

Physical Therapy

Journal of the American Physical Therapy Association



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PHYS THER. 2012; 92:83-97.

Originally published online September 23, 2011

doi: 10.2522/ptj.20100373

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Management of Sternal Precautions Following Median Sternotomy by Physical Therapists in Australia: A Web-Based Survey

Lara J. Tuyl, Jennifer H. Mackney, Catherine L. Johnston

Background. Sternal precautions are utilized within many hospitals with the aim of preventing the occurrence of sternal complications (eg, infection, wound breakdown) following midline sternotomy. The evidence base for sternal precaution protocols, however, has been questioned due to a paucity of research, unknown effect on patient outcomes, and possible discrepancies in pattern of use among institutions.

Objective. The objective of this study was to investigate and document the use of sternal precautions by physical therapists in the treatment of patients following median sternotomy in hospitals throughout Australia, from immediately postsurgery to discharge from the hospital.

Design. A cross-sectional, observational design was used. An anonymous, Web-based survey was custom designed for use in the study.

Methods. The questionnaire was content validated, and the online functionality was assessed. The senior cardiothoracic physical therapist from each hospital identified as currently performing cardiothoracic surgery (N=51) was invited to participate.

Results. The response rate was 58.8% (n=30). Both public (n=18) and private (n=12) hospitals in all states of Australia were represented. Management protocols reported by participants included wound support (n=22), restrictions on lifting and transfers (n=23), and restrictions on mobility aid use (n=15). Factors influencing clinical practice most commonly included “workplace practices/protocols” (n=27) and “clinical experience” (n=22).

Limitations. The study may be limited by response bias.

Conclusions. Significant variation exists in the sternal precautions and protocols used in the treatment of patients following median sternotomy in Australian hospitals. Further research is needed to investigate whether the restrictions and precautions used are necessary and whether protocols have an impact on patient outcomes, including rates of recovery and length of stay.

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[Tuyl LJ, Mackney JH, Johnston CL. Management of sternal precautions following median sternotomy by physical therapists in Australia: a Web-based survey. *Phys Ther.* 2012;92:83–97.]

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Published Ahead of Print:

September 23, 2011

Accepted: July 11, 2011

Submitted: November 7, 2010



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Cardiac surgery, such as coronary artery bypass grafting (CABG) and valve replacement, is commonly used in the management of heart disease.¹⁻⁴ More than 17,000 CABGs are performed annually in Australia, and more than 300,000 CABGs are performed annually in the United States.¹⁻³ Median, or midline, sternotomy is the most frequently used incision during cardiac surgery, as it provides optimal access to the heart and surrounding blood vessels.⁵⁻⁸ Median sternotomy involves the division of the manubrium and sternum centrally and wide separation using retractors.⁵ The sternum is most commonly closed using stainless steel wires.^{8,9} For the majority of patients, the sternum heals well. The incidence of postoperative sternal complications, such as sternal dehiscence, infection, and sternal instability, is reported as between 1% and 5%.^{5,10} Deep wound infection is the most severe of the possible sternal complications and is associated with prolonged hospitalization, high costs, and high rates of morbidity and mortality.¹¹⁻¹⁴

Protocols and policies have been developed within institutions relating to the sternal precautions used by physical therapists in their treatment of patients who have undergone median sternotomy.¹⁵⁻¹⁸ Restrictions on movement and sternal loading are frequently imposed on patients, including limiting upper-limb movements to bilateral movements only and limiting weight bearing through the upper limbs.¹⁵⁻¹⁹ Despite the common use of postoperative restrictions, the impact of upper-limb movement and loading on the healing sternum is not known, and current precautions, therefore, are based only on proposed theoretical rationale.¹⁷⁻²¹ Furthermore, sternal precautions following median sternotomy have been criticized in recent literature,

with suggestions that current protocols are overly restrictive and impede patients' recovery and postoperative quality of life.^{18,19,22,23}

There is limited research investigating the sternal precautions used by physical therapists in their treatment of patients who have undergone median sternotomy, and no clinical guidelines in this area have been published.^{17,18,20,21} The physical therapy treatment of patients following cardiac and thoracic surgery has previously been investigated in Australia and New Zealand,^{21,24,25} in the United Kingdom,²⁶ and more recently in Canada²⁷ and Sweden.²⁸ To our knowledge, no such studies have been published in the United States. Most of these studies, however, investigated the overall physical therapy treatment of patients who had undergone cardiac surgery. Although more recent studies^{27,28} included questions relating to sternal care, none addressed specifically or in detail sternal protocols and precautions, such as upper-limb movement and loading restrictions. In order to facilitate further research, advance patient care, and provide a basis for the development of evidence-based clinical guidelines, current practice needs to be documented and evaluated. The aim of this study was to investigate and document current sternal care practices being utilized by physical therapists in their treatment of patients following median sternotomy.

Method

This study used a cross-sectional, observational survey design.

Survey Instrument

There was no existing survey instrument that met the objectives of this study. A Web-based survey, therefore, was custom designed by the authors using professional knowledge and clinical experience in the field of cardiothoracic physical

therapy. The survey items were reviewed by a panel of 10 experts who had presented at the 2005 and 2007 Australian Physiotherapy Association National Cardiothoracic Group Conferences in the area of cardiothoracic surgery. Feedback on question content and validity and on overall survey readability and utility was provided by the experts, and the survey was modified accordingly. The Web-based functionality of the survey then was tested using a sample of convenience of 10 cardiothoracic clinicians from 5 hospitals (public and private). The Web-based platform was found to function well. However, as a result of the test, small adjustments were made to the manner in which the outcome data were provided to the researchers. The responses of the participants to the survey questions were not analyzed at this stage.

