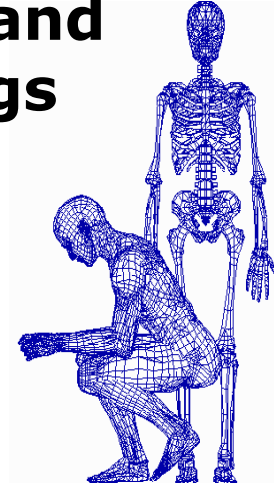


# Safe Patient Handling in Operating Rooms and Orthopaedic Settings

Thomas Waters, PhD, CPE

National Institute for Occupational Safety and Health



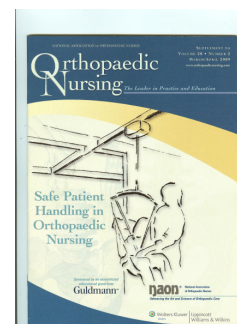
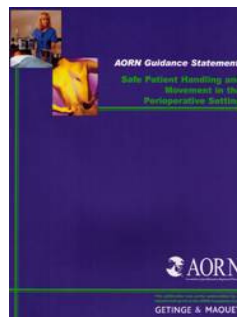
*"The findings and conclusions in this presentation are those of the author and do not necessarily represent the views of NIOSH."*

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## Documentation on Patient Care Ergonomics in Operating Rooms and Orthopaedic Settings



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## The Ergonomic Challenge

The adult human form is an awkward burden to lift or carry. Weighing 200 pounds or more, it has no handles, it is not rigid, and it is susceptible to severe damage if mishandled or dropped.

(Lancet, 1965)

## Manual Lifting Techniques

- UNSAFE
- Manual lifting techniques increase risk for injury. Many manual techniques have been banned because they also pose risk and discomfort for patient:
  - ◆ Hook and Toss (aka Drag Lift)
  - ◆ Arm and leg lift (two person lift with caregiver arms under patient axilla and thigh)
  - ◆ Shoulder lift (aka Australian Lift)

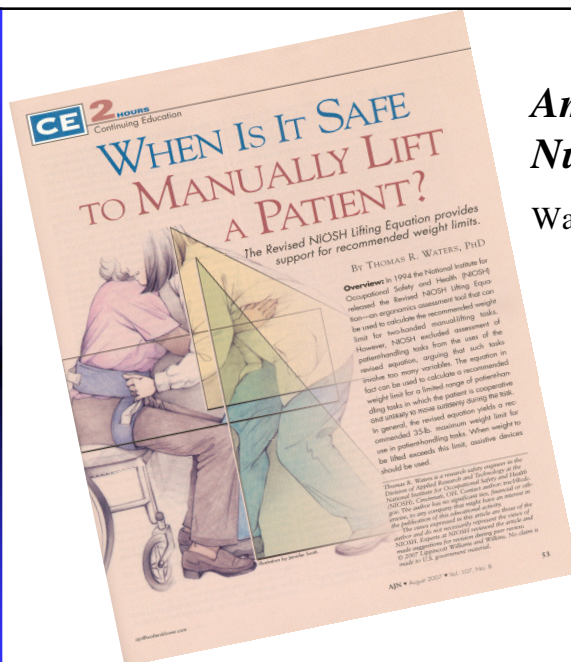
## Defining High Risk Tasks

Job demands that may exceed the limits of human capabilities

- ◆ Heavy loads
- ◆ Sustained awkward positions
- ◆ Bending and twisting
- ◆ Excessive reaching
- ◆ Fatigue or stress
- ◆ Excessive Force
- ◆ Standing for long periods

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### *American Journal of Nursing - 2007*

Waters T.R., 107(8): 53-58.

Provides rationale for 35lb maximum recommended weight limit for patient lifting.

Weight limit is based on the Revised NIOSH Lifting Equation.

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## **NIOSH Lifting Equation Applied to Manual Patient Lifting**

- Does not apply when patient is uncooperative
- Represents a maximum recommended weight limit under ideal conditions (limit may be lower if arms are extended).
- Assumes lifting task occurs with upper arm parallel to trunk and lower arm at 90 degree angle.

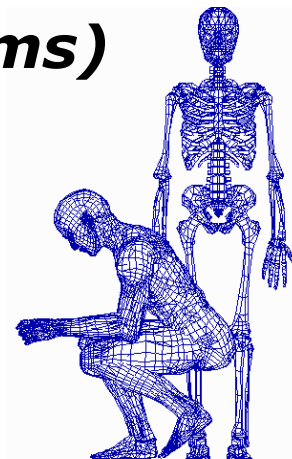
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## ***Ergonomic Guidelines for Perioperative Environment (Operating Rooms)***

**AORN Guidance Statement- Safe Patient Handling in the Perioperative Setting**

**Developed by AORN, VA, ANA, and NIOSH Task Force**



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**Guideline for safe patient handling in the perioperative setting (AORN, 2007)**

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## High Risk Tasks: Operating Room

- Standing long periods of time
- Lifting and holding patient's extremities
- Holding retractors for long periods of time
- Transferring patients on and off operating room tables/beds
- Reaching, lifting and moving equipment
- Repositioning patients on operating room beds



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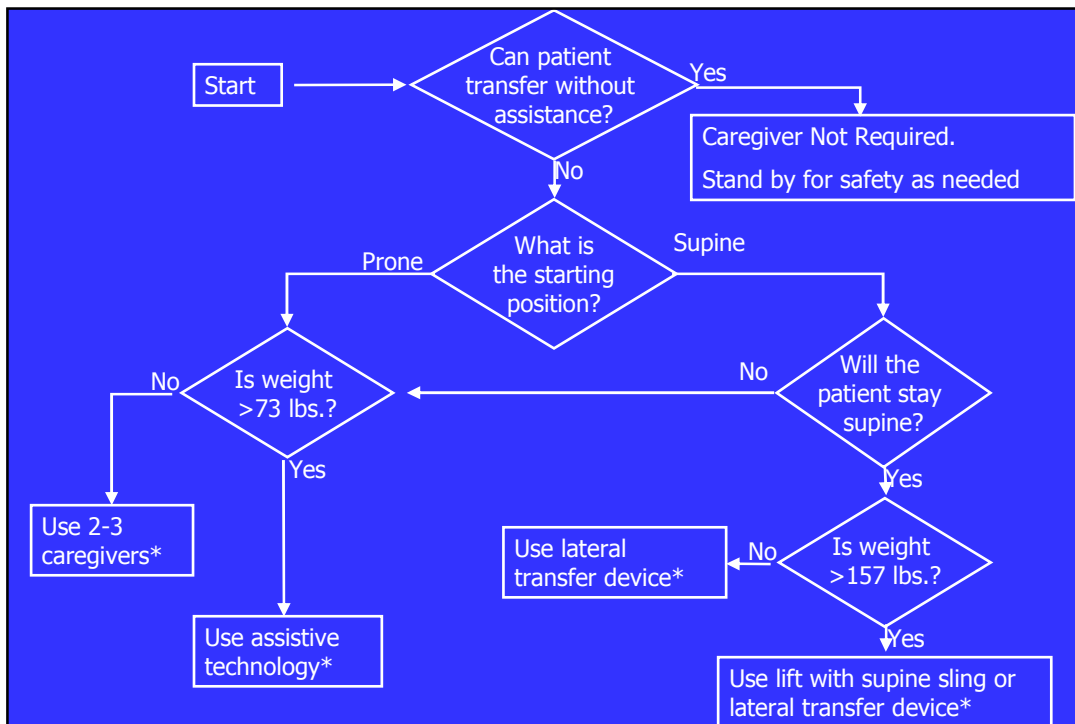
## Ergonomic Tools for Perioperative Safe Patient Handling & Movement

