Author’s response to reviews

Title: Does the implementation of a care pathway for patients with hip or knee osteoarthritis lead to fewer diagnostic imaging and referrals by general practitioners? A pre-post-implementation study of claims data.

Authors:
Esther van den Bogaart (e.vandenbogaart@maastrichtuniversity.nl)
Mariëlle Kroese (marielle.kroese@maastrichtuniversity.nl)
Marieke Spreeuwenberg (m.spreeuwenberg@maastrichtuniversity.nl)
Ramon Ottenheijm (ramon.ottenheijm@maastrichtuniversity.nl)
Patrick Deckers (p.deckers@zuyderland.nl)
Dirk Ruwaard (d.ruwaard@maastrichtuniversity.nl)

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Author’s response to reviews:

Maria Zalm and Doris Cuckovic,
Editor
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Paper title: Does the implementation of a care pathway for patients with osteoarthritis lead to less diagnostics and referrals by general practitioners? A pre-post-implementation study of claims data.

Paper ID: FAMP-D-19-00051

Dear Ms. Zalm and Ms. Cuckovic,

Thank you very much that based on the reviewers’ reports and your own assessment as Editor our manuscript entitled “Does the implementation of a care pathway for patients with osteoarthritis lead to less diagnostics and referrals by general practitioners? A pre-post-implementation study of claims data” may be considered for publication in BMC Family Practice. We have carefully considered the reviewers’ comments and revisions and editorial requests. Please find below our reaction to the reviewers indicated with symbol ‘&gt;’. The
adaptations we made in the manuscript can be found accordingly below. These are visible in the manuscript by track changes.

Based on the review commentary, we thoroughly examined the manuscript and made adjustments where necessary, such as removing repetitions, removing the cost savings analysis, incorporating the number of patients who went on to undergo hip or knee arthroplasty and adding a more detailed interpretation of our results in the discussion part.

We really hope you will reconsider our manuscript for publication and are looking forward to your reply.

Yours sincerely,

Also on behalf of all authors,

Esther H.A. van den Bogaart, MSc

Maastricht University
Faculty of Health, Medicine and Life Sciences
Department of Health Services Research
P.O. Box 616, 6200 MD Maastricht
The Netherlands
Telephone number: +31 43 38 82199
E-mail: e.vandenbogaart@maastrichtuniversity.nl

Reviewer 1 - Gillian Hawker.

Comment 1

This is a well-written and important manuscript reporting on the impact of a GP stepped care pathway on ordering of diagnostic tests and referrals to orthopaedic surgery for patients with hip and knee OA using administrative claims data.

We thank Ms. Gillian Hawker for reviewing our manuscript, for her compliments on our manuscript and for her constructive feedback.

Comment 2

Abstract - results: I found this bit difficult to understand as written and suggest reworking to simply the message. Perhaps the text could be replaced with a simplification of the tables 1 and 2?
We thank Ms. Gillian Hawker for her advice to simplify the results part of the abstract. Therefore, we rewrote this part in order to make it better to understand. For convenience purpose, we have added the entire abstract below.

Abstract, line 3, page 2

Background: The Dutch care for hip and knee osteoarthritis (OA) is of good quality, but there is room for improvement regarding the efficient use of diagnostics and conservative treatment. Therefore a stepped-care approach, in the shape of the care pathway ‘Better exercise in osteoarthritis’, was implemented to reduce the number of diagnostics requested by GPs and referrals of GPs to orthopaedic care.

Methods: In 2015, the pathway was implemented with the use of educational meetings, distributing guidelines and incorporating reminders in the GPs’ referral application. To evaluate the effect of the pathway on the diagnostic and referral behaviour of GPs, hip and knee related health insurance claims were used together with claims of other joints and of a control region for comparison. The average number of claims and the percentage change in the post-implementation period were described. Binary logistic regression analysis was used to examine the interaction between region (intervention and control) and period (pre- and post-implementation). Using random sampling of patient records, information about the practical application of the pathway and the number of hip or knee arthroplasties was added.

Results: In both regions, the number of diagnostics decreased and the number of initial consultations increased during the post-implementation period. Significant interaction effects were found in knee-related diagnostics (p ≤ 0.001) and diagnostics of other joints (p = 0.039). No significant interaction effects were found in hip-related diagnostics (p = 0.060) and in initial consultation claims of hip (p = 0.979), knee (p = 0.281), and other joints (p = 0.464). Being referred according to the pathway had no significant effect on the probability of undergoing arthroplasty.

Conclusion: The implementation of the pathway had a positive effect on the diagnostic behaviour related to the knee of GPs in the intervention region. The decrease in the number of diagnostics of other joints indicates that the pathway positively influenced the GPs diagnostics behaviour in general. The referral behaviour of GPs is a point of attention for future interventions and research. Focusing on the effect of the pathway on the entire width of care for hip and knee OA can be helpful.

Background: line 1 - the OA community is working hard to get rid of the perception that OA is a "degenerative disease" as it leaves many patients thinking it is simple aging and nothing can be done - I would respectfully ask that the sentence simply be revised to "Osteoarthritis is a common joint disorder..."

We thank Ms. Gillian Hawker for her advice to remove the part in the first line of the background that OA is a degenerative disease. Therefore, we revised the sentence.
Osteoarthritis (OA) is a common joint disorder affecting more than half of the population aged 65 years and older (1, 2).

Comment 4

Background: line 50 - should the word 'adequate' be 'appropriate'? 

We agree with Ms. Gillian Hawker that the word appropriate is more suitable in this sentence. Therefore, we corrected the sentence.

Background, line 19, page 5

As a result, fewer hip and knee arthroplasties would be necessary, based on the assumption that a group of patients is already appropriately managed in primary care.

Comment 5

Method: While not the focus of the manuscript, it would be useful to know how the implementation of the stepped care pathway was undertaken - how did you come up with the education materials and computer reminders for example? Were patients engaged in the implementation?

We thank Ms. Gillian Hawker for her question about how the implementation of the stepped care pathway was undertaken. To clarify this, we adapted the text in the method section of the manuscript. In addition to your question, patients were not engaged in the implementation.

