

Reduction of Deep Infections and Length of Stay in Paediatric Spinal Deformity Surgery After the Introduction of A Standardised Care Pathway

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ABSTRACT

AIM: The purpose of the study was to investigate the impact of a new care pathway in reducing deep infections and length of stay

following paediatric spinal deformity surgery in our institution.

METHOD: Restropective longitudinal cohort study of patients pre and post-institution of a new care protocol for paediatric patients undergoing scoliosis surgery were analysed. The new protocol introduced in 2010 involved all aspects of care pre, intra- and post operatively including patient, nurse and surgeon education with strict adherence to rules regarding wound care.

RESULTS: In total, 246 patients undergoing 275 procedures were studied. Between 2008 - 2009, 80 index procedures were performed, and between 2011 - 2012, 144 cases following the implementation of the pathway. There were no important demographic differences between the 2 cohorts. A significant reduction was seen in rates of infection from 37% to 2.9% for neuromuscular cases and 9.5% to 2.3% for idiopathic cases. An increased number of operations performed was also associated with a reduced mean hospital stay.

CONCLUSION: Deep infection rates following paediatric spinal deformity surgery carry major implications for morbidity. Complications including length of stay may be reduced with a team based approach to wound care.

Key words: Paediatric Scoliosis; Wound Infection; Team Approach; Care Pathway

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INTRODUCTION

Surgical correction of spinal deformities may be associated with numerous post-operative complications such as blood loss, neurological deficit, movement of instrumentation and deep wound infections often resulting in additional procedures, prolonged hospitalisation, increased cost and poor patient outcomes^[1]. The Scoliosis Research

Society(SRS) morbidity and mortality database, including 19360 patients, reported superficial and deep infection rates for paediatric scoliosis correction procedures as 1.0% and 1.7% respectively^[11] although smaller cohorts and reported more variable wider ranges of deep infection across all pathologies from 0.4% - 8.7%^[2].

Specifically, SRS reported infection rates for adolescent idiopathic scoliosis (0.8%) were lower than for neuromuscular scoliosis (3.8%)^[11]. These higher reported infection rates for patients with neuromuscular/syndromal scoliosis are relatively low in this cohort with others quoting a range of infection rates from 3.8% to 20.0%^[2,3,5,6] in this group. Economic implications resulting from deep infections are considerable: further investigations, potential further surgery, radiological procedures, long term antibiotic therapy and follow up. There is a significant increase in length of stay, loss of productivity for the patient and family and increased burden of travelling for repeated appointments^[7].

Factors contributing to a higher infection rate in neuromuscular scoliosis patients include recumbency, urinary and/or faecal incontinence wherein potential contamination of the wound is a major concern. Moreover, buttock or sacral pressure sores may develop due to skin insensitivity and pelvic decompensation, which can cause direct contamination or haematological spread to the surgical incision^[8]. Other general factors affecting infection include poor nutritional status^[9], excess body weight (insulin resistance or overt diabetes) or patients with a greater number of co-morbidities^[10]. Optimising the patient's general health pre-operatively is a crucial element in minimising infection risk.

The National Institute for Clinical Excellence (NICE) published clinical guidelines on best practice for managing surgical incisions with pre, intra and post-operative recommendations: Pre-operatively a thorough assessment of patient factors including MRSA screening with positive cases being treated with topical wash and nasal cream for 5 days, followed with repeat MRSA clear screen prior to surgery. Intra-operatively the process use of aseptic technique and suitable skin preparation was emphasised. Post-operatively wounds should undergo continual assessment, with minimal dressing changes and referral to wound care specialists if necessary. Furthermore, education of healthcare professionals, patients and carers on optimal wound care and identification of a non-healing wound is crucial, with adequate support from professionals and written sources of information^[11].

Intra-operatively many factors have been shown to be associated with increased deep infections including greater instrumentation volume^[12], longer length of operating time, significant blood loss, a posterior surgical approach and haematoma formation^[13,14]. Specific approaches to wound closure, such as application of betadine to lavage the wound^[15,16], and insertion of drains^[17] have all been shown to reduce this risk.

In order to minimise deep infection a conceptual model of a wound care pathway was developed based on the "4P's" which help standardise the clinical processes: Protocols, Policies, Procedures, and Patient education tools^[18]. This conceptual model was based upon the three phases of tissue repair: inflammatory, proliferative and maturation and allowed clinicians to monitor outcomes based on observable clinical parameters.

