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Report

Knee replacement surgery for osteoarthritis: effectiveness, practice variations, indications and possible determinants of utilization

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Osteoarthritis (OA) of the knee is an extremely common cause of severe pain and disability in the community. It has been estimated that ~7.5% of people over 55 yr have some knee pain and disability associated with radiographic evidence of OA, and that ~2% have severe problems [1–3]. Surgery, particularly total knee replacement, is recommended for those with severe disease, and can be of great value [4–10]. However, recent reports have emphasized a number of problems associated with knee surgery, including the lack of clear indications [11], variations and inequities in use [12–14], and possible under-utilization [15, 16].

Many other treatments are available for knee OA, including education, behavioural change, physical interventions and drugs. Several management guidelines have been published over the last few years, most of which recommend a sequential approach, using simple measures first, such as education and advice about exercise, footwear and weight reduction, followed by the use of analgesics and physical therapy, reserving non-steroidal anti-inflammatory drugs, intra-articular interventions and surgery for the more severe cases [17–20].

This paper reviews the literature on the effectiveness of total knee replacement surgery (TKR) for OA of the knee, the evidence of practice variation and under-utilization, and the publications on possible indications for TKR. We then discuss some of the determinants of utilization, exploring possible reasons for what could be a major discrepancy in the UK between need and supply of TKR. We confine the discussion to joint replacement surgery, which can be considered the final and only irreversible step in the therapy of OA, as well as the most expensive, rather than trying to review all treatments for knee OA. However, the paper also raises a number of more general issues about health care utilization by older people with musculoskeletal disorders.

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Methods

There are two parts to this investigation.

Part one: a literature survey to investigate the effectiveness, utilization and indications for TKR. A literature review utilizing Ovid Medline, Embase, Science Citation Index, Cochrane Musculoskeletal review group specialized trials database, specialist journals and conference proceedings has been undertaken to create a database of publications from 1990 to the present on interventions for knee OA. Only English language publications were reviewed, and we acknowledge the publication bias that this may cause. This literature review was used to summarize existing evidence on the effectiveness of TKR, and practice variations in utilization.

Part two: the use of consensus techniques in an attempt to delineate the factors most likely to determine the utilization of TKRs for OA. Two consensus panels (with 10 people in each panel) consisting of primary care physicians, epidemiologists, rheumatologists,

physiotherapists, orthopaedic surgeons, psychologists and social scientists from five different European countries (the UK, Sweden, Germany, Italy and France) were assembled and met on four separate occasions, each for a whole day, meeting to examine some of the problems surrounding the use of TKR in the management of knee OA. One panel concentrated on issues relating to patient entry to the medical system that might lead to surgery, the other on surgical decision making. Discussion between panel chairmen after the first two meetings led to the construction of a hypothetical model, which assumes that the pathway to knee replacement involves passage via a medical 'gatekeeper' (commonly the primary care physician) to the surgeon, in which there are three main points at which decisions might be taken, either by the physician or the patient, which will determine subsequent utilization of surgery (Fig. 1).

The panels then sought consensus on the likely determinants of the three decisions identified as the key to utilization of TKR for OA, i.e. (1) the patient's decision to seek help from the medical profession, (2) the decision of a medical 'gatekeeper' (often a primary care physician) to refer the patient to an orthopaedic surgeon, and (3) the decision of the surgeon to carry out a TKR on that patient. This consensus building exercise was facilitated by the literature review on OA of the knee, and by individual panel members accessing relevant literature from sociology and psychology fields, as well as other medical areas, and by discussion amongst the multidisciplinary, multinational panels.

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FIG. 1. The hypothetical pathway to TKR on which the consensus panel based its work.

Results

Part one: the literature review

The effectiveness of TKR for OA of the knee joint. TKR has an established place in the treatment of knee OA. A systematic review carried out in 1990 concluded that knee replacement was a safe and effective intervention, and that >60% of the many such procedures carried out each year were done on patients with a diagnosis of knee OA [21]. Several subsequent studies have confirmed that TKR is largely used for OA [15, 22], and is efficacious, improving quality of life for patients with knee OA, as well as reducing knee pain and improving function [4–10]. Furthermore, as noted, TKR is the recommended treatment for severe disease in all of the published consensus guidelines [17–20].

However, problems are apparent in the existing literature. There are very few published randomized controlled trials (RCTs) of TKR (examples being [23–25]), and no trials that compare TKR with any other intervention. Most studies are observational, and many of them use the survival of the prosthesis as the main or only outcome measure (i.e. how long the prosthesis remains in the patient), rather than any patient-centred outcomes.

