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Original Research Article

Rising From Bed: Comparison between Movement Patterns of Stroke and Healthy Individuals

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ABSTRACT

Objective: For most individuals, getting out of bed is a routine activity essential for functional independence. It is a task taught by clinicians and clarification of the movement patterns used is important. The purpose is to compare the movement patterns used to rise from bed and compare the average time taken to complete the task by normal adults and stroke.
Design: Descriptive (comparative) study.
Methods: 30 subjects (15 normal adults and 15 patients with stroke) participated in the study. The subjects were videotaped during performing 10 consecutive trials of rising from a bed. The movement patterns of each of four body regions were described according to Sarnacki's descriptions and compared between both the groups. The average time taken to complete the task of rising from bed was also compared.
Results: The results of the study revealed that there was a significant difference between both the groups on pattern of movement (p</=0.05) and average time taken to rise from bed was much higher for patients with stroke than normal adults.
Conclusion: There are differences in the movement patterns between normal adults and stroke subjects and the average time taken to rise from bed is significantly more for stroke.

Keywords: Stroke, Movement pattern, Movement pattern

INTRODUCTION

Cerebrovascular disease is the leading cause of disability in adults and each year millions of stroke survivors have to adapt to a life with restrictions in activities of daily living as a consequence of cerebrovascular disease. [1] The prevalence of stroke in India is estimated as 203 per 100,000 population above 20 years, amounting to a total of about 1 million cases. [2] Following stroke, movement deficits are characterized by weakness of specific muscles, abnormal muscle tone, abnormal postural adjustments, abnormal movement synergies, lack of mobility between structures at the shoulder girdle and the pelvic girdle, incorrect timing of

components within a movement pattern and loss of interjoint coordination. [3]

For most individuals, getting out of bed is a routine daily activity that occurs across the life span and is essential for functional independence. Physical therapists are often interested in not only whether their patients can perform this activity without assistance but also in the movement patterns (MP) used for getting out of bed. VanSant et al in their study found that subjects varied greatly in the movement patterns they used to raise. Only 25% of the subjects demonstrated a similar combination of movements during rising. [4] Green and Williams studied the differences in developmental movement patterns used by active versus sedentary middle-aged adults coming from a supine position to erect stance. He suggested that lifestyle patterns of regular, moderate physical activity may influence how a person performs the basic righting task of coming from a supine to a standing position. [5] Unrau K et al done an exploratory study of righting reactions from a supine to a standing position in adults with Down syndrome. They found the great variety of movements demonstrated by these subjects in the task of standing from a supine position. [6]

Sarnacki [7] has described the movement patterns used when rising from a bed, first describing the movement patterns of young adults performing this task and then using stage-theory constructs to propose developmental sequences of movement patterns for components of body action. The characteristics of movement pattern of rise from bed includes: (a) the need to generate momentum to move the body to vertical, (b) stability requirements for controlling the center of mass (COM) as it changes from within the support base defined by the horizontal body to that defined by the buttocks and feet, and finally to a base of support defined solely by the feet, and (c) the ability to adapt how one moves to the characteristics of the environment.

The study focuses on identifying the variability of rising from bed between normal adults and patients with hemiplegia and identifying the missing components in patient with hemiplegia, so that they can serve as a guide for rehabilitation professionals to formulate the treatment strategies to train this activity.

MATERIALS AND METHODS

Selection and description of participants: A sample of thirty subjects, including 15 normal adults and 15 with stroke recruited from Indian Spinal Injuries Centre and GB Pant Hospital, New Delhi. The inclusion criteria for Group 1 was: (1) subjects with history of first stroke confirmed by a neurologist (2) time since stroke 3 months or more (3) age 45-60 years (4) MMSE score ≥ 24 (5) ready to give informed consent. (6) able to perform rise from bed. The exclusion criteria for patients with stroke included: (1) recurrent stroke (2) occipital, cerebellar or brain stem lesions (3) any perceptual or major cognitive deficits (4) any unstable medical condition

The inclusion criteria for Group 2 (normal adults) were: (1) Age 45-60 years (2) No limitation in physical activity either due to physical or mental condition (3) MMSE score ≥ 24 (4) Ready to give informed consent

Procedure: A total of 30 subjects participated in this study. The subjects were screened on inclusion and exclusion criteria. An informed consent was taken from all the subjects and detailed explanation of the procedure was given. The subjects were assigned to Group 1 and Group 2 respectively. Subjects in both the groups were told to remove their shoes and socks and lay supine on the bed (size 1.83 m long, 0.92 m wide and 0.51 m high; mattress size

