Full title: Family satisfaction following spinal fusion in Rett syndrome

Short title: Spinal fusion in Rett syndrome

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Abstract

Purpose: We evaluated family satisfaction following spinal fusion in girls with Rett syndrome.

Methods: Families participating in the population-based and longitudinal Australian Rett Syndrome Database whose daughter had undergone spinal fusion provided data on satisfaction overall, care processes and expected changes in health and function. Content analysis of responses to open-ended questions was conducted.

Results: Families reported high levels of overall satisfaction and consistently high ratings in relation to surgical and ICU care. Outstanding clinical care and the development of strong partnerships with clinical staff were much appreciated by families, whereas poor information exchange and inconsistent care caused concerns.

Conclusions: Family satisfaction is an important outcome within a patient-centred quality of care framework. Our findings suggest strategies to inform the delivery of care in relation to spinal fusion for Rett syndrome and could also inform the hospital care of other children with disability and a high risk of hospitalisation.

Introduction

Rett syndrome is a severe neurodevelopmental disorder, occurring mainly in females and usually associated with a mutation of the methyl-CpG-binding protein 2 gene (*MECP2*) [1]. The phenotypic spectrum is wide with the specific *MECP2* mutation contributing to the clinical variation [2]. Using Australian population-based data, the incidence has been estimated to be 1/9000 female births and the prevalence 8.6 per 100,000 school-aged females [3]. Following largely normal early development, there is loss of communication, hand function and the development of intense midline hand stereotypies and impaired gait. Comorbidities often develop including scoliosis,[4] epilepsy[5] and gastrointestinal disorders[6] and clinical management is complex.

Scoliosis occurs commonly in Rett syndrome,[4, 7] and was found to affect three quarters of our Australian population-based cohort by the age of 13 years.[4] The development of scoliosis is more prevalent in the presence of mutations associated with a more severe phenotype (such as p.R270X) or being unable to walk [4, 7] although we currently know little about the trajectories of scoliosis in relation to genetic and non-genetic factors. Scoliosis is a significant comorbidity in Rett syndrome, its onset is often in early childhood and curve progression is thought to be not necessarily halted by cessation of growth.[8] A progressive scoliosis may be associated with symptoms of pain, a decline in motor skills including sitting and walking, and restrictive lung disease.[9] In the absence of an evidence base for its management, we previously used consensus methods to develop the first published guidelines on this topic [10].

Spinal fusion may be considered if the Cobb angle of the spine progresses to greater than 50 degrees but in Rett syndrome, occurs within the context of co-morbidities such as epilepsy [5], gastrointestinal dysfunction [6], osteoporosis, [11] increased sensitivity to anaesthetic drugs, and severe cognitive impairment [12]. Families experience considerable emotional stress when deciding whether to proceed with spinal fusion for their daughter [13] because the procedure is complex and lengthy. A postoperative admission to intensive care is usually necessary and the likelihood of complications is high. Short term postoperative complications are usually respiratory in nature [14] and later complications may include rod breakage and recurrence of scoliosis [15]. Following recovery, spinal symmetry and sitting balance have been shown to improve [16] and participation in activities of daily living is at least maintained at pre-operative levels particularly in those who are wheelchair dependent [17].

Understandably, many parents are anxious when making the decision to proceed with surgical management of scoliosis in Rett syndrome [13]. There is a need for better evidence to support the decision making of both clinicians and families, individually and jointly, when this option of is being considered. Evaluation in a quality of care framework needs to take account of multiple outcomes including treatment effectiveness over the short and long term; adverse effects and patient safety; economic costs; accessibility to treatment; and acceptability of the treatment including satisfaction[18]. The Australian Rett Syndrome Database (ARSD) is a longitudinal resource first established in 1993 for population-based ascertainment of Rett syndrome in Australia [19]. Comprehensive family-reported data are currently collected every two to three years

approximately. Using data from the ARSD, this study evaluated whether families were satisfied with a range of aspects of clinical care and outcomes following their daughter's spinal fusion. We also explored family explanations of satisfying or dissatisfying clinical care.

