



COST-EFFECTIVENESS ANALYSIS OF HYPERBARIC OXYGEN TREATMENT (HBOT) FOR DIABETIC FOOT ULCERS

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Diabetic Foot Ulcers (DFU) is the leading cause of Lower Extremities Amputations (LEA)



- 700 amputations of lower extremities due to diabetes mellitus (DM) in Singapore each year¹
- Almost 60% of limb amputations in SGH Department of Orthopedics are due to diabetic complications.²
- DM is the 7th leading cause of death in Singapore. About 8% of the population suffers from DM in Singapore.³
- Up to 15% of diabetics suffer from foot ulceration at some point in their lives in the UK⁴
- Throughout the world, up to 70% of all leg amputations happen to people with diabetes⁵
- Somewhere in the world a leg is lost to diabetes every thirty seconds⁴

Source:

1. Singapore Ministry of Health 2001 Annual Report
2. Tan et. al., *Tohoku J Exp Med*;141 Suppl:575-82. Diabetic amputees in Singapore (1983)
3. Singapore Ministry of Health 2006 statistics
4. SIGN 1997
5. International Working Group on the Diabetic Foot, 2005



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Hyperbaric Oxygen Therapy (HBOT)



- HBOT has been used in chronic wounds for about 40 years. ¹
- 100% oxygen is delivered to a chamber under high pressure (2 to 2.5 ATA) for periods between 60 to 120 minutes. ²
- Typical HBOT treatment course consists of 15-30 such sessions. ²
- Administering oxygen to hypoxic tissue shown to improve vasoconstriction, activate fibroblast, down-regulate inflammatory cytokines, up-regulate growth factors – all proxies for wound healing. ²

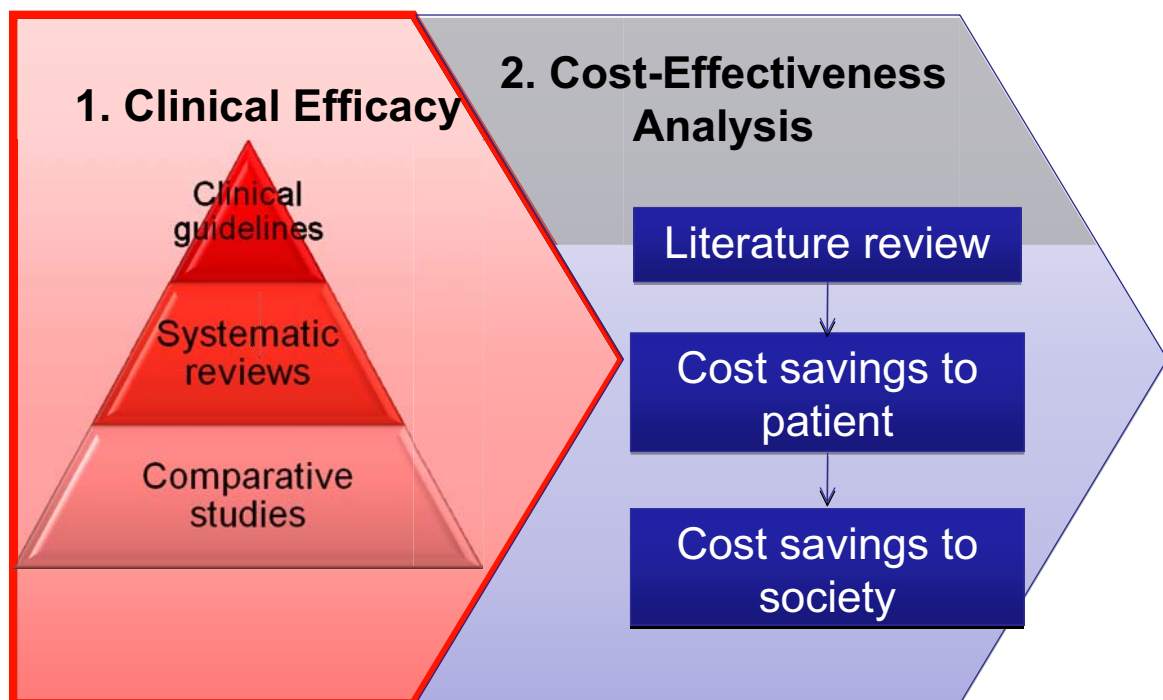
Source:

