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Policies and cost analyses of voluntary assisted dying (VAD) laws – a mapping review & analysis

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Abstract

Objectives To investigate the current literature on healthcare policies and cost analyses around international Voluntary Assisted Dying (VAD) laws. The study design is a mapping literature review following Preferred-Reporting-Items-for-Systematic-Reviews-and-Meta-Analyses (PRISMA) guidelines.

Methods Original research articles published between January 1990 to March 2023, investigating the financial cost and healthcare budget effect of VAD laws internationally. Citations were screened for relevance and eligibility, and any non-full-text research that did not explore cost analysis was excluded. The following data sources were screened: MEDLINE, PubMed, EMBASE, CINAHL and any relevant international health authority annual reports were also reviewed.

Results Of the 2790 screened articles, eight studies met the inclusion criteria and three were included in the mapping review. The reviewed studies included prospective studies, two Canadian and one US. Only one of the Canadian studies provided a cost analysis using data from current VAD laws. All three studies showed VAD laws would reduce healthcare spending, with the US approximating $627million in 1995. Canada approximating $17.1 to $77.1million in 2017 and $86.9 to $149.0million in 2021, overall, leading to an average percentage reduction in costs of approximately 87% compared to original costs of end-of-life care.

Conclusion This review identifies a scarcity in cost-analysis literature and provides a summary of the latest international VAD laws, from which a potential cost reduction is apparent. The absence of retrospectively collated financial VAD data highlights a need for future research to inform policymakers of the economic factors affecting current policies with a need for annual fiscal reports and to optimise future legislative frameworks internationally.

Key points

- This study highlights the absence of cost analysis reports on the provision of VAD globally, at a time when VAD is becoming an evolving part of end-of-life care particularly in developed countries base on the notion of patient autonomy.

- The impact of this study is its ability to inform future research and policymakers of the economic factors affecting current VAD policies with a need for annual fiscal reports and to optimise future legislative frameworks internationally.

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Keywords Voluntary assisted dying, Physician assisted suicide, Euthanasia, Medical assistance in dying, Cost analysis, Healthcare budget, Financial

Introduction

Over the past 20 years, assisted dying practices, have expanded significantly around the world across 10 jurisdictions. Both physician assisted suicide (PAS) and euthanasia (as they were formally known) have been legalised in 8 countries, while in Switzerland and 11 US states PAS alone is available.

The definitions around assisted dying vary across literature and different countries, based primarily on terminology used to draft legislation. For example in Australia and New Zealand [1–7] the terminology Voluntary Assisted Dying (VAD) is widely used to avoid stigmatisation, make clear distinction from suicide *(i.e. seeking death without a terminal or debilitating disease)* and avoid conflict with the existing Commonwealth criminal code acts (1995) [8, 9]. In the US the terms 'assisted dying' and 'aid in dying' are used to describe VAD services [10] while in Canada 'Medical Assistance in Dying (MAiD)' is their terminology of choice [11]. To facilitate better understanding, the various definitions are indicated below.

Voluntary Assisted Dying (VAD) [1–7] *[synonymous with 'Medical Assistance in Dying' (MAiD) = Canada, 'Aid in dying' = Spain or 'Physician assisted dying', 'Assisted/Aid-in dying' = US]:* An umbrella term to describe the act of assistance provided to a mentally competent adult by a *medical practitioner (or in some cases a nurse practitioner)* to end their life using a prescribed life-terminating medication (i.e. VAD medication). It includes:

- Self-administered VAD*[synonymous with PAS = Netherlands, Belgium, Luxemburg, Columbia, Austria and Switzerland, or 'Physician-assisted-dying', 'Assisted/Aid-in dying' = US, or 'Ingested/oral aid in-dying' = Spain, or self-administered MAiD = Canada]:* where the individual takes the VAD medication themselves to end their own life.
- Physician administered VAD*(synonymous with Euthanasia/Voluntary Euthanasia = Netherlands, Belgium, Luxemburg, or 'Intravenous Aid in-dying' = Spain, or clinician-administered MAiD = Canada]: where the person has the VAD medication administered by a medical practitioner (or in some cases a nurse practitioner).*

Despite the ongoing debate around which of the various terminologies around assisted dying practices are the most correct or appropriate; we will be utilising the bolded terms defined above throughout the rest of this paper to avoid confusion and maintain readability. The exception will be when quoting directly from the reviewed papers and in Table 2.

It is however important to differentiate from the existing practices in end of life care. Palliative care is an approach to healthcare where a decision has been made not to pursue curative and often futile management outcomes for people with a life-limiting illness. Palliative care is based on the notion of helping the individual live as fully and as comfortably as possible with no active intention of hastening or prolonging death but rather easing suffering [12, 13].

