Costing analysis of a web-based platform and of standard treatment of care of patients with osteoarthritis in Sweden

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Abstract

Osteoarthritis (OA) constitutes a significant burden on patients, health care systems, and on the broader society. It is estimated that around a quarter of the adult population in Sweden is affected by osteoarthritis in the knee, hip, or hand. The prevalence of the disease is projected to continue increasing over the coming decades, largely due to aging and adverse life-style factors. The pressure on health care systems will continue to increase as a consequence. Prevention and effective care are considered critical to manage the challenge posed by osteoarthritis. In parallel, digital technologies offer opportunities to deliver care in potentially cost-effective ways, including for osteoarthritis. This study conducts a costing analysis of a new digital platform (Joint Academy) for delivering care to patients with osteoarthritis and compares that with the existing model of treatment provided according to national guidelines in Sweden (the BOA program). The results show that the digital model costs around one quarter (26%) of the existing face-to-face model of care. Based on existing evidence on the effects of the alternative models, the findings also suggest that the digital model offers a cost-effective alternative to the existing model of OA care. Depending on the extent to which the digital model can substitute for the existing model of care, significant resources can be saved.

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Introduction

The development and application of digital technologies across the health sector provide the opportunity to deliver care to patients in new ways. Among other things, care can be provided by means of internet-based digital platforms that are readily available to large groups of patients and the general public at large. These types of telehealth applications have the potential to provide care at lower costs compared with traditional programs of care. Cost advantages are likely to exist both on the health care provider side and on the patient side, as well as to the broader society (Elbert, Os-Medendorp et al. 2014; McKinsey & Company 2016; Abimbola, Keelan et al. 2019).

One of the main advantages of digital telehealth innovations is the ability of patients to receive care in their home to avoid travelling back and forth from the provider's clinic. A recent example of such an application is Joint Academy (JA), which is used to deliver care to patients that have been diagnosed with osteoarthritis (OA) of the knee or hip (Dahlberg, Grahn et al. 2016; Nero, Dahlberg et al. 2017; Dahlberg, Dell'Isola et al. 2020).[1] The JA platform was developed from the existing evidence-based treatment for patients with OA, the Better Management of Patients with Osteoarthritis (BOA) program. Since its initiation in 2014, the JA platform has evolved to take full advantage of the available technology. The digital model of care consists of a patient interface that provides individually tailored information on exercises for rehabilitation and support for life-style changes. It also has a provider interface where a trained physiotherapist can monitor progress of the patient and provide feedback and support throughout the treatment period.

Evaluating the resources required to deliver the two alternative models of osteoarthritis care in the Swedish setting would contribute to informing policy making. The aim of this study is to assess the cost of providing the two models of care and to compare these to evaluate the differences in resource use. The study adopts a societal perspective by assessing all resources needed to deliver an episode of care to the patients. In particular, the analysis includes costs on the health system and patient side. The study also measures carbon dioxide (CO_2) emissions due to transportations undertaken by the patients. Based on the results of the costing analysis and on existing evidence on the effects of the two models of OA care, the incremental cost-effectiveness

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[1] ICD-10 XIII M15-M19.

ratio (ICER) is also computed. Finally, an analysis of the expenditure implications of scaling-up the most cost-effective model of care is done.

The next section provides a brief review of the international evidence on osteoarthritis in terms of prevalence and of the economic burden of the condition. The subsequent section describes the two models of care under investigation. The next two sections describe the methods and the findings of the main analysis, respectively. The study ends with a discussion of the results and draws some conclusions. The analysis did not review original patient data and did not require ethical approval.[2]

Osteoarthritis: prevalence and evidence on burden

Osteoarthritis is the most common disease affecting the joints of mainly the knees, hips, and hands. In terms of burden of disease it is estimated to be the 11th most common cause of disability in the world (Cross, Smith et al. 2014). In the U.S., OA is the fifth leading cause of disability (Bitton 2009). Due to its high prevalence and its debilitating effects, the economic cost of OA is estimated to be relatively high. While few high-quality studies exist, estimates of the economic burden of musculoskeletal diseases, of which OA is the most common, suggest that it may be as high as two percent of gross domestic product (GDP) in industrialized countries (c.f.). Estimates from various countries show that the indirect costs of OA (i.e. lost income, reduced productivity, spending on home care) can reach around USD 4,600 per person annually. The largest direct cost of OA includes the cost of medication and surgery. A recent cost-of-illness study of OA found that the total costs of the condition is estimated at around 10,000 euros per year (Salmon, Rat et al. 2016). Furthermore, people affected by osteoarthritis of the hip or knee face a higher risk of mortality and co-morbidities, especially from cardiovascular diseases . Primary and secondary prevention is therefore seen as critical in the management of OA at the level of populations (Litwic, Edwards et al. 2013).

