Supplemental Online Content

O'Connor DA, Glasziou P, Maher CG, et al. Effect of an individualized audit and feedback intervention on rates of musculoskeletal diagnostic imaging requests by Australian general practitioners: a randomized clinical trial. *JAMA*. Published September 6, 2022. doi:10.1001/jama.2022.14587

This supplemental material has been provided by the authors to give readers additional information about their work.

eAppendix 1. Template for Intervention Description and Replication (TIDieR) Checklist

Brief name	Audit and feedback for reducing musculoskeletal diagnostic imaging requests by high requesting Australian GPs
Why	Audit and feedback is a widely used strategy for improving professional practice. A small number of trials have evaluated this intervention for improving the appropriateness, or reducing overuse, of musculoskeletal diagnostic imaging requesting (including of the lumbar spine, cervical spine, hip, knee and ankle) by GPs with mixed effects. The factorial design employed in this trial allowed us to evaluate two potential effect modifiers of audit and feedback: (1) the frequency of feedback and (2) an enhanced feedback display. Meta-regression from the Cochrane audit and feedback review suggests providing feedback on more than one occasion is associated with increased effects. Furthermore, theories that seek to explain how audit and theory works suggest that multiple instances of feedback encourage a 'feedback loop'. The way in which feedback data is displayed has also been identified as a potential effect modifier. A recent paper on optimising audit and feedback informed by empirical and theoretical knowledge suggests the feedback display should attract and maintain the attention of recipients on relevant information and in a manner that highlights key recommendations. Clinical Performance Feedback Intervention Theory (CP-FIT) also highlights the importance of the feedback display and asserts that feedback is more likely to be effective when it employs user-friendly designs which minimise cognitive load and help recipients decide what aspects of their performance require attention.
What (materials)	Group 1 (control) received no audit and feedback information on their musculoskeletal diagnostic imaging requesting during the trial. Group 2 ('standard once') received a 3-page written audit and feedback report with standard display, delivered by mail on one occasion (8 November 2019) (Supplementary file 3). Group 3 ('enhanced once') received a 3-page written audit and feedback report with enhanced feedback display (i.e., yellow shading in the table on page 3 aimed at drawing the recipient's attention to where their request rate was in the top 20% of referrers). The report was delivered on one occasion (8 November 2019). Group 4 ('standard twice') received a 3-page written audit and feedback report with standard display (as per Group 2) with the exception of an additional statement advising recipients they would receive updated feedback in 9-12 months. The first feedback report was delivered by mail on 8 November 2019. The second feedback report was delivered by mail on 9 November 2020. Group 5 ('enhanced twice') received a 3-page written audit and feedback report with enhanced feedback display (as described in Group 3) on two occasions (8 November 2019 and 9 November 2020).
What (procedures)	Written audit and feedback reports were mailed to GP recipients.
Who provided	Written audit and feedback reports were designed by the research team in consultation with the Australian Government Department of Health staff, the Chief Medical Officer of Australia and the Acting Chief Medical Officer of Australia. Data on GP diagnostic imaging requesting was extracted from the Medicare Benefits Schedule administrative database by Australian Government Department of Health staff. This data was used to populate feedback reports which were mailed to recipients by Australian Government Department of Health staff on 8 November 2019 (Groups 2-5) and 9 November 2020 (Groups 4 and 5 only).
How	Written reports were delivered by mail.
Where	Written reports were mailed to high requesting GPs located in any state or territory of Australia.
When and how much	Written audit and feedback reports were delivered on 8 November 2019 to GP recipients allocated to Groups 2 to 5 and on a second occasion (9 November 2020) to GP recipients allocated to Groups 4 and 5 only.
Tailoring	Recipients received audit and feedback reports that displayed their individual musculoskeletal diagnostic imaging requesting data. No other tailoring occurred.
Modifications	The first written audit and feedback report mailed to GP recipients allocated to Groups 4 and 5 contained a sentence that said "*I will send you another letter in 9-12 months with updated information on your diagnostic imaging. I hope you will find it useful to see how you compare to your peers at that time*." Delivery of the second feedback report to GPs allocated to Groups 4 and 5 occurred at 12 months from

	baseline (rather than at 9 months up to 12 months) on 9 November 2020. This was chosen because the Australian state of Victoria experienced a second wave of the COVID-19 pandemic during 30 June 2020 to the end of October 2020 and the researchers considered it appropriate to delay delivery of the second feedback letter until after this second wave had subsided. The second feedback report stated that updated diagnostic imaging requesting data was provided to recipients for the period 8 November 2019 to 7 March 2020 given the impact of the COVID-19 pandemic on the Australian healthcare system and associated widespread changes to GP requesting rates.
How well (planned)	Written audit and feedback reports were mailed to GP recipients using their nominated mailing address. We did not track delivery of the feedback reports to recipients but recorded those that were returned to sender (e.g., if the GP was no longer at that address). No attempts were made to locate another mailing address for return to sender reports.
How well (actual)	Written audit and feedback reports were mailed to 3,055 GP recipients allocated to one of the four intervention groups at baseline on 8 November 2019. A total of 166 baseline audit and feedback reports were returned undelivered. A second audit and feedback report containing updated diagnostic imaging requesting information as planned was mailed on 9 November 2020 to 1,292 of the 1521 GPs allocated to Groups 4 or 5. A total of 52 audit and feedback reports sent on the second occasion were returned undelivered (25 in 'standard twice' group; 27 in 'enhanced twice' group). 229 of the 1521 GPs allocated to Groups 4 or 5 were not sent a second audit and feedback report as planned because either (i) their first audit and feedback report was returned undelivered and we did not have another mailing address for them (n=87); (ii) they had no Category 1 patient consultations (i.e., they had not practiced) for the period 8 November 2019 to 7 March 2020 (n=59); (iii) they had requested *not* to receive a second audit and feedback report (n=3); or (iv) they had fewer than 333.3 patient consultations for the period 8 November 2019 to 7 March 2020 so calculating their requesting percentile was not reliable (n=80). Given this, the latter group of 80 GPs were sent an alternative audit and feedback report providing data on the number of requests they had made for each of the 11 targeted imaging tests for the period 8 November 2019 to 7 March 2020 (Supplementary file 3) instead of the second report as planned (as described in 'Interventions' and 'What (materials)').

Appendix 1 – Group 2 audit and feedback report (standard display on one occasion)

Australian Government

Department of Health

8 November 2019 Your reference: «reference_»

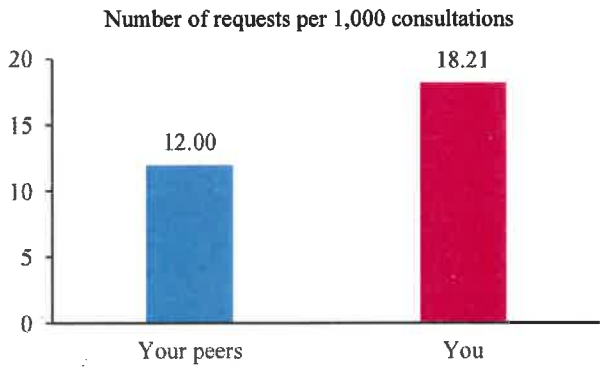
«Title» «First_name» «Last_name»
«Address_Line_1»
«Address_Line_2»
«Suburb» «State» «Postcode»

Dear «Title» «Last_name»

Your musculoskeletal diagnostic imaging request rate is higher than 80% of General Practitioners practicing in a similar geographical region in Australia

You may be aware that overuse of diagnostic imaging services has become a problem in Australia. Most people who present with musculoskeletal pain in the absence of worrying features do not need any imaging as it does not help management. Pain can improve rapidly, for example, around 50% of people who experience an episode of back pain will recover within 2 weeks.

I am writing to you because you request more musculoskeletal diagnostic imaging services than 80% of general practitioners (GPs) practicing in Australia, and your rate on 4 individual items is also higher than 80% of your peers. This rate is displayed below and in the table provided on page 3.



GPs are important stewards in maximising the quality use of diagnostic imaging for the benefit of patients. You can help by reflecting on your requesting data provided in this letter and limiting requests to only those clinical situations where imaging will change your patient's treatment plan and improve their health outcomes. The benefits of tackling this

problem include reducing the potential for harm from cumulative exposure to ionising radiation for some investigations, as well as reducing the harm that can come from identifying incidental findings. Not only may this increase patient anxiety, it can also lead to a cascade of further unnecessary tests and treatments.

Resources to support you

Please visit www.health.gov.au/imaging-requests for links to resources that may be helpful.

We welcome your feedback

If you have any questions or feedback, including suggestions on how we can better support you, please contact my team at diagnostic.imaging@health.gov.au, or on 1800 318 207. Please quote your CSE number located on the top right corner of page 1 of this letter when contacting my team.

Yours sincerely

Professor Brendan Murphy
Chief Medical Officer

Your diagnostic imaging requests between 1 January 2018 and 31 December 2018

The table below shows the selected musculoskeletal diagnostic imaging services that were rendered as a result of your imaging requests.

Imaging type	Number you requested	Your requesting rate per 1,000 consults	Requesting rate of your GP peers per 1,000 consults
Low back CT	21	3.51	1.19
Low back x-ray	0	0.00	0.53
Neck CT	13	2.17	0.29
Neck x-ray	1	0.17	0.24
Neck MRI	0	0.00	0.22
Shoulder x-ray	14	2.34	1.48
Shoulder ultrasound	33	5.51	2.67
Hip x-ray	0	0.00	1.48
Hip ultrasound	2	0.33	1.35
Knee x-ray	6	1.00	0.31
Ankle/hind foot ultrasound	19	3.17	0.66
Total	109	18.21	12.00
Number of consultations	5987	**Your overall requesting percentile**	80

How did you calculate my request rate?

We calculated your request rate based on the number of musculoskeletal services (listed above) that you requested for your patients in 2018. We have only included those requests that led to a Medicare Benefits Scheme (MBS) service being rendered by a radiologist.

We are unable to determine the clinical reason for your diagnostic imaging requests from MBS data, however your rate is higher than 80% of your GP peers. While there may be a reason for your high imaging rate, we encourage you to reflect and reduce where clinically indicated and appropriate.

How did you calculate my percentile ranking?

Your percentile ranking was calculated by comparing your request rate to that of other GPs practicing in a similar geographical location in Australia.[1]

How did you account for varying patient loads or number of days worked?

The rates in the table are presented as a proportion of the number of consultations that you rendered in 2018 to account for varying patient loads or days worked throughout the year.

[1] Based on the Modified Monash Model. See our resource page for more information.

Appendix 2 – Group 4 audit and feedback reports (standard display on two occasions: at baseline and at 12 months)

Australian Government

Department of Health

8 November 2019 Your reference: «reference_»

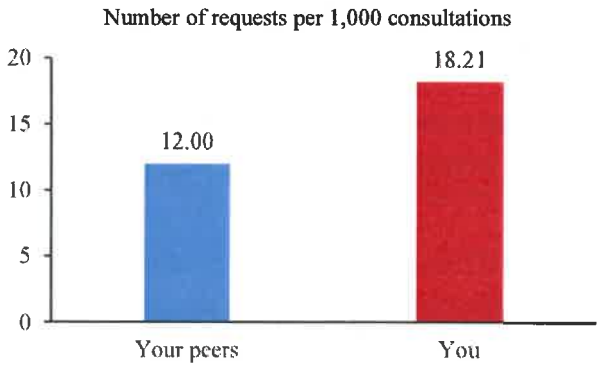
«Title» «First_name» «Last_name»
«Address_Line_1»
«Address_Line_2»
«Suburb» «State» «Postcode»

Dear «Title» «Last_name»

Your musculoskeletal diagnostic imaging request rate is higher than 80% of General Practitioners practicing in a similar geographical region in Australia

You may be aware that overuse of diagnostic imaging services has become a problem in Australia. Most people who present with musculoskeletal pain in the absence of worrying features do not need any imaging as it does not help management. Pain can improve rapidly, for example, around 50% of people who experience an episode of back pain will recover within 2 weeks.

I am writing to you because you request more musculoskeletal diagnostic imaging services than 80% of general practitioners (GPs) practicing in Australia, and your rate on 4 individual items is also higher than 80% of your peers. This rate is displayed below and in the table provided on page 3.



GPs are important stewards in maximising the quality use of diagnostic imaging for the benefit of patients. You can help by reflecting on your requesting data provided in this letter and limiting requests to only those clinical situations where imaging will change your patient's treatment plan and improve their health outcomes. The benefits of tackling this

problem include reducing the potential for harm from cumulative exposure to ionising radiation for some investigations, as well as reducing the harm that can come from identifying incidental findings. Not only may this increase patient anxiety, it can also lead to a cascade of further unnecessary tests and treatments.

