Title

The child with Rett syndrome: how can clinical ethics guide the management of the comorbidities?

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Abstract (212/250)

Rett syndrome is a rare disorder caused by a mutation in the *MECP2* gene. Those affected generally have severe functional impairments and medical comorbidities such as scoliosis and poor growth are common. There is a paucity of information on the natural history of many rare disorders and an even greater deficit of evidence to guide best practice. The population-based and longitudinal Australian Rett Syndrome Database established in 1993 has supported investigations of the natural history of Rett syndrome and effectiveness of treatments. This paper reviews the disorder Rett syndrome and evidence for the management of scoliosis and poor growth within a clinical ethics framework. Compared to conservative management, we have shown that spinal fusion is associated with reduced mortality and better respiratory health. We have also shown that gastrostomy insertion is associated with subsequent weight gain. Family counselling for both procedures necessarily must include family perspectives and careful clinical attention to family needs and wishes. Vignettes describing family decision-making and experiences are presented to illustrate the principals of beneficence and autonomy in determining the best interests of the child and family. A blend of evidence-based practice with a strong clinical ethics framework has capacity to build existing strengths in families and reduce the negative impacts of disability, and in so doing, optimize the health and wellbeing of those with Rett syndrome.

Key words: Rett syndrome, rare disease, scoliosis, gastrostomy, clinical ethics

What is already known on this topic:

- Rett syndrome is a rare disorder caused by a mutation on the *MECP2* gene.
- Those with Rett syndrome have severe functional impairments and medical comorbidities such as scoliosis and poor growth are common.
- Clinical management can be complicated because of impaired communication and cognition, and sometimes decreased sensitivity to pain.

What this paper adds:

- Well maintained population databases form critical infrastructure for investigating the management of rare disorders.
- An emerging framework of evidence for spinal fusion and gastrostomy supports their beneficence for the child.
- Engaging parents in clinical counselling assists them to consider their families' needs when providing consent for surgical procedures such as spinal fusion and gastrostomy.

Introduction

It is nearly thirty years since Rett syndrome was first described in English as "a progressive syndrome of autism, dementia, ataxia, and loss of purposeful hand use in girls".[1] In 1993, the Australian Rett Syndrome Database (ARSD) was established (http://www.aussierett.org.au)[2] to shine the spotlight on the phenotype and complexities of this rare disorder, once described by Bengt Hagberg as one of "clinical peculiarities and biological mysteries".[3] Rett syndrome's genetic cause, a mutation in the gene methyl-CpG-binding protein 2 (*MECP2*) was identified in 1999,[4] enabling the ARSD to explore relationships between genotype and phenotype.[2] Families with a daughter with Rett syndrome living across Australia have been providing information to the ARSD in successive waves for over 20 years but of the more than 400 girls and women currently registered, approximately 18% have died.[5] This national population-based resource provides infrastructure to investigate the natural history of Rett syndrome and is now providing capacity to investigate the effects of interventions.[2]

This paper reviews the presentation of Rett syndrome, and discusses the ethical implications of some medical and surgical issues. Ethical themes running through these encounters include:

1. how best-practice decisions are made when there is absent or limited evidence (illustrating the principal of beneficence), and
2. how the best interests of the child are determined, taking into account the impaired communication skills and cognition of the patient, and the needs and wishes of families (illustrating the principal of autonomy).

Rett syndrome

Rett syndrome is a rare neurodevelopmental disorder that affects approximately one in 9000 live female births.[6] It is characterized by largely normal early development followed by loss of communication and hand function, impaired gross motor skills and the development of hand stereotypies.[7] Additional criteria include altered breathing patterns, scoliosis, sleep disturbances and poor growth.[7] The impairments are severe with serious impacts on the health of the child.