1.82 m long, 0.92 m wide and 0.10 m thick) with their arms beside their body and their head on a pillow. Each subject followed simple verbal instructions without prior visual demonstration. Each subject was videotaped while performing 10 consecutive trials of rising from the preferred side of the bed. On the cue "Ready," taping began. When the cue "Go" was given, the subject rose from the bed at their normal pace. Subjects were asked to perform 10 consecutive trials at intervals of a few seconds. [8]

Layout of the videotaping field: Two video cameras of SONY DSC S950 (each camera equipped with an automatic focus and a power zoom lens) were used. One camera faced the side of the bed, and the other camera faced the foot of the bed. The side-view camera was positioned perpendicular to the long axis of the bed, approximately 5.83 m from the midpoint of the bed. The center of the camera lens was approximately 0.89 m above the floor. The other camera was positioned perpendicular to the short axis of the bed, approximately 5.94 m from the midpoint of the bed. The center of this camera lens was approximately 1.03 m above the floor. Videotaping from this position provided a foot view of a subject while lying supine. The videotapes were reviewed, and the movement patterns observed for a body region were classified using Sarnacki's descriptions. [7] All the data was taken on data collection form. The evaluation was done by 2 raters independently.

Figure 1: Movement patterns of normal adult in side view (A-P)

Figure 2: Movement patterns of patient with hemiplegia in side view (A-P)

Data Analysis: Statistics were performed using the SPSS software (version 17.0). Mode of the 10 trials was used to analyze the commonest movement pattern between Group 1 and Group 2. An unpaired t-test was used to analyze the difference between the ages, height, weight, MMSE scores and average time taken to complete the task by Group 1 and Group 2. Significant level of $p \leq 0.05$ was fixed.

Kappa statistics was used to measure the interrater reliability between Rater 1 (R1) and Rater 2 (R2).

RESULTS

Comparison of demographic variables between normal adults and hemiplegic subjects

Thirty subjects including 15 normal adults (10 males and 5 females) and 15 patients with hemiplegia (6 males and 9 females) participated in this study. The demographic data of all the subjects is given in the Table 5.1 and the comparison of their demographic data is illustrated in Figure 5.1. The mean age of normal adults was 51.33 ± 3.39 years and of patients with hemiplegia was 54.33 ± 4.80 years. The mean height of normal adults was 164.70 ± 9.55 cm and of patients with hemiplegia was 162.53 ± 8.24 cm. The mean weight of normal adults was 68.06 ± 11.79 kg and of patients with hemiplegia was 66.53 ± 6.76 kg. The mean score of MMSE for normal adults was 29.80 ± 0.41 and of patients with hemiplegia was 28.66 ± 1.63. There was no significant difference between normal adults and patients with hemiplegia with respect to age, height, weight except MMSE scores where the difference was significant ($p > 0.05$)

Table 1: Comparison of percentage of occurrence of each movement pattern for normal adults and patients with hemiplegia

Movement Pattern	Percentage of occurrence of movement pattern for normal adults	Percentage of occurrence of movement pattern for hemiplegic patients
Far upper extremity	0.0	0.0
Lateral lift and push	33.3	0.0
Push		
Double push	53.3	6.7
Lift and push	13.3	26.7
Lift and reach	0.0	6.7
ND	0.0	60
Near upper extremity		
Lateral lift and push	0.0	13.3
Grasp and push		
Push	13.3	46.7
ND	86.7	0.0
	0.0	40.0
Axial region		
Pelvis leads	0.0	0.0
Lateral roll	0.0	0.0
Roll off	33.3	26.7
Come to sit	66.7	73.3
ND	0.0	0.0
Lower extremities		
Step off	0.0	6.7
Asynchronous lifting	0.0	20.0
with leg extension		
Asynchronous lift	13.3	40.0
Synchronous	86.7	13.3
ND	0.0	20.0

ND = Movement "not described" by Sarnacki.

