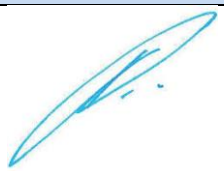
STUDY DATA		
Research title	Effectiveness of total hip arthroplasty for patients with osteoarthritis, a target trial emulation study using Santeon data.	
Acronym/ short study title	EAGLE	
Date / Version	17-5-2023	
Study number	SDB 2023-002	
Type of study	☒ Retrospective study (file/status review) Prospective study with questionnaires, interviews, etc.	
Principal investigator *this must be a staff member of a Santeon Hospital*	Prof R.W. Poolman, orthopedic surgeon	
Executive researcher(s)	A.D. Klaassen, PhD candidate and orthopedic researcher, OLVG W. Jorritsma, data analyst value-based health care (VBHC), OLVG N.W. Willigenburg, research coordinator, OLVG A.J. de Vries, research coordinator, Martini hospital	
Researchers Participating Santeon Hospitals	**Data** *Note the name, position, and hospital of the local principal investigator per Santeon Hospital (this must be a staff member)* *(It is not mandatory for all Santeon Hospitals to participate)*	**Signature**
	1 Rudolf W. Poolman, Orthopedic surgeon OLVG	

	2	B.L.E.F. (Bas) ten Have Orthopedisch chirurg Dr. C.L.E. (Carina) Gerritsma – Bleeker Orthopedisch Chirurg Martini Ziekenhuis 	
	3		
	4		
	5		
	6		
	7		
Petitioner *(The person who submits the study to the Management Committee)*	Name: Amanda Klaassen Function, department and hospital: Researcher and quality officer orthopedic department, OLVG Phone number: 020 599 2572 / 06-53437040 Email address: a.d.klaassen@olvg.nl		
The study is conducted under:	☒ General scientific research ☐ PhD research ☐ Other, namely: <click here if you want to enter text>		

SUMMARY

The ideal research design to investigate effectiveness of total hip arthroplasty (THA) compared to no surgery, would be to randomize patients between surgery and non-surgery. However, such a randomized controlled trial (RCT) is deemed unethical due to the effect size of THA shown in observational studies. To our knowledge, the effect of THA has never been investigated through an RCT, however, the effect and importance of THA for patients and society seems to be underestimated in observational studies.

During the Covid-19 pandemic elective orthopedic interventions such as THA were often cancelled and the waiting time to surgery increased. Independent of patient characteristics and potential prognostic factors, some surgeries could be performed and other surgeries were cancelled and patients remained on the waiting list, this circumstance allows for a natural experiment. We aimed to perform a target trial emulation (TTE) study on the effect of THA (1). In this study we will compare changes in hip disability in patients with hip osteoarthritis between two groups: THA versus non-surgery (due to the delay in surgery due to the covid pandemic).

We hypothesize that THA is effective compared to non-surgery in reducing hip disability in patients with hip osteoarthritis measured with the Hip disability and Osteoarthritis Outcome Score Physical function Short form (HOOS-PS).

The secondary aim of our study is to assess effectiveness of THA with respect to pain measured with a numerical rating scale (NRS) during weight bearing.

1. INTRODUCTION

Total hip arthroplasty (THA) is one of the most frequently performed orthopedic surgeries. Studies show that THA is an effective treatment to reduce pain and to improve hip function and quality of life in patients with osteoarthritis of the hip. However, the effectiveness of THA has never been investigated by means of a randomized controlled trial (RCT), which is the gold standard to assess effectiveness of an intervention.

During the Covid-19 pandemic, elective orthopedic interventions were defined as not urgent and therefore cancelled. The National Institute for Public Health and the Environment (RIVM) estimated that in 2020 and 2021 in total 32,000 Quality-Adjusted Life Years (QALYs) were not realized due to postponing THA in patients with osteoarthritis of the hip in the Netherlands (9, 10). Better understanding of the treatment effect of THA, compared to non-surgery, could help improve prioritization of interventions.

