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Hemiplegic Shoulder Pain Prevention: A Collaborative Approach with Nursing and Occupational Therapy in Acute Care

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Abstract

Background

Hemiplegic shoulder pain is a common problem after stroke. Prevention is the ideal management strategy for this type of shoulder pain. However, many healthcare providers are not trained in management techniques for hemiplegic shoulder pain. The nursing staff is the primary care provider in the acute care hospital. Therefore, the Arm in Arm project, a quality improvement initiative, was developed to improve acute care nursing staff's clinical practice for implementing the recommended positioning and handling techniques into routine care for patients with arm hemiplegia after stroke.

Methods

The 10-week quality improvement project was implemented by an occupational therapist who worked collaboratively with the nurse educator on the neurology unit to change practices among the nursing staff in positioning and handling techniques with patients with arm hemiplegia. The quality improvement project was grounded in the Knowledge-to-Action Process Framework and focused on the action cycle of Knowledge-to-Action for implementation. Knowledge translation strategies such as mini-trainings, knowledge champions, infographics, wristbands, signs, and screensavers were implemented to increase adherence to techniques. A self-developed observation checklist monitored the nursing staff's adherence to techniques. Observation of routine care was performed to evaluate the adherence to positioning and handling techniques.

Results

After ten weeks, the nursing staff's adherence to positioning techniques in routine care increased from 12% to 71%, and their adherence to handling techniques increased from 50% to 91%.

Conclusion

This project demonstrates that a quality improvement project supported by knowledge translation strategies can improve the nursing staff's competency and adherence to positioning and handling techniques for patients with arm hemiplegia after stroke in an acute care hospital. Furthermore, the collaboration between occupational therapy and the nurse educator was vital to enhancing knowledge translation efforts for a program such as the Arm in Arm project.

Keywords: shoulder pain, stroke, hemiplegia, knowledge translation

Introduction

Stroke is a leading cause of disability in the United States and arm hemiplegia is a common secondary effect of stroke (Griffin, 2014; Ranford et al., 2019). Further, hemiplegic shoulder pain (HSP) is one of the most common and disabling complications after stroke, with a prevalence as high as 75% (Anwer & Alghadir, 2020; Xie et al., 2021). HSP can develop as early as the second week, may continue several months after stroke in 65% of patients, and is associated with reduced functional arm use (Kumar, 2019; Praveen Raj et al., 2021). HSP can delay the rehabilitative process with associated lower Barthel Index for Activities of Daily Living scores, resulting in a lower percentage of individuals returning home, and higher depression rates (Gilmore et al., 2004; Kumar, 2019; Murie-Fernández et al., 2012; Vasudevan & Browne, 2014). It also can independently predict a decreased quality of life due to reduced participation in activities of daily living (ADLs), transfers, and mobility (Walsh et al., 2022).

Causes of HSP include adhesive capsulitis, rotator cuff injury, acromion impingement syndrome, complex regional pain syndrome, spasticity, shoulder subluxation, brachial plexus injury, and thalamic syndrome (Anwer & Alghadir, 2020). Although HSP is multifactorial, poor positioning and inadequate handling have been identified as causative factors in its development (Praveen Raj et al., 2021). Despite the high incidence and known causes, HSP continues to be a common problem post-stroke, suggesting that it is not managed well (Smith, 2012).

Prevention is a crucial strategy for managing HSP (Coskun Benlidayi & Basaran, 2014). Implementing management techniques for arm hemiplegia, such as positioning and handling, is critical to preventing HSP. During the flaccid stage, the shoulder is

vulnerable to injury due to joint laxity, so initiating proper handling and positioning techniques in the first few days after a stroke is pivotal (Vasudevan & Browne, 2014). In 1992, Carr and Kenney recommended positioning the shoulder in protraction, shoulder flexion, the wrist in neutral, and finger extension to prevent HSP due to arm hemiplegia (Maxwell & Nguyen, 2013; Vasudevan & Browne, 2014). It is also recommended to limit passive range of motion of the shoulder to 90 degrees of flexion and abduction to avoid subacromial trauma (Griffin, 2014). Additionally, use a gait belt during transfers and ambulation with patients with arm hemiplegia to avoid pulling the affected arm. Slings may be used during transfers and ambulation, but limited use is encouraged to prevent shoulder internal rotation, which has been linked to shoulder pain (Griffin, 2014).

