Management Principles for the Transtibial Amputation Level

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Patient Case

- At point of amputation:
  - 42yo Caucasian male
  - 5’9”
  - 191 lbs
  - Family: married w/ 2 elementary school-aged children
    - Kids in little league sports
  - Occupation: postal worker (~15yrs)
    - mail route includes both driving & walking
    - Patient self-reports that 1.5hr/ day: route walking
      - walking intermittent; frequently in/out of mail truck to access long driveways in agricultural & rural homes

Patient Case

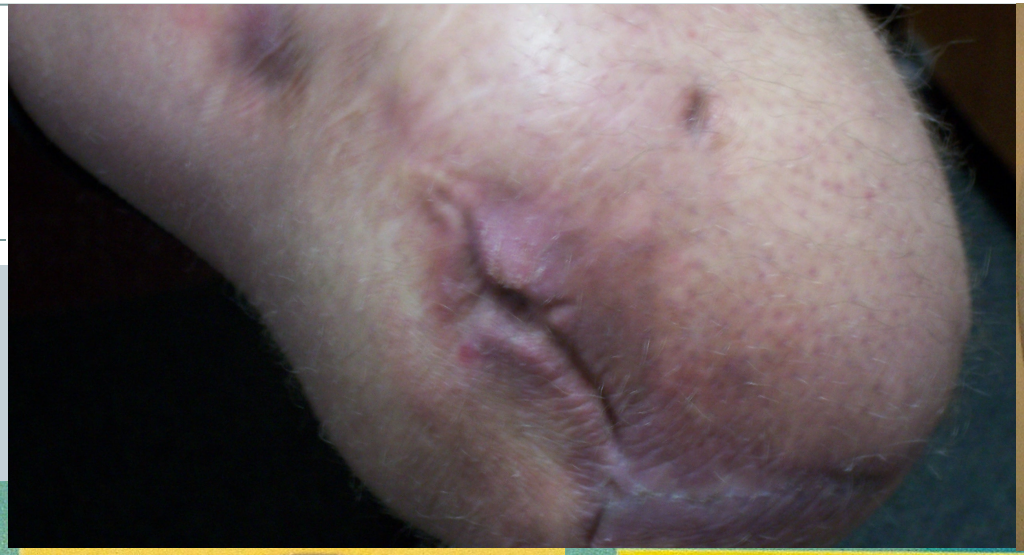
- Patient lost Rt LE 2° MVA 2yr prior to this report
  - Prosthetic experience:
    - preparatory prosthesis thru 1st yr
      - flexible keel foot & ankle unit
      - rigid frame/flexible interface socket (both thermoplastic)
      - 9mm urethane liner
      - suspension sleeve
    - Beginning his 2nd yr using a prosthesis, transitioned to:
      - flexible interface/rigid frame socket
        - (thermoplastic and laminated thermoset respectively)
      - 3mm silicone locking liner with pin suspension
      - Energy Storing (Variflex) Foot