Method, line 20, page 7

The pathway ‘Better exercise in osteoarthritis’ was designed, using the national guidelines for hip and knee OA (34), by members of an expert group, consisting of two GPs, a physical therapist, an orthopaedic surgeon, a rheumatologist, a radiologist, a physician assistant and a coordinator of MCC Omnes. In February 2015, the pathway ‘Better exercise in osteoarthritis’ was implemented in the Western Mining District. The pathway was implemented based on three interventions: educational meetings, distribution of the guidelines, and reminders. All interventions were developed and coordinated by members of the expert group and focused on improving the stepped care approach of hip and knee OA treatment, reducing diagnostic imaging requests and referrals to orthopaedic surgeons. The educational meetings consisted of one meeting organised for GPs and physiotherapists together at the start of the implementation process and was followed by advanced educational courses organised separately for GPs and physiotherapists. The educational meetings focussed on recognizing OA and red flag situations,
the content of the pathway and related guidelines, the role of different professionals within the
pathway (with emphasis on GPs and physiotherapists) and the application of the pathway in
practice, for example by discussing practical cases, patient communication skills training and
practicing administering corticosteroid injections. The educational meetings were voluntary and
professionals earned medical education credits for their presence. The guidelines were
distributed by placing a visualisation and explanation of the stepped-care pathway at the website
of MCC Omnes and in the newsletter and on the mobile application of MCC Omnes. In addition,
to support GPs in applying the pathway in practice, a reminder of the steps to be followed
popped up in the GPs’ referral application (called ZorgDomeiën) when requesting diagnostics or
when referring patients to orthopaedic care.

Around 20% of the GPs in the intervention region attended the first education meeting. To
optimise the reach of the pathway, information about the content of the educational meetings was
distributed on the website and in newsletters of MCC Omnes. In addition, the expert group
assumed that the attended GPs spread the content of the meetings among their colleagues within
their general practice and that all GPs, affiliated with MCC Omnes, eventually conform to their
initiatives.

Comment 6

Method: Please describe how the control region was selected.

We thank Ms. Gillian Hawker for her suggestion to describe how the control region was
selected. To clarify this, we adapted the text in method section of the manuscript.

Method, line 29, page 6

The control group incorporated three other regions. These regions were selected because they are
located in the same province as the intervention region and therefore generally have the same
population characteristics: declining and ageing.

Comment 7

Method: page 8 first paragraph - why was the pre implementation period 3 years while the post
implementation period was only 2 years?

We thank Ms. Gillian Hawker for her question about the duration of the pre and post
implementation period. The post implementation period only existed for two years due to the
lack of availability of data after those years. This is caused by the delay in the processing of the
claims data by the health insurer. To clarify this in the manuscript, we adapted the text in the
method section of the manuscript.
Due to the delay in the processing of the claims data by the health insurer, a post-implementation period of two years, instead of three years, was selected.

Comment 8

Method: I found the description and rationale for cost savings estimates confusing - why did you not use the actual costs based on the numbers of claims for diagnostics, ortho consultations, etc? Could you have incorporated the numbers of patients referred to ortho surgery who went on to undergo hip or knee arthroplasty? if not why not?

We thank Ms. Gillian Hawker for her question about the description and rational for the cost savings estimates. We did not use the actual costs because these were not available since price agreements are confidential. However, we have decided to remove the cost savings estimate section because it raises too many questions. This is in line with your comment 11 and the comments of the other reviewers. Furthermore, we added information about the number of patients referred to orthopaedic care according to the pathway and the number of patients who went on to undergo hip or knee arthroplasty, which was investigated on a sample basis. To process this information in the manuscript, the background, method, result and discussion have been rewritten.

In addition, this study evaluates to what extent the pathway is applied in practice before patients are referred to orthopaedic care and the effect of the pathway on the appropriateness of these referrals.

Additionally, to collect information about the practical application of the pathway and the appropriateness of referrals to orthopaedic care within the intervention region, a sub-study was conducted using random sampling of patient records of the regional hospital. Approximately 10% of the total number of the records of patients with a suspicion of hip or knee OA and with an initial orthopaedic consultation during the period from February 2015 to October 2016 (post-implementation period) were included.

The patient records collected using the random sampling contain the answers to the questions related to the reminder that popped-up in the GPs’ referral application when they refer patients to orthopaedic care. These answers were used to check whether patients had been referred
according to the pathway. Furthermore, the patients’ records were used to investigate if arthroplasty was performed.

Method, line 12, page 12

The number and percentages of patients referred to orthopaedic care according to the pathway and the number and percentages of arthroplasties performed are presented. Pearson's chi-square test was used to test the difference in the probability of undergoing arthroplasty between patients who were referred according to the pathway and patients who were not.

Results, line 4, page 15

Practical application of the pathway

Figure 2 and 3 show the number and percentage of patients referred by their GP to orthopaedic care with a suspicion of hip or knee OA and the number of performed arthroplasties. Figure 2 shows that the majority of patients with a suspicion of hip OA (56.7%) were referred according to the pathway. After the referral, 68.6% of the patients who were referred according to the pathway were diagnosed with OA. For patients not referred according to the pathway, this percentage was 56.4%. Finally, the percentage of patients who underwent arthroplasty was lower for patients referred according to the pathway than for patients not referred according to the pathway (35.3% and 38.5%, respectively). In addition, Figure 3 shows that the majority of patients with a suspicion of knee OA (53.8%) were referred according to the pathway. After the referral, 75.8% of the patients who were referred according to the pathway were diagnosed with OA. For patients not referred according to the pathway, this percentage was 59.0%. Finally, the percentage of patients who underwent arthroplasty was higher for patients referred according to the pathway than for patients not referred according to the pathway (39.6% and 28.2%, respectively).

Table 6 shows that for both patients with a suspicion of hip and knee OA, the probability of undergoing arthroplasty does not significantly differ for patients who were or were not referred according to the pathway.

See manuscript for added figures and table:

- Results, line 1, page 16 = Figure 2: Flow chart of patients referred with a suspicion of hip OA and the probability of arthroplasty
- Results, line 6, page 16 = Figure 3: Flow chart of patients referred with a suspicion of knee OA and the probability of arthroplasty
Results, line 12, page 16 = Table 6 Differences in percentages and numbers of arthroplasty in patients with suspected hip (N = 90) and knee (N = 169) OA being referred or not referred according to the pathway

Discussion, line 21, page 18

Additionally, the pathway seems to have less effect on the referral behaviour of GPs. Regarding to the claims data, a significant difference in the number of initial orthopaedic consultations in the intervention region during the post-implementation period compared to the control region was not found. Furthermore, the random sample of the patient records showed that not all GPs seem to conform to the pathway since almost half of the patients were not referred to orthopaedic care according to the pathway. Besides this, patients with a suspicion of hip or knee OA referred to orthopaedic care according to the pathway had the same probability to undergo arthroplasty than patients referred not according to the pathway. This seems to indicate that the quality of referring did not improve through the implementation of the pathway.