The nursing staff is a key provider for patients with arm hemiplegia after stroke in the acute care setting (Oldland et al., 2020). Therefore, the nursing staff must have the knowledge and skills to prevent HSP through positioning and handling. Positioning patients with arm hemiplegia differs from standard positioning during care (Winegar et al., 2017). Unfortunately, many nurses are not trained in the positioning and handling techniques that can prevent HSP and are unaware of how to prevent this type of shoulder pain after stroke (Seneviratne et al., 2005; Winegar et al., 2017).

The Arm in Arm project, a quality improvement (QI) initiative, was developed and implemented in an acute care hospital using knowledge translation (KT) strategies to improve the nursing staff's adherence to management techniques for arm hemiplegia. The QI initiative aimed to evaluate a collaborative approach between nursing and occupational therapy to improve adherence to positioning and handling techniques that can prevent HSP in an acute care hospital. This paper describes the Arm in Arm project

implementation in an acute care hospital and its impact on the nursing staff's competency and adherence to management techniques for arm hemiplegia.

Methods

The Arm in Arm project was developed and led by an occupational therapist (OT) in collaboration with the clinical nurse educator of the neurology unit. The neurology staff members involved in this project's implementation included an OT, physical therapy assistant (PTA), a clinical nurse educator, and a staff registered nurse (RN). This project did not require institutional review board (IRB) approval according to the University of Rochester Medical Center's (URMC) guidelines, as this project's primary focus was to improve patient care within the hospital (University of Rochester, 2019).

Setting and Participants

The program was implemented in a 25-bed neurology unit in acute care, a comprehensive stroke center at URMC. As a QI project, the 34 participants were not approached for consent. The program participants included RNs, licensed practical nurses, and personal care technicians caring for patients with stroke while assigned to the neurology unit at URMC. The QI project was implemented with permanent and contract nursing staff working full-time or part-time during the 7 a.m.-3 p.m. shift.

Program Description

The Arm in Arm project was grounded in the Knowledge-to-Action (KTA) Process Framework (Sudsawad, 2007). The KTA Process Framework describes the process of knowledge creation and an action cycle for implementing knowledge into practice. A KT framework was necessary for this QI project as comprehensive literature guides best practices for positioning and handling techniques to prevent HSP after stroke. However,

this literature still has not been integrated well into practice. Therefore, this project focused on the action cycle of the KTA Process Framework for implementation. The 10-week program included education adapted to meet the needs and workflow processes of the neurology unit, ongoing informal surveys of the nursing staff to understand the barriers and facilitators to knowledge use, establishing KT strategies to address known barriers, tailoring of interventions based on identified barriers, and ongoing assessment to monitor knowledge used by the nursing staff (Supplemental Material Figure 1).

Before the program's start, inadequate positioning and handling techniques for patients with arm hemiplegia were identified as a problem in acute care at URMC, as frequently observed by the OT during therapy. After the problem was identified, knowledge regarding the recommended positioning and handling techniques for HSP prevention was gathered from the literature. With time constraints also identified as a barrier to the implementation of any training at URMC, a 10-week program was developed by the OT. The project aimed to improve acute care nursing staff’s clinical practice for implementing the recommended positioning and handling techniques into routine care for patients with arm hemiplegia after stroke through audit and feedback and additional KT strategies. The goals were to have the nursing staff demonstrate 100% competency with the recommended techniques and increase their adherence to the techniques to 75%. The OT shared the 10-week program's description, timeline, and aims with the neurology unit nurse manager, who approved and participated in the QI program.

The program began with obtaining the nursing staff's pre-training baseline adherence to positioning and handling techniques through observations by the primary

OT during week 1 (Supplemental Material 2). Mini-training on positioning and handling techniques occurred during weeks 2-4 of the program and was adapted to the context of acute care. These trainings were guided by a competency checklist, which was used to check off each nursing staff member's competency with positioning and handling techniques (Supplemental Material 3). The mini-trainings were embedded in the nursing staff's morning and afternoon routine patient care. Three weeks of training was necessary to target the varying schedule of the nursing staff and reach the greatest amount of staff providing care on the unit. Each mini-training occurred in patients' rooms for approximately 15 to 20 minutes. The nursing staff members who did not receive training during the designated three-week period received supplementary training during weeks 5 through 10 to ensure that all dayshift nursing staff were trained.

