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Developing a standardised approach to virtual clinic follow-up of total joint replacement

Abstract

Aims

This study aimed to develop a virtual clinic for the purpose of reducing face-to-face orthopaedic consultations.

Methods

Anonymised experts (TJA patients, surgeons, physiotherapists, radiologists and arthroplasty practitioners) gave feedback in a Delphi Consensus Technique. This consisted of an iterative sequence of online surveys during which virtual documents - a patient-reported questionnaire, a standardised radiology report and a decision-guiding algorithm - were modified until consensus was achieved. We tested the patient-reported questionnaire on seven TJA patients in orthopaedic clinics using a Think Aloud process to capture difficulties with its completion.

Results

A patient-reported 13-item questionnaire was developed that covers pain, mobility and activity. The radiology report included up to ten items (e.g. progressive peri-prosthetic bone loss) depending on type of arthroplasty. The algorithm concludes in one of three outcomes: review at surgeon's discretion (3 – 12 months); see at next available clinic; or long term follow-up / discharge.

Conclusion

The virtual clinic approach with attendant documents achieved consensus by orthopaedic experts, radiologists and patients. The robust development and testing of this standardised virtual clinic provides a sound platform for UK organisations to adopt a virtual clinic approach for follow up of total joint arthroplasty patients.

- Virtual clinics offer a potential solution to the problem of overwhelmed orthopaedic outpatient clinics for the follow-up of hip and knee arthroplasty patients.
- This study developed a standardised approach to virtual clinic follow-up of patients with total joint replacements using expert opinion from orthopaedic experts from across the United Kingdom.

Introduction

The routine outpatient follow-up of joint arthroplasty patients places a significant time and financial burden on orthopaedic services in the UK, with over 195,000 total joint arthroplasties (TJA) carried out in England and Wales during 2016.[1] This represents an increase of 3.68%[1] over 2015 figures[1] and over 40% since 2010.[2] Although risk of early failure of joint arthroplasties is low (4.2% at 13 years[1]), joints may be asymptomatic and are associated with higher costs and poorer outcomes.[3] For these reasons, early identification of patients at risk of revision is essential.

The British Orthopaedic Association recommends follow-up of TJA patients within one year of surgery, at seven years and then every three years.[4] However, this is resource-intensive given that only 14,500 revisions take place annually.[1] Moreover, the British Orthopaedic Association suggests that follow-up does not need to be carried out in outpatient clinics but could be performed by post or telephone using a validated outcome measure or questionnaire.[4] Such 'virtual' clinics are already used to ease patient burden with significant cost savings in other clinical areas,[5, 6] and with the increasing safety of arthroplasties, orthopaedic specialists are supporting the concept of follow-up by appropriate 'virtual' clinics.[7] The orthopaedic virtual clinic usually involves patients completing a questionnaire at home and attending at their convenience for an X-ray, with a subsequent letter from the orthopaedic consultant informing the patients of their need for follow-up. The virtual clinic identifies those patients who require out-patient face-to-face appointments and more importantly it identifies the 80% or so of patients who can safely avoid traditional outpatient visits,[8] freeing up significant time for orthopaedic surgeons to operate or review patients with potentially serious problems.

The aim of this study was to provide a standardised approach and assessment of virtual clinic follow-up of total joint arthroplasty patients.

Participants and Methods

This study used a modified Delphi Consensus Technique[9] in three workstreams to develop the components of the virtual clinic:

1. Workstream 1: development of a patient-reported questionnaire.
2. Workstream 2: development of a standardised radiology report.
3. Workstream 3: development of the clinical pathway algorithm.

Delphi consensus survey

The Delphi Technique is used for achieving a consensus of experts on a given topic through an iterative series of, typically, questionnaires.[9] In a Delphi procedure, the opinions of experts on the topic being evaluated are gathered, findings are fed back into the expert panel in a repeated cycle. In this way, expert opinion is evaluated, acted upon and re-evaluated until consensus on the topic being explored is reached by the Delphi expert panel.