Estimates from Sweden suggest that every fourth person is affected by osteoarthritis and that it is expected to increase in prevalence due to aging, obesity, and other life-style factors (Englund and Turkiewicz 2014; Nemes, Gordon et al. 2014). These changes will put additional pressure on health services, including those for primary care (Turkiewicz, Petersson et al. 2014). In turn, health care and other expenditures due to OA can be expected to increase unless effective

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[2] See Etikprövningslagen (2003:460; the Research Ethics Act) for details on specific requirements; https://etikprovningsmyndigheten.se/for-forskare/vad-sager-lagen/.

preventive measures can be identified and effectively implemented (Rolfson, Ström et al. 2012). Understanding the relative cost and effectiveness of available treatment and prevention alternatives would therefore appear to be of considerable policy relevance.

Treatment models

The costing analysis compares the resources needed to deliver two alternative treatment programs for osteoarthritis patients. The first model is the existing, best practice osteoarthritis treatment program in Sweden, the BOA-model.[3] This model is compared with a new web-based model of care, the Joint Academy platform for osteoarthritis care. Both models provide individually tailored rehabilitation programs for patients that have been diagnosed with osteoarthritis and where a non-surgical treatment regimen is deemed the most appropriate approach by an orthopedic surgeon.

The Better Management of Patients with Osteoarthritis (BOA)

The evidence-based treatment model of a patient who has been diagnosed with osteoarthritis of the knee, hip, or hand in Sweden is the Better Management of Patients with Osteoarthritis (BOA) program. Normally the person who has been diagnosed with osteoarthritis receives a recommendation by a general practitioner, a physiotherapist, or an orthopedic specialist to register with a BOA-program near his or her place of residence or work. In practice, however, only around half of Swedish patients receive such a recommendation (Svensson, Abbott et al. 2019; Cronström, Nero et al. 2020).

The BOA model of care involves several standardized activities, including two to three physiotherapist-led, one-hour face-to-face introductory sessions with information about the condition, risk factors, and available treatments.[4] One additional session involves information by a former patient (1 hour; 43,5% participate in such a session; Svensson, Abbot et al., 2019, figure 24). The patient is then offered an individually tailored rehabilitation/training program over a period of at least six weeks twice weekly one-hour sessions. The sessions are led by a physiotherapist and around 60 percent of patients participate in such sessions (c.f., figure 23). In all, a typical episode of treatment in the BOA-model involves 16 hours of provider (physiotherapist and a co-patient) contact time. The patient may also receive care from an

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[3] Also known as *Artrosskolan* in Swedish; similar programs exist also in other European and OECD-countries.
[4] Based on interviews with staff with BOA experience and on https://artrosbehandling.se/egenvard-och-artrosskola/.

occupational therapist in case of need. Around 68 percent of patients are followed-up three months and twelve months after completing an episode of care in terms of mobility, pain, and health related quality of life (HQoL using the EQ-5D-5L instrument).

The BOA model of care involves additional resources for the clinic, the patient, and others, including planning and preparation of sessions, transportation to and from the site, direct costs (user-fees), and time off work for patients who are employed. In addition, physiotherapists who would like to qualify for the BOA program are required to take a one-day course led by a senior physiotherapist.