In concert with training, KT strategies were employed to support the implementation of the training. KT strategies ensure that the nursing staff are aware of and use evidence-based practice to inform decision-making (Yost et al., 2014). The KT strategies used during this program also served as reminders of the techniques for the nursing staff. The strategies were implemented during the initial week of training and continued until the end of the program.

While multiple KT strategies were employed, the knowledge champions (KC) were major program components. Primary and secondary KC were identified and available daily to reiterate and remind the nursing staff of the techniques during morning and afternoon huddles and routine patient care. The huddles are pre-established and used to assign and pair the nursing staff to patients' rooms for routine care. These

huddles are also a venue for managers and staff communication regarding updates, compliance issues, and practice concerns on the unit.

The audit and feedback (A&F) process, another important KT strategy of the program, began during the fifth week and lasted six weeks until the program's end. A&F was implemented to improve and influence the nursing staff's adherence to the recommended positioning and handling techniques. The A&F process used during this project was based on the 5-step cyclical process described by Benjamin (Benjamin, 2008). The five steps included 1) preparing for the audit, 2) selecting criteria, 3) measuring performance, 4) making improvements, and 5) sustaining improvements (Benjamin, 2008). These steps co-occurred with the steps of the KTA Process Framework. Refer to Supplemental Material 4 for a list and description of all KT strategies implemented in this program.

Recommended management techniques for arm hemiplegia were gathered to prepare for the audits. From this, a checklist was developed and criteria were established based on the positioning and handling techniques recommended by Carr and Kenney, the Chest, Heart, and Stroke Scotland, and National Clinical Guidelines for Stroke (Smith, 2012; Maxwell & Nguyen, 2013; Vasudevan & Browne, 2014; Intercollegiate stroke et al., 2016). Three raters, the primary OT (author EC) and two OTs, were trained in positioning and handling techniques. The raters performed audits through observations using a checklist to monitor the nursing staff’s adherence to the recommended positioning and handling techniques post-training (Supplemental Material 1). Adherence to the recommended positioning and handling techniques was measured through frequent 30-minute observations. Following the observations, the raters

conducted brief, informal surveys with the nursing staff to gather barriers and facilitators to implementing positioning and handling techniques into routine care from their perspectives.

Observation data and the staff's survey report were used to identify improvement strategies. The primary OT collaborated with the clinical nurse educator to address identified barriers and commonly observed challenges to tailor interventions for the upcoming week. The nursing staff received feedback on adherence via email and during Monday morning huddles. The project leader implemented the tailored intervention that week to improve adherence to techniques such as providing new hires with training or retraining on techniques to the nursing staff as needed. Identifying methods to sustain the use of techniques was ongoing throughout the project, with final recommendations developed and provided by the project leader and clinical nurse educator at the program's end.

Data Collection

Demographic information was gathered during the mini-trainings. The competency checklist (Supplemental Material 3) ensured the nursing staff demonstrated knowledge and understanding of the positioning and handling techniques during the three weeks of mini-trainings. The raters used the clinical observation checklist (Supplemental Material 2) to perform pre-training and post-training observations. Over six weeks, raters completed a minimum of 5 scheduled observations per week during morning and afternoon routine care. Although the nursing staff knew that observations were occurring, they were unaware of the day and time the observations were scheduled. Observations only occurred during routine care performed by the nursing

staff on any patient with arm hemiplegia after stroke who presented with a manual muscle strength grade of 3-/5 or less at their initial OT evaluation. Patients with stroke with a manual muscle strength grade of 3/5 or greater were excluded from the observations. The nursing staff were aware they were being observed as they received the informal surveys after observations and weekly feedback regarding results. All data were collected and recorded in Microsoft Excel and analyzed using descriptive statistics.

Results

Of the 34 nursing staff initially participating in the QI project, 31 were fully trained in positioning and handling techniques during this project, with a 100% participation rate. Three nurses received training in positioning techniques during the first week of training but did not receive training in handling techniques due to not renewing their contracts. The nurses did not renew their contracts before the A&F process began and did not interfere with the project results. Demographics displayed in Table 2 include all 34 participants.

