Cardiology in the Young

cambridge.org/cty

Wound management across Australian and New Zealand pediatric cardiac services: a cross-sectional survey

Jennifer Orchard[1], Jessica Suna[1], Anna Renner[1], Lara Gordon[2], Lianne McCarthy[3], Natasha Pool[1], Mary Tallon[4,5,6] and Amanda J. Ullman[1,7,8]

[1]Queensland Children's Hospital, Children's Health Queensland Hospital and Health Service, Brisbane, Australia; [2]The Children's Hospital at Westmead, The Sydney Children's Hospital Network, Sydney, Australia; [3]Starship Child Health, Te Toka Tomai, Auckland, New Zealand; [4]HeartKids Ltd, Parramatta, Australia; [5]School of Nursing, Curtin University, Perth, Western Australia; [6]Perth Children's Hospital, Perth, Western Australia; [7]School of Nursing, Midwifery and Social Work, The University of Queensland, Brisbane, Australia and [8]NHMRC Centre for Wiser Wound Care, Griffith University, Brisbane, Australia

Original Article

Cite this article: Orchard J, Suna J, Renner A, Gordon L, McCarthy L, Pool N, Tallon M, and Ullman AJ (2024) Wound management across Australian and New Zealand pediatric cardiac services: a cross-sectional survey. *Cardiology in the Young* **34**: 1432–1438. doi: 10.1017/S1047951123003025

Received: 23 May 2023
Revised: 5 July 2023
Accepted: 5 July 2023
First published online: 6 November 2023

Keywords:
Paediatric cardiac surgical wound care practices; CHD; multimodal research and education

Corresponding author:
J. Orchard;
Email: jennifer.orchard@health.qld.gov.au

Abstract

Background: CHD is associated with considerable burden of care. Up to one-third of babies born with CHD require surgery or intervention during the first year of life with an associated increased risk of surgical site infection. Pediatric wound care is informed largely by adult data, with no national or international guidelines available. *Aim:* To examine pediatric cardiac surgical wound care practices reported by healthcare professionals Australia and New Zealand-wide. *Methods:* A bi-national cross-sectional survey exploring pre-, intra- and post-operative wound practices was distributed using Exponential Non-Discriminative Snowball Sampling. Data were subject to descriptive analysis using SPSS Statistics 22.0. *Findings:* Sixty-eight surveys representing all Australian and New Zealand pediatric cardiac surgical services were analyzed. Most respondents were experienced nurses. Pre-operative care varied greatly in practice and pharmaceutical agents used. Little consistency was reported for intra- and post-operative wound care. Nursing and medical staff shared responsibility for wound care. Wound photography was widely used, but only uploaded to electronic medical records by some. *Discussion:* These results highlight that wound care management is largely informed at an institutional level. The many practices reported are likely to reflect a range of factors including cardiac condition complexity, surgery, prematurity, and the presence of scar tissue. The importance of a research and training program, which is multimodal, available, and reflective, is highlighted. *Conclusion:* These findings call for the establishment of a nurse-led program of research and education. The resultant suite of cardiac wound strategies could offer an effective and consistent pathway forward.

Globally, the reported prevalence of Childhood-onset Heart Disease varies between 4 and 10 per 1,000 live births.[1–3] Half of these babies will require surgical intervention in their lifetime, and almost a quarter will develop an infection related to their hospital stay, sometimes in the sternal or thoracotomy surgical wound.[4–6] Surgical site infections increase morbidity and mortality, quadruple the risk of death, and double the length of hospital admission and/or intensive care stay.[7,8]

Paediatric surgical site infection management strategies are largely drawn from data extrapolated from adult guidelines.[9–11] Because of the quality of evidence available, the clinical practice guidelines are often principle-based, rather than direct, pragmatic instruction required for a diverse population with varying anatomy, physiology, and associated risk for complications such as surgical site infections and wound dehiscence. No national or international guidelines currently exist for the management of cardiac surgery wounds in children. Further, there are little high-quality research trials on this topic to inform the development of these guidelines.