Joint Academy

The Joint Academy (JA) model of care is an alternative type of osteoarthritis care based on a digital application through which the patient undergoes an episode of care. The model has been shown to have positive effects on key indicators including mobility, pain, and physical function in a recent study (Nero, Dahlberg et al. 2017). The JA model is initiated by the patient providing key information about his or her condition into the system platform. The information is reviewed by a physiotherapist who then contacts the patient via the application. Specifically, the following contacts are identified as constituting the regular set of physiotherapy activities and interactions (duration in minutes and means of interaction): start-up meeting (15; telephone); daily coordination and adjustment (varies as needed; JA-webpage); weekly follow-up (5-8; web); 6-week follow-up meeting (15; telephone); monthly follow-up session (5-8; web); 3-month follow-up (15; telephone); additional interactions (as needed). In all, a typical episode of care consists of at least 18 activities that take around 143 minutes (2,38 hours) to perform over a period of care of twelve weeks.[5]

During the first session the diagnosis is confirmed, and the patient is able to ask for any additional information about the treatment model or his or her particular concerns related to the condition. Similar to the BOA program, the JA model of care is open-ended and continues as long as the patient's condition improves or until other treatment is needed, such as surgery (total joint replacement).

Similar to the BOA model of care, the JA model requires other resources, including preparations and follow-up on the part of the provider and the patient. In addition, in order to provide care over the JA-platform, the physiotherapist is required to take a mandatory online training course

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[5] Based on the Terms of References for physiotherapists by Joint Academy.

in the use of the platform and a short-course in online physiotherapy provision. Finally, the physiotherapist is required to pass an online certification exam. These training and exam events take a total of two hours.

Methods

The analysis adopts a societal perspective using the general methods for the costing of health services and treatment programs (Drummond, Sculpher et al. 2015). In particular, it involves three main steps: (i) identification of cost items; (ii) measurement (or quantification) of resource use; and (iii) valuation of each cost item.

The aim of the analysis is to estimate the resources needed to deliver an episode of osteoarthritis care (the unit cost) by either model in 2018, the most recent full year for which data are available. Because both models provide individually tailored regimens there is significant variation across patients with respect to the scope and intensity of the treatment episodes. To ensure a fair comparison between the models, an episode is defined as care over a 12 week-period for both models. Furthermore, care is taken to avoid over- or underestimation of resource use by adopting a conservative approach to the quantification and valuation in cases when use can only be estimated by means of inexact methods, such as transportation time and technical support costs.

In the first step of the analysis each cost item is listed across three main domains: the health care system (i.e. clinic or provider); the patient; and other sectors of society. Identification was done by reviewing documents that describe the two models and by consulting experienced users of the two models of care. Using the same sources of information, each cost item was quantified in terms of time or other resources needed to deliver the care. Finally, valuation was done by consulting relevant sources of information for the particular cost item, such as mean gross hourly wage rates (of physiotherapists and patients). The table below lists the main costing items for each domain and describes how they have been quantified and valued (Table 1).

Table 1. Identification, quantification, and valuation of main cost items

Identification of cost item by domain	Quantification	Valuation	Source
A) Provider/Clinic/Health system (BOA and JA)			
Contacts/Visits	Estimate number and duration in hours of contacts/visits per episode of care	Mean gross hourly wage by professional (physiotherapist), including non-wage social fees (50.1%)	Statistics Sweden – www.scb.se
Introduction			JA and BOA[1]
Training/Rehabilitation session			JA and BOA
JA-contacts (asynchronous)			JA and BOA
Administration			
Technical support (JA)	Budgeted amount/number of patients		JA
Preparations/Follow-up	Share of contact/visit duration	Mean gross hourly wage by professional (physiotherapist)	Statistics Sweden – www.scb.se
Training education	Training of physiotherapists in technical application and digital care	Mean gross hourly wage by professional (physiotherapist)	Statistics Sweden – www.scb.se
Training		Mean gross hourly wage multiplied by 1,5	JA and BOA
B) Patient	Estimate number and duration in hours of contacts/visits per episode of care	National mean gross hourly wage, net of non-wage social fees	Statistics Sweden – www.scb.se
Introduction			JA and BOA
Training/Rehabilitation session			JA and BOA
JA-contacts (asynchronous)			JA
Administration			
Preparations/Follow-up	Share of contact/visit duration	National mean gross hourly wage	JA and BOA
Transportation to and from clinic	Average distance to clinic		Riksrevisionen rapport 2014:22; Bilaga 1 – Analys av närhet till vårdcentral
Direct costs	SEK		
User-fees			
C) Other			
CO2-emissions	Estimate length of transportation	Calculate CO2-emissions	Emisso; http://www.utslappsratt.se/berakna-utslapp/berakning-av-utslapp-fran-bilar/