I will send you another letter in 9-12 months with updated information on your diagnostic imaging. I hope you will find it useful to see how you compare to your peers at that time.

Resources to support you

Please visit www.health.gov.au/diagnosticimaging for links to resources that may be helpful.

We welcome your feedback

If you have any questions or feedback, including suggestions on how we can better support you, please contact my team at diagnostic.imaging@health.gov.au, or on 1800 318 209. Please quote your CSE number located on the top right corner of page 1 of this letter when contacting my team.

Yours sincerely

Professor Brendan Murphy
Chief Medical Officer

Your diagnostic imaging requests between 1 January 2018 and 31 December 2018

The table below shows the selected musculoskeletal diagnostic imaging services that were rendered as a result of your imaging requests.

Imaging type	Number you requested	Your requesting rate per 1,000 consults	Requesting rate of your GP peers per 1,000 consults
Low back CT	21	3.51	1.19
Low back x-ray	0	0.00	0.53
Neck CT	13	2.17	0.29
Neck x-ray	1	0.17	0.24
Neck MRI	0	0.00	0.22
Shoulder x-ray	14	2.34	1.48
Shoulder ultrasound	33	5.51	2.67
Hip x-ray	0	0.00	1.48
Hip ultrasound	2	0.33	1.35
Knee x-ray	6	1.00	0.31
Ankle/hind foot ultrasound	19	3.17	0.66
Total	109	18.21	12.00
Number of consultations	5987	**Your overall requesting percentile**	80

How did you calculate my request rate?

We calculated your request rate based on the number of musculoskeletal services (listed above) that you requested for your patients in 2018. We have only included those requests that led to a Medicare Benefits Scheme (MBS) service being rendered by a radiologist.

We are unable to determine the clinical reason for your diagnostic imaging requests from MBS data, however your rate is higher than 80% of your GP peers. While there may be a reason for your high imaging rate, we encourage you to reflect and reduce where clinically indicated and appropriate.

How did you calculate my percentile ranking?

Your percentile ranking was calculated by comparing your request rate to that of other GPs practicing in a similar geographical location in Australia.[1]

How did you account for varying patient loads or number of days worked?

The rates in the table are presented as a proportion of the number of consultations that you rendered in 2018 to account for varying patient loads or days worked throughout the year.

[1] Based on the Modified Monash Model. See our resource page for more information.

Australian Government

Department of Health

Acting Chief Medical Officer

9 November 2020

Your reference: «reference_»

«Title» «First_name» «Last_name»
«Address_Line_1»
«Address_Line_2»
«Suburb» «State» «Postcode»

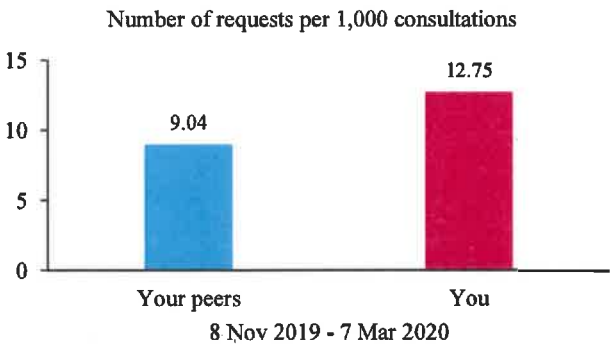
Dear «Title» «Last_name»

GPs (General Practitioners) are important stewards in maximising the quality use of diagnostic imaging for the benefit of patients. You can help by reflecting on your requesting data provided in this letter and limiting requests to only those clinical situations where imaging has the potential to change your patient's treatment plan and improve their health outcomes.

Your musculoskeletal diagnostic imaging request rate is at the 87th percentile of GPs practicing in a similar geographical region in Australia

On 8 November 2019, Professor Brendan Murphy sent you a letter that outlined your musculoskeletal diagnostic imaging request rate compared to your GP peers in Australia during 2018. At that time your request rate was at the **95th percentile** of your GP peers across the imaging items identified. Professor Murphy indicated in his last letter that you would receive an update on your diagnostic imaging requests.

Between 8 November 2019 and 7 March 2020, your musculoskeletal diagnostic imaging request rate was at the **87th percentile** of your GP peers. This rate is displayed below and in the table provided on page 3.



We recognise the COVID-19 pandemic has had a significant impact on the healthcare system, including on diagnostic imaging requesting. This letter only includes information up until 7 March 2020, after which the data shows widespread changes in GP requesting rates.

The benefits of tackling this issue include:

- Reducing the potential for harm from cumulative exposure to ionising radiation for some investigations.
- Reducing the harm that can come from identifying incidental findings, which may increase patient anxiety and lead to further unnecessary tests and treatments.

Resources to support you

Please visit www.health.gov.au/imaging-requests for resources for patients and medical professionals and opportunities for Continuing Professional Development (CPD).

We welcome your feedback

If you have any questions or feedback, including suggestions on how we can better support you, please contact my team at diagnostic.imaging@health.gov.au. Please quote your CSE number located on the top right corner of page 1 of this letter when contacting my team.

I appreciate your time in considering the information in this letter and your efforts to optimise the use of musculoskeletal diagnostic imaging in line with best practice.

Yours sincerely

Professor Paul Kelly
Chief Medical Officer

9 November 2020

Your diagnostic imaging requests during 2018 and from 8 November 2019 to 7 March 2020

The table below shows the selected musculoskeletal diagnostic imaging services that you requested in 2018 compared to other GPs, and the requesting rates from 8 November 2019 to 7 March 2020.

The imaging types where your rate is higher than 80% of your peers are highlighted below.

Imaging type	1 Jan 2018 to 31 Dec 2018 Requesting rate per 1,000 consults		8 Nov 2019 to 7 Mar 2020 Requesting rate per 1,000 consults	
	You	Your GP peers	You	Your GP peers
Low back CT	3.51	1.50	1.53	1.11
Low back x-ray	0.00	0.78	0.00	0.52
Neck CT	1.67	0.35	1.19	0.25
Neck x-ray	1.00	0.42	0.17	0.15
Neck MRI	0.00	0.22	0.00	0.22
Shoulder x-ray	1.34	1.48	2.21	1.38
Shoulder ultrasound	5.52	2.67	4.42	1.99
Hip x-ray	0.83	1.48	0.68	1.46
Hip ultrasound	0.33	1.35	0.34	1.24
Knee x-ray	1.00	0.31	0.51	0.19
Ankle/hind foot ultrasound	3.17	0.66	1.70	0.53
Total	18.35	11.22	12.75	9.04
Number of consultations	5980		5876	
Your overall requesting percentile	95		87	

Why am I receiving diagnostic imaging requesting data?

You are receiving this information because in 2018 you requested more musculoskeletal diagnostic imaging services than 80% of GPs practicing in Australia. This letter provides updated information on your requesting rate from 8 November 2019 to 7 March 2020. Your overall requesting percentile for this period appears in the final row of the table above.

How did you calculate my request rate?

We calculated your request rate based on the number of musculoskeletal services (listed above) that you requested for your patients in the specified timeframes. We have only included those requests that led to a Medicare Benefits Scheme (MBS) service being rendered by a radiologist.

We are unable to determine the clinical reason for your diagnostic imaging requests from MBS data. This information is provided to help you review the appropriateness of your requesting pattern within your practice context and reduce requesting where clinically indicated. We acknowledge that requesting rates are influenced by many factors, including special interest areas of GPs and the demography of their patients.

How did you calculate my percentile ranking?

Your percentile ranking was calculated by comparing your request rate to that of other GPs practicing in a similar geographical location in Australia.[1]

How did you account for varying patient loads or number of days worked?

The rates in the table are presented as a proportion of the number of consultations that you rendered in the specified timeframes to account for varying patient loads or days worked throughout the year.

[1] Based on the Modified Monash Model. Please visit www.health.gov.au/imaging-requests for more information.

Appendix 3 – Group 3 audit and feedback report (enhanced display on one occasion)

Australian Government

Department of Health

8 November 2019 Your reference: «reference_»

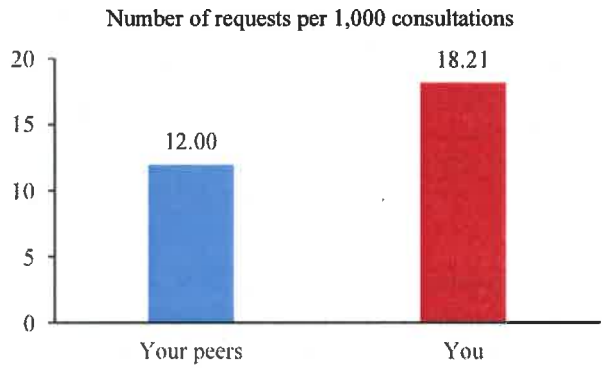
«Title» «First_name» «Last_name»
«Address_Line_1»
«Address_Line_2»
«Suburb» «State» «Postcode»

Dear «Title» «Last_name»

Your musculoskeletal diagnostic imaging request rate is higher than 80% of General Practitioners practicing in a similar geographical region in Australia

You may be aware that overuse of diagnostic imaging services has become a problem in Australia. Most people who present with musculoskeletal pain in the absence of worrying features do not need any imaging as it does not help management. Pain can improve rapidly, for example, around 50% of people who experience an episode of back pain will recover within 2 weeks.

I am writing to you because you request more musculoskeletal diagnostic imaging services than 80% of general practitioners (GPs) practicing in Australia, and your rate on 4 individual items is also higher than 80% of your peers. This rate is displayed below and in the table provided on page 3.



GPs are important stewards in maximising the quality use of diagnostic imaging for the benefit of patients. You can help by reflecting on your requesting data provided in this letter and limiting requests to only those clinical situations where imaging will change your patient's treatment plan and improve their health outcomes. The benefits of tackling this

problem include reducing the potential for harm from cumulative exposure to ionising radiation for some investigations, as well as reducing the harm that can come from identifying incidental findings. Not only may this increase patient anxiety, it can also lead to a cascade of further unnecessary tests and treatments.

Resources to support you

Please visit www.health.gov.au/diagnosticimaging for links to resources that may be helpful.

We welcome your feedback

If you have any questions or feedback, including suggestions on how we can better support you, please contact my team at diagnostic.imaging@health.gov.au, or on 1800 318 208. Please quote your CSE number located on the top right corner of page 1 of this letter when contacting my team.

Yours sincerely

Professor Brendan Murphy
Chief Medical Officer

Your diagnostic imaging requests between 1 January 2018 and 31 December 2018

The table below shows the selected musculoskeletal diagnostic imaging services that were rendered as a result of your imaging requests. The specific imaging areas where your rate is higher than 80% of your peers is shaded below.

Imaging type	Number you requested	Your requesting rate per 1,000 consults	Requesting rate of your GP peers per 1,000 consults
Low back CT	21	3.51	1.19
Low back x-ray	0	0.00	0.53
Neck CT	13	2.17	0.29
Neck x-ray	1	0.17	0.24
Neck MRI	0	0.00	0.22
Shoulder x-ray	14	2.34	1.48
Shoulder ultrasound	33	5.51	2.67
Hip x-ray	0	0.00	1.48
Hip ultrasound	2	0.33	1.35
Knee x-ray	6	1.00	0.31
Ankle/hind foot ultrasound	19	3.17	0.66
Total	109	18.21	12.00
Number of consultations	5987	**Your overall requesting percentile**	80

How did you calculate my request rate?

We calculated your request rate based on the number of musculoskeletal services (listed above) that you requested for your patients in 2018. We have only included those requests that led to a Medicare Benefits Scheme (MBS) service being rendered by a radiologist.

We are unable to determine the clinical reason for your diagnostic imaging requests from MBS data, however your rate is higher than 80% of your GP peers. While there may be a reason for your high imaging rate, we encourage you to reflect and reduce where clinically indicated and appropriate.

How did you calculate my percentile ranking?

Your percentile ranking was calculated by comparing your request rate to that of other GPs practicing in a similar geographical location in Australia.[1]

How did you account for varying patient loads or number of days worked?

The rates in the table are presented as a proportion of the number of consultations that you rendered in 2018 to account for varying patient loads or days worked throughout the year.

[1] Based on the Modified Monash Model. See our resource page for more information.