Table 2

Nursing Staff Demographics

Gender	
Female	30
Male	4
Non-binary	0
Job Title	
RN Associates	6
RN Bachelors	14
LPN	5
PCT	5
Other:	
Nursing Summer Student	2
RN Masters	2
Employment Status	
Full-time permanent	10
Full-time contract	15
Part-time permanent	6
Part-time contract	2
Unknown status	1
Years of Work Experience with Stroke	
0-1 years	18
2-3 years	7
4-5 years	4
6-9 years	3
10+ years	2

Baseline observation demonstrated 12% adherence to positioning techniques and 50% adherence to handling techniques. Post-training, 207 observations were performed over six weeks. In the initial week after training, the nursing staff's adherence to the recommended positioning techniques increased to 52% and 80% for handling techniques. Observations continued through to week 10 of the project, with an overall increase to 71% for positioning techniques and 91% for handling techniques (Figures 1

and 2). Table 3 provides information on the number of observations performed week to week.

Figure 1

Weekly Hemiplegic Positioning Techniques Pre-and Post-Training Comparison

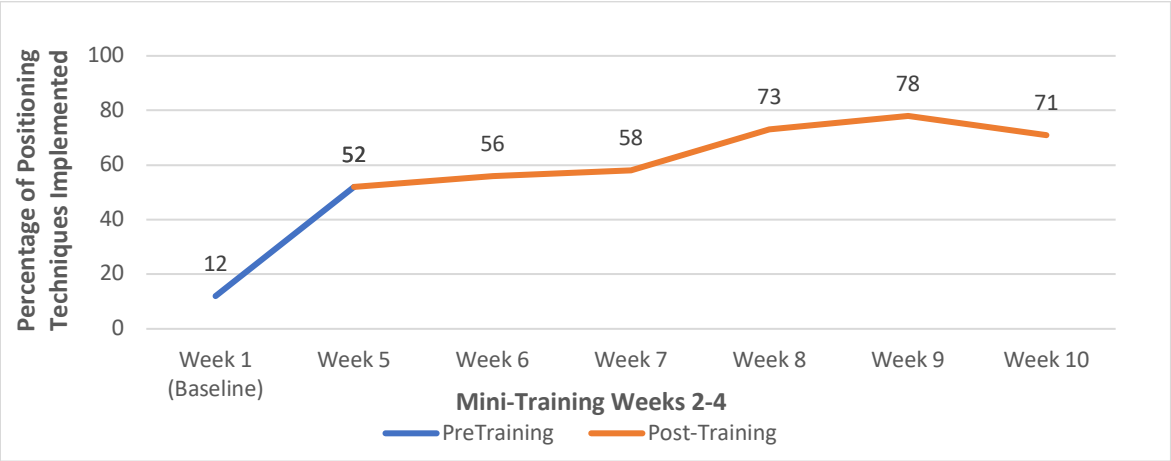

Figure 2

Weekly Hemiplegic Handling Techniques Pre-and Post-Training Comparison

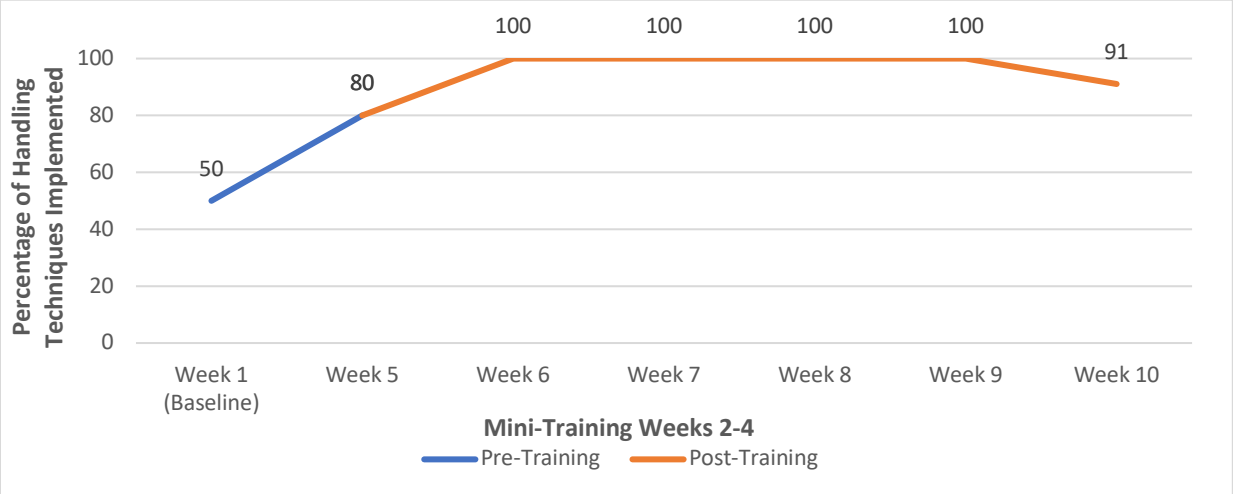

Table 3

Arm in Arm: Weekly Audit Results

	Baseline	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
Positioning observations	33	25	16	33	22	32	35
Positioning techniques implemented	4	13	9	19	14	25	25
Weekly % of positioning techniques implemented	12	52	56	58	73	78	71
Weekly % of positioning techniques compared to baseline	--	40	44	46	61	66	59
Handling observations	6	5	3	5	2	11	11
Handling techniques implemented	3	4	3	5	2	11	10
Weekly % of handling techniques implemented	50	80	100	100	100	100	91
Weekly % of handling techniques implemented compared to baseline	--	30	50	50	50	50	41

Discussion

The results of this project demonstrate that a QI project supported by KT strategies can improve the nursing staff's competency and adherence to positioning and handling techniques for patients with arm hemiplegia after stroke in an acute care hospital. By the program's final week, the Arm in Arm project successfully increased positioning techniques by 59% and handling techniques by 41%. The nursing staff demonstrated 100% adherence to the recommended handling techniques during weeks 6 through 9. Inadequate handling techniques occurred only during one observation during week 10, decreasing the adherence to handling techniques by 9%.

A review of the observation checklist (Supplemental Material 2) demonstrated that the elbow criteria, elbow extension with less than 30 degrees of elbow flexion of the affected arm, were frequently not implemented. Successful adherence to the training required all indicators on the checklist to be implemented. Including the elbow as an indicator may have decreased the positioning results. Positioning the elbow in less than 30 degrees of extension may not have always been feasible with the development of spasticity as a natural course of recovery. When the raters observed the elbow, spasticity may have pulled the arm into greater than 30 degrees of elbow flexion. Future projects similar to the Arm in Arm project may want to exclude the elbow as an indicator in the observation checklist and focus entirely on the shoulder. Additionally, future projects may want to include external rotation as an indicated position for those with arm hemiplegia. Stiffness of the internal rotators has been identified in patients with HSP (Jia et al., 2023).

