An electronic clinic for arthroplasty follow-up: a pilot study

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Background: Most outpatient orthopedic follow-up visits for patients who had total joint arthroplasty are routine among those with well-functioning implants. The technology and resources now exist to enable patient assessment without requiring attendance in hospital. We tested an electronic clinic for routine follow-up in a small cohort of arthroplasty patients.

Methods: We randomly assigned primary arthroplasty patients scheduled for routine annual outpatient review into 2 groups: group A completed a Web-based assessment 4 weeks after the clinical assessment, whereas group B completed the Web-based assessment first. Standard clinical questionnaires were included. We also collected radiographic data and information on assessment duration and cost.

Results: Forty patients participated in the study. The average age of participants was 58 years. There were 12 men and 8 women in each of the 2 groups. The average total time spent by patients on an outpatient visit was 115 minutes, compared with 52 minutes for the electronic assessment. Participants reported the electronic assessment to be more convenient and less costly.

Conclusion: This pilot study supports the practical use of an electronic clinic for the follow-up of arthroplasty patients. Further studies examining the complex interaction of factors involved in patient clinics are needed.

Contexte : La plupart des consultations de suivi orthopédique en service externe pour des patients qui ont subi une arthroplastie totale sont routinières chez ceux dont les implants fonctionnent bien. La technologie et les ressources nécessaires pour évaluer le patient ailleurs qu'à l'hôpital existent maintenant. Nous avons fait l'essai d'une clinique électronique de suivi de routine pour une cohorte peu nombreuse de patients ayant subi une arthroplastie.

Méthodes : Nous avons réparti au hasard en 2 groupes des patients qui avaient subi une arthroplastie primaire et devaient se soumettre à un examen annuel de routine en service externe : les patients du groupe A ont rempli une évaluation sur le web 4 semaines après l'évaluation clinique et ceux du groupe B ont rempli l'évaluation sur le web en premier. Des questionnaires cliniques normalisés étaient inclus. Nous avons aussi réuni des données radiographiques et de l'information sur la durée et le coût de l'évaluation.

Résultats : Quarante patients ont participé à l'étude. Les participants avaient en moyenne 58 ans. Il y avait 12 hommes et 8 femmes dans chacun des 2 groupes. Les patients ont passé au total 115 minutes en moyenne en consultation au service externe comparativement à 52 minutes pour l'évaluation électronique. Les participants ont signalé que l'évaluation électronique était plus commode et moins coûteuse.

Conclusion : Cette étude pilote appuie l'usage pratique d'une clinique électronique pour le suivi des patients qui ont subi une arthroplastie. Il faudra effectuer d'autres études pour examiner l'interaction complexe entre les facteurs en cause dans les cliniques de suivi des patients.

Routine patient review following total joint arthroplasty is important for evaluating clinical outcome and implant survivorship and for auditing clinical practice. Accurate assessment of patient functioning postarthroplasty plays a key role in the research and development of future implant and surgical technology. Health care systems, however, are under pressure to cope with the increasing demands for joint replacement and the workload associated with assessing and monitoring patient outcomes.

We recognize that most outpatient orthopedic arthroplasty follow-up visits are routine in patients with well-functioning implants and, therefore, may not be an efficient use of a specialist's services. Similarly, considerable time and effort to attend follow-up clinics can be inconvenient for these patients, especially those travelling long distances. The benefits of reducing review appointments to free time for new patients have been recognized, resulting in the use of telemedicine and telephone follow-ups.[1–5] A more efficient and acceptable manner to monitor arthroplasty outcomes that is acceptable to both the patient and the health care system is needed.

The technology and resources to enable patient assessment without attendance in hospital now exist. Many subjective, patient-based questionnaires for arthroplasty evaluation, administered by mail, telephone and in-clinic touch-screen computers, have been previously validated and used for research purposes. In addition, the use of digital radiographs and technology such as the picture archiving computer system (PACS) allow images to be reviewed outside the hospital.[6,7] By combining these 2 methods of assessment, it is possible to create an electronic clinic (eClinic) for review of arthroplasty patients. An eClinic could potentially reduce the outpatient clinic workload and free up outpatient appointments for new referrals. The purpose of this study was to test an eClinic for routine follow-up among a small number of arthroplasty patients.