The final version of the Web-based survey questionnaire consisted of 40 questions in 7 sections. The first 4 sections related to domains of practice (wound support, lifting, transfer, and mobility aid restrictions). In Australia, wound support for a sternotomy is widely acknowledged and accepted as anterior hand pressure centrally over the wound using a pillow. The remaining sections included respondent demographics, factors influencing practice, and a final open-ended section where respondents could provide any additional information. Questions were mainly in closed categorical form, with some open-ended questions for written responses. The survey questionnaire is presented in the Appendix.

Target Population

Senior cardiothoracic physical therapists from all hospitals in Australia where cardiac surgery was performed using median sternotomy were invited to participate. "Senior physical therapist" is a commonly

used and accepted clinical role in Australian hospitals (public and private). The “senior cardiothoracic physical therapist” would be understood by all to be the person who has the most senior role and oversight of the group of physical therapists managing the care of patients undergoing cardiothoracic surgery in the particular hospital.

A list of appropriate hospitals was produced by investigating the Australian Institute of Health and Welfare and the Australasian Society of Cardiac and Thoracic Surgeons Web sites. Individual hospital Web sites then were examined. If cardiothoracic surgery (including median sternotomy) was not clearly identified as being performed at the site, the surgical departments of these hospitals were contacted by telephone for simple clarification. In all, 51 hospitals were included, and the senior cardiothoracic physical therapist from each identified hospital was invited to participate. There were no exclusion criteria.

Data Collection

Information packs were sent to each identified hospital in June 2010. These packs included an information statement, consent form, site identification card, and self-addressed reply-paid envelope. Respondents were requested to sign and return the consent form, which included the provision of a contact e-mail address. Those who completed the consent process as requested were sent login details and instructions to complete the Web-based survey. Site identification cards and completed consent forms were returned to separate investigators. The site identification cards, therefore, could not be matched to the returned consent forms, maintaining the respondents' anonymity. Use of site identification cards facilitated tracking of responses and, through the use of reminders, allowed the maxi-

mization of response rate. Invited participants who had not returned their consent form within 3 weeks were sent a reminder in the form of a second information pack. Those who had been provided with login details as a result of returning their signed consent form, but had not completed the survey, were sent 2 reminder e-mails (2 weeks apart).

Data Analysis

Data were downloaded from the survey Web site into a database and analyzed using JMP (version 8.0) and SAS (version 9.2) statistical software programs (SAS Institute Inc, Cary, North Carolina). Descriptive analysis included frequency and contingency tables for categorical variables and calculation of median and range for continuous variables. The chi-square test was applied to contingency tables for comparisons between the categorical variables of type of sternal precaution (ie, wound support, lifting restrictions, transfer restrictions, and mobility aid restrictions) and responses from public and private hospitals. The Fisher exact test was used (using SAS software when necessary) when tables contained low expected cell counts or when the chi-square test *P* value was below .3. The continuous variables “years of experience in physical therapy” and “years of experience in cardiothoracic physical therapy” were grouped into categories to facilitate interpretation. Open written responses were analyzed via simple thematic analysis.

Results

From the 51 hospitals sent invitations to participate, 32 consent forms (62.7%) were returned. The respondents were allocated login details and enrolled in the Web-based survey. Of those who returned their consent form and were enrolled in the Web-based survey, 30 went on to complete the Web-based survey (58.8%). Analysis for each

question was performed in relation to the number of possible respondents. For example, there were 24 possible respondents for the sections investigating wound support, lifting restrictions, transfer restrictions, and mobility aid restrictions. The flow of respondents through the study is shown in the Figure.

Responses were obtained from all states in Australia currently performing cardiothoracic surgery, as well as the Australian Capital Territory. Both public hospitals (*n*=18) and private hospitals (*n*=12) were represented. There was a statistically significant difference between the response rates of public and private hospitals (*P*<.004). The response rate of private hospitals was 44.4% (12/27) compared with the public hospital response rate of 83.3% (20/24). Information regarding participant and site characteristics is displayed in Table 1.

Wound Support

Use of sternal wound support was reported by most respondents (*n*=22, 91.7%). Of these respondents, almost all reported that wound support commenced immediately postsurgery (*n*=21, 95%). Cessation of wound support was variable, and responses included: “≤7 days post-op” (*n*=8, 36.4%), “8-14 days post-op” (*n*=5, 22.7%), “>14 days post-op” (*n*=6, 27.3%), and “once the sternum is healed” (*n*=3, 13.6%). There was no significant difference (*P*=1.0) in the number of respondents using wound support between public hospitals (14 out of 15) and private hospitals (7 out of 8).