Note: 1) Consultations with key informants of the respective care model. BOA – Better Management of Patients With Osteoarthritis; JA – Joint Academy; CO2 – Carbon dioxide; SEK – Swedish kronor;

The most common resource is time used for various care activities, including training/rehabilitation sessions, preparations and follow-up, and transportation. Time is valued according to the human capital method using average gross hourly wage rates for physiotherapists and the general population obtained from Statistics Sweden wage statistics.[6] Providers' time is valued including non-wage social fees set at the legally mandatory minimum rate of 31,42 percent of gross wage.[7] Patients' time is valued at the reference value of leisure of 30 percent of the gross wage rate and net of any social fees. To account for the cost of rent in the BOA model of care a ten percent surcharge is added on the hourly value of staff time.

In both models of care, the patient undergoes a set of training and other types of sessions. As described above, these are face-to-face sessions in the BOA model of care and online based in the JA model. An important difference between the models is that the sessions are group-based in the BOA model. This means that to obtain the unit cost of care, these costs are divided by the average number of participants. From a payer perspective, however, the costs for a physiotherapist remain the same regardless of the number of participants in a group session. Consequently, these costs are reported separately in order to obtain a comprehensive cost profile of the models. In addition, when adjusting the time-period for the BOA model, the introduction and information sessions are only counted once as these are independent of the length of treatment.

In addition to the time costs associated with the training sessions resources are also needed for preparatory and follow-up activities of each session. In the BOA model they involve activities such as preparing the training facility, arranging equipment, and booking patients. In the JA program they mostly involve reading up on the patient's reporting data and preparing responses to any particular question or issue the patient may have raised in his or her weekly reports. These resources are reported separately as Administration costs and have been measured by consulting physiotherapists from both models of care who were able to provide estimates of the time required for these supporting activities.

As mentioned above, physiotherapists in the Joint Academy program are mandated to undergo formal training and to pass a particular test in order to obtain the required certificate to receive patients in this program. The training program involves three separate sessions: a 20-minute self-learning session on general OA care; a 40-minute self-learning session on technical and care

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[6] See https://www.scb.se/hitta-statistik/sverige-i-siffror/lonesok/.

[7] See https://www.ekonomifakta.se/Fakta/Skatter/Skatt-pa-arbete/Sociala-avgifter/ for details.

related aspects of providing OA care over a digital platform; and a final one-hour JA-staff supported test involving vignette like situations of digital OA care. As these types of costs are one-off activities they are reported separately in the results section. As also noted above, the BOA program also requires participating physiotherapists to take a one-day training course. The costs of these training events are estimated and reported below.

The digital foundation of the JA model of care requires a certain amount of technical support, both to physiotherapists and to patients. Such support is provided as needed on a stand-by basis. To quantify the unit cost of this item the total annual cost of support is divided by the total number of patients in 2018. While it is likely that also providers in the BOA model of care require a certain amount of technical and other types of support, no information and data on such support have been obtained and it is therefore assumed that the total cost of technical and other support in this model is equal to half of that of the JA model.

Transportation costs for the BOA group of patients are estimated by multiplying driving time based on average distance to a health care clinic in Sweden with the average number of appointments. This estimate is based on a recent analysis by the Swedish National Audit Office of the distance and travel time to a primary care clinic by the general population (Riksrevisionen 2014). However, this estimate is most likely an underestimate of travel time as the number of BOA clinics is less than half of the number of primary care clinics in the country.[8]

Vehicle transportations are assumed to lead to some level of CO_2-emmissions (Dullet, Geragthy et al. 2017). While the transportation mode varies, it can be assumed, given the debilitating nature of osteoarthritis, that the majority of transportations is made using a motor vehicle (car or bus). Finally, it is assumed that all patients reach the national user-fee ceiling of 1,100 SEK per year in direct financial costs.