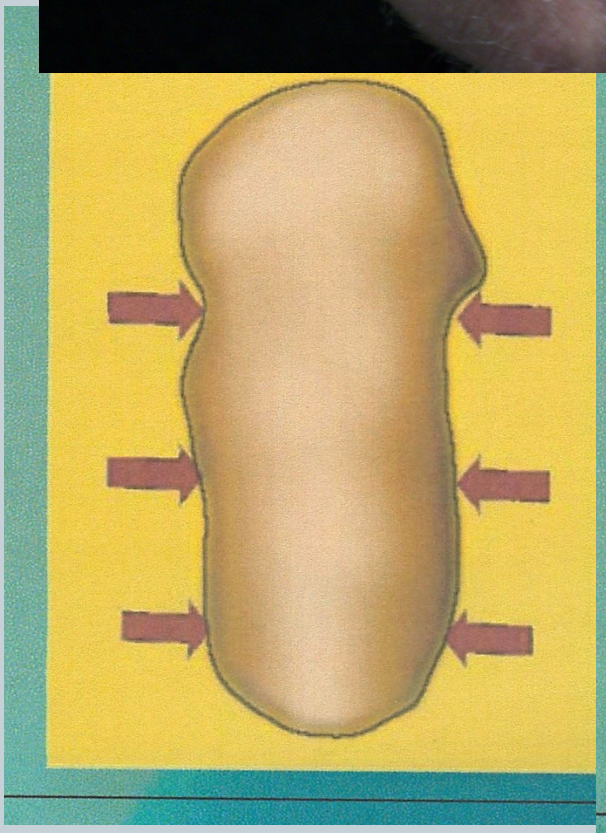
Patient Case

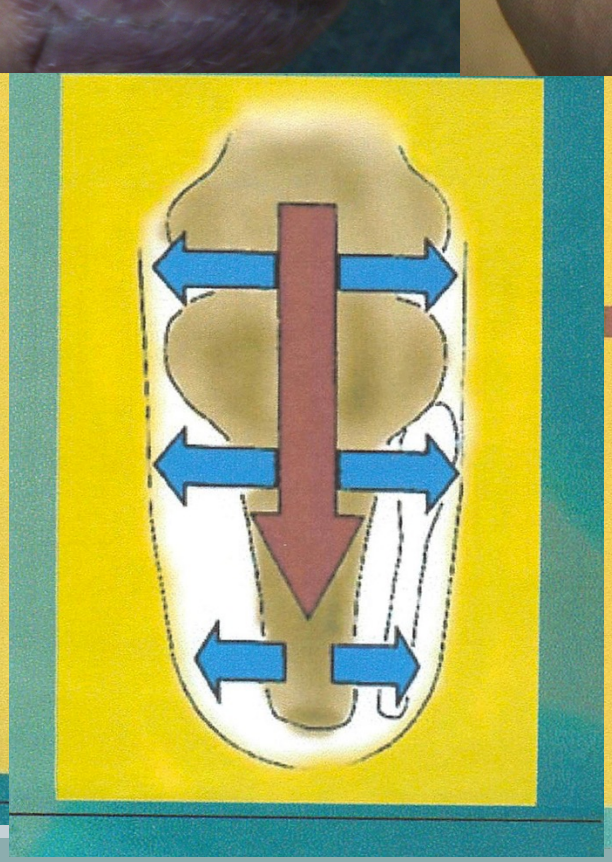
- Since his amputation:
  - activity level ↓d (over 1st yr post-amputation)
    - resulting in weight gain to 235lbs
  - At this time, he began transitioning back to work full-time in original mail route
    - light-duty
    - part-time basis
  - Patient began c/o LBP & residual limb skin issues (pain & skin BD) while ↑ing his walking activities
- Returned to prosthetist for help
- Prosthetist requested Physical Therapist evaluation.

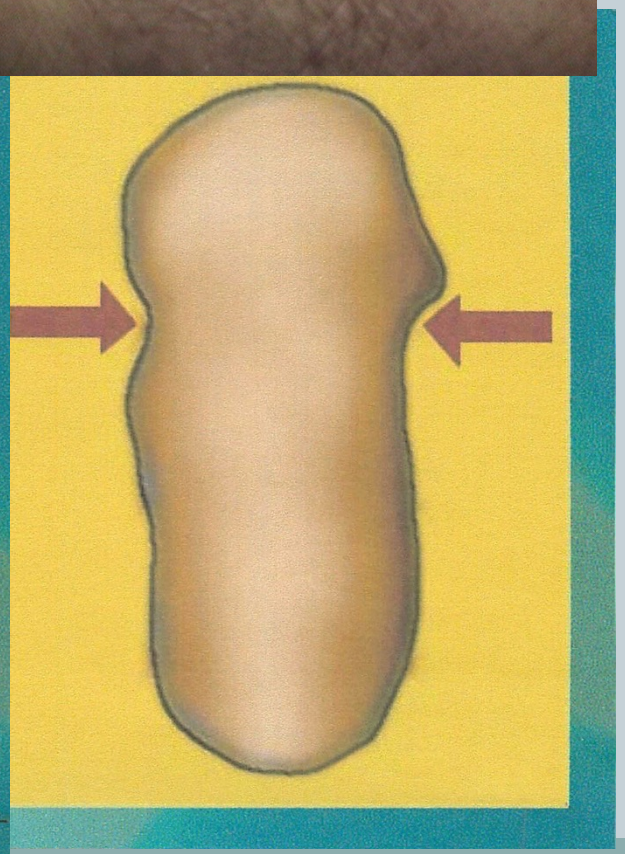
TT Management

- What is the better **prosthetic** approach in the Middle-Aged, active TT population?
  - Interface
  - Suspension
  - Foot/AnkleEnergy Storing & Release?
- What is the better **physical therapy** approach in the Middle-Aged, active TT population?
  - Musculoskeletal System
  - Neuromuscular System
  - Cardiopulmonary System
  - Integumentary System









