A multi-centre, randomized controlled trial of the effectiveness of positioning on quadriplegic shoulder pain

Key Words

Quadriplegia, Shoulder Pain

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Background and Purpose: Retrospective studies indicate a high incidence of shoulder pain in patients in the acute stage after cervical spinal cord injury. The purpose was to evaluate the effectiveness of positioning in reducing shoulder pain. **Methods:** Subjects were patients with quadriplegia. Subjects were randomly assigned to receive conventional care (including glenohumeral and scapular range of motion [ROM]) or conventional care plus regular positioning. Outcomes measured included weekly ROM and pain. On transfer to rehabilitation, and at 3 months after onset Functional Independence Measures [FIM] were obtained. Baseline data were compared using chi square and un-paired t tests. Outcomes were compared using repeated measure analysis of covariance (pain, ROM) and unpaired t tests for FIM. **Results:** There were no significant differences between treatment groups. **Conclusions:** Shoulder pain in this population was as little as that reported in previous retrospective studies and may be due to the rigorous, early ROM, with this amount of positioning providing no additional benefit.

Reseignements Généraux et Objet : Des études rétrospectives indiquent une incidence élevée de douleur de l'épaule chez les patients ayant subi une blessure de la moelle épinière cervicale au stade aigu. L'objet était d'évaluer l'efficacité du positionnement pour réduire la douleur de l'épaule. **Méthodes :** Les sujets souffraient de quadriplégie. Ils ont été assignés au hasard à des soins conventionnels (comprenant des exercices d'amplitude articulaire gléno-humérale et scapulaire) ou à des soins conventionnels conjointement à des exercices de positionnement réguliers. Les paramètres mesurés chaque semaine comprenaient l'amplitude articulaire et la douleur. Lors de leur transfert dans un service de réadaptation et trois mois après, des mesures de l'indépendance fonctionnelle ont été prises. On a comparé les données de base en utilisant les tests chi au carré et les tests t non appariés. On a comparé les résultats en utilisant une analyse des mesures répétées de la covariance (douleur, amplitude articulaire) et les tests t non appariés pour la mesure de l'indépendance fonctionnelle. **Résultats :** On n'a noté aucune différence significative entre les groupes de traitement. **Conclusion :** La douleur de l'épaule dans cette population était aussi faible que celle signalée dans des études rétrospectives antérieures, ce qui peut être dû aux exercices d'amplitude articulaire précoces et rigoureux. Les exercices de positionnement n'ont offert aucun avantage additionnel.

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A high incidence of shoulder pain has been reported in patients with spinal cord injuries (SCI).[1-5] Shoulder pain following SCI may be either acute or chronic, localized or diffuse, uni- or bilateral, and may be associated with joint contracture. The presence of pain makes it intolerable to perform active, active-assisted or passive shoulder range of motion (ROM). Individuals with quadriplegia require full and pain-free range in order to maximize their functional independence during rehabilitation. Patients in the acute stage following SCI face a period of adjustment during which they must recover from concomitant injuries, comply with rehabilitation, and adjust to a very different quality of life. These patients may be depending exclusively on their upper extremities to carry out all activities of daily living, including locomotion, dressing, feeding and transfers, in an effort to compensate for their lower limb paralysis. Cambell and Koris state that "patients with SCI injury levels at C5 or lower may have the ability to use their shoulders for independent transfers, decompression raises, wheelchair locomotion and positioning of the hand" for ADL.[6] Patients who develop pain describe a slow onset of a fairly constant, dull shoulder pain, which varies little throughout the day.