Comment 9

Method: final paragraph on page 8 - I am confused by the analytic description - it sounds like your dependent variable was the total number of claims (a count) whereas it is described as a binary outcome - please clarify.

We thank Ms. Gillian Hawker about her question about the analytic description of our dependent variable. To clarify this, we adapted the text in the method section of the manuscript.

Method, line 4, page 12

Furthermore, binary logistic regression analyses were used to determine the influence of the implementation of the pathway on the proportion of health insurance claims for diagnostics and initial orthopaedic consultations per 1,000 insured persons in the intervention region compared to the control region. The dependent variable in these models was a binary variable indicating diagnostic and initial consultation claims, yes or no.

Comment 10

Results: As per above, it would be very interesting to know what proportion of surgeon consultations resulted in surgery.

We thank Ms. Gillian Hawker about her question of what proportion of surgeon consultations resulted in surgery. We agree that this is very interesting to know. Therefore, we added information about the number of patients who went on to undergo hip or knee
arthroplasty, which was investigated on a sample basis as described at our answer on your comment 8.

Comment 11

Results: as per above, as presented, I am not sure that the cost savings analysis is sufficient added value to the paper - one can extrapolate savings from Tables 1 and 2.

We thank Ms. Gillian Hawker that she shares her doubts with us about the cost savings analysis. As described in our answer at comment 8, we have decided to remove the cost savings estimate section.

Comment 12

Discussion: Do you have any data that would point to what specific elements of the intervention or implementation strategy were most responsible for changed physician care behaviours?

We thank Ms. Gillian Hawker for her question if there is any data available that would point to what specific elements of the intervention or implementation strategy were most responsible for changed physician care behaviour. We do not have any data to answer this question. However, we have rewritten the discussion to put more emphasis on the possible influence of these elements.

Discussion, line 3, page 22

Based on the results, it is difficult to indicate which intervention (educational meetings, distribution of the guidelines, or reminders) contributed most to the decrease in the number of requested diagnostic procedures related to the knee and other joints since this study did not examined the effect of the different interventions separately. However, in a systematic review conducted by French et al. (2010) reminders were mentioned as potentially effective to change health professional behaviour and improve the use of diagnostic imaging. In the same review, educational meetings were not shown to be effective for changing imaging ordering behaviour. Furthermore, Hollingworth et al. (2002) found no evidence about the effect of distributing clinical guidelines on changing GPs imaging behaviour related to patients with lumbar spine complaints. In addition, according to the literature (75), the educational meetings organised by members of the expert group have potential to impact on referral rates. More research is needed to learn about the effects of the various interventions within the context of this pathway. This information is needed to further optimise the implementation of the pathway and to achieve a further increase in the appropriate use of diagnostic imaging and possibly achieve a decrease in the number of referrals.

Comment 13
We agree with Ms. Gillian Hawker that using “the expert group” is more suitable. Therefore, we have replaced ‘the expertise group’ with ‘the expert group’ throughout the manuscript.

Reviewer 2: Isabella Moroz

Comment 1

Overall, it is a very interesting observational study of claims data, aiming to determine whether the implementation of a stepped-care pathway for osteoarthritis management leads to decreases in diagnostics and referrals for orthopaedic consultations. The points below are meant to convey some praises to the authors for what was done well and pose some questions on aspects that were not clear.

We thank Ms. Isabella Moroz for reviewing our manuscript, for her compliments on our manuscript and for her constructive feedback.

Comment 2

Background: very good introduction to the rationale for the study, leading to clear objectives and hypotheses.

We thank Ms. Isabella Moroz for her compliments on the background section of our manuscript.

Comment 3

Design: clever in terms of i) comparing claims for hip and knee diagnostics and initial consultations to those for other osteoarthritis related care consumption, and ii) having a control region.

We thank Ms. Isabella Moroz for her compliments on the design section of our manuscript.

Comment 4

Setting: for comparison purposes, it would be helpful to know the population size of the control region, # of practices/GPs in it, and how/why it was chosen to be the comparator region.
We thank Ms. Isabella Moroz for her suggestion to describe the population size of the control region, number of practices and number of GPs. To clarify this, we have rewritten the method part. To clarify how and why the control region was chosen to be the comparator region we have rewritten the method part.

Method, line 29, page 6

The control group incorporated three other regions. These regions were selected because they are located in the same province as the intervention region and therefore generally have the same population characteristics: declining and ageing. Table 1 presents the approximated number of inhabitants, GP practices and permanent working GPs per region to indicate the size of these control regions compared to the intervention region.

See manuscript for added table:

• Method, line 1, page 7 = Table 1 Number of inhabitants, GP practices and permanent working GPs per region

Comment 5

Intervention: was training for GPs and physiotherapists mandatory or voluntary or incentivized in any way (eg continuing medical education credits)?

We thank Ms. Isabella Moroz for her question if training for GPs and physiotherapists was mandatory or voluntary or incentivized in any way. To clarify this, we adapted the text in method section of the manuscript.

Method, line 2, page 7

The educational meetings were voluntary and professionals earned medical education credits for their presence.

Comment 6

Intervention: Is there any way to check what was the penetration or reach of the intervention? For example, an estimate of the percentage of GPs exposed to the intervention?

We thank Ms. Isabella Moroz for her question if it is possible to check what the penetration or reach of the intervention was. To clarify this, we adapted the text in method section of the manuscript.
Method, line 9, page 8

Around 20% of the GPs in the intervention region attended the first education meeting. To optimise the reach of the pathway, information about the content of the educational meetings was distributed on the website and in newsletters of MCC Omnes. In addition, the expert group assumed that the attended GPs spread the content of the meetings among their colleagues within their general practice and that all GPs, affiliated with MCC Omnes, eventually conform to their initiatives.

Comment 7

Intervention: are all GPs required to use the ZorgDomain referral application? Is this application also used to make referrals to other relevant allied health providers such as dieticians, psychologists, and physiotherapists? It would be interesting to compare the referral rates to these specialties between the intervention and control region in the context of the present study.

We thank Ms. Isabella Moroz for her questions about the ZorgDomain referral application. All GPs were required to use the ZorgDomain referral application for the referring process to secondary care. However, the application is not used when referring to other providers such as dieticians, psychologists, and physiotherapists. Therefore, referral rates to these providers are lacking. We underline the importance of these data. To emphasize this more in the manuscript, we have rewritten the discussion and limitations section.

