

## Paediatric spina bifida inpatient treatment at Wellington Regional Hospital: a cost analysis of sequential patients

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### Abstract

**Aims** To sample and analyse the number, type, length of stay and costs of admissions for children with spina bifida, and to review operations requiring general anaesthesia and radiological investigations of patients undergoing surgical management for spina bifida.

**Methods** Six sequential adolescents with spina bifida managed through the paediatric surgical services at Wellington Regional Hospital (Wellington, New Zealand) from November 2008 to November 2009 were sampled for retrospective analysis. One neonatal case was also chosen. All hard copy notes, radiology packets, electronic notes and radiological studies were requested and reviewed for these seven patients covering all lifetime admissions. Inpatient length of stay and operation costs were also analysed.

**Results** Six adolescent patients (10–21 years) had undergone a total of 124 operations requiring general anaesthesia—average 20.67 (19–28). There were 125 admissions in total for this group—average 20.83 (14–34) with an average length of stay of 8.53 days per admission and an average cumulative length of stay of 177.67 days. As a group, the adolescents had spent 1066 days as inpatients. Adolescents received an average of 75.33 (36–164) radiological procedures, including an average of 7.5 CT scans (4–13). The neonate had 10 operations, four admissions, 67 radiological investigations and a total length of stay of 194 days. The average cumulative cost per adolescent was NZ\$944,000 (\$472,000–\$1,202,000) with a total cost of NZ\$5,664,000. The cost for the neonate was NZ\$678,340.

**Conclusions** This study found inpatient costs for paediatric spina bifida patients were significantly higher than the only previous estimate carried out in New Zealand. This study also shows the burden on patients and their families/whānau in the high numbers of admissions, major operations, long periods spent as inpatients and the high number of radiological investigations.

In this study, conducted at Wellington Regional Hospital (Wellington, New Zealand), we aimed to sample and analyse the number, type, length of stay and costs of admissions for children with spina bifida.

### Methods

To obtain the most representative sample possible of the patient base, it was decided to choose six sequential contacts with the paediatric surgical service at Wellington Regional Hospital from November 2008 to 2009 (admissions and outpatient visits). Ethics approval was obtained. Hard copy notes and radiology were reviewed, as well as electronic, notes and radiological procedures.

Admissions, length of stay, radiological procedures and, frequency, nature and durations of surgical operations were calculated. An operation was defined as a procedure requiring general anaesthesia

(GA). Therefore, MRI or CT scans requiring GA were included in the operations tally. Sample size was restricted to 7 patients because of the enormous time resource required to analyse large volumes of records.

Costings (inpatient only) were analysed. These were calculated by average daily inpatient cost multiplied by length of stay. Operative costs calculated by theatre utilization time and disposables cost per procedure.

## Results

The numbers of operations requiring GA on each adolescent are summarised in Table 1, showing an average of 20.67 operations (17–28) and a total of 124.

**Table 1. Number of operations on adolescent patients**

Adolescent	Number of operations (requiring general anaesthesia)
1	25
2	28 (+1c)
3	17
4	18
5	17
6	19
<b>Total</b>	<b>124</b>
<b>Average</b>	<b>20.67</b>

Note: +1c refers to one cancelled operation, which was not included in the final tally.

**Table 2. Neonatal operations**

Neonate	Number of operations (requiring general anaesthesia)
1	10

Table 3 summarises the admissions and total lengths of stay as hospital inpatients. As a group, the six adolescents in this study had cumulatively spent 1066 days in hospital as inpatients, averaging 177.67 days (75–272). There had been a total of 125 individual admissions to Wellington Regional Hospital, with an average of 20.83 (14–34). The average length of stay per admission was 8.53 days (5.36–12.36).