- 1. Lateral Transfers**
2. Positioning/Repositioning on OR bed
3. Lifting & Holding Legs, Arms, & Head
4. Prolonged Standing
5. Retraction
6. Lifting & Carrying Supplies/Equipment
7. Pushing, Pulling, & Moving Wheeled Equipment

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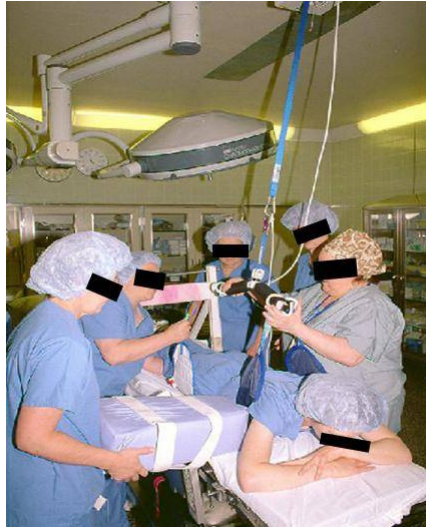




## Ergo Tool 1: Rationale: Supine to Prone Transfer

- Anesthesiologist supports head & neck (8.4% of body weight<sup>1</sup>)
- Maximum worst-case 2-handed load\* is 22.2 lbs. per caregiver
- 3 caregivers + anesthesiologist can safely transfer a patient up to 72.7 lbs.
  - 3 caregivers x 22.2 lbs. = 66.6 lbs.
  - 8.4% of 72.7 lbs. = 6.1 lbs.
  - 66.6 lbs. + 6.1 lbs. = 72.7 lbs.

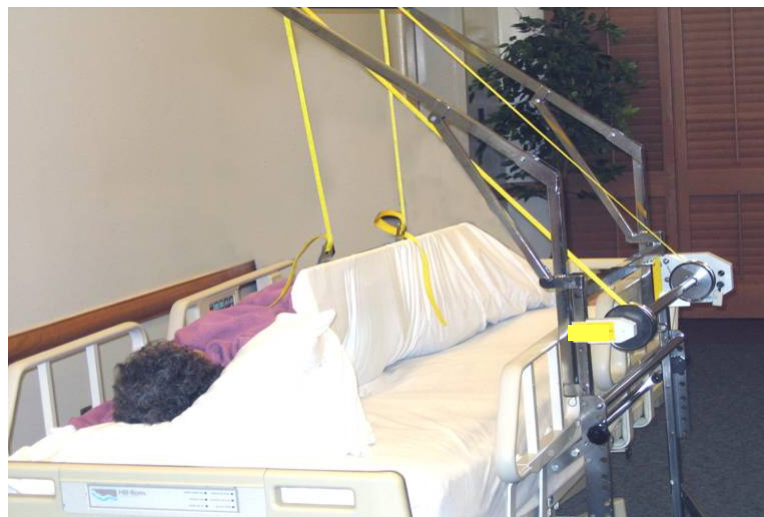
## Prone-to-Prone Transfer: Ceiling Lift & Sling



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## Supine-to-Prone Transfer: Manual Mechanical Device



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## Supine-to-Supine Transfer: Various Devices



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## Supine-to-Supine Transfer: Friction Reducing Device



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## Supine-to-Supine Transfer: Air-Assisted Lateral Transfer Device



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## Supine-to-Supine Transfer: Manual Mechanical Device



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## Supine-to-Supine Transfer: Powered Mechanical Device



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## Ergonomic Tools for Perioperative Safe Patient Handling & Movement

1. Lateral Transfers
- 2. Positioning/Repositioning on OR bed**
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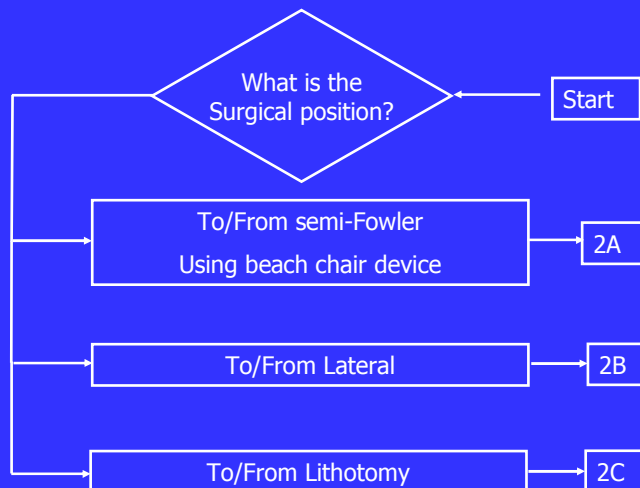
## Ergo Tool # 2: Positioning or Repositioning on OR bed