A review of the literature revealed one case series and four retrospective chart reviews assessing shoulder pain among patients with quadriplegia in the acute phase. Silfverskiold and Waters assessed shoulder pain and functional disability in a case series of 40 patients with quadriplegia within 6 months following injury.[1] They evaluated the presence, duration and location of shoulder pain and quantified the degree of functional disability. They report 78% (N = 31) of the patients experienced shoulder pain in that initial 6 months, most experiencing an insidious onset (N = 23). Twenty-six patients were mildly disabled functionally, 3 moderately and 2 severely disabled. Waring and Maynard undertook a retrospective review of the charts of patients (N = 52) following spinal cord injury, and found that 75% had shoulder pain documented at least once in the acute phase, while 60% had pain for 2 weeks or more.[2] The onset of pain was within the 2 weeks following the injury in 52%. Patients aged over 50 years, those with decreased shoulder ROM, and those not receiving shoulder exercises in the first two weeks following injury were at greatest risk of developing acute shoulder pain. In another retrospective chart review, shoulder pain was reported in 54% of patients.[3] Of this series, 20 were patients with quadriplegia, and 73% of those experienced shoulder pain (unpublished data). Patients who developed pain were unable to perform independent ROM of their upper extremities. This occurred with, for example, patients with external cervical fixators which interfered with range of motion, and those with systemic complications such as paralytic ileus which decreased the patients' strength and/or endurance. MacKay-Lyons, again in a retrospective chart review (N = 19) reported a 68% incidence of shoulder pain.[4] In that series, all patients with complete SCI suffered shoulder pain. Length of bed rest was a significant factor, but the age of the patient was not correlated. Williams and Ross, in another retrospective review of 124 charts, reported an overall prevalence of pain of 48.3%, and a statistically significant correlation between the presence of shoulder pain and a diagnosis of C3-4 SCI, and with length of stay.[5] There was no unique contribution of age to the diagnosis of shoulder pain.

In a descriptive paper, Scott and Donovan (1981) described the prevention of shoulder pain and contracture in 15 acute quadriplegic patients by means of a protocol of specific positioning.[7] Patients in their facility were positioned in supine and alternate side lying, each for two hour periods. While the patient was in supine, he was positioned with his arms at 90 degrees of abduction, with elbows extended and the arms resting on a padded arm board which slid between the mattress and the bed. While in supine, the shoulders were passively moved into full abduction with external rotation 10 times twice daily. When the patient was in side lying, he was positioned with a pillow in his underneath axilla to reduce direct pressure on the shoulder, and his upper arm was positioned on pillows placed posterior to his thorax, so that the shoulder was extended and abducted. Scott and Donovan used no control group, and no specific outcome measures were described, but it was their opinion that the regimen of specific positioning reduced the incidence of shoulder pain, in comparison with patients treated previously.[7]

Mechanisms explaining the shoulder pain include muscle weakness leading to shortening and capsule tightness, muscle imbalance, pain from nerve root injury, and pain referred from the spinal column fracture/dislocation.[2,4] Heterotrophic ossification has also been suggested as a mechanism for the pain.[5] Campbell and Koris studied the etiology of shoulder pain in patients within 6 months of having sustained a cervical SCI.[6] They listed diagnoses including capsular contracture/capsulitis, rotator cuff tears, anterior instability, rotator cuff impingement, glenohumeral osteoarthritis and the latter in conjunction with osteonecrosis.6

At the time this trial was implemented, physical therapy for the shoulders of patients with quadriplegia in the 4 facilities participating in this trial included passive, or active assisted range of motion for impaired muscle groups, strengthening of spared muscle groups, and pain treatment as required. The passive ROM included both glenohumeral ROM and scapular stretches using a manoeuvre described by Maitland.[8]

Physiotherapists at the 4 participating hospitals were aware of the protocol described by Scott and Donovan as one method which may reduce the incidence of shoulder pain.[7] They were reluctant to precisely duplicate the positioning because they felt that patients should be encouraged to move their arms where possible, while in the supine position. For this reason the decision was made to position the patient once daily while in supine. As well, limitations of physiotherapy staffing made it impossible to perform the protocol more than once daily and not at all on weekends.

The purpose of this study was to evaluate whether a programme of spe-

cific positioning in addition to the standard treatment of shoulder joint and scapular stretching is effective in reducing shoulder pain in patients with quadriplegia.

Methods

Subjects

A convenience sample of subjects was recruited over a 3 year period in 4 Canadian trauma centres. It was not possible to estimate sample size since there were no existing data on which to base the calculation. A multi-centred design was deemed necessary because recruitment of an adequate sample of subjects was anticipated to be difficult. Subjects were included who had sustained a traumatic spinal cord lesion (either complete or incomplete) at or above the C 8 level, as documented by CT scan, and/or physical assessment findings. Subjects with incomplete transections were required to have some degree of motor deficit. Subjects had been transferred expeditiously to the trauma centres for complete spinal cord management, although they may have received emergency care at other facilities. Subjects were excluded from the study if they had sustained a fractured scapula, clavicle, or acromial head at the time of trauma, or if for any reason they required shoulder immobilization following the accident.