Lifting Restrictions

Lifting restrictions were used by 95.8% of the respondents (*n*=23). Respondents were asked to define their use of lifting restrictions by commenting on both weight and height restrictions. This information

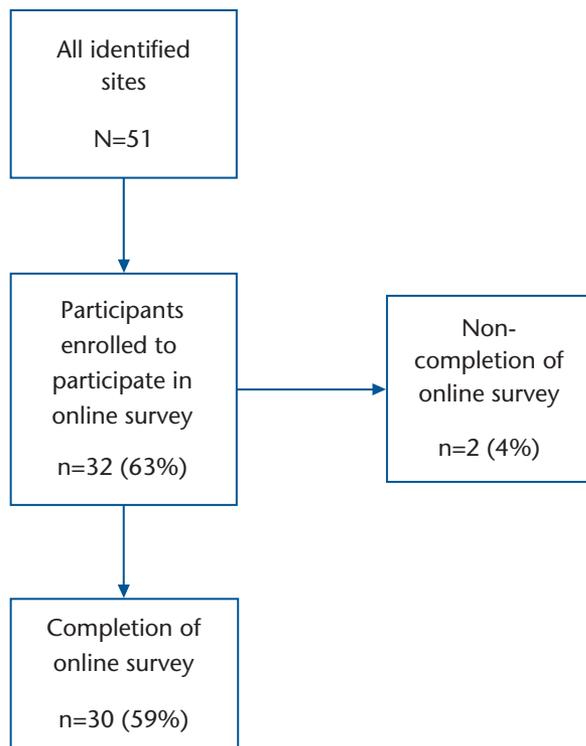


Figure. Flow diagram of respondents to survey investigating current physical therapy management of sternal precautions following median sternotomy.

Table 1. Demographics of the National Survey of Senior Cardiothoracic Physical Therapists in Hospitals Performing Cardiothoracic Surgery in Australia

| Respondent and Site Demographics | N | % |
|--|----|-------|
| Physical therapy experience | | |
| <4 years | 5 | 16.7 |
| 4–9 years | 9 | 30.0 |
| >9–15 years | 4 | 13.3 |
| >15 years | 12 | 40.0 |
| Cardiothoracic physical therapy experience | | |
| <4 years | 7 | 23.3 |
| 4–9 years | 8 | 26.7 |
| >9–15 years | 8 | 26.7 |
| >15 years | 7 | 23.3 |
| Qualifications | | |
| Bachelor’s degree | 30 | 100.0 |
| Honors | 4 | 13.3 |
| Master’s degree | 4 | 13.3 |
| PhD | 0 | 0.0 |
| Type of facility | | |
| Public | 18 | 60.0 |
| Private | 12 | 40.0 |

is shown in Table 2. All respondents reported that lifting restrictions commenced immediately postsurgery. The reported time of cessation of both height and weight restrictions was variable. The reported use of lifting restrictions was very similar for public hospitals (16 out of 16) and private hospitals (7 out of 8) ($P=.3$).

Transfer Restrictions

Transfer restrictions, which included bed mobility restrictions, were reported to be used by 95.8% of the respondents ($n=23$). Information relating to the use of transfer restrictions is displayed in Table 3. Almost all respondents reported that transfer restrictions commenced immediately postsurgery ($n=22$, 95.6%). The cessation of transfer restrictions was reported by the majority of respondents to occur 3 to 6 weeks postoperatively ($n=15$, 65.2%). However, other responses included “once the sternum is assessed to be stable” ($n=4$, 17.4%) and “when medical clearance is given by the general practitioner or surgeon” ($n=3$, 13.0%). The proportions for public and private hospitals using transfer restrictions were the same as for lifting restrictions ($P=.3$).

Mobility Aid Restrictions

Mobility aid restrictions were used by 62.5% of the respondents ($n=15$). Further details of mobility aid restrictions used are displayed in Table 3. In responses where “Other” was selected, respondents usually indicated that mobility aids were allowed if patients had a problem with balance or were unable to mobilize independently and that patients were to minimize weight bearing through their arms as much as possible. Most respondents indicated that restrictions on the use of mobility aids commenced immediately postsurgery ($n=12$, 80.0%). The reported time of cessation of mobility aid restrictions again was

variable. Respondents from private hospitals were less likely to place restrictions on the use of mobility aids, and this difference was statistically significant at discharge, with 12 out of 16 public hospitals reporting use of this restriction compared with only 3 out of 8 private hospitals ($P < .027$). All respondents from private hospitals indicated that no restrictions are placed at discharge “as long as that aid can be independently and safely used.”

Rationale for and Purpose of Restrictions

Respondents’ opinions about the purpose of and rationale for each domain of practice were sought. Responses relating to wound support, lifting restrictions, transfer restrictions, and mobility aid restrictions are shown in Table 4.

Discussion

This is the first study worldwide to investigate and publish current practices specifically relating to the use of sternal precautions in the physical therapy treatment of patients who have undergone median sternotomy. The response rate of 59% is consistent with commonly reported survey response rates and superior to average reported response rates of Web-based surveys.²⁹⁻³⁶ Because the inclusion criteria included all hospitals in Australia, the response rate represents a substantial proportion of the population of interest. Both public and private hospitals from all Australian states currently performing cardiothoracic surgery were represented in our survey. The results, therefore, are likely to be generalizable to the wider Australian population of physical therapists involved in treatment of patients following median sternotomy.

The findings of this study reveal that there is considerable variation in the sternal precautions used by physical therapists throughout Australian hos-

Table 2.