The prevention of surgical site infections in this population crosses many health disciplines and departmental siloes. As the children pass through pre-operative units, operating theatres, ICUs, infant/cardiac surgical wards, and into the home care environment, their wound is managed by interdisciplinary clinicians with a range of expertise and training. Each interaction with this vulnerable cohort and surgical wound is an opportunity to promote wound healing, or conversely, cause surgical site infections. Studies focusing on reducing infection in delayed sternal closure and examining optimal antibiotic regimes suggest the need for coordinated wound assessments.[12,13,18] However, there is a paucity of evidence examining nursing and interdisciplinary practices regarding acute surgical wound management in this population.[12–13] In particular, nurses are a vital workforce to ensure the effective management of post-surgical wounds in paediatrics,[14] but their current practice and training are relatively unexplored.

This study aimed to explore wound management practices by health care professionals caring for children undergoing cardiac surgery in Australia and New Zealand. The results of this study will then be used to design high-quality interventional studies and local education and quality improvement projects to improve the use of evidence in cardiothoracic wound care practice, and thereby prevent surgical site infections.

Materials and method

Design

A bi-national cross-sectional study, using an online survey, was used to explore current practices surrounding paediatric cardiac surgery wounds across Australia and New Zealand.

Data collection methods

The online survey was structured using local wound management guidelines unspecific to paediatric/cardiac services. In addition to collection of basic survey respondent characteristics, it included 24 items across the domains of pre-operative (i.e., skin assessment, skin preparation), intra-operative (i.e., skin decontamination, dressings), post-operative (i.e., wound surveillance), and wound management (i.e., topical agents, wound documentation, systemic antibiotic indications, education). The survey included multi-choice and free text responses (see Supplementary file). The survey was iteratively developed by the investigator team (10 nurses, >100 combined years of paediatric, wounds, and/or cardiac care practice), and internally piloted for face and content validity,[14,15] prior to distribution.

Sample characteristics

An Exponential Non-Discriminative Snowball Sampling approach was used. At least one nurse from each Australian or New Zealand healthcare facility known to provide paediatric cardiac surgical care (n = 5) was contacted and recruited to complete the survey. They then provided multiple referrals to varying clinical departments within their own institute. Each new referral provided more data for referral and so on until there were enough subjects for the sample. All clinicians in an Australia or New Zealand institution who actively provide cardiac surgical management of children were eligible to participate.

Survey administration

The survey was distributed in June and July 2022, via email to existing collaborative networks. Participants were provided with an anonymised link to the purpose-built Microsoft® Form. The survey was open for just under two months and closed on the 29th of July 2022.

Ethical considerations

Ethics approval was obtained from the Children's Health Queensland Hospital and Health Service Human Research Ethics Committee before the study commenced. Consent was obtained by the participant agreeing to complete the survey. All data were collected anonymously and results have not been linked to individuals or health services.

Data analysis

All results were analysed descriptively according to their characteristics and distribution. Continuous variables are described as mean, median, standard deviation and interquartile range values. Categorical data are described using frequencies and percentages. Response rate calculation was not feasible, due to distribution methods (i.e., mixed paediatric/adult associations, social media). Data were analysed using PASW 22.0 (SPSS Inc., Chicago, IL). Missing data are described throughout the results tables.

Results

Respondent characteristics and descriptive results

Table and Figure 1 display the demographic and professional characteristics of the respondents. There were 68 respondents to the survey, representing all Australian states and New Zealand with paediatric cardiac surgical services (Northern Territory and Tasmania do not have dedicated services). The majority of respondents were nurses, with greater than 10 years of practice. They represented the range of practice areas managing post-cardiac surgery wounds, including the paediatric intensive care unit, general ward, and overarching service roles. Two-thirds (65%) of respondents reported using adult based cardiac post-operative wound management guidelines.

