Reference

Hangsheng, L., Chen, C. Hanson, M. Chaturvedi, R. Mattke, S. and Hillestad, R.

RAND Corporation, Santa Monica, California, on request from AOPA.

Economic Value of Advanced Transfemoral Prosthesis

RAND research report, 2017, available online at https://www.rand.org/pubs/research_reports/RR2096.html

Products

Microprocessor-controlled prosthetic knees (MPKs)

Major Findings

With MPKs compared to non-microprocessor-controlled prosthetic knees (NMPKs):

→ MPKs are clearly cost-effective devices in a K3/K4 population

MPKs have an incremental cost-effectiveness ratio (ICER) of 11,606 USD per quality-adjusted life year (QALY), well below the accepted threshold (50,000 USD as well as NICE 20,000 £)

→ Reduction in falls accounts for the majority (95%) of economic benefits

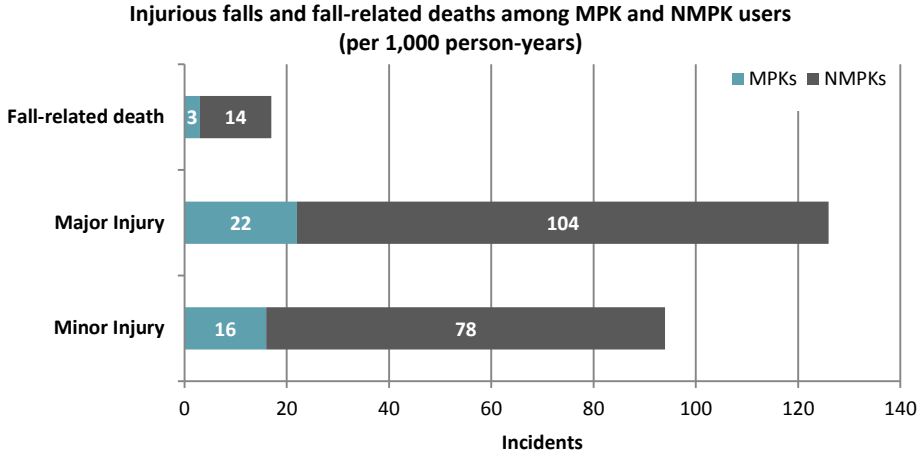
Reduction of direct health care costs: 3,496 USD per person per year

Incidence of fall-related deaths reduced substantially

Incidence rate of fall-related deaths with MPK (3) substantially lower than NMPK (14) per 1,000 person-years

→ Incidence of osteoarthritis reduced substantially

16 fewer incidences of osteoarthritis per 100 people with MPKs



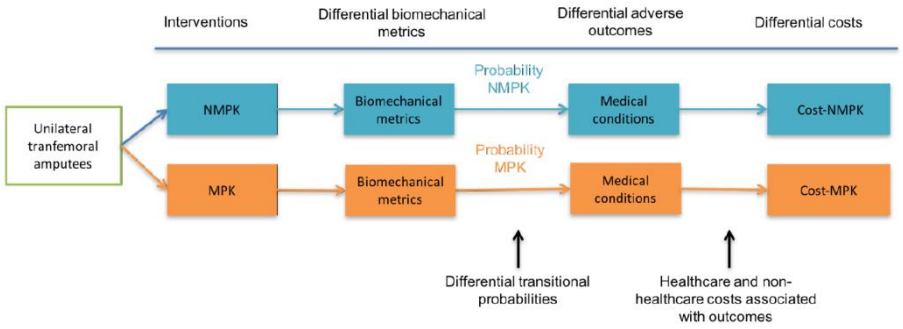
"According to the simulation results, the incidence rate of major injurious falls is 22 per 1,000 person-years among MPK users compared with 104 among NMPK users. For minor injurious falls, the incidence rate is 16 versus 78 per 1,000 person-years. The incidence rate of fall-related deaths is three and 14 per 1,000 person-years among MPK and NMPK users, respectively. But simply, 11 lives are saved by MPKs if we observed 1,000 amputees for one year." (Hangsheng et al. 2017)

Population

Subjects:	Unilateral Transfemoral Amputees (target population)
Previous prosthesis:	n.a.
Amputation causes:	n.a.
Mean age:	n.a.
Mean time since amputation:	n.a.
MFCL:	K3 and K4 (target population); K1 and K2 analysed separately (limited results, probabilistic sensitive analysis)

Study Design

A cohort-level Markov model simulates MPK compared to NMPK use over a time horizon of 10 years; input parameters are based on literature review of clinical outcomes and economic impacts of advanced prosthetics, as well as technical expert panel meetings and analysis of Medicare claims data.



