Critical Limb Ischemia – CLI
Advances in Limb Salvage

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Prevalence of PAD

In a primary care population defined by age and common risk factors, the prevalence of PAD was approximately **one in three** patients.

NHANES\(^1\)  
Aged >40 years  
\(4.3\%\)

San Diego\(^2\)  
Mean age 66 years  
\(11.7\%\)

NHANES\(^1\)  
Aged 70 years  
\(14.5\%\)

Rotterdam\(^3\)  
Aged >55 years  
\(19.1\%\)

Diehm\(^4\)  
Aged 65 years  
\(19.8\%\)

PARTNERS\(^5\)  
Aged >70 years, or 50–69 years with a history diabetes or smoking  
\(29\%\)

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NHANES=National Health and Nutrition Examination Study  
PARTNERS=PAD Awareness, Risk, and Treatment: New Resources for Survival [program].

Relative Risk Factors for PAD

- Smoking
- Diabetes
- Hypertension
- Hypercholesterolemia
- Hyperhomocysteinemia
- C-Reactive Protein

PAD Risk Factors are “Synergistic”

PAD Presentation

- ~15% Classic (Typical) Claudication
- ~33% Atypical Leg Pain (functionally limited)
- 50% Asymptomatic
- 1%-2% Critical Limb Ischemia
Cardiovascular Events with PAD

- Patients with symptomatic PAD face up to 6x greater risk of death from CVD, including MI and stroke.

<table>
<thead>
<tr>
<th>Event</th>
<th>Increased Risk of CV Mortality</th>
</tr>
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<tbody>
<tr>
<td>Stroke$^1$</td>
<td>2–3x</td>
</tr>
<tr>
<td>Fatal MI or CHD Death$^2$</td>
<td>4x</td>
</tr>
<tr>
<td>Death from CVD$^2$</td>
<td>6x</td>
</tr>
</tbody>
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Prognosis:
Survival in Patients With PAD

Natural History/Presentation of PAD

PAD Population (50 years and older)

Initial clinical presentation

- Asymptomatic PAD: 20%-50%
  - Progressive functional impairment

- Atypical leg pain: 40%-50%

- Claudication: 10%-35%

- Critical limb ischemia: 1%-2%
  - 1-year outcomes
    - Alive w/ 2 limbs: 50%
    - Amputation: 25%
    - CV mortality: 25%

5-year outcomes

Clinical Classification of PAD

<table>
<thead>
<tr>
<th>Fontaine</th>
<th>Rutherford</th>
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<tbody>
<tr>
<td></td>
<td>Grade</td>
</tr>
<tr>
<td>Stage</td>
<td>Clinical</td>
</tr>
<tr>
<td>I</td>
<td>Asymptomatic</td>
</tr>
<tr>
<td>IIa</td>
<td>Mild claudication</td>
</tr>
<tr>
<td>IIb</td>
<td>Moderate to severe claudication</td>
</tr>
<tr>
<td>III</td>
<td>Ischemic rest pain</td>
</tr>
<tr>
<td>IV</td>
<td>Ulceration or gangrene</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
Clinical Definition of CLI?

- Ischemic rest pain
- Ischemic ulcer
- Failure to heal wounds
- Gangrene
CLI

• **Ischemic Rest Pain**
  – Due to inadequate flow to match resting metabolism
  – Constant pain
  – Worsened by elevation (e.g. bedtime, sleep)
  – Improved with dependent position
    • e.g. Hanging foot over side of bed
  – *Limb threatening*
CLI

- Ischemic Ulceration
  - Inadequate flow to preserve cutaneous integrity
    - Most frequent sites
      - Over ‘contact’ areas on feet and toes
    - Can be quite painful
    - Definitely limb threatening
CLI

Gangrene

– Essentially dead tissue
  • Dry gangrene - mummified tissue (‘scab’)  
    – Not threatening in and of itself
  • Wet gangrene - infected necrotic tissue
    – Acutely limb and life threatening
    – *Surgical emergency*
CLI - Hemodynamic Definition?