1. Kulonen et. al. 1968
2. Cochrane Systematic Review of HBOT for Chronic Wounds, 2004

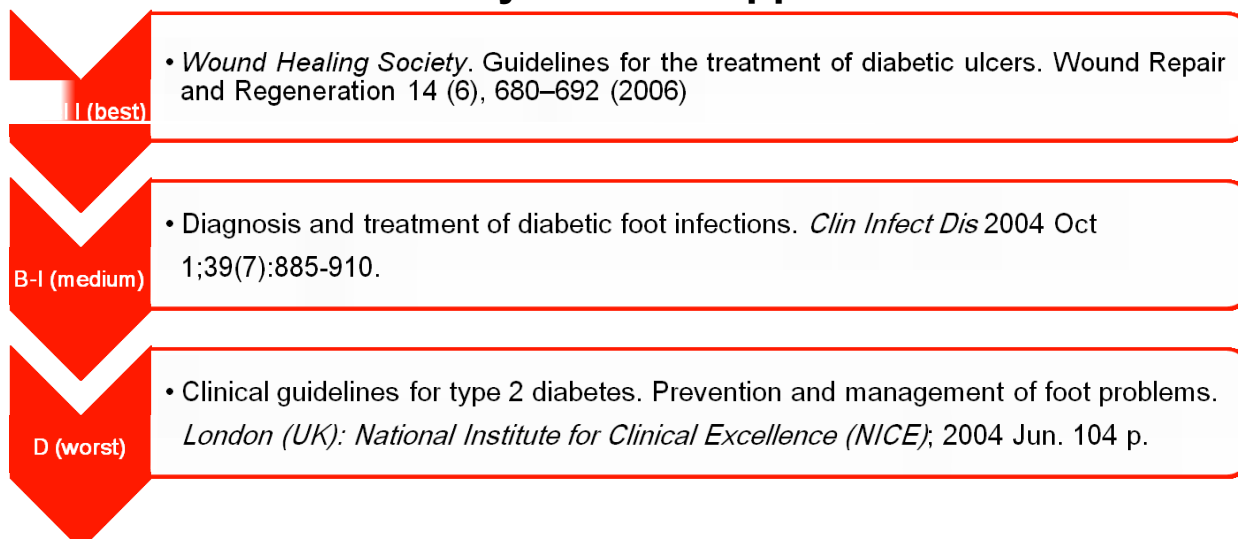


HBOT chamber in Tan Tock Seng Hospital, Singapore

Objectives and Methods



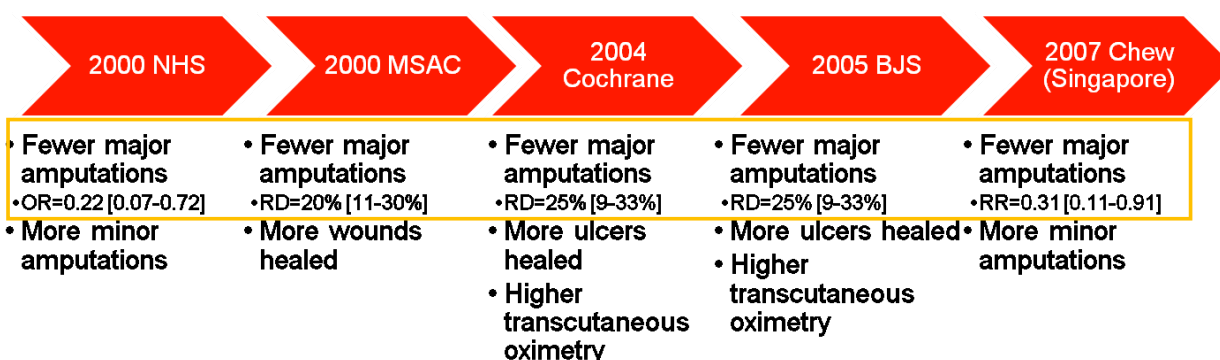
Evidence for Clinical Efficacy: Clinical Guidelines vary in their support for HBOT