Subjects meeting the inclusion criteria were asked to participate in the study and provided oral, informed consent, after having been informed of their rights. In most cases it was up to the patient's next of kin to provide written consent since many patients were unable to write because of the nature of injury, and the fact they were in the intensive care unit immediately after the surgical stabilization of their cervical spine, and many were mechanically ventilated. Subjects were entered into the study as soon as they were medically stable, and able to tolerate physical therapy management.

Thirty-nine subjects entered the trial. This included 23, 8, 5 and 3 respectively, from the 4 sites. The mechanism of the spinal cord injury was a motor vehicle accident (17 subjects), following a fall (10), diving accident (8), cycling accident (2), and following being struck by an object on the head or neck (2). The cervical spines of 94% of patients were surgically stabilized. On average, subjects entered the study 9 days (conventional care average 8.6 ± 4.5 days, positioning group 10.9 ± 8.2) from the date of the trauma. Patients remained in the acute care facility on average for 6.1 weeks (conventional care group), and 5.8 weeks (positioning group). Patient characteristics are displayed in Table 1. On entry to the trial, patients were asked whether they had ever experienced any shoulder pain prior to the SCI. The only statistically significant difference between the 2 groups on any of these characteristics was the proportion of subjects who had any shoulder pain or problems prior to their spinal cord lesion. More subjects in the group receiving positioning had suffered a previous shoulder problem (Table 1). We recorded the number of hours daily each subject was able to sit up in a chair as a surrogate measure of general medical stability and readiness for comprehensive rehabilitation. Subjects were able to sit in a chair for approximately 2 hours at 2 weeks, and this increased to over 7 (conventional care group) and 11 (positioning group), with no statistical difference between the groups (Table 2).

Table 1. Patient Characteristics

Characteristic		Group 1 (N = 21) Conventional Care	Group 2 (N = 18) Positioning + Conventional Care
Age (years ± SD)		43.9 ± 18.9	33.5 ± 15.5
Gender (% male)		90%	89%
History of previous shoulder problems (% yes)		14%	39%*
Degree of spinal cord injury (% complete)		52%	56%
Level of injury	C2	1	0
	C3	2	0
	C4	2	4
	C5	4	7
	C6	8	6
	C7	4	1
Weeks in acute care		6.1 ± 3.5 (2-16)	5.8 ± 4 (2-12)

**significance $p < 0.05$*

Procedure

On entry to the trial, demographic data were collected. Patients were randomly assigned (using a random number generator and a system of sealed envelopes) taking into account whether the subject had received a complete or incomplete spinal cord transection. This prognostic stratification, ensuring that those with complete lesions were equally distributed in each treatment group, was the only stratification variable used.

Eligible subjects received physical therapy care which was standardized across sites. Written details of the protocol were made available to each physiotherapist treating patients in the trial, and this was supplemented by frequent phone calls to discuss problems. Physical therapy treatment commenced as soon as the patient was admitted to the intensive care unit, and declared medically stable. Respiratory care was based on the physical therapist's assessment of the patient. Patients received breathing exercises to prevent or manage atelectasis and maintain respiratory muscle endurance. These were also done with patients who were mechanically ventilated if the ventilator mode made this feasible. Secretion removal techniques were performed as required. These

Table 2. Patient Outcomes (pain and sitting time) at 2, 3 and 12 weeks post injury

Measure	Conventional care	Positioning + Conventional Care	Repeated Measures ANCOVA F (Time) p =	Repeated Measures ANCOVA F (Group /time) p =
Pain VAS *				
Left - week 2	1.9 ± 2.7	2.3 ± 2.4	$F_{2,50}$ = 0.04 p = 0.96	$F_{2,50}$ = 0.07 p = 0.94
Left - week 3	1.6 ± 2.7	2.2 ± 3.1		
Left - week12	2.2 ± 2.7	1.9 ± 1.7		
Right- week 2	2.1 ± 2.0	1.7 ± 2.3	$F_{2,50}$ = 0.90 p = 0.41	$F_{2,50}$ = 0.68 p = 0.51
Right-week 3	2.3 ± 2.8	2.0 ± 3.1		
Right-week12	2.0 ± 2.8	1.9 ± 2.8		
Hours in chair				
Week 2	1.7	2.3	$F_{2,26}$ = 28.98 p = 0.00	$F_{2,26}$ = 1.15 p = 0.33
Week 3	2.2	2.1		
Week 12	7.6	11.0		