The KT strategies embedded into this QI project were a significant contributor to the project's success. The informal surveys allowed the nursing staff to describe barriers and facilitators. Identifying barriers allowed tailored interventions to facilitate and promote awareness and knowledge implementation (Sudsawad, 2007) and informed the feedback process. During the informal surveys with the raters, nursing staff identified the orange wristbands and positioning signs as the most beneficial facilitators. Barriers identified by the nursing staff include time constraints, heavy assistance needed for positioning stroke patients, particularly when a nursing shortage was experienced, burnout, and a lack of empathy for patients' shoulder pain by some nursing staff members. The audit component of the A&F process revealed specific techniques that were implemented and those that were not. For example, the observations captured specific criteria to determine whether the affected arm was positioned in shoulder abduction with elbow extension while supported by pillows when in bed or seated in a chair. If the criteria were not implemented, it provided the opportunity to provide performance feedback and focus on techniques that needed reviewing. It also updated the nursing staff on their progress and improvement.

The significant contribution of KT strategies to the Arm in Arm project is consistent with other QI programs. An A&F program implemented by Jolliffe et al. (2019) evaluated the impact of a prospective A&F program on clinicians' adherence to clinical practice guidelines in brain injury rehab. When audits revealed low adherence to guidelines, feedback sessions were provided to increase staff's awareness of expected behavior (Jolliffe et al., 2019). After the study's completion, results showed a significant

increase from 38.8% at baseline to 83.6% at the end of the intervention in clinicians' adherence to practice guidelines.

The KCs were another effective KT strategy of the Arm in Arm project. The primary KC was absent during weeks 6 and 7, coinciding with only a 2% increase in positioning techniques during this timeframe. Upon the KC's return in week 8, adherence to positioning increased by 15% from week 7. This was the largest increase recorded during the six weeks of A&F. The strong influence of a KC on nursing staff behaviors was also seen in a study by Donati et al. (2020). This study used infection control link nurses as KCs to increase nurses' compliance with hand hygiene in acute care. The study's completion showed a significant increase in the nurses' compliance with hand hygiene, from 63% to 77.3%.