Main findings

Pre-operative practices

As reported in Table 2, over 40% (n = 28) of survey participants were unsure if pre-operative skin assessments occurred at their place of practice, however, 54% (n = 37) did recognise that skin assessments were conducted during a patient's pre-admission visit. Skin assessment tools employed included Glamorgan Tool (33%, n = 4), Risk Assessment (33%, n = 4), and Others (33%, n = 4).

Almost all respondents (93%; n = 63) reported using pre-operative washing plans, however, timing and washing agents differed. Pre-operative washing was carried out both the night prior to and the day of surgery amongst 57% (n = 39) of survey respondents. Chlorhexidine gluconate solution added to wash water was identified as the most common washing agent (26%, n = 18), followed by a chlorhexidine gluconate-impregnated sponge (22%, n = 15) and multiple washing agents (18%, n = 12). A total of eight agents were identified, with antibacterial wipes used alone (44%, n = 30) and in conjunction with pre-operative washes (24%, n = 16).

Prophylactic antibacterial topical ointments (i.e., mupirocin) were identified by 57% (n = 39), with 5% unsure of commencement and duration of mupirocin. While 57% (n = 39) reported use of mupirocin, wide variety of application days were reported, both pre- (3–1 days pre-op), intra- (day of surgery), and post- (1–5 days) operatively, including over eleven different schedules.

Intra-operative practices

Most respondents (65%; n = 68) were unsure of what type of skin solution was used in theatre, with the remaining using chlorhexidine gluconate in alcohol (21%; n = 14), Povidine iodine in alcohol (9%; n = 6), and Povidine iodine in water (4%; n = 3).

There was a variety of approaches to surgical wound management after direct closure in theatres. While 29% (n = 18) of respondents were unsure and 13% (n = 9) reported their dressing type varied depending on patient characteristics and/or

https://doi.org/10.1017/S1047951123003025 Published online by Cambridge University Press