The *MECP2* gene is located on the X chromosome and whilst MeCP2 protein expression occurs throughout the body, it is expressed particularly abundantly in the central nervous system.[8] There have been more than 400 individual mutations of the *MECP2* gene identified (http://mecp2.chw.edu.au) including point mutations, or deletions in the C-terminal of the *MECP2* gene or larger deletions that occur relatively commonly. Recent large sample studies have enabled relationships between these common mutations and phenotype to be demonstrated. For example, the p.Arg133Cys, p.Arg294* or the p.Arg306Cys mutations are typically associated with a milder phenotype[9] including better gross motor[10] and hand function[11] skills and later onset of scoliosis.[12] However, the p.Arg133Cys mutation can also be associated with retention of some use of words[13] whereas the p.Arg294* can be associated with more difficult behaviours.[14] Other mutations including the p.Arg168*, p.Arg270* or large deletions are associated with a more severe phenotype.[9]

Children with an intellectual disability are at increased risk of hospitalization. For those with a known biomedical cause such as Rett syndrome, the risk is more than seven times that of the general population.[15] During episodes of illness, clinicians who are typically unfamiliar with the disorder examine the child and plan clinical care, and families themselves are frequently the educators of clinicians with regard to their daughter's condition. The family may be required to repeat their child's complex medical history at each visit or admission and often multiple times during the same visit or admission. All families have a critical role to play in the management of sick children but this role is amplified for families whose child has a rare disorder.

Linking evidence with clinical needs

Research-based evidence is not available to guide all clinical decisions and many clinicians will extrapolate from experiences with similar clinical situations with more common disorders. Formal approaches to clinical reasoning such as use of specific "decision support tools"[16] may be useful. Decision support tools use a specific framework for ensuring that questions are articulated in relation to gathering adequate information to achieve a full understanding of the

problem; considering the implications of no treatment; weighing the potential benefits and harms of treatments that are available; and discussion of the implications of potentially valuable treatments with the family. These principles are also relevant to rare disorders, and require time and resources that are not available in emergency settings but which generally can be made available in other settings.

Needs and wishes of the child and family

In Rett syndrome, altered sensitivity to pain is common[17] and impaired cognition and communication skills limit the child's ability to express discomfort. It can be difficult to judge the cause of a problem and its severity. Clinicians need to listen to families and understand their concerns, and then determine necessary investigations even when signs are subtle. For example, an upper limb fracture could be indicated in the first instance by altered hand mouthing behaviours.[17] Pain assessment in intellectual disability is difficult, and relies on experience and training to interpret non-verbal communication.[18,19] There is evidence that parents can reliably interpret communications from the child in circumstances associated with pain, and should be relied upon to guide clinical decision-making. When developing a pain rating scale for use with children with cognitive and communication impairments, parent estimates were used as the benchmark against which to assess the prevalence of behavioral features denoting distress during episodes of pain.[20] Parents of children with any severe disability including Rett syndrome generally know their child best and would be considered the gold standard in being able to assess their child's pain.

Patient autonomy includes being informed and engaged in discussions as to the course of health care, the provision of consent or otherwise, and engagement as care proceeds, processes that cannot occur with severe cognitive impairment.[21] Parents usually take the role of decision-maker on behalf of their child's best interests although there are examples of parental autonomy resulting in decisions not being made in the best interests of the child.[22] The best interests of the child are not always the same as the interests of the parents, which may be swayed by guilt, unresolved grief or fear.

It is incumbent upon clinicians to create an environment that facilitates dialogue and communication around the needs of cognitively impaired children, so that parents can comfortably communicate their knowledge. It is important in this context for clinicians to report to parents when they cannot explain symptoms, or disagree with parents so that these issues can be discussed, and options for additional observation, review or recruitment of additional decision making support can be considered.

Comorbidities are common in Rett syndrome as they are for other children with severe disability

Clinical care is complex because of the high prevalence of comorbidities, typically gastrointestinal problems including poor growth,[23] scoliosis,[24] and epilepsy.[25] Unusual breathing patterns,[26] difficulties with sleep[27] and a high propensity to bone fracture because of low bone density[28] are also common. The following review is based on ethics approvals from the Princess Margaret Hospital for Children and Royal Perth Hospital, Perth; Women's and Children's Hospital, Adelaide; Royal Children's Hospital and Monash Medical Centre, Melbourne; Sydney Children's Hospitals Network, Sydney; Mater Children's Hospital and Royal Children's Hospital, Brisbane. Ethics approval was obtained to link the cohort to the National Death Index administered by the Australian Institute of Health and Welfare. and families provided informed consent.