The ideal research design to investigate effectiveness of THA would be to randomize patients between surgery and (delayed) non-surgery. Such an RCT is deemed unethical due to the effect size of THA shown in observational studies. It is considered unethical to withhold the patients who are allocated to the conservative treatment from the apparent benefits of THA. The required investments in time and money to perform an RCT and expected difficulty to include sufficient patients do not outweigh the benefits of measuring the effect of THA to demonstrate its urgency. Moreover, a potential benefit of research with observational data is, that it better reflects real-world data.

During Covid-19, there were different phases of hospital reduction and restoring of surgical capacity. During periods when surgeries were scaled down nationwide, only emergency surgeries for fractures, infections, and revisions were performed in the orthopedic department. However, our study specifically

focuses on elective primary total hip replacements for osteoarthritis, and during the research period, there was no prioritization based on the severity of symptoms within this osteoarthritis population.

Within the COVID period there were various periods of scaling up and down surgical capacity for elective hip operations, caused by external factors. For example, patient A, scheduled for surgery on Tuesday, proceeded, while patient B, scheduled for Thursday, had to be rescheduled due to changed government or regional policy effective the next day. Patient C had surgery while patient D was cancelled because the surgeon suddenly had to quarantine due to a child or partner with a COVID infection. These issues caused that in some patients THA could be performed and in other patients THA was cancelled.

We assume that whether or not such surgeries took place during the COVID period was beyond the control of patients, doctors and researchers and can be seen as a form of (pseudo)randomization. In a traditional RCT, randomization is done by means of computerized random sequence generation. In an emulation trial (1, 11), randomization is introduced by factors outside of our control, in this case whether THA surgery was cancelled or not due to the COVID-19 pandemic and the resulting scarcity of operating rooms for THA surgery.

An important step in RCT emulation is to verify the validity of the assumption that a comparison between two groups (in our study patients who did and who did not undergo THA surgery within the COVID period) is indeed (pseudo)random and requires analysis. The answer to this question is an outcome of the research, not something we can determine with certainty in advance.

Therefore, the aim of this study is to measure if THA is effective in restoring physical function in patients with osteoarthritis of the hip compared to non-surgery in existing Value-Based Health Care (VBHC) data by means of RCT Target Trial Emulation.

2. RESEARCH QUESTION/ RESEARCH OBJECTIVE

The primary aim of this study is to measure if THA is effective to reduce disability in physical function in patients with osteoarthritis of the hip compared to non-surgery by means of RCT Target Trial Emulation. We hypothesize that THA is effective compared to non-surgery in reducing hip disability in patients with hip osteoarthritis measured with the Hip disability and Osteoarthritis Outcome Score Physical function Short form (HOOS-PS).

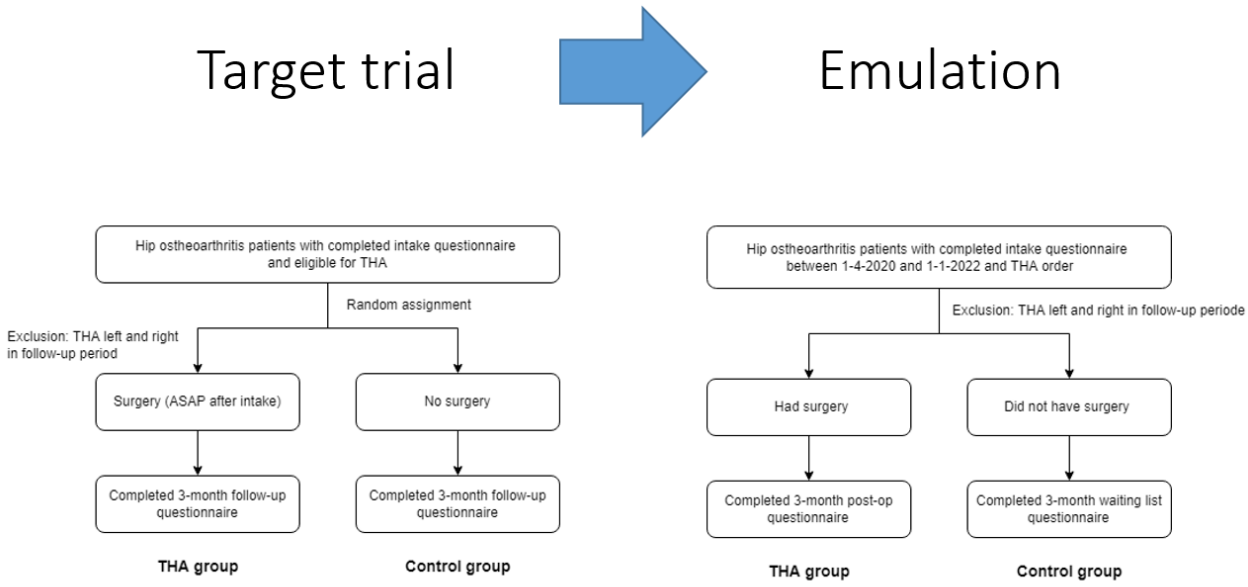
Secondary aims of this study are to assess improvement in terms of pain during weight bearing measured on a numerical rating scale (NRS) and assess patient reported improvement in functioning and pain measured by an anchor based question. We hypothesize that THA is effective compared to non-surgery in reducing pain.