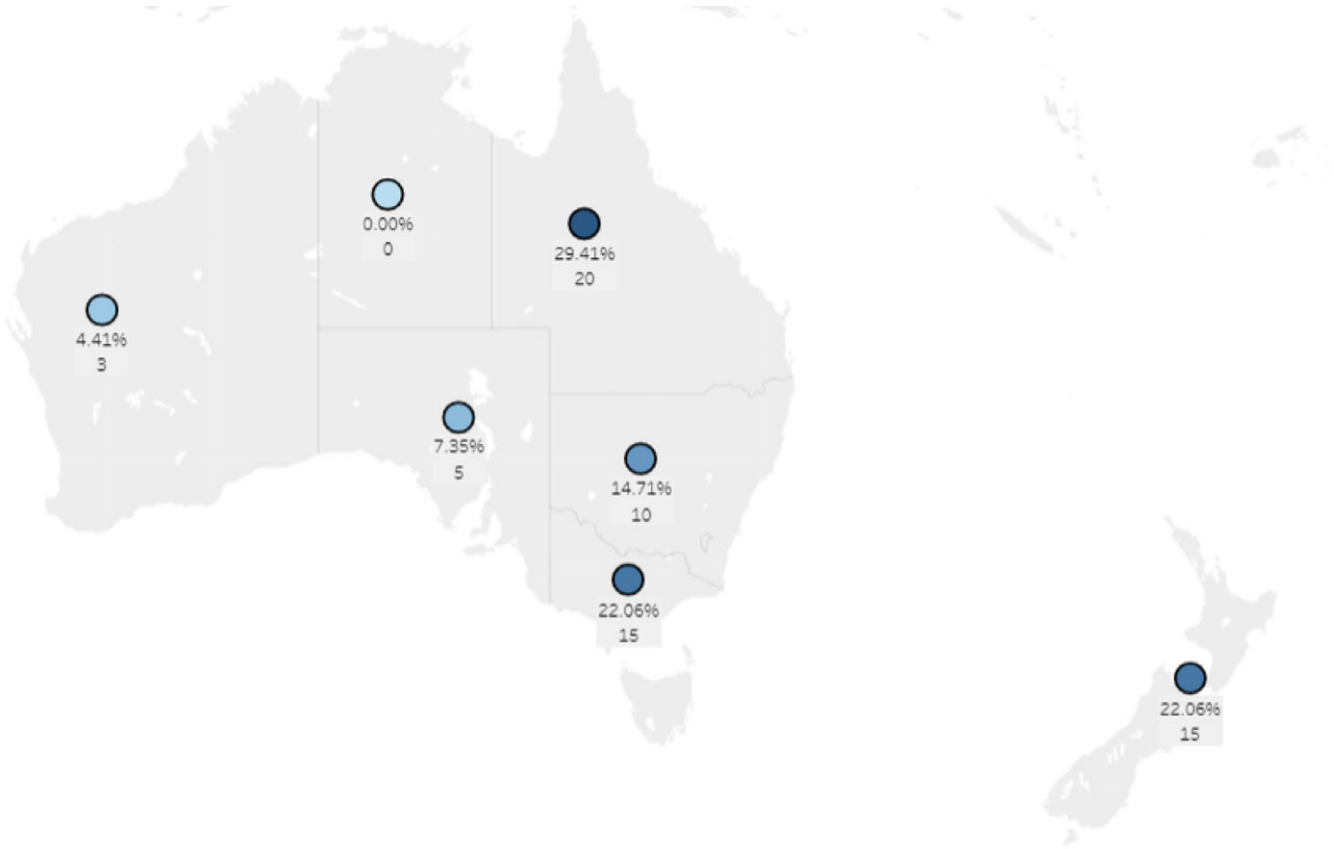

Figure 1. Geographical distribution of survey respondents.

surgeon preference, 26% (n = 18) reported that their centre uses occlusive hydrocolloid dressings, 13% (n = 9) transparent adhesive film dressings, 7% (n = 5) used surgical wound glue, and 6% (n = 4) used bordered film dressings.

Participants were primarily unsure (74%, n = 50) regarding dressing types used when the patient's sternum is left open in the immediate post-operative period. While 10% (n = 7) sometimes used a patch, however, they were uncertain about what patch material was used.

Post-operative management

As reported in Table 3, most participants identified post-operative wound surveillance as a shared responsibility at 72% (N = 49). Frequency of post-operative wound surveillance was variable; with daily (37%; N = 37) being the most common, followed by as required (24%; N = 24), with 14% (N = 14) reporting that their surveillance was conducted more frequently than daily (multiple response options available).

The post-operative day dressings are removed also varied between 3–9 days (mean: 6 days [SD2.8]). The location for dressings removal when a patient was discharged was most frequently done in either post-operative surgical review clinic at 36% (N = 23) or post-operative surgical review clinic/ GP at 28% (N = 18). Many (30%; N = 19) were unsure where patients' dressing removal took place.

Most participants reported a combination of agents 41% (N = 41) were used, followed chlorhexidine gluconate solutions 32% (N = 32) and saline 24% (N = 24). Topical agents were used commonly on the wound and surrounding skin at 81% (N = 99).

Only 21% (N = 14) of respondent's identified that a tool/ checklist was used to assess wound healing. Of those, there was not a standardised tool used either within individual centres or as a whole. Dressing changes were most commonly completed by multiple individuals with 49% (N = 72), or by bedside nurses (24%; N = 16). The date of suture removal varies between 1 and 2 weeks (mean: 11 days [SD 3]).

As reported in Table 4, wound swabs to assess for wound infections were most commonly taken by multiple individuals (physicians and nurses; 53% [N = 36]). Just under half the participants at 49% (N = 33) identified that infectious disease team were involved in wound management. Wound photography is relatively standard practice across all centres as an aid for wound surveillance with 87% (N = 59) responding that this was used within their centre. Only 51% (N = 35) of respondents reported that these photos were uploaded to patient's medical record.

Only 34% (N = 23) of respondents identified they used specific definitions to describe wound infections. The instigation of antibiotic therapy was most commonly a combined approach with multiple individuals/teams (80%; N = 55). Reasons for starting antibiotics were also varied.

