Costs and outcomes of five surgical treatments for great saphenous varicose veins;

High Ligation and Stripping, Laser Ablation, Radiofrequency Ablation, Steam Vein Sclerosis and Cyanoacrylate Glue

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Master Thesis

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May 2014

2014

A decision analysis of five surgical treatments for great saphenous varicose veins;
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http://www.duo.uio.no

Publishing: Reprosentralen, Blindern, Oslo.

ABSTRACT

Background: Although varicose vein disease primarily causes cosmetic concern it can also develop into disabling venous ulcers. For advanced disease, surgical intervention is a mainstay for a majority of patients. Several new techniques have evolved during the last decade and a handful of these are offered through the Norwegian Statutory Health Care System. Few economic evaluations have been performed considering surgery for varicose vein disease, none including the range of new endovascular techniques.

Objectives: The aim of the current thesis was to estimate costs and outcome of five common techniques of varicose vein surgery in a Norwegian Health Care Setting (*high ligation and stripping*, *radiofrequency ablation*, *endovenous laser ablation*, *steam vein sclerosis* and *cyanoacrylate glue*) using both a societal perspective and a health care perspective.

Methods: A structured literature search was made to determine the clinical effectiveness and the rate of compilations in the five methods. Data on costs and health-related quality of life related to varicose vein disease were also collected. With the aid of an expert panel, a structured decision tree was developed using TreeAge software. A one-year perspective was modelled, and a variety of common complications were included. Monte Carlo simulation was used for probabilistic sensitivity analyses.

Results: In the societal perspective the *laser ablation* strategy was the most cost-effective with an incremental cost-effectiveness-ratio (ICER) of NOK 70,539 compared to a no treatment alternative, and had a 42% probability of being cost-effective using a willingness-to-pay threshold of NOK 500,000. In a health care perspective, however, the *steam vein sclerosis* strategy was the most cost-effective with an ICER of NOK 34,005 compared to a no treatment alternative, and this strategy had a 50% probability of being cost-effective.

Conclusion: Recent endovenous surgical treatment alternatives (including *laser ablation* and *steam vein sclerosis*) provide clinically effective treatment for advanced, symptomatic varicose vein disease and are cost-effective in a Norwegian Health Care Setting. The societal perspective envelop costs related to varicose vein surgery that are not accounted for in a health care perspective, and is therefore recommended when undertaking comprehensive cost-effectiveness analyses.

ACKNOWLEDGEMENTS

As a clinical doctor the patient is your concern, no matter the cost. When introducing economics to the doctor the cost is suddenly of concern – and then you realize how more patients can be helped by your cost-concern. Since 2009 my endeavour towards a Master of Health Economics, Policy and Management has been an eye-opener in my every-day clinical environment. In addition to lasting friendships and a broad network - the skills and insights gained from the Department of Health Management and Health Economics will hopefully help me as a clinician navigate the ever-changing Health Care sector.

I would like to thank my supervisor and colleague doctor Ivar S Kristiansen for introducing me to the exiting area of decision analytic modelling, particularly through this thesis work. I give a salute for your knowledge and for amusing conversations throughout the past year. I also would like to express my gratitude to Birthe Neset for her rapid responses and flexibility through my time at the department.

Further my friends and fellow students Søren Klitkou and Benny A Persson should be thanked for their support, sharing of notes, discussion groups and taping of lectures in my absence. Thanks also go to my boss, Tove Zakariassen, who has been understanding and willing to let me go on with my many projects.

Finally, my patient and caring wife Olga Therese, thank you for the love and support.

Eivind Inderhaug

May 2014

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ACRONYMS/ABBREVATIONS

CA	Cyanoacrylate glue
CEA	Cost-Effectiveness Analysis
CEAC	Cost Effectiveness Acceptability Curve
CEAP	Varicose vein disease classification by; Clinical severity, Etiology or cause, Anatomy, Pathophysiology
DRG	Diagnosis Related Group
DVT	Deep venous thrombosis
EVLA	Endovenous laser therapy
EQ-5D	Standardized instrument for use as generic measure of quality of health related life
FNO	Finance Norway
GBP	British pound
GRADE	Criteria for ranking medical studies by their scientific quality
HL/S	High ligature and stripping
HUI	Health Utility Index
HTA	Health technology assessment
ICER	Incremental cost-effectiveness ratio
ICU	Intensive Care Unit
NAV	The Norwegian Labour and Welfare Administration
NHS	National Health Service
NICE	National Institute of Clinical Excellence
NOK	Norwegian Kroner
NPE	The Norwegian System of Patient Compensation
OR	Operating Room
PE	Pulmonary embolism

PTS	Post thrombotic syndrome
QALY	Quality-adjusted life-years
RCT	Randomized controlled trial
RFA	Radiofrequency ablation
SF-6D	Short-form 6. See EQ-5D.
SG	Standard Gamble
SVS	Steam vein sclerosis
TTO	Time-trade off
UFGS	Ultrasound-guided foam sclerotherapy
VTE	Venothrombotic events

1. Introduction

Varicose veins are common in the adult population causing cosmetic concern as well as bothersome symptoms if left untreated. Although medical compression stockings are a first choice of treatment, a majority of patients with advancing disease will at some point consider surgical treatment. Surgery has expanded from a traditional open approach to multiple endovascular options including laser, radiofrequency ablation, steam sclerosis and cyanoacrylate glue. The latter alternatives are shown to be clinically effective and less invasive – therefore patients can be treated with a low risk of complications and short postoperative immobilisation. New medical devices, however, often come at a higher initial cost and therefore clinical benefits needs to be compared to those of the gold standard treatments weighted relative to their cost. Such comparisons may be undertaken in cost-effectiveness analyses, but very few have been published for the recent endovascular innovations, and none has been performed in the setting of the Norwegian Health Care System.

This thesis aims to compare the surgical treatment options for varicose vein surgery available in the Norwegian Heath Care System utilizing a structured decision tree, comparing both cost and effects of the relevant alternatives. Societal costs beyond the initial treatment of the varicose veins have been modelled and accounted for.

2. Background

2.1 Varicose vein treatment

Varicose veins are common in the adult population and about one in four will develop the condition throughout life ([1]). Women are more susceptible than men; other risk factors include advancing age, pregnancy, standing-up work and obesity ([2]). Defect valves in the venous system cause a reduction in the returning blood flow from the legs. This will in turn predispose for the development of dilated and tortuous veins from the leg to the thigh. Although initially the condition causes primarily cosmetic worries, its impact on daily life can be significant. Symptoms span from slight discomfort and cosmetic concerns to pain in severe cases ([2]). A mutilating end-stage of the varicose vein disease is a chronic leg ulcer (figure 2). Some studies indicate that approximately 80% of these ulcers have a chronic venous pathogenesis ([3]).

Figure 1 – Great saphenous vein varicoses

The CEAP classification (Clinical severity, Etiology or cause, Anatomy, Pathophysiology) is a conventional way of staging varicose vein disease ([4]). The clinical severity classification spans from C0; representing no visible skin change, to C5/C6 with healed or active leg ulcers. The indications for varicose vein surgery are debated, but C2; simple varicose veins with established symptoms are often the mildest stage where surgery is considered (figure 1) ([5]).

Figure 2 – Venous ulcer as end stage of varicose veins

The current treatment options for varicose veins are multiple. A few decades ago the alternatives were restricted to stripping of the vein, performed as open surgery, or non-operative treatment with compression stockings. Still, the use of medical compression stockings is the first choice intervention and has been proven effective both in prevention and treatment of venous ulcers. ([6]). For this treatment to be effective the stocking must be worn throughout the day and many patients find this treatment bothersome and aesthetically unfavourable. The evolution of surgical techniques has, however, provided a range of approaches proven to efficiently reduce or eliminate the varicose veins and thereby provide relief of symptoms ([7]).