Progressive scoliosis can cause pain and further restrict motor skills and breathing

Scoliosis is the most common orthopaedic comorbidity in Rett syndrome occurring in three quarters by age 15 years.[29] It is progressive in many girls, associated with pain, deterioration of motor skills and the development of a respiratory deficit. Spinal surgery may be recommended when the curve reaches a magnitude greater than 50° to prevent further progression and enable a good seated posture.[30] Families then weigh up the benefits and risks of spinal surgery. Spinal fusion is a complex and lengthy procedure, with a high post-operative complication rate,[31] and unsurprisingly parents experience fear and worry in relation to the potential for

complications, pain and for their daughter's survival.[32] Spinal fusion has been performed in approximately 25% of those registered in the ARSD. Box 1 present pre- and post-operative reflections from a mother whose daughter with Rett syndrome underwent spinal fusion.

Linking evidence with clinical needs

There is growing evidence on outcomes following spinal fusion in Rett syndrome, consistent with Parent 1's observations and understanding shown in Box 1. Post-operatively, general health is often improved, preoperative mobility level at least maintained,[32] and parents are usually satisfied with the outcomes.[33] However, postoperative complications that are mostly short term[31] and the general fragility of Rett syndrome (eg, propensity to fracture) can also influence recovery.[32] Using data from the ARSD and interrogating medical records at eight tertiary hospitals throughout Australia, we found reduced mortality in those with severe scoliosis who underwent spinal fusion (n=98) compared to conservative management (n=42). After adjusting for mutation type and age of scoliosis onset, the risk of death was 70% less in the surgery group compared with those managed conservatively at any point in time. This effect was particularly marked for those with an earlier onset scoliosis who also had a moderately reduced likelihood (59%) of later lower respiratory tract infections.[5] For example, the estimated survival probability at 20 years for all with a severe scoliosis was 77.4%, but was 59.4% when restricted to those who were managed conservatively.[5] These new data relate to a total population and provide estimates of outcomes. It is however important to remember that as for any group findings, these data inform clinical counselling because the intervention may be less relevant to an individual child and family.

Needs and wishes of the child and family

Spinal surgeons counsel families regarding relevant information, paying particular attention to the potential for complications including death following surgery. As illustrated in Box 1, parent 1 and the spinal surgeon agreed as to treatment for this child, supported by evidence and the individual needs of the family. This parent and others in a qualitative study[32] have reported favourably on their daughter's health and wellbeing following spinal fusion. On the other hand, the clinician and parents could both choose not to undertake surgery. The surgery would be

associated with some discomfort, risks and benefits including longer life expectancy but for an individual child, the risks may not be justified because of extremely poor health. Alternatively, the clinician and parent might not agree. The parents could decline surgery for many reasons: fearful for their child to go through such a procedure, influenced by other experiences of poor outcomes or they may simply feel that their child is not well enough. The child is sometimes able to indicate discomfort in relation to her spinal posture but not always. The parent however has the responsibility of providing consent and if parents do not consent to spinal fusion, this autonomy is of necessity respected.

The concept of evidence based practice is a blend of research evidence, clinician experience and family/patient preferences.[34] Research findings allow one to take covariates such as mutation type, age and clinical severity into account but there is extraordinary heterogeneity in any clinical population and one size does not necessarily fit all. The role of clinical counselling is to balance the framework of evidence from a patient population with the needs and wishes of the family for an individual child.

Additionally, Box 1 illustrates the mother's overall feelings about spinal fusion, how she coped and what she advised for other parents. She projected the need for positive thinking, not believing everything that you hear and to be mindful of both clinical and family members being a team to support the child. Her advice stood the test of her lived experience of spinal fusion for her daughter. She also believed that progressive severe scoliosis could kill her daughter. Whilst spinal fusion has been associated with longer survival in Rett syndrome, it is important to acknowledge that in Australia, slightly less than two thirds of females with Rett syndrome live to 37 years[35] and that scoliosis is just one of many medical factors that can influence survival in Rett syndrome.

Feeding difficulties and poor growth

Poor growth is common in Rett syndrome, and associated with feeding difficulties and gastrointestinal problems.[36,37] Many individuals also have disturbed breathing patterns with

episodic hyperventilation, breath holding and air swallowing, further reducing oral intake, increasing caloric expenditure and causing abdominal pain. Conservative management strategies are used initially for poor growth but with persistent difficulties, gastrostomy may be recommended.[37] Gastrostomy is usually a simple surgical procedure to perform but parents are often slow to accept this for their child.[38]