- Ankle Pressure < 50-70 mmHg
- Toe Pressure < 30-50 mmHg
- TcPO2 < 30-50 mmHg
Validation of the relationship between ankle–brachial and toe–brachial indices and infragenicular arterial patency in critical limb ischemia

Matthew C Bunte¹, Jessen Jacob², Benjamin Nudelman¹ and Mehdi H Shishehbor¹
Validation of the relationship between ankle-brachial and toe-brachial indices and infragenicular arterial patency in critical limb ischemia

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CLI
Prevalence

• PAD affects 8-12 million people in the U.S.¹
• Up to 2 Million with Critical Limb Ischemia (CLI)²
  • “The rule of Quarters”³
    • Within one year of CLI diagnosis:
      • 25% will resolve
      • 25% will have persistent CLI and ulceration
      • 25% will undergo major amputation
      • 25% will die
    • 150,000 Amputations Yearly Due to CLI²

¹US Department of Health & Human Services National Institute of Health August 2006.
³Rundback JH. Vascular Disease Management 2013; 10: 152-158
5-Year Mortality Rates for PAD and CLI

If PAD/CLI Progresses, it may lead to AMPUTATION

- **Average days in hospital** – 71 days/year\(^1\)
- **Readmission** rates – 74% at 1 year\(^2\), 19.5 times/year\(^1\)
- **Follow-up care** in other institutions – 76% go to in-patient rehabilitation and skilled nursing facilities after discharge from the hospital\(^3\)
- **Depression** – 32 to 34% suffer from depression symptoms\(^4\)
- **Ambulation** – 60-80% can’t walk\(^5\)
- **Contralateral amputation** – 40%\(^2\)
- **2-year mortality** rate – 40%\(^6\)

4. Desmond DM and MacLachlan M. J Pain Symptom Manage 2006;31:362—368
CLI & Amputations

4M People with Critical Limb Ischemia

25% Die within 1 yr of CLI onset

30% will get amputation

Of those with an amputation...
Nearly half will die within 1 yr

Death within 1 year

1. Nehler et al., Epidemiology of peripheral arterial disease and critical limb ischemia in and insured national population. *J Vasc Surg*, 2014; 60(3): 686-695
## CLI and Amputations

<table>
<thead>
<tr>
<th>Amputations are prevalent for CLI treatment...</th>
<th>Amputations continue to be a primary treatment...</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>40%</strong> of CLI patients will require a major amputation within 6 months of diagnosis(^1)</td>
<td><strong>67%</strong> of Medicare CLI patient amputations were the first procedure(^2)</td>
</tr>
<tr>
<td><strong>150,000</strong> Amputations per year due to CLI(^2)</td>
<td><strong>71%</strong> of major amputations* had no initial revascularization option offered(^2)</td>
</tr>
</tbody>
</table>

*Major amputations as defined by amputation above the foot

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Angiograms and Revascularization are Underutilized Prior to Amputation\(^1\)

20,464 MEDICARE Patients with PAD who underwent major leg amputations between 2003-2006.

> 50% Never had an Angiogram or Vascular Intervention/ Surgery

Interventions within one year prior to amputation

Amputation Rates Decrease as Revascularization Rates Increase

Single Center 12 Year Review

N = 1615 lower extremity vascular procedures
# Mortality & Morbidity of Amputations and Endovascular Interventions

<table>
<thead>
<tr>
<th>Metric</th>
<th>Amputation\textsuperscript{1,2}</th>
<th>Endovascular\textsuperscript{1,3,4,5}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perioperative mortality – ATK</td>
<td>5-10%</td>
<td>1-3%</td>
</tr>
<tr>
<td>Perioperative mortality – BTK</td>
<td>15-20%</td>
<td></td>
</tr>
<tr>
<td>Major complications</td>
<td>20-37%</td>
<td>5-9%</td>
</tr>
<tr>
<td>Most frequent complications</td>
<td>DVT: 13-26%, Infection: 10-30%, Cardiac: 9-10%</td>
<td>Bleeding: 5-7%, Infection: 1-4%, Cardiac: 1%</td>
</tr>
<tr>
<td>In-hospital revision rate</td>
<td>ATK: 12%, BTK: 20%</td>
<td>Revised with: Endo: 1%, Bypass: 9%, Amputation: 4%</td>
</tr>
</tbody>
</table>

3. BASIL Trial participants. Lancet 2005; 366: 1925-34
What are the Economic consequences of amputations?

- Average hospital cost for wound infection = $19-$42K\(^1\)
- Amputees are readmitted an average of 19.5 times/year, with over an average of 71 days spent in the hospital annually\(^2\)