3. METHODS

3.1 Study design

Hip osteoarthritis patients eligible for THA and placed on the waiting list for surgery will be included when the preoperative intake questionnaire is completed between 1-4-2020 and 1-1-2022. In a retrospective dataset we compare two standard care strategies: THA and wait-and-see, in which patients did not receive THA and remain on the waiting list. Patients were assigned to one of the two groups based on

whether surgery could be performed or whether THA was cancelled and patients remained on the waiting list. The first group (THA group) consists of patients that received surgery before 1-1-2022 and completed a 3-months postoperative questionnaire before 1-4-2022. The second group (control group) consists of patients which did not receive surgery before 1-1-2022 and completed a waiting list questionnaire before 1-4-2022. The target trial and emulation plan are shown in Figure 1 and the time-schedule of the emulation trial is shown in Figure 2. Patients that received THA on both sides between 1-4-2020 and 1-1-2022 will be excluded. The response rates on follow-up questionnaires will be reported for both groups. We will compare characteristics (age, sex, PROM-outcomes at baseline and physical therapy before the hospital visit) for patients that completed the follow-up questionnaires (completers) and patients that did not complete the follow-up questionnaires (non-completers). In the primary analysis we will correct for patient characteristics.



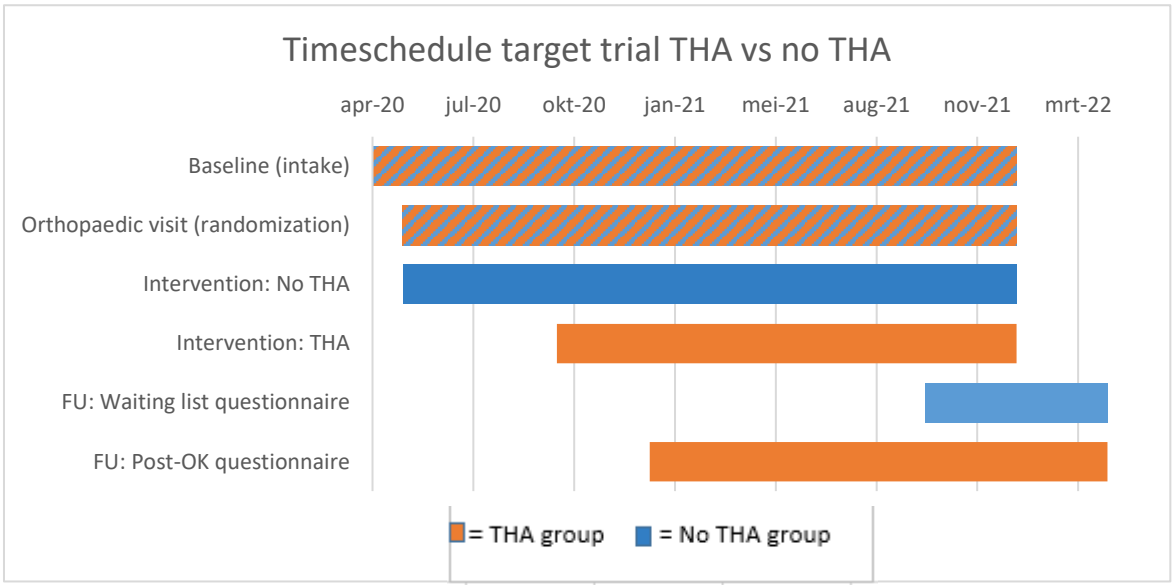


Figure 2: Timeline target trial emulation
THA= Total Hip Arthroplasty
FU = Follow-up

In this study we compare the effect of THA compared to non-surgery on hip disability measured with the HOOS-PS change score from baseline up to approximately 3-months by means of RCT Target Trial Emulation, which aims to mimic a traditional RCT. Function and pain as a secondary outcome are measured by means of patient reported outcome measures (PROMs) pre-operatively and post-operatively or post-waiting list. The pre-operative intake questionnaire and the 3-months postoperative questionnaire are part of standard care. The waiting list questionnaire was administered during the Covid-19 pandemic to monitor patients' health status in two Santeon Hospitals (OLVG and Martini) in all patients who were at least three months on the waiting list. Therefore our study will be performed with data of these two Santeon Hospitals. All data is available through the routinely collected data for hip osteoarthritis within the VBHC program and in addition the outcomes of the administered waiting list questionnaire. Therefore, it is not needed to obtain additional information from patients.

