Cost-Effectiveness of Adding Intermittent Pneumatic Compression to Pharmacological Thromboprophylaxis After Total Hip and Knee Arthroplasty: A French Health-System Analysis

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Background

- Venous thromboembolism (VTE) is a major preventable complication of elective total hip and knee arthroplasty (THA/TKA). Pharmacological prophylaxis, typically low-molecular-weight heparin (LMWH), is standard; mechanical methods such as intermittent pneumatic compression (IPC) may be used alongside it.[1]
- With enoxaparin plus standard mechanical prophylaxis, 1.8% of patients still had symptomatic VTE within 90 days in the CRISTAL trial.[2,15]
- Deep-vein thrombosis (DVT) can lead to post-thrombotic syndrome (PTS) and pulmonary embolism (PE) can be fatal, adding lifetime costs and QALY losses.[1,3]
- The cost-effectiveness of adding IPC to LMWH has not been established from a French health-system perspective.

Objective

To evaluate, from a French health-system perspective, the lifetime cost-effectiveness of adding IPC to standard LMWH prophylaxis after elective THA and TKA.

Methods

- Design: decision-analytic cost-utility model with a 90-day acute phase and a lifetime phase (cohort aged 69 years; remaining life expectancy 15 years), reported per CHEERS 2022.[13]
- Comparators: LMWH alone (standard care) vs LMWH plus IPC (combined). IPC is modelled as an adjunct to, not a substitute for, anticoagulation.
- Effects: combined-arm symptomatic VTE anchored to the CRISTAL enoxaparin arm (1.82%), in which IPC calf devices and stockings were standard at all sites.[2,15] IPC effect: in a THA cohort with historical controls, adding IPC to aspirin-based prophylaxis significantly reduced ultrasound-detected asymptomatic calf DVT from 10.2% to 4.6% (RR 0.451);[4] the model applies this RR to symptomatic VTE on LMWH, an assumption discussed in the Limitations. LMWH-alone rate (4.04%) derived.
- Lifetime consequences: PTS incidence, costs and disutility, PE case-fatality (17%), bleeding and utilities from NICE NG89;[1,3] case-fatality within the 2019 ESC range.[5]
- Costs (EUR, at source price years, not inflated): IPC device acquisition (data on file), French LMWH price,[11] complication costs[7–9] and lifetime PTS costs. Index procedure cost (PMSI 2018)[10] is identical in both arms. Costs and QALYs discounted at 2.5% per year.[12]
- Analysis: France applies no fixed willingness-to-pay threshold, so the incremental cost per QALY gained is reported (€30,000/QALY shown for reference only). One-way sensitivity; a conservative IPC-effect scenario (RR 0.684) from a randomised trial of IPC added to LMWH (DVT 2.6% vs 3.8%), chosen because it tests IPC on an LMWH background, as in our model, although in gynaecological pelvic surgery;[6] and a threshold analysis on the IPC effect.

Model structure

Elective THA / TKA
LMWH alone
vs
LMWH + IPC

→

90-day acute phase
Symptomatic DVT
Symptomatic PE
Major bleeding

→

Lifetime phase
PTS after DVT (annual cost, disutility)
Fatal PE (QALYs lost)

Key model inputs

Parameter	Base case	One-way range	Source
Symptomatic VTE, LMWH + IPC (90 d)	1.82%	±30%	CRISTAL[2,15]
IPC relative risk (applied on top of LMWH)	0.451	0.684 (scenario)	Daniel 2008;[4] Sang 2018[6] (gynaecological surgery)
Symptomatic VTE, LMWH alone (90 d)	4.04%	—	Derived
DVT share of symptomatic VTE	70%	60–80%	Assumption
Major bleeding (both arms)	1.47%	—	NICE NG89[1]
PTS after symptomatic DVT	25%	10–40%	NICE NG89[1,3]
PE case-fatality	17%	10–30%	NICE NG89 (base case);[1] ESC 2019 (range)[5]
PTS disutility, per year	0.04	0.02–0.07	NICE NG89[1,3]
PTS cost, per year	€760	—	NICE NG89[1,3]
Symptomatic DVT episode	€3,000	€2,000–4,000	Assumption informed by Sicras-Mainar 2012[8]
PE episode (12 months)	€9,135	€4,517–10,620	Farmakis 2022[7]
Bleeding-related complication	€2,001	—	Ye 2013[9]
LMWH (enoxaparin 40 mg) course	€108	—	VIDAL[11]
IPC device acquisition cost	Data on file	±20%	Manufacturer[14]
Remaining life expectancy	15 years	10–20 years	Assumption
Discount rate (costs, QALYs)	2.5%	—	HAS[12]

LMWH course identical in both arms (24.5 doses, pooled THA 35 d / TKA 14 d), so the LMWH price does not affect the ICER. Utilities: 90-day baseline 0.58; acute relative decrement −14% (DVT) and −19% (PE);[1,3] long-term utility 0.78 (assumption).

