CADTH RAPID RESPONSE REPORT: REFERENCE LIST

Microprocessor Controlled Limbs for Patients with Amputation: Clinical Effectiveness, Cost Effectiveness and Guidelines

Service Line: Rapid Response Service
Version: 1.0
Publication Date: July 24, 2019
Report Length: 7 Pages

CADTH

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Cite As: *Microprocessor controlled limbs for patients with amputation: clinical effectiveness, cost effectiveness and guidelines*. Ottawa: CADTH; 2019 Jul. (CADTH rapid response report: reference list).

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Funding: CADTH receives funding from Canada's federal, provincial, and territorial governments, with the exception of Quebec.

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Research Questions

1. What is the clinical effectiveness of micro-processor-controlled prosthetics for patients with amputation at the hand, elbow, ankle, or knee?
2. What is the cost-effectiveness of micro-processor-controlled prosthetics for patients with amputation at the hand, elbow, ankle, or knee?
3. What are the evidence-based guidelines regarding micro-processor-controlled prosthetics for patients with amputation at the hand, elbow, ankle, or knee?

Key Findings

One systematic review, 14 non-randomized studies, and two economic evaluations were identified regarding the clinical effectiveness of micro-processor-controlled prosthetics for patients with amputation at the hand, elbow, ankle, or knee. In addition, two evidence-based guidelines were identified.

Methods

A limited literature search was conducted by an information specialist on key resources including MEDLINE, the Cochrane Library, the University of York Centre for Reviews and Dissemination (CRD) databases, the websites of Canadian and major international health technology agencies, as well as a focused Internet search. The search strategy was comprised of both controlled vocabulary, such as the National Library of Medicine's MeSH (Medical Subject Headings), and keywords. The main search concepts were microprocessors and artificial limbs. No filters were applied to limit the retrieval by study type. The search was also limited to English language documents published between January 1, 2014 and July 15, 2019 Internet links were provided, where available.

Selection Criteria

One reviewer screened citations and selected studies based on the inclusion criteria presented in Table 1.

Table 1: Selection Criteria

Population	Patients with an amputation at the hand, elbow, ankle, or knee
Intervention	Microprocessor-controlled prosthetics (e.g., C-leg braces)
Comparator	Q1-2: Other prosthetic devices (e.g., regular braces), non-microprocessor-controlled devices, other microprocessor-controlled devices

Outcomes	Q1: Clinical effectiveness (e.g., patient quality of life, falls, adverse events) Q2: Cost effectiveness Q3: Guidelines
Study Designs	Health technology assessments, systematic reviews, meta-analyses, randomized controlled trials, non-randomized studies, economic evaluations, evidence-based guidelines

Results

Rapid Response reports are organized so that the higher quality evidence is presented first. Therefore, health technology assessment reports, systematic reviews, and meta-analyses are presented first. These are followed by randomized controlled trials, non-randomized studies, economic evaluations, and evidence-based guidelines.

One systematic review, 14 non-randomized studies, two economic evaluations, and two evidence-based guidelines were identified regarding the clinical or cost effectiveness of micro-processor-controlled prosthetics for patients with amputation at the hand, elbow, ankle, or knee. No relevant health technology assessments or randomized controlled trials were identified.

Additional references of potential interest are provided in the appendix.

Health Technology Assessments

No literature identified.

Systematic Reviews and Meta-analyses

1. Morgan SJ, Hafner BJ, Kartin D, Kelly VE. Dual-task standing and walking in people with lower limb amputation: a structured review. *Prosthet Orthot Int*. 2018 Dec;42(6):652-666.
   PubMed: PM30047839

Randomized Controlled Trials

No literature identified.

Non-Randomized Studies

2. Fuenzalida Squella SA, Kannenberg A, Brandao Benetti A. Enhancement of a prosthetic knee with a microprocessor-controlled gait phase switch reduces falls and improves balance confidence and gait speed in community ambulators with unilateral transfemoral amputation. *Prosthet Orthot Int*. 2018 Apr;42(2):228-235.
   PubMed: PM28691574

3. Hahn A, Sreckovic I, Reiter S, Mileusnic M. First results concerning the safety, walking, and satisfaction with an innovative, microprocessor-controlled four-axes prosthetic foot. *Prosthet Orthot Int*. 2018 Jun;42(3):350-356.
   PubMed: PM29400252

4. Hasenoehrl T, Schmalz T, Windhager R, et al. Safety and function of a prototype microprocessor-controlled knee prosthesis for low active transfemoral amputees switching from a mechanic knee prosthesis: a pilot study. *Disabil*. 2018 02;13(2):157-165.
[PubMed: PM28399722](https://www.ncbi.nlm.nih.gov/pubmed/28399722)

5. Howard CL, Wallace C, Perry B, Stokic DS. Comparison of mobility and user satisfaction between a microprocessor knee and a standard prosthetic knee: a summary of seven single-subject trials. *Int J Rehabil Res*. 2018 Mar;41(1):63-73.
[PubMed: PM29293160](https://www.ncbi.nlm.nih.gov/pubmed/29293160)

6. Kaufman KR, Bernhardt KA, Symms K. Functional assessment and satisfaction of transfemoral amputees with low mobility (FASTK2): a clinical trial of microprocessor-controlled vs. non-microprocessor-controlled knees. *Clin Biomech*. 2018 Oct;58:116-122.
[PubMed: PM30077128](https://www.ncbi.nlm.nih.gov/pubmed/30077128)