Table2: Interrater reliability between Rater 1 (R1) and Rater 2 (R2) for each component of movement pattern

Movement Pattern	Kappa
Far upper extremity	911
Near upper extremity	951
Axial region	918
Lower extremities	.949

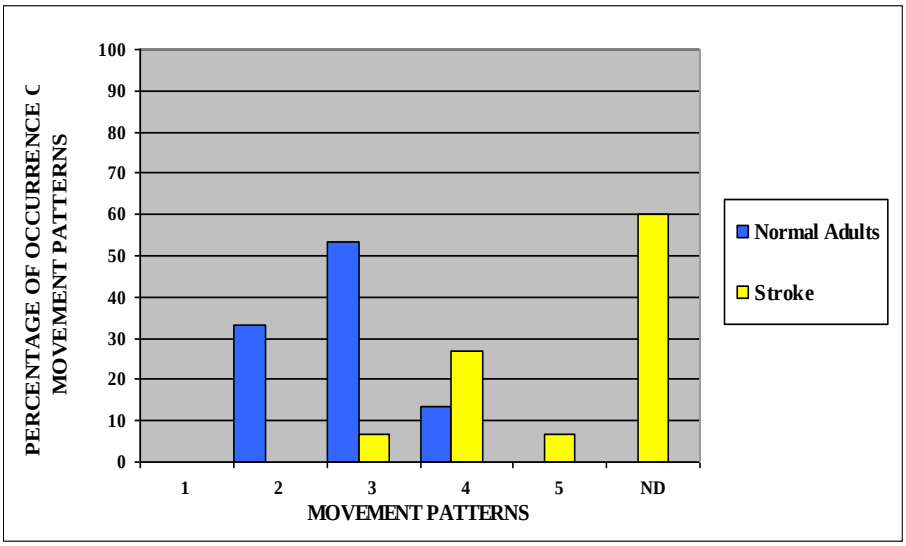

Figure 3: Percentage of occurrence of movement patterns for far upper extremity (FUE) component for normal adults and subjects with stroke

Movement Patterns
1 – Lateral lift and push
2 – Push
3 – Double push
4 – Lift and push
5 – Lift or lift and reach
ND – Movement "not described" by Sarnacki

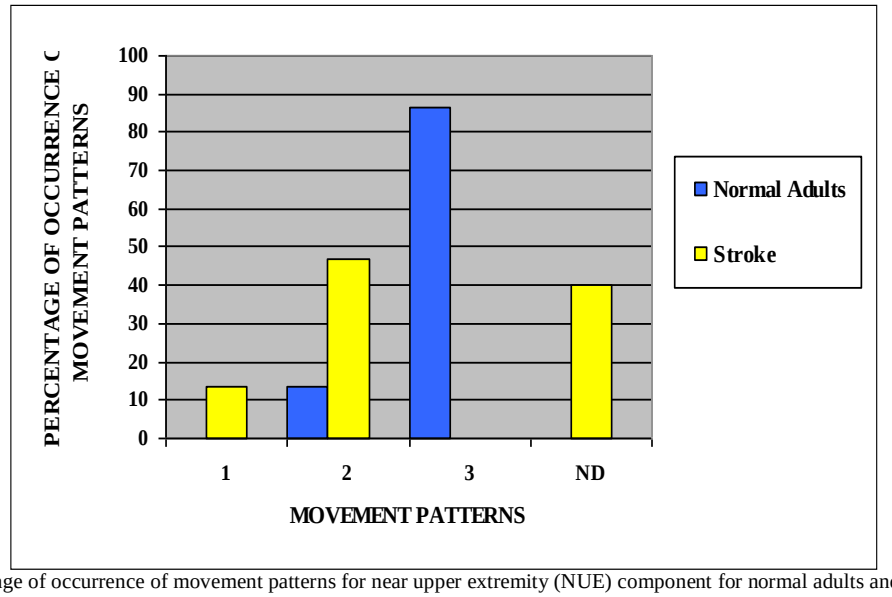

Figure 4: Percentage of occurrence of movement patterns for near upper extremity (NUE) component for normal adults and subjects with stroke

Movement Patterns
1 – Lateral lift and push
2 – Grasp and push
3 – Push
ND – Movement "not described" by Sarnacki