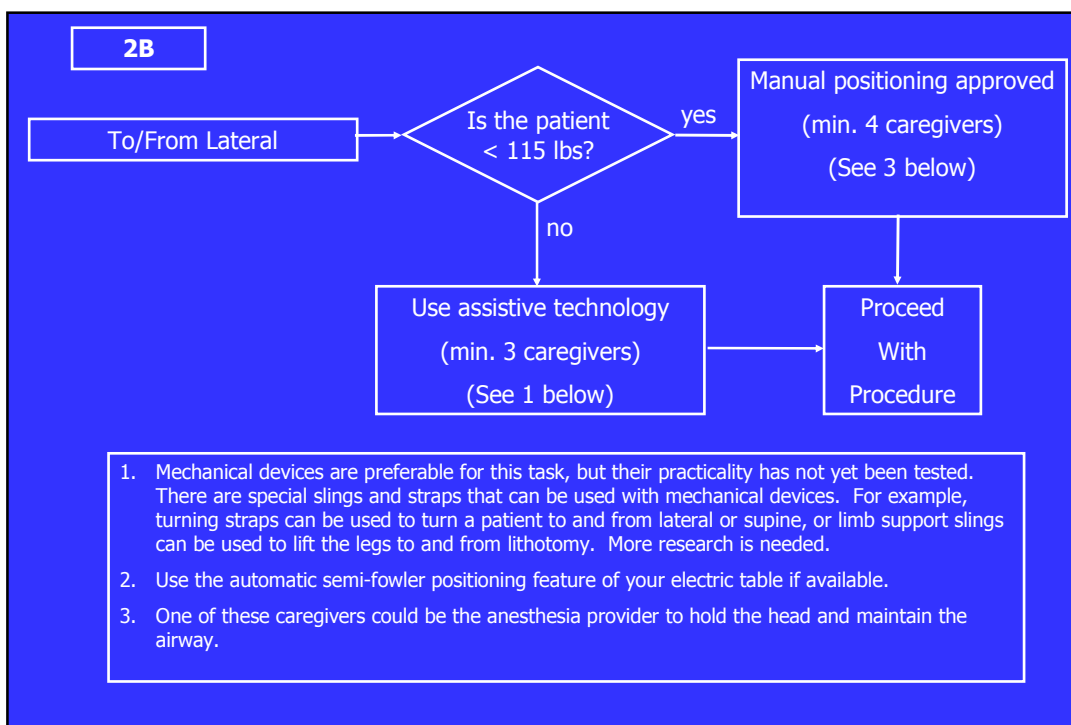
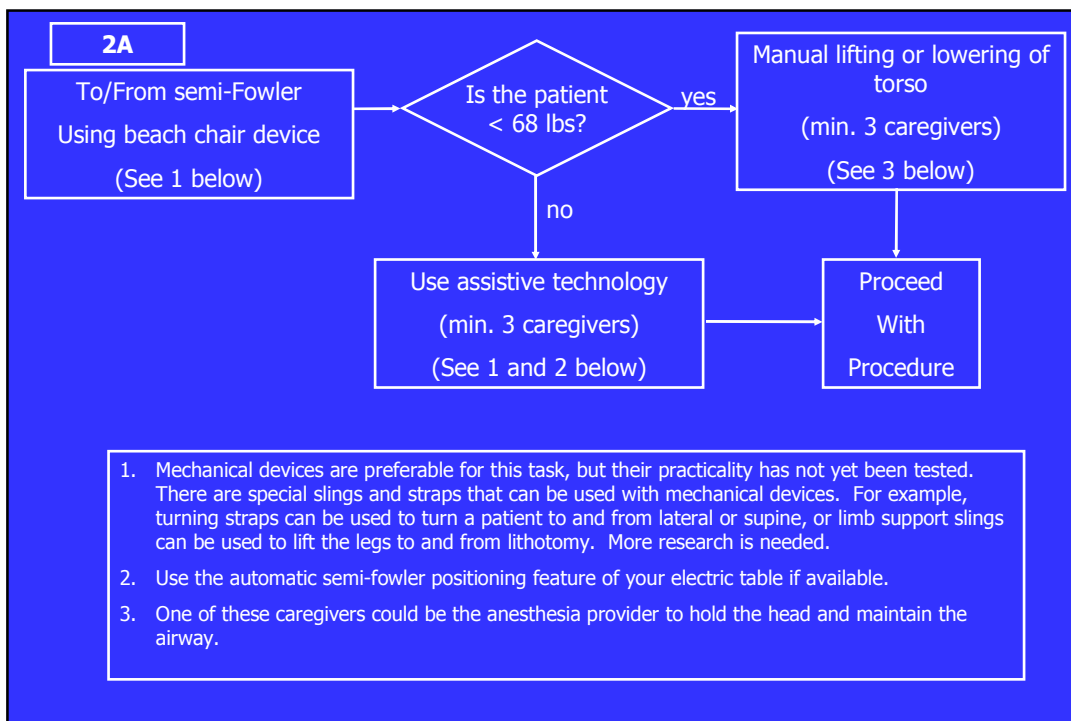
- Tool is to be used to assess repositioning patient to or from supine position while on the OR bed.
- Assumes one of three primary surgical positions to be used: semi-Fowler, lateral, or lithotomy positions.
- Recommendations are given relative to patient body weight (BW).

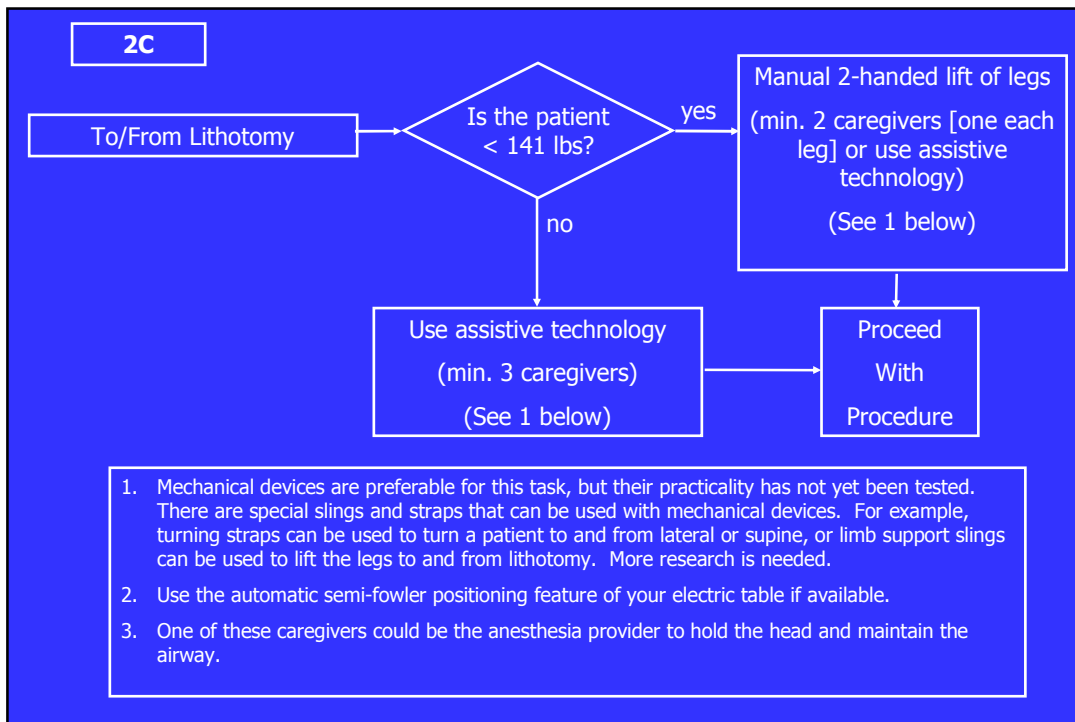
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### Tool #2: Positioning and Repositioning the Patient on the OR bed to and from the Supine Position







## Ergo Tool #2: Full-Body Sling Lifts

- Most common lifting aid
- Many are mounted on a portable base, although ceiling lifts are becoming popular
- Sling lifts are used for highly dependent patient transfers





## Ergo Tool #2: Sling Categories



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## Ergo Tool #2 Examples of Body Part Positioners



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## Ergonomic Tools for Perioperative Safe Patient Handling & Movement

1. Lateral Transfers
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### Ergo Tool # 3: Lifting & Holding Legs, Arms, & Head



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## **Ergo Tool # 3: Lifting & Holding Legs, Arms & Head**

- Acceptability of task is dependent upon patient weight.
- Table indicates whether it would be acceptable for one caregiver to lift or hold the listed body part.
- Respecting these limits should minimize risk of muscle fatigue and the potential for musculoskeletal disorders.

