ELECTIVE (SSC5c) REPORT (1200 words)

A report that addresses the above four objectives should be written below. Your Elective supervisor will assess this.

Objective 1: What is the epidemiology of paediatric head injury in New Zealand? How does it differ in incidence from the UK, and the global average?

Head injury is the leading cause of death and disability in the paediatric population [1]. The reported incidence of infantile subdural haematoma in New Zealand is 14 per 100 000 [2] which is comparable to the UK (reported incidence of 12.54 per 100 000 [3]).

Of significance - legal and societal - is the epidemiology of paediatric non-accidental head injury in New Zealand. UNICEF reported [4] an incidence of 1.3 per 100 000 in deaths from child abuse in this country, which is approximately six times higher than the OECD average. Besides, the annual incidence of fatal head injuries secondary to child abuse in Auckland has increased from 0.1 per 100 000 in 1991 to 0.4 per 100 000 in 2010 [2], with younger children bearing the brunt of the abuse.

John et al [2] showed that the commonest mechanisms of injury in these cases from New Zealand included falls or had no history of trauma; of note is the height of reported falls. Falls of less than 1 m in fatal head injuries were due to non-accidental injury, especially in non-ambulatory children. Injury patterns included skull fractures, subdural haemorrhage (commonly in under 2 years of age), and diffuse axonal injury (commonly in older children). Furthermore, retinal haemorrhage in children, although common after birth, was shown to be a significant indicator of non-accidental injury in cases from New Zealand [5]. It is also noteworthy that a higher incidence of inflicted head injury was seen in the Maori population compared to the New Zealand European population [2]. Although limited research is available on the factors underlying this incongruity, three broad explanatory frameworks [6] have been described: (1) the higher rates of poverty and disadvantage in the Maori population, with social deprivation strongly linked to child abuse; (2) higher degree of familial adversity in Maori families; and

(3) lesser identification with a traditional Maori cultural identity as a risk factor with strength in a Maori identity shown to be protective.

Data from the UK on paediatric head injuries is limited. In one study from Staffordshire, almost one in ten children aged 1 or younger admitted due to traumatic brain injury were subject to non-accidental injury [7].

1. Ponsky TA et al. Analysis of head injury admission trends in an urban American pediatric trauma center. J Trauma. 2005 Dec;59(6):1292-7.
2. John SM et al. Fatal pediatric head injuries: a 20-year review of cases through the Auckland coroner's office. Am J Forensic Med Pathol. 2013 Sep;34(3):277-82.
3. Hobbs C et al. Subdural haematoma and effusion in infancy: an epidemiological study. Arch Dis Child. 2005 Sep;90(9):952-5.
4. UNICEF. 'A league table of child maltreatment deaths in rich nations', Innocenti Report Card No.5, September 2003. UNICEF Innocenti Research Centre, Florence.
5. John SM et al. Patterns of structural head injury in children younger than 3 years: a ten-year review of 519 patients. J Trauma Acute Care Surg. 2013 Jan;74(1):276-81.
6. Marie D et al. Ethnic Identity and Exposure to Maltreatment in Childhood: Evidence from a New Zealand Birth Cohort. Social Policy Journal of New Zealand. 2009 Aug; 36.
7. Hawley CA et al. Prevalence of traumatic brain injury amongst children admitted to hospital in one health district: a population-based study. Injury. 2003 May;34(4):256-60.

Objective 2: How are paediatric neurosurgical services delivered in New Zealand? What are the referral patterns for Starship Children's Hospital, with respect to caseload and referring regions? How does this differ from the UK?

Starship Children's Hospital is the national tertiary referral centre for paediatric neurosurgical services and the only one of its kind in New Zealand. With 200 beds, Starship treats around 100 000 children a year. Starship also has the nation's only dedicated paediatric intensive care unit (PICU) team which includes a specialised retrieval team. The Starship PICU retrieval service, operating since 1992, perform

300 missions per year with a major focus on Auckland and North Island and utilises helicopters, fixed wing aircraft, and ambulances. Otherwise, cases are referred by GPs, similar to the UK. Neurosurgical services, therefore, are accessible for children across North Island - home to 76% of New Zealand's population of 4.5 million (Census 2014).

In contrast, for a population of 64.1 million, the United Kingdom is home to 7 dedicated paediatric neurosurgical units at children's hospitals across the country, with Great Ormond Street Hospital for Children (GOSH) the largest and most famous of these. GOSH has 387 beds and treats around 240 000 children a year. There is, however, no such PICU retrieval team in the UK compared to Starship. Due to the remote locations attended to by the Starship retrieval team as well as the availability of only one paediatric neurosurgical centre in Auckland, there is great need for such a mobile retrieval service. The UK's 7 dedicated paediatric neurosurgical units, however, are located in major cities and accessible to the majority of the surrounding population.

Objective 3: To understand the management of common paediatric neurosurgical diseases in a specialist centre.

It was a great privilege to have spent 6 weeks with the paediatric neurosurgeons at Starship Children's Hospital. I had limited exposure to this subspecialty prior to my elective as neurosurgical services are extremely centralised at specialist centres in the UK, for example GOSH in London. Due to GOSH covering all of London, the other neurosurgical units in the city, including The Royal London Hospital, see minimal or no paediatric work. However, Starship's pre-eminent role in New Zealand as a tertiary referral centre for paediatric neurosurgery ensured that I was exposed to a wide variety of pathologies.