Linking evidence with clinical needs

Gastrostomy has been performed in nearly 30% of those registered in the ARSD. Most children will gain weight following gastrostomy insertion and families have reported satisfaction with outcomes of gastrostomy.[39] When feeling less anxious about care, they are better able to provide food, fluids and prescribed medications and the burden and stress of prolonged feeding are reduced.[39] Literature relating to children with other developmental disabilities is consistent with our findings in Rett syndrome.[40,41] However, the evidence base in relation to other outcomes following gastrostomy is more limited. We do not know the prevalence of complications following gastrostomy insertion, the effect on life expectancy, nor whether or not the child then needs fewer hospitalisations for epilepsy management or lower respiratory tract infections. Surprisingly little is known about the wider impacts of gastrostomy feeding on family factors such as maternal wellbeing, fatigue, capacity for employment or family quality of life. Additionally, the importance of the efficiencies afforded by gastrostomy for unaffected siblings to cater for their needs from time-poor parents or allaying their concerns and anxieties for their sister who finds feeding extraordinarily difficult are not known. Clinicians must therefore supplement the evidence that is available with their own clinical experience and some will therefore not offer gastrostomy, possibly because of limited experience with Rett syndrome. Continuing examination of outcomes for treatments that are well established but poorly understood is clearly justified.

Needs and wishes of the child and family

Similar to spinal fusion, meaningful family and clinician communications are needed to address clinical concerns (eg poor growth, risk of aspiration, difficulty administering medications).

Parents have to consider the advantages and disadvantages of gastrostomy. For example, there may be health benefits for their child and reduced family burden and strain in relation to regular prolonged feeding times. On the other hand, their child will forego the physical and social joys of eating. How can we judge the importance of eating to her quality of life in relation to the competing interests of her respiratory health and family burden of feeding? Alternatively, some mothers have reported feelings of embarrassment when tube feeding their child publicly and disappointment if gastrointestinal problems such as reflux persist following gastrostomy insertion.[42] In contrast to spinal fusion, the procedure is simple and associated with fewer complications. Nevertheless, these issues are complex and families often need time to decide and some parents will refuse gastrostomy.

The quote from Parent 2 in Box 2 illustrates maternal feelings of guilt that she could not feed and nourish her daughter. The quote from Parent 3 in Box 2 illustrates how another mother did not perceive her daughter's poor growth but following gastrostomy, experienced positive outcomes and was able to reflect on her journey of understanding her daughter's needs. Whilst we are unclear as to many outcomes, clinical counselling should be sensitive to family issues and contexts and take into account their goals to determine the potential for beneficence or otherwise for both child and family health and wellbeing.

Conclusions

The Australian Rett Syndrome Database is a population based resource that is unique worldwide and has recruited and tracked the progress of those affected by Rett syndrome for over 20 years. Nurturing and maintaining the database has been supported by clinicians around Australia who have referred their patients and provided data. This initiative therefore describes a community that is working towards untangling the issues associated with a rare disorder. A blend of evidence-based practice with a strong clinical ethics framework has capacity to build existing strengths in families and reduce the negative impacts of disability, and in so doing, optimize the health and wellbeing of those with Rett syndrome.

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References

1. Hagberg B, Aicardi J, Dias K, Ramos O. A progressive syndrome of autism, dementia, ataxia, and loss of purposeful hand use in girls: Rett's syndrome: report of 35 cases. Annals of neurology 1983;14:471-9.
2. Downs J, Leonard H. Longitudinal and population-based approaches to the study of the lifelong trajectories of children with neurodevelopmental conditions. In: Ronen GM, Rosenbaum PL, eds. Life Quality Outcomes in Children and Young People with Neurological and Developmental Conditions. London: Mac Keith Press; 2013:329-343.
3. Hagberg B. Rett syndrome: clinical peculiarities and biological mysteries. Acta paediatrica (Oslo, Norway : 1992) 1995;84:971-6.
4. 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;23:185-8.
5. Downs J, Torode I, Wong K, et al. Surgical fusion of early onset severe scoliosis increases survival in Rett syndrome: a cohort study. Dev Med Child Neurol 2016 58(6):632-8.
6. Fehr S, Bebbington A, Nassar N, et al. Trends in the diagnosis of Rett syndrome in Australia. Pediatric Research 2011;70:313-9.
7. Neul JL, Kaufmann WE, Glaze DG, et al. Rett syndrome: Revised diagnostic criteria and nomenclature. Annals of Neurology 2010;68:944-50.