Lifting Restrictions Used in the Physical Therapy Treatment of Patients Who Have Undergone Median Sternotomy

| Variable | n | % |
|---|----|------|
| Lifting restrictions used | | |
| A weight restriction on unilateral lifting | 18 | 78.2 |
| A weight restriction on bilateral lifting | 22 | 95.6 |
| Restricting the height an object can be lifted to | 5 | 21.7 |
| Other | 7 | 30.4 |
| Weight restrictions specified initially | | |
| 1 kg | 2 | 8.7 |
| 2-5 kg | 18 | 78.5 |
| 6-10 kg | 1 | 4.3 |
| Lifting of any weight prohibited | 1 | 4.3 |
| Any weight within pain limitation | 1 | 4.3 |
| Weight restrictions specified at discharge | | |
| 1 kg | 0 | 0.0 |
| 2-5 kg | 19 | 82.6 |
| 6-10 kg | 1 | 4.3 |
| Lifting of any weight prohibited | 0 | 0.0 |
| Any weight within pain limitation | 3 | 13.0 |
| Height restrictions specified initially | | |
| Lifting height to onset of pain | 3 | 13.0 |
| Lifting height to $\leq 90^\circ$ of shoulder flexion | 3 | 13.0 |
| No overhead lifting | 6 | 26.1 |
| No height restriction applied | 13 | 56.5 |
| Other | 3 | 13.0 |
| Height restrictions specified at discharge | | |
| Lifting height to onset of pain | 5 | 21.7 |
| Lifting height to $\leq 90^\circ$ of shoulder flexion | 2 | 8.7 |
| No overhead lifting | 4 | 17.4 |
| Not applicable, no height restriction applied | 13 | 56.5 |
| Other | 5 | 21.7 |

pitals in the treatment of patients who have undergone median sternotomy. Sternal wound support was used in most settings and lifting, transfer, and mobility aid restrictions were commonly enforced. The types of restrictions and the timing of their cessation were variable. The prevention of sternal instability and pain management were the most commonly cited reasons for the use of the restrictions.

Lifting Restrictions

Lifting limitations included both weight and height restrictions. There was some uniformity in the weight restrictions used, and the common use of a weight restriction of 2 to 5 kg (4.4-11 lb) throughout Australia is consistent with suggestions that strict movement and weight limitations often are placed on patients following median sternotomy.^{15,19,22,23}

Management of Sternal Precautions Following Median Sternotomy

Table 3.

Transfer Restrictions, Mobility Aid Restrictions, and Other Restrictions Used in the Physical Therapy Treatment of Patients Who Have Undergone Median Sternotomy

| Variable | n | % |
|---|----|------|
| Transfer restrictions specified initially | | |
| No upper-limb unilateral pulling permitted | 16 | 69.6 |
| No upper-limb unilateral pushing permitted | 17 | 73.9 |
| No upper-limb bilateral pulling permitted | 5 | 21.7 |
| No upper-limb bilateral pushing permitted | 8 | 34.7 |
| Pain limited bilateral arm movements | 9 | 39.1 |
| Pain limited unilateral arm movements | 6 | 26.1 |
| Other | 4 | 17.4 |
| Transfer restrictions specified at discharge | | |
| No upper-limb unilateral pulling permitted | 13 | 56.5 |
| No upper-limb unilateral pushing permitted | 14 | 60.9 |
| No upper-limb bilateral pulling permitted | 5 | 21.7 |
| No upper-limb bilateral pushing permitted | 7 | 30.4 |
| Pain limited bilateral arm movements | 10 | 43.5 |
| Pain limited unilateral arm movements | 8 | 34.8 |
| None | 0 | 0.0 |
| Mobility aid restrictions specified initially | | |
| No use of unilateral walking sticks permitted | 6 | 40.0 |
| No use of 4-wheel walkers permitted | 1 | 6.7 |
| No use of pick-up frames permitted | 5 | 33.3 |
| No use of forearm support frames permitted | 3 | 20.0 |
| All patients mobilizing with a forearm support frame ^a post-sternotomy | 0 | 0.0 |
| Other ^b | 8 | 53.3 |
| Mobility aid restrictions specified at discharge | | |
| No use of unilateral walking sticks permitted | 4 | 26.7 |
| No use of 4-wheel walkers permitted | 2 | 13.3 |
| No use of pick-up frames permitted | 4 | 26.7 |
| No use of forearm support frames permitted | 4 | 26.7 |
| None as long as the aid can be independently and safely used | 8 | 53.3 |
| Other | | |
| Driving restrictions ^c | 4 | 44.4 |
| No sleeping on side | 1 | 11.1 |
| Increased strictness and length of precautions in patients identified as at risk | 1 | 11.1 |

^a A forearm support frame is widely acknowledged in Australia as a wheeled walking frame with forearm rest pads, which provide support to the upper body during mobilization.

^b Responses usually indicated that use of mobility aids was restricted unless patients were unable or it was unsafe to mobilize independently.

^c Driving restrictions usually lasted for 6 weeks.

It has been argued that the weight restrictions placed on patients following sternotomy are too stringent.^{18,19,22,23} Adams et al¹⁹ calculated the forces required to perform a number of activities of daily living (ADL); however, they provided a limited description of the methods used to measure force, and their study participants were healthy. Despite these limitations, they found that many of the activities investigated (eg, opening and closing doors) required 5.7 kg (12.5 lb) or more of force.¹⁹ Patients would commonly be performing such ADL tasks at discharge without restriction. These findings highlight the potentially illogical nature of some documented restrictions, which recommend lifting less than 2.27 kg (5 lb) following sternotomy.¹⁹ Compared with these guidelines, the instructions given to patients at discharge in Australian hospitals are slightly less restrictive.

Upper-limb movement and exercise during the recovery process following median sternotomy provide benefits.¹⁷⁻²⁰ Upper-limb movement and exercise are thought to enhance circulation to the muscles of the chest wall, shoulder girdle, and sternum.^{17,19} Remaining active also is important to prevent general physiological decline, such as the development of adhesions and muscle atrophy.^{17,19} It is possible that instructions given to patients at discharge limiting upper-limb activity could be detrimental to their recovery by restricting their functional ability and preventing or delaying the resumption of normal activities.^{15,18,19} Restrictive limitations may compromise the ability of patients, especially those of older age and those with previously impaired mobility, to perform simple, independent functional tasks, such as getting out of bed and standing from a chair.