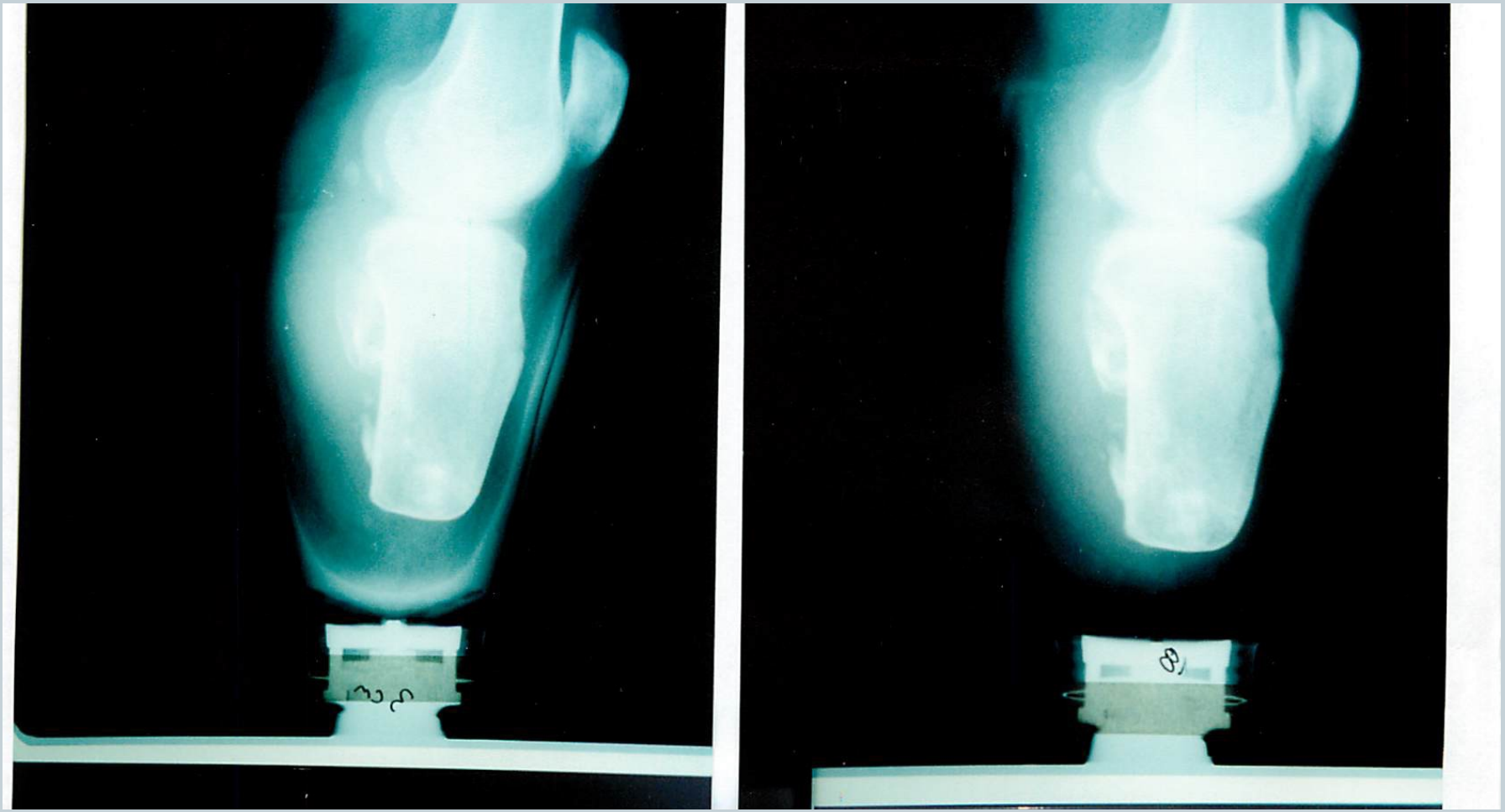
Interface

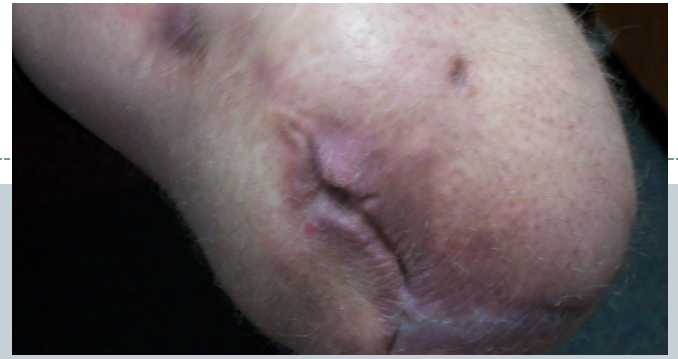
- Interface (Kahle JT. JPO)
  - Specific Weight Bearing/Patella Tendon Bearing
    - Fleshy residuum; difficult to stabilize tissue
    - Distal end stabilization
      - Potentially least tolerated
  - Total Surface Bearing
    - Decreased friction
    - After trying prep prosthesis w/suspension sleeve, patient preferred to go away from sleeve
  - Hydrostatic Design
    - Distal end stabilization
    - ROM
      - Pin

Suspension

- Suspension
  - Sleeve
    - After using sleeve in prep prosthesis, pt rejected sleeve
      - Another factor eliminating VASS/HSD
  - Negative pressure
    - Intolerance for sleeve
  - Pin/lanyard
    - Minimized pistoning to swing only
    - Stabilized soft tissue within sleeve
    - Liner is less skin coverage than sleeve
      - Outdoor work as postal worker in FL
    - Makes donning/doffing faster than sleeve
      - Can roll pants up to donn vs. pants off

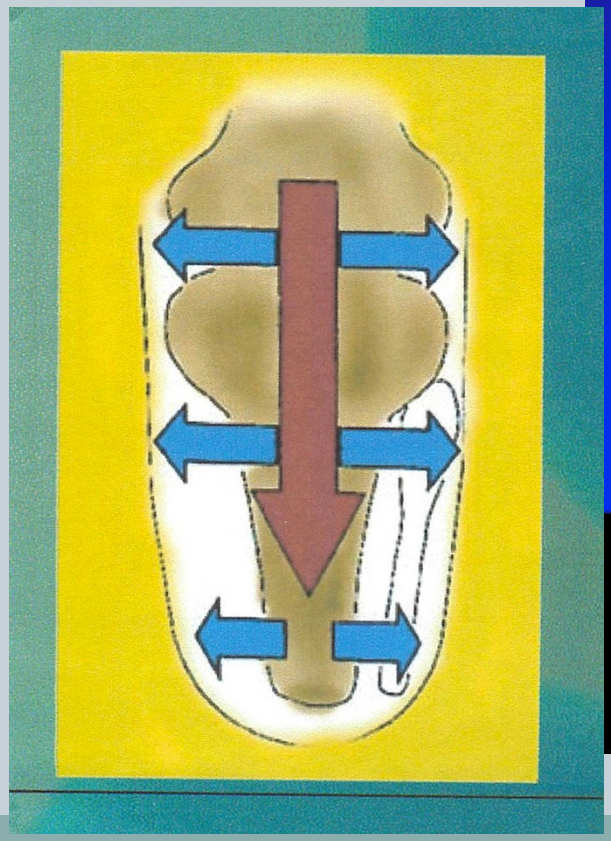
“Hydrostatic”