* $\bar{x} \pm SD$

included 2 to 4 hourly position changes (including alternate side lying), manual percussions and manual and mechanical vibrations, and tracheal or endo-tracheal suctioning to clear secretions. After extubation patients were assisted with coughing using an abdominal thrust during the patient's expiratory phase of respiration. As well, full active-assisted or passive range of motion (depending on the completeness of the injury) was done for the lower extremities. For the upper extremity, full range of motion was done, either passively, active-assisted, or resisted, depending on the innervation of the muscles. If a subject complained of shoulder pain he was provided with medications, transcutaneous nerve stimulations, heat or ice treatments. In addition to routine glenohumeral joint range of motion exercises, all subjects received scapular stretches as described by Maitland.[8] The scapula was passively protracted and retracted around the thoracic wall. This was followed by elevation and depression and then rotation of the scapula. Each stretch was maintained for 15 to 30 seconds, and repeated from 2 to 4 times, once daily. All subjects received physical therapy treatment at least once daily on weekdays, and the frequency and amount of physical therapy provided was based on each patient's need and activity tolerance.

The physiotherapists providing these treatments were Canadian trained at 3 of the sites, with 4-5 years of practice in PT (all in the field of neurology/neurosurgery) at 2 sites, and 21-23 years (almost all in neurology) at 1 site. At the other site, 1 PT (trained in United Kingdom 8 years previously) and the second (trained in the Ireland 6 years previously) both had extensive neurological PT experience.

Group 1. Patients who were randomized to this group received the conventional care described above.

Group 2. Subjects randomized to this group received (once) daily positioning, in addition to the stretches and the other management described above. The arms were placed on padded supporting boards (which slide under the mattress) and provided support with the shoulders abducted to 90 degrees, while the elbows were in extension for approximately 30 minutes (Figures 1,2). Following that, the shoulders were positioned on pillows in 180 degrees of flexion and lateral rotation for approximately 15 minutes. If a subject could not tolerate the positioning for these lengths of time, positioning for a shorter duration was provided, and then increased until the protocol could be resumed. Subjects were positioned in this manner once daily on weekdays for the period they were in an acute care facility. The protocol was not continued in the rehabilitation centre.

Measurements

The primary outcome measures comprised pain as measured by a visual analogue scale (VAS) and shoulder joint range of motion (ROM). These data were collected on entry to the trial, and thereafter once weekly towards the end of each week, when the subject had received 5 days of regular week-day physical therapy. Data were collected by a single physiotherapist at each site who was blinded to the treatment allocation of the patient. The physiotherapists collecting the measurements were from other clinical services and aware that the study was underway, but unaware of the treatment allocation of each patient. Weekly measurements continued until the subject was transferred to a rehabilitation centre. Range of motion and pain were also measured 12 weeks after the date of the trauma. Functional capacity was a secondary outcome measured, on transfer from the acute care centre to the rehabilitation facility, and 12 weeks after injury.

The amount of discomfort or pain which the patient was experiencing in the general shoulder area was documented by means of a visual analogue scale (VAS). The VAS is a 10 centime-

Figure 1.

Figure 2.

tre scale and is widely used in subjective pain measurement having high reproducibility,[9,10] responsiveness to change,[11] and concurrent validity.[10,12,13] The VAS was administered weekly immediately prior to goniometry measurement. Since subjects were unable to place a mark on the VAS, a standardized explanation was read to each subject who orally rated the intensity of any shoulder pain experienced during the previous 24 hour period. This period was chosen to reflect the time period which the patient would most reliably recall. The VAS anchors were from 0 to 10, and described as "no pain at all" to "the worst shoulder pain you can imagine". Subjects were asked to provide a score or number which best described their pain. Those who were intubated and unable to speak had the standard explanation read to them, and were asked to indicate the appropriate score (which was read in the sequence "1, 2, 3" etc. by the outcome assessor) using a pre-agreed facial expression or head movement. Subjects were shown their previous response since researchers have demonstrated that this results in improved validity of subjective measures of change.[14]

Passive shoulder joint ROM was measured using the landmarks and protocol described by Clarkson.[15] Measurements recorded included shoulder flexion, abduction, and medial and lateral rotation, and at each data collection site a single universal goniometer was used. Reliability of joint range using a goniometer have been shown to have maximal intra-tester reliability when one device is used, and one protocol utilized, with an Intra-class Correlation Coefficient between 0.87 and 0.99.[16]

Functional capacity was estimated using the Functional Independence Measure (FIM). This tool was developed to estimate the burden of care, includes a minimum number of key activities, and is a measure of the level of disability.17 Inter-rater reliability greater than 0.83 has been reported,[18,19] and it is responsive to change.[18] The FIM has been used to measure disability among patients with spinal cord injury.[20-23]

complete FIM was used, with the range of scores between 18 and 126.