Table 4.

Rationale Used by Senior Cardiothoracic Physical Therapists for Use of Wound Support and Restrictions in Patients Who Have Undergone Median Sternotomy^a

| Rationale for Use | Wound Support (n=22) | | Lifting Restrictions (n=23) | | Transfer Restrictions (n=23) | | Mobility Aid Restrictions (n=15) | |
|---|----------------------|----------------|-----------------------------|----------------|------------------------------|----------------|----------------------------------|----------------|
| | n | % ^a | n | % ^a | n | % ^a | n | % ^a |
| Prevention of incision dehiscence | 9 | 40.9 | 20 | 87.0 | 10 | 43.5 | 7 | 46.7 |
| Prevention of sternal instability | 14 | 63.6 | 23 | 100.0 | 22 | 95.7 | 15 | 100.0 |
| Prevention of sternal breakdown and infection | 7 | 31.8 | 10 | 43.5 | 9 | 39.1 | 8 | 53.3 |
| Pain management | 20 | 90.9 | 16 | 69.6 | 16 | 69.6 | 7 | 46.7 |
| I am not sure | 0 | | 0 | | 0 | | 0 | |

^a Percentage of the number of possible respondents for each question.

Transfer Restrictions

With respect to transfer and bed mobility restrictions, unilateral pushing and unilateral pulling were the movements most commonly restricted during hospitalization and at discharge. Restrictions on bilateral pushing and pulling were used less commonly. There may be some theoretical support for these restrictions in the published literature.^{17,21} The use of bilateral upper-limb movements, producing symmetrical load on the sternum, may be more beneficial for sternal healing compared with the asymmetrical loads produced by unilateral upper-limb movements.^{17,21} El-Ansary et al¹⁷ investigated the relationship between upper-limb movements and pain in patients with chronic sternal instability and found that unilateral upper-limb movements (loaded or unloaded) were significantly associated with sternal pain compared with bilateral upper-limb movements. These authors suggested that unilateral upper-limb movements may produce mechanical “shearing” forces on the opposing ends of the sternum in all planes of movement, which could cause irritation of bony and neural structures.¹⁷ Studies using human cadavers³⁷ and synthetic sternum models³⁸ also have investigated the effects of forces through the sternum. McGregor et al³⁷ found that bilateral

forces applied from a lateral direction caused greater cadaver sternal distraction than forces applied in an anterior-posterior or rostral-caudal direction. No measurements were made of unilateral distraction forces on sternal separation; therefore, no inferences can be drawn from the data to describe the effect of unilateral upper-extremity movements on sternal separation. There also have been no studies conducted with patients in the acute post-operative recovery phase. Until further research into the effects of unilateral and bilateral upper-limb movements on the healing sternum is undertaken, the basis for implementing restrictions on unilateral upper-limb movement remains theoretical.^{17,18,20}

The initial restrictions reported by many respondents differed from the restrictions specified at discharge. During the first 4 to 6 weeks of the bone healing process, the callus formed is still very weak,³⁹ which brings into question the rationale for the initial prescription of modifications and for the modification of restriction specifications at discharge. Patients are commonly discharged approximately only 5 to 7 days following their surgery,¹⁶ and it is likely that no significant healing would have taken place by this stage.

As with lifting restrictions, the impact of transfer restrictions on patients’ ability to perform ADL tasks is uncertain and needs to be considered. The ability to perform ADL tasks is rarely used as an outcome measure following cardiac surgery.^{15,40} LaPier et al¹⁵ investigated the impact of CABG on the ability to perform ADL tasks. However, as sternal precautions prohibited some of the ADL tasks on the Functional Status Index (FSI), the tasks that were overtly limited by the sternal precautions were omitted. Their results showed a significant loss of function in the remaining indices immediately postsurgery. Problems commonly experienced by participants included difficulty opening containers, putting on clothing, and rising from a chair.¹⁵ The authors suggested that sternal precautions, fear of activity, and exacerbation of symptoms may be related to this postoperative loss of physical function.¹⁵ For example, patients endeavoring to adhere to sternal precautions relating to transfer restrictions may have reported the problem of difficulty in rising from a chair, as for some patients this activity may place significant force through the upper limbs. Potentially, difficulties with ADL tasks experienced by patients who have undergone CABG may be further affected by their adherence to sternal precautions.

Mobility Aid Restrictions

There was significant variation in both the restrictions on types of mobility aids used and when these restrictions ceased. Although a large proportion of respondents reported restricting the type of mobility aid permitted, many indicated that restrictions on mobility aids were not applied if the patient was unsafe or unable to walk independently. It is possible that patients requiring mobility aids postoperatively are more likely to have multiple comorbidities such as obesity or diabetes mellitus. As these comorbidities are documented as being risk factors for sternal complications,^{7,10,41} it may be argued that it is these patients with whom these restrictions should be enforced rather than other patients.

Private hospitals were less likely than public hospitals to specify mobility aid restrictions at discharge, and this difference was statistically significant ($P < .027$). The reason for this difference is unclear. One possible explanation may be that patients in public hospitals are, on average, from lower socioeconomic groups and have more complex conditions.⁴² They may be more likely, therefore, to require a mobility aid. Furthermore, these patients may be managed within the public system, as these sites often have the increased capacity required to provide adequate care to patients at higher operative risk.