To test the assumption that group allocation is (pseudo)random and cannot be explained by patient characteristics or severity of pain and hip disability at baseline, a logistic regression analysis will be performed on patients within the VBHC data set between 1-4-2020 and 1-1-2022. Group being the dependent variable (THA vs. non-surgery) and age (continuous), sex (M/F), physical therapy before the hospital visit (yes/no), follow-up time in days (continuous), pain at baseline (NRS, continuous) and the HOOS-PS at baseline (continuous) will be included in the model as independent variables. Secondly, we will test the assumption that follow-up time in days is not statistically significantly different between the THA and non-surgery group. Follow-up time is defined by calculating the number of days between the date of the orthopedic visit) and the date of the follow-up questionnaire. Results will be considered statistically significant when $p \leq 0.05$. In case an independent variable has a statistically significant effect on group assignment and/or follow-up time in days is significantly different between the two groups, clinical relevance will be considered and discussed within the research team, for example the effect size on chance to be allocated to the THA or non-surgery group.

We hypothesize that patient characteristics (i.e. sex, age, severity of symptoms at baseline) do not affect group allocation and follow-up time is similar for THA and non-surgery patients. If this is true, the proposed Target Trial Emulation will provide the first evidence on the effectiveness of THA surgery in terms of causal inference.

3.2 Procedure and intervention (if applicable)

This is a retrospective study and all procedures have already been performed within standard care. In a retrospective dataset we compare two standard care strategies: THA and wait-and-see, in which patients did not receive THA and remain on the waiting list.

1.1 Duration of study

The study will be conducted with existing data starting from 1-4-2020 up until 31-3-2022. Patients on the waiting list for THA and with a completed intake questionnaire between 1-4-2020 and 1-1-2022 are included for this study and outcomes will be collected up until 31-3-2022. Mean follow-up time in days will be calculated for both the THA and non-surgery group. The timeline for this target trial emulation is presented in figure 2.

1.2 Recruitment and selection of subjects

1.2.1 Screening/selection

Retrospective data will be collected by A.D. Klaassen and the VBHC data analysts at OLVG and Martini hospital.

1.2.2 Study population

Patients with hip osteoarthritis that were on the waiting list for THA between 1-4-2020 and 1-1-2022 and had a completed intake questionnaire will be included. The number of patients is dependent on how many patients completed the questionnaires and needs to be investigated. However, based on the waiting list at the time and the number of performed surgeries in the two hospitals, we expect to include at least 100 patients in each cohort (THA group and non-surgery group). Since we use observational data for trial emulation, no sample size calculation is needed (8).