Some of the commonest diseases I saw were paediatric brain tumours. In children, these are commonly located infratentorially and they present with features of cerebellar or brainstem dysfunction, or in

extremis due to obstructive hydrocephalus. Surgical resection offered the best hope of survival in the majority of these cases and I was able to appreciate the different approaches to the posterior fossa. The proximity of crucial brainstem structures, vessels, cranial nerves, and the cerebellum ensures that a posterior fossa decompression is not for the faint-hearted! Interestingly, patients who underwent posterior fossa surgery developed posterior fossa syndrome or cerebellar mutism. Of unknown pathophysiology, the syndrome entails post-operative mutism as well as a range of neuropsychological features but resolves spontaneously (and unpredictably!). Two particular cases left an impression on me: the first case was of a 2 year old boy with an extensive posterior fossa tumour which appeared to invade the cervical spine. Nearly all of the tumour was resected but there was a significant risk of on-table death due to the massive tumour load and blood loss. Post-operatively, this previously active boy developed posterior fossa syndrome and a right facial nerve palsy. It was humbling to realise this unforgiving nature of neurosurgery. The other case that stands out is one where there was no neurosurgical intervention offered: an unwell infant was transferred to Starship for management of his obstructive hydrocephalus and further evaluation of a suspicious posterior fossa lesion. An EVD was inserted and plans were made to resect the lesion on the following available list while more detailed imaging was requested. The imaging, however, showed extensive metastatic disease with the tumour invading the skull base into the pharynx. Overnight, he developed suspicious skin lesions which appeared to be growing by the hour. Plans for resection were shelved. Despite world-class facilities at a specialist children's hospital, it was clear that there was little that could be done to save this child's life; an extremely sad reminder of our limits as doctors.

As mentioned previously, New Zealand has high rates of non-accidental injury and there were two particular cases which illustrated this sad statistic. I met little JF, an unusually quite baby, on my first ward round at Starship. JF was admitted after suffering a cardiac arrest and further investigations suggested shaken baby syndrome. Post-resuscitation, JF had extensive damage to his hemispheres and showed little activity. I was again involved in JF's care when I assisted with his VP shunt. JF faces a life of

profound neurocognitive disability, if at all he survives to adulthood. The other case that struck me was a similar story: a baby boy admitted to PICU after several arrests with evidence of generalised bruising, notably linear rod-like marks on his back. Although no neurosurgical intervention was required, his medical issues were of significant concern and the poor child passed away a few days later. A brutal end to a short and painful life.

Finally, I observed a highly specialised neurosurgical procedure – EDAS - used to treat Moyamoya disease, an extremely rare condition. EDAS is an alternative to the STA-MCA bypass preferred in other centres and in older children. It involves placing the superficial temporal artery onto the cortical surface to allow collateral vasculature to develop. I had not previously been aware of EDAS as a therapeutic option in Moyamoya disease and the procedure and associated case discussions were of excellent educational value.

Objective 4: To demonstrate commitment to neurosurgery through an intensive experience of neurosurgical procedures with the possibility of undertaking research, as required by the neurosurgery training programme directors in the United Kingdom.

I was able to fulfil both parts of this objective i.e. to gain operative experience as well as undertake research to ensure that my CV is competitive.

My daily routine at Starship consisted of attending the paediatric ward round at 7.30am before spending the rest of the day in theatres. Two theatres were dedicated for neurosurgery while paediatric patients were usually operated on twice a week. I attended both adult and paediatric lists to maximise my experience.

In the UK, super-specialisation in neurosurgery is common so most consultants will have a specific interest – tumours, for example – which mean that for students shadowing particular consultants, their

exposure will be limited to a particular subspecialty. Moreover, interventional radiology is a major specialty in the UK with a focus on coiling cerebral aneurysms. The majority of aneurysms will go straight to the radiology suite in the UK. In New Zealand, neurosurgeons maintain a broader interest and, therefore, a variety of procedures may be observed by shadowing one consultant. Surgical clipping is still a favoured option for cerebral aneurysms, especially in younger patients. Therefore, I was exposed to a vast array of cranial procedures, some of which I had never seen before. Having observed spinal and trauma cases at The Royal London Hospital, the cranial cases at Auckland complemented my prior experience. Particular highlights include all the aneurysm procedures as I had never seen clipping previously; the anatomy demonstrated in each of the cases was extremely educational. Also, craniofacial procedures to treat craniosynostosis were also a first; watching the forehead being fractured and the orbital rim advanced was simply amazing while the post-operative results were astonishing. I was also allowed to perform my first burr hole on a paediatric patient while I also learnt how to approximate the galea with sub-galeal sutures, both of which were very rewarding.

I was also fortunate to be involved in research on my elective. Under the supervision of Mr Heppner, I submitted two case reports for consideration to the SBNS and EANS Conferences later this year, with a view to writing these up for publication. I was also interested in the management of neonatal intraventricular haemorrhage and post-haemorrhagic hydrocephalus at this centre and have completed data collection and analysis, and hope to submit this to a related Conference as well as potentially writing it up for publication.

Acknowledgments

My sincere thanks to Mr Peter Heppner, who was an excellent supervisor; he was friendly, keen on teaching (and taught well!) and getting us involved in theatre while encouraging us to visit the best of New Zealand! He always had time for us regardless of the time of day or our endless questions while he went above and beyond to help us with the case reports.

I would also like to thank the registrars who have all been friendly and keen on getting me involved in theatre as well. My thanks especially to Vanessa, who was full of incredibly useful advice on anything neurosurgery-related as well as how to survive as a house officer (much needed advice!). John, Shinuo, and Bobby have been very friendly and regularly invited me to scrub in theatre. Steph and Lisa were helpful on the ward and allowed me to get involved with ward work as well as going to theatre.

I am extremely grateful to all the staff in the Neurosurgery Department at Starship and Auckland City Hospital for making my 6 weeks here an unforgettable experience.