The absence, withdrawal, or refusal of life-saving treatment in many countries, is a legal and ethical part of palliative care when performed with the patient or proxy's agreement. Such practices—referred to as advance directives [14]—are not characterised as VAD, but instead form part of common law, "governing the doctor-patient relationship and the provision of medical treatment more generally" [15]. Therefore, the term passive euthanasia, in legal and ethical literature, is no longer deemed appropriate [16].

Although many stakeholders avoid the pragmatic discussion around the cost of such practices, it is believed that one of the discrete reasons legislating VAD laws could be politically favourable, is due to the significant reduction in the healthcare cost burden associated with end-of-life care. Despite being morally controversial, understanding the financial impact of assisted dying practices is important in determining how it is funded and the ethical dilemmas around the commercialisation of death. However, exploring the impacts of these practices and policies—particularly in the context of overall healthcare costs—has yet to be investigated collectively.

Most existing research include surveys, opinion pieces and discussions that have been performed at national levels in professional journals, newspapers or as public discussion pieces. However, very few peer-reviewed research articles have investigated the cost burden or savings associated with the legalisation of VAD laws. Those published, were qualitative studies analysing the effects of the financial burden on patients' decision making [17–20]. This study was therefore the first of its kind to review available literature investigating healthcare cost analyses around VAD (and associated legal terms) policies internationally. An additional objective was to identify the current VAD practices and statistics from international health authority annual reports, where available.

Methods

Search strategy

The overall search strategy focused on databases and government reports and was conducted in accordance with the PRISMA guidelines (Appendix A) [21]. The databases, MEDLINE, PubMed, EMBASE and CINAHL were searched between November 2020 – March 2023 using the key words: 'Voluntary assisted dying' OR 'Physician assisted suicide' OR 'Euthanasia' OR 'Medical assistance in dying' combined with (i.e. AND) 'Cost' OR 'Cost Analysis' OR 'Healthcare budget' OR 'Financial'. These terms were carried through each of the databases as key search terms and mapped onto Medical Subject Heading (MeSH) in MEDLINE or Emtree in EMBASE. Additionally, any relevant international health authority annual reports from jurisdictions that have legalised assisted dying were also reviewed for eligibility.

Eligibility criteria

Full text, original studies published between January 1990 to March 2023 and the latest health authority annual reports from each legalising jurisdiction (where available) were reviewed. No limits on language were set. However, articles needed to investigate the financial cost or cost savings of assisted dying laws. References of the included articles were also reviewed for any additional literature that may have met inclusion criteria.

Study selection

Electronic titles, abstract and full texts for eligible articles were screened and reviewed by authors SI and BC and an independent reviewer (trained in research methods) for relevance based on the eligibility criteria pre-specified. Full texts were analysed for inclusion using the pre-determined selection criteria. Reviewers dealt with discrepancies through discussion and through consult collectively with the research team (SI, AJ and BC). Additionally, international health authority annual reports were reviewed for any cost analysis breakdown. To summarise current assisted dying practices internationally, data from each jurisdictions' published annual reports were also extracted using a pre-formulated table (Table 1) modified from a previously published review [22].

Results

Of the 2790 screened articles, 137 were deemed potentially eligible at title and abstract screening. Of these, eight met the inclusion criteria for review (Fig. 1). Three of which provided quantitative cost-analysis of VAD laws [23–25]. Additionally, 18 health authority annual reports were included with retrospective data on their respective assisted dying processes.

Current VAD laws internationally

Currently, almost all jurisdictions have a legally mandated requirement to review and report the frequency and demographics of patients requesting and receiving VAD [16]. The latest reported data (Table 1) released by each jurisdiction [26–43] demonstrated a total percentage of death that year ranging from < 0.1% to 4.2%.

The leading reason for an assisted dying request across all countries was malignancy, followed by neurodegenerative disorders. Belgium was the exception, with polypathologies (i.e. a collection of syndromes or morbidities that are not necessarily terminal, and alone may not cause suffering, but collectively do so) being the second leading cause for assisted dying requests. Having been one of the first nations to implement and legislate an VAD law, the Netherlands have the highest uptake and annual rate of deaths due to VAD. However, The Netherlands along with Belgium, are the only jurisdictions to allow minors, with parental consent, from 12 to 16 years, and without parental consent for those aged 16 to 18 years, to receive physician administered VAD [38, 44]. Additionally, mental illness and dementia are included as valid conditions acceptable for requesting assisted dying in the Netherlands and Belgium.

Canadian laws have recently been updated with the passing of a new C-7 bill [45], expanding the eligibility criteria of people who can access VAD, from terminal cases to those with any refractory, sufferable illness. As of late 2023, this will include individuals suffering from refractory mental illnesses. In the US all 11 states with legislation for VAD do so for self-administered VAD exclusively. However, the US state of Montana is still a contentious legal battle, with the few requests for self-administered VAD having only been granted following a supreme court ruling. As a result, only physicians willing to defend their case in court using the precedence of Baxter v. Montana (2009) follow through with the provision of self-administered VAD.