2.2 Cost-effectiveness of varicose vein surgery

With commercially driven technology development, new medical devices are patented with a high starting price compared to conventional surgery. Although new devices may entail benefits as less invasiveness, less postoperative pain and shorter sick leave – these benefits has to be weighed against the additional cost of equipment and resources associated with its use. Such assessments of cost-effectiveness can provide important information in decision-making and policy settings. An example is a recent German study investigating the impact of reimbursement of ClosureFast - a radio-frequency treatment for varicose veins (8). The results of the analysis indicated that a general reimbursement of ClosureFast through the German Statutory Health insurance would be cost saving.

Even though a range of studies claims to perform cost-effectiveness assessments, some only accounts for the cost and are not cost-effectiveness studies in the strict sense ([20], [21]). Lattimer and co-workers randomized patients for foam sclerotherapy (UFGS) and laser ablation (EVLA) ([18]). At

three months they evaluated failure of treatment and summarized costs included in the two treatment alternatives. Their main finding was that EVLA was 3.15 times more expensive than UFGS (EUR 230 versus EUR 724) but the re-treatment rate of the UFGS therapy was high due to initial failure. Another study by Rasmussen and co-workers compared four methods for varicose vein surgery, including EVLA, RFA and HL/S in a randomised trial including 500 consecutive patients ([9]). They found that all treatment options were efficacious in eliminating the varicose veins and SF-36 scoring was reported at three days and 30 days postoperatively. Foam sclerotherapy (UFGS) and RFA entailed significantly better scores than the two other treatment strategies, but these differences diminished at one month postoperatively. When comparing the resource use the RFA strategy was the most costly procedure while UFGS was the least costly. When including time lost from work, the EVLA and HL/S had the highest cost while UGFS had the lowest cost (EUR 2,200 and EUR 2,199 compared to EUR 1,554). No valuation of the outcome in terms of QALYs or similar was presented in the study.

Only a few studies have performed comprehensive cost-effectiveness analyses of the conventional alternatives for surgical treatment. The REACTIV trial was a combined randomized trial, an observational study and an assessment of the cost-effectiveness of varicose vein treatment undertaken by the NHS ([12]). This study, however, only considered conservative treatment, injection sclerotherapy and HL/S as treatment strategies. The randomized trial was performed as three separate trials assessing treatment outcomes in groups of patients with *mild*, *moderate* and *severe* varicose vein disease. In the *mild* group patients were randomized to conservative treatment or injection sclerotherapy, while the *moderate* and *severe* groups were randomized to conservative treatment and HL/S. Unfortunately, only the *severe* group was large enough to produce any clear results. The main finding was that surgery provided a clinical effective as well as a cost-effective treatment of varicose veins with an incremental cost-effectiveness ratio (ICER) of GBP 7,175 per QALY relative to conservative treatment. At the time this study was performed, none of the more recent endovascular alternatives considered in the current thesis (RFA, EVLA, SVS, CA) were available in the NHS.

Gohel and co-workers modelled a 5-year perspective for eight popular varicose vein treatments strategies including RFA, EVLA, and UFGS ([11]). Of all the strategies the most cost-effective were UFGS in an office-based setting (relative to no treatment) with an ICER of GBP 1,366, EVLA with an ICER of GBP 5,799 (relative to UFGS) and RF with an ICER of GBP 17,350 (relative to EVLA). The traditional HL/S had an ICER of GBP 19,012 (relative to RF). Concerns about the safety and the clinical effectiveness of the UFGS alternative have risen after reports on frequent thromboembolic events (VTE) and a high rate of recurrence after this treatment ([22], [23]).

A recent Health Technology Assessment (HTA) sponsored by the NHS ([66]) developed a model for comparing the strategies of HL/S, RF, EVLA, UFGS and conservative treatment. The data on clinical effectiveness were based on a thorough systematic review performed for the purpose of the modelling. The main conclusion of the study was that there were small differences in the clinical effectiveness of the endovascular treatment alternatives relative to the traditional HL/S and therefore the cost of these strategies would have a major effect on the cost-effectiveness. The HL/S strategy was dominated by UFGS. The EVLA had an ICER of GBP 518,000 (relative to stripping) while the RF had an ICER of GBP 1,352,992 (relative to EVLA). The EVLA and RF alternatives therefore were less likely to be cost-effective given the NHS threshold of GBP 20.000 per QALY.

2.3 Varicose vein surgery in the Norwegian Health Care sector

The information service "Free Hospital Choice Norway", run by The Norwegian Directorate for Health provides information on the services provided for Norwegian citizens ([24]). In February 2014 HL/S was offered by 45 hospitals, SVS/RF/EVLA was offered by 16 hospitals while CA was offered by 7 hospitals. The latter two groups were predominantly offered by private hospitals with some sort of public-private agreement. Waiting lists for surgery with any technique, as presented through "Free Hospital Choice Norway", was variable – but in some regions the waiting time was more than one year for the initial appointment with a vascular surgeon ([24]). Additional waiting time for the actual surgery applies after this appointment. The private hospital sector is expanding due to growth of private health insurances and an increasing willingness to pay for health care services. Numbers from Finance Norway (FNO) indicates that 380,000 Norwegians had a private health insurance in 2013; this was an increase by 15% from 2012 ([25]). The choice to "go private" with the varicose vein disease can seem increasingly attractive when facing the long waiting time for treatment. Private hospitals are tempting patients with shorter waiting times, but there has also been a tendency that they offer surgical techniques that gives a shorter sick leave ([11], [24]).

2.4 Surgical treatment of varicose veins offered in the Norwegian Health care scheme

While the surgical high ligation and stripping (HL/S) still remains a gold standard treatment, the minimally invasive endovascular approaches have proven to be effective and safe ([9],[11]). Several techniques have been developed in parallel and make out the conventional endovascular alternatives to HL/S. Four of these endovascular techniques, presented below, were offered in the Norwegian Health Care system in 2013 ([24]). A brief presentation of the techniques will be given below, and a

further elaboration on the effectiveness of the individual technique will be presented under *Methods and data*.

High ligation and stripping (HL/S)

Through an incision in the groin the saphenofemoral junction is identified so that a division and ligature of the vein can be performed. All tributaries are also ligated. A venous stripper is then introduced and advanced below the knee. A new incision is then made to locate the stripper and to ligate the distal part of the vein. The vein is then pulled out retrogradely by retracting the stripper. General anaesthesia has traditionally been used for the procedure, but use of local anaesthetics is increasing ([15]). The most common complication is wound haematoma. It has been hypothesized that a high incidence of groin haematoma can stimulate neovascularization and therefore contributes to a high recurrence rate in this surgical technique ([16]). Other complications such as infection, sensory loss, chronic pain or DVT are less frequent ([26]).

Radio-frequency ablation (RFA)

This procedure is performed endovascularly with radio-frequency energy supplied via a catheter electrode in the vein ([5]). The surgery is done under ultrasound guidance and requires only a small incision at the level of the knee for the introduction of the probe. The energy applied causes a thermal reaction in the vein while the probe is retracted from the level of the saphenofemoral junction towards the knee. Tumescent anaesthesia, a form of local anaesthetic that also protects the skin from burns, is deposited subcutaneously in the extent of the vein. The procedure can therefore be done at an outpatient clinic without the assistance of a surgical team. The minimally invasive approach, using tumescent anaesthesia, facilitates a quick return to work because of the immediate mobilization after surgery ([15]).

Endovenous laser therapy (EVLA)

An optical laser fibre is inserted in the vein at the lowest level of the varicose veins. Under ultrasound guidance the laser is advanced to just below the saphenofemoral junction and then withdrawn under partial compression of the vein. A certain amount of intravascular blood is needed for a coagulation of the vein to take place. Both general and local anaesthesia can be used for the procedure; the addition of/replacement with tumescent anaesthesia (as described above) is not uncommon ([9]). The relatively rare complications include bruising, local indent of the skin above the coagulated vein, phlebitis of the deep of superficial vein or thermal damage to the skin ([26]).

Steam vein sclerosis (SVS)

The steam ablation technique is a further development from the thermal endovenous therapies

(EVLA and RFA) using heat to cause endothelial destruction and therefore venous occlusion. In other thermal techniques perforation of the venous wall has been described as a complication due to a high focal thermal energy. The rationale behind steam ablation is a more homogenous application of the energy and therefore a lower risk of wall perforation. The procedure can be performed at an outpatients clinic using tumescent anaesthesia and therefore have the benefit of quick return to activity and work. A 96% obliteration rate has been displayed at 12 months postoperatively using this technique ([27]).