1.2.3 Inclusion criteria

Inclusion criteria:

- Patients on the waiting list for primary THA between 1-4-2020 up to 31-3-2022 in OLVG or Martini hospital.
- Completed intake questionnaire (HOOS-PS baseline)
- Indication osteoarthritis of the hip

1.2.4 Exclusion criteria

Exclusion criteria:

- Patients that received THA on both sides within follow-up (1-4-2020 and 1-1-2022) will be excluded.
- Patients with other indications than osteoarthritis of the hip were excluded.

1.2.5 Number of subjects/ sample size

Since we use observational data for trial emulation no sample size calculation is needed (8). The participants are already exposed to an intervention or not. Differences in the primary and secondary outcomes (PROMs) between groups will be interpreted using 95% confidence intervals and thresholds for clinical relevance which are reported below.

1.3 Data collection: variables and measurement methods

1.3.1 Primary outcome measure (dependent variable)

Primary outcome is the change score for hip function measured with the HOOS-PS at 3-months postoperative in the THA group and at least 3-months post waiting list in the control group compared to baseline. The HOOS-PS is a 5-item questionnaire that quantifies hip disability. The raw outcome is converted to a Rasch-based interval score ranging from no difficulty (0) to extreme difficulty (100) (3,4,5). The minimal clinically important difference (MCID) for the HOOS-PS is 23 points (6). We will also calculate the minimal important change in our study population, based on an anchor question.

3.5.2. Secondary outcome measure

Secondary outcomes are change scores on other patient reported outcome measures (PROMs). Pain during weight bearing is measured on a numerical rating scale (NRS) ranging from 0-10. The minimal clinically important difference (MCID) for the NRS is 2 points. The anchor based questions range from 1-7 for functioning and pain. These PROMs were obtained at baseline (except the anchor based question) and at 3-months postoperatively and at least 3-months post waiting list

1.3.2 Overview of variables and measurement instruments

Variable	Measuring instrument/ Source of data	Outcome values	Measurement time
Sex	VBHC data (source is EHR*)	numeric (1 = F, 2 = M) 999 or NA is missing	Baseline
Age at time of inclusion	VBHC data (source is EHR*)	Numeric 999 or NA is missing	Baseline
Date for order THA	VBHC data (source is EHR*)	date (YYYY-MM-DD)	Baseline
Surgery date	VBHC data (source is EHR*)	date (YYYY-MM-DD) or not applicable (NA)	Date of surgery
Date completion of baseline questionnaire	VBHC data (source is EHR*)	date (YYYY-MM-DD)	Baseline
HOOS_PS_BL	HOOS_PS_PI VBHC data (source is EHR*)	HOOS-PS personal interval level score at baseline. Numeric (0-100) 999 or NA is missing	Baseline
Pain weight bearing at baseline	NRS VBHC data (source is EHR*)	numeric (0-10) 999 or NA is missing	Baseline
Patient followed physical therapy before hospital visit	VBHC data (source is EHR*)	No (0) / Yes (1) 999 or NA is missing	Baseline
Date completion of 3-months postoperative questionnaire	VBHC data (source is EHR*)	date (YYYY-MM-DD) or not applicable (NA)	3-months PO
Date completion of 3-months waiting list questionnaire	VBHC data (source is EHR*)	date (YYYY-MM-DD) or not applicable (NA	≥ 3-months waiting list
HOOS_PS_3M_PO	HOOS_PS_PI VBHC data (source is EHR*)	HOOS-PS personal interval level score at 3-months postoperatively. Numeric (0-100) 999 or NA is missing	3-months PO
HOOS_PS_3M_WL	HOOS_PS_PI Waiting list questionnaire (source is EHR*)	HOOS-PS personal interval level score at 3-months waiting list. Numeric (0-100) 999 or NA is missing	≥ 3-months waiting list