There were several limitations of the Arm in Arm project. The training was only provided to the day shift and did not include evening or night shift training. Other challenges include data collection during routine patient care, such as toileting tasks. Occasionally, raters could not observe positioning and handling techniques when the nursing staff requested privacy for the patient. Also, not all patients on isolation precautions were observed. This project occurred during the COVID-19 pandemic and was a barrier to completing all observations. Furthermore, higher adherence could have also occurred as the nursing staff typically did not transfer patients out of bed and mainly performed bed mobility during routine care, which may have left fewer opportunities for error. Finally, the nursing staff were aware that their adherence to positioning and handling techniques was monitored, which may have increased their adherence.

Conclusion

Implementation of best practices of positioning and handling techniques after stroke can be improved through a QI project grounded in a KT framework. It is not known if the consistent use of these strategies can impact rehabilitation outcomes such as length of stay, functional status, and discharge location. The Arm in Arm project is a KT program that can be implemented in similar acute care hospitals. Implementing the mini-training during the nursing staff's well-established routine patient care by the primary OT and PTA was less time-consuming. The established huddles and routine patient care also made the observations' timing simpler, allowing the flexibility of observations within a 30-minute timeframe. Therefore, establishing or developing huddles that include routine patient care is advantageous in the acute care setting, particularly for fast-paced institutions. Finally, collaborative efforts between the nursing staff and therapists are necessary to optimize care after stroke to prevent HSP (Zeferino & Aycock, 2010). Thus, collaboration is vital to enhance KT efforts for a program such as the Arm in Arm project.

Acknowledgment

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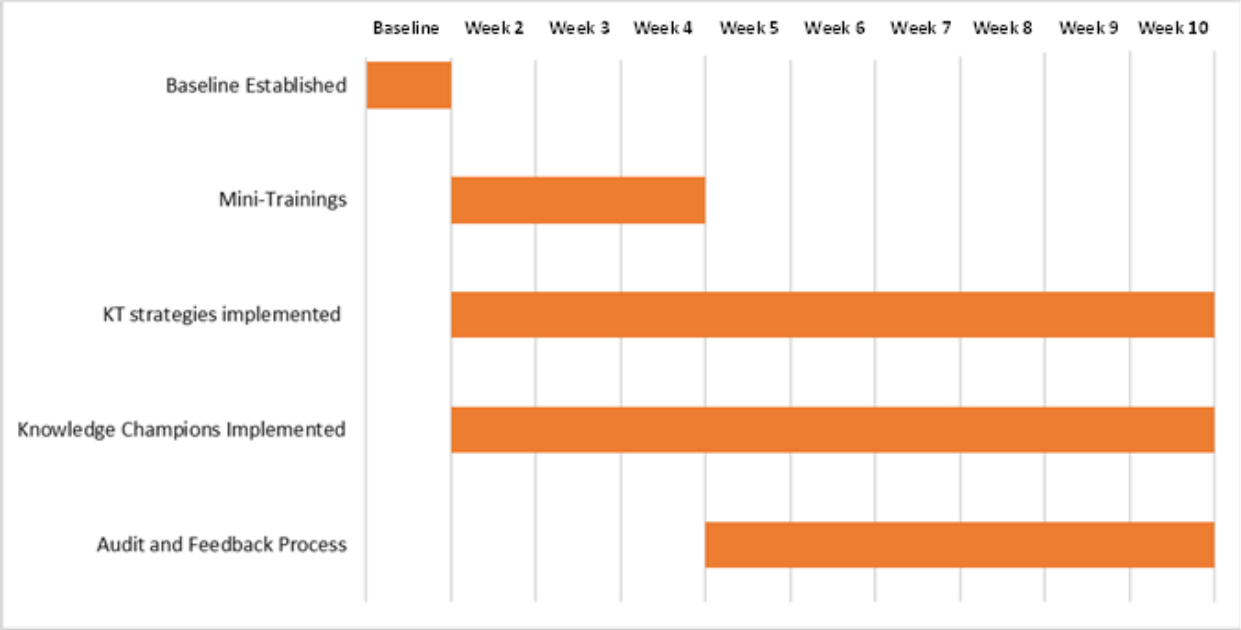
Supplemental Material for Hemiplegic Shoulder Pain Prevention: A Collaborative Approach with Nursing and Occupational Therapy in Acute Care