Results

≈€1,500 per QALY

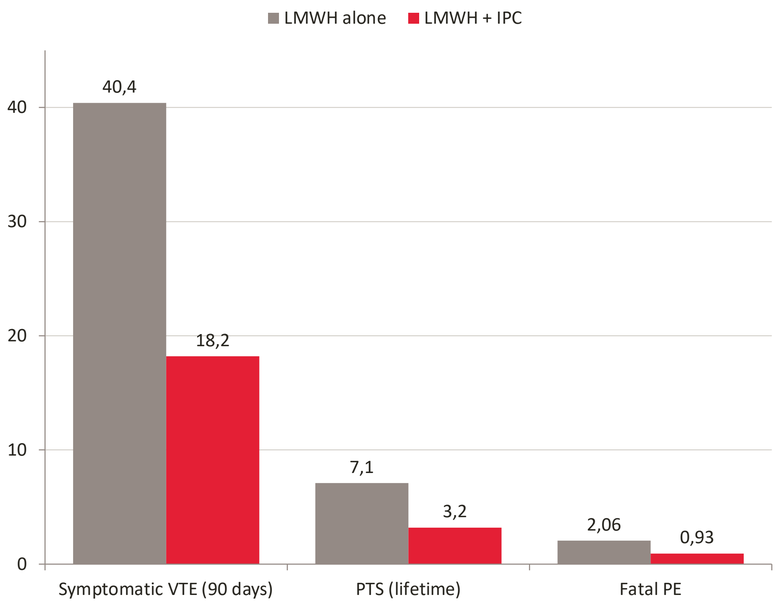
incremental cost-effectiveness ratio of adding IPC to LMWH — lifetime horizon, French health-system perspective (base case €1,474)

22
symptomatic VTE avoided per 1,000 patients

+€19
incremental cost per patient (lifetime)

+0.013
QALYs gained per patient (lifetime)

Symptomatic VTE and consequences, per 1,000 patients



Avoided per 1,000 patients: 22 symptomatic VTE, 3.9 PTS cases and 1.1 fatal PE.

Incremental results per patient (LMWH + IPC vs LMWH alone)

Component (lifetime, discounted)	Incremental
Avoided acute VTE care	−€107
Avoided lifetime PTS care	−€36
Major bleeding (no difference assumed)	€0
Net incremental cost, incl. IPC acquisition	**+€19**
QALYs gained — avoided fatal PE	+0.0109 (83%)
QALYs gained — avoided PTS	+0.0019 (15%)
QALYs gained — avoided acute VTE	+0.0002 (2%)
Total QALYs gained	**+0.013**
Cost per symptomatic VTE avoided	€870
ICER (€ per QALY gained)	**€1,474**

Scenario and threshold analyses

Scenario	Δ cost	Δ QALYs	€ / QALY
Base case	**€19**	**0.013**	**1,474**
Conservative IPC effect (RR 0.684)[6]	€108	0.005	≈21,900
PE case-fatality 10%	€19	0.009	2,246
PE case-fatality 30%	€19	0.021	900
IPC acquisition cost −20%	−€13	0.013	Dominant
IPC acquisition cost +20%	€52	0.013	3,967
IPC RR at which ICER = €30,000	—	—	RR 0.73

Dominant = lower lifetime cost and more QALYs than LMWH alone.

Reading the results

In the model, adding IPC more than halved symptomatic VTE (4.0% → 1.8%) at an incremental cost of €19 per patient over a lifetime.

Avoided acute VTE care and lifetime PTS care offset most of the IPC acquisition cost.