Appendix 4 – Group 5 audit and feedback reports (enhanced display on two occasions: at baseline and at 12 months)

Australian Government

Department of Health

8 November 2019 Your reference: «reference_»

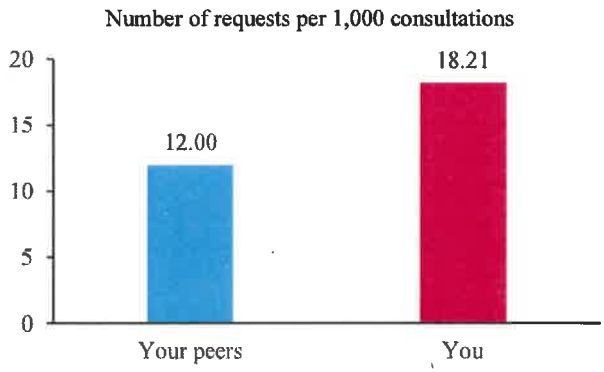
«Title» «First_name» «Last_name»
«Address_Line_1»
«Address_Line_2»
«Suburb» «State» «Postcode»

Dear «Title» «Last_name»

Your musculoskeletal diagnostic imaging request rate is higher than 80% of General Practitioners practicing in a similar geographical region in Australia

You may be aware that overuse of diagnostic imaging services has become a problem in Australia. Most people who present with musculoskeletal pain in the absence of worrying features do not need any imaging as it does not help management. Pain can improve rapidly, for example, around 50% of people who experience an episode of back pain will recover within 2 weeks.

I am writing to you because you request more musculoskeletal diagnostic imaging services than 80% of general practitioners (GPs) practicing in Australia, and your rate on 4 individual items is also higher than 80% of your peers. This rate is displayed below and in the table provided on page 3.



GPs are important stewards in maximising the quality use of diagnostic imaging for the benefit of patients. You can help by reflecting on your requesting data provided in this letter and limiting requests to only those clinical situations where imaging will change your patient's treatment plan and improve their health outcomes. The benefits of tackling this

problem include reducing the potential for harm from cumulative exposure to ionising radiation for some investigations, as well as reducing the harm that can come from identifying incidental findings. Not only may this increase patient anxiety, it can also lead to a cascade of further unnecessary tests and treatments.

I will send you another letter in 9-12 months with updated information on your diagnostic imaging. I hope you will find it useful to see how you compare to your peers at that time.

Resources to support you

Please visit www.health.gov.au/diagnosticimaging for links to resources that may be helpful.

We welcome your feedback

If you have any questions or feedback, including suggestions on how we can better support you, please contact my team at diagnostic.imaging@health.gov.au, or on 1800 318 210. Please quote your CSE number located on the top right corner of page 1 of this letter when contacting my team.

Yours sincerely

Professor Brendan Murphy
Chief Medical Officer

Your diagnostic imaging requests between 1 January 2018 and 31 December 2018

The table below shows the selected musculoskeletal diagnostic imaging services that were rendered as a result of your imaging requests. The specific imaging areas where your rate is higher than 80% of your peers is shaded below.

Imaging type	Number you requested	Your requesting rate per 1,000 consults	Requesting rate of your GP peers per 1,000 consults
Low back CT	21	3.51	1.19
Low back x-ray	0	0.00	0.53
Neck CT	13	2.17	0.29
Neck x-ray	1	0.17	0.24
Neck MRI	0	0.00	0.22
Shoulder x-ray	14	2.34	1.48
Shoulder ultrasound	33	5.51	2.67
Hip x-ray	0	0.00	1.48
Hip ultrasound	2	0.33	1.35
Knee x-ray	6	1.00	0.31
Ankle/hind foot ultrasound	19	3.17	0.66
Total	109	18.21	12.00
Number of consultations	5987	**Your overall requesting percentile**	80

How did you calculate my request rate?

We calculated your request rate based on the number of musculoskeletal services (listed above) that you requested for your patients in 2018. We have only included those requests that led to a Medicare Benefits Scheme (MBS) service being rendered by a radiologist.

We are unable to determine the clinical reason for your diagnostic imaging requests from MBS data, however your rate is higher than 80% of your GP peers. While there may be a reason for your high imaging rate, we encourage you to reflect and reduce where clinically indicated and appropriate.

How did you calculate my percentile ranking?

Your percentile ranking was calculated by comparing your request rate to that of other GPs practicing in a similar geographical location in Australia.[1]

How did you account for varying patient loads or number of days worked?

The rates in the table are presented as a proportion of the number of consultations that you rendered in 2018 to account for varying patient loads or days worked throughout the year.

[1] Based on the Modified Monash Model. See our resource page for more information.

Australian Government

Department of Health

Acting Chief Medical Officer

9 November 2020

Your reference: «reference_»

«Title» «First_name» «Last_name»
«Address_Line_1»
«Address_Line_2»
«Suburb» «State» «Postcode»

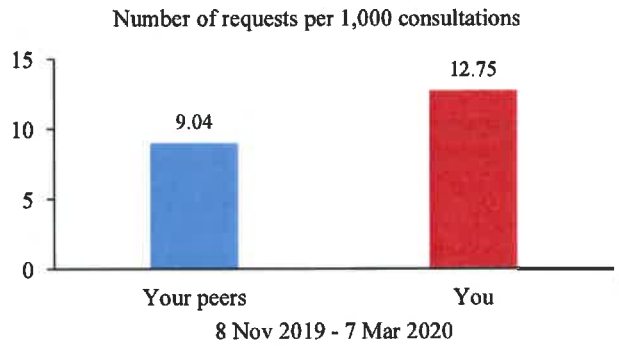
Dear «Title» «Last_name»

GPs (General Practitioners) are important stewards in maximising the quality use of diagnostic imaging for the benefit of patients. You can help by reflecting on your requesting data provided in this letter and limiting requests to only those clinical situations where imaging has the potential to change your patient's treatment plan and improve their health outcomes.

Your musculoskeletal diagnostic imaging request rate is at the 87th percentile of GPs practicing in a similar geographical region in Australia

On 8 November 2019, Professor Brendan Murphy sent you a letter that outlined your musculoskeletal diagnostic imaging request rate compared to your GP peers in Australia during 2018. At that time your request rate was at the **95th percentile** of your GP peers across the imaging items identified. Professor Murphy indicated in his last letter that you would receive an update on your diagnostic imaging requests.

Between 8 November 2019 and 7 March 2020, your musculoskeletal diagnostic imaging request rate was at the **87th percentile** of your GP peers. This rate is displayed below and in the table provided on page 3.



We recognise the COVID-19 pandemic has had a significant impact on the healthcare system, including on diagnostic imaging requesting. This letter only includes information up until 7 March 2020, after which the data shows widespread changes in GP requesting rates.

The benefits of tackling this issue include:

- Reducing the potential for harm from cumulative exposure to ionising radiation for some investigations.
- Reducing the harm that can come from identifying incidental findings, which may increase patient anxiety and lead to further unnecessary tests and treatments.

Resources to support you

Please visit www.health.gov.au/imaging-requests for resources for patients and medical professionals and opportunities for Continuing Professional Development (CPD).

We welcome your feedback

If you have any questions or feedback, including suggestions on how we can better support you, please contact my team at diagnostic.imaging@health.gov.au. Please quote your CSE number located on the top right corner of page 1 of this letter when contacting my team.

I appreciate your time in considering the information in this letter and your efforts to optimise the use of musculoskeletal diagnostic imaging in line with best practice.

Yours sincerely

Professor Paul Kelly
Chief Medical Officer

9 November 2020

Your diagnostic imaging requests during 2018 and from 8 November 2019 to 7 March 2020

The table below shows the selected musculoskeletal diagnostic imaging services that you requested in 2018 compared to other GPs, and the requesting rates from 8 November 2019 to 7 March 2020.

The imaging types where your rate is higher than 80% of your peers are highlighted below.

Imaging type	1 Jan 2018 to 31 Dec 2018 Requesting rate per 1,000 consults		8 Nov 2019 to 7 Mar 2020 Requesting rate per 1,000 consults	
	You	Your GP peers	You	Your GP peers
Low back CT	3.51	1.50	1.53	1.11
Low back x-ray	0.00	0.78	0.00	0.52
Neck CT	1.67	0.35	1.19	0.25
Neck x-ray	1.00	0.42	0.17	0.15
Neck MRI	0.00	0.22	0.00	0.22
Shoulder x-ray	1.34	1.48	2.21	1.38
Shoulder ultrasound	5.52	2.67	4.42	1.99
Hip x-ray	0.83	1.48	0.68	1.46
Hip ultrasound	0.33	1.35	0.34	1.24
Knee x-ray	1.00	0.31	0.51	0.19
Ankle/hind foot ultrasound	3.17	0.66	1.70	0.53
Total	18.35	11.22	12.75	9.04
Number of consultations	5980		5876	
Your overall requesting percentile	**95**		**87**	

Why am I receiving diagnostic imaging requesting data?

You are receiving this information because in 2018 you requested more musculoskeletal diagnostic imaging services than 80% of GPs practicing in Australia. This letter provides updated information on your requesting rate from 8 November 2019 to 7 March 2020. Your overall requesting percentile for this period appears in the final row of the table above.

How did you calculate my request rate?

We calculated your request rate based on the number of musculoskeletal services (listed above) that you requested for your patients in the specified timeframes. We have only included those requests that led to a Medicare Benefits Scheme (MBS) service being rendered by a radiologist.

We are unable to determine the clinical reason for your diagnostic imaging requests from MBS data. This information is provided to help you review the appropriateness of your requesting pattern within your practice context and reduce requesting where clinically indicated. We acknowledge that requesting rates are influenced by many factors, including special interest areas of GPs and the demography of their patients.

How did you calculate my percentile ranking?

Your percentile ranking was calculated by comparing your request rate to that of other GPs practicing in a similar geographical location in Australia.[1]

How did you account for varying patient loads or number of days worked?

The rates in the table are presented as a proportion of the number of consultations that you rendered in the specified timeframes to account for varying patient loads or days worked throughout the year.

[1] Based on the Modified Monash Model. Please visit www.health.gov.au/imaging-requests for more information.

Australian Government

Department of Health

Acting Chief Medical Officer

9 November 2020

Your reference: «Reference»

«Title» «First_name» «Last_name»
«Address_Line_1»
«Address_Line_2»
«Suburb» «State» «Postcode»

Dear «Title» «Last_name»

General Practitioners (GPs) are important stewards in maximising the quality use of diagnostic imaging for the benefit of patients. You can help by reflecting on your requesting data provided in this letter and limiting requests to only those clinical situations where imaging has the potential to change your patient's treatment plan and improve their health outcomes.

On 8 November 2019, Professor Brendan Murphy sent you a letter that outlined your musculoskeletal diagnostic imaging request rate compared to your GP peers in Australia during 2018. At that time your request rate was at the **«percentile_2018»th percentile** of your GP peers across the imaging items identified. Professor Murphy indicated in his last letter that you would receive an update on your diagnostic imaging requests.

Between 8 November 2019 and 7 March 2020, you had a very low number of consultations. Therefore, calculating a musculoskeletal diagnostic imaging request rate would not accurately reflect your current practice. The number of services you requested is displayed in the table provided on page 3.

We recognise the COVID-19 pandemic has had a significant impact on the healthcare system, including on diagnostic imaging requesting. This letter only includes information up until 7 March 2020, when the data shows widespread changes in GP requesting rates.

The benefits of tackling this issue include:

- Reducing the potential for harm from cumulative exposure to ionising radiation for some investigations.
- Reducing the harm that can come from identifying incidental findings, which may increase patient anxiety and lead to further unnecessary tests and treatments.

Resources to support you

Please visit www.health.gov.au/imaging-requests for resources for patients and medical professionals and opportunities for Continuing Professional Development (CPD).

We welcome your feedback

If you have any questions or feedback, including suggestions on how we can better support you, please contact my team at diagnostic.imaging@health.gov.au. Please quote your CSE number located on the top right corner of page 1 of this letter when contacting my team.

I appreciate your time in considering the information in this letter and your efforts to optimise the use of musculoskeletal diagnostic imaging in line with best practice.

Yours sincerely

Professor Paul Kelly
Acting Chief Medical Officer

Your diagnostic imaging requests from 8 November 2019 to 7 March 2020

The table below shows the selected musculoskeletal diagnostic imaging services that you requested from 8 November 2019 to 7 March 2020.

Imaging Type	Number you requested
Low back CT	«nbr_low_back_ct_2020»
Low back x-ray	«nbr_low_back_xray_2020»
Neck CT	«nbr_neck_ct_2020»
Neck x-ray	«nbr_neck_xray_2020»
Neck MRI	«nbr_neck_mri_2020»
Shoulder x-ray	«nbr_shoulder_xray_2020»
Shoulder ultrasound	«nbr_shoulder_us_2020»
Hip x-ray	«nbr_hip_xray_2020»
Hip ultrasound	«nbr_hip_us_2020»
Knee x-ray	«nbr_knee_xray_2020»
Ankle/hind foot ultrasound	«nbr_ankle_us_2020»
Total	«nbr_all_2020»
Number of consultations	«nbr_consults_2020»

Why am I receiving diagnostic imaging requesting data?