Methods

Available data from family questionnaires administered on recruitment to the ARSD and approximately biennially since 1996 were used for this analysis [19]. The family questionnaires have had a high response fraction (from 82-89%) over the lifetime of the ARSD and the most recent 2011/2012 family questionnaire was returned by 237/275 (86.2%) families. In May 2013, the ARSD included 392 females born since 1976 with 69 (17.6%) having died since data collection commenced in 1993. Since 1996, 85 (22.1%) girls and women with Rett syndrome have undergone a spinal fusion. Sixteen (18.8%) have since died: one during the immediate post-operative period and the remainder a median of ten (range 1-19) years following surgery. The spinal fusion satisfaction questionnaire was administered to 67 (including five deceased by 2013) of the 85 families either as part of the 2011 follow-up or by telephone and a response received from 61 (91%).

For those families who reported their satisfaction following spinal fusion, their daughter's scoliosis had been diagnosed at a median (range) age of 7 years 11 months (1year 6 months – 14 years 6 months) years and scoliosis surgery performed at 13 years 1 month (7 years 1 month -17 years 11months). Satisfaction data was collected at a median age of

21 years 7 months (9 years 6 months – 35 years 1 months), 7 years 6 months (3 months – 20 years 6 months) after the surgery. The distribution of pathogenic mutations and pre-operative mobility levels are shown in table 1.

Insert table 1 about here

The spinal fusion satisfaction questionnaire was included in the 2011/2012 questionnaire and was developed specifically for this study, following evaluation of relevant literature and family input. The questionnaire comprised five items in relation to satisfaction overall and 12 questions in relation to specific aspects of care from admission through to discharge from hospital. Each question was rated on a 5-point Likert scale ranging from very satisfied to very dissatisfied. Items also included satisfaction in relation to expected changes in health and function after spinal fusion: the progression of the curve, general health, discomfort, frequency of respiratory infections, energy level, happiness, appearance, and ease of functional tasks and functional abilities including transfers, dressing, sitting, standing, walking and eating. Each of these questions was rated on a 5-point Likert scale ranging from strongly agree to strongly disagree. Parents were asked to complete open-ended questions concerning the most and least satisfying aspects of their daughter's spinal fusion care. Other data included the age at which spinal fusion was performed and the time between the surgery and completion of the 2011/2012 questionnaire. The level of pre-operative mobility was sourced from the relevant questionnaire and coded on a 4-point scale as walking independently, walking with assistance, able to take weight for transfers or were wheelchair dependent. Four girls

were able to walk independently: two with a p.R133C mutation, one with a p.R294X mutation and one with a p.T158M mutation.

Ethical approval was provided by the ethics committee of the Princess Margaret Hospital in Western Australia. Parents gave informed consent for their children to participate in this study and for the publication of the results.

Statistical analysis

Descriptive statistics are reported for subject characteristics and parent ratings of each item. All but one family reported overall satisfaction as either very satisfied or satisfied and for these two groups, independent sample t-tests were used to compare by age at surgery and time since surgery, and Fisher exact test was used to evaluate the association between pre-operative mobility and overall satisfaction.

Content analysis was conducted using data from the open-ended questions. Data were grouped by the content area of the question and then read and re-read to gain familiarity and form initial ideas of the data set. The researcher then coded recurring words, phrases or concepts within these areas, and integrated similar codes to define the key themes. The themes were marked within the data to allow further reflection on each thematic decision and either confirm, refute or modify the original interpretations. A second researcher reviewed all coding decisions to increase credibility of analysis.