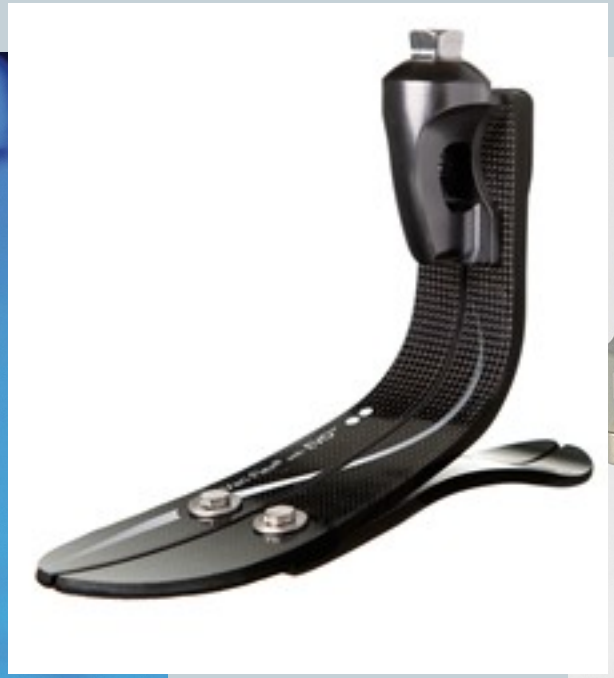
TT Management

- Interface + Suspension = Design



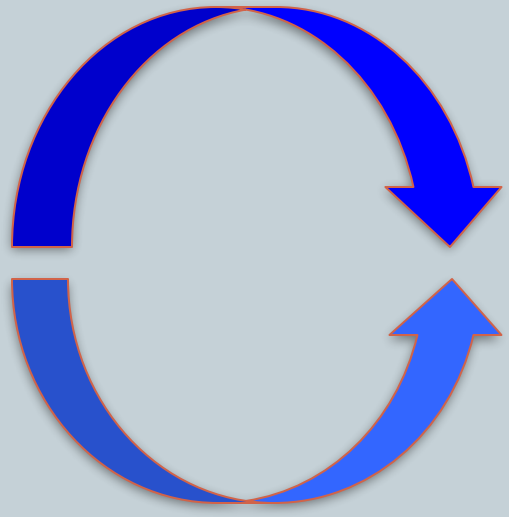
TT Management

- Foot + Components



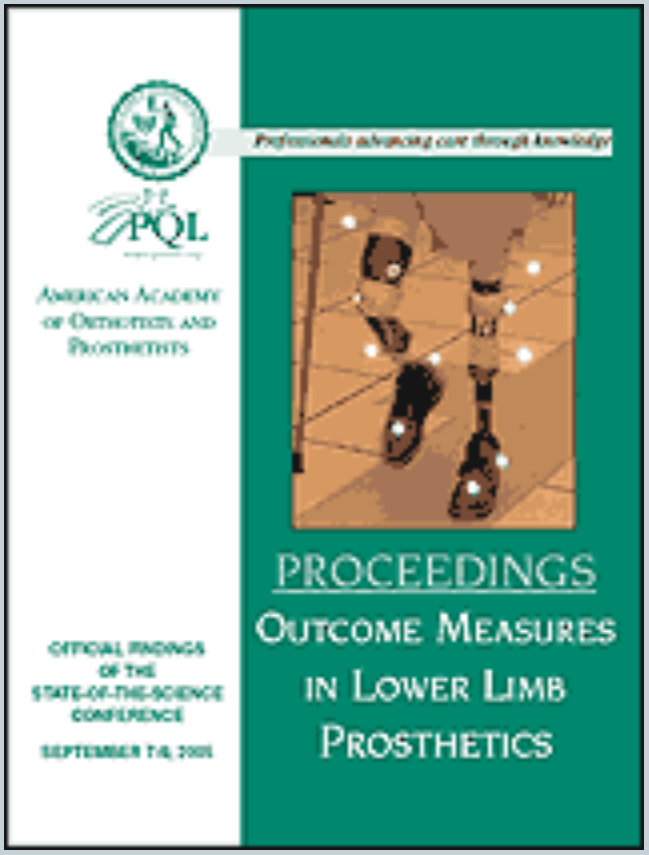
Clinical Outcomes

- Improved skin issues
- Improved comfort
- Increased sedentary lifestyle
  - Weight gain
  - Low back pain
  - Fatigue
  - Depression
- Exercised all prosthetic options



Outcome measures/evidence based practice

- Not your enemy
- Is it coming or not?
- Why?
- What are your goals?



Clinical Management-using evidence to *OUR* advantage

- Sacrifice external for internal validity, but not for *US!*
- There is NEVER a perfect study
- Baseline = some point in time
- Evidence vs.(?) profit based practice

Practical Outcome Measures

- PEQ vs. PEQ-A
- L Test vs. TUG, 6 Minute, etc.
- AMP vs. SOAP, subjective
- HAI/SAI vs. MRPP
- 4 Square vs. BBS

Practical Outcome Measures?

SUBJECT INFORMATION

NAME	
AGE	43
GENDER	Male
HEIGHT	165.5 cm
ID_1	
ID_2	
ETHNICITY	General Population
OPERATOR	lm
TEST DATE	March 15, 2012
TEST NUMBER	574

BODY COMPOSITION RESULT

% FAT	20.5	%
% FAT FREE MASS	79.5	%
FAT MASS	13.798	kg
FAT FREE MASS	53.469	kg
BODY MASS	67.267	kg
BODY VOLUME	63.940	L
BODY DENSITY	1.052	kg/L
THORACIC GAS VOLUME	3.509	L

TEST PROFILE

DENSITY MODEL	Siri
THORACIC GAS VOLUME MODEL	Predicted

OPERATOR COMMENTS

Body Fat: A certain amount of fat is absolutely necessary for good health. Fat plays an important role in protecting internal organs, providing energy, and regulating hormones. The minimal amount of "essential fat" is approximately 3-5% for men, and 12-15% for women. If too much fat accumulates over time, health may be compromised (see table below).