Delphi panellists were anonymised to minimise potential bias caused by the effect of published professors and internationally recognised experts exerting an unintended influence over other panellists e.g. preventing the possible reluctance of some panellists to disagree with high-ranking or specialists' opinions or to be forthright with their own opinions. This is an important component of the Delphi process.[10] To maintain anonymity and to minimise inconvenience, travel and time commitments for respondents, we used an online survey.[11]

Each online survey was open for ten days, with Workstream 3 extended to 13 days enabling an improved response. For all surveys, up to two reminder emails containing a link to the survey were sent to non-respondents. At the end of each survey, results were collated and analysed, and the virtual clinic document being evaluated was modified. We anticipated that each stage would consist of two surveys, but participants were informed that a third round might be necessary. Each survey took place no more than two weeks after the previous survey.

Appropriate experts were approached to participate as Delphi survey panellists. Details of each Delphi panel and how panellists were approached are given in Table 1.

The initial development of each document is described in Table 2.

Workstream 1: developing the patient-reported questionnaire

The initial content of the patient-reported questionnaire was based on a version of a virtual clinic questionnaire from a peer-reviewed study[8] and further developed using a number of validated outcome measures such as the Oxford Hip Score.[11] Even though there were similar items between these measures, we included all similar items for expert review because it was our intention that the experts would reach consensus on which content (e.g. item wording) was most appropriate. The first round of the survey asked respondents to rate each questionnaire item from '5' to '1' ('Very Important' to 'Not at all Important'). However, when experts recognised the importance of an item in evaluating change in joint arthroplasty patients, similar items were all given the strongest endorsement possible. This meant that in the second survey, a majority of items were retained. To overcome this issue, in Round 2 of the Delphi survey we asked experts to indicate which questionnaire items were: 'Essential for inclusion';' Important but could be omitted'; and 'Not at all important'. Secondly, for additional guidance to reach consensus, we also asked respondents to select the most important and second most important questionnaire items in each section of Pain, Mobility and Daily Activities.

Following the revisions from the Delphi process we undertook 'Think-aloud' Interviews as part of the validation process. This technique is a well-recognised method for questionnaire and instrument development.[12] It tends to be used to ascertain whether patients actually understand the questions in the way a health care specialist or a researcher would. It is also seen as a valuable approach to ensure that patients can retrieve from memory the information which the question requires and whether all important aspects are being considered in the questionnaire.[13] We planned to include a sample of around ten patients to test the usability, as is common in other studies, with final numbers determined once data saturation is reached. Patients due to attend an arthroplasty follow up clinic were informed about the Think-Aloud interviews by including Patient Information Sheets with the clinic appointment letter. Patients who were willing to participate indicated this to their clinic's arthroplasty practitioner and were approached by a researcher for Think-Aloud interviews. Participants were given the option to conduct the Think-Aloud interviews at the clinic, at their home or at any place and time convenient to them. Participants were given the opportunity to ask questions of a researcher, and they signed informed consent forms before the interviews. Consent included the recording of the interviews to make sure that any issues identified by the Think-Aloud interviews were taken into account during the analysis. Recordings were anonymous and were transferred to secure electronic storage.

Patients were asked to '*think aloud when answering each question*' and to talk as much as possible about their thoughts as they work through the questionnaire items. Patients were prompted occasionally with conditional reactive probes such as '*What is going through your mind as you answer this question*'.[14] Once the patient had completed the questionnaire, they were asked general questions as appropriate; for example, if they had paused or apparently struggled with an item, they

were asked '*Did you find [this item] hard to answer or understand?*'. The purpose of this was to identify where the questionnaire was confusing, misleading or lacked clarity for accurate completion, and thus guide appropriate modification of the questionnaire to address these issues.

Workstream 2: developing the standardised radiology report

Respondents were asked to rate each of the initial 34 items to indicate how important each item was for the purposes of assessing radiograph change in the ongoing wellbeing of both the patient and their joint arthroplasty, from 5 (Essential) to 1 (Not at all important). A text box was included for each item, in which respondents could leave comments, and a text box was included at the end of the survey for Delphi panellists to leave general comments.