Education and training

Most respondents (82%; N = 56) routinely provide education and information to families, mainly via written format (65%; N = 44). Only 22% (N = 15) of clinician respondents had received any training in wound management, and of those, the training was on average 6 years ago (SD 4). Most participants (88%; N = 60) highlighted they would like training in wound management.

https://doi.org/10.1017/S1047951123003025 Published online by Cambridge University Press

Table 1. Respondent characteristics (N = 68).

	n (%)
Current role	
Registered nurse	33 (49%)
Care coordinator/clinical nurse	15 (22%)
Clinical nurse consultant	10 (15%)
Nurse educator	2 (3%)
Surgical fellow	2 (3%)
Other	5 (13%)
Years of practice	
<3 years	2 (2%)
>3 years and <5 years	6 (9%)
>5 years and <10 years	13 (19%)
>10 years and <20 years	25 (37%)
>20 years	22 (32%)
Place of work	
Queensland	20 (29%)
New Zealand	15 (22%)
Victoria	15 (22%)
New South Wales	10 (15%)
South Australia	5 (7%)
Western Australia	3 (4%)
Area of practice	
Paediatric ICU	26 (38%)
Cardiology ward	23 (34%)
Overarching service role	7 (10%)
Outpatient department	5 (7%)
Neonatal ICU	2 (3%)
Theatre	2 (3%)
Paediatric ward	2 (3%)
Other	1 (1%)
Average number of cardiac surgical patients seen per week	
<1 patient	3 (4%)
>20 patients	8 (12%)
>1 patient to <5 patients	17 (25%)
>10 patients to <20 patients	13 (19%)
>5 patients to <10 patients	27 (40%)
Use specific cardiac post-operative wound management guidelines	
Yes	44 (65%)
No	12 (18%)
Unsure	12 (18%)

Table 2. Pre-operative practices (N = 68).

	n (%)
Pre-operative skin assessment	
Yes	37 (54%)
Unsure	28 (41%)
No	3 (4%)
Timing of pre-operative skin assessment	
Pre-operatively in pre-admission visit	37 (54%)
Unsure	25 (37%)
Day of surgery	6 (9%)
Pre-operative wound risk assessment tools	
No	34 (50%)
Unsure	22 (32%)
Yes	12 (18%)
Name of wound risk assessment tools	
Glamorgan	4 (33%)
Risk assessment	4 (33%)
Other	4 (33%)
Local plan for pre-operative skin preparation	51 (75%)
Local pre-operative washing plans	63 (93%)
Timing of washes	
The night prior to surgery & day of surgery	39 (57%)
The night prior to surgery	11 (16%)
The day of surgery	8 (12%)
Unsure	7 (10%)
5 days prior to surgery	2 (3%)
Daily for 5 days before surgery	1 (1%)
Washing agent used in pre-operative washes	
CHG solution added to wash water	18 (26%)
CHG-impregnated sponge	15 (22%)
Multiple washing agents	12 (18%)
CHG wipes	9 (13%)
Soap and water	6 (9%)
Triclosan wash	1 (1%)
Unsure	7 (10%)
Antibacterial wipes in pre-operative skin preparation	30 (44%)
Antibacterial wipes used in addition to pre-operative washes	16 (24%)
Prophylactic antibacterial topical ointment (e.g., mupirocin)	39 (57%)
CHG: chlorhexidine gluconate	

Discussion

Surgical site infections and wound dehiscence are serious and common problems for infants and children recovering from cardiothoracic surgery. However, the Australian and New Zealand management of paediatric cardiothoracic wounds (both sternal and thoracotomy) were shown throughout this survey to be a highly varied practice. This current state is mostly because of the absence of evidence-based, comprehensive clinical practice guidelines being available to inform practice. These guidelines are likely

https://doi.org/10.1017/S1047951123003025 Published online by Cambridge University Press

Table 3. Post-operative wound surveillance and management (N = 68).