The latest jurisdictions to have legalised VAD include; Spain [43], the US state of New Mexico [46] and the Australian states of Queensland, Tasmania, South Australia and New South Wales [2–4, 7, 47–49].

Study characteristics

All three cost analysis studies were prospective estimates of new or updated VAD laws in their respective countries (Table 2). One was an independent cost estimate of the new Canadian Bill C-7 proposed for 2021. Cost analysis was conducted by using retrospective cost data from current VAD practices (under Bill C-14)

Table 1 Latest international VAD law data. (as of March 2023)

Country/State	Type of VAD	Eligibility: Age/Condition	Latest year reported data	VAD Deaths* that year	Total % of all deaths that year~	Leading causes for request
Netherlands (1973[†]/2002)	Self & Phys. VAD	• 12-16yo with parental consent • >16yo with incurable constant suffering *(incld. mental illness & dementia if in ACD)*	2021	7666	4.5%	1. Malignancies 2. Neurological 3. CVD
Belgium (2002)	Self & Phys. VAD	• < 18yo with parental consent for terminal condition • >18yo with incurable constant suffering *(incld. mental illness)*	2022	2966	2.5%	1. Malignancies 2. Poly-pathologies* 3. Neurological
Luxembourg (2009)	Self & Phys. VAD	• >18yo with incurable condition *(incld. ADC)*	2020	25	0.5%	1. Malignancies 2. Neurodegenerative
Colombia (1997[†]/2015)	Self & Phys. VAD	• 7-14yo with parental consent for incurable condition • >14yo with incurable condition	2022	99	~0.04%	1. Oncological (90%) 2. Non-oncological
Canada (2016)	Self & Phys. VAD	• >18yo with a grievous, irremediable medical condition *(incld. mental illness from 2024)*	2021	10,064	3.3%	1. Malignancies 2. CVD 3. Respiratory 4. Neurological
Australia (1996[†]) Victoria (2019)	Self & Phys. VAD	• >18yo with condition that is terminal within 6 months (or within 12 months if neurological)	2021-22	901	0.58%	1. Malignancy 2. Neurodegenerative 3. CVD 4. Respiratory
Western Australia (2021)			2021-22	190	1.1%	
Tasmania (Oct 22)			a	a	a	a
Queensland (Jan 23)			a	a	a	a
South Australia (Jan 23)			a	a	a	a
New South Wales (Nov 23)			a	a	a	a
New Zealand (2021)	Self & Phys. VAD	• >18yo with condition that is terminal within 6months	2021-22	214	~0.55%	1.Malignancy 2.Neurological 3.Other
Spain (2021)	Self & Phys. VAD	• >18yo with a condition causing incurable suffering *(incld. ADC)*	2021	180	~0.03%	1.Malignancy 2.Other
Switzerland (1942[†])	Self VAD	• None specified (Decriminalised but not legislated) Organisations set ethical guidelines which is >18 yo and is available to foreigners	2022	1125^	1.9%	1. Malignancy 2. Poly-morbidity* 3. Chronic Pain
USA Oregon (1997)	Self VAD	• >18yo with terminal condition that will likely cause death within 6 months	2021	238	0.59%	1. Malignancy 2. Neurological 3. CVD
Washington (2008)	Self VAD		2021	387	0.7%	1. Malignancy 2. CVD 3. Neurodegenerative
Vermont (2013)	Self VAD		2019-21	29	-	1. Malignancy 2. ALS 3. Neurodegenerative
California (2016)	Self VAD		2021	486	0.15%	1. Malignancy 2. Neurological 3. CVD
Colorado (2016)	Self VAD		2021	189	-	1. Malignancy 2. Neurological 3. CVD
District of Columbia (2016)	Self VAD		2019	7	-	1. Malignancy 2. Neurological
Hawaii (2016)	Self VAD		2021	49	-	1. Malignancy 2. Neurological 3. CVD
Maine (2016)	Self VAD		2021	63	-	1. Malignancy 2. Neurological 3. CVD & COPD
New Jersey (2016)	Self VAD		2021	50	-	1. Malignancy 2. Neurodegenerative 3. Respiratory
New Mexico (2021)	Self VAD		2021-22	>100	-	a.
Montana (2009)	Self VAD	N/A[#]	N/A[#]	N/A[#]	N/A[#]	N/A[#]
Austria (2022)	Self VAD	• >18yo with terminal or permanently debilitating suffering condition	a	a	a	a
Italy (2020)	Self VAD	Recent court rulings have decriminalised self VAD and created a defence for doctors. Legislation is being discussed and developed.				
Germany (2020)	Self VAD	Recent court rulings have decriminalised self VAD and created a defence for doctors. Legislation is being discussed and developed.				