Methods

We identified primary arthroplasty patients scheduled for forthcoming routine annual outpatient review at our institution. Patients who had their arthroplasty procedure more than 1 year previously and/or were living in the peripheral community were included. Patients were excluded if they were enrolled in another study requiring specific follow-up or if they did not have a community hospital in closer proximity than our institution. We contacted patients by telephone and invited them to participate. All participants provided informed consent in clinic. For those who declined to participate, we recorded the reason as well as their age, sex, postal code and surgeon. The University of Western Ontario Ethics Review Board approved our study protocol.

The first 40 consenting patients were randomly assigned by computer to 1 of 2 groups. Group A attended routine outpatient assessment and completed standard clinical questionnaires, including the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Short Form 12 (SF12) Health Survey and the Hip and Knee Society Scores.[8–10] To ensure consistency of these measures across time, the same group completed the questionnaires a minimum of 4 weeks later using the eClinic Web-based patient evaluation system. Group B completed the Web-based evaluation first, followed 4 weeks later by routine outpatient assessment.

To ensure the security and confidentiality of the electronic Web-based assessment, each patient was given the website address and a unique username and password to gain access to the Web page and enter their data. The Web page could be accessed from any Internet-ready computer. Patients were allowed to ask someone to help them access the eClinic. The Web page contained the same questionnaires used in the outpatient clinic, with the exception of the Hip and Knee Society Scores. These scores require clinician input that we could not reproduce in the eClinic setting. The Web-based program was set up to not allow the patient to advance unless each question was answered. On completion of the assessment, the data automatically uploaded to the institution's database, and no physician input was required. Patients were provided with a telephone number to call if problems arose with the electronic assessment. The time interval between the assessments was a minimum of 4 weeks to prevent the recall of questions.

In contrast to the other follow-up assessments, which were carried out at the lead study hospital, radiography took place at a local community hospital; patients would travel to whichever hospital was closest to them. All radiographs were available for viewing at the time of the routine outpatient clinic via the PACS. Routine assessment of these radiographs included evaluation by medical staff who recorded any radiographic changes. These data were manually entered into a password-protected, secure arthroplasty database. All radiographic changes were analyzed by an independent investigator and recorded on the same chart used by the reviewing surgeon in clinic. The adequacy of the radiographs taken off-site at the community hospital was assessed in comparison with on-site institute protocol for adequate exposure, ability to see appropriate bony landmarks, appropriate anteroposterior pelvis and lateral hip views and standing anteroposterior and lateral knee views with the entire prosthesis visible. The time taken to assess all these radiographs was recorded. The study surgeon compared the radiographic analyses recorded in the outpatient clinic with those of the independent observer. Radiographs were analyzed for evidence of radiolucent lines, heterotopic bone formation, osteolysis, wear, subsidence and implant position.

To measure the feasibility of the eClinic, we conducted a telephone follow-up with participants after the study concluded. Patients were asked which method of assessment was most convenient and which method they would prefer for their next review. We also compared the amount of information missing for the clinical questionnaires completed during the outpatient assessment with those completed as part of the electronic assessment, in which no missing values were accepted.

We collected data on the patients' travelling and waiting times for clinic and radiography visits as well as the costs incurred; these data were estimated by the patient and not formally measured. The time taken to complete each

online assessment was recorded automatically, from time of logon to time of logoff, as was feedback regarding difficulties encountered with the eClinic, its convenience and patient preference for future assessments.

The estimated process time for obtaining radiographs was compared with that in an audit of arthroplasty patients who were not involved in this study but attended an outpatient clinic at the study hospital over a period of 75 days. We recorded the duration of these patients' visits, from the time they entered the radiology department to the time they left the department after the radiographs were processed.

Statistical analysis

We used descriptive statistics to summarize demographic and clinical variables. Using a Pearson χ^2 test, we compared patients who consented to participate with nonconsenters based on age, sex, surgeon, postal code and type of arthroplasty. Reliability coefficients (intraclass correlation coefficient) were reported as a measure of the test–retest reliability of the questionnaire scores obtained for each group. The proportion of abnormalities was compared using a χ^2 test. We used an independent samples t test to compare time- and cost-related measures between the 2 groups. We considered results to be significant at $p < 0.05$.

RESULTS

Ninety-four patients were identified from the hospital database for forthcoming outpatient arthroplasty review appointments. Of these patients, 63 met our inclusion criteria and 40 (63%) agreed to participate in this study. Participants were, on average, 58 years old and were 38 months postsurgery, whereas nonparticipants were on average 56 years old and 41 months postsurgery.