	n (%)
Individual responsible for post-operative wound surveillance	
Shared responsibility	49 (72%)
Departmental nursing team (e.g., intensive care and ward nurses)	5 (7%)
Consultant surgeon/Surgical fellows	4 (6%)
Surgical nursing team (e.g., specialist cardiac nurses)	4 (6%)
Unsure	1 (1%)
Other	5 (7%)
Frequency of post-operative wound surveillance (multiple responses)	
Daily	37 (37%)
As required	24 (24%)
When departments report a concern	15 (15%)
More frequently	14 (14%)
Other	7 (7%)
Unsure	3 (3%)
Post-operative day dressings removed, mean ± SD	6 ± 2.8
Post-operative dressing removal location (when discharged)	
In post op surgical review clinic	23 (36%)
In post op surgical review clinic or at the local general practitioner	18 (28%)
At the local general practitioner	3 (5%)
Cardiology outpatient	1 (2%)
Unsure	19 (30%)
Use checklist/tool to assess wound healing	14 (21%)
Wound cleansing solution used *(multiple responses)*	
CHG	44 (44%)
Saline	38 (38%)
Povidine/iodine	11 (11%)
Other	4 (4%)
Unsure	2 (2%)
Individual responsible for dressing changes	
Bedside nurses	16 (24%)
Surgical fellows/ Consultant surgeons	12 (18%)
Multiple individuals	40 (59%)
Individual responsible for suture removal	
Bedside nurses	13 (19%)
Multiple individuals	42 (62%)
Surgical medical team	4 (6%)
Surgical nursing team or clinical nurse consultant/specialist	2 (3%)
Unsure	1 (1%)
Not applicable (dissolvable sutures used)	6 (9%)
Day of suture removal, mean ± SD	11 ± 3

CHG: Chlorhexidine gluconate; SD: Standard deviation

Table 4. Wound complication identification and treatment (N = 68).

	N (%)
Responsible for wound swabs	
Bedside nurses	25 (37%)
Multiple individuals	36 (53%)
Surgical fellows	7 (10%)
Topical agents used on wound and surrounding skin	55 (81%)
Infectious disease team involvement	33 (49%)
Photos	
Photos of wounds taken for surveillance	59 (87%)
Uploaded into electronic medical record	35 (51%)
Capture wound infection data in database	26 (38%)
Specific definitions to describe wound infections	23 (34%)
Antibiotic therapy instigated by	
Consultant surgeons	8 (12%)
Surgical fellows	3 (4%)
Multiple individuals/teams	55 (80%)
Unsure	2 (2%)
Reason for starting antibiotics *(multiple responses)*	
Febrile or other clinical signs of infection	52 (40%)
Positive wound swab	47 (28%)
Wound exudate	37 (22%)
Redness	23 (14%)
Unsure	6 (4%)
Other	3 (2%)
Use topical agents on wounds for infections	4 (6%)

absent because of lack of clinical trials to inform them, and the tradition of this speciality's research being driven by surgeons with differing priorities. However, nursing research has a strong background in the creation of high-quality evidence in wound care but has more traditionally focussed on pressure injuries and mechanical skin injuries, rather than surgically inflicted wounds.[16] Paediatric cardiothoracic wound management to prevent infections and promote wound healing represents a strong opportunity for interprofessional collaboration, and future interventional studies of innovation effectiveness (e.g., chlorhexidine-impregnated dressings).

Identifying the wound care management needs of this patient population requires an interprofessional health care team to assist clinical leaders in decisions around wound care and understanding the available consumables and equipment to assist with wound healing. This process should involve using clinicians with expertise in evidence-based practice, as well as patient education and preventative measures to reduce the risk of wound infection and complications.[17] In order to assist future clinicians in making informed decisions around wound care, it is important that resources are easily available, clear to understand, and promote a standardised approach. This standardised approach should include specific care practices (e.g., cleaning, dressing, and prophylactic antibiotics) across

https://doi.org/10.1017/S1047951123003025 Published online by Cambridge University Press

the major domains of wound management (pre-, intra-, and post-operative care),[18] which would be a good focus for future quality improvement and interventional studies.