Pain weight bearing at 3-months postoperatively	NRS VBHC data (source is EHR*)	numeric (0-10) 999 or NA is missing	3-months PO
Pain weight bearing at 3-months waiting list	NRS VBHC data (source is EHR*)	numeric (0-10) 999 or NA is missing	≥ 3-months waiting list
Anchor based question for pain postoperatively	Anchor	Numeric (1-7) 1= very much deteriorated 2= much deteriorated 3= slightly worsened 4= not changed 5= slightly improved 6= much improved 7= very much improved 999 = missing value	3-months PO
Anchor based question for function postoperatively	Anchor	Numeric (1-7) 1= very much deteriorated 2= much deteriorated 3= slightly worsened 4= not changed 5= slightly improved 6= much improved 7= very much improved 999 = missing value	3-months PO
Anchor based question for pain waiting list	Anchor	Numeric (1-7) 1= very much deteriorated 2= much deteriorated 3= slightly worsened 4= not changed 5= slightly improved 6= much improved 7= very much improved 999 = missing value	≥ 3-months waiting list
Anchor based question for function waiting list	Anchor	Numeric (1-7) 1= very much deteriorated 2= much deteriorated 3= slightly worsened 4= not changed 5= slightly improved 6= much improved 7= very much improved 999 = missing value	≥ 3-months waiting list

- EHR = Electronic health record.
- NRS = Numerical rating scale
- PO = postoperatively

1.4 Data analysis

1.4.1 Data inspection

Missing data will be defined in the database as 9999 or NA. Patients with a missing baseline HOOS-PS will not be included in the database. Extreme values will be explored by visual inspection such as boxplots and scatterplots. Extreme values will be verified and discussed in the research team before starting the analysis.

1.4.2 Analyses

1. Measure if THA is effective to improve physical function in patients with osteoarthritis of the hip compared to non-surgery by means of RCT Target Trial Emulation.

2. Assessment to test the assumption that group allocation to the surgery group or non-surgery group cannot be explained by patient characteristics by means of logistic regression analysis. Secondly we test the assumption that follow-up time in days is similar between the two groups.

1. <u>Measure effect of THA:</u>

Two multiple regression analyses will be performed with the HOOS-PS and pain change score, respectively, as the dependent variable, and experimental condition (THA/ no-THA), age, sex, HOOS-PS score at baseline, pain score at baseline, physical therapy before baseline (yes/no) and follow-up time in days as independent variables. All regression coefficients and their 95% confidence intervals will be provided. Differences will be considered statistically significant when $p \leq 0.05$ and clinically relevant when differences exceed the MCID of 23 points for the HOOS-PS and 2 points for the NRS (6,7).

Descriptives on all independent variables will be presented and assessed by visual inspection of boxplots (for continuous variables) or tables (for categorical variables). These results will be provided for transparency purposes.

2. <u>Test whether assumptions for target trial emulation are met.</u>

A logistic regression analysis will be performed on patients within the VBHC data set between 1-4-2020 and 1-1-2022 to check whether the group allocation cannot be explained by patient characteristics. Group being the dependent variable (THA vs. non-surgery) and age (continuous), sex (M/F), physical therapy before the hospital visit (yes/no), follow-up time in days (continuous), pain at baseline (NRS, continuous) and the HOOS-PS at baseline (continuous) will be included in the model as independent variables. Results will be considered statistically significant when $p \leq 0.05$. In case an independent variable has a statistically significant effect on the outcome, clinical relevance will be considered and discussed for the effect size on chance to be allocated to the THA or non-surgery group. Secondly, we will test the assumption that follow-up time in days is not statistically significantly different between the THA and non-surgery group. Follow-up time is defined by calculating the number of days between the date of the orthopedic visit) and the date of the follow-up questionnaire.

1.4.3 Software program

Data analysis: SPSS, R
Data collection: SAS Enterprise guide and Questmanager

2. ETHICAL CONSIDERATIONS

2.1 Burden and compensation for the test subject

There is no additional investment required for patients, all data has already been collected.