After round 1 of this Delphi process, for all except two respondents, the feedback comments and responses were easily addressed. Two respondents were contacted for elaboration on their feedback comments, as their feedback was unclear on how to re-word the radiology report items for round 2.

For subsequent rounds of the Delphi process, respondents were asked to consider each item with three possible endorsements: 'Essential for capturing changes in joint arthroplasty that could trigger a face-to-face appointment with the surgeon'; 'Could be omitted, but must be retained if other items are removed'; and 'Not important: item could be omitted'.

Workstream 3: developing the Virtual Clinic clinical pathway algorithm

To support completion of the Stage 3 survey, respondents were given a copy of the initial clinical decision algorithm.

Each item in the survey corresponded to one of the algorithm's 18 pathways. For each pathway, respondents were asked for their opinion on its appropriateness by endorsing one of two options: 'Appropriate (this pathway ends in an appropriate intermediate step)'; or 'Inappropriate (this pathway ends in an inappropriate intermediate step)'.

If the pathway was rated as Inappropriate, respondents completed a mandatory text box to suggest which additional intermediate step or changes should be included.

The final pathways led to one of three possible clinical outcomes for the appropriate follow-up of total joint arthroplasty patients. Respondents were asked for their opinion on the appropriateness of the outcomes by endorsing one of two options: 'Appropriate: this is an appropriate outcome'; or 'Inappropriate: this is an inappropriate outcome'. If a respondent endorsed the 'Inappropriate' response, a text box appeared in which they were required to state why the pathway was Inappropriate and to propose an alternative. A text box was also included at the end of each survey for experts to leave general comments.

Ethics

The study was approved by London - City & East Research Ethics Committee (REC reference 17/LO/0530).

Data analysis

We used descriptive statistics for Delphi experts' responses to items for deciding to retain or reject items from each Delphi survey,[15, 16] deciding *a priori* to retain or reject items when 70% of respondents indicated this. Items were returned for further review in the subsequent rounds if they were not fully rejected. In subsequent rounds, respondents indicated which items were most

important and which items were second most important; these responses were used as a secondary guide to support selection or rejection of items.

Text box comments were not subjected to data analysis, but actioned as necessary following discussion within the research team.

Results

The Delphi consensus process for each virtual clinic document was completed in two rounds of surveys. The numbers of participants who responded to the Delphi surveys and the numbers of comments left by respondents are given in Table 3.

Patient-reported questionnaire

In round 1, 25 of 38 items were rated 4 or 5 by more than 70% of respondents, and none of the items were rejected (no items were rated 1 or 2 by more than 70% of the respondents).

For the second survey we retained all items which were rated 3 or higher by more than 70% of respondents. This produced consensus for 13 items, as shown in **Error! Reference source not found.**. These items formed the final version of the questionnaire.

Respondents' comments. Respondents' comments related to: general presentation of items of the virtual clinic documents; items which should be amended, added or should or could be removed; and other general comments (detailed in Table 4).

Think-aloud interviews. A total of seven patients participated in Think-Aloud interviews to allow us to improve understanding and accurate completion of the questionnaire. Five patients attending an outpatients clinic completed the Think Aloud interviews while at the clinic, and the patient-reported questionnaire was modified immediately afterwards based on any problems that were identified.. The modified questionnaire was subsequently used in Think-Aloud interviews with two patients who had requested to complete the questionnaire at their home. We had planned to use ten patients but no further comments or changes emerged after five patients. The additional two patients ensured the usability of the questionnaire. They found no problems with the questionnaire, suggesting that the questionnaire was clear and that there were no problems completing it. Because of this, the decision was taken to conduct no more Think Aloud interviews. Problems identified are given in Table .

Radiology report

The first survey suggested that a number of items could be omitted. Comments suggested that some items were not specific enough and respondents provided alternative wording for the item. Other suggestions proposed items for inclusion. This resulted in an amended radiology report of 25 items for panellists' review in the second survey.

Error! Reference source not found. shows responses from the second survey to develop the radiology report. No items were rejected outright, and all but one in each section were endorsed by at least 70% of respondents. Comments are given in Table 4. They suggested slight modifications to items. This resulted in a standardised radiology report of 24 items: five each for reporting on a cemented hip cup, a cemented femoral component, an uncemented femoral component and a knee arthroplasty; and four items for an uncemented hip cup.