You are receiving this information because in 2018 you requested more musculoskeletal diagnostic imaging services than 80% of GPs practicing in Australia. This letter provides updated information from 8 November 2019 to 7 March 2020.

eAppendix 2. Data Analysis Notes

The details of regression modelling are described in the data analysis section

The data for this study was extracted from the MBS data set and was provided in the wide form (each raw represents individual GP)

As previously stated, the mixed effect regression model was used to estimate the effect of the intervention on changes in the rate in DI requests.

For this analysis the rate per 1000 category 1 consultations was calculated frow each GP based on:

$$rate\_BL = \frac{Total\ DI\ requests\ during\ the\ 12\ month\ preciding\ the\ intervention}{Total\ Category\ 1\ consultations\ during\ the\ 12\ month\ preciding\ the\ intervention} * 1000$$

For the baseline rate and

$$rate\_n = \frac{\sum_{i=1}^{n} DI\ requests}{\sum_{i=1}^{n} Category\ 1\ consultatiosn} * 1000$$

For the rates observed during the study period.

Where n is the follow-up time, i = follow up month. (for this study n = 6, 12, or 18).

The distribution of rate_n was assessed using both histogram and Shapiro-Francia test. Considering large sample, the focus was draw to W'.

Following this assessment both baseline and observed rates were transformed using

$$ln\_rate = \ln(rate\_n + cons)$$

Both qnorm plot and Shapiro-Francia test of the ln_rate were used to confirm the normality.

The regression model was constructed as

xi: mixed ln_rate intervention i.locality ln_rate_BL ||cluster:

for the main analysis (all interventions combined) , and

xi: mixed ln_rate int_a##int_b i.locality ln_rate_BL ||cluster:

to examine the effect of each effect modifier.

For both models: locality is a stratification factor (metropolitan vs not area) and cluster is a random effect factors (practice)

For the sensitivity analysis 1 both models were further adjusted for volume of imaging tests, years in general practice, GP' age sex by adding these factors to the model

Following the regression analysis, the predicted value was calculated using

predict yhat_rate

predict r, resid

and the Kernel density plot was constructed to visually validate the normality of residuals, and 'iqr' command (*iqr r*) was used to numerically assess the symmetry and presence/absence of sever outlier. The absence of severe outliers confirms that residuals are normally distributed.)

Additionally, *estat icc* was used to estimate Intraclass correlation.

eAppendix 3. Clarification of Administrative Error

The total number of practices is higher than that reported in the SAP (n=2,271) to accurately represent the total number of randomized practices. Some practices were randomized into two groups due to an address classification administrative error which occurred in July 2019 prior to randomization and detected during the data cleaning. 1,220 of the total 3,819 GPs were assigned an incorrect Monash Model (MM) category, which was used as a stratification factor in the randomisation. The incorrect MM coding was evenly distributed across the five groups.

The locality classification (i.e., metropolitan and regional/rural/remote) of each GP's primary practice address was based on the Modified Monash Model (MMM).[1] The model classifies areas into 1 of 7 categories (MM_1 is classified as a major city; MM_7 is classified as very remote area), based on areas geographic location, remoteness and population size. MM classification for GP primary practice addresses was provided by the geospatial (GIS) team within the Department of Health prior to randomisation in July 2019 (See figure below).

General practices containing eligible high-requesting GPs, clustered based on exact-matched primary practice addresses, were randomized to either no intervention control or to one of four intervention groups by a statistician in Nov 2019, stratified by geographic region (using locality classification: metropolitan and regional/rural/remote).

During data cleaning, we identified that some GPs with the same practice address were assigned different MM categories and locality classification. Due to an administrative error in general practice locality classification prior to randomisation, 395 practices were stratified into both metropolitan and non-metropolitan areas. This resulted in some GPs within the same practice having the chance of being randomized to different study groups. Following further investigation, it was revealed the error occurred when MM data were being exported to a spreadsheet, and was caused by human error by the GIS team in July 2019.

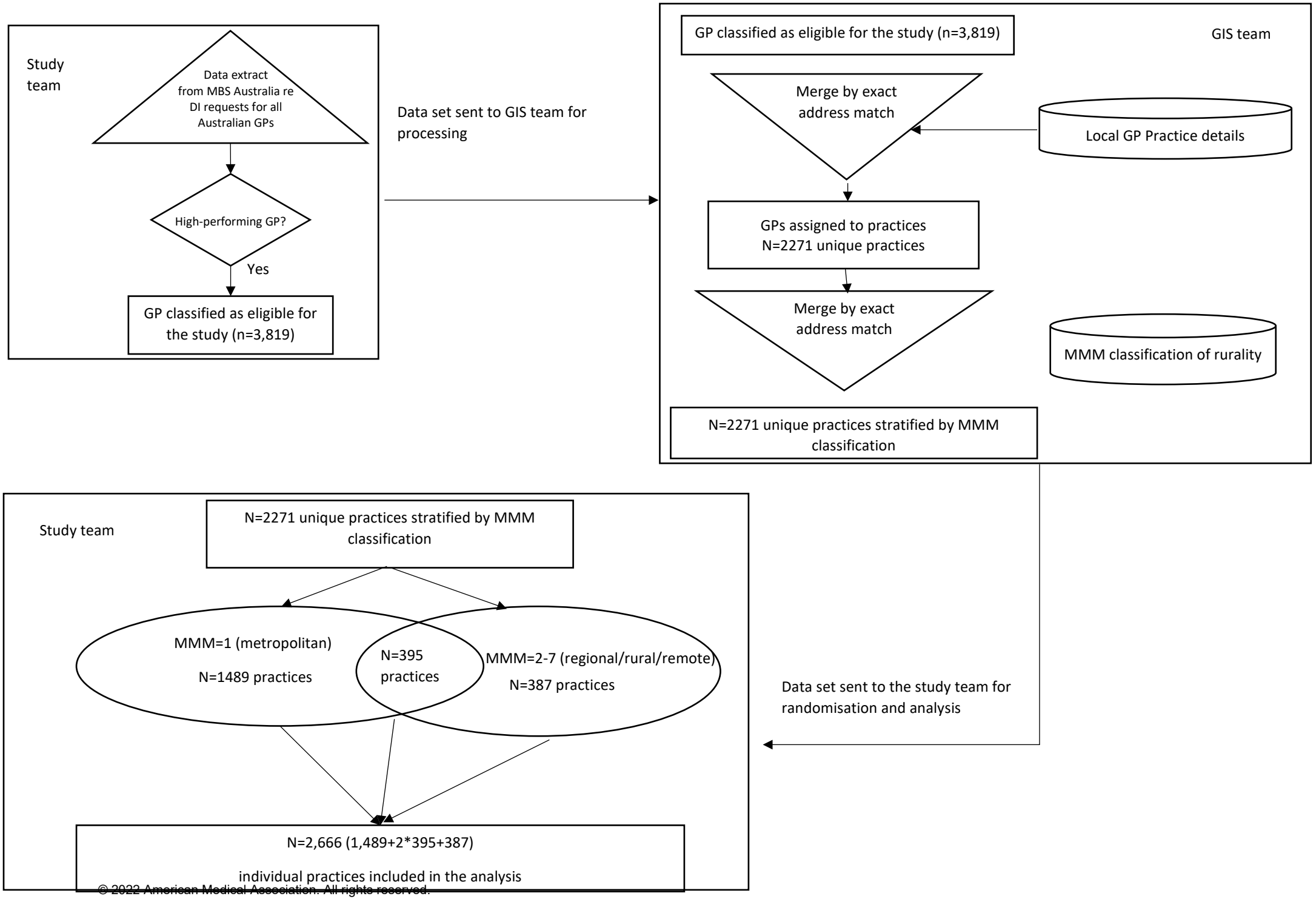
In order to minimize the impact of this error on study validity and adhere to the study protocol, the 395 practices randomized to both metropolitan and non-metropolitan strata were reclassified and treated as 790 individual practices, effectively increasing the number of practices to 2,666.

Of the 395 affected practices, 307 were randomized into two groups (111 practices to both control and intervention, with potential for cross contamination of 336 GPs in these practices; and 196 practices to two different intervention groups, with potential for cross contamination of 647 GPs) and 88 practices were assigned into the same group.

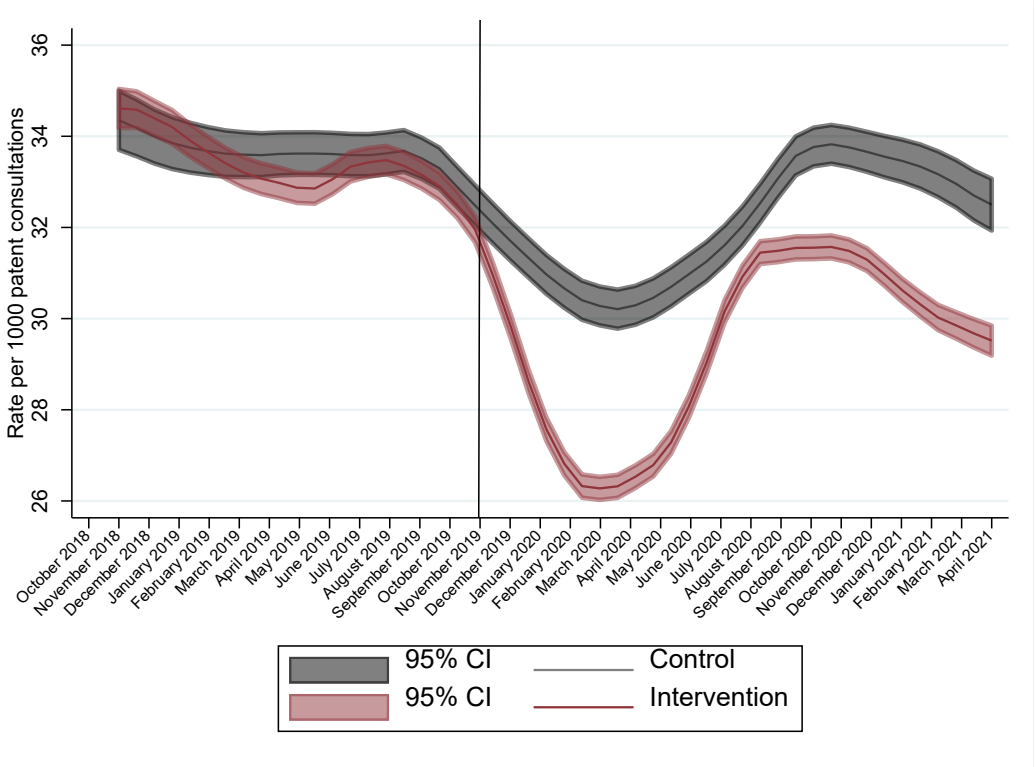
Although unfortunate, this classification error was purely administrative and unrelated to trial outcomes or GP profiles. As such it is very unlikely to have introduced any bias in the randomized comparison. This is confirmed by our sensitivity analysis where we excluded general practices allocated to different arms and obtained the same results. No other error has been detected and we have no reason to suspect potential lingering effects that might impact the trial integrity. The fact that outcome data are obtained centrally via an extract of the Australian Medicare Benefits Schedule provides further protection against potential biases in the outcomes.

