PATIENT TRANSFER AND POSITIONING AID:

RERC on AMI's National Design Competition

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Abstract

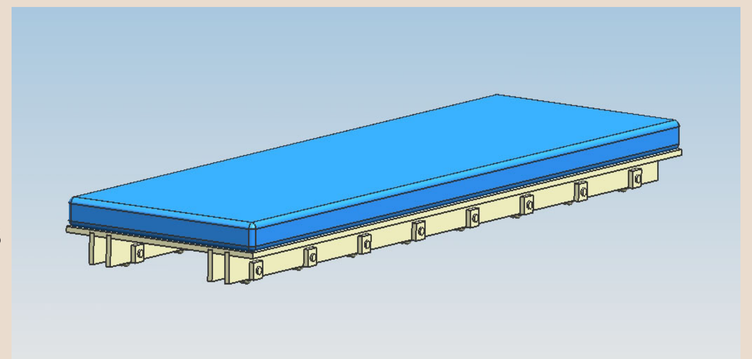
Current imaging systems require patients to mount the imaging device table and then remain static for an extended period of time to ensure appropriate imaging accuracy and reliability. Here, we report the design of a novel device, called the "Roller PATH" [for Patient Aid and Transfer Help], that will help disabled patients meet both these requirements. The design is comprised of three components: a mobile patient transfer table, an imaging bed track and a hospital bed track. Material composition is entirely comprised of non-ferrous, radiolucent elements. Initial calculations show a theoretical maximum deflection of 0.4249 cm under a distributed load of 2135 N on the patient transfer table. Test results indicate a deflection of 0.3289 cm. Dropouts and image artifacts are not present upon inspection and SNR analysis of MR and CT data. Ergonomic patient testing shows positive survey results.

Problem Statement

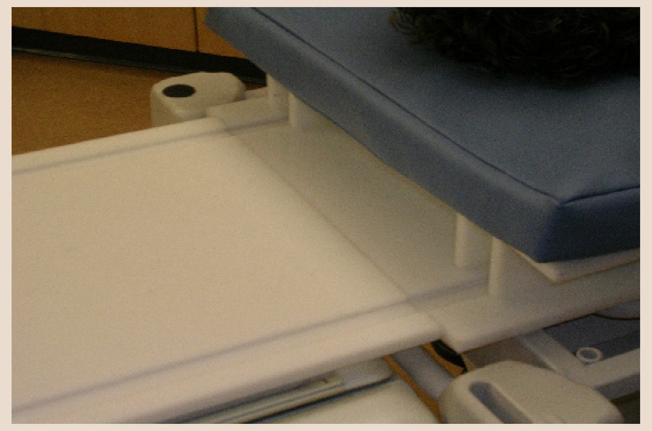
Patient positioning limitations onto and within medical imaging devices, which may include the initial patient transfer and/or maintaining static positioning during data acquisition and measurement, have rendered many individuals with disabilities unable to reap the benefits of imaging technologies. To date, foam wedges and/or wrap-around "coils" are used for static positioning within CT and MR scanning systems. However, more versatile and effective means are required to meet the wide range of disabilities and imaging systems that are encountered by medical physicians and technicians on a daily basis.

Design Theory

Consists of three component design system
- A patient transfer table with mattress
- An imaging bed track
- A hospital bed track

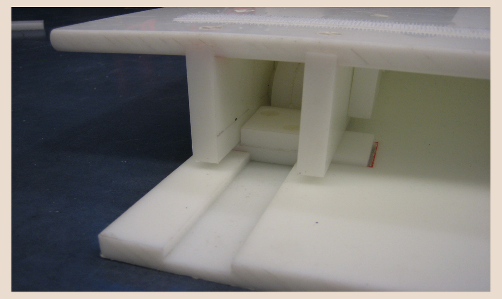


Design contains non-ferrous, radiolucent materials
- High-density polyethylene (HDPE): frame
- Nylon: wheels, axles, screws
- Hook and loop cloth fasteners: connectivity
- High-density (HD) foam: patient pad
- Vinyl: patient pad



Patient transfer table is the movable component
- Two long columns of 8 wheels on underside
- Additional support structures on wheel frames
- Patient pad for support and comfort

Design glides between two sets of tracks
- One track resides on stretcher or hospital bed; one track on imaging table
- Patient transferred into imaging room on stretcher
- Technician aligns the bed and imaging table
- Track lock is used to secure alignment
- Transfer is performed
- Wheel locks are placed for safety and reliability



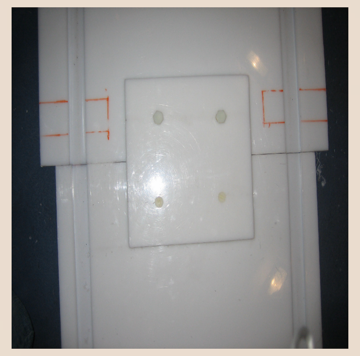
Device works with neck foams and sandbag immobilizers