However, despite a baseline focus on standardisation, this is a complex population where targeted, specialised care is often necessary. This heterogeneity includes the severity of conditions, presence of co-morbidities (i.e., genetic syndromes), age-specific structures (e.g., skin), and the developing body over the life span.[17] This is especially pertinent in paediatrics, with major physical maturation and changes between 0 and 18 years. The maturity of skin structures affects infection prevention, wound healing, and underlying skin pathologies.[16,19] During the neonatal period, the skin is especially friable and at risk for significant complications such as infections and subcutaneous fat necrosis.[20] During adolescence, wound practices must recognise and plan for the development of breasts and chest hair, and the increased probability of acne. The developmental stage of the patient also has an effect on the compliance to wound management, including the consideration of wound care as a potentially difficult, traumatic, or painful procedure.[21] Overall, while this means that although the principles should be standardised, specific care needs to be adaptive and personalised to the individual patient requirements.

The cross-sectional survey results signalled that there is a demand from healthcare professionals for the provision of education and training for those involved in the management of cardiac surgical wounds in the paediatric population. Given that the majority of respondents in the survey were nursing professionals, we can assume that this would be deemed particularly beneficial in this healthcare group. However, because of the multi-disciplinary team involvement with surgical wound management, it would be important to extend education and teaching to all healthcare professionals involved in the management of cardiac surgical wounds. This training needs to include the use of evidence-based practice in this field of care using the most up-to-date research for wound management as well as drawing on existing wound management programmes. Practically, centres should also partner with existing advanced wound care practitioners, including plastic surgery, and access their disciplines' clinical research.

This research has limitations. Despite the survey being multi-centred, the results cannot be generalised outside of Australia and New Zealand affecting the external validity of the outcomes discussed. Additionally, as there were multiple respondents from each centre, variability of knowledge on individual aspects of care may differ, and not reflect actual practice. However, it provides a good base to develop further research using a larger international study population. In addition, surveys do not always accurately reflect actual practice and may be impacted by response bias, ultimately affecting the internal validity of the data. The reliability of the data could also be affected by the use of a survey tool, with results not necessarily being repeatable. However, despite the limitations, this is the first study to investigate practices surrounding wound care in the paediatric cardiac surgery patient population and will contribute to designing a larger multi-centred study and a growing body of evidence.

Conclusion

This study has provided insight into the varied range of surgical wound care practices for children undergoing cardiac surgery across Australia and New Zealand. Largely linked to evidence from the adult population, the variety of wound care practices reported in this study highlights the yawning gap in research evidence for wound management and surgical site infection guidelines that specifically address the unique needs of the paediatric cardiac surgical cohort. Paediatric cardiac surgical wound care strategies continue to be informed mostly by surgical preference. The considerable burden related to morbidity and mortality risks associated with surgical site infection among vulnerable newborn infants and children undergoing cardiac surgery warrants a comprehensive nurse-led enquiry. The recent establishment of a collaborative forum for Australia and New Zealand paediatric cardiac surgical nurses provides a timely opportunity to progress research enquiry in this area. A programme of interventions and education has the potential to provide a consistent suite of cardiac surgical wound care strategies for newborn infants and children undergoing cardiac surgery that are implemented and evaluated by the paediatric cardiac surgical nurses who care for them.

Supplementary material. The supplementary material for this article can be found at https://dx.doi.org/10.1017/S1047951123003025.

Acknowledgements. We would like to acknowledge the nurses who took the time to participate in the survey and the clinical associations who supported the research through distribution.

Competing interests. The authors have no conflicts of interests to disclose. The project was unfunded.