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## **Ergo Tool #3: Questions about Lifting & Holding Legs, Arms, & Head**

- Does limb need to be raised for the entire surgical skin prep?
- Does limb need to be lifted by scrubbed or unscrubbed personnel?
- Is the person holding the limb strong enough to perform the task?
- Is there an alternative practice that can be adopted?
- Is there equipment that could be used to support the task?
- Is it possible to hold a heavy limb safely without risk of injury to the nurse or patient?

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## Ergo Tool # 3: Lifting & Holding Legs, Arms, & Head

- Patient weight is divided into ten categories, ranging from very light to morbidly obese.
- Weight limits are provided for one-handed and two handed lifting.
- Endurance times for holds for respective body parts are provided for 0, 1, 2 or 3 minutes with one or two hands.

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## Ergo Tool # 3: Lifting & Holding Legs, Arms, & Head

Patient Weight lbs (kg)	Body Part	Body Part Weight lbs (kg)		Lift		Hold		
				1-hand	2-hand	2-hand <1 min	2-hand <2 min	2-hand <3 min
<40 lbs	Leg	<6.3 lbs	(3 kg)					
(< 18 kg)	Arm	<2.0 lbs	(1 kg)					
40-90 lbs	Leg	<14.1 lbs	(6 kg)					
(18-41 kg)	Arm	<4.6 lbs	(2 kg)					
90-140 lbs	Leg	<22.0 lbs	(10 kg)					
(41-64 kg)	Arm	<7.1 lbs	(3 kg)					
140-190 lbs	Leg	<29.8 lbs	(14 kg)					
(64-86 kg)	Arm	<9.7 lbs	(4 kg)					
190-240 lbs	Leg	<37.7 lbs	(17 kg)					
(86-109 kg)	Arm	<12.2 lbs	(6 kg)					
240-290 lbs	Leg	<45.5 lbs	(21 kg)					
(109-132 kg)	Arm	<14.8 lbs	(7 kg)					
290-340 lbs	Leg	<53.4 lbs	(24 kg)					
(132-155 kg)	Arm	<17.3 lbs	(8 kg)					
340-390 lbs	Leg	<61.2 lbs	(28 kg)					
(155-177 kg)	Arm	<19.9 lbs	(9 kg)					
390-440 lbs	Leg	<69.1 lbs	(31 kg)					
(177-200 kg)	Arm	<22.2 lbs	(10 kg)					
> 440 lbs	Leg	>69.1 lbs	(31 kg)					
(>200 kg)	Arm	>22.2 lbs	(10 kg)					

No shading: Ok to lift and hold; use clinical judgment and do not hold longer than noted.

Heavy shading: Do not lift alone; use assistive device or more than one caregiver.

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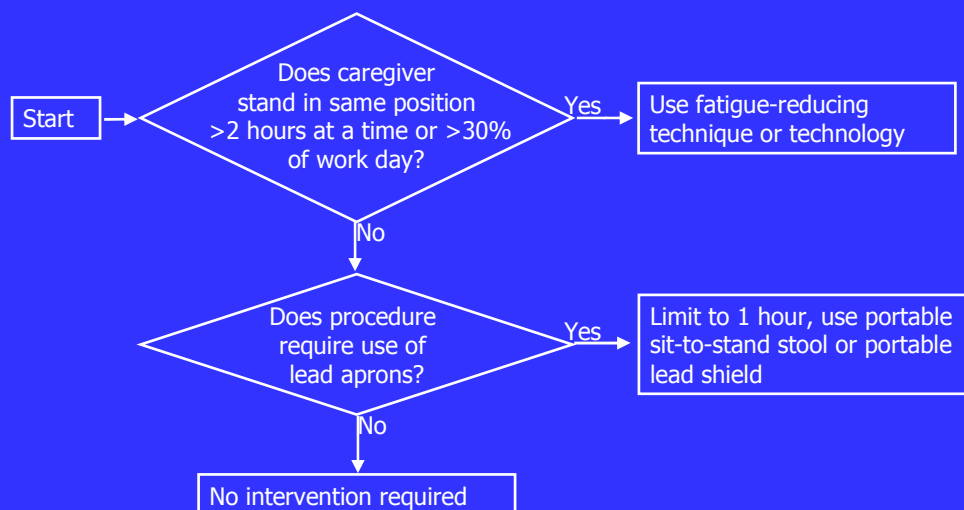
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### Ergo Tool #4: Prolonged Standing

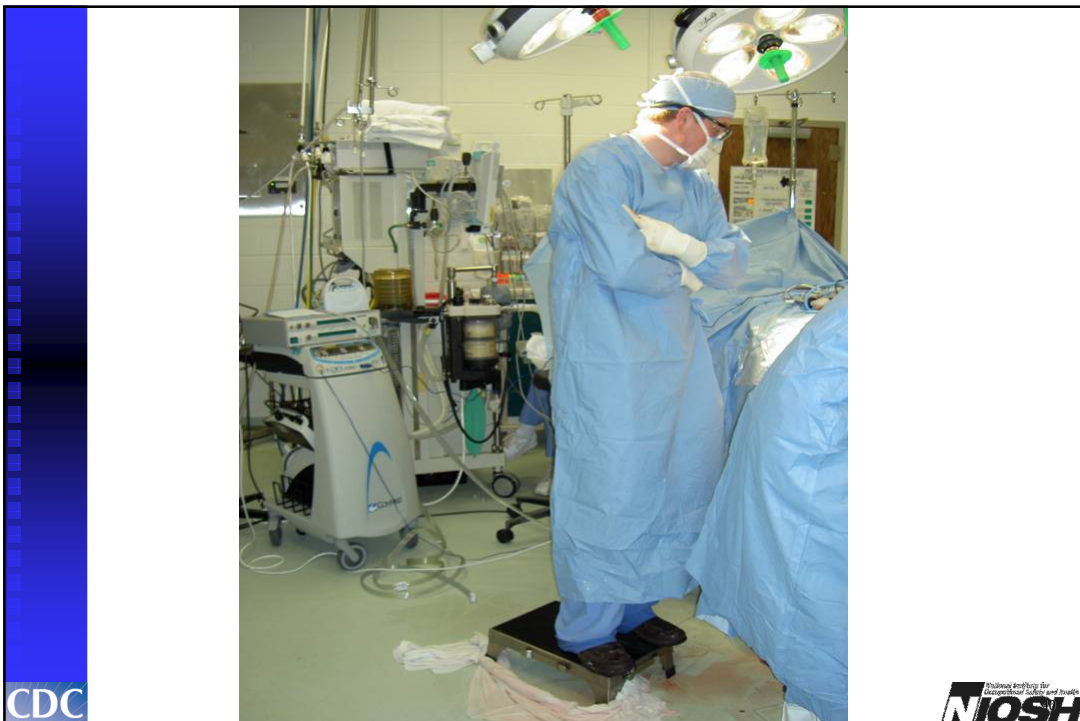


## Ergo Tool #4: Recommendations for Prolonged Standing

- Use supportive footwear
- Use support stockings/socks
- Provide anti fatigue mats-floor or standing stools
- Consider using a sit-stand chair
- Move head approximately every minute