Cyanoacrylate adhesive (CA)

This most recent addition to the varicose vein treatment is a further, and more effective, development of the liquid sclerotherapy ([29]). This new, non-ablative, procedure using a proprietary formulation of cyanoacrylate has been developed to reduce inflammation, staining and the rare complication of air embolism associated with former sclerotherapies ([28]). An intravenous access at the level of the knee is needed to introduce a syringe for application of the cyanoacrylate. The procedure can be performed without any anaesthesia other than local anaesthetics at the incision made for the catheter. The adhesive polymerises in the vein causing a local reaction promoting fibrosis of the endothelium. Almeida performed the first case-series of patients providing promising results with a 92% occlusion rate at 1 year along with only mild and transient side effects ([29]).

2.5 Aims of the thesis

The overall aim of this thesis was to investigate the comparative cost-effectiveness of available surgical interventions of great saphenous varicose veins within the Norwegian national health care system. With the inclusion of societal costs the results will provide information for decision-makers who set priorities whether it is at a local, regional and national level.

More specifically:

The purpose of this project was to explore the cost-effectiveness of high ligature and stripping, endovenous laser ablation, radiofrequency ablation, steam vein sclerosis and cyanoacrylate glue for varicose vein surgery in order to answer the following research questions:

1. What are the costs and outcomes for the different treatment modalities in a societal perspective and a health care setting?
2. How does the method for estimating the treatment costs impact the cost-effectiveness?

3. Methods and data

3.1 Model structure

A decision tree model was developed as a means to compare the alternative treatment strategies ([20]) (table 1). TreeAge Pro 2013 software was used for developing the model (TreeAge Software Inc., Williamstown, MA, USA).

Table 1 – Treatment strategies

Treatment modality	Location	Anaesthesia
No treatment		
High ligature and stripping	Day-surgery case	General
Endovenous laser ablation	Office-based/Day-care	Tumescent/local
Radio-frequency ablation	Office-based/Day-care	Tumescent/local
Endovenous steam vein sclerosis	Office-based/Day-care	Tumescent/local
Endovenous cyanoacrylate	Office-based/Day-care	Tumescent/local

The decision tree encompassed the relevant treatment options (strategies); including plausible postoperative complications and a one-year time frame for evaluation of the treatment effectiveness. Quality-adjusted life-years (QALY) were used as outcome measure and as a representation of all the health states in the model. All costs were measured in 2013 Norwegian Kroner (NOK).

The structure of the model was developed in cooperation with two vascular surgeons (C.H.S., I.G.). A specialist in internal medicine was also consulted for medical advice (G.H.) regarding handling of complications – e.g. plausible duration and adequate treatment algorithms. The treatment options were chosen to represent conventional and available techniques commonly used in the Norwegian health care setting and the expert panel was consulted in the process. An additional *no-treatment* strategy was added to the model to allow for ranking of the treatment strategies as compared to no treatment (figure 2 and 3).

Figure 3 – Tree structure treatment alternatives

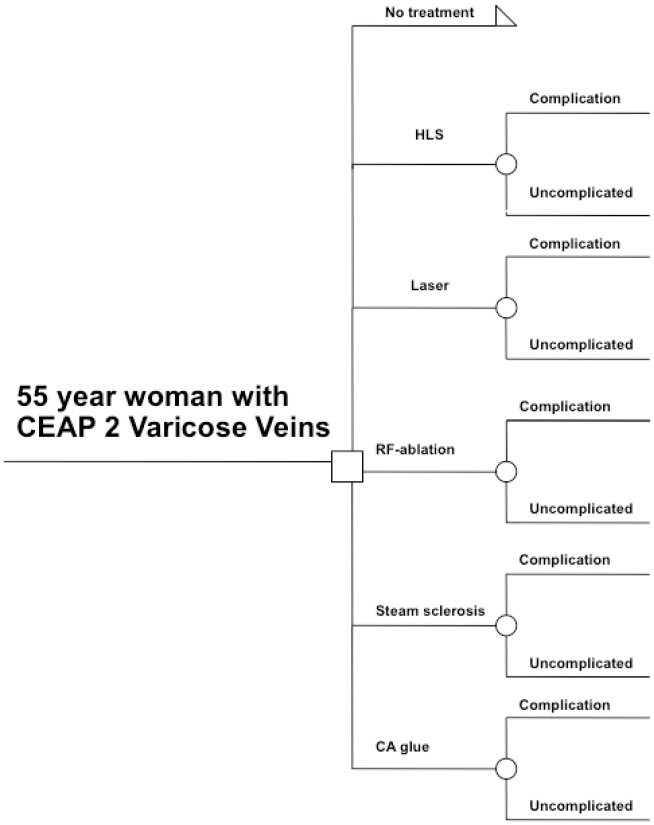
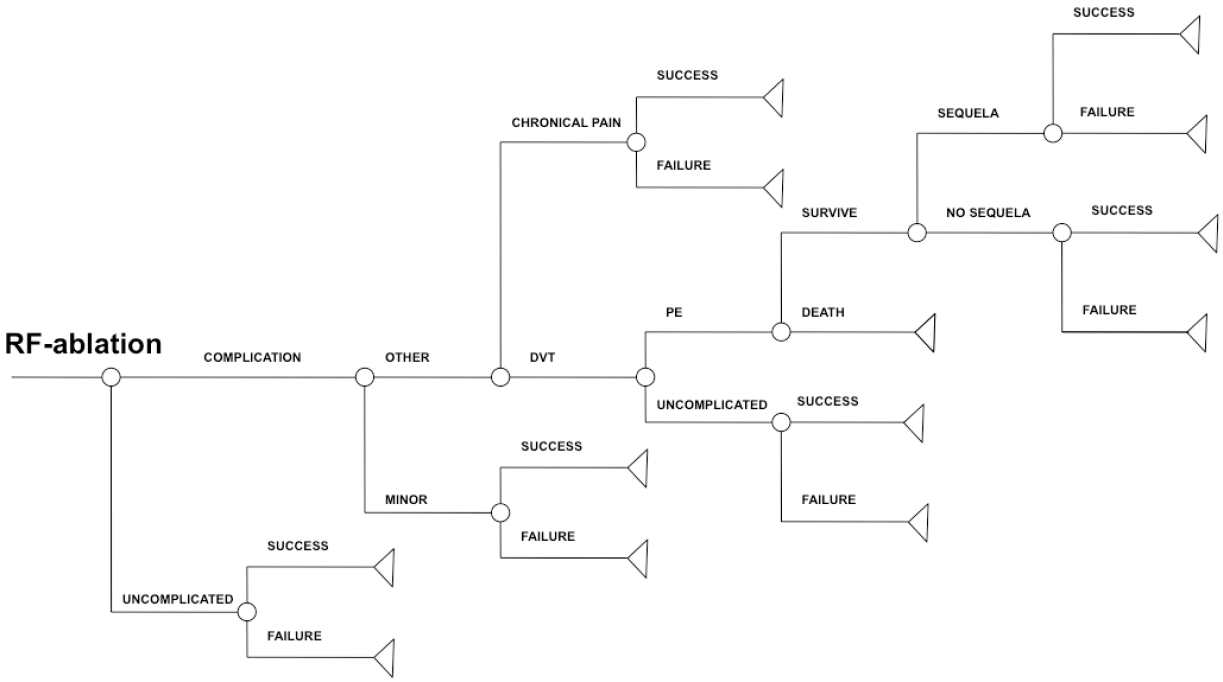


Figure 4 – Tree structure for the Radio-frequency ablation strategy



Probabilities, costs and utilities were represented by distributions to allow for probabilistic sensitivity analysis ([21]). Cost data are usually skewed and may range from zero to infinity, the common approach is to use lognormal or gamma distributions – the latter was chosen in the current model. For the probabilities, these always lie between 0 and 1 and the conventional distribution is beta, as used is in this model. Utilities can span from negative infinity (states worse than death) up to 1. The utilities are then represented with disutilities (1.0 minus the disutilities), and lognormal or gamma or beta distributions may be used. When no negative utilities are present in the model, beta distributions may be used as in this model.