Fat Free Mass: Fat free mass is everything except fat. It includes muscle, water, bone, and internal organs. Muscle is the "metabolic engine" of the body that burns calories (fat) and plays an important role in maintaining strength and energy. Healthy levels of fat-free mass contribute to physical fitness and may prevent conditions such as osteoporosis.

LMI Body Fat Rating Table*

**Applies to adults ages 18 and older. Based on information from the American College of Sports Medicine, the American Council on Exercise, Exercise Physiology (4th Ed.) by McArdle, Katch, and Katch, and various scientific and epidemiological studies.*

	BODY FAT RATING	MALE	EXPLANATION
	Risky (high body fat)	> 30%	Ask your health care professional about how to safely modify your body composition.
X	Excess Fat	20 - 30%	Indicates an excess accumulation of fat over time.
	Moderately Lean	12 - 20%	Fat level is generally acceptable for good health.
	Lean	8 - 12%	Lower body fat levels than many people. This range is generally excellent for health and longevity.
	Ultra Lean	5 - 8%	Fat levels often found in elite athletes.
	Risky (low body fat)	< 5%	Ask your health care professional about how to safely modify your body composition.

ENERGY EXPENDITURE RESULTS

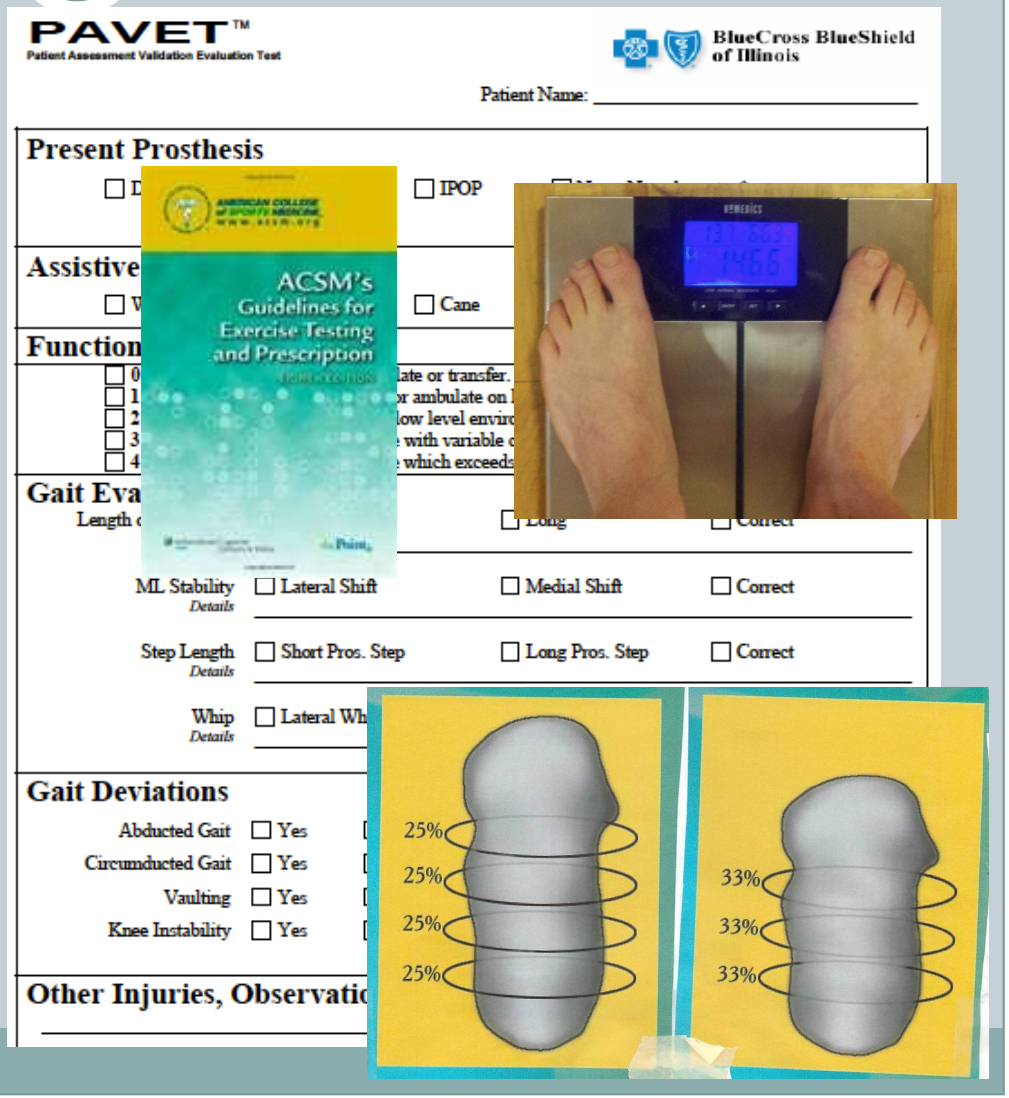
Est. Resting Metabolic Rate (RMR) kcal/day	*Est. Total Energy Expenditure (TEE) kcal/day	Daily Activity Level
1435	1837	Sedentary
	2167	Low Active
	2497	Active
	2985	Very Active
(See RMR Info Sheet for additional info)	*Est. TEE = Est. RMR x Daily Activity Level	

Applies to adults ages 18 and older. Based on information from the Institute of Medicine (2002), Dietary Reference Intakes For Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, And Amino Acids, Part I, pp93-206. Washington, D.C., National Academy of Sciences.