The analysis does not consider costs for research and development, rents of office space and equipment, and any other investment costs. The main reason for this omission is that such costs are largely unknown for the BOA model of OA care, which has been in effect several decades and developed over a similarly long period of time. Finally, no costs for pharmaceuticals have been included as medicines are not part of the standard physiotherapy treatment regimen in either of the programs.

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[8] See https://boa.registercentrum.se/ for details.

Results

Based on the estimates of the resource domains outlined in the previous sub-section, the results of the analysis show that the web-based treatment model of OA care is the least costly model of care; Table 2.

Table 2. Costs of standard treatment model (A: BOA) and web-based model (B: JA).

Domain/Item	Cost domain	A: BOA Amount/Number	Length, hrs	Total hrs	Value, SEK	Total cost, SEK	Total unit cost, SEK		B: Joint Academy Amount/Number	Length, hrs	Total hrs	Value, SEK	Total cost, SEK	Total unit cost, SEK
A. System														
	Contacts/Visits/Sessions													
A.1	Introduction/Theory	4	1	4	265,1	1 060	88		1	0,25	0,25	241	21 404	15
A.2	SOASP Group training	24	1	24	265,1	6 362	530		0	0	0	0	-	
A.3	JA-contacts (asynchronous)								15	0,11	1,65	241	141 265	99
A.4	JA-contacts (telephone)								2	0,25	0,5	241	42 808	30
		28				7 423	619		18				205 477	145
	Administration													
A.5	Technical support					270 000	88						540 000	177
A.6	Preparation; Follow-up	28	1	28	241	6 748	562		18	0,1	1,8	241	434	434
						276 748	651						540 434	610
	Training of physiotherapists													
A.7	Training in JA-use								45	3	135	241	32 535	11
A.8	Training in SOASP-use	6	8	48	241	474 288	30							
						474 288	30						32 535	11
	A: Sub-total			56		*758 459*	*1 299*				*139,2*		*778 445*	*766*
B. Patient														
	Contacts/Visits													
B.1	Introduction/Theory sessions	4	1	4	172	1 376	1 376		1	0,25	0,25	172	43	43
B.2	Training sessions	24	1	24	172	4 128	4 128		72	0,16	11,52	51,9	598	598
B.3	JA-contact								18	0,08	1,44	51,9	75	75
	Administration													
B.4	Preparation; Follow-up	28	0,25	7	172	1 204	1 204		15	0,25	3,75	51,9	195	195
	Transportation													
B.5	Transportation to/from clinic	28	0,3	8,4	172	1 445	1 445		0	0	0		-	
	Direct costs													
B.6	User-fees	1100	1	1100	1100	1 100	1 100						1 100	1 100
	B: Sub-total					*9 253*	*9 253*						*2 010*	*2 010*
C. Other			km	total										
C.1	CO-2 emissions	30	2,5	75	0,014	555 747	59		0	0			-	-
	C: Sub-total					*555 747*	*59*						*-*	*-*
	Total					**1 323 459**	**10 611**						**780 456**	**2 776**

Source: Author's calculations based on study data.

The analysis shows that, from a societal perspective, delivering one episode of care to a typical JA-patient costs 2,776 SEK compared with 10,610 SEK for a BOA-patient, a difference of 7,835 SEK or around 74 percent. In both models of osteoarthritis care, the largest costs are borne by the patient, in particularly so in the BOA model where 87 percent of total societal costs fall on the patient, compared with two-thirds in the JA model. While the largest cost item for the patient in the JA model is direct financial cost in the form of user-fees, such costs constitute the smallest cost item in the BOA model. Due to the on-sight nature of care in the latter model, the patients' largest costs are associated with the time spent on performing the sessions and on transportation to and from the clinic.

Differences between the two models of care can also be seen from the health care system perspective. The total unit cost of delivering an episode of care in the JA model is 766 SEK compared with 1,299 SEK in the BOA model, a difference of 534 SEK or 28 percent. As can be seen from the table, these costs are mostly driven by the training sessions, which are more frequent in the JA model but also considerably shorter. The administrative costs (preparations and follow-up) are higher in the BOA model compared with the JA model, even assuming that technical and other types of support costs are only half of those in the digital model of osteoarthritis care.

