of Surgery at the Radcliffe Infirmary, he chose Pennybacker to accompany him as his Assistant Surgeon[2]**.**

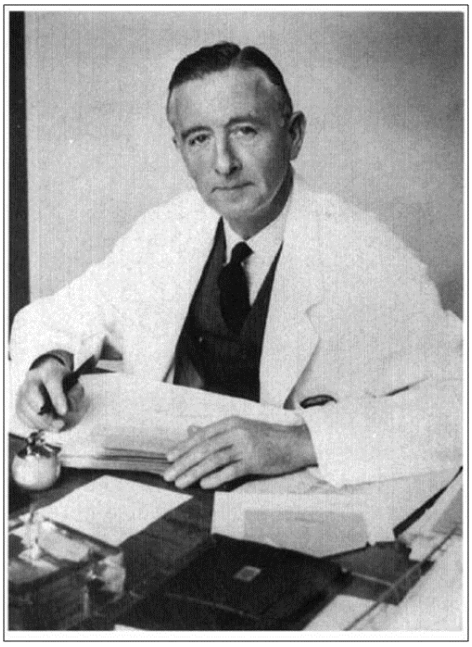


Fig1. Joseph Buford Pennybacker[i]

Wartime: Cairns & Oxford Timeline

From First Assistant to the Nuffield Professor of Surgery (1937-52), Pennybacker was made Honorary Consulting Surgeon to the War Office via the Military Hospital for Head Injuries, Oxford (1940-45)[4]. With the advent of war in 1939, Cairns and Pennybacker initially performed all operations, soon joined by other talented budding neurosurgeons [6]. As Pennybacker ultimately took over the neurosurgical service, this freed Professor Cairns to organise departmental research and his other responsibilities as consultant neurosurgeon to the army[1]**.** Despite the pressure of casualties during wartime, on-going patient study provided research opportunities and publications[6].

While Cairns spearheaded the management of head injuries and advocated the safety helmet through his seminal works, influenced by the gravity of neurotrauma presented by the war, Pennybacker's academic output focused on hydrocephalus and in particular an influential body of work on cerebral abscesses (discussed below). Examples of publications during this time include a case series on adult and paediatric Aqueduct of Sylvius stenosis[7]; subtentorial cyst formation following hydrocephalus-induced spontaneous ventricular wall rupture[8]; prophylactic penicillin in neurosurgical procedures[9]; 100 patient case series of the treatment of cerebellar abscesses[10].

With much of Cairns' time devoted to the war effort, Pennybacker took over the day-to-day running of the neurosurgical unit at the Radcliffe Infirmary [6]. He ensured with outstanding efficiency the continuity of the professorial department's neurosurgical service[11]. Nevertheless, Cairns remained closely involved and at the war's end he resumed his role as Director [6]. Pennybacker married Dr Winifred Dean in 1941 and later would settle in an old house at Hampton Poyle in the Oxfordshire countryside. This was also the year Pennybacker obtained his MD

[i] From Pereira et al. [20]. Original image kindly provided by EP

degree. His thesis on the treatment of brain abscess was awarded by the University of Edinburgh with high commendation[1]**.** In 1944, Pennybacker became Consultant Neurological Surgeon at the Radcliffe Infirmary[4].

Together, Cairns and Pennybacker established neurosurgery at the Radcliffe Infirmary and after World War II, work was shared almost equally between the two men[5]. After Cairn's death in 1952, Pennybacker became director of the new separate department of neurological surgery at the Radcliffe Infirmary, a post he held for 19 years until retirement[11]. He was made a Fellow of Wolfson College at Oxford University in 1967[4]. During his directorship, he encouraged his juniors to publish papers. He was generous in collaboration in which he provided most of the stimulus and ideas[5]. Pennybacker's diagnostic acumen became legendary and brought worldwide demand by patients for consultation and young surgeons for training.

Such international distinction was recognised by awards of honorary and corresponding membership of many neurosurgical societies abroad[1]**.** For example, the American Association of Neurological Surgeons, various Scandinavian, French, German, Spanish-Portuguese, and Czechoslovakian neurosurgical societies[4]**.** For services to many Greek patients, in 1966 he received the Cross of the Royal Order of George I. The following year saw an event of symbolic Anglo-American unity - an American bearing the names belonging to men of the War of the Independence became naturalised as a British citizen and was appointed Commander of the British Empire (C.B.E.) in recognition of his service to the nation of his adoption[1]**.**

Pennybacker retired in 1971 to a tranquil part of Argyllshire in Scotland where he indulged in his passion for gardening. He returned to the Presbyterian Church and was Clerk to the Kirk Session in Tignabruaich for several years[1]. His wife died in 1980 and he suddenly died on 27th March 1983 aged 75[2]. At a memorial service on June 11, 1983, the ancient church of St Giles in Oxford was full with those moved to give thanks for his life. The Pennybacker name lives on in two further generations of English Pennybackers through his only son[1].