7. Lansade C, Vicaut E, Paysant J, et al. Mobility and satisfaction with a microprocessor-controlled knee in moderately active amputees: a multi-centric randomized crossover trial. *Ann Phys Rehabil Med*. 2018 Sep;61(5):278-285.
[PubMed: PM29753888](https://www.ncbi.nlm.nih.gov/pubmed/29753888)

8. Moller S, Hagberg K, Samulesson K, Ramstrand N. Perceived self-efficacy and specific self-reported outcomes in persons with lower-limb amputation using a non-microprocessor-controlled versus a microprocessor-controlled prosthetic knee. *Disabil*. 2018 04;13(3):220-225.
[PubMed: PM28366038](https://www.ncbi.nlm.nih.gov/pubmed/28366038)

9. Wurdeman SR, Stevens PM, Campbell JH. Mobility analysis of amputees (MAAT 3): matching individuals based on comorbid health reveals improved function for above-knee prosthesis users with microprocessor knee technology. *Assist Technol*. 2018 Dec 28:1-7.
[PubMed: PM30592436](https://www.ncbi.nlm.nih.gov/pubmed/30592436)

10. Onat SS, Unsal-Delialioglu S, Ozel S. The importance of orthoses on activities of daily living in patients with unilateral lower limb amputations. *J Back Musculoskelet Rehabil*. 2017;30(4):829-833.
[PubMed: PM28387657](https://www.ncbi.nlm.nih.gov/pubmed/28387657)

11. Highsmith MJ, Kahle JT, Miro RM, et al. Functional performance differences between the Genium and C-Leg prosthetic knees and intact knees. *J Rehabil Res Dev*. 2016;53(6):753-766.
[PubMed: PM27997673](https://www.ncbi.nlm.nih.gov/pubmed/27997673)

12. Highsmith MJ, Kahle JT, Wernke MM, et al. Effects of the Genium knee system on functional level, stair ambulation, perceptive and economic outcomes in transfemoral amputees. *Technol*. 2016 Sep;18(2-3):139-150.
[PubMed: PM27917268](https://www.ncbi.nlm.nih.gov/pubmed/27917268)

13. Prinsen EC, Nederhand MJ, Olsman J, Rietman JS. Influence of a user-adaptive prosthetic knee on quality of life, balance confidence, and measures of mobility: a randomised cross-over trial. *Clin Rehabil*. 2015 Jun;29(6):581-591.
[PubMed: PM25288047](https://www.ncbi.nlm.nih.gov/pubmed/25288047)

14. Wong CK, Rheinstein J, Stern MA. Benefits for adults with transfemoral amputations and peripheral artery disease using microprocessor compared with nonmicroprocessor prosthetic knees. *Am J Phys Med Rehabil*. 2015 Oct;94(10):804-810.
PubMed: PM25768067

15. Highsmith MJ, Kahle JT, Shepard NT, Kaufman KR. The effect of the C-Leg knee prosthesis on sensory dependency and falls during sensory organization testing. *Technol*. 2014 Jan 27;2013(4):343-347.
PubMed: PM25075259

Economic Evaluations

16. Chen C, Hanson M, Chaturvedi R, Mattke S, Hillestad R, Liu HH. Economic benefits of microprocessor controlled prosthetic knees: a modeling study. *J Neuroeng Rehabil*. 2018 Sep 05;15(Suppl 1):62.
PubMed: PM30255802

17. Cutti AG, Lettieri E, Del Maestro M, et al. Stratified cost-utility analysis of C-Leg versus mechanical knees: findings from an Italian sample of transfemoral amputees. *Prosthet Orthot Int*. 2017 Jun;41(3):227-236.
PubMed: PM27025244

Guidelines and Recommendations

18. Stevens PM, Wurdeman SR. Prosthetic knee selection for individuals with unilateral transfemoral amputation: a clinical practice guideline. *J Prosthet Orthot*. 2019 Jan;31(1):2-8.
PubMed: PM30662248

19. The Rehabilitation of Individuals with Lower Limb Amputation Work Group. Va/DoD clinical practice guideline for rehabilitation of individuals with lower limb amputation v.2.0. Washington (DC): U.S. Department of Veterans Affairs and U.S. Department of Defense; 2017:
https://www.healthquality.va.gov/guidelines/Rehab/amp/VADoDLLACPG092817.pdf. Accessed 2019 Jul 23.
See recommendation 15 (Pre-prosthetic phase)

Appendix — Further Information

Review Articles

Systematic Review with Unspecified Comparator(s)

20. Kannenberg A, Zacharias B, Probsting E. Benefits of microprocessor-controlled prosthetic knees to limited community ambulators: systematic review. *J Rehabil Res Dev*. 2014;51(10):1469-1496.
PubMed: PM25856664

Non-Randomized Study

21. Cao W, Yu H, Zhao W, Meng Q, Chen W. The comparison of transfemoral amputees using mechanical and microprocessor- controlled prosthetic knee under different walking speeds: a randomized cross-over trial. *Technol Health Care*. 2018;26(4):581-592.
PubMed: PM29710741

Clinical Guidelines – Uncertain Methodology

22. Sedki I, Fisher K. Developing prescribing guidelines for microprocessor-controlled prosthetic knees in the South East England. *Prosthet Orthot Int*. 2015 Jun;39(3):250-254.
PubMed: PM24669001

Additional References

Secondary Review of a Systematic Review

23. Hafner BJ, Sawers AB. Issues affecting the level of prosth-etics research evidence: secondary analysis of a systematic review. *Prosthet Orthot Int*. 2016 Feb;40(1):31-43.
PubMed: PM25249383