Of the respondents who reported implementing mobility aid restrictions at discharge, restrictions on the use of unilateral and bilateral mobility aids were equally reported. These restrictions are inconsistent with the reported restrictions on transfers (unilateral upper-limb movements being the most commonly restricted in this instance). Mobility aids involving the use of bilateral forces through the upper limbs (ie, pick-up frames and forearm sup-

port frames) were reported to be restricted as frequently as mobility aids involving unilateral forces (ie, unilateral walking sticks).

These restrictions also raise the issue of the postoperative mobility and functional capacity of patients who had preoperatively required a walking aid. If the instruction is to not allow any weight bearing through the upper limbs, utilizing a mobility aid is difficult. When the use of mobility aid restrictions is considered in combination with lifting and transfer restrictions, it is evident that there is immense potential to have a detrimental impact on patient recovery, including functional capacity and ability to perform necessary ADL tasks. Time required to attain independent mobility also could be affected, potentially leading to an increased length of stay and greater resource utilization.

Rationale for and Purpose of Restrictions

Sternal precautions are used in an effort to prevent the occurrence of sternal complications such as sternal dehiscence, infection, and sternal instability following median sternotomy.^{7,10,40,41} In this study, the most commonly reported rationale for the use of restrictions was the prevention of sternal instability and for the use of wound support was pain management, followed by prevention of sternal instability. Sternal instability involves nonphysiologic or abnormal motion of the sternum after either bone fracture or disruption of sternal wires and is characterized by clicking, pain, and discomfort during ADL tasks.^{17,20,43}

Despite the purposes of sternal precautions reported by respondents, the causes of sternal complications such as instability or dehiscence are likely to be unique to the individual. Preoperative risk factors that may contribute to the risk of

developing sternal complications include diabetes mellitus, obesity, smoking, chronic obstructive pulmonary disease, osteoporosis, larger female breast size, and previous sternotomy.^{5,7,10,41} Perioperative risk factors reported include prolonged bypass time, bilateral internal mammary artery grafting, transfusions, and prolonged hospital stay.^{5,41,44,45} Thus, it may be argued that sternal precautions may be better used by patients who have, or develop, risk factors for sternal complications rather than by all patients regardless of risk.

The impact of movement and loading on the healing sternum is not known. Therefore, restrictions such as those described are not currently based on any empirical evidence. Other factors, such as a stable and enduring approximation,^{8,46} may be more important in promoting sternal union. The significant strain placed on the sternum by frequent coughing also has been acknowledged.^{8,18,22,45,46} Brocki et al¹⁸ suggest that unsupported, frequent coughing is the single main cause of mechanical stress through the sternum. This conclusion supports the argument that strict postoperative lifting and movement restrictions may be unnecessary.^{18,19,22} Indeed coughing may be a far more significant factor in the development of sternal complications than whether precautions are used in the treatment of patients who have undergone median sternotomy.¹⁸ This survey did not investigate respondents' opinions regarding the effect of coughing on sternal healing.

Web-Based Survey Design

The advantages and disadvantages of Web-based surveys compared with paper-based surveys were considered. Advantages include cost efficiency, immediate access to the results, faster data analysis, decreased likelihood of incomplete

responses, and minimization of transcription and data entry errors.⁴⁷⁻⁴⁹ Disadvantages include increased effort, expertise, and costs of survey development; computer or Internet access problems; and lack of computer literacy of the respondent.⁴⁸⁻⁵⁰ For the convenience of both investigators and respondents, it was decided that a Web-based survey instrument was more appropriate for our investigation. One positive aspect was that the Web-based survey prevented respondents from completing sections that were not appropriate based on earlier responses. This aspect contributed to the accuracy of the responses and reduced the potential for error.

Limitations

One limitation of this study is a potential response bias. There was a statistically significant difference between the response rates of public and private hospitals ($P < .004$). One possible explanation for this finding is that private facilities or surgeons may contract with their preferred physical therapy providers and the therapists are not based on site. The information packs were sent to hospital addresses, and in the case of some private hospitals, the packs may not have reached the appropriate person.

Only one physical therapist from each site was invited to participate in this study. It is possible that other physical therapists at the same site might have given different responses. However, as most questions related to factual information and the survey was to be completed by the senior cardiothoracic physical therapist, it is likely that responses among individuals at the same site would generally be consistent. Different responses may have been given to the questions relating to personal opinion (eg, relating to rationale for restrictions); therefore, all questions relating to personal

opinion can be taken to represent only the individual responding to the survey and not the site in general.

Conclusions

To our knowledge, this is the first study to conduct and publish results of a national survey specifically investigating the current sternal precautions used in the treatment of patients who have recently undergone median sternotomy. Internationally, published literature has investigated the physical therapy treatment of patients who have undergone cardiac surgery.^{24,26-28} No studies, however, have investigated in detail the management of the sternum. Tucker and colleagues²⁴ and Reeve and Ewan²⁶ conducted comprehensive investigations of the general physical therapy treatment of patients undergoing cardiac surgery in Australia and the United Kingdom, respectively. However, sternal precautions were not investigated. We also are not aware of any published studies investigating the current practices of physical therapists in the United States. To our knowledge, only 2 published studies have included questions relating to sternal management.^{27,28} Overend and colleagues,²⁷ in their Canadian study, found that sternal precautions and restrictions varied. Interestingly, their results differed from ours in that bilateral upper-limb exercises were restricted more commonly than unilateral exercises. Westerdahl and Moller,²⁸ in their national survey of Sweden, found that although sternal precautions were commonly enforced, they also were variable.