References

1. Australian Government. National Strategic Action Plan for Childhood Heart Disease. Department of Health, Canberra, 2019.
2. Australian Institute of Health and Welfare. Congenital Heart Disease in Australia. Australian Government, Canberra, 2019.
3. Ferencz C, Rubin JD, McCarter RJ, et al. Congenital heart disease: prevalence at livebirth. The Baltimore-Washington infant study. Am J Epidemiol 1985; 121: 31–36.
4. Bratzler DW, Dellinger EP, Olsen KM, et al. Clinical practice guidelines for antimicrobial prophylaxis in surgery. Am J Health Syst Pharm 2013; 70: 195–283.
5. Ridderstolpe L, Gill H, Granfeldt H, Ahlfeldt H, Rutberg H. Superficial and deep sternal wound complications: incidence, risk factors and mortality. Eur J Cardiothorac Surg 2001; 20: 1168–1175.
6. Sahu MK, Siddharth CB, Devagouru V, et al. Hospital-acquired infection: prevalence and outcome in infants undergoing open heart surgery in the present era. Indian J Crit Care Med 2017; 21: 281–286.
7. Braxton JH, Marrin CA, McGrath PD, et al. 10-year follow-up of patients with and without mediastinitis. Semin Thorac Cardiovasc Surg 2004; 16: 70–76.
8. Demmy TL, Park SB, Liebler GA, et al. Recent experience with major sternal wound complications. Ann Thorac Surg 1990; 49: 458–462.
9. Huang JH, Sunstrom R, Munar MY, et al. Are children undergoing cardiac surgery receiving antibiotics at subtherapeutic levels? J Thorac Cardiovasc Surg 2014; 148: 1591–1596.
10. Kreter B, Woods M. Antibiotic prophylaxis for cardiothoracic operations. Meta-analysis of thirty years of clinical trials. J Thorac Cardiovasc Surg 1992; 104: 590–599.
11. Sochet AA, Cartron AM, Nyhan A, et al. Surgical site infection after pediatric cardiothoracic surgery. World J Pediatr Congenit Heart Surg 2017; 8: 7–12.
12. Woodward C, Taylor R, Son M, Taeed R, Husain SA. Efforts to reduce infections in delayed sternal closure patients: a survey of pediatric practice. World J Pediatr Congenit Heart Surg 2020; 11: 310–315.
13. Woodward CS, Son M, Calhoon J, Michalek J, Husain SA. Sternal wound infections in pediatric congenital cardiac surgery: a survey of incidence and preventative practice. Ann Thorac Surg 2011; 91: 799–804.
14. Bannigan K, Watson R. Reliability and validity in a nutshell. J Clin Nurs 2009; 18: 3237–3243.

15. DeVon HA, Block ME, Moyle-Wright P, et al. A psychometric toolbox for testing validity and reliability. J Nurs Scholash 2007; 39: 155–164.
16. August D, Ullman A, Coyer F. Device related pressure injuries across the critical care lifespan. Nurs Crit Care 2023; 28: 6–8.
17. Prendin A, Tabacco B, Fazio PC, de Barbieri I. Management of pediatric cardiac surgery wound: a literature review. Acta Biomedica Atenei Parmensis 2021; 92: e2021203.
18. Jha NK, Shafique M, Thomas R, Pangilinan Cruz S, Tariq G, Kiraly L. The sternal wound management in pediatric cardiac surgical patients: implementation of wound care pathways incorporating principles of wound bed preparation paradigm and early-advanced therapy. Adv Skin Wound Care 2022; 35: 00–00.
19. August D, van der Vis KM, New K. Conceptualising skin development diagrammatically from foetal and neonatal scientific evidence. J Neonatal Nurs 2019; 25: 311–314.
20. Stefanko NS, Drolet BA. Subcutaneous fat necrosis of the newborn and associated hypercalcemia: a systematic review of the literature. Pediatr Dermatol 2019; 36: 24–30.
21. Shiferaw A, Mola S, Gashaw A, Sintayehu A. Evidence-based practical guideline for procedural pain management and sedation for burn pediatrics patients undergoing wound care procedures. Ann Med Surg 2022; 83: 104756.

https://doi.org/10.1017/S1047951123003025 Published online by Cambridge University Press