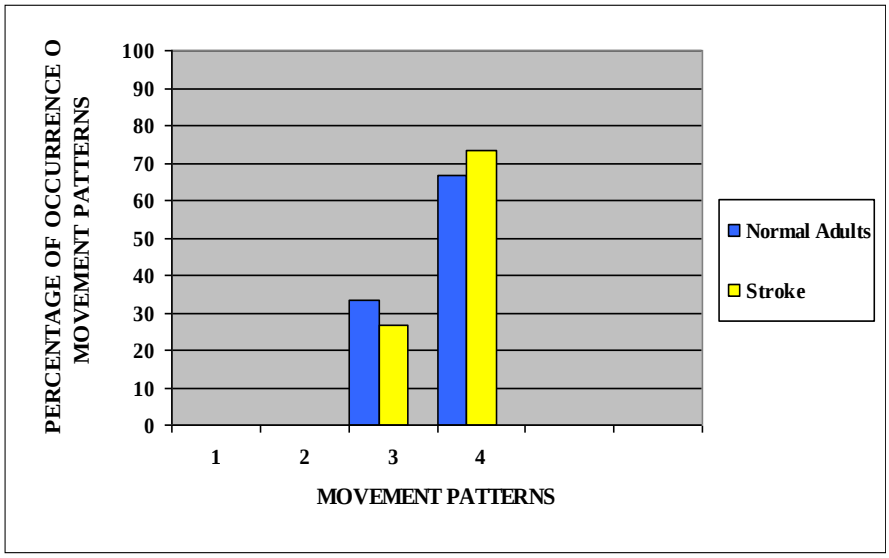

Figure 5: Percentage of occurrence of movement patterns for axial (AX) region component for normal adults and subjects with stroke

Movement Patterns
1 – Pelvis leads
2 – Lateral roll
3 – Roll off
4 – Come t

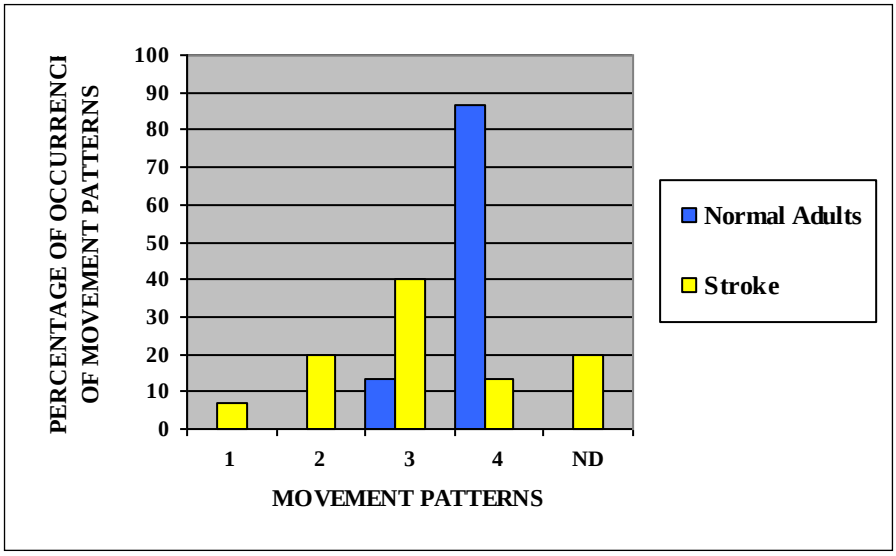

Figure 6: Percentage of occurrence of movement patterns for lower extremity (LE) component for normal adults and subjects with stroke

Movement Patterns
1 – Step off
2 – Asynchronous lifting with leg extension
3 – Asynchronous lift
4 – Synchronous
ND – Movement "not described" by Sarnacki

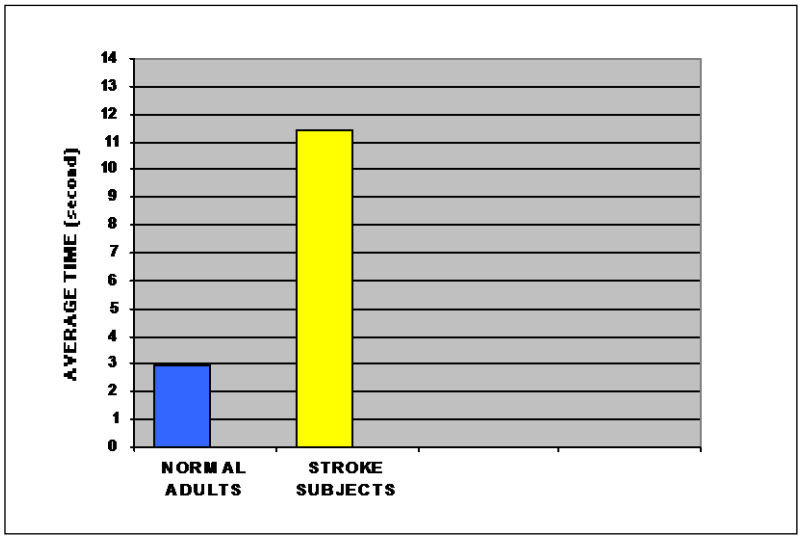

Figure 7: Comparison of Average Time (seconds) taken to rise from bed by normal adults and subjects with stroke