In 2008/9 we were concerned at a rise in infections in our unit and acted by instituting a specific spinal wound care pathway based on NICE recommendations and this conceptual model. We present the results following the instigation of this pathway and its impact on deep infection rates and length of hospital stay for paediatric spinal deformity patients having correction surgery.

MATERIALS AND METHODS

Study Design

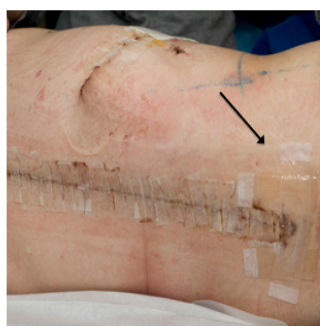
In a single-tertiary centre we retrospectively and prospectively collected data on two consecutive series of paediatric patients presenting to an orthopaedic spinal unit for posterior deformity correction procedures between January 2008 and December 2012. Retrospective patient data was collected from January 2008 - December 2009. Following institution of the new protocol prospective data was collected from January 2010 - December 2011. Each patient or their caregiver consented to inclusion in data collection for the study. Data for 2010 is not analysed as the protocol was not introduced uniformly across all practice until the end of 2010 and gradual changes occurred as the protocol was developed and instigated. The data is therefore presented before any protocol was started and after it was finalised. We have however included this data in our results but not our statistical analysis.

All patients (before and after the new policy) were followed-up at 12 days post-operatively by telephone by a recently appointed Spinal Nurse Practitioner (SNP). In addition, patients were encouraged to return for a wound review in the SNP clinic at 12 - 14 days and further consultant-led follow up at 6 - 8 weeks. Patients were advised to use the SNP dedicated telephone helpline during working hours 7 days a week for support and advice and to return for re-assessment in a hot clinic if wound complications were suspected up to 12 months post operatively. All paediatric patients continued to be followed up annually up to a minimum of 2 years and the incidence of superficial or deep infection and length of hospital stay recorded.

The specific standardised wound care changes introduced in 2010 were as follows: (1) Pre-operative education for patients and carers about post-operative wound care and prevention of infection, closely supervised by the Spinal Nurse Practitioner; (2) Meticulous supervised wound closure with bioclusive dressings and use of surgical wound drains for 48hours; (3) Withholding aseptic dressing changes until day 5 and 12 postoperatively; (4) Dedicated expert advice and support for patients including helpline and healthcare professionals regarding wound care postoperatively in Primary and secondary and primary care.

Pre-operatively patients with carers undertook an Advanced Nurse Practitioner led pre-operative assessment, which included Methyl Resistant Staph Aureus (MRSA) screening. Additionally a scoliosis information leaflet was produced, including advice about post-operative wound care. Intra-operatively, the use of drains had not been previously standardised or routine and dressings were variable with no regulation of re-dressing or stipulated rules for wound care. This was standardised and the dressing used was a robust bioclusive primary and secondary dressing with additional double sided sticky tape which was applied distally and proximally. The drains and epidural catheter were sited adjacent but outside the primary wound dressing and inside the secondary dressing to enable easy removal at 48 hours. Post-operatively patients were advised to keep the wound well dressed, avoid showering over the wound for at least 12 days or until the wound was dry; undergo a wound inspection at 5 and 12 days; and call the spinal telephone helpline immediately if they had any concerns. Patients and carers were educated about effective wound care and identifying infections, and the helpline number was included on the leaflet and hospital discharge summary. Posters were made (Figure 1) for education of staff to increase awareness.

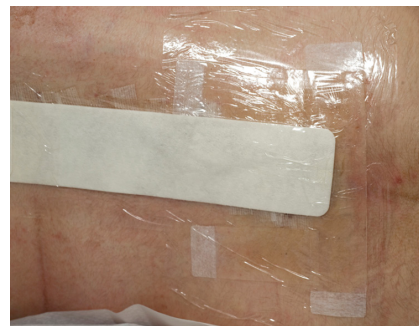
The same operating room was used for all cases and clear instructions and posters were sited to remind staff about good clinical practice e.g. minimising theatre personnel, limitation of door opening,



Following wound closure apply steristrips to the full length of the wound incision. Apply VAC tape to the distal end of the wound



Apply tegaderm pad to the full length of the wound with additional tegaderm bioocclusive dressing distally to cover the VAC double sided tape



Close up of how to apply VAC tape, tegaderm pad along full length of incision with extra bioocclusive distally to cover VAC tape



A secondary dressing of an absorbent pad and additional bioocclusive dressing over the primary dressing. If an epidural and drains are used then ensure that sited to facilitate easy removal, as shown with small adjacent dressing following removal of drains and epidural.