BOD POD Life Measurement, Inc. • 1-800-4 BOD POD • www.lifemeasurement.com LMI

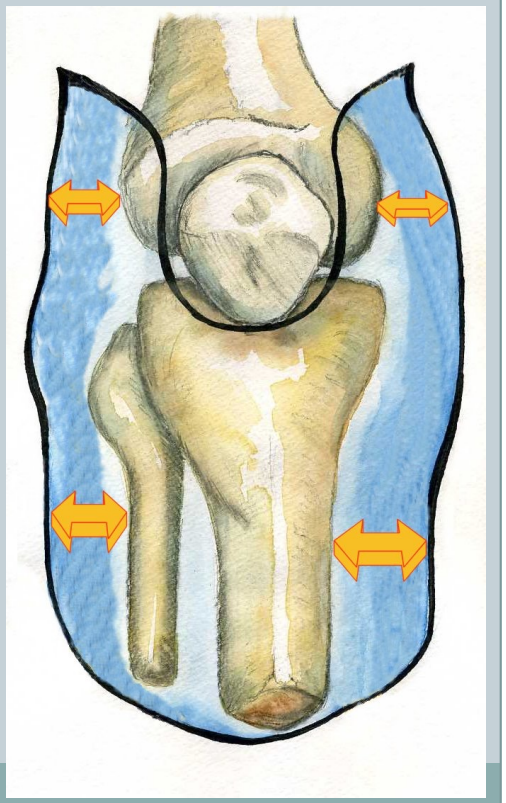
Clinical Outcome Measures

- Weight
- HR
- Perceived Exertion
  - Borg MSSE 1982
- PAVET Scale
- SOAP
  - Self report
- Measurements
- Sock Ply



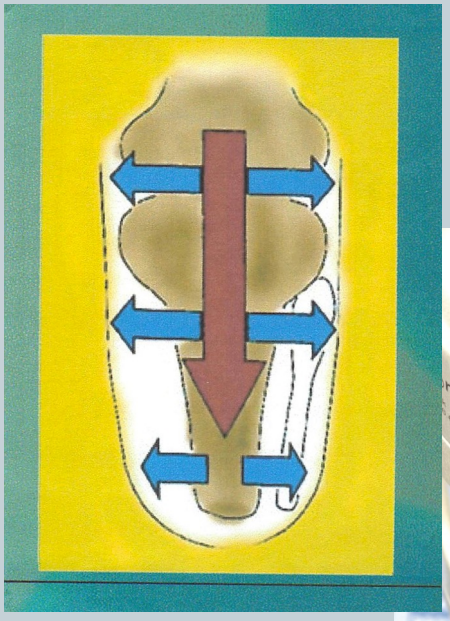
Prosthetic Summary

- Initially successful
  - With transition back to work
  - Part time; desk work initially → walking; in/out mail truck…
- Skin Breakdown tissue destabilization
- Return to Prosthetist:
  - Attempt custom gel pads, TEC spots to separate distal invagination…unsuccessful
  - Redesign of interface, suspension, and components
  - Improved but still intermittent skin issues
  - Weight gain, fatigue, LBP



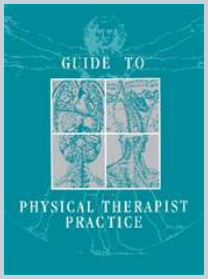
TT Management

- Sometimes EVERYTHING is not enough…PT team

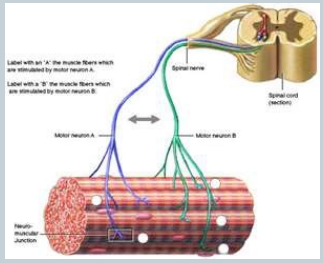


PT Evaluation

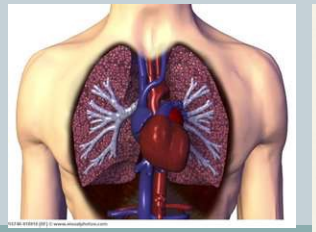
- 4 Practice Patterns

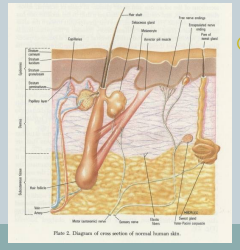


- What is the better **physical therapy** approach in the Middle-Aged, active TT population?
  - Musculoskeletal System



  - Neuromuscular System
  - Cardiopulmonary System

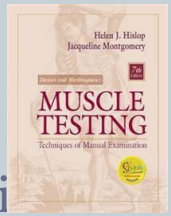




  - Integumentary System

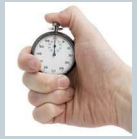
TT Evaluation. Physical Therapy.