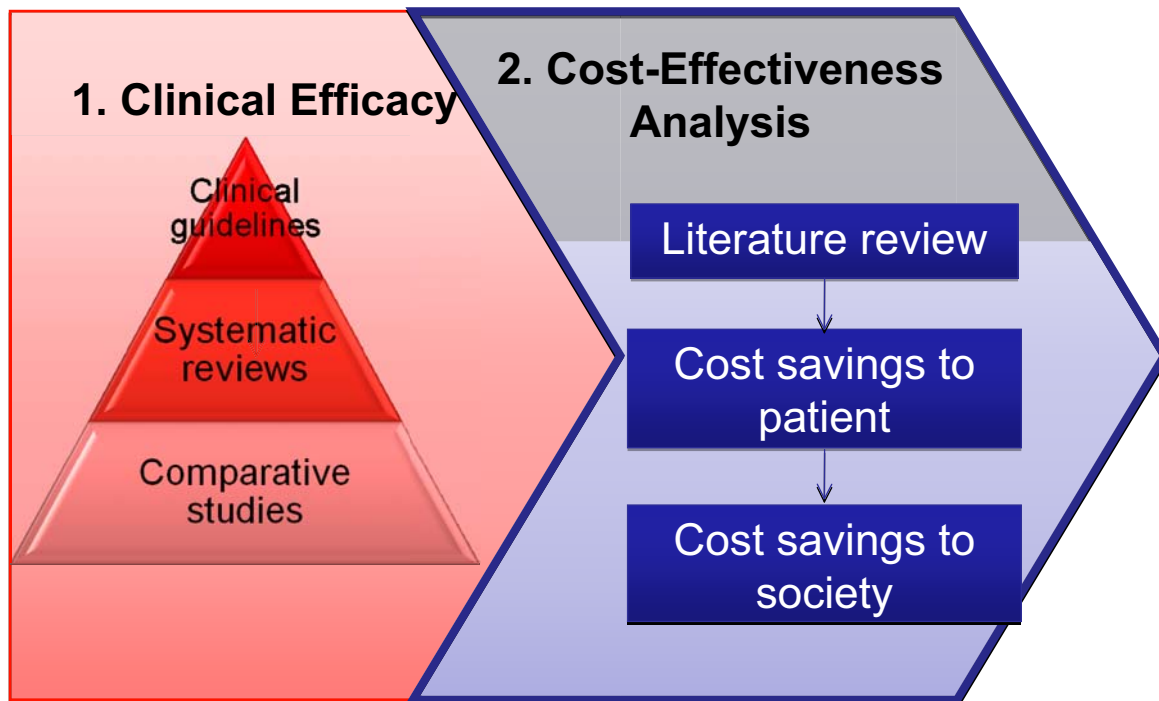
Current MOH guidelines for DM (2006)
 Patients identified with foot-related risk conditions should have access to a specialized foot care team which should include diabetes specialist, podiatrist, physiotherapist trained in diabetes, diabetes nurse educator and vascular and orthopaedic surgeon (SIGN, 1997). - Grade B, Level III”

Evidence for Clinical Efficacy: Systematic Reviews





- Search terms: hyperbaric oxygen* diabet*
- Databases: Medline, Cochrane, DARE, NHS EED, HTA
- Exclusion criteria: topical or localised HBOT, non-diabetic wounds, non-English reviews,