Influence on British Neurosurgery

Pennybacker's notable contribution to neuroscience began in Oxford whilst collaborating with the neurophysiologist Derek Denny-Brown after Sir Charles Scott Sherrington's retirement [3]. Together they published the first electromyography study of single motor unit action potentials in patients with neurological disorders. However he was not by inclination an academic scientist. In fact, the neurosurgeon Eric Sidney Watkins recalled Pennybacker telling him that that "research was only gravy, and that the bread and butter of neurosurgery was the ward work and the operating theatre**"** [12]. This mentality did not preclude him from making a significant contribution to the advancement of neurosurgical management via practical advances, which when applied could improve clinical practice.

Other visiting neurosurgeons were impressed with his ability to operate with economy of movement, an unhurried speed and still achieve excellent results - challenging the neurosurgical dogma at the time. Neurosurgery no longer needed

the deliberately slow tempo of Cushing or Cairns to achieve good results and he recognized that time-consuming operations could be accelerated without sacrificing neatness or diligence[6] . Such a philosophy was an eye opener to visitors still committed to the slow rituals of the Cushing tradition[3]. Pennybacker, without sacrificing his traditional neatness, gentleness and attention to detail, enabled more patients to be treated[11].

However, perhaps his greatest contribution was in the management of cerebral abscess, the theme of his MD thesis. Following Fleming's discovery of Penicillin in 1929, from 1938, the antibiotic was studied and purified in Oxford by a team led by Howard Florey, an Australian expatriate like Cairns. Here, Pennybacker treated the first patient with brain abscess to be cured with the help of penicillin.

A Historic Case

Pennybacker reported his first and historic case at length in 1951 of a 49 year old man admitted with confusion and an empyema of the left frontal sinus[13]. The anterior wall of the sinus was removed and the abscess drained. The patient deteriorated, developing aphasia and a dense right hemiplegia. A week post-admission, bifrontal burr hole drainage of a cerebral abscess was performed, aspirating 30-35 ml of pus, which grew pneumococci. Thorotrast was instilled into the cavity for radiographic monitoring in the form of a "pyogram" (See Fig 2.). The patient deteriorated despite two further aspirations and two weeks post-admission, Pennybacker injected 2500 units into the cavity, repeated six times over three weeks. Serial cultures of aspirated pus became sterile and the patient's condition improved.

The patient happened to be readmitted a few days later with incontinence, a seizure and recurring hemiparesis. Pennybacker explored the left frontal lobe via a craniotomy and excised a trilocular abscess with a dural attachment posterior to the frontal sinus, explaining the relapse. Pennybacker is noted to have seen the patient daily and several times a day, employing his astute neurological skills to evaluate the response to treatment immediately[14]. This historic case highlighted the value of penicillin but the role of excision in the definitive cure of particularly mutli-loculated cerebral abscess.

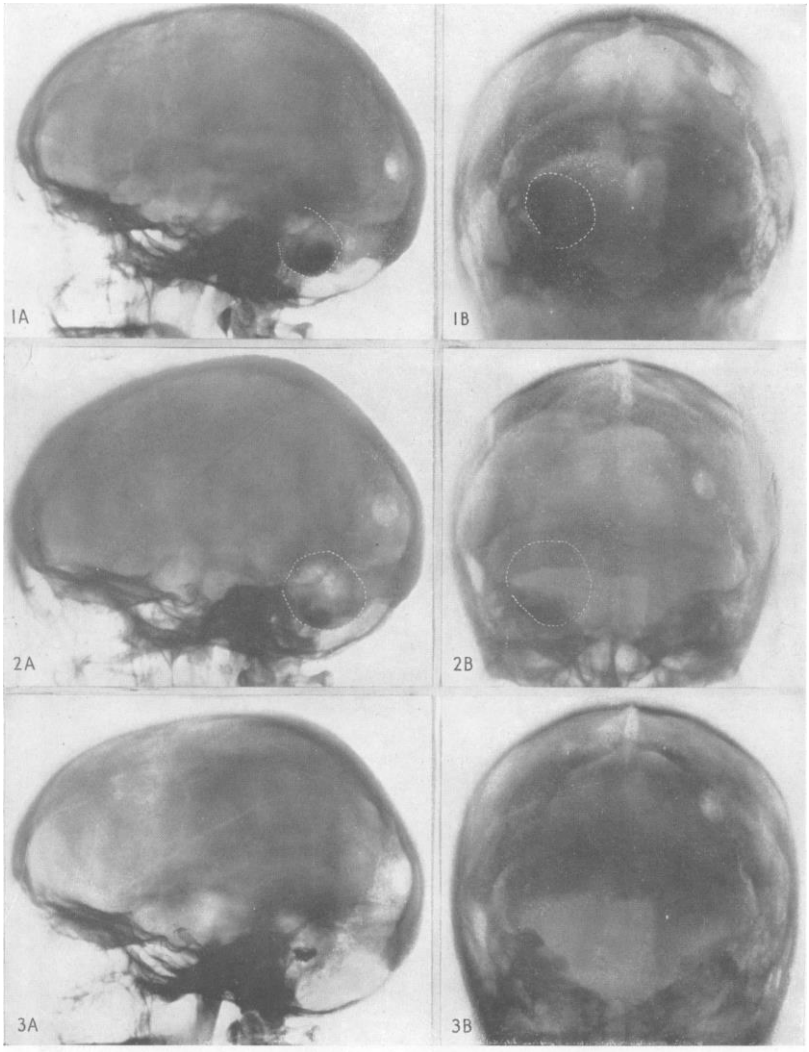
The Pennybacker System of Cerebral Abscess Management