The model was developed to capture health care costs as well as other costs (societal perspective). The option to restrict to only direct cost was also modelled to use a somewhat narrower health care provider setting. In the former, the costs of production losses from work absenteeism were included.

3.2 Model assumptions

All costs assumed to be equal between the strategies were omitted (e.g. preoperative assessment). Based on availability of data in the existing literature a 1-year perspective was chosen to represent the postoperative course ([5]).

Based on epidemiological data on demography ([2], [30]) a *base case* representative of the patient population was chosen for modelling purposes. This representative was a female aged 50 with vena saphena magna insufficiency graded as CEAP C2 ([31]). The choice of base case had an influence on the following input data; *life expectancy*, *annual income*, *success-rates* after the different treatment options and the *rate of complications*.

Postoperative complications:

Minor complication: A «minor complication» is a hybrid state representing a range of different complications described for the various treatments ([32-36]). The most common complication is haematoma, wound infection, temporary sensory loss and pain or bruising ([32-36]).

DVT/PE: The pathophysiology and causality of DVT and PE are highly complex ([37]). Both diseases are intervened in causality and prognosis. For the current model a simplification was made so that PE could only follow DVT. Further, post-thrombotic syndrome (PTS) was only modelled as a complication in PE. Under the assumption that PTS would be less severe after DVT it was omitted in the DVT state. Another simplification was the choice of not modelling recurrent VTE due to the time frame of the model. Studies have reported up to 30% recurrence of VTE after the initial event,

however a majority of these happen beyond the first year of the initial VTE ([37]).

Chronic pain: The state of chronic pain is modelled as separate from minor complication due to its persisting duration. This complication is probably due to nerve damage and occurs because of the close proximity of nerves to the varicose vein ([73]). Modelling this state was initiated by the expert panel due to a significant incidence found in their work with patient claims in The Norwegian System of Patient Compensation (NPE).

3.3 Input parameters

A PubMed search was done on the 20th of July 2013 identifying randomised controlled trials and meta-analyses from 2003 to date on the five relevant treatment options. Search terms were; «varicose veins», «radiofrequency ablation, RFA», «endovenous laser therapy, EVLA», «high ligation and stripping, stripping and sapheno-femoral ligation», «steam sclerosis», «cyanoacrylate, Saphenon, VenaSeal.» The initial search resulted in 175 papers on «RF-ablation», 604 papers on «EVLA», 114 papers on «HL/S», 11 papers on «steam» and 1 paper on «glue». The highest-level evidence papers were then selected according to GRADE ([38]) criteria so that meta-studies and randomised controlled trials were used where available. A minimum 1-year clinical follow-up was used as cut-off for inclusion. Reference lists of meta-studies were explored.

3.3.1 Probabilities/clinical effectiveness:

The probabilities used in the model are presented in table 2. The highest level of evidence data has been used where available, only where no data have been found expert opinion has been used. Ranges of the different estimates are presented in the table.

Table 2 – Probabilities used in the the model

Unit	Value	SD [(a)]	Source	Comment
Failure HL/S	0.0585	0.0292	(39, 40-42, 9, 10, 13, 43-47)	Literature search – pooled average
Failure EVLA	0.0490	0.0245	(39, 40-42, 9, 10, 13, 47-54)	Literature search – pooled average
Failure RFA	0.0815	0.0407	(10, 43-45,47, 48)	Literature search – pooled average
Failure SVS	0.039	0.0195	(27)	Cohort, n=75
Failure CA	0.08	0.04	(29)	Cohort, n=38
Minor complication HL/S	0.145	0.0725	(10)	RCT, n=59
Minor complication EVLA	0.088	0.044	(10)	RCT, n=62

Minor complication RFA	0.216	0.108	(10)	RCT, n=137
Minor complication SVS	0.173	0.0865	(27)	Multi-centre cohort, n=88
Minor complication CA	0.21	0.105	(29)	Cohort, n=38
DVT HL/S	0.053	0.026	(55)	Cohort, n=377
DVT RFA	0.07	0.035	(56, 57)	Retrospective case-series, n=277
DVT EVLA	0.01	0.005	(57)	Retrospective case-series, n=350
DVT SVS	0	0	(27)	Cohort, n=75
DVT CA	0	0	(29)	Cohort, n=38
Chronic pain HL/S	0.015	0.0075	Expert opinion	Danish registry of patient injuries. (I.G.)
Chronic pain Endovascular treatments	0.0075	0.00325	Expert opinion	Danish registry of patient injuries. (I.G.)
PE in DVT under adequate treatment	0.044	0.022	(37)	Systematic review, n=2093, accumulative 6 months
Death in PE under adequate treatment	0.036	0.018	(37)	Systematic review, n=2093, accumulative 6 months
Sequela in PE – Posthrombotic syndrome	0.18	(0.147-0.213)	(58)	Retrospective case-series, n=1626

(a) When SD was not available, ½ "Value" was set as SD

3.3.2 Utilities; QALYs and QALY weights

A simplified literature search was done in PubMed using the search terms; "utilities", "QALY", "DVT", "deep venous thrombosis", "PE", "pulmonary embolism" and "complications". Reference lists were also explored looking for appropriate QALY-weights. As recommended by the National Institute of Clinical Excellence (NICE), priority was given to utilities that were derived from a generic utility instrument (EQ-5D, SF-6D or HUI) in clinical trials ([74]). The utilities for *varicose veins* disease and for *surgery* are both based on SF-6D from clinical trials. Secondary the utilities for DVT, PE, sequela after PE and chronic pain were based on time trade-off (TTO). Choice-based methods for valuation of health states like time trade-off, standard-gamble and VAS (visual analogue scale) are also conventional ways of valuing health states. They are, however, often based on a public audit and not actual patients ([74]). In cases where no equivalent health-state could be found, a health state resembling that in the model has been chosen with similar characteristics concerning chronicity and severity (e.g. chronic pain).

In the «DVT» arm of each treatment option «death» has been assigned as a possible outcome of pulmonary embolism. The associated life year loss was based on 2012 mortality tables from Statistics Norway ([59]). For a 55-year-old woman the life year loss was 29.4, or 16.8 discounted at 4%. A differentiation has been made in the postoperative disutility due to surgery. Based on the findings of Michaels and co-workers of different *quality of life* reporting at 1 week post-surgery after conventional surgery and the EVLA-procedure, one has chosen to only calculate with this

disutility in those treated with HL/S ([12]).

Table 3 – Health related quality of life (utilities) according to disease states

Unit	Value	SD	Source	Comment
Varicose vein	0.79	0.1	(12)	SF-6D in 77 patients
Surgery	0.60	0.1	(12)	SF-6D
Minor complication	0.82	0.1	(12)	Expert opinion
DVT	0.88	0.1	(60)	54 patients retrospect, TTO
PE	0.66	0.1	(60)	54 patients retrospect, TTO
Sequela PE – post thrombotic syndrome	0.79	+/- 0.32	(61)	TTO, Post ICU-patients
Chronic pain	0.74	0.1	(62)	TTO, 102 public patients

3.3.3 Costs

All costs were measured in 2013 Norwegian kroner (NOK). The average wage rate for women in public sector was NOK 439,200 (NOK 36,600 per month) for 2012 according to Statistics Norway ([63]).