**Table 3. Adolescent admissions and lengths of stay (LOS)**

Adolescent	Number of admissions	Cumulative LOS (d)	LOS per admission (d)
1	34	252	7.41
2	23	155	6.74
3	14	75	5.36
4	15	184	12.27
5	22	272	12.36
6	17	128	7.53
<b>Total</b>	<b>125</b>	<b>1066</b>	
<b>Average</b>	<b>20.83</b>	<b>177.67</b>	<b>8.53</b>

Admission details for the neonate are shown in Table 4. There were four admissions overall, with a total length of stay of 194 days. It is important to highlight that this is longer than the average length of stay for the adolescent patients reviewed.

Table 5 and 6 summarise the radiological procedures undergone by the patients in our study. The most important findings are the high number of procedures with radiation exposure. Adolescent patients had had on average 55.67 X-rays (23–141), 7.5 CT scans (4–13) and four nuclear medicine investigations (0–9). The neonate had had 34 X-rays, but no CT or nuclear medicine investigations.

**Table 4. Neonatal admissions and length of stay (LOS)**

Neonate	Admissions	NICU (d)	HDU (d)	Total LOS	LOS per admission
1	4	5	21	194	48.5

**Table 5. Adolescent radiological procedures**

Patient	X-ray	USS	CT	MRI	Nuclear med	Total
1	141	10	9	1	2	164
2	20	5	5	3	3	36
3	46	0	13	4	2	65
4	38	1	4	3	0	46
5	66	7	5	6	9	93
6	23	8	9	0	8	48
<b>Total</b>	<b>334</b>	<b>31</b>	<b>45</b>	<b>17</b>	<b>24</b>	<b>452</b>
<b>Average</b>	<b>55.67</b>	<b>5.17</b>	<b>7.5</b>	<b>2.83</b>	<b>4</b>	<b>75.33</b>

**Table 6. Neonatal radiological procedures**

Neonate	X-ray	USS	MRI	Total radiology
1	34	23	3	67

**Table 7. Adolescent costing**

Adolescent	Total cost (\$NZ)
1	1,202,000
2	902,000
3	472,000
4	956,000
5	1,070,000
6	1,062,000
<b>Total</b>	<b>5,664,000</b>
<b>Average</b>	<b>944,000</b>

**Table 8. Neonatal costing**

Neonate	Total cost (\$NZ)
1	678,340

Tables 7 and 8 show the cumulative costs of adolescent and neonatal inpatient treatment inpatient at Wellington Regional Hospital. The average cost of adolescent treatment—including operative costs and inpatient stay—was NZ\$944,000 (\$472,000–\$1,202,000). Costs for the neonate amounted to NZ\$678,340.

## Discussion

This is a pilot study, carried out in one New Zealand paediatric tertiary surgical centre.

The results demonstrate the enormous morbidity faced by these children and their families. Six of the seven patients are paraplegic. Children can expect to spend almost half a year in hospital by the time of their late adolescent years. Almost all will (in addition to initial spinal cord closure) require repeated neurosurgical procedures for shunts as well as major bladder, bowel and orthopaedic spine surgery. These procedures prevent deterioration of disability levels rather than restoring normal function.

The vast majority of admissions were for surgical reasons and intensive, skilled nursing is required.

It is to be noted we did not analyse costs outside the Wellington paediatric inpatient service. Four patients came from provincial towns but admissions to their local hospitals were not included.

The costings in this study are likely to significantly underestimate the true costs of treating inpatient paediatric spina bifida patients for this and other reasons. The study was conservative in its estimates in order to avoid 'double dipping'. Although during the data collection all laboratory investigations were accounted for, the costs for some were not calculated, rather they were seen to be included in the costs for a day of stay.

Secondly the inpatient ward costs for these children would be at the higher end of a range but average inpatient case mix costs were used.

There were many costs that were outside of our scope, for which we did not gather data. These include costs incurred to peripheral hospitals, as well as costs associated with prenatal and obstetric care, district nursing, social work, special education, transport, wheelchairs and mobility aids, orthotics, physiotherapy, occupational therapy and outpatient consultations. Social costs to the family such as loss of parental employment were also not calculated.