Our results show that significant variation exists in the sternal precautions used by physical therapists in public and private hospitals throughout Australia. Similar studies in the United States and the United Kingdom would provide comparative information regarding

international nuances of sternal management following median sternotomy. In addition, further research into this area is necessary to investigate the effect of movement and loading on the healing sternum, whether the restrictions and precautions used are necessary, and whether protocols affect patient outcomes, including functional capacity. Results of future research may contribute to the development of evidence-based guidelines for the treatment of patients who have undergone median sternotomy.

Ms Mackney and Ms Johnston provided concept/idea/research design, project management, and facilities/equipment. All authors provided writing and data collection and analysis. The authors thank all of those who took part in this survey.

Ethics approval for this study was sought and obtained from the Human Research Ethics Committee of The University of Newcastle.

An abstract of selected outcomes from this study was presented at the 16th International Congress of the World Confederation for Physical Therapy; June 20-23, 2011; Amsterdam, the Netherlands.

DOI: 10.2522/ptj.20100373

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Appendix.

Web-Based Survey Questionnaire^a

Sternotomy Management Survey

(Note: this is a hard copy version; the final version is Web-based)

Question 1. In your clinical setting, are the post-op care and instructions given to patients post-sternotomy influenced by the healing sternum? (*tick one*)

- Yes No

(*Respondents who answer “No” to Question 1 are directed to Section F, Question 30)

Section A

Question 2. In your clinical setting, does the management of patients post-sternotomy include the use of wound support? (*tick one*)

- Yes No

(*Respondents who answer “No” to Question 2 are directed to Section B, Question 6)

Question 3. In your clinical setting, when does the use of wound support commence? (*tick one*)

- Immediately post-op 1–3 days post-op >3 days post-op
 Other, please specify: _____

Question 4. In your opinion, what is the purpose of wound support? (*tick all that apply*)

- Prevention of incision dehiscence Prevention of sternal instability
 Prevention of sternal breakdown/infection Pain management
 I am not sure
 Other, please specify: _____

Question 5. In your clinical setting, when does the use of wound support cease? (*tick one*)

- ≤7 days post-op 8–14 days post-op
 >14 days post-op Once the sternum is healed
 Once the sternum is assessed to be stable

Section B

Question 6. In your clinical setting, does the management of patients post-sternotomy include the use of lifting restrictions? (*tick one*)

- Yes No

(*Respondents who answer “No” to Question 6 are directed to Section C, Question 16)

Question 7. In your clinical setting, what is considered a lifting restriction? (*tick all that apply*)

- A weight restriction on unilateral lifting
 A weight restriction on combined bilateral lifting
 Restricting the height an object can be lifted to
 Other, please specify: _____

Question 8. In your clinical setting, when does the use of lifting restrictions commence? (*tick one*)

- Immediately post-op 1–3 days post-op >3 days post-op
 Other, please specify: _____

Question 9. In your opinion, what is the purpose of lifting restrictions? (*tick all that apply*)

- Prevention of incision dehiscence Prevention of sternal instability
 Prevention of sternal breakdown/infection Pain management
 I am not sure

(Continued)

Management of Sternal Precautions Following Median Sternotomy

Appendix.

Continued

Question 10. In your clinical setting, what is the initial weight restriction given to patients post-sternotomy? (*tick one*)

- 1 kg 2-5 kg 6-10 kg
 No weight restriction specified Any weight within pain limitation

Question 11. In your clinical setting, what weight restrictions do you specify on discharge? (*tick one*)

- 1 kg 2-5 kg 6-10 kg
 No weight restriction specified Any weight within pain limitation

Question 12. In your clinical setting, when does the use of weight restrictions cease? (*tick one*)

- <1 week post-op 1-3 weeks post-op
 3-6 weeks post-op Once the sternum is healed
 Once the sternum is assessed to be stable
 When medical clearance is given by the general practitioner or surgeon

Question 13. In your clinical setting, what is the initial height restriction applied to lifting objects? (*tick all that apply*)

- Lifting height limited to onset of pain
 Lifting height limited to ≤ 90 degrees of shoulder flexion
 No overhead lifting
 No height restriction applied
 Other, please specify: _____

Question 14. In your management of patients post-sternotomy, what height restrictions do you specify on discharge? (*tick all that apply*)

- Lifting height limited to onset of pain
 Lifting height limited to ≤ 90 degrees of shoulder flexion
 No overhead lifting
 Not applicable, no height restriction applied
 Other, please specify: _____

Question 15. In your clinical setting, when does the use of height restrictions cease? (*tick one*)

- <1 week post-op 1-3 weeks post-op
 3-6 weeks post-op Once the sternum is healed
 Once the sternum is assessed to be stable
 When medical clearance is given by the general practitioner or surgeon
 Not applicable, no height restriction applied

Section C

Question 16. In your clinical setting, does the management of patients post-sternotomy include transfer restrictions? (*tick one*)

- Yes No

(*Respondents who answer "No" to Question 16 are directed to Section D, Question 22)

Question 17. In your clinical setting, what bed mobility and transfer restrictions do you apply? (*tick all that apply*)

- No upper-limb unilateral pulling permitted
 No upper-limb unilateral pushing permitted
 No upper-limb bilateral pulling permitted
 No upper-limb bilateral pushing permitted
 Pain limited bilateral arm movements
 Pain limited unilateral arm movements
 Other, please specify: _____

(Continued)

Appendix.