Clinical pathway algorithm

The first survey in the development of the clinical algorithm was met with almost universal consensus, except for a pathway relating to the orthopaedic surgeon's secondary check of any

radiography report which identified concerns with the arthroplasty. The second survey suggested that the clinical decision algorithm was generally acceptable but highlighting that it can be challenging for some orthopaedic centres to obtain radiologists' support.

The algorithm was modified accordingly based on these comments and after discussion with the research team; no further surveys were conducted and the final version is shown in **Error! Reference source not found.**.

Discussion

The aim of this study was to develop a standardised approach and assessment for a virtual clinic follow-up of total joint arthroplasty patients using anonymous opinions gathered from expert orthopaedic specialists and patients. Using online surveys, we achieved consensus on a patient-reported questionnaire, a standardised radiology report and a clinical decision algorithm.

Delphi consensus survey

The Delphi panel was diverse in its membership and included all appropriate levels of expertise for informing the virtual clinic development. Respondents were from a wide geographical area across the UK to ensure a depth and breadth of experience and expertise. Anonymisation of the Delphi process attempted to minimise any 'bandwagon' effect and peer pressure.

Patient-reported questionnaire

Items on the first draft of the patient-reported questionnaire were based both on a questionnaire developed in a previous peer-reviewed study[8] and on validated outcome measures used for evaluating hip and knee arthroplasty patients. This ensured that the first draft had a degree of validity for evaluating TJA patients. The Delphi surveys reduced the initial number of items from 45 to 13. We found that comments were helpful for improving the items to maximise clarity and clinical relevance. The final questionnaire has five more items than the earlier version of a virtual clinic questionnaire on which the new questionnaire was based; six of the original items are still included on the new questionnaire, including those with slightly modified wording and it includes seven new items that could potentially reduce the numbers of TJA patients incorrectly identified as needing face-to-face clinical review by the orthopaedic team.

Radiology report

The radiologists who helped to develop the draft radiology report were experienced radiologists within the orthopaedic speciality but we recognise that not all teams have this support. Feedback from respondents suggested wide variability in the quality of x-ray reporting. However, this underpins the importance of standardised x-ray reporting. Meanwhile, many orthopaedic surgeons review all their patients' x-rays, and many advanced arthroplasty practitioners have received training and are highly competent at interpreting changes on radiographs. We recommend that local orthopaedic centres adjust use of the virtual clinic in line with their own practice and resources but we suggest that the standardised report will improve x-ray reporting where specialist radiology report is absent.

Clinical pathway algorithm

Feedback for the clinical decision algorithm was generally positive, but there were concerns about decision pathways from the outcome of the Radiology report and from the assessment of Pain. Concerns about the Pain pathways related to evidence for the algorithm's threshold for pain of 4/10, with some experts suggesting that ANY indication of pain should be referred for a review. However, this threshold is based on a systematic review suggesting that 4/10 and above is common in joint

arthroplasty patients.[17] Some suggested that there was no requirement for the x-ray report, citing a lack of expert support in some sites, but we contend that this emphasises the need for a standardised report.

Limitations

Expert panellists in each Delphi survey were not randomly selected but identified through their seniority and involvement at high levels of orthopaedic surgery e.g. current or ex-Presidents of the British Orthopaedic Association, British Hip Society or other specialists known to the research team. Some participants were approached because they had expressed an interest in either participating in research (through the NIHR Leeds Biomedical Research Centre (BRC) Patient and Public Involvement (PPI) Group). Although how participants were selected is a potential source of bias, we were able to include leading experts using this approach. We believed that this approach would minimise non-responses to the Delphi survey.

Participants in the Delphi process were all interested and supportive in the concept of a virtual clinic, which might have introduced bias into the results. We recognise that expert opinion is the lowest form of evidence in the hierarchy of evidence. Moreover, it has been suggested that this expert opinion could be diluted by the consensus approach,[18] producing a compromise consensus.[19]

Subsequent clinical use of the radiology report after its development has resulted in a number of changes to layout (but not to the content produced by Delphi panel experts). For example, a text box is included for indicating why a patient has been called to a face-to-face clinic. This suggests a Think Aloud approach for the radiology report would have also been useful to identify and address problems with its clinical use.