Men were significantly more likely to participate than women ($p = 0.010$), and patients who had knee replacements were significantly more likely to participate than those who had hip replacements ($p = 0.019$). The 23 patients who did not consent to participate gave the following reasons: not interested ($n = 12$), no computer ($n = 7$), incapacitated by cerebral palsy ($n = 1$), incapacitated by a stroke ($n = 1$), non-English speaker ($n = 1$) and nursing home resident ($n = 1$).

Ten patients who had knee replacements and 10 who had hip replacements were randomly assigned to group A, whereas group B comprised 14 patients who had knee replacements and 6 who had hip replacements ($p = 0.07$). The average age at surgery was 56 (standard deviation [SD] 7.7) years in group B and 60 (SD 8.3) years in group A ($p = 0.08$). Both groups comprised 12 men and 8 women.

All participants completed their first assessment. For the second assessment of the study, 4 people failed to attend the outpatient clinic as scheduled, whereas 1 person did not complete their electronic assessment within the period allocated. All patients required a reminder before they eventually completed the assessment. All patients underwent radiologic assessment at their local community hospitals without issue.

For the eClinic, 39 of 40 patients stated the instructions for completing the assessment were clear: 9 (22.5%) patients had logon problems, 3 (7.5%) had difficulty with their passwords (case sensitive), 2 (5.0%) attempted to find the Web page using a search engine, 1 (2.5%) had difficulty finding a computer to use, 2 (5.0%) tried accessing the Web page while the server was down (technical difficulties) but were successful thereafter and 1 (2.5%) remained logged on despite completing the assessment. Four (10.0%) patients had issues with the questions asked during the electronic assessment: 3 found the questions too long and confusing, and 1 experienced a server crash partway through completion. The average time taken from successful logon to completion of the electronic assessment was 12 (range 4–30) minutes, with 4 (10.0%) patients requiring assistance from a friend or relative to complete the online process. There were no significant differences between groups on Web-based evaluation time.

Travel time to the study hospital for the outpatient clinic averaged 48 minutes for the whole group. Group A had a significantly longer average travel time than group B (53 min v. 43 min; $p = 0.02$). Although the difference was significant, it was probably not relevant. All patients then waited on average 24 minutes before being seen by the doctor. There were no significant differences for this wait between groups.

Time spent with the physician in the outpatient clinic includes recording of Hip and Knee Society Scores, radiographic evaluation and examination. Patients generally completed all other questionnaires while sitting in the waiting area. The average duration of data collection at outpatient visits without radiographic assessment was 35 minutes compared with an average duration of 12 minutes with the eClinic. We found a significant difference in the average radiograph processing time for the radiographs obtained at the local hospital between groups (42.8 min in group A v. 20.2 min in group B; $p = 0.04$).

The result of patient feedback at the conclusion of the study revealed that 38 (95%) patients found the eClinic assessment more convenient, 1 (2.5%) had no preference and 1 (2.5%) found the outpatient clinic more convenient owing to the proximity of the study hospital to their workplace. Thirty-eight patients preferred the eClinic for future assessments, whereas 2 preferred to see a doctor.

From the questionnaires completed by all 40 patients at the outpatient clinic, 12 values in total were missing for the SF12, and 8 were missing for the WOMAC ($p < 0.01$). The portion of the Hip and Knee Society Scores that relied strictly on patient input was also examined for missing values. In total, 6 values were missing for the hip society score

and 7 were missing for the knee society score. There were values missing for radiographic evaluation and/or clinician component scores in all patient records.

Reliability coefficients ranged from 0.85 to 0.96, indicating "good" to "excellent" test–retest reliability on the questionnaire measures. The only exception was the SF12 mental scale score for Group A, which had a "moderate" or "acceptable" coefficient of 0.67. Higher scores on the WOMAC were recorded at the eClinic than at the outpatient clinic; however, the difference was not significant. There was no significant difference between the mental and physical component scores on the SF12 completed at the eClinic or the outpatient clinic (Table 1).

All patients had their radiographs assessed at the outpatient clinic; however, the assessments were complete for only 18 (45.0%) patients.