Figure 1 How to perform the scoliosis dressing Step by step guide.

mask compliance. There was no change in perioperative antibiotic prophylaxis for all cases in the study - on induction, intra-operative if greater than 4 hours and for 48 hours intravenously post-operatively. All wounds were lavaged with dilute betadine solution and had pulse lavage before and after the instigation of the wound care protocol. All wounds were closed with senior supervision and using the same sutures with a sub-cuticular closure to skin and steristrips. All procedures were carried out by the same cohort of four experienced consultant orthopaedic spinal surgeons.

Statistical Analysis

Baseline characteristics between the groups for age and number of comorbidities were compared using Student's T-test and Chi-squared test respectively. Deep infection rates, for all scoliosis curve subtypes, between the 2 groups (pre-protocol 2008/9 and post-protocol 2011/12) were compared using Fisher's exact test. Length of stay between the groups was compared using Student's T-test. Data from 2010 was excluded from statistical analysis. Statistical significance was accepted at $p < 0.05$.

RESULTS

In total, 246 paediatric patients undergoing 275 procedures were included in the study. During 2008/9 (before the implementation of the infections protocol), 80 deformity corrections were performed (19 neuromuscular/syndromal, 19 congenital and 42 idiopathic). During 2011/12 (after the implementation of the infections protocol) 144 cases were conducted (35 neuromuscular/syndromal, 25 congenital and 84 idiopathic). In the pre-protocol group (2008/9) 4 patients (5%) were lost to follow-up and in the post-protocol (2011/12) 3 patients (2.8%) were lost at 2-year follow-up. No significant difference was identified between the groups for age or prevalence of co-morbidities.

All neuromuscular/syndromal scoliosis corrections were single or double curves ranging from 40 - 120 degrees. All congenital and idiopathic cases were either thoracic or thoraco-lumbar fusions for curves > 40 degrees. Three cases were anterior/posterior idiopathic fusions, and 6 cases were revised to magnetically driven rods in the post-protocol 2011/12 group. The baseline characteristics and curve subtypes of the cases included in the study are summarised in Table 1. The absolute numbers of deep infections per annum, based on scoliosis subtype, are detailed in Table 2.

Pre-protocol (2008/9) there was an increased incidence of deep infection in the neuromuscular/syndromal cases (37%) when compared to both the congenital (5.2%) and idiopathic (9.5%) cases. Post-protocol (2011/12) the incidence of deep infection in neuromuscular/syndromal, congenital and idiopathic cases were all reduced to 2.9%, 0% and 2.3% respectively, when compared to the pre-protocol incidences.

The mean infection rates (all scoliosis subtypes) pre and post-protocol was 16.3% and 2.8% respectively, which was highly statistically significant ($p < 0.0004$) (Table 3). The commonest pathogens isolated were staphylococcus aureus in both groups, with the exception of the pre-protocol neuromuscular/syndromal cases, in which a high incidence of enterococcus faecalis was isolated. No cases of MRSA were identified.

An increase in the number of annual operations from 37 in 2008 to 71 in 2012 was observed. The mean length of stay pre and post-protocol was 6.3 and 5.6 days respectively but was not statistically significant ($p = 0.700$). No significant difference in the length of surgery or bed availability was observed between the groups.

DISCUSSION

Deep infections are a serious complication following deformity procedures, resulting in significant morbidity, a small risk of mortality

Table 1 Summary of patient demographics.

Year	Congenital (M/F)	Neuromuscular / Syndromal (M/F)	Idiopathic (M/F)	Total (M/F)	Curvatures / Procedures
2008	12 (4/8)	8 (1/7)	17 (5/12)	37 (10/27)	Congenital 40 - 120 degrees
					Neuromuscular/Syndromal 40-120 degrees
					Idiopathic 40 - 70 degrees
2009	7 (2/5)	11 (4/7)	25 (5/20)	43 (11/32)	Congenital 40 - 90 degrees
					Neuromuscular/Syndromal 70 - 100 degrees
					Idiopathic 40 - 100 degrees
2010	13 (5/8)	15 (8/7)	23 (1/22)	51 (14/37)	Congenital 70 - 130 degrees
					Neuromuscular/Syndromal 50 - 120 degrees
					Idiopathic 40 - 70 degrees
2011	10 (4/6)	22 (4/18)	41 (5/36)	73 (13/60)	Congenital 60 - 145 degrees
					Neuromuscular/Syndromal 40 - 110 degrees
					Idiopathic 40 - 80 degrees
					(1 case anterior/posterior fusion)
					(2 cases revised to magnetically driven rods)
2012	15 (7/8)	13 (6/7)	43 (5/38)	71 (17/54)	Congenital 50 - 120 degrees
					Neuromuscular/Syndromal 50 - 120 degrees
					Idiopathic 40 - 80 degrees
					(2 cases anterior/posterior fusion)
					(4 cases revised to magnetically driven rods)

Table 2 Summary of infections per aetiology scoliosis and overall.