Table 1 (continued)

Self VAD Self-administered VAD

Phys VAD Practitioner/Physician administered VAD

ACD Advance Care Directives

~ = was calculated as a percentage of annual all-cause mortality for that year

^ = Only took into account Self VAD provided by 'EXIT' for Swiss citizens only. 'Dignitas' run Self VAD for foreigners was not included

* = collection of syndromes/morbidities that are not necessarily terminal and alone may not cause suffering but collectively they do

= Self VAD is NOT formally legalised but Baxter v. Montana (2009) Supreme Court ruling "consent" can be asserted as defence in criminal charges against Self VAD

– = % are negligible or unattainable at time of table formulation

a. = Data not available yet as legislation only recently passed awaiting implementation

+ = For Self VAD, deaths are the based on the number of prescription dispensed (i.e. the drug has been supplied for use)

$ = Years where VAD was tolerated/accepted but not formally legalised, or legalised and then the law reversed (e.g. AUS 1996 – 1997)

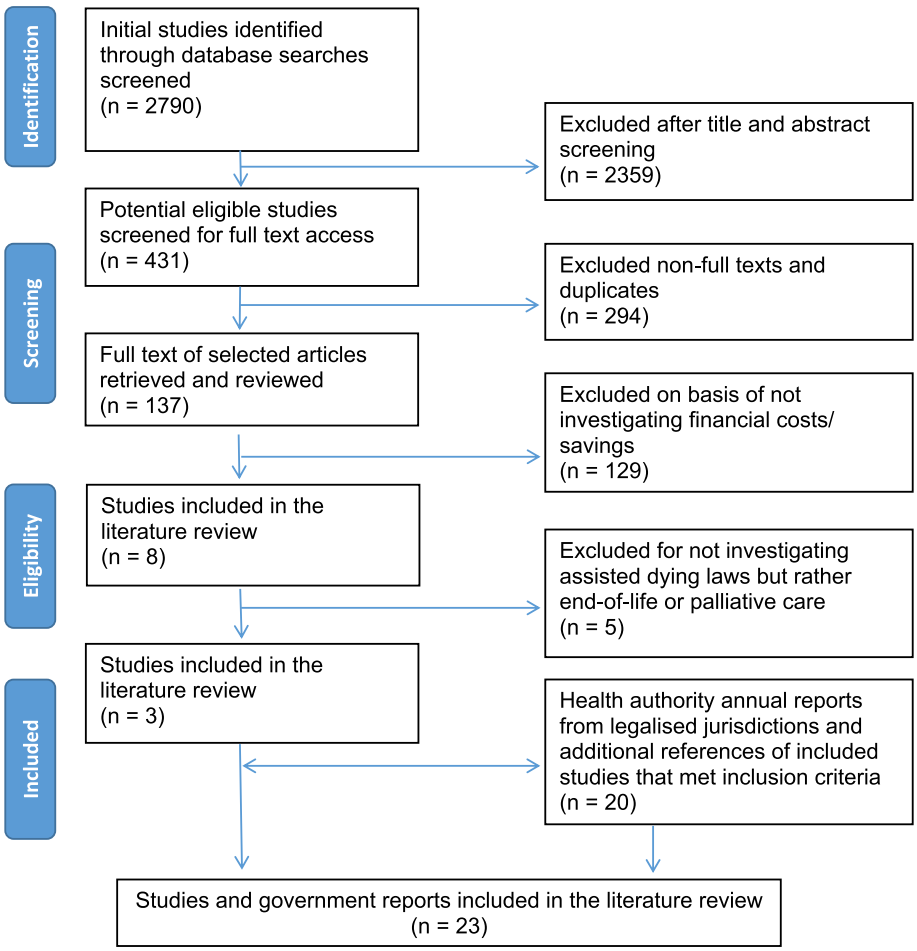

Fig. 1 Flow chart of search strategy and study selection based on PRISMA guidelines

and comparing it to the extrapolated incremental costs accrued due to the eligibility expansion of VAD (Bill C-7) [23]. The updated, 2017 Canadian cost analysis study, which combined data on VAD from the Netherlands and Belgium, and compared with Canadian-specific end-of-life care data to estimate the effects of VAD on healthcare costs in Canada before its legalisation [25]. The third, 1998 US study assessed the potential cost savings forecast as a result of self-administered VAD based on the assumption that individuals would be forgoing the last month of life and hence the cost of care during that time [24].