In London, Pennybacker had witnessed the failure of cerebral abscess management, which comprised drainage by indwelling tubes and open drainage known as marsupialization. He evolved his strategy in Oxford to combine antibiotics with surgery. With increased availability of penicillin from 1944, his abscess mortality fell from 46% to 29% [14].

This was undoubtedly compounded by improvements in pre-operative imaging; percutaneous angiography confirmed the diagnosis of supratentorial abscess while ventriculography defined cerebellar abscesses[14]. Pennybacker preferred burr hole aspiration for intracranial abscesses secondary to chronic otitis media with close collaboration with otologists. This contrasted with Sir William Macewen's direct aspiration through a mastoidectomy. In his series, Pennybacker

notes that for cerebellar abscesses, he preferred to approach the abscess through a clean field, commenting that "…more often than not it [the alternative approach] will be ineffective, and if a temporary improvement does occur, it is usually at the expense of the formation of a fungus which adds considerably to the difficulties and dangers of dealing with the residual abscess..." [10].

Fig 2. Historic use of post-operative pyograms in intracranial abscess [10]



1 A+B: Initial post-operative pyogram
2 A+B: Pyogram at 5 days showing increase in size of abscess
3 A+B: Pyograms at 3 months post-operatively showing small thorotrast-encrusted mass adherent to posterior surface of petrous bone

Furthermore, the analysis of pus permitted a microbiological diagnosis along with the advantage of a therapeutic decrease in intracranial pressure (ICP). When ICP remained elevated, a craniotomy or cerebellar decompression was performed[14]. A small dose of penicillin (the effects on cerebrospinal fluid (CSF) were known) was usually injected into the abscess cavity on first and subsequent aspirations; higher doses used when there was a well-established capsule. This was followed up by systemic penicillin and oral sulphonamides. Post-operative pyograms monitored response to treatment and the abscess was excised in most cases[14]. He primarily used sulfadiazine but was aware of penicillin-resistant organisms such as Proteus which were sensitive to streptomycin and other antibiotics[9].

Pennybacker uniquely oversaw a comparative study of different surgical strategies for cerebral abscess. A follow-up study of 295 patients with cerebral abscess compared treatments in Oxford, Edinburgh and Manchester over 25 years, followed up for at least a year[9]. At the time, Oxford favoured excision with preliminary aspiration, sometimes performing decompressive craniotomy or craniectomy. Edinburgh preferred continuous drainage and Manchester varied its practice. A controlled comparison was not possible due to aspiration results biased by inclusion of patients *in extremis*, treated by aspiration alone [14].

TABLE 1: Pennybacker's comparison study [9]

Treatment modality	Patients (n)	Died (n)	Mortality (%)
Aspiration (with or without decompression)	95	58	**61**
Drainage (by tubes or marsupialization)	89	45	**50**
Excision (with or without aspiration and/or decompression)	111	15	**13**
Total	295	118	**40**

Pennybacker also collaborated with thoracic surgeon, Holmes Sellors, on metastatic abscesses from the chest[15]. They reported that combined treatment with penicillin and a sulphonamide rendered it possible to excise the cerebral abscess and thereafter to treat the chest lesion successfully.