8. Samaco RC, Neul JL. Complexities of Rett Syndrome and MeCP2. The Journal of Neuroscience 2011;31:7951-9.
9. Bebbington A, Anderson A, Ravine D, et al. Investigating genotype-phenotype relationships in Rett syndrome using an international data set. Neurology 2008;70:868-75.
10. Downs J, Stahlhut M, Wong K, et al. Validating the Rett Syndrome Gross Motor Scale. PloS one 2016;11:e0147555.
11. Downs J, Bebbington A, Jacoby P, et al. Level of purposeful hand function as a marker of clinical severity in Rett syndrome. Developmental Medicine and Child Neurology 2010;52:817-23.
12. Downs J, Torode I, Wong K, et al. The Natural History of Scoliosis in Females with Rett Syndrome. Spine (Phila Pa 1976) 2016 41(10):856-63.
13. Leonard H, Colvin L, Christodoulou J, et al. Patients with the R133C mutation: is their phenotype different from Rett syndrome patients with other mutations? Journal of Medical Genetics 2003;40:e52.
14. Robertson L, Hall SE, Jacoby P, Ellaway C, de Klerk N, Leonard H. The association between behavior and genotype in Rett syndrome using the Australian Rett syndrome database. American Journal of Medical Genetics Part B-Neuropsychiatric Genetics 2006;141B:177-83.
15. 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.
16. Hoffmann TC, Legare F, Simmons MB, et al. Shared decision making: what do clinicians know and why should they bother? Medical Journal of Australia 2014;201:35-9.
17. Downs J, Geranton S, Bebbington A, et al. Linking MECP2 and pain sensitivity: the example of Rett syndrome. American Journal of Medical Genetics Part A 2010;152A(5):1197-1207.
18. Burkitt CC, Breau LM, Zabalia M. Parental assessment of pain coping in individuals with intellectual and developmental disabilities. Research in developmental disabilities 2011;32:1564-71.
19. van der Putten A, Vlaskamp C. Pain assessment in people with profound intellectual and multiple disabilities; a pilot study into the use of the Pain Behaviour Checklist in everyday practice. Research in developmental disabilities 2011;32:1677-84.
20. Stallard P, Williams L, Velleman R, Lenton S, McGrath PJ, Taylor G. The development and evaluation of the pain indicator for communicatively impaired children (PICIC). Pain 2002;98:145-9.
21. Racine E, Bell E, Shevell M. Ethics in Neurodevelopmental Disability. In: Bernat JL, Beresford R, eds. Handbook of Clinical Neurology. San Francisco, CA: Elsevier B. V.; 2013:243-63.
22. Hickey KS, Lyckholm L. Child welfare versus parental autonomy: medical ethics, the law, and faith-based healing. Theoretical medicine and bioethics 2004;25:265-76.
23. Motil KJ, Caeg E, Barrish JO, et al. Gastrointestinal and nutritional problems occur frequently throughout life in girls and women with Rett syndrome. Journal of pediatric gastroenterology and nutrition 2012;55:292-8.
24. Ager S, Fyfe S, Christodoulou J, Jacoby P, Schmitt L, Leonard H. Predictors of scoliosis in Rett syndrome. Journal of Child Neurology 2006;21:809-13.
25. Bao X, Downs J, Wong K, Williams S, Leonard H. Using a large international sample to investigate epilepsy in Rett syndrome. Dev Med Child Neurol 2013;55:553-8.
26. Julu PO, Kerr AM, Apartopoulos F, et al. Characterisation of breathing and associated central autonomic dysfunction in the Rett disorder. Arch Dis Child 2001;85:29-37.
27. Wong K, Leonard H, Jacoby P, Ellaway C, Downs J. The trajectories of sleep disturbances in Rett syndrome. Journal of Sleep Research 2015;24(2):223-33.
28. Downs J, Bebbington A, Woodhead H, et al. Early determinants of fractures in Rett syndrome. Pediatrics 2008;121:540-6.
29. Downs J, Torode I, Wong K, et al. The natural history of scoliosis in females with Rett syndrome. Spine 2016 41(10):856-63.