We have tabulated the studies in the literature which use some patient outcome (such as pain or disability), along with the two published meta-analyses on the subject (Table 1) [6, 26–33]. The table shows the wide variations in the types of prosthesis and in outcome measures used, making it difficult to come to a clear conclusion. Outcomes appear to vary considerably, but there are no data to help explain this variation (i.e. no guidelines as to which patients do well and which do not). In spite of these problems, it would appear that most patients get a great deal of relief of pain and disability, and we would agree with the overall conclusions of the reviews of Frankel *et al.* [21] and Callahan *et al.* [6] and the recent Patient Outcomes Research Team (PORT) report on knee replacement surgery from the USA [15], all of which conclude that TKR is effective in the treatment of OA of the knee.

Evidence for practice variation in the utilization of TKR. There has been an increase in the utilization of TKR over the last two decades. Recent surveys have also shown that the number of knee replacements is continuing to increase in many countries (whereas rates for hip replacement now seem more stable): the growth rate in North America, for example, was 18.5% per annum between 1985 and 1990 [13, 34].

However, as summarized in Table 2 [12, 13, 15, 16, 21, 22, 34], there are a number of publications that indicate a wide discrepancy in the rates of TKR per head of population in different countries and communities. Of particular concern are the variations in pros-

TABLE 1. Does total knee replacement (TKR) work [6, 26–33]? Studies were only included if they used a patient outcome scale, not only survivorship of prostheses, to measure success of TKR. Studies were identified using a search strategy on Medline (1990 to present). Aggregated data are presented in the first two papers (Callahan *et al.* [6, 26])

Author(s)	Date	Types of operation	Numbers studied	Study design	Outcome measures	Outcome summary
Callahan *et al.* [26]	1995	Uni-compartmental or bi-compartmental knee arthroplasty	46 studies uni-compartmental with 2391 patients and 18 on bi-compartmental with 884 patients	Meta-analysis	Global function and pain score. Survivorship	Uni-compartmental global rating of 80.9 post-operatively complication rate 18.5% and revision rate 9.2% at 4.6 yr. Bi-compartmental knee replacement figures were 78.3, 30 and 7.2%, respectively, with average follow-up of 4.6 yr
Callahan *et al.* [6]	1994	Tri-compartmental arthroplasty	154 cohorts. 9879 patients	Meta-analysis	Global function and pain scores. Survivorship	89% patients had good or excellent results. 86.6 global rating at average 4.1 yr follow-up, up from 43.5 average pre-operatively. Of 26 studies that report pain at follow-up, 75% of patients reported no pain
Dawson *et al.* [27]	1998	Uni-lateral total knee arthroplasty	117 patients	Observational	New questionnaire design compared with SF-36 results	Pain improved from 31.91 to 59.04, and physical activity from 18.51 to 42.6 on SF-36 measure for post-operative compared to pre-operative
Martin *et al.* [28]	1997	Press-fit condylar total knee arthroplasty	290 patients	Observational	Knee Society score. Survivorship	Average follow-up 6.5 yr (range 5–9 yr). Knee Society scoring pre-operative 28, post-operative 88. Functional score pre-operative 49 and post-operative 72. 95% of patients had no pain with walking and were satisfied with the outcome. Complication of 2.9% if older prosthesis excluded
Knight *et al.* [29]	1997	Modular porous-coated anatomic (PCA) total knee arthroplasty	78 knee replacements	Observational	Hospital for Special Surgery (HSS) score and ROM scores	Minimum 5 yr follow-up. HSS scores improved from 51.2 pre-operatively to 89 post-operatively at 1 and 2 yr, and 86 at 5 yr
Rissanen *et al.* [30]	1996	Knee and hip replacement	276 hip patients. 176 knee patients	Observational	Nottingham health profile and 15D health-related quality of life, physical activity and functioning	Patients' quality of life was comparable with general population. 9.7% had worse quality of life on all measurements post-operatively than at baseline
Lubitz *et al.* [31]	1996	Total knee replacement. Conservative medical management	485 medical patients. 291 surgical patients	Observational	Socio-demographic, social support, generic SF-36, and knee specific function questionnaire. In-home physical examination. 100-point rating scale (0 best–100 worst)	Pre-operative patients had more pain (16) than medically managed patients (13), worse function (55 *vs* 45). Post-operative patients had less pain (9 *vs* 12) and better function (34 *vs* 43) than medically managed patients at 6 month follow-up
Kirwan *et al.* [32]	1994	Knee and hip replacement	335 operations on knee and hip. 76 knee replacements for OA	Observational	Pain (visual analogue scale) and disability (Health Assessment Questionnaire)	48% pain reduction for patients with knee OA. 95% of patients showed improvement
Larsson *et al.* [33]	1988	Uni-compartmental arthroplasty	102 knees	Observational	Hospital for Special Surgery (HSS) score. Survivorship	77 average HSS score post-operative at 8.1 yr average follow-up compared with a score of 43 pre-operatively

theses being used [14] and the wide discrepancies in rates of use in different areas of a single country [13]. There is also worrying evidence for inequities from the data of Katz *et al.* [34] which suggests that age, gender and race affect use in the USA. There is other evidence to suggest that older people and those who are over-weight are often denied the operation [15].