Table 2 Quantitative reviewed articles on cost analysis of VAD laws

AUTHORS	YEAR	COUNTRY	STUDY DESIGN	ASSUMPTIONS	COST OF VAD PER CASE	ESTIMATED NET COST/ REDUCTION OF VAD LAWS *(3 = 1 – 2)* **3 = *Net reduction/saving*** **1 = *Average cost of end-of-life (with or without palliative saving)*** **2 = *Total cost of VAD***	ESTIMATED % NET REDUCTION **(% = 3 ÷ 1 x 100)** ***3 = Net reduction/saving*** **1 = *Average cost of end-of-life***
Trachtenberg A.J. et al	2017	Canada	Prospective cost analysis based on predicted uptake and estimated life expectancy	- Proportion of VAD deaths (based on Netherlands & Belgium) - Palliative care savings was estimated for both a 40% and 70% saving - Deaths due to MAiD estimated at 1%,2%,3% and 4% - Cost of VAD was estimated at a low and high cost level based on (Tauseputrol et al.) - No additional out of pocket costs	**Low cost Estimate:** Completed ~ $268.75 Assessed but incomplete ~ $154.40 **High cost Estimate:** Completed ~ $751.85 Assessed but incomplete ~ $314.00	**Not including palliative care saving:***(low–high cost range)* 1. $34.7 to $138.8 million (CAD) 2. $1.5million to $14.8 million (CAD) **3. $31million to $132.6million (CAD)** **Including Palliative care savings of 40%:** **1.** $20.8million to $83.3million (CAD) **3. $17.1million to $77.1million (CAD)**	**89.3% to 95.5%** reduction not including palliative care **82.2% to 92.5%** reduction including 40% palliative care savings
Bernier G. et al	2020	Canada	Prospectively estimate cost between current and new C7 MAiD bill	- End of life costs based on (Tauseputrol et al.) - Palliative care savings = based on Way Forward Initiative [50] - Dollars extrapolated CPI - No additional out of pocket costs **Based on existing retrospective MAiD data:** - VAD = 2.2% of all deaths - 51% of patients will be male; - 13% will be between 18 and 59 years old, 50% between 60 and 79, and 37% 80 years old and over; - 66% will have cancer as the main underlying condition; - 14% will see their life shortened by 2 weeks, 25% by one month, 45% by three months, 13% by six months and 3% by a year	**Actual costs based on existing retrospective MAiD data (incld. oversight bodies)** Completed = $3085.32 Assessed but incomplete = $1491.87	**Including Palliative care savings of 50% for 80% of the patient population, at existing rate of uptake of 2.2% for patients eligible under Bill C-14:** **1a.** $109.2 million (CAD) **2a.**$22.3 million (CAD) **3a.$86.9 million (CAD)** **Including Palliative care savings of 50% for 80% of the patient population, at existing rate of uptake of 2.2% for patients eligible under Bill C-7 (new):** **1b.** $66.5 million (CAD) **2b.**$4.4 million (CAD) **3b.$62.1 million (CAD)** **Total Net reduction with addition of new C-7 Bill savings ($86.9 m + $62.1 m) = $149.0 million (CAD)**	**Eligible under Bill C-14** (3a **÷ 1a x 100) =** 79.6% **Eligible under Bill C-7** (3a **+ 3b) ÷ (1a + 1b) x 100) =** 84.8%

Table 2 (continued)

AUTHORS	YEAR	COUNTRY	STUDY DESIGN	ASSUMPTIONS	COST OF VAD PER CASE	ESTIMATED NET COST/ REDUCTION OF VAD LAWS *(3 = 1 – 2)* **3 =** ***Net reduction/saving*** **1 =** ***Average cost of end-of-life (with or without palliative saving)*** **2 =** ***Total cost of VAD***	ESTIMATED % NET REDUCTION **(% = 3 ÷ 1 x 100)** ***3 = Net reduction/saving*** **1 =** ***Average cost of end-of-life***
Emmanuel E.J. et al	1998	USA	Prospective cost analysis	- VAD = 2.7% of all deaths - End of life costs based on Medicare cost in last 1 and 2 months of life - Cost of VAD was - 1995 dollars used - Assuming healthcare costs are solely Medicare covered - No additional out of pocket costs	Not calculated	**At rate of 2.7% of deaths, for patients with 1 month left to live:** **1.** $627million (1995 USD) **2.** N/A **3. $627million (1995 USD) proxy measure of savings**	N/A

Cost of VAD calculations

Retrospective costs of VAD practices were reported by Bernier G. et al. (2020). Based on current laws, costs included three components:

1. Physician time billed (for first and second consults, administering drugs and filling out required documents/certificates)
2. Drug and supply costs
3. Review by oversight bodies/panels

For a completed VAD case, the total cost, including oversight bodies, was $3085.32. For assessed cases that did not receive VAD, the total cost, including oversight bodies, was $1491.87 [23].