Results

Families reported high satisfaction levels following their daughter's surgery (median 5, range 2-5), would consent to their daughter having the same procedure if facing again for the first time (median 5, range 2-5), would recommend spinal fusion to other families facing a similar situation (median 5, range 2-5) and now felt less anxious about her future health (median 4, range 2-5). One family reported overall dissatisfaction, possibly because of the recurrence of scoliosis 16 years following surgery although the post-operative course had been relatively uneventful. The remainder of families were either satisfied or very satisfied. The mean age at surgery was 12 years 10 months SD 2 years 7 months for those who were "very satisfied" and 13 years 3 months SD 1 year 11 months for those who were "satisfied" (p=0.49), and the duration since surgery was shorter for those who were "very satisfied" (7 years 5 months SD 6 years 1 month) compared to those who were "satisfied" (10 years 7 months SD 6 years 5 months, p=0.06). There were similar distributions of ratings for general satisfaction for each level of pre-operative mobility (p=0.56).

Families reported high levels of satisfaction with aspects of care whilst an inpatient (table 2). Ratings were consistently high with regard to surgical and ICU care with greater variation during pre-operative preparation, after being transferred from ICU to the ward and in relation to discharge planning. The majority of parents were satisfied with improvement in their daughter's spinal symmetry and appearance and about three quarters with improvements in their daughter's general health, frequency of respiratory infections, well-being and level of comfort (table 3). Approximately two thirds were satisfied with their daughter's improved sitting, and ease of dressing and transfers.

Insert tables 2 and 3 about here

Themes related to relationships with health care professionals, care in the hospital and longer term issues. Themes together with sample quotes are shown in table 4. Overall, the majority of comments were positive but with some negative experiences and the content analysis allowed for exploration of this variation. Families valued the expertise of the specialist care team, particularly when staff were confident, experienced and proactive in delivering the necessary care. However, confidence in the specialist care team was diminshed when the standard or amount of care was variable. The development of partnerships between families and clinical staff was considered extremely important. Families wanted regular, clear and consistent information. They were also disappointed if their assessment of their daughter was not taken into account during clinical decision-making.

Pain management was a concern at all stages of care and families were vigilant as "she could not communicate if she had severe pain" Girls with Rett syndrome usually lose the ability to say words at the time of regression [20, 21] and usually do not regain these abilities.[20] Sensitivity to pain can be increased or decreased in Rett syndrome and responses to painful stimuli are often delayed.[22] Pain was managed well in ICU settings and less consistently in ward settings. Some families reported that the timing of administration of pain medications in ward settings was more variable than in ICU settings, and this was perceived as associated with greater discomfort for their daughter

and more anxiety for parents. Nevertheless, families were often pleasantly surprised at how quickly their daughter recovered post-operatively, sitting out of bed and walking again if she had been able pre-operatively. Families reported the development of postoperative complications as dissatisfying but acknowledged the clinical expertise delivered in their management. The largest proportion of quotes described benefits over the longer term for their daughter's health, wellbeing and functional abilities, and often greater ease performing daily care. This was an extremely positive aspect of family experiences in relation to spinal fusion. Longer term aspects were also mentioned including the need for careful and regular review of seating arrangements, adjustment to new daily care procedures postoperatively and a small proportion described later complications including recurrence of scoliosis.

Insert table 4 about here

Discussion

With an opportunity to reflect, the majority of families reported high levels of satisfaction in relation to their daughter having had a spinal fusion and benefits in terms of her spinal symmetry, wellbeing and function. Outstanding clinical care and the development of strong partnerships with clinical staff were much appreciated by families, whereas poor information exchange and inconsistent care caused concerns.

Spinal fusion is a complex surgical procedure and the decision to proceed with surgery is associated with considerable anxiety for families [13]. Those who are empowered weigh

the risks and benefits very carefully on behalf of their daughter who with impaired communication skills cannot usually provide her assent for the surgery. Nevertheless following surgery, the majority of families reported high satisfaction levels, would consent to spinal fusion if facing the same situation again, and would recommend spinal fusion to other families facing a similar situation. Families were pleased with benefits for their daughter's spinal symmetry and appearance, health and comfort, and greater ease of sitting, dressing and transfer activities. They also perceived that their daughter was more comfortable and felt happier. These sentiments are similar to those reported by families of children with severe cerebral palsy after a spinal fusion [23, 24] and are potential explanatory variables for the high levels of parental satisfaction overall.