Although we attempted to ensure anonymity of Delphi panel members, some participants were aware of each other's involvement and some discussion took place between participants before they independently completed the survey.

Another limitation of our approach was our requirement for participants to have access to emails and the Internet, and we also assumed that participants had the technical ability to navigate through online surveys. This is unlikely to have been a problem for health care professionals but might have omitted a section of the patient population, from whom feedback could have been most important. We attempted to address this through Think Aloud interviews but this did not necessarily account for the missing demographic.

The response rate in the radiology report consensus surveys was poor (37.5% and 58%), particularly from the recognised experts in x-ray review (radiologists and surgeons). This might have produced a non-response bias where those who did not respond had systematically different opinions to their professional colleagues who did.

Summary

This paper describes the development of a standardised approach to virtual clinic follow-up of TJR which reduces the burden on orthopaedic clinics for face-to-face follow-up of 200,000 hip and knee TJA patients per year in England and Wales. It will create out-patient capacity for those patients who do require traditional out-patient appointments and maximise efficient deployment of orthopaedic resources. Wider testing is required for hospitals to be able to implement the virtual clinic, and this is currently being undertaken.

Acknowledgments

Redacted

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Table 1. The background of participants for each stage of virtual clinic development, how they were identified and how they were approached.

	Participants	Source of recruitment	How approached
Stage 1: Questionnaire	Six hip or knee arthroplasty patients	NIHR Leeds Biomedical Research Centre (BRC) Patient and Public Involvement (PPI) Group.	Approached using a form which gave details of the study and inclusion criteria that included hip or knee TJA and access to a computer connected to the internet. It is not known how many of the PPI group met the inclusion criteria; all respondents were included in this study.
	Six senior experienced orthopaedic surgeons	Initially, surgeons who were members of the British Orthopaedic Association who were undertaking at least 100 or more hip and / or knee arthroplasty operations per year.	Personal approach to known leading surgeons then using snowball sampling.[20]
	Six arthroplasty Care Practitioners	Arthroplasty Care Practitioners Association.	Approached through a former collaborator who is a member of the Association. It is not known how many of each professional group were approached using this technique; all respondents were included in this study.
	Four MSK/orthopaedic physiotherapists	Identified through local health service orthopaedic clinics and snowball sampling.[20]	Approached directly by researcher.
Stage 2: Radiology report	The same participants as Stage 1, less the patients and with three additional surgeons, one experienced arthroplasty practitioner and six radiologists.	The additional surgeons and arthroplasty practitioner were from sites across the UK who had agreed to take part in a proposed service evaluation of the virtual clinic.	Approached directly by researcher.
		The radiologists included the two experts who had drafted the initial radiology report, and the remaining four were known to these experts.	Approached by participating radiologists.
Stage 3: Clinical pathway algorithm	Seventeen experienced orthopaedic surgeons.	Eight surgeons from Stage 2 plus nine surgeons from sites across the UK who had agreed to take part in a proposed service evaluation of the virtual clinic.	Approached directly by researcher.

Table 2. Descriptions of how each virtual clinic document was initially drafted.