In a separate session, all 40 radiographs were independently assessed by an orthopedic surgeon using PACS. It took a total of 60 minutes to review all the radiographs (1.5 min per patient). The radiographs were first assessed to determine if they were adequate for reporting and, second, whether they were taken as per study hospital protocol; 15 (37.5%) were not taken according to protocol. All 25 remaining radiographs were adequate for assessment except 1 in which the tip of the stem was absent from view. This independent analysis had a greater rate of detection of abnormal radiologic findings than the outpatient clinic assessment. Comparing the independent surgeon's assessment of the radiographs with those assessed in the outpatient clinic from which no values were missing (n = 24) revealed that both the doctor in clinic and the independent surgeon reported the same normal findings for 8 radiographs, abnormal findings were reported by the doctor in clinic but not the independent surgeon for 2 radiographs, and abnormal findings were reported by the independent surgeon but not by the doctor in clinic for 14 radiographs. The independent radiographic analysis of all 40 patients resulted in significantly more abnormal findings than the standard outpatient clinic assessment (14 [35.0%] patients v. 3 [7.5%] patients; p = 0.003). All patients were given a further review at 1 year because no clinically significant implant problems were detected.

A total of 1630 arthroplasty patients who were not involved in the study were included in a practice audit at the study hospital to determine the duration of patients' visits from the time they entered the radiology department and had their radiographs processed to the time they left the department. These patients waited an average of 24 (range 1–135) minutes in the radiology department before having their radiographs processed. The radiographic procedure took an average of 8 (range 2–230) minutes, and the total time spent in the radiology department was an average of 32 (range 3–230) minutes.

Table 2 compares the duration of outpatient clinic visits with that of eClinic assessments. The mean total time spent by patients on an outpatient clinic visit was 115 minutes (travel 48 min, clinic 35 min, radiography 32 min), whereas that for the eClinic assessment was 52 minutes (travel 10 min, eClinic assessment 12 min, radiography 30 min). The time saved by the eClinic patients was 63 minutes. The mean cost of travel was estimated to be $20 (range $10–$60) for the outpatient clinic and $18 (range $10–$40) for the eClinic patients to have radiographs processed at their local hospital. This amounts to a perceived cost saving by the eClinic patient of $2. The most frequently reported duration for a review appointment with the clinician in this study was 19 minutes.

Discussion

This information technology–based pilot study succeeded in recruiting 63% of eligible arthroplasty patients approached for participation. The fact that the average age of those enrolled was 58 years implies that the older population is becoming more computer literate. The demographic characteristics of those who did not consent to participate in the study did not differ greatly from those of our study group, except women were less likely to participate than men. The mean age of the patients in each group was similar, but younger than that of the average Canadian arthroplasty patient, typically 68–72 years.[11] Previous studies have shown higher response rates in older populations using postal mail-outs to collect data.[12]

Our study population was randomly assigned to 1 of 2 groups of equal size. Patients in group A completed their

Table 1. Scores on standard clinical questionnaires completed as part of the eClinic compared with those completed at the outpatient clinic

	Group; mean (SD) score		
Questionnaire	eClinic	Outpatient clinic	p value
SF12 mental component	51.2 (8.7)	52.9 (8.7)	0.59
SF12 physical component	43.8 (12.9)	37.8 (13.8)	0.22
WOMAC	72.3 (19.7)	64.6 (22.7)	0.33

SD = standard deviation; SF12 = Short Form 12 Health Survey;[8] WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index.[9]

Table 2. Comparison between the duration of the eClinic assessment and the outpatient clinic assessment*

	Group; mean (range) min	
Patient time	eClinic	Outpatient clinic
Travel time to hospital†	10 (1–30)	48 (15–90)
Duration of outpatient clinic visit/Web evaluation	12 (4–30)	35 (5–205)
Radiograph processing time	30 (4–210)	32 (1–135)
Total	52	115

*Time and cost to enter data into database not included.
†For the eClinic, travel was required to have radiographs processed at the local hospital.

Web-based assessments 4 weeks after their clinical assessments, whereas group B completed the Web-based assessment first. Not only did this reduce bias associated with the experience of one assessment over the other, it also accounted for any variation in the running of an outpatient clinic, which can fluctuate on a weekly basis. The patients in each group all complied with their first assessment, with some in each group requiring a reminder to comply with the second assessment. This outcome lends credibility to the use of the eClinic, because our population showed no bias toward either method of assessment. Furthermore, the eClinic assessments resulted in total completeness of data, whereas outpatient assessments, at which both patients and clinicians were required to fill out data sheets, resulted in a number of missing values.