Supplemental Material 1 (Figure)

Arm in Arm 10-Week Project Timeline



Supplemental Material 2 (Table)

Clinical Observation Checklist for Hemiplegic Arm Management

*(** specifies indicators needed for "implemented" techniques. If the indicators are not met, techniques are deemed unimplemented***)***

	Check the appropriate box to select "Yes" or "No". **Explain responses if answered "No" in the space below each question.**	**Yes**	**No**
	POSITIONING TECHNIQUES		
	☐ **Right Arm Affected** ☐ **Left Arm Affected**		
1.	Patient in bed? (If yes, skip to question **#3**)		
2.	Patient in chair? (If yes, skip to question **#14**)		
3.	How is the patient in bed? (If patient is in right side-lying, skip to question **#9**. If in left side-lying, skip to question **#16**. If sitting up in bed, skip to question **#22**) ☐ Supine ☐ Right Side-lying ☐ Left Side-lying ☐ Sitting up		
	Supine		
4.	Affected arm supported on pillow(s)? **		
5.	Affected arm slightly abducted? **		
6.	Elbow of affected arm is extended? (can be slightly flexed)**		

7.	Wrist of affected arm is in neutral?		
8	Fingers of affected arm are extended?		
Right Side-lying (Right Arm Affected)			
9.	Arm forward (not tucked underneath patient)? **		
10.	Elbow of affected arm is extended? (can be slightly flexed)		
Right Side-lying (Left Arm Affected)			
11.	Affected arm supported on pillow(s)? **		
12.	Arm forward (not tucked underneath patient)? **		
13.	Elbow of affected is extended? (can be slightly flexed) **		
14.	Wrist of affected arm is in neutral?		
15.	Fingers of affected arm are extended?		
Left Side-lying (Left Arm Affected)		**Yes**	**No**
16.	Arm forward (not tucked underneath patient)? **		

17.	Elbow of affected arm is extended? (can be slightly flexed)		
Left Side-lying (Right Arm Affected)			
18.	Affected arm supported on pillow(s)? **		
19.	Elbow of affected arm is extended? (can be slightly flexed)**		
20.	Wrist of affected arm is in neutral?		
21.	Fingers of affected arm are extended?		
Sitting up in bed or Sitting up in chair			
22.	Arm supported on pillow(s)? **		
23.	Arm forward (not tucked underneath patient)? **		
24.	Elbow of affected arm is extended? (can be slightly flexed)**		
25.	Wrist of affected arm is in neutral?		
26.	Fingers of affected arm are extended?		
HANDLING TECHNIQUES			

	☐ **Right Arm Affected** ☐ **Left Arm Affected** ☐ **1-Person Assist** ☐ **2-Person Assist**		
27.	Gait belt used?		
28.	Pulling of the affected arm? **		
29.	Transfer to unaffected side?		

Specific indicators for the affected arm were identified based on recommendations by Carr and Kenny (1992), the Chest, Heart, and Stroke Scotland, and the national clinical guidelines for stroke.

Indicators included the affected arm supported on pillows with shoulder flexion, slight shoulder abduction, shoulder protraction while the patient is lying on the affected side, and avoidance of pulling/underarm anchoring of the affected arm.

Additional Recommendations identified by the project leader as an indicator

*Elbow extension $\leq$ 30 degrees of elbow flexion to account for spasticity in biceps

Supplemental Material 3 (Table)

Competency Checklist of Hemiplegic Arm Management Techniques

ARM POSITIONING IN BED	
Supine	
Right Arm Hemiplegia	**Left Arm Hemiplegia**
☐ Arm supported on a pillow ☐ Slight shoulder abduction ☐ Elbow extension (≤30 degrees of flexion) ☐ Wrist in neutral ☐ Fingers extension	☐ Arm supported on pillow ☐ Slight shoulder abduction ☐ Elbow extension (≤30 degrees of flexion) ☐ Wrist in neutral ☐ Fingers extension
Right Side-lying	
☐ Shoulder forward ☐ Elbow ~ 90* of flexion **Use pillows for right arm as needed**	☐ Arm supported on pillow (when lying on unaffected side) ☐ Shoulder forward ☐ Elbow extension (≤30 degrees of flexion) ☐ Wrist in neutral ☐ Fingers extension
Left Side-lying	
☐ Arm supported on pillow (when lying on unaffected side) ☐ Shoulder forward	☐ Shoulder forward ☐ Elbow extension ~ 90* of flexion