It is extremely difficult to extract comparative rates of usage in different countries from these data, as they are not presented in comparable age/sex-matched ways. However, rough estimates of usage per 1000 in those over the age of 65 yr indicate rates of around 0.5–0.7 in the UK and Canada, but rates of >2 in the USA [12, 13, 21, 22]. Data from industrial market research also suggest that rates are generally higher in the USA than in most other countries (personal communication, Johnson and Johnson). European market data also indicate that there are great discrepancies in different countries within Europe, with roughly similar rates of use per head of population in France, The Netherlands, Germany, Scandinavia, Switzerland and the UK, but lower rates in Ireland, Italy and Spain, for example, as well as very much lower rates in Turkey, Poland and Slovenia (personal communication from Johnson and Johnson).

Indications and needs for TKR in OA of the knee. There are no evidence-based indications for TKR in knee OA. Three recent publications have presented data from different consensus-style approaches to the problem [35–37]. Manusco *et al.* [35] carried out a postal survey of orthopaedic surgeons. They reported no clear consensus, but most agreement was achieved on severe daily pain, with attendant X-ray evidence of loss of joint space, as the key indications for TKR. A high patient motivation was also cited as a common reason for going ahead with surgery, whereas co-morbidities and technical difficulties were reasons for not doing an operation. Naylor and Williams [36] carried out a Delphi consensus technique using 120 scenarios, in order to try and gain agreement on priorities for hip and knee

TABLE 2. Variation in usage of total knee replacement [12, 13, 14, 16, 21, 22, 34]. Studies were included if they provided information on longitudinal, geographical or demographic variation in rates of TKR rates. Studies were identified using a search strategy on Medline (1990 to present)

Author(s)	Date	Type of operation	Study statistics	Study design	Outcome measures	Outcome summary
Coyte *et al.* [13]	1997	Knee arthroplasty	18 530 knee replacements in Ontario between 1984 and 1991	Epidemiological	Variation in distribution of TKR in Ontario, Canada	Variation in rates of TKR between counties diminished between 1984 and 1991 from very high to moderate variance (ratio of high to low counties change from 8.1 to 3.4 over period). Growth in TKR of >15% per year between 1984 and 1990, from 2.09/10 000 to 4.90/10 000
Phillips *et al.* [14]	1996	Total knee arthroplasty	1162 questionnaires (721 replies)	Survey	Surgeons' TKR preferences in the UK	34 677 TKRs being performed in the UK per year (34.3 per surgeon). 41 different prostheses used (5 accounted for 61% of total). 95.2% of surgeons used cemented prostheses. 98% of surgeons used metal back tibial prostheses. 32% always resurfaced the patella, while 19% never resurfaced
Katz *et al.* [34]	1995	Total knee arthroplasty	414 079 hospitalizations from Medicare records	Epidemiological	Demographic profile of TKR in the USA	Receiving a TKR is a function of gender, age and race. Women twice as likely to receive a TKR. Whites 1.5 times as likely as blacks to receive a TKR
Tennant *et al.* [16]	1995	Total knee arthroplasty	18 827 questionnaires with an 86% response rate. 1277 questionnaires specifically about knee pain targeted at subgroup	Survey	Lequesne survey, SF-36 and Stanford Health Assessment questionnaires. Demographic profile of TKR in the UK	20.4/1000 judged to have pain and disability consisent with need for arthroplasty in over-55 population (35/1000 for >75 yr, and 12.9/1000 for 55–64). Extreme cases (those classified as needing immediate surgery) 10.7 *vs* 1.1/1000 for the respective age groups, with overall result of 16.4/1000
Knutson *et al.* [22]	1994	Knee arthroplasty	30 003 knees	Register	Demographic data and survivorship	Rate of 160/100 000 for the 60–69 age group and 325/100 000 for the 70–79 age group
Peterson *et al.* [12]	1992	Knee and hip arthroplasty	56 204 hip and 68 491 knee arthroplasties conducted across the USA	Geographical	Age-adjusted rates of TKR in the USA	Wide variation in utilization. No relationship between number of surgeons and rates of TKR, slight correlation with population density and rates of TKR. 89% of knee replacements were for people with osteoarthritis. Variation from 0.219/100 in New Jersey to 0.977/100 in Utah
Frankel *et al.* [21]	1990	Knee and hip replacement	TKR rates from 1980–1988/89 based on HIPPE and HES data	Epidemiological	Variations and change in rates of TKR by regional health authority in the UK	Regional variations in rates of TKR in the UK between 13/100 000 (NW Thames) and 25/100 000 (South Western). Increase in overall rate of TKR from 39 to 68/100 000 between 1980 and 1988 for the 65–74 age group