Pennybacker was concerned with post-operative disability and 47% of patients in his multicentre study exhibited post-operative seizures. He prescribed routine prophylactic anti-epileptics, usually phenobarbitone[14]. He also paid close attention to motor and visual impairments in survivors. Consequently, Pennybacker warned against radical excision of the abscess along with the inflammatory and oedematous white matter. Although, he acknowledged its potential life-saving value, he recognised the potential for neurological compromise and advocated careful dissection close to an encapsulated abscess[14].

His final paper on cerebral abscess management in 1961 dealt with otogenic abscess[16]. Since 1950, mortality had fallen from 36% (18 in 50) to 5.7% (2 in 35). Thus he was less insistent in total excision of all abscesses. Pennybacker realised that improving appearances on serial pyograms, CSF results and air encephalography indicated a likely cure.

Beyond his work on cerebral abscesses, Pennybacker was also one of the first doctors in the UK to recognise Harvard neurosurgeons William Mixter and Joseph Barr's studies on lumbar disc protrusions as the cause of sciatica[17]. This enabled him to challenge the diagnosis of 'sciatic neuritis', the attributed cause of sciatica by the physicians at Queen Square[3].

Contribution To The Wider Neurosurgical Community

Pennybacker made a significant contribution to the Society of British Neurological Surgeons (SBNS) and its international relations. The SBNS was the

first neurosurgical society of its kind to be established in Europe in 1926, with Sir Charles Balance as its first president[18]. Pennybacker succeeded Douglas Northfield in 1960 as secretary and was replaced by Jack Small as treasurer[1]. As secretary and treasurer, he guided and influenced its development and policies over many years[5].

The SBNS was keen to engage with the European community early on as Pennybacker recalled in his Cairns memorial lecture[19]**,**

"…It has been the intention of the founders that one of two yearly meetings should be held abroad…the original intention of our foreign meetings was to become acquainted with our continental colleagues to see how they did things to develop friendships and I suppose to spread our own brand of the gospel"…

Pennybacker extended this sentiment and became a key founding member of the European Association of Neurosurgical Societies (EANS). In fact, one of the few references of the first meeting of the EANS in Paris, 1967 is a letter Pennybacker wrote in 1978 [18]:

"…My part in the foundation of EANS was very modest. I think it was common knowledge at the time that the British were not enthusiastic about it and some with a wry smile felt that the organisers had pulled a fast one in making Johnson the first president as with this honour, the British could hardly refrain from participation. This was probably an unworthy interpretation…Be that as it may, we did come in, as I remember with some discreet encouragement from Sixto Abrader and Hugo Krayenbühl. As secretary of the British society, I was asked to go to a meeting in Paris to consider, among other things, the constitution. You have probably got the date of this; it was sometime before the Prague meeting, and apart from myself there were Marcel David, Kristiansen, Sixto Abrader and I think one other. I remember that we spent some time arguing about what the name of the association should be before we got down to a discussion of the constitution. After a general expression of views, I was asked to withdraw, with Abrader and Kristiansen to prepare a draft, each of us being fairly fluent in English. This we did over a couple of hours and I remember being rather dissatisfied with it as a rushed job which could have been improved if we had spent longer at it. Nevertheless it was accepted and I think that arrangement was that it would be considered by individual societies for comment and/or amendment before submission to the Association at its next meeting…"

Pennybacker retired from his secretary role from the SBNS in 1969 and tribute was paid to his long service[1]. He valued the SBNS highly and provided help and encouragement to its younger members[11]. In 1972, the SBNS commissioned a portrait of Pennybacker on his retirement to recognise his outstanding services to the Society and regret at his decline of the Presidency[1]. Although the reasons for this are unclear. Perhaps it was due to his intrinsically modest nature and believing his strengths lay in the administrative duties for the society and achieving fulfilment serving in this way. The following year, the Cairns memorial prize was established following a Pennybacker' suggestion that Cairns lecture he had been invited to give could be suspended in favour of a prize to encourage young neurosurgeons. George Brocklehurst won, delivering an abstract of his essay on

the foramen of Magendie[1]. In 1975, the Cairns lecture and prize was re-instated and the SBNS persuaded Pennybacker to return from retirement to deliver it. This was to be the 7th in the series on the 50th anniversary of the society and Pennybacker recalled his earliest memories of the Society, it's members and his days with Cairns at the London Hospital[1]. It was apparent he had played a leading part almost from the beginning despite turning down leadership of the SBNS[5].