Data Analysis

Characteristics of the 2 groups at baseline were compared using unpaired Student's t tests (age) and chi square (gender, level of injury, complete versus incomplete spinal cord lesion, presence of previous shoulder problems, use of pain medications). A repeated measures analysis of variance (ANCOVA)(group by time), with a univariate

Table 3. Repeated Measures ANCOVA Table comparing Patient Outcomes (shoulder ROM, measured in degrees) at 2, 3 and 12 weeks post injury

Measure	Conventional Care	Positioning + Conventional Care	F (Time) p =	F (Group /time) p =
Shoulder Flexion				
Left – week 2	154	153		
Left – week 3	159	150	$F_{2,44} = 0.91$	$F_{2,44} = 0.17$
Left – week 12	146	153	$p = 0.41$	$p = 0.85$
Right – week 2	155	154		
Right – week 3	148	148	$F_{2,44} = 1.38$	$F_{2,44} = 0.23$
Right – week 12	148	153	$p = 0.26$	$p = 0.80$
Abduction				
Left – week 2	155	156		
Left – week 3	153	153	$F_{2,44} = 0.39$	$F_{2,44} = 0.13$
Left – week 12	143	161	$p = 0.68$	$p = 0.88$
Right – week 2	156	152		
Right – week 3	149	148	$F_{2,44} = 0.27$	$F_{2,44} = 0.07$
Right – week 12	151	157	$p = 0.76$	$p = 0.93$

approach and using the first data point (Time 1) as a covariate was used to compare weekly VAS pain scores, shoulder ROM and the number of hours subjects were up in the chair. Length of stay (in weeks) in the acute care facility, and FIM scores were analyzed using unpaired Student's *t* tests. Data was analyzed using SPSS software.

Results

Pain VAS scores for weeks 2, 3 and 12 are displayed in Table 2. There were no statistically significant differences between groups on the VAS at any time. FIM scores at the time of transfer to rehabilitation were 55 (± 15) for subjects in the conventional care group and 53 (± 5) in the group receiving positioning. At 12 weeks the FIM scores were 73 (± 26) and 82 (± 28) respectively. There were no statistically significant differences between the groups at either time on FIM scores. Range of motion (mean scores for each measurement) for weeks 2, 3 and 12 were analyzed, and the data are summarized in Tables 3 and 4. There were

Table 4. Repeated Measures ANCOVA Table comparing Patient Outcomes (shoulder ROM, measured in degrees) at 2, 3 and 12 weeks post injury

Measure	Conventional Care	Positioning + Conventional Care	F (Time) p =	F (Group /time) p =
Shoulder ROM				
Med Rotation				
Left – week 2	89	88		
Left – week 3	87	91	$F_{2,42} = 0.54$	$F_{2,42} = 1.46$
Left – week 12	83	86	$p = 0.59$	$p = 0.24$
Right – week 2	84	87		
Right – week 3	86	85	$F_{2,44} = 0,16$	$F_{2,44} = 1.26$
Right – week 12	83	85	$p = 0.85$	$p = 0.29$
Lat Rotation				
Left – week 2	75	78		
Left – week 3	74	79	$F_{2,42} = 0.21$	$F_{2,42} = 0.41$
Left – week 12	67	85	$p = 0.82$	$p = 0.66$
Right – week 2	76	83		
Right – week 3	77	77	$F_{2,44} = 0.60$	$F_{2,44} = 0.30$
Right – week 12	76	82	$p = 0.55$	$p = 0.75$

no statistically significant differences between the 2 treatment groups at any time.