Table 4 – Unit costs of the model

Unit	Unit cost (NOK)	SD	Source	Comment
HL/S	6,470	2,500	Haraldsplass Deaconess Hospital/Helse Bergen HF	Table 5
EVLA	5,580	2,500	Haraldsplass Deaconess Hospital/Helse Bergen HF	Table 6
RFA	5,986	2,500	Haraldsplass Deaconess Hospital/Helse Bergen HF	Table 7
SVS	5,088	2,500	Haraldsplass Deaconess Hospital/Helse Bergen HF	Table 8
CA	12,125	2,500	Haraldsplass Deaconess Hospital/Helse Bergen HF	Table 9
Minor complication	5,000	1,000	Average costing/DRG-weight	Table 10
DVT	5,000	1,000	Average costing/DRG-weight	Table 11
PE	10,000	2,500	Average costing/DRG-weight	Table 12
Sick Leave per month	36,600	5,000	Statistics Norway	Based on average pay women 55 (2013)
Loss of future production	2,835,572	500,000	NAV, Labour market Statistics	Discounted (0.04) average loss of production of woman from age 55-67
Misc.				
Sick leave HL/S	12 days		Expert opinion	
Sick leave EVLA	3 days		Expert opinion	
Sick leave RFA	3 days		Expert opinion	
Sick leave SVS	3 days		Expert opinion	
Sick leave CA	1 day		Expert opinion	

For the costs of the different surgical techniques a micro-costing has been done. Prices of procedure specific multi-use and disposable equipment are collected from the Norwegian distributors of the technical equipment. Procedure related costs for single-use and multi-use equipment are collected from Haraldsplass Deaconess Hospital, while average wage-rates are collected from Helse Bergen HF. Detailed cost-data are presented in tables 5 throughout 9.

Table 5 – Costing of high ligature and stripping at day-surgery unit (a)

Cost Item	Cost (NOK)	Comment/Source
Procedure related disposables	789	Surgical drapes, dressings, suture, gloves, sterile wash etc.
Multi-use surgical equipment	108[(b)]	
Overhead costs	2,659	From Norwegian Directorate of Health "DRG 2013" (64)
Personnel costs for procedure at outpatient clinic	2,658	Based on average wages in Helse Bergen HF. Including social costs. Only procedure related cost are accounted for.
Reprocessing of multi-use equipment	267	(75). The costs have been adjusted for change in consumer price index to 2013 NOK.
Total	**6,470**	

(a) All costs without VAT
(b) A 1-year straight-line depreciation has been used. 100-patients/year is assumed.

Table 6 – Costing of laser ablation at outpatient clinic (a)

Cost Item	Cost (NOK)	Comment
Procedure specific disposables	2,230	Catheter and introducer
Procedure related disposables	389	Surgical drapes, dressings, suture, gloves, sterile wash etc.
EVLA console per patient	200[(b)]	
Multi-use surgical equipment	54[(c)]	
Tumescence pump	22[(b)]	
Overhead costs	1,330[(d)]	From Norwegian Directorate of Health "DRG 2013" (64)
Personnel costs for procedure at outpatient clinic	1,088	Based on average wages in Helse Bergen HF. Including social costs. Only

		procedure related costs are accounted for.
Reprocessing of multi-use equipment	267	(75). The costs have been adjusted for change in consumer price index to 2013 NOK.
Total	**5,580**	

(a) All costs without VAT
(b) A 5-year straight-line depreciation has been used. 100 patients/year is assumed
(c) A 1-year straight-line depreciation has been used. 100 patients/year is assumed
(d) For procedures at the outpatient clinic ½ the overhead cost of that of the day-surgery unit has been assumed

Table 7 – Costing of radiofrequency-ablation at outpatient clinic (a)

Cost Item	Cost (NOK)	Comment
Procedure specific disposables	2,700	Catheter
Procedure related disposables	389	Surgical drapes, dressings, suture, gloves, sterile wash etc.
RF system generator	136[(b)]	
Multi-use surgical equipment	54[(c)]	
Tumescence pump	22[(b)]	
Overhead costs	1,330[(d)]	From Norwegian Directorate of Health "DRG 2013" (64)
Personnel costs for procedure at outpatient clinic	1,088	Based on average wages in Helse Bergen HF. Including social costs. Only procedure related cost are accounted for.
Reprocessing of multi-use equipment	267	(75). The costs have been adjusted for change in consumer price index to 2013 NOK.
Total	**5,986**	

(a) All costs without VAT
(b) A 5-year straight-line depreciation has been used. 100 patients/year is assumed
(c) A 1-year straight-line depreciation has been used. 100 patients/year is assumed
(d) For procedures at the outpatient clinic ½ the overhead cost of that of the day-surgery unit has been assumed

Table 8 – Costing of steam vein sclerosis at outpatient clinic (a)

Cost Item	Cost (NOK)	Comment
Procedure specific disposables	1,800	Catheter
Procedure related disposables	389	Surgical drapes, dressings, suture, gloves, sterile wash etc.
SVS system generator	138[(b)]	
Multi-use surgical equipment	54[(c)]	
Tumescence pump	22[(b)]	

Overhead cost	1,330[(d)]	From Norwegian Directorate of Health "DRG 2013" (64)
Personnel costs for procedure at outpatient clinic	1,088	Based on average wages in Helse Bergen HF. Including social costs. Only procedure related cost are accounted for.
Reprocessing of multi-use equipment	267	(75). The costs have been adjusted for change in consumer price index to 2013 NOK.
Total	**5,088**	

(a) All costs without VAT
(b) A 5-year straight-line depreciation has been used. 100 patients/year is assumed
(c) A 1-year straight-line depreciation has been used. 100 patients/year is assumed
(d) For procedures at the outpatient clinic ½ the overhead cost of that of the day-surgery unit has been assumed

Table 9 – Costing of cyanoacrylate at outpatient clinic (a)

Cost Item	Cost (NOK)	Comment
Procedure specific disposables	9,000	Introducer and glue
Procedure related disposables	389	Surgical drapes, dressings, suture, gloves, sterile wash etc.
Multi-use surgical equipment	54[(c)]	
Tumescence pump	22[(b)]	
Overhead cost	1,330[(d)]	From Norwegian Directorate of Health "DRG 2013" (64)
Personnel costs for procedure at outpatient clinic	1,088	Based on average wages in Helse Bergen HF. Including social costs. Only procedure related costs are accounted for.
Reprocessing of multi-use equipment	267	(75). The costs have been adjusted for change in consumer price index to 2013 NOK.
Total	**12,150**	

(a) All costs without VAT
(b) A 5-year straight-line depreciation has been used. 100 patients/year is assumed
(c) A 1-year straight-line depreciation has been used. 100 patients/year is assumed
(d) For procedures at the outpatient clinic ½ the overhead cost of that of the day-surgery unit has been assumed

Minor complication: An average costing has been performed to give an average price of the state "minor complication" (table 10). DRG weight and unit cost are from Activity Based Financing (in Norwegian: "Innsatsstyrt finansiering 2013") by The Norwegian Directorate of Health ([64]).

Table 10 – Costing of a "minor complication" (a)

Type of service/ intervention	Unit	Unit cost (NOK)	Total cost (NOK)	Comment
Visit to outpatient clinic	1.5	868	1,302	Based on DRG 905E (b)
Antibiotics	0.5	153	77	10 days of Dalacin
Painkillers	0.5	113	56	Box of Pinex Forte
One sick day	3	1,830	5,490	Average pay 2013 for women 50-55 ([63])
Total			**6,924**	

(a) I.e. bleeding or small infection
(b) From Activity Based financing 2013 ([64])

PE: An average costing has been performed after consulting the expert panel (G.H.) on the treatment of a PE as a complication to surgery (table 11). DRG weight and unit cost are from Activity Based Financing ([64]).

Table 11 – Costing of a case of PE

Type of service/ intervention	Unit	Unit cost (NOK)	Total cost (NOK)	Comment
Admittance	1	55,147	55,147	Based on DRG 78 (a)
Klexane pack of 10 pre-filled disposable syringes	1	479	479	5 days initial anti-thrombotic treatment
Warfarin box of 100 2.5 mg tablets	8	129	1,035	Secondary anti-thrombotic treatment
One sick day	5	1,830	9,150	Average pay 2013 for women 50-55 ([63])
Total			**65,811**	

(a) From Activity Based financing 2013 ([64])

DVT: An average costing has been performed after consulting the expert panel (G.H.) on the treatment of a DVT as a complication to surgery (table 12). DRG weight and unit cost are from "Activity Based Financing" by The Norwegian Directorate of Health ([64]).