There are risks associated with the surgical procedure and post-operative respiratory complications are common [14]. The occurrence of short term complications was remembered vividly by families of young people with Rett syndrome, even after a considerable time period, although these did not influence overall satisfaction levels. Longer term complications such as return to surgery and recurrence of scoliosis occurred infrequently but were a source of considerable dissatisfaction for families. Overall satisfaction decreased slightly with time, possibly related to later complications in a small number of women.

During development, the spine grows in synchrony with the rib cage and lungs and spinal deformity is associated with altered lung function consistent with a restrictive lung deficit [25]. Therefore, the goal of management of spinal deformity is for the child to develop

the largest and most symmetric thoracic shape. Surgeons plan the timing of the surgery taking into account both the severity and stiffness of the spinal curve and potential for further growth of the spine and lungs. The timing of surgery can also be influenced by available hospital resources. Spinal fusion in Rett syndrome is conducted within a framework of altered neurological function and the development of additional deformity alongside the fusion is also possible. Some women developed later complications and monitoring over the longer term is necessary to implement strategies for their amelioration and/or management as soon as possible.

During the hospital stay, families reported anxiety regarding the procedures their daughter was undergoing and other aspects such as the appearance of the scar and pain management. With impaired expressive communication skills and altered sensitivity to pain [22], careful observations and consultation with carers are critical when assessing for pain and discomfort. Families valued the efforts of the clinical teams to develop and maintain lines of communication with them by consulting with them in a timely manner on assessment and management issues in relation to pain, gastrointestinal dysfunction and regaining mobility. The skills of specialist pain management teams contributed to excellent ICU care and also when discharged back to the ward although there was sometimes less consistency in ward settings. For example, some families spoke of their frustrations when the administration of pain medications was scheduled for busy nursing handover periods and there were then lengthy delays.

The cumulative risk of hospitalisation for those with severe intellectual disability is up to 10 times that of children in the general population [26] and spinal fusion is a potential treatment for many other disorders in childhood in which the nervous system is adversely affected. These include discrete disorders such as Rett syndrome with a known specific genetic cause and others such as cerebral palsy which are heterogenous in their aetiology.[27] Many childhood neurological disorders begin in early childhood, are complex and chronic, and many are associated with intellectual as well as behavioural and motor impairments. Hospitalisations are frequent [26] with spinal fusion being one among many other indications for a hospital admission. Our findings suggest strategies in relation to effective building of family clinician relationships and the importance of ensuring seamless administration of pain management regimens across intensive care and ward settings could prove helpful for optimising clinical care more generally for this vulnerable group.

The mutations most commonly represented were p.T158M, p.R270X and large deletions. The p.R270X mutation is associated with a severe phenotype[2] as are the large deletion mutations [28], whereas the p.T158M is more intermediate in severity [2]. However, smaller proportions of girls with a mutation more usually associated with a milder phenotype such as p.R133C, p.R294X [2] and C terminal deletions [29] were also represented. Pre-operatively, the majority of girls were wheelchair dependent or walked with assistance, consistent with findings that scoliosis is more likely when early development has been poor [4]. A smaller proportion (n=4) was able to walk pre-operatively and continued to walk following spinal fusion, consistent with data from the

UK [15]. Progressive scoliosis occurs across a range of phenotypes in Rett syndrome and routine monitoring for all girls with Rett syndrome during clinical consultation is important.

The Australian Rett Syndrome Database is population-based and longitudinal [19] which allowed us to identify almost all girls and women in Australia who have had a spinal fusion since 1993. For the current study, our response fraction was high including most families whose daughter was still alive at the time of administration of the questionnaire. We did not have data from the family whose daughter died in the post-operative period but our sample included one family whose daughter had died shortly before the questionnaire was administered and who remained keen to report as part of their continued advocacy for her daughter.