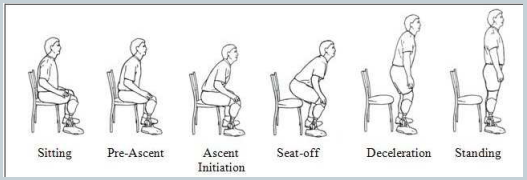
- Musculoskeletal:
  - MMT (Hislop & Montgomery)
  - Functional Strength:
    - Stair Climbing



Mvt	Amp Side	Sound Side
Hip Ext	**4-/5**	4/5
Hip AB	5/5	5/5
Knee Flx	**3/5**	5/5
Knee Ext	5/5	5/5

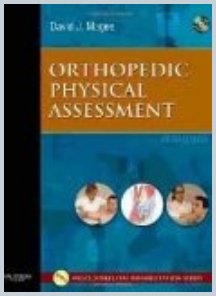
      - Step-to up/dn 5 stai
        - (Schmalz G&P 2007)- TTA results in knee / moment ~21% of controls, related to loss of tib ant & gastrosoleus, the knee is held in ext longer than controls' knees
    - STS
      - Visible shift to sound side in stand & sit
      - 3.3s (avg of 3) to stand w/UE's
        - TTA's: 2.8s w arm rests; 3.1 w/out
          - (Agrawal et al. Ergonomics 2011)
      - 1.3s (avg of 3) to sit; collapse into chair

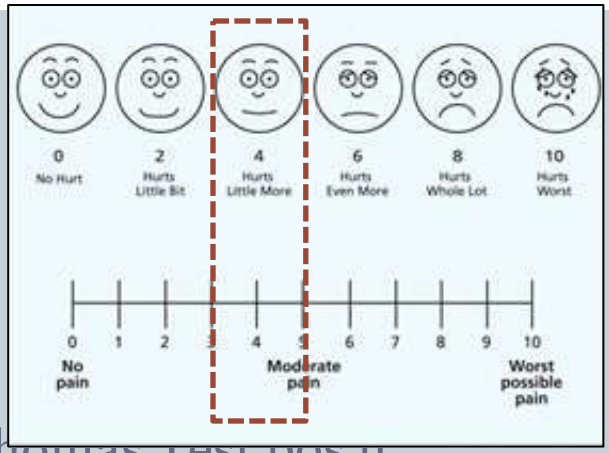




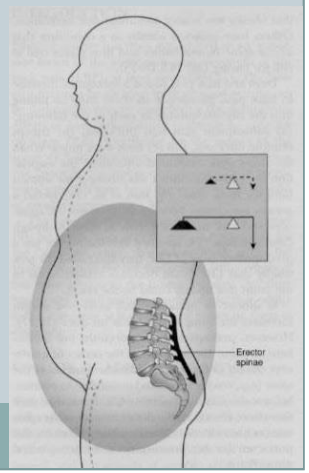
TT Evaluation. Physical Therapy.

- Musculoskeletal:
  - LBP
    - 4/10 pain- *"always there"*
    - flexion contracture (Magee D.)
      - + Thomas Test for psoas tightness
      - Lacked 7° from neutral (amp side) in Thomas Test pos II



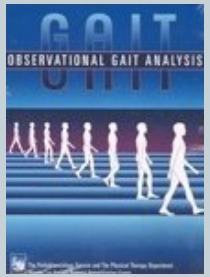


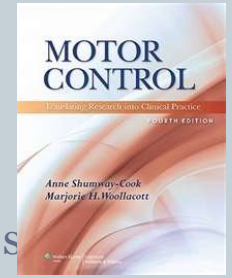
- Contributors to LBP:
  - new posture
  - wt gain + ↑d sitting + mobility challenges + skin issues)
  - weight gain & psoas contracture ↑ lordosis
    - (leimholn)



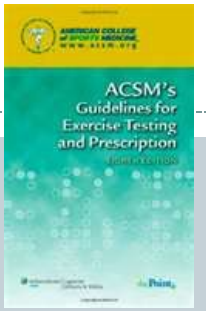
TT Evaluation. Physical Therapy.

- Neuromuscular:
  - OGA Revealed:
    - Weight shift over prosthesis in prosthetic stance
    - Short sound step length
      - (Brunnekeefe et al. & Krebs et al.)- OGA≈80%reliable
      - (Highsmith et al. JPO 2010)
  - Motor control
    - Gait
      - adaptation of altered gait pattern due to ↓ comfort, stability, s
      - re-learn to improve symmetry
    - Transitional movements
      - Shift weight to sound side; asymmetry; 1-legged task?
        - (Agrawal et al. Ergonomics 2011)- show >26% asymmetric load in STS
      - Stairs up w/ good; & ↓ step time on prosthesis while climbing
        - (Schmalz G&P 2007)

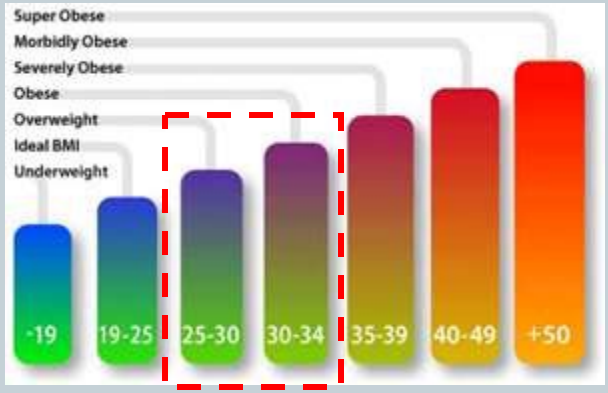




TT Evaluation. Physical Therapy.