Discussion, line 29, page 21

Another point of attention mentioned during the expert meetings was the quality of physical therapy. Although the educational meetings and the distribution of the guidelines also aimed at physiotherapists, the focus of this study was on the impact of the implementation of the pathway on GPs behaviour. However, if physiotherapist do not use conservative treatment optimally and patients therefore do not experience improvements, GPs may feel forced to refer patients to orthopaedic care. Therefore, the practical implications of the pathway for physiotherapists and possibly other healthcare professionals (such as dieticians and psychologists) should be addressed in future research.

Limitations, line 1, page 23

Furthermore, the present study focused merely on the effects of the implementation of the pathway on GPs behaviour. However, healthcare professionals like physiotherapists, dieticians and psychologist are also involved in the conservative treatment of patients with hip and knee OA. Therefore, research on the effects of the pathway across the entire width of care for hip and knee OA is necessary in order to improve the effect of the pathway.
Comment 8

Figure 1 provides a very helpful visual display of the pathway.

&gt; We thank Ms. Isabella Moroz for her compliments on our visualization of the pathway.

Comment 9

Outcome measures: how does claim data make it possible to distinguish the initial consultations from all other types of orthopaedic consultations?

&gt; We thank Ms. Isabella Moroz for her question how it is possible to distinguish the initial consultations from all other types of orthopaedic consultations. In the Dutch system, they work with Diagnosis Treatment Combination (DTC).

Method, line 19, page 10

Based on the claims data, it was not possible to determine the total number of GP referrals to orthopaedic care, due to a lack of follow-up of the referral or non-attendance (40). Therefore, the actual claims of initial orthopaedic consultations related to osteoarthritis of the hip and knee and other joints were used, both in the intervention and control region. Initial consultations were recognized by the so-called Diagnosis Treatment Combination (DTC) (in Dutch: Diagnose Behandel Combinatie, DBC) (41). Every DTC has a unique performance code that includes all information about the type of care (initial or follow-up) the demand for care, the diagnosis and type of treatment.

Comment 10

Outcome measures: The description of how the cost estimations were calculated is not clear (page 8, line 23-25): "...the average tariffs for a maximum of two hip- or knee-related consultations from 2012 to 2016..."

&gt; We thank Ms. Isabella Moroz for her comment that the cost estimations calculations are not clearly described. However, after thoroughly examination of the review comments we decided to remove the part about the cost estimations.

Comment 11

Analysis: page 8, line 35: what exactly was averaged for the characteristics of the intervention and control region in terms of the numbers of insured persons reported later in table 1? The analysis specifies total counts whereas the table specifies an average number of insured persons.
We thank Ms. Isabella Moroz for her question about what exactly was averaged for the characteristics of the intervention and control region in terms of the number of insured persons reported later in Table 1. To clarify this, we adapted the text in method section of the manuscript.

Method, line 29, page 11

Characteristics of the intervention and control region during the pre- and post-implementation period were presented. The number of insured persons was presented with averages per period, gender was presented using the percentages of men, and age was presented with means and standard deviations (SDs).

Comment 12

Discussion: raises some good points (for example, that implementation of the pathway went beyond awareness of requesting hip/knee diagnostics to influence requesting other diagnostics in general, and the importance of raising patient awareness and educating patients), but the authors did not sufficiently address the observed increase in initial orthopaedic consultations in both regions post-implementation. What may have happened to cause this increase in both regions?

We thank Ms. Isabella Moroz for her suggestion to pay more attention to the observed increase in initial orthopaedic consultations in both regions post-implementation and what may have happened to cause this increase in both regions. To address this more, we added a paragraph about this in the discussion section of the manuscript.

Discussion, line 33, page 20

An explanation for the lack of effect found in the present study regarding the referral behaviour of GPs may be the fact that the practical application of the pathway is not optimal since not all patients were referred to orthopaedic care according to the pathway. This could explain why no decreasing effect was found in the number of initial consultation claims. According to Rogers (2003), when implementing an innovation, a part of the target group is sceptical and will offer resistance to change behaviour. Therefore, gaining insight into the application of the pathway by GPs may provide valuable information about the non-users. These insights can be used to evaluate barriers for application and to tailor interventions in order to stimulate the practical application (71). Another explanation for the lack of effect could be the worldwide consistent increase in the incidence of joint arthroplasty (72). This also explains the similar increase found in the control region. Additionally, during the expert meetings it emerged that patients can have a strong preference for a referral to orthopaedic care. Therefore, a referral sometimes is the only way to let patients accept that surgical treatment might not be beneficial. Literature confirms that patients’ preferences and GPs’ perception of patient pressure indeed influence the GP referral behaviour (48, 58). This supports the evidence that guidelines are relatively ineffective when implemented on their own (59-61). Again, improving patient-centred communication skills can be useful. During the expert meetings, increasing the consultation time per patient was
mentioned as an important criterion to apply these skills properly. Literature shows that longer consultations are associated with greater patient enablement (50), higher patient-centeredness (51), and a higher degree of lifestyle advice and preventive activities (52). However, evidence about the influence of consultation length on the number of referrals and patient satisfaction is lacking (53). In addition, exploring other interventions focussing on referring more appropriately to specialised medical care can be beneficial to reduce the inefficient use of limited resources (62-64). Examples of such interventions are peer-reviewing referrals within a general practice before sending them to specialised medical care, enabling GPs to obtain the advice of medical specialists, periodic visits by medical specialists to GP practices, and shifts to outpatient clinics in which orthopaedic surgeons or other health-care professionals with a special interest in musculoskeletal problems (for example GPs, nurse practitioners, or physician assistants) provide care in a community setting (62). These alternatives appear promising with respect to reducing unnecessary referrals to specialised medical care but require further investigation into the effects on quality of care, patients’ experiences, and cost of care (62).

Reviewer 3: Helena Britt

Comment 1

I think the study that is worth reporting, but its length, complex wording, repetition and inclusion of a lot of unrelated excess in the Discussion, makes it difficult to absorb. I kept feeling I was reading a chapter from a Thesis, not a paper for wider publication.

We thank Ms. Helena Britt for reviewing our manuscript and for estimating the value of this study. We also thank her for the constructive feedback. In order to make our manuscript more readable, we have tried to formulate sentences less complex and with less repetition without deleting necessary information.