References

https://www.health.gov.au/sites/default/files/documents/2020/07/modified-monash-model-fact-sheet.pdf

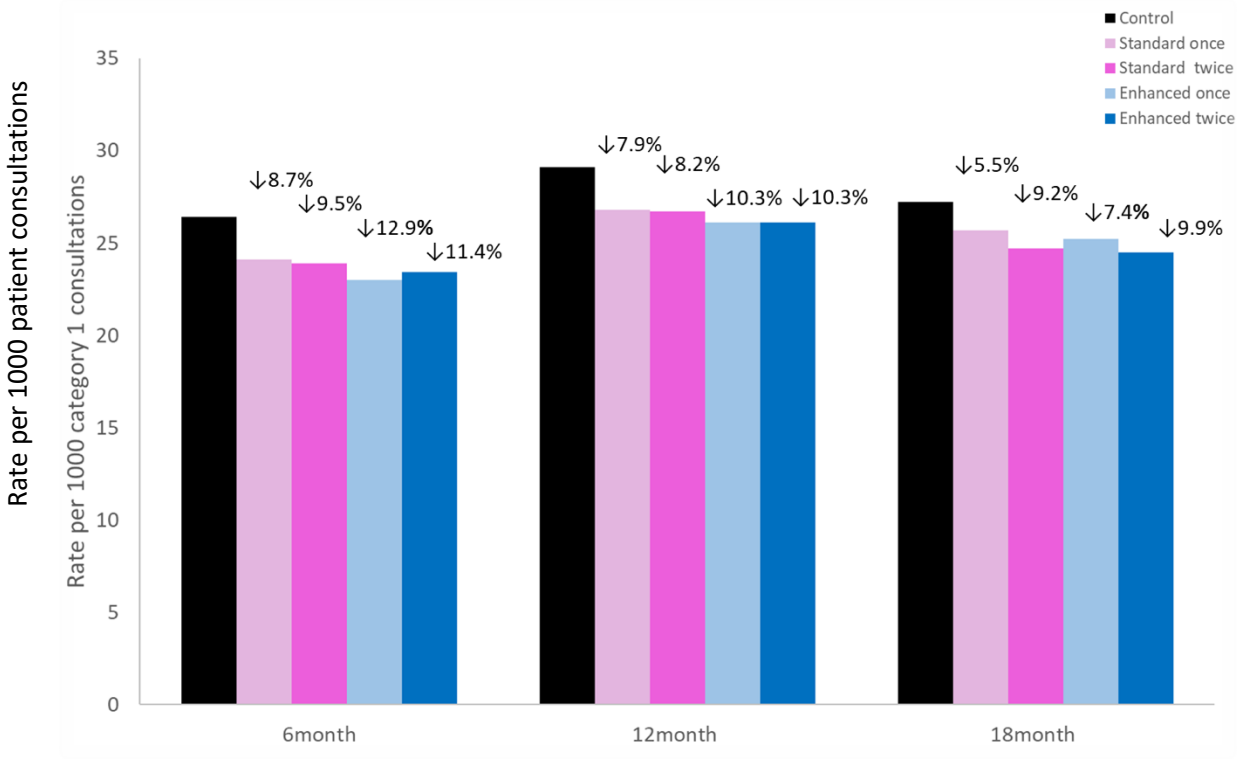


eFigure 1. Overall Rates of Musculoskeletal Diagnostic Imaging Requests Over Time With 95% CI



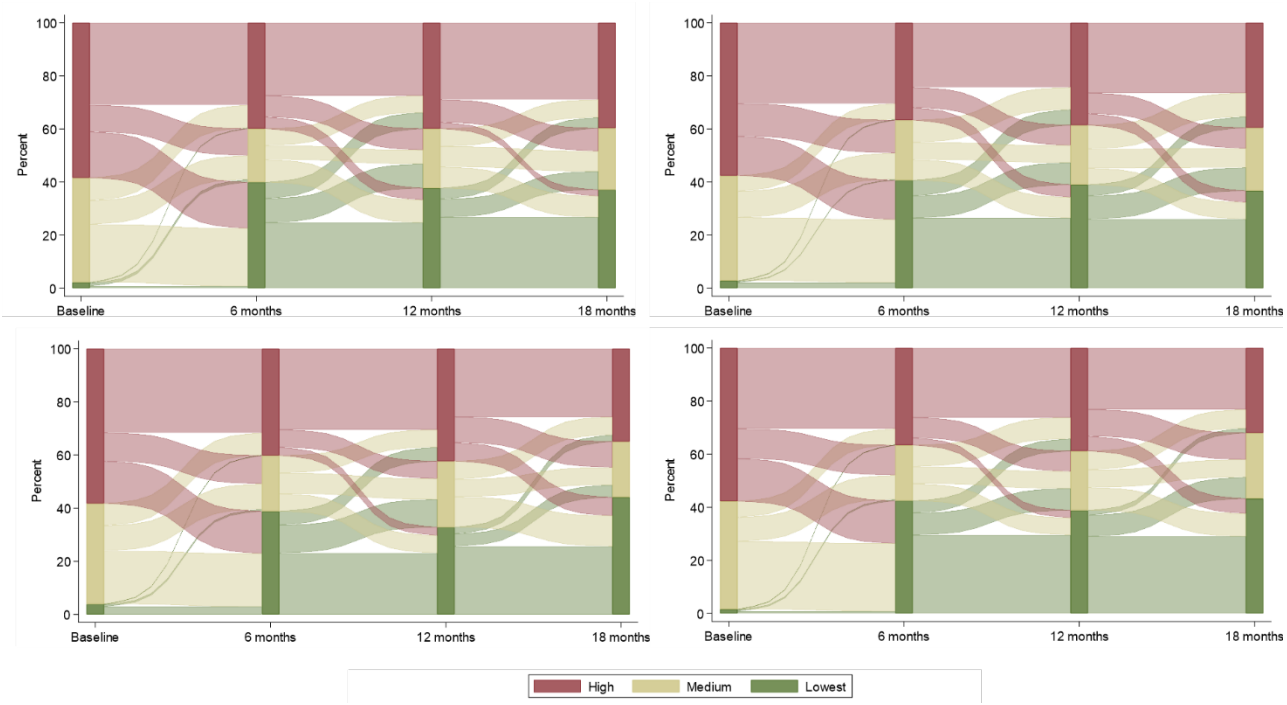
Local polynomial smooth plot with 95% CI created in Stata using lpolyci command using Epanechnikov kernel function

eFigure 2. Relative Reduction in Overall Rate of Musculoskeletal Diagnostic Imaging by Group Over 6, 12 and 18 Months



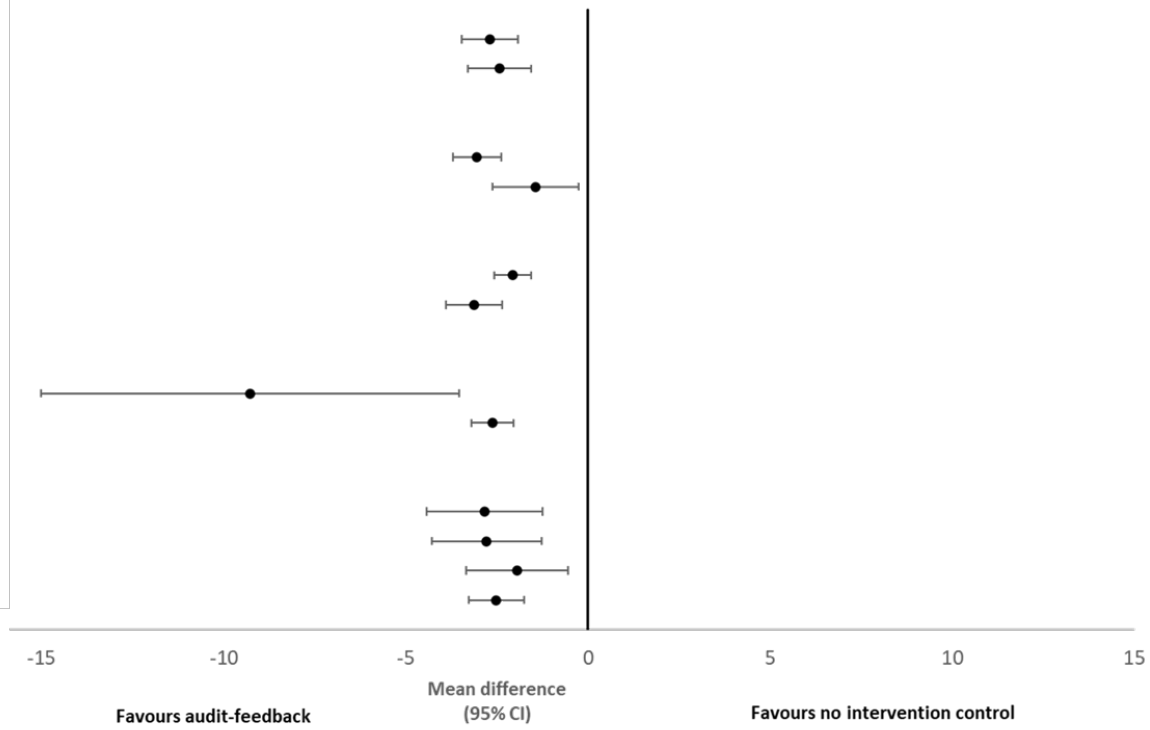
Note: observed median rates are cumulative from time 0 (date of first feedback sent to GPs (8 November 2019)) until 6, 12 or 18 months, reported per 1,000 consultations

eFigure 3. Sankey Diagrams of Percentage Rank of Overall Musculoskeletal Diagnostic Imaging Requests Per 1,000 Consultations for 4 Active Intervention Groups: Standard Delivered Once (Top Left), Enhanced Delivered Once (Top Right), Standard Delivered Twice (Bottom Left), Enhanced Delivered Twice (Bottom Right)



eFigure 4. Forest Plot for Subgroup Analysis of Primary Outcome

	Overall request rate, mean (SD) Intervention	Control	Adjusted mean difference (95%CI)	P.Value
Sex				
Male	28.5 (7.5)	31.2 (8.2)	-2.69 (-3.46, -1.92)	0.81
Female	26.5 (6.6)	28.9 (6.8)	-2.43 (-3.30, -1.56)	
Location				
Metropolitan	27.2 (7.1)	30.3 (91.)	-3.05 (-3.71, -2.38)	0.37
Other	29.3 (7.3)	30.8 (6.7)	-1.45 (-2.63, -0.26)	
Ranking				
<90	23.4 (4.0)	25.4 (4.1)	-2.07 (-2.57, -1.56)	0.61
>=90	30.7 (7.3)	33.8 (8.0)	-3.13 (-3.90, -2.36)	
Volume				
Low (1-6)	16.9 (8.6)	26.1 (10.8)	-9.27 (-15.01, -3.54)	0.003
High (7-11)	27.9 (7.0)	30.5 (7.6)	-2.63 (-3.20, -2.05)	
Years of Practice				
<5	24.8 (6.6)	27.6 (6.1)	-2.84 (-4.43, -1.25)	Ref.
>=5 and <10	26.8 (6.9)	29.6 (7.6)	-2.78 (-4.28, -1.28)	0.93
>=10 and <15	27.2 (5.8)	29.1 (6.4)	-1.95 (-3.35, -0.56)	0.82
>=15	28.7 (4.3)	31.2 (8.1)	-2.52 (-3.28, -1.76)	0.88



eTable 1. Comparison Between Included and Excluded GPs

	Total randomised N=3,819	Included in primary analysis N=3,660	Excluded from primary analysis N=159	
GP age (years)				<0.001
Under 40	334 (8.7%)	326 (8.9%)	8 (5.0%)	
40 - 49	814 (21.3%)	803 (21.9%)	11 (6.9%)	
50 - 59	1,128 (29.5%)	1,105 (30.2%)	23 (14.5%)	
60 - 69	1,142 (29.9%)	1,087 (29.7%)	55 (34.6%)	
70 and over	400 (10.5%)	338 (9.2%)	62 (39.0%)	
Missing, n	1	1	0	
Sex				0.13
Female	1,489 (39.0%)	1,439 (39.3%)	50 (31.5%)	
Male	2,327 (60.9%)	2,218 (60.6%)	109 (68.6%)	
Unknown	3 (0.1%)	3 (0.1%)	0 (0.0%)	
Geographical region				
Metropolitan	2,897 (75.9%)	2,786 (76.2%)	111 (69.8%)	0.07
State				0.84
Australian Capital Territory (ACT)	29 (0.8%)	28 (0.8%)	1 (0.6%)	
New South Wales (NSW)	1,012 (26.5%)	974 (26.6%)	38 (23.9%)	
Northern Territory (NT)	10 (0.3%)	9 (0.3%)	1 (0.6%)	
Queensland (QLD)	1,146 (30.0%)	1,100 (30.1%)	46 (28.9%)	
South Australia (SA)	206 (5.4%)	196 (5.4%)	10 (6.3%)	
Tasmania (TAS)	68 (1.8%)	65 (1.8%)	3 (1.9%)	
Victoria (VIC)	923 (24.2%)	883 (24.1%)	40 (25.2%)	
Western Australia (WA)	425 (11.1%)	405 (11.1%)	20 (12.6%)	
Years of practicing, median (Q1-Q3)	20.5 (8.8 - 27.7)	19.7 (8.7 - 27.5)	27.8 (16.9 - 29.8)	<0.001
Total patient consultations at baseline median (Q1-Q3)	4,501 (2,822 - 6,591)	4,645 (3,045-6,691)	839 (1-1,815)	<0.001
Total diagnostic imaging tests requests at baseline, median (Q1-Q3)	148 (89 - 221)	153 (94 - 225)	26 (0-60)	<0.001
Overall baseline requesting rate, per 1000 consultations, median (Q1-Q3)	32.3 (27.3-38.1)	32.3 (27.3-38.0)	32.6 (25.5 - 39.8)	0.99
Study group				0.10
1	764 (20.0%)	727 (19.9%)	37 (23.2%)	
2	761 (19.9%)	722 (19.7%)	39 (24.5%)	
3	780 (20.4%)	753 (20.6%)	27 (17.0%)	
4	760 (19.9%)	739 (20.2%)	21 (13.2%)	
5	754 (19.7%)	719 (19.6%)	35 (22.0%)	