Continued

Question 18. In your clinical setting, when does the use of bed mobility and transfer restrictions commence? (*tick one*)

- Immediately post-op 1-3 days post-op >3 days post-op
 Other, please specify: _____

Question 19. In your opinion, what is the purpose of bed mobility and transfer restrictions? (*tick all that apply*)

- Prevention of incision dehiscence Prevention of sternal instability
 Prevention of sternal breakdown/infection Pain management
 I am not sure

Question 20. In your clinical setting, what bed mobility and transfer restrictions do you specify on discharge? (*tick all that apply*)

- None
 No upper-limb unilateral pulling permitted
 No upper-limb unilateral pushing permitted
 No upper-limb bilateral pulling permitted
 No upper-limb bilateral pushing permitted
 Pain limited bilateral arm movements
 Pain limited unilateral arm movements

Question 21. In your clinical setting, when does the use of bed mobility and transfer restrictions cease? (*tick one*)

- <1 week post-op 1-3 weeks post-op
 3-6 weeks post-op Once the sternum is healed
 Once the sternum is assessed to be stable
 When medical clearance is given by the general practitioner or surgeon

Section D

Question 22. In your clinical setting, does the management of patients post-sternotomy include restrictions on the type of mobility aid used? (*tick one*)

- Yes No

(*Respondents who answer "No" to Question 22 are directed to Section E, Question 28)

Question 23. In your clinical setting, when do restrictions on the use of mobility aids commence? (*tick one*)

- Immediately post-op 1-3 days post-op >3 days post-op
 Other, please specify: _____

Question 24. In your clinical setting, what mobility aid restrictions do you apply? (*tick all that apply*)

- No use of unilateral walking sticks permitted
 No use of 4-wheel walkers permitted
 No use of pick-up frames permitted
 No use of forearm support frames permitted
 All patients commence mobilizing with a forearm support frame post-sternotomy
 Other, please specify: _____

Question 25. In your opinion, what is the purpose of restricting the use of specific mobility aids during sternotomy management? (*tick all that apply*)

- Prevention of incision dehiscence
 Stabilizing the upper limbs to allow the accessory muscles to assist in breathing
 Prevention of sternal instability
 Prevention of sternal breakdown/infection
 Pain management
 I am not sure

(Continued)

Management of Sternal Precautions Following Median Sternotomy

Appendix.

Continued

Question 26. In your clinical setting, what mobility aid restrictions do you specify on discharge? (*tick all that apply*)

- No use of unilateral walking sticks permitted
- No use of 4-wheel walkers permitted
- No use of pick-up frames permitted
- No use of forearm support frames permitted
- None, as long as that aid can be independently and safely used

Question 27. In your clinical setting, when do the restrictions placed on mobility aid use cease? (*tick one*)

- <1 week post-op
- 1-3 weeks post-op
- 3-6 weeks post-op
- Once the sternum is healed
- Once the sternum is assessed to be stable
- When medical clearance is given by the general practitioner or surgeon
- When cleared by the physical therapist

Section E

Question 28. In your clinical setting, does the management of patients post-sternotomy include any *other* restriction/management that concerns the sternum/wound area? (*tick one*)

- Yes
- No

(*Respondents who answer "No" to Question 28 are directed to Section F, Question 30)

Question 29. Please specify this precaution:

In your opinion, what is the purpose of this precaution? _____

In your clinical setting, when does the use of this precaution commence? _____

In your clinical setting, when does the use of this precaution cease? _____

In your clinical setting, what instructions about this precaution do you specify on discharge? _____

Section F

Question 30. What has directed your current clinical practice relating to post-sternotomy management? (*tick all that apply*)

- University studies
- Workplace practices/protocols
- Clinical experience
- Journal articles
- Formal professional development or in-service training
- Other

Question 31. Have you read any current literature regarding the use of sternal precautions in post-sternotomy management? (*tick one*)

- Yes
- No

Question 32. In your professional opinion, what do sternal precautions achieve? (*tick all that apply*)

- Prevention of incision dehiscence
- Prevention of sternal instability
- Prevention of sternal breakdown/infection
- Pain management
- Nothing
- Other, please specify: _____

Section G

Question 33. How long have you been working in the field of physical therapy? _____ years/months

Question 34. How long have you been working in cardiopulmonary physical therapy/thoracic surgery? _____ years/months

Question 35. What are your tertiary education qualifications? (*tick all that apply*)

- Bachelor's degree
- Honors
- Master's degree
- PhD

(Continued)

Appendix.

Continued

Question 36. What year did you graduate? _____

Question 37. What state or territory are you currently working in?

- ACT NSW
- NT QLD
- SA TAS
- VIC WA

Question 38. How many patients are you treating per week?

- 0-4 5-9
- 10-14 >15

Question 39. What type of facility do you currently work in?

- Public Private

Question 40. What geographical area do you work in?

- Metropolitan Rural Regional

^a Post-op=postoperatively, ACT=Australian Capital Territory, NT=Northern Territory, SA=South Australia, VIC=Victoria, NSW=New South Wales, QLD=Queensland, TAS=Tasmania, WA=Western Australia.

Physical Therapy

Journal of the American Physical Therapy Association



Management of Sternal Precautions Following Median Sternotomy by Physical Therapists in Australia: A Web-Based Survey

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PHYS THER. 2012; 92:83-97.

Originally published online September 23, 2011

doi: 10.2522/ptj.20100373

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