Comment 2

Overall: This is a very, very long and heavy paper. I believe that at least 1/3rd of it could go. This is due to, unnecessary words and repetition. Sentences are convoluted, and careless. The first example I will give is the quoted aims above. How about reducing this to 2.5 lines in the following manner?

e.g.1 This study aimed to evaluate the effect of the implementation of the care pathway 'Better exercise in osteoarthritis', on GP diagnostic imaging ordering and referrals to orthopaedic surgeons for 1) hip, and 2) knee, osteoarthritis (OA).

We thank Ms. Helena Britt for her suggestion to shorten the sentences about the aim of the study in the background section. We have rewritten this part.

Background, line 29, page 5
This study aimed to evaluate the effect of the implementation of the care pathway 'Better exercise in osteoarthritis', on GP diagnostic imaging requests and GP referrals to orthopaedic surgeons for hip and knee OA.

Comment 3

Method: e.g. 2. Para 1 (lines5-12) page 5 (4.5 lines), could more clearly be stated as:

This is an observational quantitative study of GP diagnostic and ordering behaviour, and orthopaedic referral rates pre and post implementation of the intervention, using health insurance data 2012-16.

We thank Ms. Helena Britt for her suggestion to shorten the sentences about the study design in the method section. We have rewritten this part.

Method, line 10, page 6

This is an observational study comparing the diagnostic and referral behaviour of GPs in the pre- and post-implementation period of the intervention using health insurance claims data from 2012 to 2016.

Comment 4

Method: e.g.3 Page 5 para 3: lines 30-37. The following suggestion reduced this paragraph from 4.5 to 3.5 lines. The Western Mining District has a population of about 185,000. The population is declining and ageing. In 2016 it had 49 GP practices with 113 permanent working GPs and one hospital. The control group incorporated three other regions located in the province of Limburg.

We thank Ms. Helena Britt for her suggestion to shorten the sentences about the setting in the method section. We have rewritten this part.

Method, line 25, page 6

The Western Mining District has a population of about 185,000 people. The population is declining and ageing (35). The control group incorporated three other regions. These regions were selected because they are located in the same province as the intervention region and therefore generally have the same population characteristics: declining and ageing.

Comment 5
1.2 You regularly use of two sentences to make one statement. This was also extremely frustratigin.

e.g. Page 7, para 2 lines 38-52 I would suggest the following 4 lines!....

Annual diagnostic imagining claims related to OS of the hip, knee, and other joints (NOTE the LAST OF THESE HAS ALREADY BEEN DEFINED, YOU DONT NEED IT AGAIN!), and the annual claims for initial orthopaedic consultations(as a proxy measure of number of GP referrals) for each problem group in the intervention and the control regions were compared.

ectar; We thank Ms. Helena Britt for her suggestion to shorten the sentences about the outcome measures in the method section. We have rewritten this part.

Method, line 12, page 10

The annual number of diagnostic imaging claims requested by GPs and the number of initial orthopaedic consultations (as a proxy measure of number of GP referrals) related to OA of the hip and knee and other joints were compared between the intervention and control region.

Comment 6

Your repeated use of unnecessary words to begin a sentence including: " in addition; furthermore, as a result, therefore," + adding 'also' in the middle of a sentence, with absolutely no need to do so, nearly drove me (as a reader) to distraction. Remove all those that are superfluous.

ectar; We thank Ms. Helena Britt for her suggestion to remove ‘also’ in the middle of a sentence when the sentence begins with words like “in addition, furthermore, as a result”. We have carefully run through the entire manuscript and, where superfluous, removed these words.

Comment 7

Once you have defined a concept in the methods, then you do not have to redefine it every time you mention it. Also you to osteoarthritis of the knee, at its first mention in the methods ( OA knee ) in brackets. This also applies to OA Hip. You could then use this shorthand for the remainder of the paper. Same with

ectar; We thank Ms. Helena Britt for her suggestion to not redefine a concept every time. Therefore, we have carefully run through the entire manuscript and removed these repetitions if necessary. Moreover, we also replaced osteoarthritis with the abbreviation (OA) after it is first mentioned (except when used in figures and tables, since they must stand on their own).
Comment 8

Introduction: Page 3, line 10, this sentence suggests that 1.25 M. people were diagnosed in 2016. perhaps " had diagnoses osteoarthritis?" ( not WERE diagnosed with”).

We agree with Ms. Helena Britt that this sentence leads to a wrong interpretation. Therefore, we have rewritten the sentence.

Introduction, line 8, page 4

In 2016, an estimated 1.25 million people (around 7% of the population) had the diagnoses OA in the Netherlands (7).

Comment 9

Introduction: Line 18-19: Try : Recent increases in the prevalence of obesity ( a major determinant of OA) suggests the prevalence of OA is likely to row in the future”.

We thank Ms. Helena Britt for her suggestion to improve this sentence. We have rewritten the sentence.

Introduction, line 13, page 4

Recent increases in the prevalence of obesity, a major determinant of OA, suggests that the prevalence of OA is likely to rise in future (8-10).

Comment 10

Introduction: Line 23: "these costs are expected to rise" ( expected by whom ( no ref. Do you mean could be expected, or 'are likely to" (as this is opinion, not fact). 'increase in obesity? try" 'increase in prevalence of obesity"

We thank Ms. Helena Britt for her suggestion to improve this sentence. We have rewritten the sentence.

Introduction, line 16, page 4

In view of the increasing prevalence, these costs are likely to rise substantially.

Comment 11
Introduction: Line 32-39: could be compressed to two short sentences.

&gt; We thank Ms. Helena Britt for her suggestion to shorten this part. We have rewritten the sentences.

Introduction, line 22, page 4

OA is primarily a clinical diagnosis (13). This implies that in most cases the diagnosis can be based on history taking and physical examination (14, 15). Despite the recommendations in the guidelines (15), Smink et al. (2014) found that general practitioners (GPs) often request for diagnostic imaging.

Comment 12

Introduction: Page 4: lines 0-3. Which patients? do you mean all those referred to the orthopod?

Turn the sentence around so it makes sense. ’eg ’have found that a majority of patients referred to an OS did not receive prior conservative treatment etc”.

&gt; We thank Ms. Helena Britt for her suggestion to improve this sentence. To clarify to which patients we are referring, we have rewritten the sentence.

Introduction, line 3, page 5

Despite the availability of guidelines, several studies have found that a majority of patients referred to an orthopaedic surgeon did not receive appropriate prior conservative treatment (25-29).

Comment 13

Introduction: Line 35: do you mean 90% of costs for imaging associated with OA in total?; OA of hip and knee? Check the reference and define.

&gt; We thank Ms. Helena Britt for her suggestion to better define this sentence. Therefore, we have rewritten the sentence.