Net healthcare cost reductions

Bernier G. et al. 2020, estimated the net healthcare reductions to be $86.9 million (CAD) based on existing laws (Bill C-14). They also estimated an additional $62.1 million (CAD) saving for the new proposed law (Bill C-7). In total, the net predicted healthcare cost reduction was $149.0 million (CAD), or 84.8% compared to the original cost of end-of-life care. However, this net saving was only 0.08% of the total Canadian healthcare budget [23]. These results were based on previous research [51] on the average cost of end-of-life care being $53,661 (CAD in 2013) per person and approximately $4.7 billion (CAD in 2013) annually; after accounting for demographic variability (including; sex, age, expected time of death and cancer vs no cancer). These calculations were adjusted by 50% for 80% of requests, per the predicted savings from palliative care. The average end-of-life care cost along with cost of VAD were used to calculate the net healthcare cost reduction.

Trachtenberg A.J. et al. (2017) used the same methodology to calculate a net healthcare reduction ranging between $34.7—$138.3 million (CAD in 2017). The variability was based on estimated death by VAD being 1%—4%. This range was adjusted based on predicted palliative care savings estimated at both 40% and 70%. Additionally, the estimated costs of VAD were predicted for a low and high cost scenario to be between $268.75—$751.85 (CAD in 2017) for completed cases, and $154.40—$314.00 (CAD in 2017) for assessed cases, respectively [25].

Emmanuel E.J. et al. (1998) estimated a net healthcare reduction of $627 million (USD in 1995), with assumptions that 2.7% of deaths were with Self VAD—based on Dutch trends, and that patients would have one month left to live [52, 53]. This cost reduction did not include the additional costs of implementing Self VAD and therefore relied on the cost forgone at end-of-life as a proxy for healthcare costs saved.

Discussion

Critical appraisal

Overall the articles reviewed [23–25] aimed to provide financial estimates of the costs and or savings associated with the implementation of VAD laws. All three articles provided a level of insight into these financial estimates with sound projections. However, Bernier G. et al. [23] and Trachtenberg A.J. et al. [25] reported their methodology and results according to the Joanna-Briggs (JBI) critical appraisal checklist for economic evaluations [54]. Conversely, Emmanuel E.J. et al. [24] failed to meet the JBI checklist because they did not account for all relevant costs or have them measured accurately (Table 3).

Trachtenberg A.J. et al. stated their primary objective was to *"combine the use of medical assistance in dying from countries where it is legal, with Canadian-specific end-of-life cost data to estimate the effect of this intervention on health care costs in Canada"* [25]. It also reviewed the alternative options of palliative care as a net healthcare cost reduction and adjusted their results based on the projected uptake of this comparator. Bernier G. et al. [23] used the same methodology as Trachtenberg A.J. et al. [25] to provide a cost evaluation of current Canadian VAD laws and estimate the costs or savings associated with a change in legislation to expand the accessibility of those laws. Emmanuel E.J. et al. [24] did not clearly state the objective or aims of their study, instead providing a vague synopsis of the ethical dilemma's faced around VAD practices.

Emmanuel E.J. et al. [24] also failed to base their assumptions, regarding clinical effectiveness, on solid evidence. They relied on case reports, international trends, and US Medicare data, which constitute relatively unreliable reflection on the overall costs associated with end-of-life care in a country with a predominately privatised healthcare system. Trachtenberg A.J. et al. [25] modified the Emanuel E.J et al. [24] model with significant updates to include more recent and detailed demographic estimates of the patients who may choose VAD, including age, sex and underlying diagnosis, in addition to Canadian-specific cost data. They also performed more rigorous sensitivity analyses and discussed the multivariant changes needed to be accounted for when finalising the cost estimates. Bernier G. et al. [23] further updated Trachtenberg A.J. et al.'s [25] assumptions and used current data of Canadians who utilised the VAS laws legalised from 2016, rather than extrapolating the uptake of VAD laws based on Netherlands and Belgium trends. As a result, their measured costs and outcomes are more accurate and reflective of the Canadian population.

Table 3 Results of critical appraisal of included studies, using the Joanna Briggs Institute Checklist for Economic Evaluations (54)

Study	1. Is there a well-defined question?	2. Is there comprehensive description of alternatives?	3. Are all important and relevant costs and outcomes for each alternative identified?	4. Has clinical effectiveness been established?	5. Are costs and outcomes measures accurately?	6. Are costs and outcomes valued credibly?	7. Are costs and outcomes adjusted for differential timing?	8. Is there an incremental analysis of costs and consequences?	9. Were sensitivity analyses conducted to investigate uncertainty in estimates of cost or consequences?	10. Do study results include all issues of concern to users?	11. Are the results generalisable to the setting of interest in the review?	Quality rating * *(> 80% = High, < 50% = Low)*
Emmanuel E.J. et al. (1998)	No	No	No	Unclear	Unclear	Unclear	Yes	No	No	No	No	Low
Trachtenberg A.J. et al. (2017)	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes	No	High
Bernier G. et al. (2020)	Yes	Yes	Yes	Yes	Unclear	Yes	Unclear	Unclear	Unclear	No	No	Moderate

* Yes = 2, Unclear = 1, No = 0 and Total = 22

Emmanuel E.J. et al. [24] failed to explain sufficiently how their calculations were valued. They did not take into consideration the costs associated with the process of VAD. They also generalised the costs of care for patients with cancer to all patients who potentially utilise VAD—leading to a sample bias and poorer external validity.