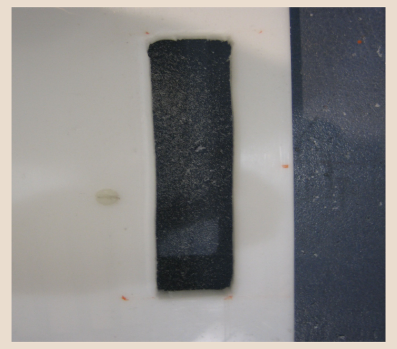
Construction

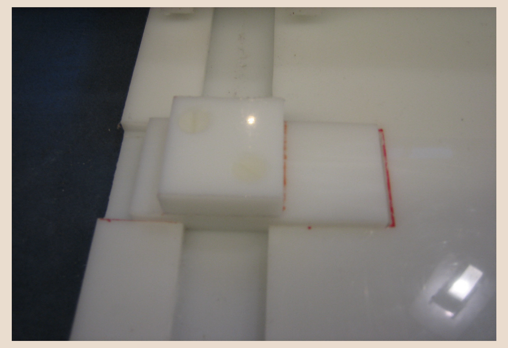
Transfer frame, patient pad, and tracks were completed for December 2005

Construction in 2006 consisted of design additions including:
- Wheel locks for patient safety
- Track locks for positioning and alignment
- Table hand holes for technician
- Neck immobilizer for static positioning
- Various testing apparatuses

Total Expenditures: $1,040.72
Remaining Budget: $960.28







Validation and Verification

MECHANICAL TESTING

- Tested deflection, creep, and hysteresis of bed center
- Bed height recorded at weight increments by profilometer
- Maximum loading: 2135 N
- Final bed heights recorded after 20 minutes

Analysis
- Theoretical maximum deflection found by calculating for distributed load of 2135 N
- Measurements calculated for deflection in center of the bed using proportions
  - ∂edge = measured edge deflection
  - ∂calc = calculated center deflection
  - $\partial calc = -177.8(\partial edge)/101.6$

Results
- Maximum experimental deflection: 3.29 cm
- Bed edge returned back to original height
- Deflection occurred for 20 minutes, then remained constant

ERGONOMICS TESTING

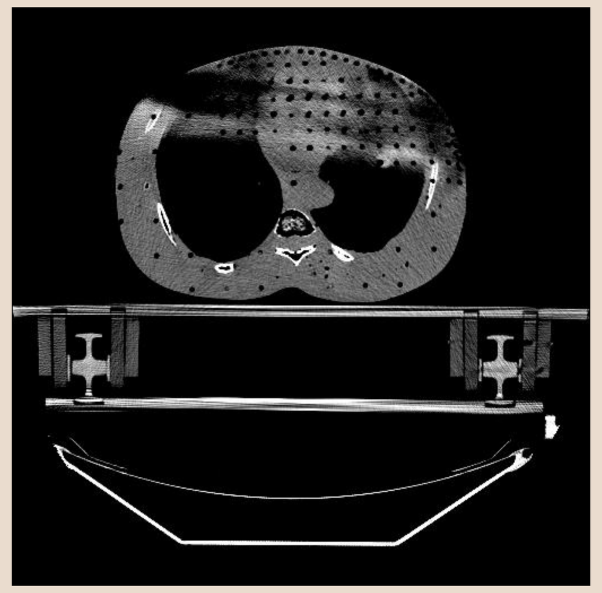
- Measures usability, safety, and comfort of transfer bed from the perspective of the patient and technician
- Patients and technicians asked to rate aspects of safety, comfort, and ease of use

Results

	Mean	Max	Min	St. Dev.
Patient comfort	4.8	5	4	1.58
Patient steadiness	4.1	5	4	1.42
Patient stability	4.4	5	3	0.73
Patient safety	3.8	5	2	0.78
Technician ease	4.8	5	4	0.41
Technician comfort	5.0	5	5	0.00

Validation & Verification (cont.)

IMAGE TESTING



MR Scan Type	SNR
FSE: Phantom with Device	14.9
FSE: Phantom without Device	15.6
GRE: Phantom with Device	42.9
GRE: Phantom without Device	42.7

CT Scan Type	SNR
Phantom with Device	32.8
Phantom without Device	32.9

Evaluates the design based on signal to noise ratio (SNR)
- Initial scan taken with only a phantom in the gantry of each system
- Second scan was taken with both the phantom and device
- SNR compared between the two scans
- Qualitative analysis done to confirm the absence of dropouts (MR) or artifacts (CT)

MR testing
- Two sets of pulse sequences: Fast spin echo (FSE), Gradient echo (GRE)
- ImageJ used for SNR analysis
- Compared mean photon counts for ROI within the phantom and over the background
- Calculated ratio of phantom mean to background mean

CT testing
- SNR calculated using ImageJ
- Calculations included scaling background counts and finding phantom to background mean ratio

MR results
- SNR values were within 1; image quality not affected

CT results
- SNR values with and without device were similar; image quality not affected

Further Considerations

Bed dimensions
- Dimensions: 189 cm x 59 cm x 12.7 cm
- Current bed size too bulky to hold a large patient within the bore of some medical imaging systems (particularly hybrid PET/CT designs)

Direction of transport: lateral vs. vertical transfer to accommodate room dimensions
Cost reduction: consider alternate contractors and material vendors

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