Year	Congenital (No of Infections)	Neuromuscular (No of Infections)	Idiopathic (No of Infections)	Total Operations	Total Infections(%)
2008	12(0)	8(3)	17(2)	37	5 (13.5%)
2009	7(1)	11(4)	25(2)	43	7(16.3%)
2010	13(1)	15(1)	23(0)	51	2(3.9%)
2011	11(0)	21(1)	41(0)	73	1(1.4%)
2012	14(0)	14(0)	43(2)	71	2(2.8%)

Table 3 Summary of infections per group.

Groups /Year	Number of patients	Infections
Group 1 (2008/2009)	68	12
Group 2 (2011/2012)	141	3
Total	209	15

and exerting considerable economic impacts on hospital trusts, the wider health community and families involved. Here we demonstrate that the comparative infection rates, and a reduction in length of stay between two groups of paediatric patients undergoing procedures within a tertiary spinal orthopaedic centre were significantly reduced following the implementation of a wound care pathway and robust training for healthcare professionals, patients and carers.

Infection rates in the first groups of study participants for all types of scoliosis correction were considerably higher than the reported incidence rates. The relatively high infection rates quoted here in 2008/9 compared to previously published large series (8,9) may reflect a sample error based on a relatively small series or they may truly reflect an aberrant infection rate during this time period for which the reasons could be multifactorial. Nevertheless, the concern raised resulted in the development of our wound care and infection minimisation pathway to highlight the problem and to standardise practice.

In the second groups of patients between 2011 - 2012, the internationally reported rates and reduced significantly to align more closely with the quoted incidence rates and reflects a true reduction in infec-

tion incidence. We believe this was directly as a result of the multiple changes instigated with the standardized protocol.

The formalised care pathway has multiple facets pre, intra and post-operatively and this study simply shows that a combination of these reduces wound infection rate and does not identify which of these factors is the most important. A common sense approach to minimising infection addressing all potential factors is in our view important rather than relying on one particular modality of infection prevention e.g. antibiotic prophylaxis or betadine irrigation. Prior to the formalised pathway many modalities had been used in a non-formalised way outside a protocol which can lead to confusion and uncertainty within a team on how to manage a patient, their wound and conduct post-operative care. In our experience, this is particularly important following posterior approach spinal procedures as the wounds are hidden for considerable time periods between episodic inspections and therefore patient and or carer reporting of potential problems with the dressing is crucial.

The increased number of operations performed in the post-protocol group is interesting and we cannot definitively state why this was but we did have an increased number of referrals in this period proportionately less than the increased number of operations. We hypothesise that a more efficient service with less take backs for washout of wounds and more of a team based approach facilitated more operations being performed with a reduction in the numbers of patients on our waiting list. There was no increased operating capacity and so it would seem that an improvement in the use of theatre time for primary rather than revision cases or washout may have been a major

benefit to the population as a whole of our protocol.

The benefits of the protocol introduced are maintained and through education of new staff in the unit (which is inevitable) with a specific specialist nurse the hypervigilance of wound care that was instigated continues to be a vital component. This should always be the case for all surgical patients and this study demonstrates the need for team focus and direction towards one goal using the same methods rather than all wishing to attain the same goals via different protocols as we did before. Our study has limitations with relatively small numbers, heterogenous cohort and does not address one particular potential cause of infections but we strongly feel it highlights practice in the clinical setting, and the benefit of addressing many factors in a co-ordinated organised fashion as shown by our results.

Future work has involved rigorously auditing the adherence to this pathway and ongoing deep infection rates following paediatric scoliosis corrections (currently maintained at low levels), as well as expanding the wound-care protocol to cover different spinal procedures, such as adult deformity corrections, and promoting awareness amongst other orthopaedic and neurosurgical services performing major deformity surgery. We strongly recommend the use of a specific wound care pathway in the management of these complex patients where a wound problem can lead to devastating consequence not only for the individual patient but also for the efficiency of the system as a whole.

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