eTable 2. Baseline Rates of Individual Imaging Tests Across Groups

	Intervention					Control
	Standard delivered once	Standard delivered twice	Enhanced delivered once	Enhanced delivered twice	All interventions combined	N = 764
	N = 754	N = 760	N = 780	N = 761	N = 3,055	
Lumbosacral spine						
X-ray	1.5 (0.6 - 2.8)	1.6 (0.7 - 2.7)	1.6 (0. 8 - 2.9)	1.5 (0.7 - 2.8)	1.6 (0.7 - 2.8)	1.6 (0.7 - 2.7)
CT	3.6 (2.2 - 5.3)	3.6 (2.3 - 5.2)	3.6 (2.2 - 5.1)	3.4 (2.2 - 5.1)	3.5 (2.2 - 5.1)	3.6 (2.3 - 5.2)
Shoulder						
X-ray	4.1 (2.8 - 5.6)	4.2 (2.8 - 5.6)	4.2 (2.9 - 5.7)	4.3 (2.8 - 5.7)	4.2 (2.8 - 5.7)	4.2 (2.8 - 5.6)
Ultrasound	5.1 (3.9 - 6.4)	5.2 (4.1 - 6.5)	5.1 (3.9 - 6.4)	5.2 (4.1 - 6.6)	5.1 (4.0 - 6.5)	5. 2 (4.1 - 6.5)
Cervical spine						
X-ray	0. 8 (0.3 - 1.5)	0.8 (0.3 - 1.5)	0.9 (0.3 - 1.7)	0.8 (0.3 - 1.5)	0.8 (0.3 - 1.6)	0.8 (0.3 - 1.5)
CT	1.0 (0.4 - 1.7)	1.0 (0.4 - 1.8)	0.9 (0.3 - 1.7)	0.9 (0.4 - 1. 7)	0.9 (0.4 - 1.7)	1.0 (0.4 - 1.8)
MRI	0.5 (0.0 - 1.2)	0.5 (0.0 - 1.3)	0.5 (0.0 - 1.2)	0.4 (0.0 - 1.2)	0.4 (0.0 - 1.2)	0.5 (0.0 - 1.3)
Knee						

X-ray	5.2 (3.7 - 6.6)	5.0 (3.7 - 6.6)	5.2(3.8 - 6.7)	5.1 (3.7 - 6.7)	5.2(3.8 - 6.7)	5.0 (3.7 - 6.6)
Hip						
X-ray	3.8 (2.8 - 5.3)	3.9 (2.7 - 5.4)	4.0 (2.7 - 5.4)	3.8 (2.6 - 5.0)	3.9 (2.7 - 5.3)	3.9 (2.7 - 5.4)
Ultrasound	3.2 (2.0 - 4.5)	3.2 (2.0 - 4.5)	3.1(2.0 - 4.4)	3.1 (2.1 - 4.5)	3.2 (2.0 - 4.5)	3.2 (2.0 - 4.5)
Ankle						
X-ray	4.1 (3.0 - 5.5)	3.9 (3.0 - 5.4)	4.1(2.9 - 5.4)	4.0 (2.9 - 5.4)	4.0 (2.9 - 5.4)	3.9 (3.0 - 5.4)
Ultrasound	1.6 (0.9 - 2.7)	1.6 (0.8 - 2.6)	1.5 (0.8 - 2.6)	1.6 (0.8 - 2.6)	1.6 (0.9 - 2.6)	1.6 (0.8 - 2.6)

Median (Q1-Q3) request rate per 1,000 consultations

eTable 3. Estimated Rate Differences Between Each Intervention Group and Control at 3 Time Points

	Mean rate (97.5% CI)					Adjusted mean difference (97.5 % CI) [a], p value			
	Intervention				**Control**	**Intervention**			
	Standard delivered once	**Standard delivered twice**	**Enhanced delivered once**	**Enhanced delivered twice**		**Standard delivered once**	**Standard delivered twice**	**Enhanced delivered once**	**Enhanced delivered twice**
	n=719	n=739	n=753	n=722					
6 months	25.4 (24.9-26.0)	24.9 (24.4-25.4)	24.0 (23.5-24.6)	24.7 (24.1-25.4)	27.6 (27.0-28.2)	-2.17 (-2.99, -1.35), <0.001	-2.64 (-3.42, -1.86), <0.001	-3.55 (-4.34. -2.76), <0.001	-2.85 (-3.73, -1.97), <0.001
12 months[b]	28.3 (27.7-28.8)	27.9 (27.4-28.4)	27.2 (26.6-27.7)	27.6 (26.9-28.3)	30.4 (28.7-31.0)	-2.12 (-2.99, -1.25), <0.001	-2.49 (-3.32, -1.66), <0.001	-3.20 (-4.04, -2.36), <0.001	-2.79 (-3.72, -1.87), <0.001
18 months	27.0 (26.4-27.5)	25.8 (25.3-26.3)	26.2 (25.7-26.7)	25.8 (25.2-26.4)	28.3 (27.7-28.9)	-1.33 (-2.11, -0.55), <0.001	-2.51 (-3.25, -1.78), <0.001	-2.07 (-2.83, -1.31), <0.001	-2.50 (-3.33, -1.67), <0.001

[a] difference between group and controls

[b] Primary timepoint

eTable 4. Request Rates for Individual Imaging Tests for the Main Comparison at All Timepoints

	Observed rates[a]		Model based estimates[a,b]		
	Intervention (n=2,933) Median (Q1 - Q3)	**Control (n=727) Median (Q1 - Q3)**	**Intervention (n=2,933) Mean (95% CI)**	**Control (n=727) Mean (95% CI)**	**Adj mean difference (95% CI), p-value**
Lumbosacral spine					
X-ray					
Baseline	1.6 (0.7 - 2.8)	1.6 (0.7 - 1.7)			
6 months	1.1 (0.3 - 2.1)	1.1 (0.4 - 2.4)	1.22 (1.19, 1.25)	1.32 (1.26, 1.38)	-0.10 (-0.17, -0.03), 0.003
12 months	1.2 (0.5 - 2.3)	1.2 (0.5 - 2.3)	1.41 (1.37, 1.44)	1.47 (1.40, 1.54)	-0.06 (-0.14, 0.02), 0.13
18 months	1.2 (0.5 - 2.2)	1.2 (0.6 - 2.4)	1.45 (1.42, 1.49)	1.50 (1.43, 1.57)	-0.05 (-0.13, 0.03), 0.19
CT					
Baseline	1.6 (0.7 - 2.8)	3.6 (2.3 - 5.2)			
6 months	2.4 (1.3 - 4.1)	3.1 (1.8 - 4.6)	2.52 (2.47, 2.56)	2.99 (2.90, 3.09)	-0.47 (-0.58, -0.37), <0.001
12 months	2.9 (1.7 - 4.5)	3.6 (2.1 - 5.0)	3.01 (2.96, 3.06)	3.46 (3.35, 3.56)	-0.45 (-0.56, -0.33), <0.001
18 months	3.1 (1.8 - 4.6)	3.7 (2.4 - 5.1)	3.11 (3.06, 3.16	3.65 (3.55, 3.76)	-0.54 (-0.66, -0.42), <0.001
Shoulder					
X-ray					
Baseline	4.2 (2.8 - 5.7)	4.2 (2.8 - 5.6)			
6 months	2.9 (1.7 - 4.5)	3.3 (2.0 - 4.7)	2.84 (2.80, 2.88)	3.22 (3.13, 3.32)	-0.38 (-0.49, -0.27), <0.001
12 months	3.5 (2.5 - 4.9)	3.8 (2.5 - 5.1)	3.38 (3.33, 3.43)	3.71 (3.60, 3.82)	-0.33 (-0.44, -0.22), <0.001
18 months	3.5 (2.3 - 4.8)	3.8 (2.6 - 5.0)	3.41 (3.36, 3.46)	3.74 (3.63, 3.85)	-0.33 (-0.45, -0.21), <0.001
Ultrasound					
Baseline	5.1 (3.9 - 6.5)	5.2 (4.1 - 6.5)			

6 months	3.8 (2.5 - 5.3)	4.2 (2.9 - 5.6)	3.62 (3.58, 3.65)	3.99 (3.92, 4.07)	-0.38 (-0.46, -0.29), <0.001
12 months	4.4 (3.2 - 5.8)	4.8 (3.5 - 6.2)	4.27 (4.23, 4.31)	4.61 (4.53, 4.69)	-0.35 (-0.43, -0.26), <0.001
18 months	4.5 (3.4 - 5.7)	4.8 (3.6 - 6.1)	4.31 (4.27, 4.35)	4.65 (4.57, 4.73)	-0.34 (-0.42, -0.25), <0.001
Cervical spine					
X-ray					
Baseline	0.8 (0.3 - 1.6)	0.8 (0.3 - 1.5)			
6 months	0.5 (0.0 - 1.1)	0.5 (0.0 - 1.3)	0.62 (0.61, 0.64)	0.69 (0.66, 0.73)	-0.07 (-0.11, -0.03), <0.001
12 months	0.6 (0.2 - 1.2)	0.5 (0.2 - 1.4)	0.74 (0.72, 0.76)	0.77 (0.74, 0.81)	-0.03 (-0.07, 0.01), 0.16
18 months	0.6 (0.2 - 1.2)	0.6 (0.2 - 1.3)	0.76 (0.74, 0.78)	0.76 (0.73, 0.80)	-0.003 (-0.05, 0.04), 0.87
CT					
Baseline	0.9 (0.4 - 1.7)	0.9 (0.4 - 1.8)			
6 months	0.6 (0.0 - 1.3)	0.7 (0.0 - 1.6)	0.72 (0.70, 0.74)	0.86 (0.81, 0.90)	-0.14 (-0.18, -0.09), <0.001
12 months	0.7 (0.3 - 1.4)	0.9 (0.3 - 1.7)	0.89 (0.87, 0.91)	1.02 (0.96, 1.07)	-0.12 (-0.17, -0.07), <0.001
18 months	0.8 (0.3 - 1.4)	0.9 (0.3 - 1.7)	0.93 (0.90, 0.95)	1.05 (0.99, 1.10)	-0.12 (-0.18, -0.06), <0.001
MRI					
Baseline	0.4 (0.0 - 1.2)	0.5 (0.0 - 1.3)			
6 months	0.3 (0.0 - 0.9)	0.4 (0.0 - 1.1)	0.50 (0.49, 0.52)	0.58 (0.55, 0.61)	-0.08 (-0.11, -0.04), <0.001
12 months	0.4 (0.0, 1.0)	0.5 (0.0 - 1.2)	0.62 (0.60, 0.64)	0.67 (0.63, 0.71)	-0.05 (-0.09, -0.0003), 0.05
18 months	0.4 (0.1, 1.0)	0.5 (0.1 - 1.2)	0.65 (0.63, 0.67)	0.70 (0.66, 0.74)	-0.06 (-0.10, -0.01), 0.01
Knee					
X-ray					
Baseline	5.2 (3.8 - 6.7)	5.0 (3.7 - 6.6)			
6 months	3.8 (2.5 - 5.4)	4.2 (2.8 - 5.7)	3.69 (3.64, 3.74)	3.98 (3.87, 4.10)	-0.29 (-0.42, -0.17), <0.001
12 months	4.4 (3.0 - 5.7)	4.6 (3.3 - 5.9)	4.21 (4.15, 4.26)	4.44 (4.33, 4.57)	-0.24 (-0.36, -0.12), <0.001