In comparison, Bernier G. et al. and Trachtenberg A.J. et al. [23, 25] measured the costs and outcomes with sufficient explanation of how the calculations were valued. For example, the cost of end-of-life care in Ontario, Canada, was calculated at an individual patient level on a cumulative daily basis using administrative data. The potential savings associated with VAD were calculated based on the assumption that VAD accounted for either 1%, 2%, 3% or 4% of total deaths. Trachtenberg A.J. et al. [25] utilised Ontario physician and pharmacist fees and Alberta's suggested drug costs to approximate the overall cost of VAD. This was further adjusted to take into account a high cost (hospital-based) scenario and a low cost (community-based) scenario.

Both Bernier G. et al. and Trachtenberg A.J. et al. [23, 25] implemented extensive sensitivity analyses. However, Bernier G. et al. failed to discuss these results in a discussion section with any substantial comparison to existing literature. Assumptions were varied regarding sex, age group, cancer status and effect on life expectancy. These modelled variations identified that even if the potential savings are overestimated and costs underestimated, the implementation of VAD will likely remain at least cost-neutral.

Emmanuel E.J. et al.'s [24] internal validity is poorest due to the lack of credible cost evaluation and lack of calculations for the costs of implementing VAD laws. This, therefore, means the overall estimated costs or savings are inaccurate and introduce additional confounding factors and biases.

For example, in addition to the lack of cost calculations for the provision of VAD laws, the confounding factor of life-years remaining if VAD was not up-taken was also unaccounted for. The article would have benefited from sensitivity analysis to account for these and other variables. (i.e. demographics, disease state and spending incurred at different times of end-of-life). In contrast, both Bernier G. et al. and Trachtenberg A.J. et al. [23, 25] have sound internal validity. They accounted for the confounder of variable time spent at the end-of-life by the provision of ranges and calculations for multiple scenarios to ensure as many variables were accounted for as possible.

The inherent potential bias introduced by using different data estimates and costing methods was another limitation in Trachtenberg A.J. et al.'s study [25]. For example, Netherlands and Belgium VAD data used to build case estimates relied on international policies that do not match those later developed in Canada. However, being a prospective study, this bias was unavoidable and altogether accounted for in their discussion. It is only by comparing the estimates to the current data used by Bernier G. et al. in 2020 [23] that the minor variation in patient uptake can be appreciated.

All three studies' external validity and generalisability were relatively narrow, with the estimate calculations being specific to the USA or Canada only. With healthcare cost estimates from Ontario and Alberta Canada or Medicare USA data being used, the external validity is restricted primarily to those two provinces in Canada or the public US healthcare system. Therefore, the ability to apply these results to any other jurisdiction is not possible. Additionally, the absence of other non-financial cost evaluation, such as cost-utility, reduces the applicability to individual patients and their families in assessing the overall cost–benefit of VAD laws. This was an reported limitation to all three studies and would be beneficial for future research in this field particularly as a comparator to these fiscal evaluation studies.

Statement of principal findings

This review has identified a significant deficit in literature and data on evaluating healthcare costs or savings of VAD laws internationally. The only current cost-analysis data identified were the two Canadian studies reviewed. Trachtenberg A.J. et al. used estimated cost values for the administration of MAiD, while Bernier G. et al. used retrospective cost data to evaluate the predicted cost reduction of VAD laws. [23, 25] Emmanuel E.J. et al., on the other hand, extrapolated cost savings without taking into account the cost of administration. End-of-life costs were used as a proxy to estimate the total cost reduction from VAD laws. [24] Overall, the results from all three studies indicated that VAD laws can result in a substantial net reduction in healthcare costs and should not result in any excess financial burden to the healthcare system. However, in comparison to the total healthcare budget for that jurisdiction, and in the way the studies were conducted, the savings were deemed negligible.

Strengths and weaknesses of the study

Given the global discussion about VAD as a contemporary bioethical debate, this mapping review fills a gap in the literature investigating the cost analysis of VAD laws internationally. Previous reviews [55, 56] have reported on the numbers, characteristics, and trends for VAD laws; and others [16, 57] on the attitudes of patients, carers, physician and the general public. This review was

also rigorous in its approach and followed the PRISMA guidelines.