Table 12- Costing of a case of DVT

Type of service/ intervention	Unit	Unit cost (NOK)	Total cost (NOK)	Comment
Admittance	1	32,504	32,504	Based on DRG 131 (a)
Klexane pack of 10 prefilled disposable syringes	1	479	479	5 days initial anti-thrombotic treatment
Warfarin box of 100 2.5 mg tablets	4	129	518	Secondary anti-thrombotic treatment

One sick day	3	1,830	5,490	Average pay 2013 for women 50-55 ([63])
Total			**38,991**	

(a) From Activity Based financing 2013 ([64])

Sick leave: We assumed that one month represents 20 days of work (given a standard 5-day Norwegian work week). One day of work absenteeism represent a wage of NOK 1,830. We added 40% to account for employer's additional contributions. Sick leave in the different groups of surgery were based on expert evaluation, numbers from the literature confirm the difference in sick leave for the different methods ([9,35]).

Loss of future production: The probability of not being employed was based on average of age-adjusted rates from NAV. For women 55-59, 60-64 and 65-67 the rates were 19.9%, 27.3% and 14.7%, respectively. Based on these numbers, the probability of being employed was consequently assumed to be 80% throughout the period 55-67 years. In Norway the retirement age is 67 years and no production beyond age of 67 was included. The calculated production loss, if the patient dies within the first year after varicose vein surgery, was found to NOK 2,835,572. This cost was discounted at a conventional 0.04%.

3.4 Evaluation of the model

To evaluate the robustness of the model probabilistic sensitivity analysis was applied. This allowed for evaluation of all parameter uncertainties by replacing point estimates in the model by conventional probability distributions. Due to non-linearity of the model, the mean of the expectation is not equal to the expectation of the mean ([21]). The model results were therefore based on Monte Carlo simulations.

Monte Carlo simulation with 10,000 iterations was run to get an estimate on the overall uncertainty in the model. The alternative strategies were ranked by expected (mean) cost. Strategies that were more expensive and did not offer any greater expected benefit was denoted as "dominated" and therefore excluded. The incremental cost-effectiveness ratios (ICER) for the non-dominated strategies are presented. Also cost-effectiveness acceptability curves (CEAC) were used as a summary of the uncertainty in the estimates of the cost-effectiveness ([20]). A suggested threshold for cost-effectiveness in the Norwegian Health Insurance Scheme of NOK 500,000 was applied and the decision uncertainty in that the given strategy is the most cost-effective in this threshold will be presented ([65]).

4. Results

One year without any treatment for varicose veins entailed a QALY of 0.790, but no costs (table 7 and 8). The highest QALY over the first year was found in the SVS and EVLA strategy (0.976 and 0.975, respectively), the lowest QALY was found in RF-ablation (0.960). In terms of societal costs, the HL/S strategy had the highest expected total cost over the first year (NOK 29,275), while EVLA had the lowest (NOK 13,010).

Table 13 – One-year costs (2013 Norwegian Kroner (NOK)) and outcome (QALYs) in a societal perspective according to strategy (a)

Treatment strategy	**Cost of surgery** (NOK)	**Expected total cost over the 1st year** (NOK)	**Expected QALY over the 1st year**	**Incremental cost**	**Incremental QALY**	**ICER**
No treatment	0	0	0.790	0		
Laser ablation (EVLA)	5,580	13,010	0.975	13,010	0.18	70,539
Steam vein sclerosis (SVS)	5,088	13,317	0.976	307	0.001	327,807
Cyanoacrylate adhesive (CA)	12,150	17,362	0.969	4,045	Dominated	Dominated
RF ablation RF)	5,986	17,505	0.960	4,188	Dominated	Dominated
High ligation/ stripping (HL/S)	6,470	29,275	0.971	15,958	Dominated	Dominated

(a) Results from Monte Carlo simulation with 10,000 iterations.

Table 14 – One-year costs (2013 Norwegian Kroner (NOK)) and outcome (QALYs) in a health care perspective according to strategy (a)

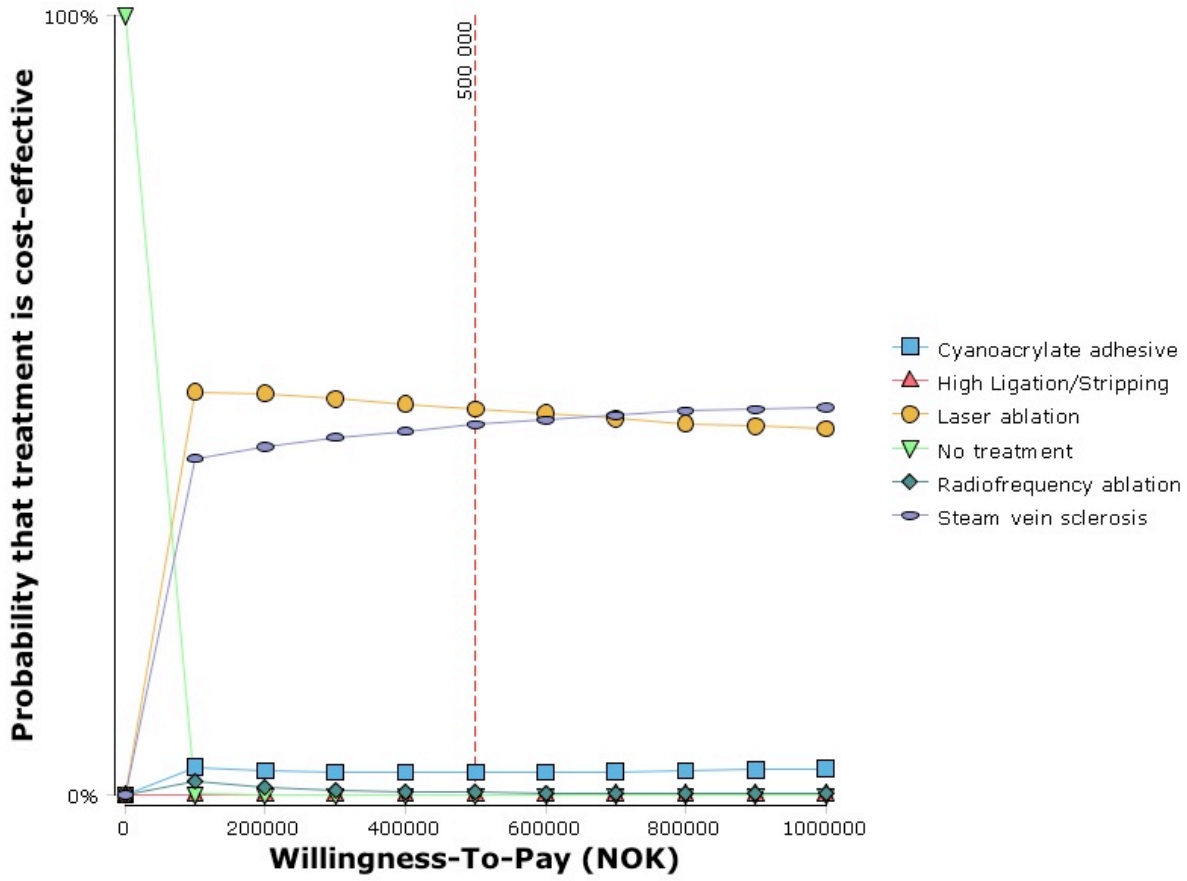
Treatment strategy	**Cost of surgery** (NOK)	**Expected total cost over the 1st year** (NOK)	**Expected QALY over the 1st year**	**Incremental cost**	**Incremental QALY**	**ICER**
No treatment	0	0	0.79			
Steam vein sclerosis (SVS)	5,088	6,304	0.975	6,304	0.19	34,005
Laser ablation (EVLA)	5,580	6,576	0.975	273	Dominated	Dominated
RF ablation (RF)	5,986	9,577	0.960	3,272	Dominated	Dominated
High ligation/stripping (HL/S)	6,470	9,679	0.971	3,374	Dominated	Dominated
Cyanoacrylate adhesive (CA)	12,150	13,585	0.969	7,280	Dominated	Dominated

(a) Results from Monte Carlo simulation with 10,000 iterations.

In the societal perspective EVLA is the most cost-effective treatment strategy with an ICER of NOK 70,539 as compared to the no-treatment strategy (table 13). Replacing EVLA by SVS entails NOK 327,807 per additional QALY. All other strategies had higher costs and worse outcome (were strictly dominated).