Fewer major amputations consistently cited as a significant outcome



Other economic analyses report HBOT for DFU as cost-effective

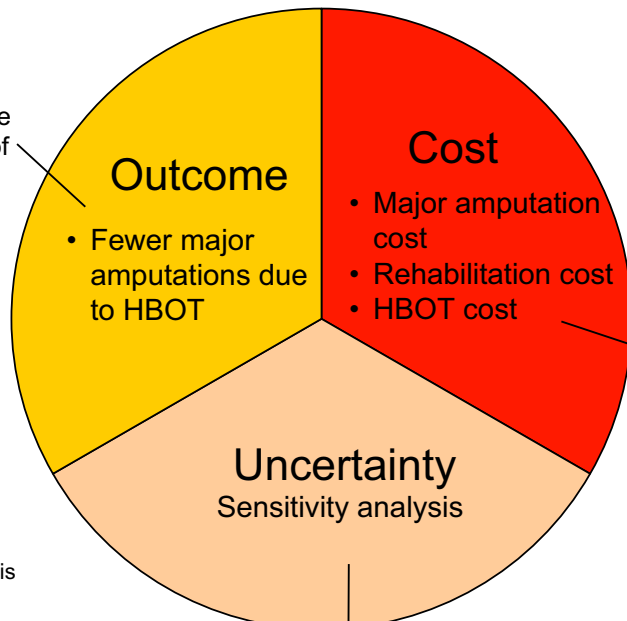
Study	Cost Analysis	Assumptions
Ontario HTA (2005) 	C\$53,800 (\$77,800*) saved per amputation avoided	33% less risk of major amputation Amputation cost = C\$60,000 HBOT cost = C\$6,200
MSAC (2000) 	AU\$11,142 (\$14,485) spent per amputation avoided	11% less risk of major amputation Amputation cost = AU\$14,805 HBOT cost = AU\$6,941 Rehabilitation cost = AU\$8758
Guo (2003) 	Incremental cost per QALY: 1 yr – US\$27,310 (\$41,831) 5 yr – US\$5,166 (\$7,913) 12 yr – US\$2,255 (\$3,453)	Hypothetical cohort of 100 60-year-olds. Considered 3 outcomes (major amputations, minor amputation, healed)
Abidia (2003) 	£2974 (\$9,127) saved using HBOT	103 less dressing changes Dressing cost = £58 HBOT cost = £3000

*All foreign currencies were converted to Singapore dollars as of 29 June 2007

Cost-Effectiveness Analysis Methodology



Taken from Cochrane Systematic Review of HBOT for Chronic Wounds (2004)



Estimated from inpatient charges from 2 major restructured hospitals in Singapore (2006)

Taken from charges by Hyperbaric Medical Services, Singapore

Method similar to analysis by Australia MSAC

	Overall average	Best case	Worst case
Reduced risk of major amputation	25%	33%	9%
Amputation & rehabilitation cost	\$4,900 (35 days)	\$2,400 (14 days)	\$12,100 (110 days)
HBOT cost	\$5,200 (20 sessions)	\$3,900 (15 sessions)	\$7,800 (30 sessions)

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HBOT for DFU results in national cost of \$4.3 million to national savings of \$1.6 million



Basis: 100 patients	With HBOT	Without HBOT	Incremental
HBOT Cost (\$260/session)	\$520,000	\$0	
Number of major LEA	75	100	25 LEAs avoided
LEA & rehab cost (\$18,900/LEA)	\$1,417,500	\$1,890,000	
Total cost	\$1,937,500	\$1,890,000	\$47,500
Cost per LEA avoided			\$1,900

	Assumptions	Cost per LEA avoided	Annual costs (700 LEAs)
Base case	20 HBOT sessions, 25% LEA avoided	\$1,900	\$332,500
Best case	15 HBOT sessions, 33% LEA avoided	-\$7,082 (savings)	-\$1,635,900 (savings)
Worst case	30 HBOT sessions, 9% LEA avoided	\$67,767	\$4,269,300

- HBOT costs society \$1,900 to prevent a major LEA.
- This figure ranges from cost of \$68,000 to savings of \$7000.
- HBOT will cost society \$4.3 million in the worst case and save \$1.6 million in the best case to prevent 9 to 33% of the 700 LEAs each year.

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HBOT will reduce bed occupancy by at least 2.4 beds per day








	Number of patient-days avoided due to amputations prevented by HBOT	=	Average length of stay for LEA	X	Number of LEA due to DFU per year	X	Risk of LEA reduced by HBOT
	2450 patient-days (6.7 beds/day)	=	14 days	x	700 patients	x	25%
Worst case	882 patient-days (2.4 beds/day)	=	14 days	x	700 patients	x	9%
Best case	3234 patient-days (8.9 beds/day)	=	14 days	x	700 patients	x	33%

Taking away the 9 to 33% of 700 amputations prevented by HBOT every year, bed occupancy will drop by:

882 to 3234 beds per year OR
2.4 to 8.9 beds per day.

How does Singapore compare with other countries?