Introduction, line 22, page 5

The Dutch National Health Care Institute estimated that 90% of the costs associated with diagnostic imaging related to both hip and knee OA are unnecessary and that with the implementation of the guidelines, more than €14 million could be saved by deploying conservative treatment (12).
Comment 14

Introduction: Lines 42-44: convoluted statement!

&g; We thank Ms. Helena Britt for her feedback. To make the sentence more readable, we have adjusted it.

Introduction, line 26, page 5

The pathway may positively influence quality and health outcomes. In addition, unnecessary costs could be avoided by implementing these improvements (12).

Comment 15

Introduction: Lines 40-48. You tell me that GP consultations are covered by health insurance. Are specialists’ medical care and imaging costs also covered?

&g; We thank Ms. Helena Britt for her question about the coverage by health insurances. For specialists’ medical care and diagnostic imaging, a compulsory deductible is levied. To clarify this in the manuscript, we have rewritten the sentence.

Method, line 5, page 7

Primary care is delivered by GPs and GP consultations are fully covered by the health insurance (37). For consulting a medical specialist, a compulsory deductible is levied. The same applies for diagnostic tests (including diagnostic imaging) and pharmaceuticals prescribed by GPs. This implies that there will be additional costs for the patient if the compulsory deductible has not been met at the time of claim processing.

Comment 16

Methods: Watch you tense particularly in this section, you switch between [present and past tense].

&g; We thank Ms. Helena Britt for her feedback on the use of the present and past tense in the methods section. Therefore, we have carefully run through the method section of the manuscript and changed the tense if necessary.

Comment 17

Methods: Page 5: Line 58: ‘were informed in writing afterwards”. "Informed" of what?
We thank Ms. Helena Britt for her question about this sentence. However, when rewriting the method section we decide to remove this sentence.

Comment 18
Methods: Page 6: Para 1., Did the pop up come up whenever the GP was ordering imagining or referring to orthopaedic care/ or did it only come up if the problem label/diagnosis was knee of hip OA? This is important. If it was the former, no wonder the intervention had an effect on ordering from other joint OA. And if so this would be a limitation of the study because the intervention was not only aimed at OA knee and Hip.

We thank Ms. Helena Britt for her question about the pop-up reminders. The pop-up only appears when GPs request imagining for the knee or hip. There is no pop-up when GPs request imaging for other joints. Therefore, this is not a limitation of the study.

Comment 19
Methods: Page 6, line 59 and in a number of other places you speak of 'collecting' the claims data. You did not 'collect' it, it was analyses of an administrative database.

We agree with Ms. Helena Britt that ‘collecting’ the claims data is not correct. Therefore, we have rewritten the sentences were we mentioned this.

Methods, line 11, page 9
To compare the number of hip- and knee-related claims with other OA-related care consumption, claims related to other joints (neck, shoulder, upper arm, elbow, forearm, hand, wrist, fingers, ankle, foot, and toes) were used.

Methods, line 21, page 10
Therefore, the actual claims of initial orthopaedic consultations related to OA of the hip and knee and other joints were used, both in the intervention and control region.

Declarations, line 19, page 24
In addition, participant consent was not necessary as this study used de-identified data which was obtained as part of evaluation of patient care, which was confirmed by the Medical Research and Ethics Committee of Zuyderland Medical Centre and Zuyd University of Applied Sciences (Application number: 15-N-123).
Comment 20

Methods: Page 7: Figure 1: The GP box: do you mean approximately 6 months? (please use approximation symbol (~) rather than +/-, which is totally illogical, as you cannot follow up 6 months BEFORE the intervention!

&gt; We thank Ms. Helena Britt for her question about Figure 1. We indeed mean approximately 6 months. Therefore, we changed the symbol.

Figure 1, line 1, page 9

Comment 21

Methods: Page 7: lines 38-53: The first four lines on this para have already been stated in the methods. Delete.

&gt; We thank Ms. Helena Britt for her suggestion to delete a part of the outcome measures. We have rewritten this part (see also our answer to your comment 5).

Method, line 12, page 10

The annual number of diagnostic imaging claims requested by GPs and initial orthopaedic consultations (as a proxy measure of number of GP referrals) related to OA of the hip and knee and other joints were compared between the intervention and control region.

Comment 22

Methods: Page 7: Lines 45-52The argument about referrals to orthopod not being = to true number of referrals is OK, as we know patients do not always follow up. However, the last three lines of this para is not the right conclusion. Even if every referral was taken up and there were no non-attendances, the measurement 'number of initial consults" - would NOT = the total consultations!.

&gt; We thank Ms. Helena Britt for her suggestion to change the conclusion of this section. The problem is, that based on claims data, it is not possible to determine the exact number of referrals. Therefore, we use initial consultations as a proxy of the GPs referral behaviour. To clarify this, we have rewritten this part (see also our answer to comment 9 of Ms. Isabella Moroz).

Method, line 19, page 10
Based on the claims data, it was not possible to determine the total number of GP referrals to orthopaedic care, due to a lack of follow-up of the referral or non-attendance (39). Therefore, the actual claims of initial orthopaedic consultations related to OA of the hip and knee and other joints were used, both in the intervention and control region.

Comment 23

Methods: Page 7 Line 56: Characteristics of insured persons in the intervention and control regions were drawn from the database for: number insured, gender, and the age of the population. Do you mean the insured population? or the whole population?

&gt; We thank Ms. Helena Britt for her question about the population. We mean the entire population insured by CZ, the dominant health insurance company in the intervention region. To clarify this, we have rewritten the sentence.

Method, line 30, page 10

Characteristics of the entire population insured by CZ in the intervention region and the control region during the pre- and post-implementation period were presented.

Comment 24

Methods: Page 9: Line 1: please provide a reference for the' Enter method'.

&gt; We thank Ms. Helena Britt for her suggestion to provide a reference for the Enter method.

Methods, line 10, page 12

The Enter method was used (42).


Comment 25

Results: Page 10 Lines 26-35. second sentence. This is already stated in the method. it can be deleted here.

&gt; We agree with Ms. Helena Britt that this information is already stated in the method section. Therefore, we have rewritten this results section.
Results, line 10, page 13

In Table 3, the number of claims and the percentage change in the intervention and control region are described.

Comment 26

Results: Table 2: I would have liked to see a statistical test of this pre-post changes in this table, before you move into the logistic regression. It increases the reader's understanding of exactly what's happening.