Our questions on satisfaction were developed with reference to the literature and with family input supporting their content validity. We acknowledge that we found little variability in overall satisfaction, but our additional questions on hospital processes and our qualitative analyses provided important depth to the narrative. We also acknowledge that parents would be keen to report favourably on their feelings of satisfaction since they consented to their daughter's surgery. As articulated in Cognitive Dissonance Theory, families may have rationalised their experiences by viewing their treatment more favourably [30]. This is an unavoidable bias when studying patient satisfaction with clinical care but it nevertheless remains an important component of the quality of care outcomes framework.[18] In our study, the questions on satisfaction were administered

by a research team not involved in the provision of clinical care and families welcomed the opportunity to express both favourably and negatively about this significant event, likely associated with some reduction in bias. We used multiple questions to understand the experiences of undergoing spinal fusion and were able to provide a critique on particular aspects of clinical care processes [31]. Also, higher satisfaction was reported more frequently by families whose daughter had more recent surgery, consistent with improved pain management methods and the occurrence of longer term complications that developed in a few of the women. These provide a counterpoint to the potential effect of Cognitive Dissonance Theory.

Although challenging to measure, feelings of satisfaction are an important component of the quality of care outcomes framework. Severe progressive scoliosis is one of the downstream experiences that can follow the diagnosis of many neurodevelopmental disorders and identification of family perceptions of satisfaction or otherwise following spinal surgery can inform the provision of optimal management. Our findings from a population-based sample of families, each of whom have supported their daughter through the complex clinical processes of spinal fusion, suggest several valuable clinical strategies: the importance of optimal timing of surgery by highly skilled staff, effective building of partnerships between clinicians and families, seamless management of pain across ICU and ward settings, and continued orthopaedic surveillance over the longer term.

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References

1. Amir RE, Van den Veyver IB, Wan M, Tran CQ, Francke U,Zoghbi HY. Rett syndrome is caused by mutations in x-linked mecp2, encoding methyl-cpg-binding protein 2. Nature Genetics 1999; 23(2): 185-188.
2. Bebbington A, Anderson A, Ravine D, Fyfe S, Pineda M, de Klerk N, et al. Investigating genotype-phenotype relationships in rett syndrome using an international data set. Neurology 2008; 70(11): 868-875.
3. Fehr S, Bebbington A, Nassar N, Downs J, Ronen GM, de Klerk N, et al. Trends in the diagnosis of rett syndrome in australia. Pediatric Research 2011; 70(3): 313-319.
4. Ager S, Fyfe S, Christodoulou J, Jacoby P, Schmitt L,Leonard H. Predictors of scoliosis in rett syndrome. Journal of Child Neurology 2006; 21(9): 809-813.
5. Bao X, Downs J, Wong K, Williams S,Leonard H. Using a large international sample to investigate epilepsy in rett syndrome. Developmental medicine and child neurology 2013; 55(6): 553-558.
6. Motil KJ, Caeg E, Barrish JO, Geerts S, Lane JB, Percy AK, et al. Gastrointestinal and nutritional problems occur frequently throughout life in girls and women with rett syndrome. Journal of Pediatric Gastroenterology and Nutrition 2012; 55(3): 292-298.
7. Percy A, Lee H-S, Neul J, Lane J, Skinner S, Geerts S, et al. Profiling scoliosis in rett syndrome. Pediatric research 2010; 67(4): 435-439.
8. Lidstrom J, Stokland E,Hagberg B. Scoliosis in rett syndrome. Clinical and biological aspects. Spine (Phila Pa 1976) 1994; 19(14): 1632-5.