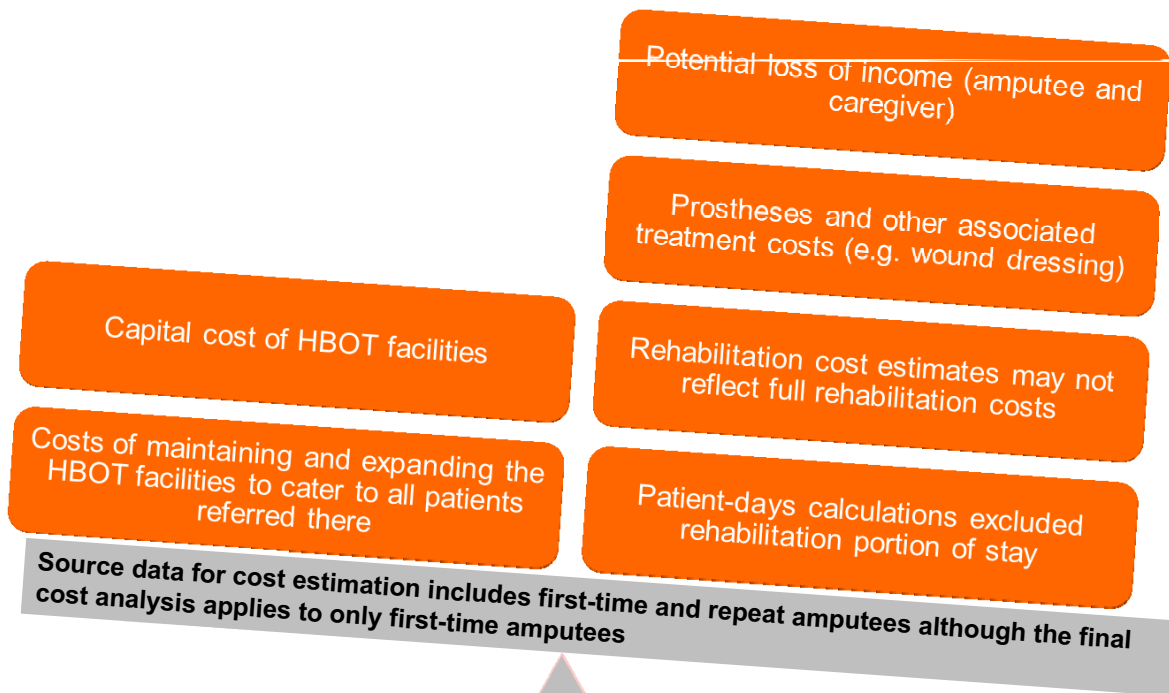
Study	Cost Analysis	Assumptions
Low (2007) 	\$1,900 spent per amputation avoided	25% less risk of major amputation Amputation cost = \$18,900 HBOT cost = \$5,200
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Limitations of Study



Overestimate savings

Underestimate savings



13

Conclusion



- Given the:
 - substantial benefit of salvaging limbs (remaining employed, better quality of life, less burden to caregiver)
 - national costs of \$4.3 million to national savings of \$1.6 million per year
 - preventable 882 to 3234 patient-days (2.4 to 8.9 beds/day)
 - minimal harm from HBOT (barotrauma, oxygen toxicity)
- Consider HBOT as a *complement* to good wound care for DFUs

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Centre of Health Services Research

THANK YOU

BACK UP SLIDES

Alternative analysis: National savings of at least \$700,000 per year



	Cost avoided for all LEA prevented by HBOT per year	=	(	LEA and rehabilitation cost as if no subsidy	-	HBOT cost	)	x	Number of LEA due to DFU per year	x	Risk of LEA reduced by HBOT
	\$2,397,500	=	(	\$18,900.00	-	\$5,200.00	)	x	700	x	25%
Worst case	\$699,300	=	(	\$18,900.00	-	\$7,800.00	)	x	700	x	9%
Best case	\$3,465,000	=	(	\$18,900.00	-	\$3,900.00	)	x	700	x	33%

The 9 to 33% of 700 amputations prevented by HBOT every year translate to national annual savings of \$700,000 to \$3.5 million and reduce bed occupancy by 2.4 to 8.9 acute beds per day.

Method similar to analysis by Ontario HTA Committee (2006)