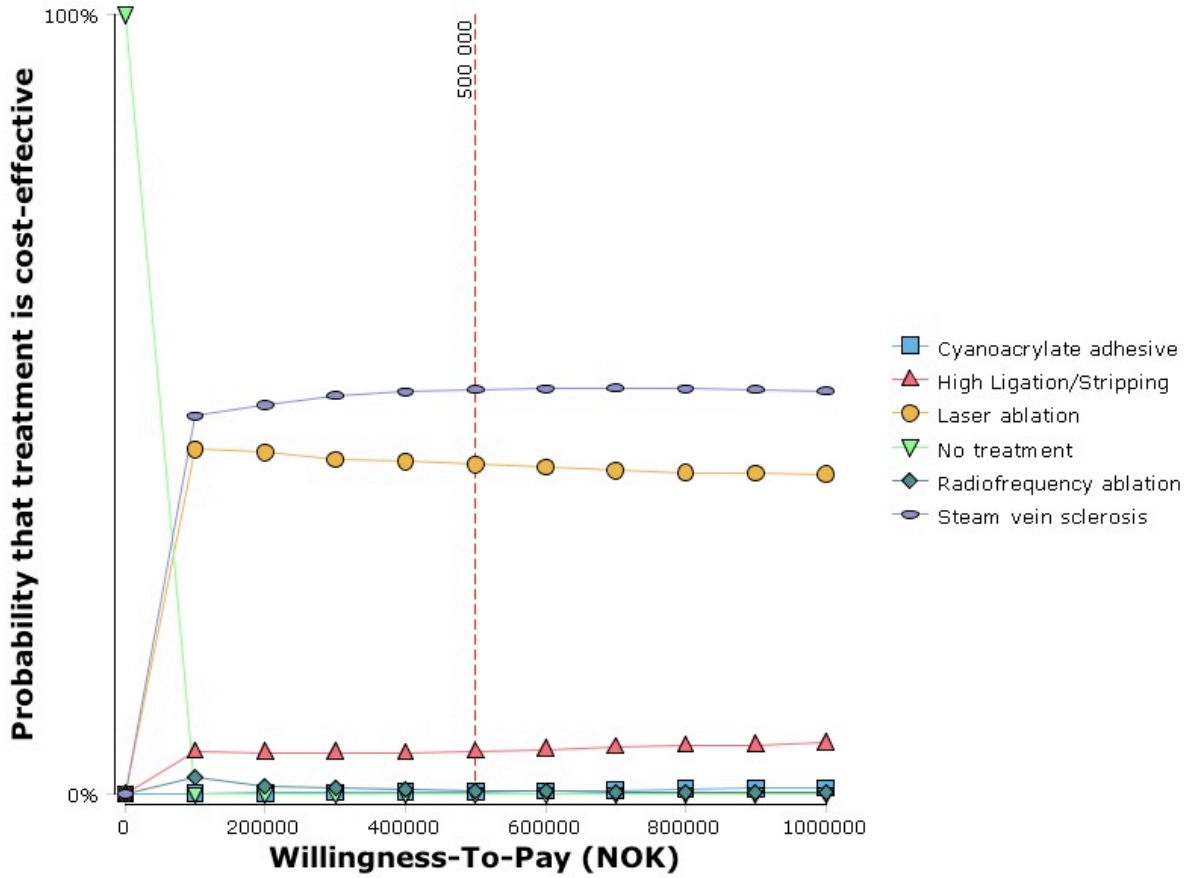
In the health care perspective SVS is the most cost-effective strategy with an ICER of NOK 34,005 as compared to the no-treatment strategy (table 14). All other cases were strictly dominated.

Figure 5 – Cost-effectiveness acceptability curve (CEAC) of treatment strategies from analysis using the societal perspective



In a societal perspective, using a willingness to pay of NOK 500,000 for a QALY, the probability that EVLA is cost-effective was 45% while the probability that SVS is cost-effective was 42% (figure 10). For RF, CA, HL/S and no treatment these probabilities are all below 5%.

Figure 6 – Cost-effectiveness acceptability curve (CEAC) of treatment strategies from analysis using the health care perspective



In the health care perspective, using a threshold of NOK 500,000 per QALY, the probability that SVS is cost-effective was 50% and the probability that EVLA is cost-effective was 42% (figure 11). For HL/S the probability that the treatment was cost-effective was 8%, while CA, RF, and no treatment had a probability all below 5%.

5. Discussion

5.1 Main results

The results of this study indicate that the optimal choice of treatment for varicose veins depends on the perspective of the decision maker. In a societal perspective endovenous laser ablation (EVLA) is the most cost-effective surgical treatment strategy of the five comparators (EVLA, SVS, RF, HL/S, CA) while in a health care perspective SVS is the optimal choice. Due to the minimal differences in the clinical effectiveness of the treatment strategies, the differences in societal costs had a major influence on the results when comparing the two perspectives.

To the best of our knowledge, this study is the only cost-effectiveness analysis on varicose vein surgery performed in a Norwegian Health Care setting. The results favouring the endovascular laser treatment, however, are not unique. Gohel and co-workers also report that EVLA likely would be cost-effective given a potential NHS threshold of GBP 20,000-50,000 ([11]). The optimal choice of treatment in their analysis, however, was UFGS. The recent health technology assessment performed by Carroll and co-workers had the same finding; the UFGS alternative was favoured over EVLA treatment. ([66]). As formerly addressed, there have been concerns about the safeness of UGFS because of reports of cerebral and neurological side effects of this treatment strategy ([9],[22],[23]). These effects were not modelled in any of the studies above. Another concern is the relatively high early recurrence rate within the first 3 months of initial surgery. In the base case analysis of the Gohel model this contributed to a low probability (<10%) that the UFGS alternative would be cost-effective at a willingness-to-pay threshold of £20,000 GBP. The UGFS is not used in the Norwegian Health Care System and has therefore not been considered in his thesis.

5.2 Limitations of the model

A major concern of most decision models is the adequacy of the chosen time-perspective. Due to the characteristics of the available data (see *Limitations of the* data) the chosen time-perspective was one year after surgery. Despite the relatively short time horizon, both the majority of costs and the most common complications seem to be encompassed by the first postoperative year ([5,12,66]). A one year perspective, however, will likely underestimate the health gain of varicose vein surgery due to the failure to include future QALY-gains of the treatment - also, the recurrence of varicose veins beyond the first postoperative year was omitted in the current model. In a work by Kuhlmann and co-workers varicose vein treatment by HL/S and RFA was modelled in the Statutory German Health Insurance setting ([8]). They found that the robustness of the economic analysis did deteriorate with the length of the time perspective due to the lack of good input data. In light of this potential

trade-off between the accuracy of the model and the completeness of the perspective, we believe that the current work gives an adequate presentation of the treatment alternatives.

In the current thesis we chose to model only treatment of unilateral varicose vein disease. Although unilateral treatment is the more conventional surgical approach, there are reports recommending bilateral concomitant varicose vein treatment ([67]). Since a majority of patients have bilateral varicose vein disease, such practice is likely to increase if more reports find it safe. Certainly, concomitant surgery of both legs is likely to yield the most cost-effective treatment strategy regardless of the modality used for treatment. Hopefully future models will shed light on the cost-effectiveness of bilateral treatment.

Although few severe complications are seen after modern varicose vein surgery, there is a range of minor complications (risk 1:100 or less) lasting from hours to weeks or months after surgery ([32-36]). The choice, in the current model, to construct a standardized hybrid *minor complication* is a simplified synthesis of the findings in the literature. Variation in the definition and reporting of complications makes more refined modelling of these complications difficult. Accordingly, the results related to the modelling of these *minor complications* should be interpreted with caution. *Chronic pain* and *deep venous thrombosis* are states describing more uniform and severe complications in the current model. The former was suggested by one of the members of the expert panel (I.G.) due to extensive work with claims for compensation from The Norwegian System of Patient Compensation (NPE). A postoperative condition with a permanent painful leg would be due to a lesion of one of the nerves in close proximity of the vein ([73]). This complication was formerly more common when ligature and stripping was performed from the groin to the ankle due to the close proximity of the saphenous nerve to the vein below the knee ([68]). Today it is conventional to strip only from the groin to the knee and other nerves are therefore at risk. More recent reports are needed to provide data on nerve damage after alteration of the technique.