2.2 Subject consent

In prospective non-WMO research, consent must always be sought from the subject. In the case of retrospective non-WMO research, this depends on the method of data collection and its processing. If in doubt, you can use the decision tree in appendix A.

Is consent sought from the subject?	☐ Yes (Complete option A 'Informed Consent Procedure') ☒ No (Enter option B 'Consent is not requested')

Option A: Informed Consent procedure

Approach to subjects	Not applicable
Informing subjects	Not applicable
Reflection period for subjects	Not applicable
Signing informed consent	Not applicable

Option B: Consent is not asked, data is anonymized.

Which exception rule(s) is/are applicable? Explain your answer at the bottom of this question.

Note:
For retrospective studies, where data from subjects are used **anonymously,** asking permission is not necessary.

For retrospective research, where data from subjects are collected and processed **in coded form,** consent of the subjects is required. Patients should be informed which personal data (no more than necessary) will be processed in what way and for what purposes. In some cases, asking for consent may be waived (exception rules). These exception rules can only be invoked if the study meets the following conditions:

- the research serves the public interest; and
- the research is meaningful and clear and cannot be conducted without the requested data; and
- the person did not object; and
- with regard to the conduct of the investigation, safeguards are in place such that the privacy of those whose data is affected is not disproportionately affected.

☐ Consent may not be required.
This applies when asking for consent would take a disproportionate amount of time and effort, for example in the case of large numbers of patients or patients who were treated a long time ago.

☐ Requesting consent is not reasonably possible, as asking consent would place such a burden on the patient that psychological harm must be feared.

☐ Requesting consent is not reasonably possible because the data subject is deceased or the address cannot be traced or if the data subject does not respond after being written to at least twice.

☐ Asking for consent is not reasonably possible because it involves drawing the right sample and asking for consent would have to be presented to many more people than necessary to answer the research questions.

☐ Requesting consent is not reasonably possible, as the consent question cannot be meaningfully asked because the study is still in an initial preparation phase.

Research data will be collected and used anonymously. Consent from subjects is therefore not required.

3. DATA MANAGEMENT & PRIVACY

3.1 Data storage, security and access during research

Paper research data

3.1.1 Where are paper research data (e.g. paper questionnaires and consent forms) stored?

☒ N/A *go to question 5.1.4*

3.1.2 Which persons have access to this storage area?
This should be at least two people because of access to the data in case of absence, illness, leaving the institution, etc. when only one person has access.

<Note here the name and position of these persons.>

3.1.3 How is it ensured that no one other than the authorized persons mentioned under 5.1.2 has access to the paper research data?

<For example, describe where the key to the locked cabinet is kept or who knows the code of the safe.>

Digital research data

3.1.4 In which system will the research data be collected and managed?

☐ GCP-proof ECRF (mandatory), such as: Castor EDC / Research Manager / Redcap, Open Clinica, other, namely <...>

☒ Other, namely No new patient data will be collected. Already available and coded patient data will be retrieved using SAS Enterprise guide and analyzed using R and SPSS.

3.1.5 Is (also) digital research data stored on a network drive of the participating hospitals ? Note, this should not be traceable data (key). These should always be stored in the hospital where they are collected (see also question 5.2.3.).

☒ Yes, namely on the network drive of the following hospital: OLVG, secure network drive of JointResearch.

☐ No, the digital research data will be stored at <location>.

3.2 Data processing

3.2.1 Will research data be anonymized or coded?

☒ Anonymized *Go to question 5.2.4*

☐ Coded

3.2.2 How will the data be encrypted?

N/A

3.2.3 Where is the trial subject identification code list (key between coded and patient traceable data) stored?

☒ At a location of the participating hospitals namely: N/A

☐ External. For external storage of the key including access authorizations, permission is requested from the patient in the patient information form (PIF).
<Institution and department external>

3.2.4 By whom will the required data be extracted from the EHR and anonymized or encrypted?

☐ Handler, namely:

☒ support research staff, namely: the data analyst involved in VBHC through the data warehouse.