Patient reported questionnaire			
Details of the final first draft	**How items were selected or developed**	**Item response categories**	**Further information**
The first draft included 38 items about patients' pain, satisfaction with their new joint, mobility, and personal and daily activities. Where there was any doubt about the suitability of an item, the item was included in the questionnaire for review by experts taking part in the Delphi consensus survey.	Items for the patient-reported questionnaire were firstly drawn from a questionnaire previously used to evaluate use of a virtual clinic.[8] Additional items were added based on a review of clinical observations and validated patient-reported hip and knee measures that are commonly used following TJA e.g. the modified Harris hip score[17] and the Oxford Knee Score.[21]	Each of the items had between two and five response category options e.g. Yes/ No, or Yes, easily / With little difficulty / With moderate difficulty / With extreme difficulty / No, impossible. These were drawn from response options of the validated measures on which the questionnaire was based.	A section was provided at the end of the questionnaire for patients to leave general comments. Comments were looked at individually as the comments did not allow for systematically grouping the responses into categories.
Radiology report			
Details of the final first draft	**How items were selected or developed**	**Item response categories**	**Further information**
The radiology report consisted of a total of 34 questions e.g. "Is there evidence of fixation screw fracture?" separated into five sections: Uncemented Hip Cup (six items), Cemented Hip Cup (five items), Uncemented Femoral Component (eight items), Cemented Femoral Component (eight items), and Knee (seven items).	The first draft of the radiology report was developed by a consultant orthopaedic surgeon and two experienced expert radiologists all of whom had extensive experience at reviewing and interpreting x-rays of TJR for signs that would suggest the need for revision surgery. Questions were formulated following a review of 30 x-rays of failed hip and knee TJR that required revision.	Item response categories for each question were identical: Yes; No; and Unable to assess.	
Clinical decision algorithm			
Details of the final first draft	**How items were selected or developed**	**Item response categories**	**Further information**
The algorithm consisted of a flow chart of clinical questions. One 'Yes' and one 'No' pathway emerged from each clinical question. Each pathway led to another clinical question, from which another 'Yes' and 'No' pathway emerged. The clinical	The first draft of the algorithm was developed using researchers' clinical experience to construct appropriate pathways from the possible answers to items of the patient-reported questionnaire and radiology report. The appropriate	See details of first draft, column 1.	The initial algorithm was reviewed and approved by all members of the research team before the Delphi survey was launched.

decision algorithm had 18 such pathways leading finally to one of four clinical decisions: Long-term follow-up or discharge; Review within three months; Arthroplasty practitioner contacts patient to discuss patient responses and determine appropriate course of action; or URGENT REVIEW	clinical decision of the virtual clinic for follow up of TJR patients therefore depended on the output from a questionnaire and radiology report that were constructed through expert opinion.

Table 3. Numbers of responses to each of three Delphi surveys to develop the virtual clinic.

		Stage 1 (questionnaire)		Stage 2 (radiology report)		Stage 3 (algorithm)	
		Round 1	Round 2	Round 1	Round 2	Round 1	Round 2
Number of respondents / total participants e.g. 4/9 means four respondents out of a total of nine panel participants	Patient	6/6	3/6	-	-	-	-
	AP	6/6	5/6	4/9	6/9	-	-
	Physio	4/4	4/4	-	-	-	-
	Surgeon	5/6	3/5	3/9	5/9	11/15	10/15
	Radiologist	-	-	2/6	3/6	-	-
	Total	21/22 (95%)	15/21 (71%)	9/24 (37.5%)	14/24 (58%)	11/15 (73%)	10/15 (67%)
Number of comments	Patient	29	11	-	-	-	-
	AP	27	11	10	3	-	-
	Physio	15	5	-	-	-	-
	Surgeon	14	3	2	11	43	17
	Radiologist	-	-	8	5	-	-
	Radiologist	-	-	8	5	-	-
	Total	85	30	20	19	43	17

Table 4. Respondents' comments from second (and final) survey to develop a patient-reported questionnaire.