Some limitations of this review included the narrow eligibility criteria around the financial cost of VAD laws. Despite the potential benefit of expanding the search strategy to include non-financial costs (patient-level research), a narrow strategy was adopted to ensure reviewed studies were comparable in their methods and results and remained in keeping with the proposed aim.

Another unavoidable limitation was the prospective data used by the reviewed articles (as discussed in the critical appraisal). This produced results dependent on multiple variables and estimates extrapolated from previously published literature from different countries. However, this was justified in the articles as the *"most comprehensive data available to build case estimates."* As a result, more extensive in-depth research analysing the cost of current VAD practices are needed to help strengthen the rigour of future reviews. This is particularly important for those government bodies of countries that have already legislated VAD laws but have yet to transparently evaluate and report the healthcare costs of such legislation in their annual reports. Moreover, VAD itself is very poorly reported in the literature. The external validity and generalisability of reviews like this are reduced due to the mono-regionality of studies.

Strengths and weaknesses in relation to other reviews, particularly relating to any differences in results

As a topic of immense contention, debate and discussion – VAD laws have challenged many, and in particular, physician groups who have long stated they *"are not agents of the state and organized medicine cannot afford to be 'neutral' on a topic that touches medicine at its very core"* [58]. From a health economics perspective VAD will and has already begun to change the premise a health costs at end-of-life. It is a developing areas that would benefit from greater research, exploring the various cost evaluations of its implementation.

This review identified a potential cost saving associated with VAD laws with an average percentage reduction in costs of 87% compared to original costs of the last month of end-of-life. Although this appears significant, compared to the jurisdictions total healthcare budget for that year, it is 0.08% [23] and 0.04% [24], which is relatively negligible. However, a 2019 US study [59] found that 46% of insurance companies would still preferentially cover Self VAD over possible life-saving treatments, indicating a commercial value present in VAD laws and therefore an ethical concern of the risks associated with the commercialisation of death.

VAD laws have come into effect on the premise of helping limit the suffering of terminally ill individuals and allow them to die with dignity. However, some argue that the additional influences of the healthcare budget and saving medical resources have steered policy makers to place VAD bills front and centre on the agenda in parliament. For example, amicus curiae brief (expert documents) submitted to the US Supreme Court speculated that cost savings made by implementing VAD laws are *"as undeniable as gravity. The earlier a patient dies, the less costly his or her care."* [24] A 1993 commentary response piece went on to state that *"while the elderly have a substantial claim to publicly-provided healthcare, it cannot be an unlimited claim."* [60] This was also identified among nurses and other allied healthcare professional in an Australian study on VAD laws, highlighting a shared concern among interviewed pharmacists around *"healthcare budget, pharmacoeconomics and the concept of medical futility... a growing economic dilemma related to a globally ageing population, and the problems associated with prolonged and unsustainable healthcare costs."* [61] These may be controversial views that healthcare should stop futile prolongation of life. However, simultaneously these are pragmatic conversations that need to be discussed transparently to ensure laws address all concerns and aspects of a new health policy.

As health economics is a fundamental aspect of any well-structured healthcare service, the absence of fiscal and health economic data and literature analysing the costs of VAD legislation has a significant impact on VAD policies. Future research is needed on financial VAD data in order to help inform policymakers about the economic factors influencing VAD laws. Additionally, annual fiscal reporting and optimisation of future legislative frameworks at an international level are needed to improve VAD policies. VAD laws are undoubtedly becoming a growing part of our healthcare systems, and evaluating costs clearly is a significant part of developing robust, safe and effective policies for VAD practices that transparently showcase the fiscal influences of such laws.

Conclusion

This mapping review highlighted a scarcity in cost-analysis data around VAD from which a potential cost reduction was indicated. The absence of current, retrospectively collated financial data on this topic (especially in annual reports) highlights the need for future research in this field to maintain transparency around fiscal outcomes. Additionally, this review can inform policymakers of the shortcomings around current policies (to include for example annual fiscal reports) and optimise future legislative frameworks internationally.

Authors' contributors

SI, AJ and BC contributed to the interpretation of the data, drafting of the review and editing the manuscript and approved final version for submission. SI developed the search strategy, conducted the literature search, extraction and data analysis in consultation with BC and AJ. The authors have full access to all of the data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis.

Abbreviations

VAD	Voluntary Assisted Dying
MAiD	Medical Assistance in Dying
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta Analyses
Self VAD	Self-administered VAD
Phys VAD	Practitioner/Physician administered VAD
ACD	Advance Care Directives
CAD	Canadian Dollar
USD	United Stated Dollar
US	United States

Supplementary Information

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Additional file 1. Appendix A: PRISMA Checklist.

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Availability of data and materials

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Declarations

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Competing interests

All authors declare that they have no competing interests.

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