DISCUSSION

The results of this study shows that patients with stroke do not rise from bed as normal adults as the abnormality is observed more in the upper extremity. Rising from bed is a common form of activity in everyday life. In this study 2 raters were taken and there were high interrater reliability values between both raters. The readings of 2nd rater were used for the purpose of blinding. There was a tremendous amount of intragroup and intergroup variability in the body action. Even across the 10 trials the subjects showed a wide variety of movement patterns.

Normal adults in our study exhibited a form of rising action similar to that reported by Sarnacki. In the far upper extremity (FUE) movement patterns, the normal adults showed the double-push and push pattern as the dominant ones, but in hemiplegic patients, subjects consistently displayed movement pattern not described by Sarnacki. However some patients also showed the lift-and-push pattern as dominant one.

The movement pattern not described by Sarnacki in FUE was multiple push pattern and is described as follows, "the arm pushes into the bed and extends until the hand or elbow is the only part of the arm remaining on the bed. The hand then pushes repeatedly at various points on the far side of the body between the starting position and the edge of the bed. The hand may or may not push to stand". The possible reasons for multiple push pattern could be spasticity in extremity of other side so no assistance was provide by the affected extremity to maintain balance and only non affected extremity was involved in the task.

In the near upper extremity (NUE) movement patterns, the normal adults showed the highest percentage for push pattern whereas the patients with stroke showed grasp-and-push and movement patterns not described by Sarnacki as their dominant patterns.

For the upper extremities, the movement patterns were highly inconsistent. Rising action variability could have been influenced by several factors which includes weakness of specific muscles, abnormal muscle tone, abnormal postural adjustments, abnormal movement synergies, lack of mobility between structures at the shoulder girdle and pelvic girdle, incorrect timing of components within a movement pattern and

loss of inter-joint coordination. [3] When a stroke patient attempts to move and encounters all these deficits, the natural reaction is to compensate with the available motor strategies. [3] One of the compensatory strategy used by stroke patients is the fixation of specific body segments. This strategy may decrease the number of motor elements (degrees of freedom) the CNS must control to accomplish the motor task. [3] Here, these patients used to fixate the affected extremity.

In the axial (AX) region, both the groups showed the come-to-sit pattern as their dominant one.

There is relative sparing of muscles of the trunk (abdominals and erector spinae) after stroke, in part due to their bilateral innervations, and several clinical studies have reported minimal reductions in strength of trunk muscles. [9]

In the lower extremity (LE), for normal adults the highest category found was the synchronous pattern unlike hemiplegics who used an asynchronous-lift pattern to rise from bed as the dominant pattern. The reason can be attributed to the imbalance between both the lower extremities. One patient showed movement pattern not described by Sarnacki owing to more extensor synergy in affected lower extremity due to which he was not able to flex his knee.

The average time taken to rise from bed was much higher for patients with stroke than the normal adults. Slowness of movement and in building up tension during the initiation of movement can have a major effect on functional performance, are more evident in fast than in slow movement. [8] In stroke subjects, goal directed movements are characterized by slowness, spatial and temporal discontinuity and abnormal patterns of muscle activation. [10] The motor behavior of the affected arm was characterized by lower movement amplitudes and prolonged movement times. We cannot rule out the possibility that muscle fatigue due to the repetitive trails affected movement patterns in our stroke patients.

Future studies can be done to study movement patterns of rise from bed in different stages of hemiplegia. Also, rise from bed with beds of different heights can be studied. Kinematic analysis with 3 dimensional views can also be used for a better comparison. The missing components identified can be trained and effect of continual practice of these components can be observed.

CONCLUSION

The results obtained from this study shows that there are differences in the movement patterns between normal adults and patients with hemiplegia. However, the patients with hemiplegia used the movement patterns not described by Sarnacki mainly for the upper extremities and the average time taken to rise from bed is significantly more for the patients with hemiplegia than the normal adults. So, our hypothesis for the study holds true.