☐ Elbow extension (≤30 degrees of flexion) ☐ Wrist in neutral ☐ Fingers extension	**Use pillows for left arm as needed**
Sitting Up in Bed	
☐ Arm supported on pillow ☐ Slight shoulder abduction ☐ Elbow extension (≤30 degrees of flexion) ☐ Wrist in neutral ☐ Fingers extension	☐ Arm supported on pillow ☐ Slight shoulder abduction ☐ Elbow extension (≤30 degrees of flexion) ☐ Wrist in neutral ☐ Fingers extension
ARM POSITIONING IN CHAIR	
☐ Arm supported on pillow ☐ Slight shoulder abduction ☐ Elbow extension (≤30 degrees of flexion) ☐ Wrist in neutral ☐ Fingers extension	☐ Arm supported on pillow ☐ Slight shoulder abduction ☐ Elbow extension (≤30 degrees of flexion) ☐ Wrist in neutral ☐ Fingers extension
ARM HANDLING DURING BED MOBILITY AND TRANSFER	
Right Arm Hemiplegia	**Left Arm Hemiplegia**
1-Person Assist ☐Ensures the affected arm is protracted when rolling to affected side	**1-Person Assist** ☐Ensures the affected arm is protracted when rolling to affected side

☐Uses sheets to roll patient to avoid hand placement on affected scapula ☐Avoids pulling the affected arm during bed mobility and transfers ☐Gait belt use during transfers ☐Transfers to unaffected side **2-Person Assist** ☐Ensures the affected arm is protracted when rolling to affected side ☐Uses sheets to roll patient to avoid hand placement on affected scapula ☐Avoids pulling the affected arm during bed mobility and transfers ☐Gait belt use during transfers ☐Transfers to unaffected side	☐Uses sheets to roll patient to avoid hand placement on affected scapula ☐Avoids pulling the affected arm during bed mobility and transfers ☐Gait belt use during transfers ☐Transfers to unaffected side **2-Person Assist** ☐Ensures the affected arm is protracted when rolling to affected side ☐Uses sheets to roll patient to avoid hand placement on affected scapula ☐Avoids pulling the affected arm during bed mobility and transfers ☐Gait belt use during transfers ☐Transfers to unaffected side

Supplemental Material 4 (Table)

KT Strategies Implemented During the Arm in Arm Project

KT Strategy	Description
Mini-training	• 15-20 minute training session provided to the nursing staff on positioning and handling techniques • Implemented during routine patient care with actual patients • Implemented during week two of the project
Knowledge champions	• Composed of a primary knowledge champion (clinical nurse educator) working weekdays and a secondary knowledge champion (staff RN) working weekends • Reiterated the importance of positioning and handling techniques • Reminded the nursing staff to implement the techniques during huddles and routine patient care • Implemented during the initial week of training
Infographics	• Three infographics located on the neurology unit • Reiterated the importance of positioning and handling techniques; provides a visual for the do's and don'ts of techniques • Implemented during the initial week of training
Screensavers	• Located on the desktops across hospital units • Used as a reminder to implement techniques

	• Used to reiterate the importance of positioning and handling techniques • Provided a visual for the recommended positioning and handling techniques during routine care • Implemented during the initial week of training
Positioning signs (orange)	• Located in patients' rooms as a reminder of positioning techniques during routine care • Implemented during the initial week of training
Positioning and handling orders	• Orders located in patients' charts to remind the staff to implement positioning and handling techniques • Encouraged the implementation of techniques as a protocol • Implemented during the initial week of training
Hemiplegic arm wristbands (orange)	• Located on the patients' hemiplegic arm as a reminder to staff to use the recommended positioning and handling techniques with patient • Implemented during the initial week of training
Audit and feedback	• A strategy used to improve professional practice either on its own or as a component of multifaceted quality improvement interventions (Ivers et al., 2012) • Implemented over a specified period • Encourage professionals to change their clinical practice when shown how they perform in

	comparison to descriptive or normative benchmarks or targets (Jamtvedt et al., 2019) • Implemented during week 5 of the project