18 months	4.5 (3.2 - 5.8)	4.7 (3.5 - 6.0)	4.35 (4.30, 4.40)	4.65 (4.53, 4.77)	-0.30 (-0.43, -0.17), <0.001
Hip					
X-ray					
Baseline	3.9 (2.7 - 5.3)	3.9 (2.7 - 5.4)			
6 months	6.6 (4.4 - 9.2)	7.3 (5.1 - 9.8)	6.54 (6.45, 6.63)	7.19 (7.01, 7.38)	-0.65 (-0.86, -0.45), <0.001
12 months	3.2 (2.2 - 4.5)	3.7 (2.6 - 4.8)	3.25 (3.20, 3.29)	3.60 (3.51, 3.69)	-0.35 (-0.45, -0.25), <0.001
18 months	3.3 (2.3 - 4.5)	3.7 (2.6 - 4.9)	3.34 (3.30, 3.39)	3.68 (3.59, 3.77)	-0.34 (-0.44, -0.24), <0.001
Ultrasound					
Baseline	3.2 (2.0 - 4.5)	3.2 (2.0 - 4.5)			
6 months	2.4 (1.3 - 3.7)	2.6 (1.5 - 4.0)	2.29 (2.26, 2.32)	2.54 (2.47, 2.62)	-0.25 (-0.33, -0.17), <0.001
12 months	2.7 (1.6 - 3.9)	2.9 (1.8 - 4.3)	2.62 (2.58, 2.65)	2.90 (2.82, 2.98)	-0.29 (-0.37, -0.20), <0.001
18 months	1.8 (1.1 - 2.6)	2.0 (1.2 - 2.9)	1.79 (1.77, 1.82)	1.98 (1.93, 2.04)	-0.19 (-0.25, -0.13), <0.001
Ankle					
X-ray[c]					
Baseline	4.0 (2.9 - 5.4)	3.9 (3.0 - 5.4)			
6 months	5.0 (3.5 - 7.2)	5.6 (4.0 - 7.8)	5.16 (5.10, 5.22)	5.80 (5.66, 5.95)	-0.62 (-0.78, -0.46), <0.001
12 months	5.2 (3.8 - 7.1)	5.5 (4.1 - 7.5)	5.37 (5.31, 5.43)	5.98 (5.84, 6.12)	-0.44 (-0.58, -0.29), <0.001
18 months	5.3 (4.0 - 7.1)	5.7 (4.3 - 7.6)	5.56 (5.50, 5.62)	5.80 (5.66, 5.95)	-0.42 (-0.58, -0.27), <0.001
Ultrasound					
Baseline	1.6 (0.9 - 2.6)	1.6 (0.8 - 2.6)			
6 months	1.2 (0.5 - 2.1)	1.3 (0.5 - 2.5)	1.30 (1.28, 1.35)	1.43 (1.38, 1.47)	-0.12 (-0.17, -0.07), <0.001
12 months	1.3 (0.6 - 2.1)	1.4 (0.7 - 2.4)	1.42 (1.40, 1.44)	1.54 (1.50, 1.59)	-0.12 (-0.17, -0.07), <0.001
18 months	1.4 (0.7 - 2.2)	1.4 (0.8 - 2.4)	1.51 (1.48, 1.53)	1.62 (1.57, 1.67)	-0.11 (-0.16, -0.05), <0.001

[a] Imaging request rates for each GP were calculated as the total number of diagnostic imaging requests from baseline to the end of the follow-up period (i.e., 6-, 12-, and 18-months) divided by the total number of consultations over the corresponding period, reported per 1,000 patient consultations.

[b] Data aggregated at the GP level were analyzed using multilevel mixed effect linear regression adjusted for the baseline imaging rate of each GP and locality. See text for details.

[c]Ankle X-ray was not targeted by the feedback intervention but was considered to be a potential substitute for ankle/hind foot ultrasound so it was included as a secondary outcome to check for switching.

eTable 5. Request Rates for Individual Imaging Tests According to Frequency of Feedback (Twice vs. Once)

	Observed rates		Model based estimates[a]			
	Twice	**Once**	**Twice**	**Once**	**Adjusted mean difference**	**p-value**
	Median (Q1 - Q3)	**Median (Q1 -Q3)**	**Mean (SD)**	**Mean (SD)**	**(97.5% CI)**	
Lumbosacral spine						
X-ray						
Baseline	1.6 (0.7 - 2.8)	1.6 (0.7 - 2.9)				
6 months	1.1 (0.3 - 2.1)	1.0 (0.3 - 1.0)	1.2 (0.80)	1.2 (0.82)	0.00 (-0.06, 0.07)	0.92
12 months	1.2 (0.5 - 2.2)	1.2 (0.5 - 2.3)	1.4 (0.93)	1.4 (0.96)	-0.02 (-0.09, 0.06)	0.67
18 months	1.2 (0.5 - 1.2)	1.2 (0.5 - 2.3)	1.4 (0.94)	1.5 (0.98)	-0.04 (-0.11, 0.04)	0.28
CT						
Baseline	3.5 (2.2 - 5.0)	3.6 (2.2 - 5.2)				
6 months	2.6 (1.3 - 4.0)	2.4 (1.3 - 4.1)	2.5 (1.21)	2.6 (1.28)	-0.09 (-0.20, 0.01)	0.04
12 months	2.9 (1.7 - 4.6)	3.0 (1.8 - 4.5)	3.0 (1.36)	3.1 (1.43)	-0.09 (-0.21, 0.02)	0.07
18 months	3.0 (1.8 - 4.5)	3.2 (1.9 - 4.6)	3.0 (1.36)	3.2 (1.47)	-0.23 (-0.34, -0.11)	<0.001
Shoulder						
X-ray						
Baseline	4.3 (2.9 - 5.6)	4.2 (2.2 - 5.7)				
6 months	2.8 (1.7 - 4.4)	3.0 (1.6 - 4.5)	2.9 (1.20)	2.8 (1.17)	0.03 (-0.07, 0.12)	0.53

12 months	3.5 (2.1 - 4.9)	3.5 (2.2 - 4.9)	3.4 (1.35)	3.4 (1.33)	-0.003 (-0.11, 0.11)	0.95
18 months	3.4 (2.2 - 4.7)	3.6 (2.3 - 4.9)	3.4 (1.31)	3.5 (1.32)	-0.11 (-0.21, 0.00)	0.03
Ultrasound						
Baseline	5.1 (4.0 - 6.5)	5.1 (3.9 - 6.4)				
6 months	3.9 (2.5 - 5.3)	3.8 (2.5 - 5.2)	3.7 (1.01)	3.6 (1.06)	0.06 (-0.02, 0.15)	0.09
12 months	4.5 (3.2 - 5.9)	4.3 (3.2 - 5.7)	4.3 (1.06)	4.3 (1.11)	0.02 (-0.07, 0.11)	0.55
18 months	4.4 (3.4 - 5.7)	4.5 (3.4 - 5.7)	4.3 (1.02)	4.3 (1.09)	-0.09 (-0.18, -0.01)	0.02
Cervical spine						
X-ray						
Baseline	0.8 (0.3 - 1.5)	0.8 (0.3 - 1.6)				
6 months	0.5 (0.0 - 1.1)	0.5 (0.0 - 1.2)	0.6 (0.42)	0.6 (0.447)	-0.02 (-0.06, 0.01)	0.15
12 months	0.6 (0.1 - 1.2)	0.6 (0.2 - 1.3)	0.7 (0.51)	0.8 (0.54)	-0.04 (-0.08, 0.00)	0.03
18 months	0.6 (0.2 - 1.1)	0.6 (0.2 - 1.3)	0.7 (0.51)	0.8 (0.55)	-0.05 (-0.10, -0.01)	0.006
CT						
Baseline	0.9 (0.4 - 1.7)	1.0 (0.4 - 1.7)				
6 months	0.5 (0.0 - 1.3)	0.6 (0.0 - 1.3)	0.7 (0.49)	0.8 (0.52)	-0.07 (-0.11, -0.03)	<0.001
12 months	0.7 (0.2 - 1.4)	0.7 (0.3 - 1.5)	0.9 (0.60)	0.9 (0.63)	-0.07 (-0.12, -0.02)	0.001
18 months	0.7 (0.3 - 1.4)	0.8 (0.3 - 1.5)	0.9 (0.60)	1.0 (0.64)	-0.09 (-0.14, -0.04)	<0.001
MRI						
Baseline	0.4 (0.0 - 1.2)	0.5 (0.0 - 1.2)				
6 months	0.2 (0.0 - 0.9)	0.3 (0.0 - 0.9)	0.5 (0.45)	0.5 (0.51)	-0.05 (-0.09, -0.01)	0.008

	12 months	0.4 (0.0 - 1.0)	0.5 (0.0 - 1.0)	0.6 (0.53)	0.6 (0.61)	-0.05 (-0.10, -0.01)	0.01
	18 months	0.4 (0.1 - 1.0)	0.5 (0.1 - 1.1)	0.6 (0.54)	0.7 (0.62)	-0.05 (-0.10, -0.004)	0.02
Knee							
X-ray							
	Baseline	5.2 (3.8 - 6.8)	5.2 (3.7 - 6.7)				
	6 months	3.8 (2.5 - 5.4)	3.8 (2.6 - 5.3)	3.7 (1.45)	3.7 (1.27)	-0.01 (-0.12, 0.10)	0.79
	12 months	4.3 (3.0 - 5.8)	4.4 (3.0 - 5.7)	4.2 (1.55)	4.2 (1.345)	-0.09 (-0.03, 0.21)	0.08
	18 months	4.4 (3.1 - 5.9)	4.6 (3.2 - 5.9)	4.3 (1.53)	4.4 (1.36)	-0.01 (-0.13, 0.10)	0.79
Hip							
X-ray							
	Baseline	3.8 (2.7 - 5.2)	3.9 (2.8 - 5.4)				
	6 months	6.6 (4.3 - 9.1)	6.6 (4.5 - 9.4)	6.5 (2.66)	6.6 (2.41)	-0.10 (-0.31, 0.11)	0.29
	12 months	3.2 (2.2 - 4.4)	3.2 (2.2 - 4.5)	3.3 (1.27)	3.2 (1.16)	0.01 (-0.09, 0.11)	0.8
	18 months	3.3 (2.3 - 4.4)	3.3 (2.3 - 4.5)	3.3 (1.28)	3.4 (1.18)	-0.03 (-0.13, 0.07)	0.56
Ultrasound							
	Baseline	3.2 (2.1 - 4.6)	3.2 (2.0 - 4.5)				
	6 months	2.4 (1.4 - 3.8)	2.4 (1.2 - 3.6)	2.3 (0.92)	2.3 (0.92)	0.08 (0.002, 0.15)	0.02
	12 months	2.7 (1.7 - 4.0)	2.6 (1.6 - 3.8)	2.7 (1.01)	2.6 (1.00)	0.12 (0.04, 0.20)	0.001
	18 months	1.8 (1.1 - 2.7)	1.7 (1.1 - 2.6)	1.8 (0.68)	1.7 (0.68)	0.09 (0.04, 0.15)	<0.001
Ankle							
X-ray[a]							
	Baseline	4.0 (2.9 - 5.4)	4.1 (2.9 - 5.5)				

6 months	5.0 (3.4 - 7.1)	5.1 (3.5 - 7.2)	5.1 (1.70)	5.2 (1.78)	-0.15 (-0.28, -0.01)	0.02
12 months	5.1 (3.7 - 7.0)	5.2 (3.8 - 7.2)	5.3 (1.65)	5.4 (1.70)	-0.04 (-0.18, 0.09)	0.47
18 months	5.3 (4.0 - 6.9)	5.4 (4.1 - 7.3)	5.5 (1.66)	1.6 (1.73)	-0.14 (-0.28, -0.002)	0.02
Ultrasound						
Baseline	1.6 (0.8 - 2.7)	1.6 (0.9 - 2.6)				
6 months	1.2 (0.5 - 2.2)	1.2 (0.4 - 2.1)	1.3 (0.57)	1.3 (0.55)	0.08 (0.04 to 0.13)	<0.001
12 months	1.3 (0.7 - 2.2)	1.3 (0.6 - 2.1)	1.4 (0.60)	1.4 (0.59)	0.04 (-0.01, 0.09)	0.07
18 months	1.4 (0.7 - 2.2)	1.4 (0.7 - 2.2)	1.5 (0.63)	1.5 (0.63)	0.01 (-0.046, 0.06)	0.77

[a]Adjusted for baseline rate and locality

eTable 6. Request Rates for Individual Imaging Tests According to Display (Enhanced vs. Standard)

