

The Incidence and Economic Impact of Major Adverse Events Associated with Intravascular Temperature Management: A Systematic Review, Analysis, and Model

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Background

Intravascular temperature management (ITM) is used for temperature control in stroke, fever management, accidental hypothermia and cardiac arrest patients.¹ While ITM systems have been reported to have faster time-to-target temperature compared to other advanced targeted temperature management (TTM) systems,² they do not offer significant improvements in either neurologic outcomes or survival compared to surface cooling devices with feedback control.³ Further, ITM systems have also been associated with infectious and non-infectious complications,⁴ and one study of consecutive cases found vena cava thrombosis present in 90% of patients treated with ITM.⁵ While the rates of thrombolytic complications in different studies are high (16%,⁴ 22%,⁶ 26%,⁷ and 90%⁵), the incidence of major adverse events (AEs) appears to be less acute.

Objective

Examine the incidence of major AEs and their contribution to the cost of care for patients undergoing ITM.

Methods

A systematic review of original research published from 2000-2025 (PubMed) was conducted to assess TTM and therapeutic hypothermia studies involving ITM which also reported major AEs including deep vein thrombosis (DVT) and pulmonary embolism (PE). The results were analyzed and the frequencies of those complications were multiplied by the range of costs for those hospital-onset AEs to arrive at an incremental per-case cost.

Results

7 records were identified. After exclusions, 5 were analyzed (Figure 1). When reported, the incidence of DVT associated with ITM was found to range from 0.3% to 4.9% of cases, and when reported, the incidence of PE was found to range from 0.5% to 12% of cases (Table 1).

Those values were applied to the range of inflation-adjusted costs for hospital-onset DVT and PE reported by the Agency for Healthcare Research and Quality.^{10,11} (Table 2) The resulting incremental per-case cost of DVT ranged from \$31 to \$712 (lowest-incidence value multiplied by the low-end value of the DVT cost range and highest-incidence value multiplied by the high-end value of DVT cost range). A similar approach was used to establish the incremental per-case cost of PE, range: \$64 to \$2,679 (Table 2).

Limitations

The review was not an exhaustive review of all studies employing ITM (see Search String). Studies may have failed to be identified by the search criteria as AEs are often delegated to the supplemental materials – an area that is typically excluded from the PubMed’s main search engine. In addition, comparisons with incidence rates for PE and DVT in other patient populations should be discouraged as patients who require ITM tend to be sicker, which put those patients at higher risk for disseminated intravascular coagulopathy.¹