9. Berven S,Bradford DS. Neuromuscular scoliosis: Causes of deformity and principles for evaluation and management. Seminars in Neurology 2002; 22(2): 167-178.
10. Downs J, Bergman A, Carter P, Anderson A, Palmer GM, Roye D, et al. Guidelines for management of scoliosis in rett syndrome patients based on expert consensus and clinical evidence. Spine 2009; 34(17): E607-17.
11. Jefferson A, Woodhead H, Fyfe S, Briody J, Bebbington A, Strauss B, et al. Bone mineral content and density in rett syndrome and their contributing factors. Pediatric Research 2011; 69(4): 293-298.
12. Tofil N, Buckmaster M, Winkler M, Callans B, Islam M,Percy A. Deep sedation with propofol in patients with rett syndrome. Journal of Child Neurology 2006; 21(10): 857-860.
13. Ager S, Downs J, Fyfe S,Leonard H. Parental experiences of scoliosis management in rett syndrome. Disability and Rehabilitation 2009; 31(23): 1917-1924.
14. Gabos P, Inan M, Thacker M,Borkhu B. Spinal fusion for scoliosis in rett syndrome with an emphasis on early postoperative complications. Spine (Philadelphia, Pa. 1976) 2012; 37(2): E90-E94.
15. Kerr A, Webb P, Prescott R,Milne Y. Results of surgery for scoliosis in rett syndrome. Journal of Child Neurology 2003; 18(10): 703-708.
16. Larsson E-L, Aaro S, Ahlinder P, Normelli H, Tropp H,Oberg B. Long-term follow-up of functioning after spinal surgery in patients with rett syndrome. European spine journal 2009; 18(4): 506-511.
17. Downs J, Young D, de Klerk N, Bebbington A, Baikie G,Leonard H. Impact of scoliosis surgery on activities of daily living in females with rett syndrome. Journal of Pediatric Orthopedics 2009; 29(4): 369-374.
18. Long AF, Dixon P, Hall R, Carr-Hill RA,Sheldon TA. The outcomes agenda: Contribution of the uk clearing house on health outcomes. Quality in health care : QHC 1993; 2(1): 49-52.
19. Downs J, Bebbington A, Woodhead H, Jacoby P, Jian L, Jefferson A, et al. Early determinants of fractures in rett syndrome. Pediatrics 2008; 121(3): 540-546.
20. Hagberg B. Clinical manifestations and stages of rett syndrome. Ment Retard Dev Disabil Res Rev 2002; 8(2): 61-5.
21. Lee J, Leonard H, Piek J,Downs J. Early development and regression in rett syndrome. Clin Genet 2013.
22. Downs J, Geranton S, Bebbington A, Jacoby P, Bahi Buisson N, Ravine D, et al. Linking mecp2 and pain sensitivity: The example of rett syndrome. American journal of medical genetics. Part A 2010; 152A(5): 1197-1205.
23. Jones K, Sponseller P, Shindle M,McCarthy M. Longitudinal parental perceptions of spinal fusion for neuromuscular spine deformity in patients with totally involved cerebral palsy. Journal of Pediatric Orthopedics 2003; 23(2): 143-149.
24. Tsirikos A, Chang W-N, Dabney K,Miller F. Comparison of parents' and caregivers' satisfaction after spinal fusion in children with cerebral palsy. Journal of Pediatric Orthopedics 2004; 24(1): 54-58.

25. Sponseller P, Yazici M, Demetracopoulos C,Emans J. Evidence basis for management of spine and chest wall deformities in children. Spine (Philadelphia, Pa. 1976) 2007; 32(19 Suppl): S81-S90.
26. Bebbington A, Glasson E, Bourke J, de Klerk N,Leonard H. Hospitalisation rates for children with intellectual disability or autism born in western australia 1983-1999: A population-based cohort study. BMJ open 2013; 3(2).
27. Bishop DVM. Which neurodevelopmental disorders get researched and why? PLoS ONE 2010; 5(11): e15112-e15112.
28. Bebbington A, Downs J, Percy A, Pineda M, Ben Zeev B, Bahi-Buisson N, et al. The phenotype associated with a large deletion on mecp2. European Journal of Human Genetics 2012; 20(9): 921-927.
29. Bebbington A, Percy A, Christodoulou J, Ravine D, Ho G, Jacoby P, et al. Updating the profile of c-terminal mecp2 deletions in rett syndrome. J Med Genet 2010; 47(4): 242-8.
30. Redelmeier DA,Dickinson VM. Determining whether a patient is feeling better: Pitfalls from the science of human perception. Journal of General Internal Medicine 2011; 26(8): 900-906.
31. Sitzia J,Wood N. Patient satisfaction: A review of issues and concepts. Social Science & Medicine 1997; 45(12): 1829-1843.