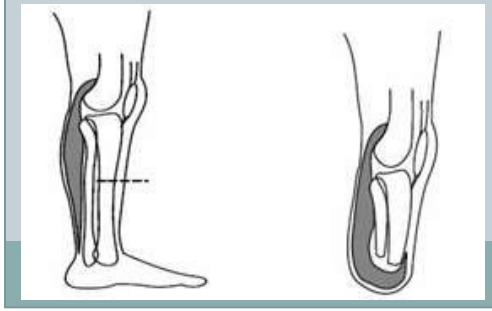
- Cardiopulmonary:
  - ACSM Guidelines/Risk Factors:
    - Sedentary Lifestyle- <30min mod phys activity/day (most days)
    - **Risk factor**
  - Weight Gain per BMI
    - 28.2 BMI originally; 34.7 BMI at max
    - **Risk factor**
  - 6MWT @ eval (Gailey et al. APMR 2002)
    - 207m
      - (K2[190m]-K3[299m])
    - 14/20RPE (Borg MSSE '82)



RPE	Description	Intensity Level
7	Easy	
8		
9	Very Light	
10		50% MHR
11	Fairly Light	
12		60% MHR
13	Somewhat Hard	
14		70% MHR
15		
16	Hard	80% MHR
17		
18	Very Hard	90% MHR
19	Very, Very Hard	
20		

TT Evaluation. Physical Therapy.

- Integumentary:
  - Poor surgical closure
    - Invagination/dehiscence
    - Posterior muscular flap had separate skin envelope;
      - Not attached to bone:
        - Triceps surae not attached distally
          - Contribution to knee flexion?
    - Can contraction contribute to stability within interface?
      - (Kegel & Burgess-isometric contraction)
    - Severe intertrigo- acute & chronic (Highsmith et al. JAAPA)



Problem List/Impressions

- Deconditioning:
  - Mobility & skin challenges
    - Asymmetric gait & transitional movements
    - Amputated side strength issues
    - Intertrigo & breakdown
    - Delayed return to work roles
    - ↑d effort to ambulate; prefer to do less of it
    - LBP
    - Weight gain
    - Mild flexion con re
    - Prosthetic complaints
  - Depression? Kids continuing on in sports; life passing me by- connected with support group (Klute et al. JRRD- Focus Group)

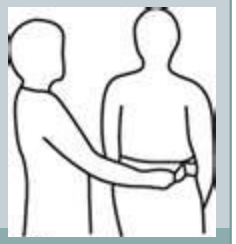
PT Management

- Integument
  - Time out of prosthesis- problem.
    - Further delay to mobility & return to activity, work, family roles
  - Prosthetically-
    - gel pads (physical barrier)
    - Skin to skin opposition under greater compression
  - In rehab- discussed chemical barrier creams
    - A&D- “vehicle” only
    - A&D zinc oxide or Desitin- buffer & bacteriostatic;
      - this was fastest to heal
  - with treadmill training, pre/post skin monitoring for:
    - Decubiti
    - Intertrigo

PT Management

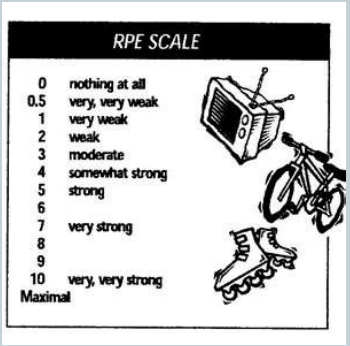
- Musculoskeletal & Neuromuscular
  - HEP:
    - Hip extension
    - Prone lying
    - Active hip flexion stretching
    - Active contraction of muscles in socket while walking (Kegel & Burgess)

  - Clinically:
    - Manual hip flexion stretching
    - Total Gym to wall mini-squat to full wall squat
    - Gait training
      - flat ground: overground (man'l, SBA/cue) to incline TM
        - ↑ velocity/duration
      - Stairs: (man'l to SBA/cue) (see Minor & Minor)
    - Transitional movements (STS & car transfer) (man'l to SBA/cue)



PT Management

- Cardiopulmonary
  - ↓ risk factor(s)
  - TM walking
    - (↑ duration, velocity/intensity)
      - ≈65%MHR to 75-80%MHR
      - ≈5min to 18min
  - Train on RPE scale
  - Monitor weight change
  - Discuss (as pt appropriately prepared):
    - caloric intake/expenditure/food pyramid
    - Participation in kids' little league activities
    - Return to work potential
  - HEP-
    - Walk when possible (stairs vs. elevator; close parking spaces)
    - Walk around block 3/7 nights/week
      - ↑ Distance
      - ↑ Intensity



Final Outcome

- Cardiopulmonary:
  - ACSM Guidelines/Risk Factors:
    - Sedentary Lifestyle- <30min mod phys activity/day (most days)
    - **Risk factor-** **Resolved**
  - Weight Gain per BMI
    - 28.2 BMI originally; 34.7 BMI at max
    - **Risk factor-** ***Resolving***

	Amp Side	
Mvt	Eval	Post Tx
Hip Ext	4-/5	**4/5**
Knee Flx	3/5	**4-/5**

- 6MWT @ eval (Gailey et al. APMR 2002)
  - 207m
    - (K2[190m]-K3[299m])
  - 14/20RPE (Borg MSSE '82)

Post tx: 311m @ 11/20 RPE

Final Outcome

- At ~2.5yrs after amputation, patient was:
  - satisfied with prosthesis
    - Minimal but recurring skin issues; manageable
  - Integrated back to societal roles:
    - work role: slightly modified version of previous duty
    - family role: w/ kids recreational schedule
  - Tolerable/manageable LBP
    - Activity related (e.g. prolonged sitting/driving)
  - By OGA, improved symmetry in
    - Overground gait
    - Stair gait
  - Improved STS
    - Duration
    - symmetry