☐ Business intelligence department (via data warehouse or Business Intelligence)

☐ A third, namely:

3.3 Sharing data

3.3.1 Will research data be shared with third parties?

☒ Yes, anonymized *proceed to question 5.3.2*

☐ Yes, coded *continue to question 5.3.2*

☐ No *continue to question 5.4*

3.3.2 To whom is the data provided / who uses the data for scientific research?

☒ Institutions/researchers within the Netherlands, namely: OLVG hospital, Amsterdam, Orthopedic research department

☐ Institutions/researchers within the European Union (EU), namely: <Note here the name and location of the institution(s).>

☐ Institutions/researchers outside the EU, namely: <Note here the name and location of the institution(s)>.
Note: For the provision of encrypted data outside the EU, patient consent should be sought via the patient information form (PIF).

3.4 How long will the data be kept?

15 years.

4. Valorization and PUBLICATION

4.1 Valorization

Our hypothesis is that for patients with hip osteoarthritis, getting total hip replacement is an effective treatment compared to not operating. Demonstrating the importance of this surgery may change healthcare practice by generating more priority and resources (such as surgery time) within hospitals and society for treatment with total hip replacement.

Using a relatively new research design (target trial emulation) can change research practice. Because randomized trials are time-consuming and costly, as well as having other potential drawbacks, alternative research designs are increasingly being considered. Participation in a randomized trial is also quite an investment for the patient. Therefore, being able to use alternative research methods to evaluate a treatment method also has a great benefit for the patient group.

4.2 Publication

The results will be submitted for publication to (inter)national peer-reviewed journal. The results will be presented to the orthopedics departments of the Santeon hospitals. Possibly, the results will be submitted for conference presentations.

5. REFERENCES

1. Groenwold RHH. Trial Emulation and Real-World Evidence. JAMA Netw Open. 2021 Mar 1;4(3):e213845. doi: 10.1001/jamanetworkopen.2021.3845.

2. Naci H. What to do (or not to do) when randomization is not possible. J Heart Lung Transplant. 2017 Nov;36(11):1174-1177. doi: 10.1016/j.healun.2017.07.008.

3. Davis AM, Perruccio AV, Canizares M, Hawker GA, Roos EM, Maillefert JF, et al. Comparative, validity and responsiveness of the HOOS-PS and KOOS-PS to the WOMAC physical function subscale in total joint replacement for osteoarthritis. Osteoarthritis Cartilage. 2009;17(7):843-7.

4. Davis AM, Perruccio AV, Canizares M, Tennant A, Hawker GA, Conaghan PG, et al. The development of a short measure of physical function for hip OA HOOS-Physical Function Shortform (HOOS-PS): an OARSI/OMERACT initiative. Osteoarthritis Cartilage. 2008;16(5):551-9.

5. de Groot IB, Reijman M, Terwee CB, Bierma-Zeinstra S, Favejee MM, Roos E, et al. Validation of the Dutch version of the Hip disability and Osteoarthritis Outcome Score. Osteoarthritis Cartilage. 2009;17(1):132.

6. Paulsen A, Roos EM, Pedersen AB, Overgaard S. Minimal clinically important improvement (MCII) and patient-acceptable symptom state (PASS) in total hip arthroplasty (THA) patients 1 year postoperatively. Acta Orthop. 2014;85(1):39-48.

7. Farrar JT, Young JP, LaMoreaux L, Werth JL, Poole RM. Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale. Pain. 2001;94:149-158.

8. Hernán MA. Causal analyses of existing databases: no power calculations required. J Clin Epidemiol. 2022 Apr;144:203-205. doi: 10.1016/j.jclinepi.2021.08.028. Epub 2021 Aug 27.

9. RIVM.co.uk https://www.rivm.nl/coronavirus-covid-19/uitgestelde-zorg

10. RIVM report on health-related consequences for postponing surgeries during Covid-19 pandemic. https://www.rivm.nl/bibliotheek/rapporten/2022-0053.pdf; page 33.

11. Hernán MA, Robins JM. Using Big Data to Emulate a Target Trial When a Randomized Trial Is Not Available. Am J Epidemiol. 2016 Apr 15; 183(8):758-64.