Table 1: Distribution of *MECP2* mutation type and pre-operative mobility levels (n=61)

Pathogenic mutation	C terminal	4 (6.6%)
	Early truncating	3 (4.9%)
	Large deletion	5 (8.2%)
	p.R106W	3 (4.9%)
	p.R133C	2 (3.3%)
	p.R168X	4 (6.6%)
	p.R255X	3 (4.9%)
	p.R270X	6 (9.8%)
	p.R294X	4 (6.6%)
	p.T158M	8 (13.1%)
	Other	8 (12.2%)
	Negative	8 (13.1%)
	Not tested	3 (4.9%)
Pre-operative mobility	Independent walking	4 (6.6%)
	Walk short distances with assistance	13 (21.3%)
	Able to support their body weight during transfers	6 (9.8%)
	Wheelchair dependent	38 (62.3%)

Table 2: Description of parent-rated satisfaction with individual aspects of care (n=63)

	Aspect of care	Mean (SD)	Median (range)
Pre-operatively	Information provided	4.24 (0.94)	4 (1-5)
	Confidence in doctors	4.40 (0.84)	5 (1-5)
	Clinical care	4.27 (0.90)	4 (1-5)
During surgery	Surgical care	4.50 (0.67)	5 (1-5)
Intensive care	Information provided	4.39 (0.70)	4.5 (2-5)
	Clinical care	4.48 (0.60)	5 (3-5)
	Pain management	4.40 (0.62)	4 (3-5)
Post-operative care on ward	Information provided	3.90 (1.04)	4 (1-5)
	Being involved in care of my daughter	4.23 (0.93)	4 (1-5)
	Pain management	4.02 (0.94)	4 (1-5)
Discharge	Discharge advice	4.03 (0.94)	4 (1-5)
	Support provided by hospital after hospital	3.67 (1.10)	4 (1-5)

Table 3: Caregiver satisfaction with change in aspects of spinal symmetry, health and wellbeing, and functional abilities following spinal fusion

		Strongly agree n (%)	Agree n (%)	Neither n (%)	Disagree n (%)	Strongly disagree n (%)
Spinal symmetry	Progression of the curve (n=57)	32 (56.1)	22 (38.6)	-	2 (3.5%)	1 (1.8%)
	Appearance (n=54)	26 (48.2)	27 (50.0)	-	1 (1.9)	-
Health and well being	General health (n=54)	18 (33.3)	31 (57.4)	4 (7.4)	1 (1.9)	-
	Discomfort (n=53)	21 (39.6)	25 (47.2)	6 (11.3)	1 (1.9)	-
	Respiratory infections (n=49)	19 (38.8)	19 (38.8)	5 (10.2)	6 (12.2)	-
	Energy levels (n=44)	8 (18.2)	14 (31.8)	15 (34.1)	7 (15.9)	-
	Seeming happy (n=51)	14 (27.5)	25 (49.0)	7 (13.7)	5 (9.8)	-
Function and care	Performance of transfers (n=43)	12 (27.9)	17 (39.5)	8 (18.6)	5 (11.6)	1 (2.3)
	Dressing (n=52)	14 (26.9)	22 (42.2)	6 (11.5)	10 (19.2)	-
	Sitting up (n=54)	18 (33.3)	22 (40.7)	4 (7.4)	9 (16.7)	1 (1.9)
	Standing (n=36)	9 (25.0)	12 (33.3)	5 (13.9)	9 (25.0)	1 (2.8)
	Walking (n=29)	4 (13.8)	8 (27.6)	9 (31.0)	7 (24.1)	1 (3.5)
	Eating (n=42)	10 (23.8)	16 (38.1)	10 (23.8)	4 (9.5)	2 (4.8)

[a] Numbers are those in the sample of 61 who perceived this aspect of health or functioning to be a problem pre-operatively giving a different denominator for each aspect of health or functioning.