(Figure from Hangsheng et al. 2017)

Results

Functions and Activities						Participation			Environment
Level walking	**Stairs**	**Ramps, Hills**	**Uneven ground, Obstacles**	**Cognitive demand**	**Metabolic Energy Consumption**	**Safety**	**Activity, Mobility, ADLs**	**Preference, Satisfaction, QoL**	**Health Economics**

*all results are for a K3-K4 population unless otherwise stated

Category	Outcomes	Results for MPKs	Sig.*
CLINICAL BENEFITS / Model Inputs			
	Overall	Overall strong evidence of improvements in walking speed, gait symmetry, ability to negotiate obstacles	n.a.
	Self-selected walking speed	MPK: 1.21 – 1.31 m/s NMPK: 1.08 – 1.21 m/s	n.a.
	Kinematic symmetry index of hip, knee and ankle joints (h, k and a)	MPK: h: 0.98, k: 0.64 and a: 0.90 NMPK: h: 0.94, k: 0.46 and a: 0.84	n.a.
Falls & fall-related mortality (literature review & simulation)	**Probability of falling per year** (literature)	**MPK: 26 %** **NMPK: 82 %**	n.a.
	Incidence rate of fall-related deaths (simulated)	**MPK: 3 per 1,000 person-years** **NMPK: 14 per 1,000 person-years**	n.a.
	Incidence rate of major injurious falls (simulation)	**MPK: 22 per 1,000 person-years** **NMPK: 104 per 1,000 person-years**	n.a.
	Incidence rate of minor injurious falls (simulation)	**MPK: 16 per 1,000 person-years** **NMPK: 78 per 1,000 person-years**	n.a.
Incidence of osteoarthritis (literature review & simulation)	Reduction of moment above the knee (literature)	Reduction of 30 %	n.a.

Category	Outcomes	Results for MPKs	Sig.*
	Incidence number (simulation)	**16 fewer incidents per 100 people over the model period (incidence rate reduced from 20% to 14%)**	n.a.
Quality of life (literature review & simulation)	SF-36 score; summary of 9 items (literature)	MPK: **37 % improvement** (720) NMPK: 526	n.a.
	PEQ score: summary of 9 items (literature)	MPK: **10 % improvement** (703) NMPK: 641	n.a.
	EQ-5D: average of 5 items (literature)	MPK: **21 % improvement** (0.78) NMPK: 0.65	n.a.
	Number of life years for 100 users over 10 years (simulation)	MPK: 554.4 NMPK: 545.7 (average increase with MPK: 14 years, ranging from 5 to 25 years)	n.a.
	Quality-adjusted life years (QALYs) (simulation)	MPK: 453.3 NMPK: 361.9 (average gain with MPK: 102 years, ranging from 82 to 125)	n.a.
DIRECT AND INDIRECT HEALTHCARE COSTS			
	Physical therapy (1st/2nd year) (Medicare)	MPK: 1,987 / 1,622 USD NMPK: 1,649 / 1,347 USD	n.a.
	Falls (cost per event)	Fall related death 27,338 USD Major injury 24,845 USD Minor injury 1,332 USD	n.a.
	Osteoarthritis (cost per event)	Osteoarthritis 180 USD	n.a.
	Overall direct cost (per-person-per-year) (simulation)	**MPK: 2,890 USD** **NMPK: 6,566 USD**	n.a.
	Direct cost saving with MPK	**3,676 USD**	n.a.
Indirect health care cost (literature review & simulation)	Lost wages (literature)	Reduction of 417 USD	n.a.
	Caregiving expenses (literature)	Reduction of 634 USD	n.a.
	Transportation expenses (literature)	Increase of 142 USD	n.a.
	Overall indirect cost (per-person-per-year) (simulation)	MPK: 4,268 USD NMPK: 5,177 USD	n.a.
Cost of device acquisition (expert input, Medicare & simulation)	Overall cost (expert input, device lifecycle estimate 5 years)	MPK: 28,000 USD NMPK: 5,500 USD	n.a.
	Device repair cost (per person per year) (Medicare)	MPK: 192 USD NMPK: 136 USD	n.a.
	Acquisition and repair costs (per person per year) (simulation)	MPK: 7,925 USD NMPK: 1,638 USD	n.a.

Category	Outcomes	Results for MPKs	Sig.*
Total cost	Total cost (per person per year) (simulation)	MPK: 15,083 USD NMPK: 13,382 USD	n.a.
	Sensitivity analysis	Total cost is sensitive to: - Proportion of medical falls - Average number of falls - Medical cost per major/minor injury fall - Osteoarthritis-related medical costs - Discount rates - Device acquisition cost (only for MPKs)	n.a.

HEALTH ECONOMIC OUTCOMES

Cost effectiveness (10-year time horizon)	**ICER K3/K4 population**	**ICER = 11,606 USD per QALY (Increase of 0.91 QALY per person)** Probabilistic sensitivity analysis: ICER per QALY: Ranging from - 25,355 USD to 36,357 USD	n.a.
	Probabilistic sensitivity analysis K1/K2 population)	ICER = 13,568 USD per QALY	n.a.

* no difference (0), positive trend (+), negative trend (–), significant (++/––), not applicable (n.a)

Author's Conclusion

"In summary, the existing published literature shows that among transfemoral amputees, MPKs are superior to NMPKs in improving parameters of physical function, such as walking speed, gait symmetry, and obstacle assessments. Those improvements lead to fewer falls and lower incidences of osteoarthritis in the intact limb. Economically speaking, MPKs also provide good value for the money compared with NMPKs. The economic benefits of MPKs are comparable to widely reimbursed technologies, such as total knee replacement and the implantable cardioverter defibrillator. It should be emphasized that the current analysis probably underestimates the clinical benefit and thus the value for money of MPKs because the effect on a number of outcomes, such as back pain and cardiovascular disease, could not be included in the model due to lack of data. If they become available, those data may increase the overall impact of MPKs. More long-term population-based studies are warranted to overcome the limitations of existing studies and provide better evidence for a value-based payment system for prosthetics." (Hangsheng et al. 2017)