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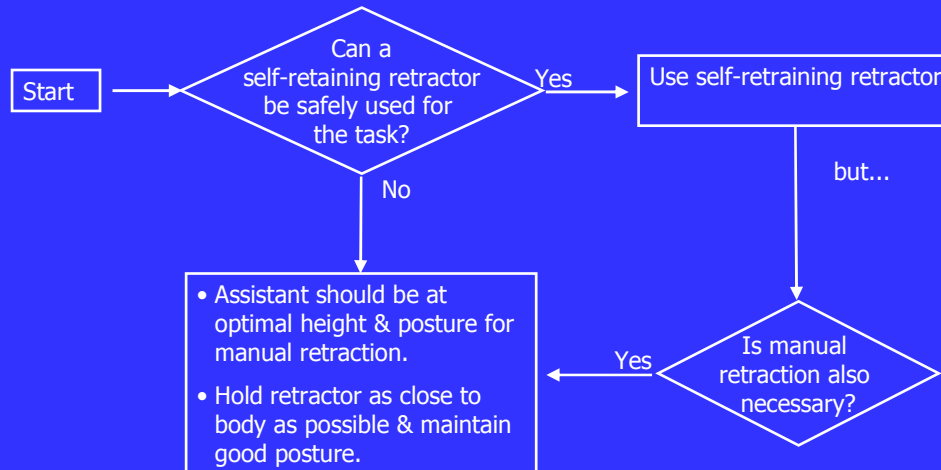
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## Ergo Tool #5: Retraction



## Ergo Tool #5: Retraction

- Arm rests if possible
- Rest breaks or reposition when possible
- Avoid using the hands- sharps injury risk

## Ergo Tool #5: Implementation Suggestions

- Use blunt retractors



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## Ergo Tool #5: Implementation Suggestions

- Use mechanical /instrument tissue retraction



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## Ergonomic Tools for Perioperative Safe Patient Handling & Movement

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## Ergo Tool #6: Lifting & Carrying Supplies/Equipment



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## **Ergo Tool #6: Lifting & Carrying Supplies/Equipment**

- Manual lifting and carrying of object is physically demanding and may place the worker at substantial risk of low back pain.
- The National Institute for Occupational Safety and Health (NIOSH) has developed a lifting equation for determining whether a selected lifting task is acceptable or not.
- The equation allows the calculation of the Recommended Weight Limit (RWL) and Lifting Index (LI) for a specified lifting task.

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## **Ergo Tool # 6: Lifting & Carrying Supplies/Equipment**

The Association for the Advancement of Medical Instrumentation, the organization that sets the standards for safety and efficacy of medical instrumentation suggests that instrument trays weigh a maximum of 25 lbs.

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## Revised NIOSH Lifting Equation

### Recommended Weight Limit (RWL)

The weight of the load that nearly all healthy workers could perform over a substantial period of time without an increased risk of developing lifting-related low back pain.

### Lifting Index (LI)

A term that provides a relative estimate of the level of physical stress associated with a particular manual lifting task.

## Recommended Weight Limit (RWL)

$$RWL = LC \times HM \times VM \times DM \times AM \times FM \times CM$$

Load Constant	LC	23 kg	51 lb
Horizontal Multiplier	HM	(25/H)	(10/H)
Vertical Multiplier	VM	$1 - (.003 V-75 )$	$1 - (.0075 V-30 )$
Distance Multiplier	DM	$.82 + (4.5/D)$	$.82 + (1.8/D)$
Asymmetric Multiplier	AM	$1 - (.0032A)$	$1 - (.0032A)$
Frequency Multiplier	FM	From FM Table	From FM Table
Coupling Multiplier	CM	From CM Table	From CM Table



## NIOSH Lifting Index (LI)

LI = Weight of Load Lifted / RWL

### Example

Assuming RWL for job was 15 kg and weight lifted was 35 kg, the LI would be:

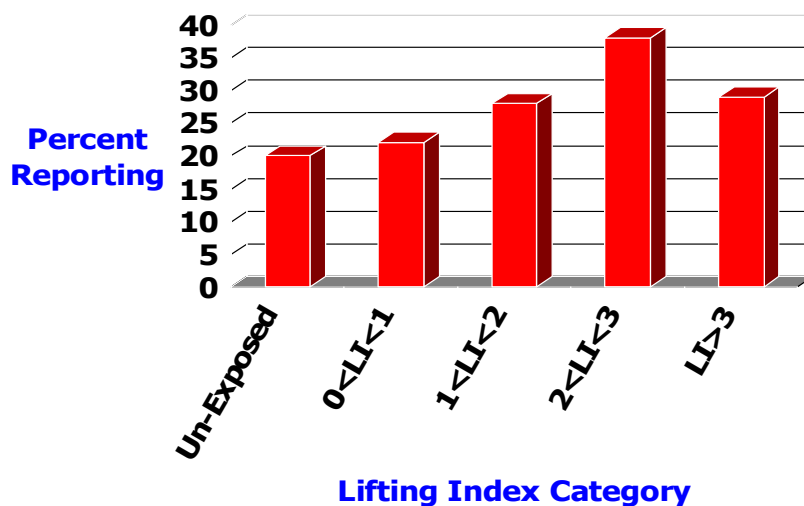
$$LI = \frac{35}{15} = 2.3$$

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## Low back pain prevalence by LI

waters et al., 1999



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Lifting Task	Lifting Index	Level of Risk
3,000 ml irrigation fluid	<0.2	
Sand bags	0.3	
Linen bags	0.4	
Lead aprons	0.4	
Custom sterile packs (eg, heart or spine)	0.5	
Garbage bags (full)	0.7	
Positioning devices off shelf or rack (eg, stirrups)	0.7	
Positioning devices off shelf or rack (eg, gel pads)	0.9	
Hand table (49" x 28")-largest hand table-used infrequently	1.2	
Fluoroscopy Board (49" x 21")	1.2	
Stirrups (2- one in each hand)	1.4	
Wilson frame	1.4	
Irrigation containers for lithotripsy (12,000 ml)	1.5	
Instrument pans	2.0	

Key	No shading	Minimal risk – Safe to lift
	Light shading	Potential risk – Use assistive technology, as available
	Heavy shading	Considerable risk – one person should not perform alone or weight should be reduced.