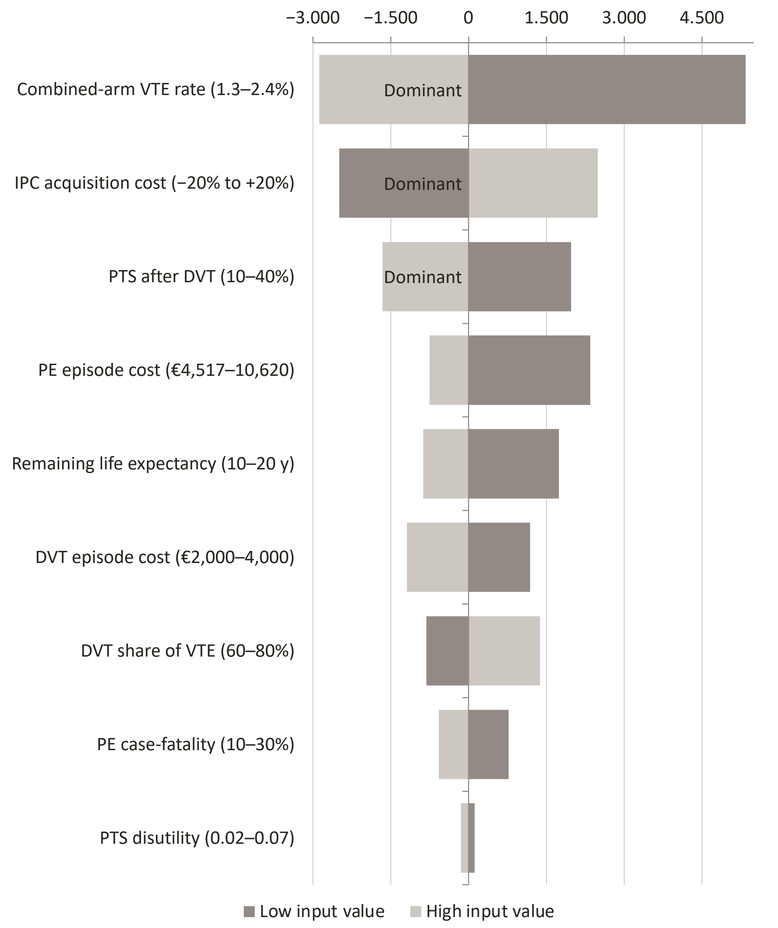
Most of the QALY gain (83%) comes from avoided fatal PE, which is why results respond to PE case-fatality.

The ICER does not depend on the LMWH price, as both arms receive the same LMWH course.

The IPC effect is the key uncertainty: the ICER stays below €30,000 per QALY as long as IPC reduces symptomatic VTE by at least 27% on top of LMWH (RR ≤0.73).

Sensitivity analysis

One-way sensitivity — change in ICER vs base case (€/QALY)



Base case €1,474 per QALY. All one-way results ranged from dominant to €6,816 per QALY; IPC was dominant in three analyses (combined-arm VTE +30%, IPC cost −20%, PTS 40%), labelled 'Dominant' in the chart; there the ICER is negative and cannot be read as a cost per QALY. Base case unchanged from the submitted abstract; additional parameters added for the poster.

Conclusions

- From a French health-system perspective, adding IPC to standard pharmacological prophylaxis after THA and TKA was estimated to reduce symptomatic VTE and be cost-effective (≈€1,500 per QALY over a lifetime horizon), driven by avoided PTS and fatal PE.
- Results remained favourable in all one-way analyses and at ≈€21,900 per QALY with a conservative IPC effect.
- As effect estimates reflect a specific IPC device, results may not generalise to other systems or scenarios.

Limitations

- The IPC effect comes from a retrospective THA cohort with historical controls (ultrasound-detected asymptomatic calf DVT; no symptomatic events; aspirin-based background)[4] and is applied to symptomatic VTE on LMWH, which may overstate the benefit. The conservative scenario also uses screen-detected DVT, from a gynaecological trial in which the difference with IPC was not statistically significant.[6]
- The LMWH-alone VTE rate is derived rather than observed.
- PTS, utility and case-fatality inputs come from UK guideline modelling;[1,3] DVT costs are Spanish;[8] the PE cost is a European registry estimate in which about half is productivity loss;[7] with direct health-care costs only (€4,517), the ICER is ≈€3,800 per QALY.
- Costs were not inflated to a common price year (conservative for avoided-event costs). Recurrent VTE and chronic thromboembolic pulmonary hypertension are captured only within the 12-month PE cost; IPC adherence was not modelled; analysis is deterministic.

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