&gt; We thank Ms. Helena Britt for her feedback on Table 2. This table contains descriptive information used as stepping stone to clarify Table 3. Therefore, a statistical test of the pre-post changes is not an issue.

Comment 27

Results: Page 11: first 2 lines, already stated in the Methods. Do not repeat the methods in the results!

&gt; We thank Ms. Helena Britt for her suggestion to remove this part of the result section. We agree that this is already stated in the methods section. Therefore, we removed this sentence.

Comment 28

Results: Superfluous words again. "Replace regarding the initial consultations, as presented in Table 4" with. There was no statistically significant ...... and add (Table 4, before the full stop and the end of the paragraph.

&gt; We thank Ms. Helena Britt with her suggestion to rewrite this part of the result section. We changed the following sentence:

Results, line 14, page 14

There was no statistically significant interaction effect between region and period in hip (OR = 1.002, 95% CI = 0.871–1.152, p = 0.979), knee (OR = 0.894, 95% CI = 0.728–1.097, p = 0.281), or other joint-related claims (OR = 1.091, 95% CI = 0.864–1.378, p = 0.464) (Table 5).

Comment 29

Results: Table 3: Three columns labelled total - total what? Savings?
We thank Ms. Helena Britt for her question about labels of the columns in Table 5. However, we have decided to remove the cost savings estimate section, and Table 5 with it, because it raises too many questions. This is in accordance with the comments made by the other reviewers.

Comment 30

Discussion: The first paragraph is a repeat of the aims and methods (( in brief). This is not needed here. The first para should summarise the major findings of this study. This is then followed by discussion about them. Your style is then to make a very long RE-statement of the result (which you shouldnt)

We agree with Ms. Helena Britt about the unnecessary repeating of aims and methods in the first section of the discussion. Therefore, we have rewritten this section.

Discussion, line 9, page 18

The present study found a significant decrease during the post-implementation period in the number of knee-related diagnostic claims per 1,000 insured persons in the intervention region compared to the control region. A similar decrease in the number of requested diagnostic procedures for other joints was found. This decrease indicates that the implementation of the pathway went beyond awareness of requesting hip- and knee-related diagnostic imaging by GPs and positively influenced the GPs when it came to requesting diagnostics in general.

Comment 31

Discussion: Page 14: lines 26-31: This statement suggests there was a STRONGER decrease in diagnostics in the intervention that in the control, which you then say was not statistically significant. If it is not statistically significant then there was no difference!. The statement should be that there was no difference and that's that!, Then tell us what the result indicates.

We agree with Ms. Helena Britt about the fact that if the result is not statistically significant then there is no difference. Therefore, we have rewritten this section. To clarify what the results indicate, we have rewritten the discussion.

Discussion, line 17, page 18

No differences in the number of hip-related diagnostic procedures was found between the intervention and control region during the post-implementation period.

Comment 32
Discussion: Most of the rest of the discussion is not about the results of the research reported in this paper. It is largely about how the intervention could be improved to perhaps be more effective, and most of the suggestions are based on the literature.

We agree with Ms. Helena Britt that the discussion section could focus more on the discussion of the results of the present research. This is in line with comment 12 of reviewer 1 and comment 12 of reviewer 2. Therefore we have rewritten the discussion section.

Discussion, line 16, page 20

The results of the present study regarding the absence of a significant decrease in the number of hip related diagnostics are in line with the study of Linsell et al. (2005) in which GPs were more likely to request an x-ray for older people with hip pain than for older people with knee pain. A possible explanation for this could be the fact that hip complaints are more complex for GPs to manage. Literature shows that pain from the hip is difficult to define and that it is difficult to determine the exact source of pain (66, 67), that hip OA patients have more advanced complaints and that triggers for symptomatic presentation in hip OA are less understood (68). When GPs experience difficulties in diagnosing hip related complaints, requesting diagnostic imaging can be a strategy to deal with these uncertainties (69). Therefore, improving GPs skills to set the diagnosis OA of the hip could be the focus in future educational meetings. In addition, during the expert meetings, GPs revealed that it could be difficult to convince patients that diagnostic imaging is not always necessary to diagnose OA. Previous studies (46-48) have found that GPs’ perception of patient pressure influences the non-adherence to guidelines concerning indications for diagnostic imaging, like an X-ray or MRI. Moreover, Baker et al. (2006) found that GPs believed that denying an X-ray could adversely affect the doctor–patient relationship. Although patient communication was part of the educational meetings, further improving GPs’ patient-centred communication skills can be useful, since these skills are associated with fewer diagnostic testing expenditures (49).

An explanation for the lack of effect found in the present study regarding the number of initial orthopaedic consultations may be the worldwide consistent increase in the incidence of joint arthroplasty (70). This also explains the similar increase in the control region. Additionally, during the expert meetings it emerged that patients can have a strong preference for a referral to orthopaedic care. Therefore, a referral sometimes is the only way to let patients accept that surgical treatment might not be beneficial. Literature confirms that patients’ preferences and GPs’ perception of patient pressure indeed influence the GP referral behaviour (48, 58). This supports the evidence that guidelines are relatively ineffective when implemented on their own (59-61). Again, improving patient-centred communication skills can be useful. During the expert meetings, increasing the consultation time per patient was mentioned as an important criterion to apply these skills properly. Literature shows that longer consultations are associated with greater patient enablement (50), higher patient-centeredness (51), and a higher degree of lifestyle advice and preventive activities (52). However, evidence about the influence of consultation length on the number of referrals and patient satisfaction is lacking (53). In addition, exploring other interventions focussing on referring more appropriately to specialised medical care can be beneficial to reduce the inefficient use of limited resources (62-64). Examples of such
interventions are peer-reviewing referrals within a general practice before sending them to specialised medical care, enabling GPs to obtain the advice of medical specialists, periodic visits by medical specialists to GP practices, and shifts to outpatient clinics in which orthopaedic surgeons or other health-care professionals with a special interest in musculoskeletal problems (for example GPs, nurse practitioners, or physician assistants) provide care in a community setting (62). These alternatives appear promising with respect to reducing unnecessary referrals to specialised medical care but require further investigation into the effects on quality of care, patients’ experiences, and cost of care (62).

Another point of attention mentioned during the expert meetings was the quality of treatment by the physiotherapist. Although the educational meetings and the distribution of the guidelines were also aimed at physiotherapists, the focus of this study was on the impact of the implementation of the pathway on GPs behaviour. However, if conservative treatment is not used optimally by the physiotherapist and patients therefore do not experience improvements, GPs may feel forced to refer patients to orthopaedic care. Therefore, the practical implications of the pathway for physiotherapists and possibly other healthcare professionals (such as dieticians and psychologists) should be addressed in future research.