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## Power Fluid Lifter



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## Ergonomic Tools for Perioperative Safe Patient Handling & Movement

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## Ergo Tool #7: Pushing, Pulling, and Moving Wheeled Equipment

- Measured forces required to push common equipment
- Maximum acceptable distances for required pushing forces determined from Liberty Mutual psychophysical limits<sup>1</sup>
- Specific recommendations made based on data
- General recommendations made based on biomechanics

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## Ergo Tool #7: Rationale

- Initial force used is “worst case” where wheels turned to oppose motion
- Sustained force is amount required to keep equipment rolling
- Mean force values of five trials used
- All forces must be acceptable to 75% of women at specified distances<sup>1</sup>

	25 ft.	50 ft.	100 ft.	150 ft.	200 ft.
Initial Force	51 lbs.	44 lbs.	42 lbs.	42 lbs.	37 lbs.
Sustained Force	30 lbs.	25 lbs.	22 lbs.	22 lbs.	15 lbs.

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## Ergo Tool #7: General Recommendations for All Equipment

- Pushing is preferable to pulling
- Push at a comfortable “middle” height (about three feet for average height)
- If push point lower, reduce maximum allowable forces by ~15%
- If task more frequent than once every 30 min, reduce max forces by ~6%
- Properly maintain equipment & casters

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## Ergo Tool #7: Specific Recommendations for Common OR Equipment

Hospital bed- unoccupied	29.8 lbs.	6.2 lbs.	>200 ft.
Specialty equipment carts	39.3 lbs.	6.1 lbs.	>200 ft.
OR stretcher- occupied (300 lbs.)	43.8 lbs.	7.9 lbs.	>200 ft.
Bed- occupied (300 lbs.)	50.0 lbs.	10.8 lbs.	>200 ft.
Specialty OR beds- unoccupied	69.7 lbs.	22.5 lbs.	<100 ft.
OR bed- unoccupied	61.3 lbs.	26.3 lbs.	<25 ft.
OR bed- occupied (300 lbs.)	112.4 lbs.	40.5 lbs.	<25 ft.
Specialty OR beds- occupied (300 lbs.)	124.2 lbs.	30.1 lbs.	<25 ft.

one caregiver

two caregivers

powered transport device

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## Ergo Tool #7: Determining Pushing Forces for Other Equipment

If you have wheeled equipment not listed in guidelines, a simple device similar to this can be used to estimate push forces



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## Ergo Tool #7: Transport Devices

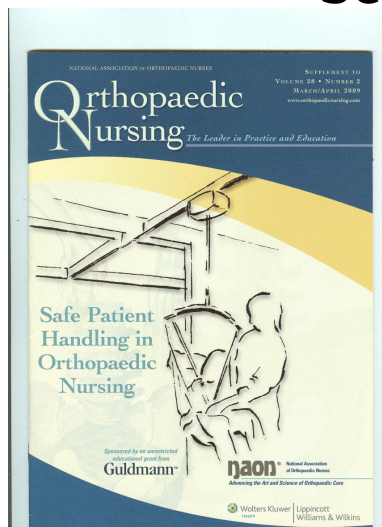
- Used to provide powered transport for otherwise manually driven equipment – beds, wheelchairs, equipment
- Dramatically reduces caregiver demands



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## NAON Guidelines for Patient Handling in Orthopaedic Settings



Supplement to Volume  
28(2), 2009

A series of six journal  
articles describing the  
guidelines in detail.

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## Interdisciplinary Safe Patient Handling Taskforce Team



- Registered Nurses
- Physical Therapists
- Ergonomists
- Researchers

Taskforce included experts from NAON, VA, ANA, and NIOSH

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- Unique handling problems due to hardware and positional precautions



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- Limbs and devices require lifting and/or holding
- Static/ awkward positions
- Joint immobility requirements



## Other requirements for handling orthopaedic patients

- Patient activity is required for treatment
- Weight bearing restrictions are likely
- Often, more than one extremity is involved

## Identification of High Risk Orthopaedic Tasks

1. Mobilization of the total hip replacement (THR) patient
2. Mobilization of a patient with a brace/splint on an immobilized extremity
3. Set up of a continuous passive motion (CPM) machine
4. Logrolling a patient in a halo vest

## Identification of High Risk Orthopaedic Tasks

5. Holding an extremity for procedures
6. Altered gait pattern with a platform walker
7. Assembling traction
8. Transfer into a car
9. Moving children with disabilities
10. Vertical transfer of patient with pelvic and external fixators

## Tasks are limited by back, arm and shoulder strength capability

Arm and shoulder strength is important because it often limits how much we can lift, push, or pull or how long we can hold something.

If we exceed muscle endurance limits, then the muscles become fatigued and lose their ability to provide force.

## Muscle Endurance Time

The time it takes a muscle to become fatigued is termed its endurance time.

Endurance Time - How long a muscle can maintain its sustained force producing capability when exposed to continuous or high frequency repetitive exertions.

# Endurance Time

Endurance Time is a function of the level of force exerted (given as a percent of MVC), the frequency of exertion (cycle time), and the muscle type.

Rohmert conducted experiments to determine the endurance time for muscles. The Rohmert curve provides an estimate of the endurance time for a continuous muscle contraction as a function of the exertion level (%MVC).

## NAON - Ergonomic Tool #3 Lifting and Holding of Limbs

Patient Weight lbs (kg)	Body Part	Body Part Weight		Lift		Hold		
		lbs	kg	1- hand	2- hand	2-hand	2-hand	2-hand
						≤1 min	≤2 min	≤3 min
≤40 lbs (≤ 18 k)	Leg	<6	< 3					
	Arm	<2	< 1					
40-90 lbs (18-41 kg)	Leg	<14	< 6					
	Arm	<5	< 2					
90-140 lbs (41-64 kg)	Leg	<22	< 10					
	Arm	<7	< 3					
140-190 lbs (64-86 kg)	Leg	<30	< 14					
	Arm	<10	< 4					
190-240 lbs (86-109 kg)	Leg	<38	< 17					
	Arm	<12	< 6					
240-290 lbs (109-132 kg)	Leg	<46	< 21					
	Arm	<15	< 7					
290-340 lbs (132-155 kg)	Leg	<53	< 24					
	Arm	<17	< 8					
340-390 lbs (155-177 kg)	Leg	<61	< 28					
	Arm	<20	< 9					
390-440 lbs (177-200 kg)	Leg	<69	< 31					
	Arm	<22	< 10					
>440 lb (>200 kg)	Leg	>69	> 31					
	Arm	>22	> 10					

No shading: Ok to lift and hold; use clinical judgment and do not hold longer than noted.

Heavy shading: Do not lift alone; use assistive device or more than one caregiver.