	Observed rates		Model based estimates[a]			
	Enhanced Median (Q1 -Q3)	Standard Median (Q1 - Q3)	Enhanced Mean (SD)	Standard Mean (SD)	Adj mean difference (97.5% CI)	p-value
Lumbosacral spine						
X-ray						
Baseline	1.6 (0.7 - 2.6)	1.5 (0.7 - 2.8)				
6 months	1.1 (0.3 - 2.1)	1.0 (0.3 -2.1)	1.2 (0.82)	1.2 (0.81)	0.03 (-0.03, 0.10)	0.27
12 months	1.2 (0.5 - 2.3)	1.2 (0.5 - 2.2)	1.4 (0.95)	1.4 (0.93)	0.05 (-0.02, 0.13)	0.13
18 months	1.2 (0.6 - 2.3)	1.2 (0.5 - 2.2)	1.5 (0.97)	1.4 (0.95)	0.04 (-0.04, 0.12)	0.23
CT						
Baseline	3.5 (2.2 - 5.1)	3.5 (2.2 - 5.1)				
6 months	2.4 (1.3 - 4.0)	2.5 (1.3 - 4.1)	2.5 (1.25)	2.5 (1.23)	0.01 (-0.09, 0.11)	0.78
12 months	2.9 (1.7 - 4.5)	2.9 (1.8 - 4.6)	3.0 (1.41)	3.0 (1.39)	-0.01 (-0.13, 0.10)	0.77
18 months	3.1 (1.8 - 4.5)	3.1 (1.9 - 4.6)	3.1 (1.43)	3.1 (1.41)	0.01 (-0.11, 0.13)	0.84
Shoulder						
X-ray						
Baseline	4.2 (2.9 - 5.7)	4.2 (2.8 - 5.6)				
6 months	2.8 (1.6 - 4.9)	3.0 (1.7 - 4.5)	2.8 (1.22)	2.9 (1.15)	-0.09 (-0.19, 0.01)	0.04
12 months	3.5 (2.1 - 4.8)	3.5 (2.2 - 4.2)	3.3 (1.38)	3.4 (1.29)	-0.07 (-0.18, 0.04)	0.17
18 months	3.5 (2.2 - 4.9)	3.6 (2.3 - 4.8)	3.4 (1.36)	3.4 (1.27)	-0.03 (-0.14, 0.07)	0.38
Ultrasound						
Baseline	5.1 (4.0 - 6.5)	5.1 (3.9 - 6.4)				
6 months	3.7 (2.5 - 5.2)	3.9 (2.6 - 5.4)	3.5 (1.01)	3.7 (1.07)	-0.15 (-0.24, -0.07)	<0.001
12 months	4.3 (3.1 - 5.7)	4.5 (3.2 - 5.9)	4.2 (1.05)	4.4 (1.11)	-0.17 (-0.26, -0.08)	<0.001
18 months	4.4 (3.3 - 5.7)	4.5 (3.4 - 5.8)	4.2 (1.03)	4.4 (1.08)	-0.15 (-0.23, -0.06)	<0.001

Cervical spine						
X-ray						
Baseline	0.8 (0.3 - 1.6)	0.8 (0.3 - 1.5)				
6 months	0.5 (0.0 - 1.2)	0.5 (0.0 - 1.1)	0.6 (0.44)	0.6 (0.43)	0.01 (-0.03, 0.04)	0.69
12 months	0.6 (0.1 - 1.2)	0.6 (0.2 - 1.2)	0.7 (0.53)	0.7 (0.53)	0.00 (-0.04, 0.04)	0.99
18 months	0.6 (0.2 - 1.2)	0.6 (0.2 - 1.2)	0.8 (0.54)	0.8 (0.54)	0.00 (-0.04, 0.05)	0.82
CT						
Baseline	0.9 (0.4 - 1.7)	0.9 (0.4 - 1.7)				
6 months	0.6 (0.0 - 1.3)	0.6 (0.0 - 1.3)	0.7 (0.53)	0.7 (0.48)	0.04 (0.00, 0.08)	0.02
12 months	0.7 (0.3 - 1.5)	0.7 (0.2 - 1.4)	0.9 (0.65)	0.9 (0.58)	0.03 (-0.02, 0.08)	0.15
18 months	0.8 (0.3 - 1.4)	0.8 (0.3 - 1.4)	0.9 (0.66)	0.9 (0.59)	0.03 (-0.02, 0.08)	0.19
MRI						
Baseline	0.4 (0.0 - 1.2)	0.4 (0.0 -1.2)				
6 months	0.3 (0.0 - 0.9)	0.3 (0.0 - 0.9)	0.5 (0.47)	0.5 (0.50)	-0.03 (-0.07, 0.01)	0.08
12 months	0.4 (0.0 -1.0)	0.4 (0.0 - 1.0)	0.6 (0.55)	0.6 (0.58)	-0.01 (-0.06, 0.04)	0.61
18 months	0.5 (0.1, 1.0)	0.4 (0.1 - 1.0)	0.6 (0.56)	0.6 (0.60)	-0.00 (-0.05, 0.04)	0.87
Knee						
X-ray						
Baseline	5.2(3.8 - 6.7)	5.2(3.8 - 6.7)				
6 months	3.7 (2.5 - 5.3)	3.9(2.6 - 5.5)	3.6 (1.45)	3.75 (1.27)	-0.13 (-0.24, -0.01)	0.01
12 months	4.3 (2.9 - 5.6)	4.5 (3.1 - 5.9)	4.1 (1.5)	4.26 (1.35)	-0.11 (-0.23, -0.01)	0.04
18 months	4.4 (3.1 - 5.8)	4.5 (3.2 - 5.8)	4.3 (1.53)	4.39 (1.35)	-0.07 (-0.19, 0.04)	0.16
Hip						
X-ray						
Baseline	3.9 (2.7 - 5.2)	3.9 (2.8 - 5.3)				
6 months	6.4 (4.2 - 9.3)	6.7 (4.7 - 9.2)	6.4 (2.69)	6.69 (2.37)	-0.28 (-0.49, -0.07)	0.003
12 months	3.1 (2.1 - 4.5)	3.3 (2.3 - 4.5)	3.2 (1.28)	3.3 (1.14)	-0.11 (-0.21, -0.01)	0.01
18 months	3.2 (2.3 - 4.5)	3.4 (2.4, 4.5)	3.3 (1.30)	3.39 (1.15)	-0.09 (-0.19, 0.01)	0.04

Ultrasound						
Baseline	3.1 (2.0 - 4.5)	3.2 (2.1 - 4.6)				
6 months	2.3 (1.2 - 3.5)	2.4 (1.3 - 3.8)	2.2 (0.90)	2.36 (0.93)	-0.15 (-0.22, -0.07)	<0.001
12 months	2.6 (1.6 - 3.8)	2.8 (1.7 - 4.0)	2.5 (0.98)	2.7 (1.02)	-0.17 (-0.26, -0.09)	<0.001
18 months	1.7 (1.1 - 2.6)	1.8 (1.1 - 2.7)	1.7 (0.67)	1.86 (0.69)	-0.12 (-0.18, -0.06)	<0.001
Ankle						
X-ray[a]						
Baseline	4.0 (2.9 - 5.4)	4.0 (2.9 - 5.5)				
6 months	4.9 (3.4 - 6.9)	5.1 (3.6 - 7.4)	5.1 (1.80)	2.5 (1.67)	-0.20 (-0.34, -0.06)	0.002
12 months	5.0 (3.6 - 6.9)	5.3 (3.9 - 7.1)	5.3 (1.75)	5.4 (1.60)	-0.08 (-0.22, 0.05)	0.17
18 months	5.3 (3.9 - 7.1)	5.4 (4.1 - 7.2)	5.5 (1.77)	5.6 (1.61)	-0.05 (-0.19, 0.09)	0.43
Ultrasound						
Baseline	1.6 (0.8 - 2.6)	1.7 (0.9 - 2.7)				
6 months	1.1 (0.5 - 2.0)	1.3 (0.5 - 2.3)	1.2 (0.55)	1.4 (0.57)	-0.11 (-0.16, -0.06)	<0.001
12 months	1.2 (0.6 - 2.1)	1.3 (0.6 - 2.2)	1.4 (0.59)	1.4 (0.60)	-0.07 (-0.12, -0.02)	0.003
18 months	1.3 (0.7 - 2.1)	1.4 (0.7 - 2.3)	1.5 (0.62)	1.5 (0.63)	-0.08 (-0.13, 0.02)	0.001

[a]Adjusted for baseline rate and locality

eTable 7. ICC (95% CI) for All Outcomes

	ICC (95% CI)
Overall	
6 months	0.03 (0.01, 0.11)
12 months	0.10 (0.06, 0.16)
18 months	0.147 (0.10, 0.21)
Lumbosacral spine	
X-ray	
6 months	0
12 months	0
18 months	0
CT	
6 months	0.02 (0.002, 0.19)
12 months	0
18 months	0.002 (0.0, 1.0)
Shoulder	
X-ray	
6 months	0.004 (0.0, 1.0)
12 months	0.06 (0.02, 0.13)
18 months	0.07 (0.03, 0.14)
Ultrasound	
6 months	0.046 (0.02, 0.12)
12 months	0.10 (0.06, 0.16)
18 months	0.09 (0.05, 0.16)
Cervical spine	
X-ray	
6 months	0.02 (0.001, 0.23)
12 months	0.02 (0.0, 0.27)
18 months	0.03 (0.01, 0.14)
CT	
6 months	0.048 (0.02, 0.14)
12 months	0.11 (0.06, 0.17)

	18 months	0.15 (0.11, 0.22)
MRI		
	6 months	0.10 (0.05, 0.17)
	12 months	0.11 (0.06, 0.17)
	18 months	0.10 (0.05, 0.17)
Knee		
X-ray		
	6 months	0.09 (0.045, 0.15)
	12 months	0.12 (0.07, 0.19)
	18 months	0.148 (0.09, 0.21)
Hip		
X-ray		
	6 months	0.045 (0.01, 0.13)
	12 months	0.05 (0.02, 0.14)
	18 months	0.08 (0.03, 0.16)
Ultrasound		
	6 months	0.03 (0.004, 0.14)
	12 months	0.07 (0.04, 0.148)
	18 months	0.09 (0.05, 0.16)
Ankle		
X-ray		
	6 months	0.09 (0.048, 0.17)
	12 months	0.12 (0.07, 0.19)
	18 months	0.13 (0.09, 0.20)
Ultrasound		
	6 months	0.13 (0.08, 0.20)
	12 months	0.14 (0.09, 0.20)
	18 months	0.15 (0.11, 0.22)

eTable 8. Sensitivity Analyses of the Primary Outcome for the Main Comparison – Model-Based Estimates

	Intervention Mean (SD) rate	Control Mean (SD) rate	Adjusted mean difference (95% CI)	p-value
ITT population				
Adjusted model [b]				
6 months	24.8 (6.74)	27.5 (7.38)	-2.77 (-3.32, -2.22)	<0.001
12 months[f]	27.7 (1.17)	30.3 (7.80)	-2.62 (-3.20, -2.04)	<0.001
18 months	26.2 (6.45)	28.2 (7.02)	-2.07 (-2.60, -1.55)	<0.001
PP population[c]				
Main model [a]				
6 months	24.6 (6.58)	27.5 (7.20)	-2.92 (-3.46, -2.39)	<0.001
12 months[f]	27.7 (7.15)	30.4 (7.75)	-2.67 (-3.25, -2.09)	<0.001
18 months	26.3 (22.19)	28.3 (24.09)	-1.96 (-2.49, -1.43)	<0.001
Adjusted model [b]				
6 months	24.6 (6.57)	27.5 (7.19)	-2.91 (-3.44, -2.38)	<0.001
12 months [f]	27.7 (7.14)	30.3 (7.77)	-2.67 (-3.25, -2.09)	<0.001
18 months	26.3 (6.53)	28.2 (7.06)	-1.97 (-2.50, -1.44)	<0.001
Active clinical practice population[d]				
Main model [a]				
6 months	24.7 (6.66)	27.5 (7.29)	-2.82 (-3.36, -2.28)	<0.001
12 months [f]	27. 9 (7.20)	30.6 (7.82)	-2.69 (-3.27, -2.10)	<0.001
18 months	26.8 (6.79)	29.2 (7.34)	-2.41 (-2.96, -1.86)	<0.001
Adjusted model [b]				
6 months	24.7 (6.64)	27.4 (7.27)	-2.77 (-3.31, -2.23)	<0.001
12 months [f]	27.8 (7.19)	30.5 (7.81)	-2.64 (-3.23, -2.06)	<0.001
18 months	26.8 (6.77)	29.2 (7.34)	-2.38 (-2.93, -1.83)	<0.001
Same location[e]				
Main model [a]				
6 months	24.8 (6.86)	27.4 7.52)	-2.66 (-3.21, -2.10)	<0.001
12 months [f]	27.7 (7.25)	30.5 (7.88)	-2.71 (-3.31, -2.13)	<0.001
18 months	26. 5 (6,83)	28.7 (7.36)	-2.19 (-2.74, -1.63)	<0.001
Adjusted model [b]				
6 months	24.8 (6.84)	27.4 (7.50)	-2.61 (-3.16, -2.05)	<0.001
12 months [f]	27.7 (7.25)	30.4 (7.90)	-2.68 (-3.27, -2.09)	<0.001
18 months	26.5 (6.82)	28.6 (7.41)	-2.17 (-2.72, -1.62)	<0.001

[a] Main model adjusted for baseline rate and locality.

[b] Main model further adjusted for baseline volume of imaging tests, years in general practice, GP age and GP sex.
[c] Per Protocol (PP) population included those who completed the study in accordance with study protocol, excluding those who did not receive at least one feedback letter (mail was undelivered / marked "returned to sender") or requested not to receive second letter or did not make any DI requests during the follow-up period or had few patient consultations (n=360) during follow-up period.
[d] Active clinical practice population excluded GPs with <1500 patient consultations during study timeframe (18 months).
[e] Same location: excluded practices with GPs randomised to different groups (either two interventions or control and intervention groups).
[f] Primary outcome.
SD - Standard deviation of mean; CI – Confidence intervals.