Finally, the BOA program of care is estimated to lead to 0,014 tons of CO-2 emissions. The value of these is obtained using the current price of emissions rights from the European CO-2 emissions market, EU-ETS.[9] The total emissions amount to 133 tons based on an estimate that around 9,500 patients participated in a full episode of care in 2018. The price of one ton of CO-2 emission is around USD 220 resulting in a total cost of around 555,747 SEK in CO-2 emissions due to transportation to and from the clinic in the BOA model of care.

Sensitivity analysis

The above analysis rests on a number of assumptions, including with respect to technical support, time of day of sessions, and to transportation distances. With respect to JA, analysis of patient usage data show that this group of patients conduct their training sessions mainly during two time periods during the day, between 8am and 10am and between 7pm and 10pm,

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[9] See https://ec.europa.eu/clima/policies/ets_en for details.

respectively. However, there is no difference with respect to age between the patients training in the morning and those training in the evening.[10]

Since no data have been obtained on the actual costs of any technical and other types of support for the BOA model of care these were assumed to be half of those in the JA model. Removing completely these types of costs from the BOA model of care does not change the overall results in any material way.

One of the largest cost items to the patient in the BOA model is transportation costs to and from the clinic. The quantity of these costs can only be estimated with some level of uncertainty. However, removing them altogether would most likely result in an underestimate of the patient costs as the face-to-face nature of that model of care does require the patient to spend some time and other resources getting to and back from the clinic to perform the training and introductory sessions.

In addition, also the CO-2 emissions are estimated with uncertainty. However, removing these would not change the overall findings in any material way given their relatively small impact on the total societal cost of osteoarthritis care by means of the BOA model.

An important caveat with the current analysis is that patients have not been randomly assigned to receive care in the JA model or the BOA model of osteoarthritis care. The failure to adjust for the patient mix may be a driving factor behind the results. However, data show that there is no difference between the JA patients and the BOA patients in terms of age (mean 62) and sex (68 percent women).

Cost-effectiveness analysis

This costing analysis has shown that the Joint Academy model of osteoarthritis care uses less resources to deliver a 12-week episode of care compared with the care-as-usual model of the BOA program in Sweden. While this is an important finding, it does not provide sufficient information to conclude that the digital model of OA care is a cost-effective alternative to the face-to-face model of such care. In a recent study of the effect of the JA model of care, Nero and colleagues find, among other things, that the JA model reduces self-reported pain after six weeks of care (Nero et al., 2017). In particular, patients receiving care in the JA model report on average a reduction in experienced pain from 5.4 to 3.5 (a reduction by 1,9 points or 35 percent

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[10] Analysis of patient use data by JA data analyst in November 2019.

on a 0-10 scale) after six weeks. Patients receiving the care in the BOA model report a reduction from 48 to 37 (a reduction by 11 points or 23 percent on a 0-100 scale) after six weeks (c.f., table 3, p. 4).

Combining the results from the costing analysis with the results from the effect analysis an incremental cost effectiveness ratio (ICER) can be computed which shows the cost per unit of effect improvement. The following ICER is calculated:[11]

$$\text{ICER} = [\text{Cost\_1} - \text{Cost\_0}]/[\text{Effect\_1} - \text{Effect\_0}] = [2{,}776 - 10{,}611]/[35 - 37] = 3{,}917 \qquad (1)$$

While there are no set thresholds to decide whether an ICER of this magnitude can be considered cost-effective, it has been shown that the Joint Academy model of care is both less costly and more effective and, consequently, ends up in quadrant II in the cost-effectiveness plane.[12] A treatment program in this quadrant would be considered cost-effective.

In a recent analysis of the cost-effectiveness of early total hip replacement (THR), Mota finds that early THR is cost-effective compared with either late THR combined with non-surgery treatment or non-surgery treatment alone in Italy (Mota 2013). However, the analysis only adopts a health system perspective and thereby fails to take into consideration the significant costs that THR may incur on the patient (and possibly other sectors). As noted earlier, the heterogeneity of patient symptoms and condition make the comparison between surgery and non-surgery treatment regiments for osteoarthritis difficult. Also, the cost of complications has been shown to exceed the benefits in terms of health related quality of life (HRQoL) (Bozic, Stacey et al. 2012).