## General Comments for Limb Lifting Tool

- These guidelines are for the average weight of the leg, arm, and head based upon the patient's weight.
- Nurses should use their clinical judgment to assess the need for additional staff member assistance or assistive devices to lift and/or hold one of these body parts for a particular period of time.
- If the limits in Ergonomic Tool #3 are exceeded, additional staff members or assistive limb holders should be used.

## Rationale for Limb Lifting Tool

- Normalized weight for each leg, each arm, and head is calculated as a percentage of body weight, where each complete lower extremity represents 15.7 % of total body mass, upper extremity (i.e., upper arm, forearm, hand) weighs 5.1% of total body mass, and the head plus neck combined weighs 8.4% of total body mass (Chaffin et al., 1999).

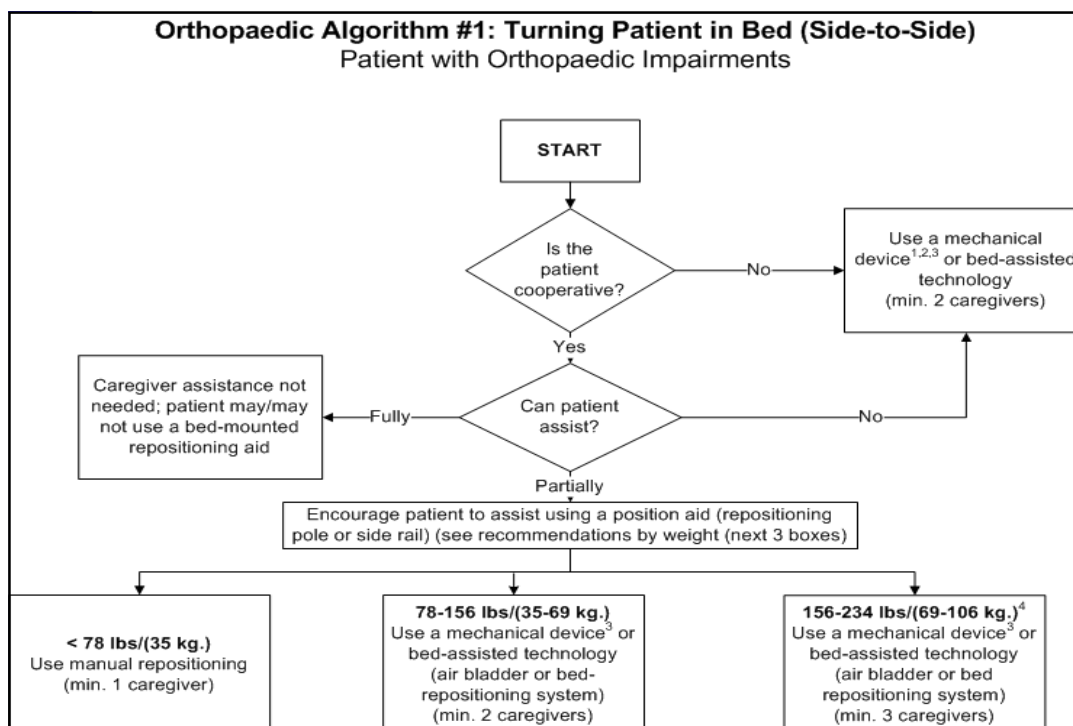
## Rationale for Limb Lifting Tool

- To accommodate 75% of the US adult female working population, maximum load for a one-handed lift is calculated to be 11.1 lbs (5.0 kg) and 22.2 lbs for two-handed lift.
- Muscle strength capabilities diminish as a function of time; therefore, maximum loads for two-handed holding of body parts are presented for 1, 2, and 3 minute durations. Muscle endurance will decrease by 48% after 1 minute, 65% after 2 minutes, and 71% after 3 minutes of continuous holding.

## Algorithm Development

- What is an Algorithm?
  - A helpful step-by-step rule
- Task Force conducted a peer review interdisciplinary process





## Logrolling an Orthopaedic Patient

- Identified as an issue by the membership
- Aggravated by decreased space in rooms
- Rationale for turning:
  - Relief of Pressure
  - Care



# Logrolling an Orthopaedic Patient

## Clinical Considerations

- ◆ Patient weight
- ◆ Cooperation
- ◆ Placement of a fixation device



## Recommendations

- Cooperation determines use of assistive device
- Spinal Precautions
- Determine need for joint precautions
  - Abduction
  - Extension
  - Rotation

## Recommendations

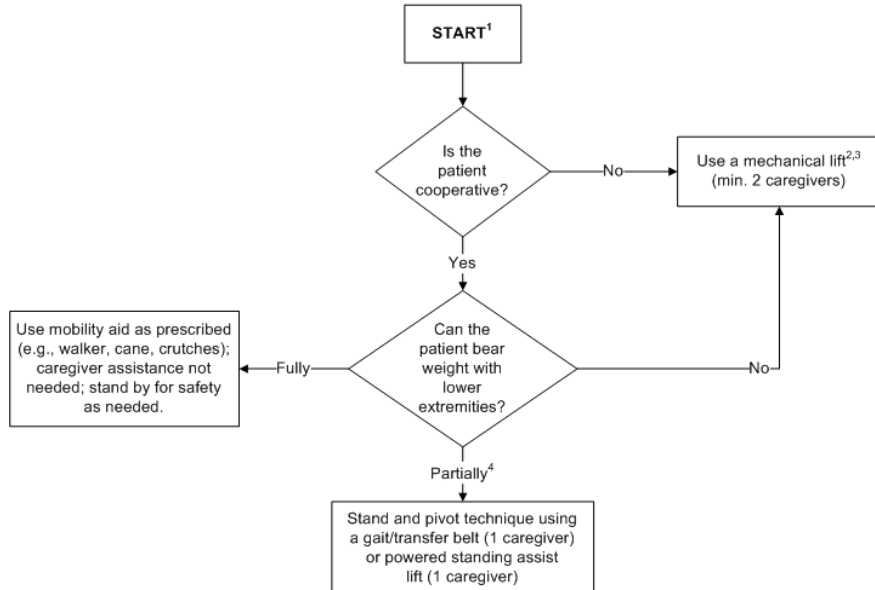
- Based on weight:
  - ◆ One nurse can safely log roll a patient weighing up to 78 lbs
  - ◆ Two caregivers are required if the patient weighs more than 78 lbs., but not more than 156 lbs
  - ◆ Three caregivers are needed if the patient weighs more than 156 lbs but not more than 234 lbs.



## Rationale

- Evaluate the required amount of force against the patient's weight in determining amount of safe movement and type of movement that can be best utilized.

**Orthopaedic Algorithm #2: Vertical Transfer of a Post-Operative Total Hip Replacement Patient  
(Bed to Chair, Chair to Toilet, Chair to Chair, or Car to Chair)**



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## Vertical Transfer of an Orthopaedic Total Hip Patient

- Includes transfer from bed to chair, chair to toilet, bed to wheelchair, chair to car.