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Appendix[8]

Movement Pattern Description

Far Upper Extremity Movement Pattern Categories

1-Lateral Llfi and Push. The upper extremity lifts or slides on the supporting surface toward the head of the bed. All or part of the extremity is placed on the bed and pushes. The extremity extends until just the hand remains on the bed. The hand lifts, and the extremity may be used as a balance assist. 2-Push. The entire upper extremity or some part of it pushes on the bed. The extremity extends until just the hand or elbow remains on the bed. The hand or elbow then lifts, and the extremity may be used as a balance assist.

3-Double push. The upper extremity pushes into the bed or is lifted and moved toward the head of the bed, and then pushes. The extremity extends until just the hand or elbow contacts the bed. The limb is then lifted and placed down on the bed again, usually near the edge, and pushes. The extremity is then lifted and may be used as a balance assist.

4-Lift and Push. The upper extremity lifts off the bed and may reach across the body. The hand is placed on the bed, on the same side of the body at some point between the starting position and the edge of the bed, and pushes. The hand lifts, and the limb may be used as a balance assist.

5-Lift or Lift and Reach. The upper extremity is lifted off the bed and may reach across the body or be used as a balance assist.

Near Upper Extremity Movement Pattern Categories

1-Lateral Lift and Push. The upper extremity lifts or slides on the supporting surface toward the head of the bed. The entire extremity, or some part of it, is placed on the bed and pushes until an extended or nearly extended position is attained and just the hand remains on the bed. The hand is lifted, and the limb may be used as a balance assist.

2.-Grasp and Push. The upper extremity slides or is lifted and positioned to enable the hand to grasp the edge of the bed. The limb, or a part of it, pushes down on the bed while the hand grips the edge. The extremity is lifted and may be used as a balance assist.

3-Push, The upper extremity or a part of it pushes into the bed. 'The extremity is then lifted from the bed and may be used as a balance assist.

Axial Movement Pattern Categorles

1-Pelvis Leads. The lower trunk rotates to the side. In the side-lying position, the upper side of the pelvis drops to the bed, and the trunk lifts and turns toward the side-facing position. A symmetrical sitting posture may be assumed before standing.

2-Lateral Roll. The head and trunk turn toward the side-facing position, with minimal flexion toward the foot of the bed. In the side-facing position, one buttock is off the bed, and the shoulders and pelvis are aligned and displaced toward the head of the bed. When the buttock comes off the bed, the head and trunk are displaced toward the head of the bed by lateral flexion or rotation of the trunk. 3-Roll Off. The head and trunk flex and turn toward the side-facing position, with the weight shifted to one buttock. In the side-facing position, the pelvis may drop to a level position. Just before both buttocks come off the bed, the head and trunk are displaced toward the head of the bed through lateral flexion or rotation of the trunk.

4-Come to Slt. The head and trunk flex symmetrically or flex and turn toward the side-facing position by pivoting on one or both buttocks. If the trunk pivots on one buttock, the pelvis may drop to a level position before standing. Just before both buttocks come off the bed, the trunk is in a symmetrical sitting posture, though it may be flexed forward.

Lower Extremity Movement Pattern Categories

1-Step Off, The lower extremities are lifted asynchronously, and the far extremity may push on the bed before lifting. The far extremity flexes toward the chest,

with the thigh reaching a position above the near thigh. The feet are usually placed on the floor asynchronously, and the near extremity may begin to extend before the far foot reaches the floor.

2-Asynchronous Llfilng wlth Leg Ertenslon. The lower extremities are lifted asynchronously off the bed. The far extremity may push on the bed before being lifted. The thighs remain parallel as they move across the bed. 'The far knee may extend as it moves across and over the edge of the bed. The far foot is in front of the near leg as the feet descend to the floor. The feet are placed on the floor, and the lower extremities extend to the upright position.

3-Asynchronous Lift, The lower extremities are lifted asynchronously off the bed. The far extremity may push on the bed before lifting and is commonly medially rotated. The thighs are parallel as they move across the bed, and the legs are parallel as they descend toward the floor. The feet are placed on the floor simultaneously, and the lower extremities extend to the upright position.

4-Synchronous. The lower extremities are lifted or slide simultaneously off the bed. A brief push on the bed may precede the lifting. The extremities move together over the edge of the bed. The feet are placed on the floor simultaneously. The lower extremities then extend to the upright position

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