Figure 1: PRISMA Diagram

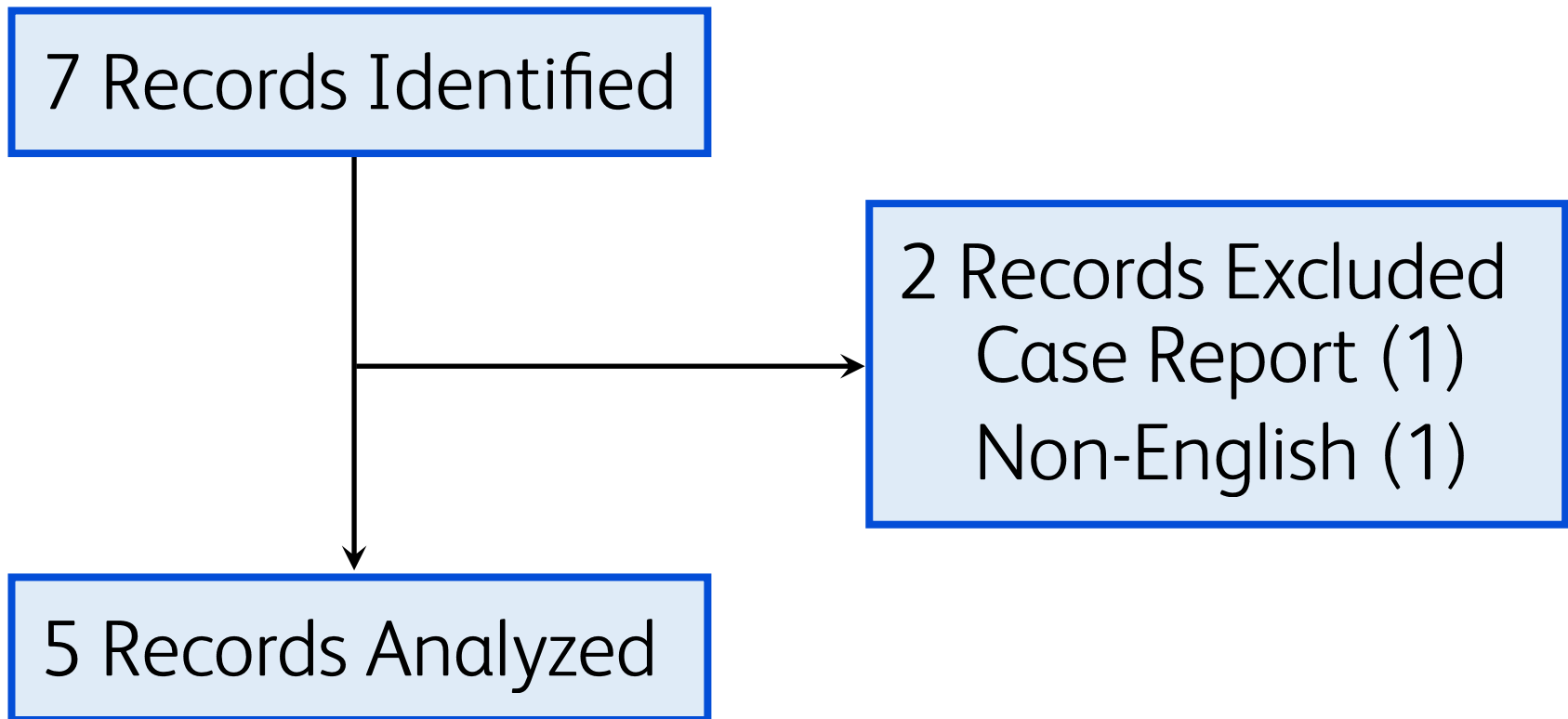


Table 1: Publication Analysis

First Author	Publication Year	Type of Patient	N	DVT Events	DVT Incidence	PE Events	PE Incidence	Thrombosis Events ^a	Thrombosis Incidence
Dankiewicz ⁸	2021	Out-of-hospital cardiac arrest	398 ^b	1	0.3%	2 ^c	0.5%		
Sahuquillo ⁹	2009	Non-penetrating head injury	24	1	4.2%				
Maze ⁶	2014	Out-of-hospital cardiac arrest	41 ^d	2	4.9%	1	2.4%	9	22%
Andremont ⁴	2018	All ICU patients requiring TTM	75			3	4.0%	12	16%
Müller ⁷	2014	Subarachnoid hemorrhage	43			5	12%	11	26%

^aAll reported Thrombosis Events, which included the reported DVT and PE events
^bITM was used in 30% of 930 hypothermia patients, of which, 95% of the hypothermia patients were treated. ITM was also used in 31% of 931 normothermia patients, of which, 46% of the normothermia patients were treated.
^cOne PE is reported to have likely begun as a DVT in the subject patient but it is only counted once for this analysis – as a PE.
^dSubjects receiving a prophylactic dose of unfractionated heparin

Table 2: Cost Avoidance Model

	DVT		PE	
	Min	Max	Min	Max
Cost (2016 Dollars)	\$7,700 ¹⁰	\$10,800 ¹⁰	\$9,500 ¹⁰	\$16,600 ¹⁰
Cost (2025 Dollars)	\$10,358 ¹¹	\$14,528 ¹¹	\$12,779 ¹¹	\$22,329 ¹¹
Incidence	0.3%	4.9%	0.5%	12%
Source	Dankiewicz ⁸	Maze ⁶	Dankiewicz ⁸	Müller ⁷
Incremental per-case, per-patient cost	\$31	\$712	\$64	\$2,679
Total incremental per-case, per-patient cost of both potential DVT and PE events		Min \$95	Max \$3,391	

Discussion

Thrombosis is a well-described complication of “traditional” endovascular central venous catheters.⁵ Therapeutic hypothermia can cause platelet margination by increasing hematocrit, changing platelet shape, lowering blood flow rate, and increasing the expression of adhesion molecules, which could potentially increase the risk of venous thromboembolism.¹ Taken together, invasive ITM, which is often tasked with cooling patients, is unsurprisingly associated with thrombolytic complications including DVT and PE.

Hospital-associated venous thromboembolism is a common source of morbidity and mortality¹⁰ and thus any evaluation of the benefits of ITM compared to other advanced TTM systems may do well to also consider both the incidence and cost of thrombolytic complications.

Conclusions

Organizations may wish to be attentive to the risk of major AEs and their attendant costs as they consider ITM for temperature control in critically ill patients. When the costs of AEs are considered, use of ITM devices may contribute as little as \$95 but as much as \$3,391 to the cost of patient care.

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Database: PubMed Search Date: 10/07/2025

PRISMA: Preferred Reporting System for Systematic Reviews and Meta-Analyses

Search String: ("therapeutic hypothermia" OR "targeted temperature management") AND ("intravascular cooling" OR "Endovascular cooling") AND ("catheter-related thrombosis" OR "pulmonary embolism")

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¹¹U.S. Bureau of Labor Statistics CPI Inflation Calculator. Washington, DC: Office of Publications and Special Studies. https://www.bls.gov/data/inflation_calculator.htm. Accessed October 7, 2025.