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## Vertical Transfer of an Orthopaedic Total Hip Patient

- Goal - to move from a supine to a seated position.
- Requires use of additional assistive devices.



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## Ergonomic Issues

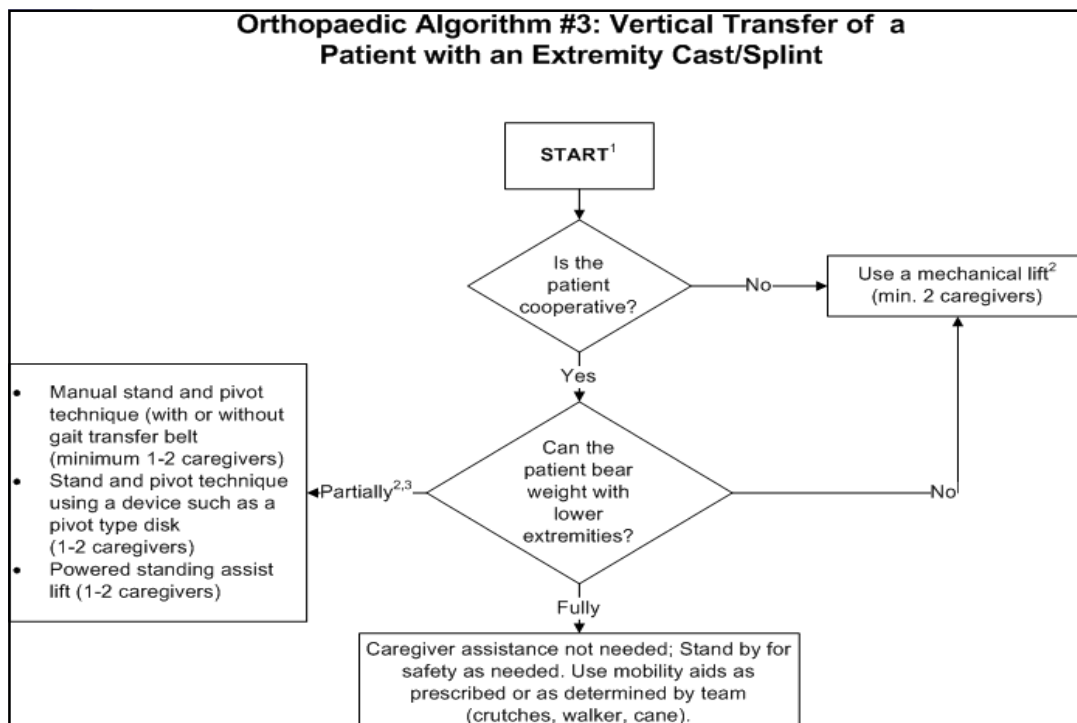
- Require a combination of lifting, pushing and pulling towards the transfer site.
- May require reaching over a surface i.e. bed to chair - leading to excessive push/pull forces.

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## Rationale

- Decrease complications (DVT, pneumonia, pressure ulcers).
- Addresses issues such as height differences among providers, level of surfaces.



## Rationale

- Evaluate the patient
- Patients body part greater than 35 lbs. should not be moved without assistance
- Weight bearing tolerance
- Ability to assist

## Recommendations

- Protect patient from further injury, while facilitating mobility improvement.
- # of caregivers should be adequate to maintain alignment and weight bearing guidelines, as well as to protect caregivers from injury.



## Ambulation

- First algorithm created in conjunction with patient safety center to address ambulation
  - ◆ Ambulation is not optional
    - Clinical pathways for joint replacement
  - ◆ Prevent complications
    - DVT, deconditioning, etc.

## Ambulation: Safety Risk

- Patient safety
  - ◆ Confusion
  - ◆ Medical instability
  - ◆ Weakness
  - ◆ Lack of experience with assistive device
  - ◆ Change in weight bearing status



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## Ambulation: Safety Risk

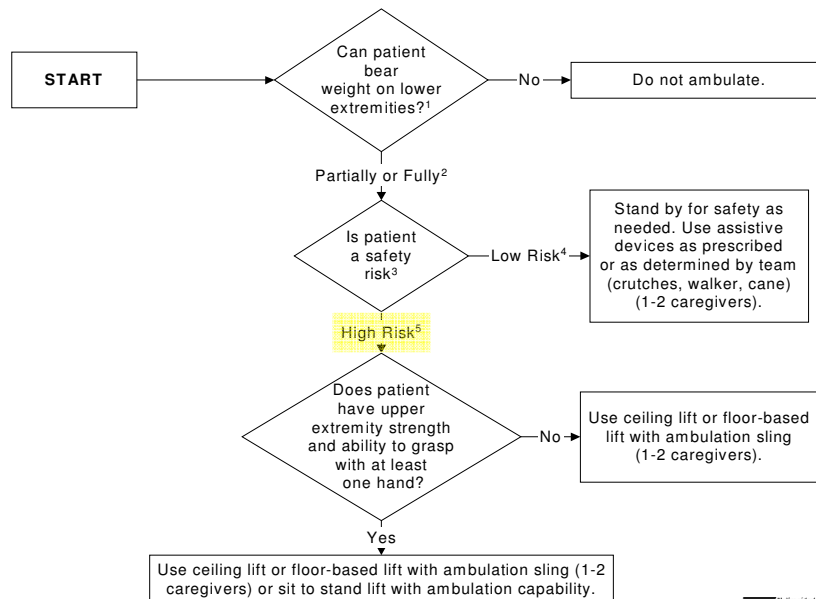
- ◆ Patient safety directly relates to caregiver safety
  - 25-50% of care giver patient handling injuries attributable to preventing patient falls.
    - Falls are often sudden or unexpected
  - Consequences of falls for orthopaedic patients
    - Additional procedures
    - Increased length of stay

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### Orthopaedic Algorithm #4: Ambulation

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## Ambulation

### ■ Ergonomic Issues

- ◆ Bending
- ◆ twisting
- ◆ lifting > NIOSH recommend lift limit (35#), awkward postures
- ◆ Simultaneous combination of all

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## Ambulation

### ■ Rationale

- ◆ Rehabilitation post injury/procedure
- ◆ Practice = greatest level of independence
- ◆ Prevent post-op or post injury complications

## Ambulation

### ■ Recommendations

- ◆ Assess for ability to bear weight
  - Assist of > 35 pounds to rise to standing, use SPHM technology
- ◆ Assess for fall risk
  - Reasonably expected to hold/lift > 35 pounds, use SPHM technology



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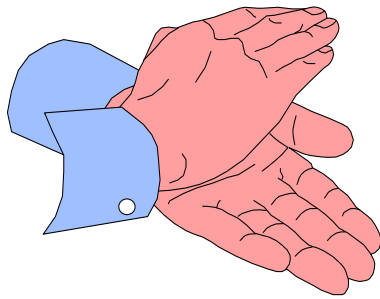


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## The End.....



(Audience  
applauds  
wildly)