30. Downs J, Bergman A, Carter P, et al. Guidelines for management of scoliosis in Rett syndrome patients based on expert consensus and clinical evidence. Spine 2009;34:E607-17.
31. Gabos PG, Inan M, Thacker M, Borkhu B. Spinal Fusion for Scoliosis in Rett Syndrome With an Emphasis on Early Postoperative Complications. Spine 2012;37:E90-E4.
32. Marr C, Leonard H, Torode I, Downs J. Spinal fusion in girls with Rett syndrome: post-operative recovery and family experiences. Child: care, health and development 2015 41(6):1000-1009.
33. Downs J, Torode I, Ellaway C, et al. Family satisfaction following spinal fusion in Rett syndrome. Developmental Neurorehabilitation 2016; 19:1, 31-37.
34. Sackett DL, Rosenberg WM, Gray JA, Haynes RB, Richardson WS. Evidence based medicine: what it is and what it isn't. BMJ (Clinical research ed) 1996;312:71-2.
35. Anderson A, Wong K, Jacoby P, Downs J, Leonard H. Twenty years of surveillance in Rett syndrome: What does this tell us? . Orphanet Journal of Rare Diseases 2014;9.
36. Baikie G, Ravikumara M, Downs J, et al. Gastrointestinal dysmotility in rett syndrome. Journal of pediatric gastroenterology and nutrition 2014;58:244-51.
37. Leonard H, Ravikumar M, Baikie G, et al. Assessment and Management of Nutrition and Growth in Rett Syndrome. Journal of pediatric gastroenterology and nutrition 2013;57:451-60.
38. Mahant S, Jovcevska V, Cohen E. Decision-making around gastrostomy-feeding in children with neurologic disabilities. Pediatrics 2011;127:e1471.
39. Downs J, Wong K, Ravikumara M, et al. Experience of gastrostomy using a quality care framework: the example of rett syndrome. Medicine 2014;93:e328.
40. Martinez-Costa C, Borraz S, Benlloch C, Lopez-Saiz A, Sanchiz V, Brines J. Early decision of gastrostomy tube insertion in children with severe developmental disability: a current dilemma. Journal of human nutrition and dietetics : the official journal of the British Dietetic Association 2011;24:115-21.
41. Sleigh G, Brocklehurst P. Gastrostomy feeding in cerebral palsy: a systematic review. Arch Dis Child 2004;89:534-9.
42. Gantasala S, Sullivan PB, Thomas AG. Gastrostomy feeding versus oral feeding alone for children with cerebral palsy. The Cochrane database of systematic reviews 2013;7:Cd003943.

Box 1: Quote illustrating parental reflections before and following spinal fusion

Parent 1: "I was extremely nervous. Just a whole lot of emotions, sleepless nights, worried about her recovery, worried about getting through the surgery, getting through the ICU stay and recovery and managing her lungs afterwards. I felt like it was a decision I had no choice but to make for her to have quality of life. I was worried about her health at the time because she was going through some pretty bad patches with central apnea as far as her breathing goes. So I was particularly worried about that. And she had a lot of tests done, lung function tests and so forth, so I was also anxious about them. I was anxious about whether she would be in good health for the surgery. She was on the waiting list and she got called up a couple of times and then it got cancelled. And you know if they call up and you cancel because of her health then she can be put back on the list for a couple of months so it's very anxious hoping your child is in good health so she can get through a big surgery.

After the surgery, my worries were gone, she did well and was only in hospital a short while …… I would advise other parents to be strong, be positive. Don't dwell on the negatives and how bad it could be, just think positively that your child will get through it. Always have positive thoughts and don't believe everything you hear. I heard horror stories from other parents but I had to focus on my daughter, not just on the horror stories. And think of how much is your child suffering and that the scoliosis could kill her, the earlier you choose to make the decision, the better the recovery for your child and the hope of her getting through it. So the earlier the better, and the better the quality of life"

Box 2: Quotes illustrating parental reflections before and after gastrostomy

Parent 2: "My daughter is so thin and I am desperately worried. I have succumbed to the acceptance that she will need a feeding tube to help her gain some weight and maintain it in times of ill health. This has been a difficult thing for me as I am sure it has been for all those who have gone through the same with your angels. There have been many years of anticipation and consideration, and feelings of dread and guilt that I could not nourish my own child."

Parent 3: "My daughter had been thin for years but after a rough two winters of chest infections and a particularly bad bout of pneumonia, she had to have a G-tube placed as an emergency procedure. I wish we had opted for the surgery prior to this, when she was well. I think in my mind I was using the excuse of Rett syndrome for her being so skinny. I would say to people 'girls with Rett are often small for their age'. But looking back at photos I can now see she wasn't just small for her age, she was too thin."