In itself *deep venous thrombosis* is only a minor complication since it frequently occurs once and resolves without any permanent sequela ([37]). *Any* VTE, however, entails a potential to progress from a minor incident to a clinically symptomatic PE where the mortality rate is non-negligible ([69]). This makes it an important complication to consider since minor differences in the incidence of DVT could potentially change the results of an economic evaluation when modelling the treatment options of varicose vein surgery. Not only would death as a result of severe PE cause loss of potential future life years, admittance to a hospital ward in the case of VTE could be a major cost driver. In 2013, the estimated costs of in-hospital care for DVT and PE was NOK 32,504 and NOK 55,346 respectively ([64])

5.3 Limitations of the data

A challenge when modelling treatment for varicose veins is the somewhat skewedness of the available data on the clinical effectiveness and the incidence of complications after surgery. The more established of the methods, i.e. HL/S, RF and EVLA has a substantially larger body of published studies, allowing more accurate estimates of probabilities and clinical effectiveness. To date, there only exists a few clinical studies on the effectiveness of the SVS and CA treatment ([27], [29]), therefore the evidence is less robust than for the former three. Hopefully, future clinical studies will contribute with more data so that future modelling will provide less uncertain cost-effectiveness estimates.

When performing the literature search on clinical outcome and complications following surgery, the length of follow-up time was limited for most treatment options. Short-term studies were common and only a few studies reported on 5-year follow-up after surgery ([5]). Even though short-time evaluation seems to be conventional for varicose vein surgery, there is a need to reveal the long-term outcomes beyond the first 12-24 months after treatment. Another issue with modelling varicose vein treatment over time is to differentiate between recurrence of varicose vein surgery due to *patency* of the formerly treated vein and a progress of the underlying disease of varicose vein insufficiency. Cohort studies/clinical long-term follow-up evaluations could perhaps help unveil such a differentiation if the treated vein was compared to an untreated contralateral leg.

A somewhat diverse reporting of outcomes also reflects a lack of consensus in the literature – to the best of our understanding; "re-canalization", "clinical failure" and "patency" seems to all refer to a recurrence of flow in the treated vein at the time of follow-up, and therefore describes whether the treatment did cure the insufficiency or not ([5]). In this study, the three terms have been considered to have the same clinical significance and are named *failure* in the model. "Technical error" seems to reefer to an immediate failure during surgery to remove the reflux of the treated vein ([5], [9], [34]). "Neovascularization" seems both to describe the progress of insufficiency in collateral veins or the formation of new varicose veins not seen on initial diagnosis ([5], [34], [47]). The latter has been interpreted as a progress of the underlying disease and therefore omitted in inclusion of outcomes success/failure in the current thesis.

In the current thesis a micro-costing of the various surgical treatments has been attempted. Multi-use procedure specific equipment, disposable procedure specific equipment and use of personnel have been identified and valued (table 5 throughout 9). The endovascular treatment alternatives are known to have a higher cost for the disposable equipment involved in the procedure (e.g. RF/Laser/SVS catheters, cyanoacrylate glue) than the HL/S. Since all the endovascular therapies

can be done in an office-based setting, these costs are partially set off by the savings when there is no need for an operating room (OR). As discussed by Macario and co-workers, estimating the costs of running an OR can be a tortuous endeavour –a cost between $29-80 2010 USD per minute, depending on the complexity of the surgical case, has been proposed ([70]). As compared to the more easily identifiable *procedure related* costs, estimating the *overhead-costs* (ranging from electricity bills to facility maintenance) is a complex and time-consuming task. In the current work, the overhead-costs are represented by costing rules from the Norwegian Directorate of Health ([64]). In a study by Schreyögg and co-workers a micro-costing approach for appendectomy was performed across 54 hospitals in 9 European countries ([74]). The over-head costs were highly variable across hospitals and across countries, spanning from EUR 105 to EUR 2028 where Spain had the lowest costs and Denmark had the highest costs. Variability in overhead-cost are likely to depend strongly on factors such as size of the surgical facilities and the case-mix of surgical cases, therefore the approach used in the current thesis might be somewhat crude in estimating the true overhead costs.

The utilities used for the different health states post-treatment are all collected from published studies ([12], [60-62]). They come from heterogeneous populations and have been acquired with the use of different valuation methods. Whilst only one of the utilities is the expression of an expert opinion, two come from multi-attribute utility instrument (EQ-5D and SF36) and four are from time trade-off (TTO). The use of health-states across valuation methods is somewhat troublesome as have been discussed by Morimoto and co-workers ([71]). The prevailing opinion is that rating-scales yield the lowest, TTO the middle and SG the highest utility for the same health states. In light of this finding, the current use of 0.79 (from SF-36) as a value for the health state *varicose veins* can perhaps overestimate the disutility of this disease as compared to other health states valued by SG – and therefore also overestimate the potential QALY gain by varicose vein surgery ([12]). However, for the purpose of the model per se, the same QALY-weight was used in all treatment pathways and did therefore not contribute to any difference between the 5 alternative treatments.

5.4 Policy implications

To our knowledge, no other study has attempted to explore the cost-effectiveness of state-of-the art varicose vein surgery in a Norwegian Health Care setting. The results of the analysis can therefore serve as a basis for chosing techniques in varicose vein surgery. The model structure and input data of the thesis has been made transparent so that new knowledge or data can be utilized in refining such a model.

Varicose vein disease is a challenge because of its high prevalence in the middle-aged female population ([2], [30]). It is seldom a serious threat to the overall health per se, but has a potential

development to venous ulcers – a costly and troublesome end-stage of the disease ([2], [72]). The current finding is in line with former studies indicating that an active surgical approach is a cost-effective strategy for clinically symptomatic varicose vein disease (CEAP C2) ([8], [12], [66]). For less severe stages of varicose vein disease, there is little evidence on the cost-effectiveness on surgical intervention. For lighter cases where the cosmetic concern is of dominance, The National Insurance Scheme of Norway should therefore likely not reimburse treatment of these stages.

An important finding in the current study is the great difference in the total cost of the first year of treatment between the health care and the societal perspective. In light of a relatively small difference in the clinical effectiveness of the treatment strategies, there seems to be a much higher societal cost for the traditional HL/S strategy due to the long sick leave period as compared to endovascular alternatives. We would therefore argue that a societal perspective is important when undertaking such a cost-effectiveness analysis. A common opinion, also commented by the expert panel, is that the cost of single-use devices in the endovascular treatment alternatives (approximately NOK 2,000-3,000) and the initial investment in a generator for the thermal ablation techniques (approximately 80,000-90,000 NOK) can affect the choice of changing from conventional HL/S to an endovascular technique.

As formerly commented, there is more effectiveness data available for the more established of the endovascular treatment alternatives. More research should be done to establish both short-term and long-term outcomes of these methods. Also there is a need for further investigation of the cost components involved in, and the pricing of surgery in day-care units as opposed to surgery at the outpatient clinic. With a development of more and more mini-invasive surgical techniques this will be valuable knowledge to Health Care organisations investigating implementation of new technologies.

5.5 Conclusions

When comparing high ligation and stripping, laser ablation, radiofrequency ablation, steam sclerosis and cyanoacrylate for treating moderate symptomatic varicose vein disease in a middle-aged woman – using published data for clinical effectiveness and Norwegian cost-data; laser ablation (EVLA) is the most cost-effective treatment strategy with an ICER of NOK 70,539 (compared to no treatment) and a probability of being cost-effective of 45% at a willingness-to-pay threshold of NOK 500,000. Social costs (sick-leave, loss of future production due to death as a complication of surgery) have a major impact on cost-effectiveness analyses and should therefore be considered when making decisions on implementing new surgical techniques. Finally, further efforts should be done to refine the cost-data of the surgical techniques considered in the current thesis.

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