Pain management techniques were recorded for all subjects. Seven patients in the conventional care group (33%) and 10 in the group receiving positioning (55%) received no medications which would have an effect on pain. A chi squared analysis showed no statistical difference between the groups (chi square = 1.947, df= 1). One subject in the conventional care group received transcutaneous nerve stimulation to his shoulder for 3 treatments during 1 week. One subject in the positioning group received an ice treatment once, and several hot pack treatments over the period of one week. The remainder of subjects in both groups received some medications which may have affected their pain. These included skeletal muscle relaxants (Baclofen, Dantrolene Sodium, Methocarbanol), and analgesics (Demerol, Methocarbanol, Naproxen, Paracetamol with and without Codeine).

In order to estimate the incidence of shoulder pain, the number of subjects reporting pain at any time of measurement were counted. Eleven subjects in the conventional care group reported some pain, as did 9 in the group receiving positioning. This indicates an overall incidence of pain of 51%. Since some patients reported only transient pain or discomfort requiring no medication and associated with no loss of ROM, we attempted to estimate the incidence of a clinically important level of pain. Patients were identified who had a score on the VAS of greater than 3 for at least 2 weeks. Using this definition, 8 patients in the conventional care group and 7 among those receiving positioning experienced this degree of pain, which was associated with the use of pain medications and reduction in ROM. This implies an incidence of 38% of clinically important pain.

Discussion

There were no statistically significant differences between the groups in pain or function (as measured by the FIM) and hours sitting in the chair. A greater number of patients in the group receiving positioning reported previous shoulder problems. This has been associated in the literature with the increased incidence of pain and may have introduced a systematic bias in favour of the conventional care group.[5]

The incidence of pain in this study is low and comparable with the lowest previously reported incidence (of between 48 and 78%). In this prospective trial, using the rigorous, regular and prospective pain (VAS) and range (goniometry) measurement techniques, 51% of subjects reported pain, and 38% had pain (of 3 on the VAS for at least 2 weeks) which was probably clinically significant and may have affected function and the patient's quality of life. These VAS scores cannot be compared with those collected from previous studies since none of the previous reports used VAS to quantify the amount of pain. This low incidence of pain and the fact that it was associated with nearly normal ROM may be a result of the daily regular physiotherapy techniques mandated by the study. When clinicians are busy, they are forced to set priorities and treat some patients while leaving others. It may have been that they chose to treat subjects in this research study while leaving others untreated. The protocol for this study specified that the intervention (positioning) was for 45 minutes once daily on weekdays. It may be that the protocol of Scott and Donovan (on which this study was based) with the specific positioning for many two hour periods daily would be effective, however this was deemed impractical for the current trial. This trial was multicentred, which increases its generalizability and may have introduced some limitations. The numbers of subjects enrolled at each site varied widely. The study commenced at one site which is also the trauma centre for a large referral area. Subsequently the other 3 sites commenced enrollment. The numbers of subjects at these sites remained much lower than at the first site. This methodology involved two clinicians at each site, to carry out the treatment protocol. Although the protocols were specified, there may have been slight differences in interpretation between sites. Patients at each site were randomly allocated to each of the 2 treatment groups, which should have reduced systematic bias. At each site the measurements were collected by a single assessor (blinded to treatment allocation) using the protocol as specified, which should have minimized variation between sites.

As well, the sample size was insufficient to demonstrate a benefit, if one existed. This means that the study lacked power to detect a difference. The mean differences between the two treatment groups on the primary outcomes of pain VAS were minimal, and sample size calculations using these data indicate that over one million subjects would have been required. The trial was terminated with 39 subjects after 3 years of data collection because clinical practice in rehabilitation changes over time, as does physiotherapy staffing, making adherence to the protocol difficult. Enrollment was arduous and complicated by the fact that many potential subjects were initially medically unstable, often with unstable cervical spines awaiting fixation and thus unable to commence active physiotherapy, and mechanically ventilated with confounding medical complications, all of which delay entry to the trial. The repeated measures ANCOVA was done using the statistical software SPSS which analyzes only complete data sets. This meant that after 3 weeks, when 25% of patients had been transferred to rehabilitation, data from those remaining in the acute care facilities was not able to included in these analyses.

Conclusions

The results of this study add prospectively collected data consisting of retrospective chart reviews to the existing physical therapy body of knowledge. These trial data were collected through widely used, reliable and valid measurement tools.

Shoulder pain in this trial was low and comparable with the lowest described in previous studies. This may be attributable to the early and rigorous protocol of conventional care which included the glenohumeral and scapular stretches, with this amount of positioning adding little benefit.

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