The use of the scoring systems for both methods of assessment showed no significant variation in scores. The scores obtained electronically tended to be higher than those obtained in the outpatient clinic. This result could be owing to the degree of anonymity allowed by the eClinic. Questions asked by an interviewer can lead to a preferred rather than a factual answer owing to a patient's embarrassment or wanting to please. Wood and McLauchlan[13] previously found that patients, when faced by a member of the medical profession, were more likely to report better outcomes.

The study population had some technical issues with eClinic assessment but most occurred early in the study and were resolved once they were highlighted and our program modified. Regarding the concerns of some patients about the length and complexity of some questions, the questions were the same as those asked in the paper questionnaires for the separate scoring systems.

The time taken to travel to the study hospital was significantly different between groups A and B; however, in reality, a 10-minute difference when travelling to a location up to 1 hour away is not unusual. A similar result was observed between groups for travel time to their local hospitals (6-minute difference, $p = 0.016$). This difference should have been eradicated by the randomization process, but the time difference was most likely not relevant because we did not consider variables such as driving conditions or volume of traffic. The significant difference in processing time of the radiograph at the local hospital may be multifactorial and should have been prevented by the randomization. It became apparent during follow-up that some patients called their local hospitals ahead of time to determine how busy the radiology departments were and scheduled appointments accordingly. This could explain the difference between the reported processing times. Patients' ability to go to a local hospital for imaging at a convenient time is an advantage over waiting in a large, busy radiology department on the day of the outpatient assessment at the study hospital.

We found the radiographic analysis was significantly more thorough when carried out in a methodical manner outside the outpatient clinic (data not shown). Access to clinical scores during the radiographic review may have facilitated the evaluation of the clinical significance of observed radiographic abnormalities. Whereas this theory was not assessed in the present study, it is an area worth exploring in future research. The importance of feedback to patients on their latest radiograph is often reassuring. Consideration for future eClinic assessments could include setting minimum score requirements and identifying changes in scores from previous assessments to highlight possible problems; patients would then receive an email confirming that their scores and radiographs have been reviewed and summarizing their progress. Any abnormalities highlighted would reflect the need for clinical assessment and an outpatient appointment.

The average time taken by a patient to have a review of their arthroplasty, including radiograph, was less with the eClinic. The eClinic saved the patient an average travel time of 38 minutes and an estimated average travel cost of $2. One limitation of this study is that the timings were estimates by the patients, which simplified our data recording because time taken to visit each hospital, park the car, catch the bus or taxi and get into the building varied among all patients. More important is the time patients perceived they allocated from their daily routines for each of these hospital appointments.

The time allocated for outpatient follow-up assessments is 5 minutes and generates an Ontario Health Insurance Plan (OHIP) billing fee payment of $22.45, whereas new patient assessments are allocated 15 minutes and generate a fee payment of $67. We found that the allocation of 5 minutes for follow-up assessments appears to underestimate the actual time needed for such apointments, which took on average 35 minutes in this study. The ability to see new patients in place of review patients, who could be assessed electronically, could potentially offset the projected loss of physician income from follow-up appointments. Reducing the number of review patients allows limited outpatient resources to be used to assess new patients and reduces waiting times. The financial impact of the eClinic could be an area of future study. Setting up an eClinic incurs annual fees that could be offset by other savings. For example, eClinic data collection would save costs on data entry because data are usually entered manually from the paper records generated in a regular clinic. In addition, the surgeon in this study only spent a total of 60 minutes assessing the eClinic patients' radiographs. Although the mean time spent with each patient in the outpatient clinic was 35 minutes, the most frequently reported visit duration was 19 minutes; when multiplied by 40 patients this time amounts to 760 minutes, leaving the surgeon with about 12.5 hours of time saved that could be allocated to other clinical interests. Although we have shown that regular follow-up of patients who have had uncomplicated arthroplasties is

usually of limited value, on occasion routine surveillance catches complications early before they become complex.

Conclusion

The time and cost associated with seeing patients in clinic is complex. There are many factors to consider, including the cost of staff, stationery, radiology and information technology services. Whereas this pilot study supports the practicality of assessing arthroplasty patients electronically, we recognize the need for further study into the financial impact and safety of this emerging technology. This study is limited in its application to primary arthroplasty patients undergoing annual review, all of whom had undergone the procedure within 5 years. Because no anomalies were detected, further research is required to assess the specificity and sensitivity of such an electronic assessment. Such research would also need to assess the potential financial rewards of introducing an eClinic to hospital, staff and patients.

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