Based on the results, it is difficult to indicate which intervention (educational meetings, distribution of the guidelines, or reminders) contributed most to the decrease in the number of requested diagnostic procedures related to the knee and other joints since this study did not examined the effect of the different interventions separately. However, in a systematic review conducted by French et al. (2010) reminders were mentioned as potentially effective to change health professional behaviour and improve the use of diagnostic imaging. In the same review, educational meetings were not shown to be effective for changing imaging ordering behaviour. Furthermore, Hollingworth et al. (2002) found no evidence about the effect of distributing clinical guidelines on changing GPs imaging behaviour related to patients with lumbar spine complaints. In addition, according to the literature (75), the educational meetings organised by members of the expert group have potential to impact on referral rates. More research is needed to learn about the effects of the various interventions within the context of this pathway. This information is needed to further optimise the implementation of the pathway and to achieve a further increase in the appropriate use of diagnostic imaging and possibly achieve a decrease in the number of referrals.

Comment 33

Discussion: In the last para of page 15, you move to discussion about the expert meetings, which were NOT reported in this paper.

We agree with Ms. Helena Britt that the expert meetings mentioned in the discussion were not reported earlier in the manuscript. Therefore, we have added this to the method section.

Methods, line 23, page 12
Expert meetings

The process of the pathway and results of the analyses were discussed during meetings with the expert group. The purpose of this meeting was to verify the findings and to contribute to a better interpretation of the results.

Comment 34

Discussion: In other words, there is very little discussion about the implications of the results of THIS study. For example, is it a good thing that the implementation resulted in INCREASED referrals, and why do you think this increase occurred in parallel with the decreased testing?

We agree with Ms. Helena Britt that the discussion section could focus more on the discussion of the results of the present research. This is in line with comment 32 and our answer on this comment.

Comment 35

Limitation section is OK though could be improved with a good edit.

We thank Ms. Helena Britt for her feedback on the limitation section. We have thoroughly examined the limitation section and we have rewritten some parts.

Limitations, line 19, page 22

To ensure anonymity, only aggregated data (number of claims per year) were available and no analysis at an individual level could be made.

Limitations, line 6, page 23

Finally, it is important to focus not only on the number of requested diagnostic imaging procedures and referrals to orthopaedic care, but also on the effect of the pathway on patient satisfaction, quality and costs of care (75).

Comment 36

Conclusion: This is again a re-statement of the result, rather than a conclusion. Also somewhat convoluted language.

We thank Ms. Helena Britt for her feedback on the conclusion section of our manuscript. We thoroughly examined the conclusion section and we have rewritten some parts.
The aim of the care pathway ‘Better exercise in osteoarthritis’ was to reduce the GP diagnostic imaging requests and GP referrals to orthopaedic surgeons for hip and knee OA. With the use of educational meetings for GPs and physiotherapists, distributing guidelines online and in newsletters, and inserting reminders into the referral application of GPs, the pathway was implemented in the Western Mining District of Limburg. The present study found a decrease in the number of knee and other joint related diagnostic requests by GPs, which indicates that the pathway positively influenced the GPs diagnostics behaviour in general. A decrease in the number of hip- and knee-related referrals to orthopaedic care was not found, this number even increased.

Future research is needed to identify the specific role of the interventions in their effectiveness in improving the diagnostic behaviour of GPs, particularly related to diagnostic procedures of the hip. In addition, further research on the referral behaviour of GPs is necessary which should focus on possible other interventions and the entire width of care for hip and knee OA in order to improve the effect of the pathway.

Comment 37

Conclusion: Your statement of a lack of decreasing effect on orthopaedic referral rates is not really honest is it? There was in fact an INCREASE in orthopaedic referrals, not a 'lack of decrease'.

We thank Ms. Helena Britt for her feedback on the conclusion section of our manuscript. We have rewritten our statement about the lack of decreasing effect on orthopaedic referral rates.

Comment 38

Conclusion: Para 2: ?Appear to be recommended?. Nothing in your research studied recommendations, so this is not a conclusion you can reach.

We thank Ms. Helena Britt for her feedback on the conclusion section of our manuscript. We thoroughly examined the conclusion section and we have rewritten some parts, see also our answer at comment 36.

Comment 39
Abstract: I have refrained from reviewing the Abstract at this stage, as so much of the paper needs to change. It would be pointless. However, I do not that the Conclusion is a gin misleading in the Abstract as well as in the body.

The abstract has been rewritten, based on the reviews comments to which we have adapted the manuscript. For convenience purpose, we have added the entire abstract below.

Abstract, line 3, page 2

Background: The Dutch care for hip and knee osteoarthritis (OA) is of good quality, but there is room for improvement regarding the efficient use of diagnostics and conservative treatment. Therefore a stepped-care approach, in the shape of the care pathway ‘Better exercise in osteoarthritis’, was implemented to reduce the number of diagnostics requested by GPs and referrals of GPs to orthopaedic care.

Methods: In 2015, the pathway was implemented with the use of educational meetings, distributing guidelines and incorporating reminders in the GPs’ referral application. To evaluate the effect of the pathway on the diagnostic and referral behaviour of GPs, hip and knee related health insurance claims were used together with claims of other joints and of a control region for comparison. The average number of claims and the percentage change in the post-implementation period were described. Binary logistic regression analysis was used to examine the interaction between region (intervention and control) and period (pre- and post-implementation). Using random sampling of patient records, information about the practical application of the pathway and the number of hip or knee arthroplasties was added.

Results: In both regions, the number of diagnostics decreased and the number of initial consultations increased during the post-implementation period. Significant interaction effects were found in knee-related diagnostics (p ≤ 0.001) and diagnostics of other joints (p = 0.039). No significant interaction effects were found in hip-related diagnostics (p = 0.060) and in initial consultation claims of hip (p = 0.979), knee (p = 0.281), and other joints (p = 0.464). Being referred according to the pathway had no significant effect on the probability of undergoing arthroplasty.

Conclusion: The implementation of the pathway had a positive effect on the diagnostic behaviour related to the knee of GPs in the intervention region. The decrease in the number of diagnostics of other joints indicates that the pathway positively influenced the GPs diagnostics behaviour in general. The referral behaviour of GPs is a point of attention for future interventions and research. Focusing on the effect of the pathway on the entire width of care for hip and knee OA can be helpful.