Health Care Economics

Day of Case
- Lab time to manage adverse event
- Bail-out stent rate: $1,070-$2,660/each\(^1\)

Durability
- Re-intervention rate at $15,000 – 27,000 each\(^2\)

Wound Healing
- Average cost to heal chronic wound = $17,096\(^3\)

Amputation
- Amputation cost = $20,000 - $60,000\(^4\)
- Annual cost of follow-up care = $49,000\(^5\)
- Annual cost of nursing home: $70,000 – 100,000\(^5\)

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So, in Summary

- Annual cost of post amputation care is approximately $49,000, per patient

- Nursing home care after amputation is approximately $100,000 per patient

- **Annual cost of care and follow up, post limb salvage:** $600

3x growth in endovascular interventions

Total endovascular interventions
RR=3.3; 95% CI 2.9-3.8

Major LE amputation
RR=0.71; 95% CI 0.7-0.8

LE bypass surgery
RR=0.58; 95% CI 0.5-0.7

J Vascular Surgery 2009; 50:54-60
Endovascular Techniques

- Subintimally dissect it
- Angioplasty
- Stent
- Laser
- Freeze
- CLI
- Sand
- Drill
Balloons

POBA

Angiosculpt

Cutting Balloon

PolarCath Balloon
Atherectomy Devices

CSI 360 Orbital Atherectomy
Silver Hawk
Turbo-Laser
Rotablator

CSI 360 Orbital Atherectomy
Drugs

Drug Eluting Stents  Drug Eluting Balloon
Retrograde Access

Pedal Access Tools

- 2.9 Fr ID Micropuncture introducer
- Check-Flo® Hemostasis Assembly
- 21 gage, 4 cm EchoTip® needle
- .018 inch nitinol wire guide
POBA-Primary Patency

p=0.004

% Patency

- All Patients
- Claudication
- Critical Limb Ischemia

Months

0 10 20 30

65.6%

42.4%
POBA-Assisted Patency

- All Patients: 93.8%
- Claudication: 92.7%
- Critical Limb Ischemia: 92.7%

p = 0.31
POBA-Limb Preservation

% Limb Salvage

- All Patients
- Claudication
- Critical Limb Ischemia

p=0.007

100%
89.8%
Importance of Restoring Perfusion
Angiosome Concept

Angiosomes of the lower extremity

- Anterior tibial angiosome
- Posterior tibial angiosome
- Peroneal angiosome
Freedom from Amputation

- P = 0.008

- P = 0.02
Failed to heal
InDirect (n=21)

<table>
<thead>
<tr>
<th>Method</th>
<th>Complete Healing</th>
<th>Failed to Heal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct (n=22)</td>
<td>91%</td>
<td>9%</td>
</tr>
<tr>
<td>Indirect (n=21)</td>
<td>38%</td>
<td>62%</td>
</tr>
</tbody>
</table>

Failed to heal
InDirect (n=21)
Conclusion

• CLI patients are at the highest risk for adverse cardiovascular events.

• Early detection and referral of CLI patients are keys in success to prevent major amputation and preserve limbs.

• Functional studies (ABI, TBI) are helpful, however do not correlate with the clinical stage of CLI or vessels occluded.

• Care for CLI patients should be team-based, with dedicated CLI team.

• Given the excessive morbidity and mortality associated with amputation, the treatment of critical limb ischemia should focus on revascularization and limb salvage rather than amputation.
Care Model for CLI
“CLI Team”

EVALUATION
- PRELIMINARY ASSESSMENT
  - Historical
  - Physical Examination
- VASCULAR SPECIALIST
- PreLIMINARY INVESTIGATIONS
  - Pathology
  - Arterial Duplex, ABI, TCOM
  - X-Ray, CT, MRI, Nuclear Med
- Ischemia
- Neuropathy
- Foot Architecture

MULTI-DISCIPLINARY TEAM
- ENDOCRINOLOGIST
- INFECTION DISEASES
- CARDIOLOGY
- ORTHOPEDICS

TREATMENT
- REvascularization
  - Endovascular
  - Open Surgical
- OR
- WOUND CARE HEALING
  - Debridement
  - Abscess Drainage
  - Minor Amputation

MAINTENANCE
- FOOTWEAR
- RISK FACTOR MODIFICATION
- DIABETES EDUCATION
- REGULAR PODIATRY
Thank You

Questions???