Total expenditure effects of the Joint Academy model

In 2018, 9,465 patients received care in the BOA model and 1,421 patients received care in the JA model for at least twelve weeks. The total societal costs of providing the BOA model of care was approximately 117 million SEK. The cost of the JA model was 4,1 million SEK. While cost effectiveness is only a necessary condition for policy consideration, the results from this costing analysis and the previously reported positive outcomes of the Joint Academy model of osteoarthritis care in Sweden suggest that it would be a cost-effective alternative to the current best practice model. Consequently, it would be of interest to estimate the expenditure savings

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[11] Multiplying the effect estimate of the JA model by 10 to get same scale.
[12] See, for example, Drummond et al., 2015, chapter 3, p. 55 for details on this graphical illustration of cost-effectiveness.

that would occur if some share of BOA treatments is substituted for by the JA model of care. Given the novel aspects of the JA platform and that it is unlikely to suit all patients, it would be unreasonable to assume that the substitution rate would be 100 percent or very close to that number. Table 3 presents the results for the amount of savings that could occur under three alternative substitution rates.

Table 3. Expenditure savings if JA substitute for BOA.

Substitution rate	Total program cost if JA substitute for SOASP	Difference, SEK	Difference, %
25%	19 705 673	80 725 584	80
50%	13 137 115	87 294 142	87
75%	6 568 558	93 862 699	93

Source: Author's calculations based on costing results and BOA data. Assuming adherence rate of 60%.

The estimates show that if half of all patients that received care by BOA in 2018 instead had received care in the less costly JA model, around 87 million SEK would have been saved in direct total societal costs of osteoarthritis care. These estimates are net of any resources saved or value gained by the estimated outcome differences between the two models, as well as other differences with respect to treatment complications and unnecessary diagnostics and surgeries that may have occurred.

Discussion and conclusions

Osteoarthritis is the most common disease of the joints and is expected to increase in prevalence over the coming decades or so. It constitutes a significant burden on individuals, communities, and on the broader society. The economic costs associated with OA are considerable and in light of the broadly recognized importance of secondary prevention of OA, it is important to understand the costs associated with various treatment regimens. This study contributes to the existing body of evidence on this issue by estimating the costs of a new digital platform for the treatment of OA and how those costs compare with the standard, evidence-based face to face model.

The costing estimates suggest that the digital JA model of osteoarthritis care costs around one-quarter of the existing, face-to-face model of care. Most of the cost differences are found on the patient side as the BOA model impose significant costs to the patients in terms of time and travel costs. In combination with the positive outcome of the JA model, these results suggest that this model is a cost-effective alternative to the existing face to face model of osteoarthritis care in Sweden. For reference, the average cost of a total hip arthroplasty (THA) in Sweden has

been estimated at 78 500 SEK in 2005 (Rolson et al., 2012). Due to disease heterogeneity these cost estimates are difficult to compare. However, it is well understood that many patients opt to not undergo surgery after going through an episode of non-surgical, first-line osteoarthritis care of either model (Nero, Dahlberg et al. 2017; Jönsson, Eek et al. 2019).

As health care systems in all countries strive to increase digitally based innovations in service provision, the JA model of osteoarthritis appears to be a relevant alternative to providing effective care to a large and increasing group of patients. Surveys from various countries also indicate that patients are interested in using digital platforms to receive care (McDaid 2010; Farkas and Biesen 2012; PWC 2015; Cronström, Nero et al. 2020). As younger people are generally more open to adopting digital innovations and the relatively older patient group receiving osteoarthritis care, the rate with which digital care can substitute for face-to-face care may be more limited compared with some other types of care.

A more general issue appears to be the limited uptake of either of the models in Sweden. While the JA model of care is relatively novel, the BOA model has been around for several years. However, uptake is low as only around 20 percent of all people who are diagnosed with osteoarthritis are registered with a provider of BOA care. To the extent that this is due to a perception of the patients that it is time consuming, the JA model of care would seem to be an attractive alternative.

A related issue is the relatively low adherence rate. For example, in the BOA model only 60 percent of patients remain after 12 weeks of treatment. The reasons for why patients drop-out are largely unknown, but would seem to be an important issue for future investigation.

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