All children with spina bifida undergoing surgery are treated with full latex-free theatre precautions which lengthens theatre times considerably.

Overall, therefore, our measured costs despite being considerable represent the tip of an iceberg.

Even with this highly conservative estimate, the cost analysis still showed that paediatric spina bifida inpatient management is significantly more expensive than the only previous New Zealand estimate.

In an unpublished study that has been quoted in reports by the Food Standards Australia New Zealand (FSANZ),<sup>1</sup> Singh & Elliot indicated that the cost of patient care for spina bifida in New Zealand up to the age of 20 was NZ\$355,060. A US study, similarly quoted by FSANZ,<sup>1</sup> estimated that the direct and indirect costs of treating patients with spina bifida over their lifetime was NZ\$565,000. Our series shows that the average cost to date for an adolescent (inpatient care alone) under 21 is \$944,000. This is far higher than previously thought.

The neonatal case reviewed demonstrates the high cost and morbidity of management that may occur during the neonatal period (NZ\$678,340). Of this care, the earned case weight to the unit was NZ\$245,000, which creates a shortfall of \$433,340 for one patient.

It is not the aim of this study to portray these patients as simply economic costs, and our data also gives an indication of the disruption to these patient's lives through the high number of admissions, and the long cumulative lengths of stay in hospital. It is simply not possible to quantify the distress to the child and family, nor the loss of opportunity as a result of spina bifida-associated disability. Our inability to cost this dimension does not indicate that we discount its importance.

A qualitative study of faecal incontinence in children with disability including those with spina bifida demonstrates the dismal quality of life many of these children face when limited access to a benchmarked tertiary services is available.<sup>2</sup>

Two other aspects of these patients' care require further discussion: the high radiation exposure and the number of ventriculoperitoneal shunt revisions undergone by patients.

Our data showed that adolescent patients had had on average 55.67 X-rays (23–141), 7.5 CT scans (4–13) and 4 nuclear medicine investigations (0–9). It is known that CT scans are associated with an increased cancer risk. A 2007 US review states that there is an estimated 1 fatal cancer per 1000 paediatric CT scans, which leads to 500 deaths a year in the US.<sup>3</sup>

Six of the seven patients have undergone bladder augmentation surgery which requires lifelong cystoscopic urological screening to monitor cancer risk.<sup>4</sup>

Recent research has suggested all neurogenic bladders have an increased risk of malignancy in these children even if not augmented.<sup>5</sup>

Hydrocephalus is often associated with spina bifida, and of our seven patients, four required VP shunts initially. Due to infection, these four patients required on average 3.75 VP shunt surgical revisions (range 1–6). This is concerning due to the recognised negative cognitive outcomes associated with multiple shunt revisions. A study found mean IQ has shown to decrease with increasing shunt revisions.<sup>6</sup>

A mean IQ of 86 was found in patients who had had one or no VP shunt revisions, while for those who had had over five, the mean IQ was 77. This was statistically significant.<sup>6</sup> Given the need for shunts is life-long further revisions are likely.

This review encountered particularly difficulty in accessing files across several DHBs with some records lost and the data from patient interviews suggests the multiple DHB model has not worked well for the care of these disabled children. Many have for social reasons been domiciled in several DHBs.

This study gives a conservative analysis of the high costs of inpatient paediatric spina bifida surgical management in one New Zealand paediatric surgical service. The enormous morbidity that these children suffer and high cost to paediatric services with poor resources emphasises the importance prevention if at all possible. The review only looked at care in the first 21 years of life.

Given the estimate of the overall cost of managing neural tube abnormalities per year in NZ (39 million dollars/yr)<sup>1</sup> the authors believe these results provide evidence to the benefits that could be achieved in the health sector by preventative measures.

One example is the mandatory supplementation of folate in bread. This has been estimated to prevent 4 to 14 live births of children with neural tube defects in NZ every year.<sup>1</sup>

**Competing interests:** None declared.

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