Respondents' comments about the general section on the replaced joint
1. Prefer layout as separate, just visually more appealing.
2. Suggest did op result reach expectations question.
3. Keeping the questionnaire simple and concise is essential
4. When did you have your joint replacement?
5. I think b and c are virtually the same question and c is probably more sensitive.
6. Have you had to visit your GP or nurse with problems with your joint replacement
Respondents' comments about PAIN items
1. If you are asking about pain when in bed, I do not think it is necessary to ask whether they have it lying down as well. (questions c and d)
2. Changes in pain or new pain is important
3. Q4 questions seem crucial to assess possible deterioration. d) is probably covered by c)
4. For Q3 a) it is increases in pain that matter, which will be covered by b) and c).
5. Not sure that e) adds anything to the answers you will get from b) and c)
Respondents' comments about KNEE OR HIP FUNCTION items?
1. 'Give away' or 'let you down' plants the idea that the replacement might do this, whereas those sensations or thoughts can very much relate to changes in muscle use, therefore I feel theses add confusion but of course the consultants might be being asked about this in the follow-up appointments
2. Q6- locking is crucial- stiffness may be expected?
3. Q7 a) covers everything, are b) and c) really necessary?
4. I think questions 6 b and 7 b could be omitted.
Respondents' comments about PATIENT MOBILITY items?
1. I would attempt to combine questions a and b as they are very similar in nature. I am not sure about walking up or down steep slopes is an essential question.
2. a and b seem to be asking the same thing and could perhaps be combined, in which case wording for b is probably clearer.
3. For question (k), is the important information whether the walking distance has changed rather than what the total distance is (this would be consistent with all other items).
4. Need only a or b
Respondents' comments about PATIENT ACTIVITY items.
1. Add not applicable to the bath question or change to bath/shower. Question about any sports resumed?
2. All appear relevant

Other comments

1. I feel the questionnaire covers most areas.
2. episodes of swelling around operated area
3. infection signs / heat, redness, swelling
4. Is it worth asking about signs of inflammation (warming of the joint?) Or obvious swelling?- which may not cause pain- especially if dulled by analgesics.
5. Has the patient noticed any swelling, redness or warmth in the joint?
6. I would like to know the type and frequency of painkillers taken

Table 5. Findings and modifications from the Think Aloud interviews.

Problem	How addressed
Patients overlooked the first instruction in the Pain section which asked them to omit that section if they had no pain in the joint for which they were completing the questionnaire.	The layout of the Pain section was modified and the instruction was re-formatted to ensure its prominence and reduce the likelihood of it being overlooked.
Patients were confused by the layout of the Visual Analogue Scale for indicating pain.	Visual analogue scale was modified and section made clearer.
Some patients were unclear about which joint they were having assessed.	The initial section in which patients were asked to indicate the joint for which they were completing the questionnaire was removed. In its place, an instruction was added on the front sheet informing the patient of which joint for which they were completing the questionnaire. This instruction is to be completed by clinic staff before posting the questionnaire out to patients. A line was added to the start of each section, just before the items: "**Thinking only about the joint replacement as indicated on the front page:**"
One patient wanted to add a comment and wrote this across the bottom of the questionnaire (patient wanted to say thanks to the surgeon).	A text box was added for patients to leave comments.

Table 4. Comments about the second version of the radiography report arranged by type of arthroplasty and then by professional background.

Comments on cemented hip cup

Arthroplasty practitioner

Cup migration, halo around screws. Comment regarding any wedges that were used re: movement, lucency as these may be used in a primary.

Radiologist

The responses depend on the definition of immediate [follow up by orthopaedic surgeon]. All the findings are important and most suggest surgical review but not necessarily immediately

part a- this presumes there has been previous plain film

part d - stating 'severe' polyethylene wear is a little subjective

Surgeon

migration of cup

I presume the fixation screw is for bone graft but it is not clear, is it for rim mesh?

Comments on uncemented hip cup

Surgeon

cup migration

Comments on cemented femoral component

Surgeon

excessive subsidence (5mm) particularly if not a taperslip construct and associated with cent fracture

Comments on uncemented femoral component

Arthroplasty practitioner

Sign of subsidence

Surgeon

pedestal formation

Progressive large radiolucent lines

Lesion at stem tip windscreen wiper ie lytic area at stem tip

Periosteal reaction may be normal for some implants

Comments on knee joint arthroplasty

Radiologist

part a - 'component' position probably includes spacer??

Any other x-ray observations that suggest failure of a knee joint arthroplasty?

Arthroplasty practitioner

Comparison with previous imaging

I would like to know if there is heterotrophic ossification, or cortical hypertrophy - if I am not reviewing the X-ray myself.

Radiologist

timing of previous plain film would be helpful to include

Surgeon

Don't mis-interpret centraliser as osteolytic lesion at tip stem

I think the x ray has to be assessed by an orthopaedic team member

Simple report as described best. Radiolucencies around uncemented cups can be difficult depending on how image created