Table 4: Themes and sample quotes describing satisfaction following spinal fusion

	Theme (n, % of phrases)[a]	Sample positive quotes	Sample negative quotes
Relationships with health care professionals	Confidence in specialist care (19, 17.2%)	"Our doctor was great, very thorough and caring with us all. The hospital were great too, very experienced in handling such cases as ours." "Happy with it all the doctors did the best they could and she is happy that's good enough for me."	"It took a long time for staff to determine that she had a urinary tract infection, 3 months for that to resolve and then she was much better." "Nursing capacities and care on orthopaedic ward varied considerably."
	Partnerships with families/carers (13, 10.9%)	"The specialist took great care to explain everything and his anaesthetist carefully checked her history before the operation." "The anaesthetist who came to see us on the ward soon after the devastating news that her spinal cord had been crushed during the surgery was fantastic. He didn't have to come and see us but he did. He was frank and encouraging at the same time and really empowered us to take each day as it comes and to fight for the rehabilitation services that she needed."	"Nursing staff were generally not very communicative - I had to probe for any answers, there was very little information forthcoming." "The orthopaedic surgeon did not always appear to take family concerns and patient feelings into account."
Care in the hospital	Co-ordinated model of care (14, 11.7%)	"Number of visits by surgeon and good nursing care was very thorough." "Nursing staff and hostel staff worked together and were fantastic." "Medical staff support and understanding.	"The co-ordination between health professionals was very poor during the post-operative period. Difficult for the different doctors from different specialities to co-ordinate care because they were often disagreeing with each other." "Wards and ICU staff needed prompts with regard to general caring, poor handovers, not taking notice of my daughter and I had to prompt for her pain management."
	Concerns about pain management (6, 5.1%)		"Frequent confrontations with nursing staff over pain management when we had come to agreement with pain management staff but nurses wouldn't give her what pain management team had ordered." "Pain management was far superior on ITU (she walked 20m without discomfort) but this was never properly managed on the ward."
	Short term course of recovery (14, 11.7%)	"Her recovery was amazingly quick, she was weight bearing in 3 days and seemed quite happy and comfortable in herself, didn't seem to be in pain at all." "It was a very quick surgery on Wed. By Sunday, her dressing was removed and cleaned. By Monday, she was home. She recovered well at home."	"Some respiratory complications were unfortunate for us and something I had not allowed for." "She had problems with recovery from morphine which were worrying at the time. "Lung collapse, urinary tract infection, pleural effusion."
	Stress for family (3, 2.5%)	-	"Seeing the red scars."
Longer term	Subsequent	"She could breathe better- we suspect she was having	

issues	health and wellbeing (31, 26.1%)	headaches due to low oxygen sat levels. She was happier, a better colour and didn't scream as much." "Her general health and wellbeing is just fantastic, she is more alert and interactive than she has ever been." "Better quality of life - better balance, more secure eg sitting on toilet, taller and more elegant, easier to buy clothes for."	
	Better function and ease of care (6, 5.1%)	"It is easier to care for her and she can sit up properly and take in what is going on." "She is very straight now and able to sit for a lot longer."	
	Family burden of providing long term support (4, 3.4%)		"She is very thin and we can feel the metal through her skin, and so we have to observe carefully and look after her seating so that she doesn't develop pressure sores." "Everything post-surgery seemed to take an inordinately long time to achieve, dressing, nappy changing, hoisting - all these tasks continue to be laboriously time consuming."
	Long term complications (9, 7.6%)		"Her curve has started to come back or at least in other places - she still wants to curve." "Having got an infection, had to go into surgery 2 more times."

[a] 119 phrases were coded into themes