Pennybacker, The Man

The complimentary remarks of many are testament to the man Pennybacker was. As a child while living in Danville on Fourth Street, a contemporary Dr George McClure Jr. recalled Pennybacker as his best friend and:

"One of the brightest boys I've ever known…brilliant…tall and handsome…courteous and graceful manners…as modest as could be…his mother had the greatest influence on us. She corrected our grammar and manners in a nice pleasant way" [1]**.**

Eric Sidney Watkins recalled meeting Pennybacker at the Blossoms Hotel in Chester, being the only neurosurgeon to seriously consider offering him a senior house officer job after the war,

"He arrived in the hotel, tall, handsome and clad in a long trench coat with a fur collar - a real film star. I carried his luggage into his bedroom from his car after which we had tea and he offered me the neurosurgery job to start on January 1st 1958. I was so astonished to be offered a job by this great man. I asked 'Mr Pennybacker, do you really think you could make me a neurosurgeon?' to which he replied "Watkins I could make a neurosurgeon out of a monkey in 18 months"[12]**.**

A recent former mentor of mine, Professor Harold Ellis, who trained under Pennybacker recalls him with much admiration:

"I was very impressed by Joe Pennybacker – I think the first American I had met. He was a tall, handsome man, who spoke with a slow Southern drawl. He had an amazing recall of his patients. On the rounds he would remind Cairns of a case they had seen at Queen Square and would give the clinical details in great depth. JP fascinated me also by using the first Dictaphone I had ever seen on which he would record the patients' discharge summaries.

Time spent in theatre was tedious with Cairns and [Walpole] Lewin operating – it seemed to us deliberately slow in Cushing's technique. However, Joe Pennybacker we realised was a brilliant technician; to see him remove a prolapsed disc was a joy – speedy bloodless and effortless."

Although Pennybacker embodied Christian virtues, he was not a religious man. He was raised as a Presbyterian and reacted later against church going in his youth. He remembered with distaste the exploration of religious feeling he had witnessed in the American South. He was constantly devoted to his wife and her welfare was of concern during retirement[1].

Relationship with Sir Hugh Cairns

Pennybacker has been described as the complement and balance to Hugh Cairns[19]. He has been previously acknowledged to be the better operator of the two, and at least as good a diagnostician, but there was no division of loyalties since both were essential to the team[19]. Despite operating with characteristic speed, Cairns' confidence in his pupil was complete and he appeared to either suppress his anxiety or was unwilling to believe that there was any serious departure from his teachings[1].

The extent of Cairns' contribution to Pennybacker's pioneering treatment of brain abscesses with penicillin is uncertain. J.M. Potter who knew both men remarks that Cairns would have been "looming around and eager to exploit what Florey was doing". Undoubtedly they shared a warm relationship and no support for Potter's suggestion has been found in the literature[14].

Working for Pennybacker

Pennybacker was said to have never a lost a day's work through illness, always available to his patients, colleagues and pupils. He is described as a private but kind and generous man, utterly without guile and malice[11]. In Oxford, he was fondly known as JP and as Peter Schurr recalls, "Pennybacker was almost never ruffled, the calm and helpful kindness of his southern American voice being an often welcome reassurance in moments of crisis"[19]. He is described as almost never rebuking anyone, as it was possible to sense his displeasure without words. His friendly arm on one's shoulder and "Well doctor, how are things going?" was itself seen as a reward and motivation[5]. His American upbringing had also instilled a strong sense of duty of a good citizen - to take on any task that he was asked to do, not for his own advancement but for the public good. He was passionate in his support for the NHS; although entitled to and accumulating significant private practice, he accommodated this within the hospital to fulfil his NHS duties[1].

His burdensome administrative and committee work for the SBNS was handled with his usual conscientiousness, efficiency and cheerfulness. It is perhaps these strengths that made the SBNS wish for his presidency[11]; also his written work was of an exceptional elegance, reflecting his extensive reading on all subjects[1]. Furthermore, his academic interjections at the SBNS meetings and RSM Neurology Section meetings were always sound and concise, reflecting his concerns with common issues surrounding neurosurgical practice at the time[1].

Conclusions

Pennybacker's inspirational journey began him aspiring to Ephraim McDowell. It saw him cross the Atlantic, learn medicine at Edinburgh, train in neurology at Queen Square in London and learn neurosurgery under Sir Hugh Cairns in Oxford. He navigated a successful career through World War Two and together with Cairns established the Radcliffe Infirmary as a highly esteemed neurosurgical unit. By increasing the operative tempo yet uncompromising the meticulousness of his surgical technique, Pennybacker challenged the Halstedian and Cushing traditions. The pioneering Pennybacker system of managing cerebral

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Not only did he contribute significantly to British neurosurgery and the training of many home-grown and international neurosurgeons, he was a remarkably kind-hearted and calm person. These qualities inspired many of his contemporaries and junior colleagues and I hope will continue to do so for generations to come.

Acknowledgements
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