replacement surgery. From this they developed algorithms, in which pain at rest, severity of functional impairment, problems with care-giving and the perceived likely improvement in function were the key determinants used to prioritize surgery. Hardron and Holmes [37] also used a Delphi consensus technique to try to derive surgical priorities. They presented a scoring system, based on the severity of pain, functional problems, joint damage, and effects on care or care-giving, with a maximum possible score of 100, as an aid to surgical decision making. This approach is summarized in Table 3.

Each of these papers is based on consensus from health care professionals, particularly orthopaedic surgeons. There is no published work on the perspectives of patients as to what factors might be prioritized.

Two publications have suggested that TKR is an under-utilized procedure, and that there is a large unmet need. Tennant *et al.* [16] came to this conclusion on the basis of an epidemiological survey which suggested that there was a high prevalence of people with severe knee disease who were not getting any medical intervention. Based on cohort studies and modelling, the recently published US PORT study also concludes that TKR is under-utilized [15].

TABLE 3. Summary of the New Zealand priority criteria for major joint replacement (Hardorn and Holmes [37])

Patients are scored from 0 to 100 on a scale that describes different levels of severity in four domains: pain, function, joint damage and other factors	
Pain (40%)	Pain severity scored 0–20
	Pain duration scored 0–20
Function (20%)	Walking difficulty 0–10
	Other functional impairment 0–10
Joint damage (20%)	Pain on active/passive motion 0–10
	Other abnormalities including loss of movement and radiographic change 0–10
Other factors (20%)	Other joints affected 0–10
	Ability to work, act as a care giver and live independently 0–10

Without clarity of indication, or any clear understanding of which patients benefit most from the procedure, or any evidence that compares TKR with other interventions, it is impossible to calculate the health care needs

for TKR within any given population. It is clear that more research is needed in these areas.

Part two: consensus work

Why do people with knee disease seek help? The first question considered was why some people with knee OA choose to seek medical help, while others do not, there being epidemiological data to suggest that many people with the condition never seek help from conventional medical practitioners [3, 12].

Knee OA predominantly affects older people, usually presenting in the fifth or sixth decade. The most important symptom of knee OA is pain, particularly use-related pain [38, 39], and the vast majority of people who come for treatment present with this symptom. The question to be answered, therefore, becomes why is it that some older adults with knee pain choose to seek help from the medical profession, whereas others do not? In seeking to find answers for this question, the panels found literature from health psychology and sociology most helpful.

A person has to take several decisions regarding health care utilization in the presence of a symptom [40]. These decisions are determined by characteristics and beliefs of the person, by his or her emotional state, and by the social and cultural environment in which they live. The result may be to seek treatment, to delay treatment or to reject professional care [41].

Recognition of a symptom has been shown to depend on personality characteristics. People vary according to whether they deal with a threat by monitoring the environment for threat-relevant information ('monitors'), or by ignoring it ('blunters'). Monitors are more likely to seek professional help than blunters [42]. Such psychological differences among people therefore influence their experience of symptoms. People who focus on themselves are more likely to notice symptoms than people who are more externally focused on their environment and their activities [43]. Disruptive symptoms that interfere with daily activities are more likely to trigger action [44]. This is especially true in the presence of social sanctioning, as when an employer applies pressure on the symptomatic individual or when benefits are no longer granted [45]. In contrast, when people attribute their symptoms to aging, they are more likely to see their problems as uncontrollable and they are less likely to seek medical attention—which may be a major issue in knee OA, in view of a general belief that it is 'part of aging' [46, 47]. On the other hand, if a condition causes pain (as knee OA usually does), it will be interpreted as more likely to require treatment [48, 49].

In a social–psychological model which became very influential in the promotion of health utilization, health beliefs were of crucial importance. According to this model, whether or not a person seeks treatment for a perceived symptom can be predicted from two factors: the extent to which the person perceives a threat to his or her health and the degree to which he or she believes that a particular health measure will be effective in reducing the threat at tolerable cost [48, 50].

Mood also influences self-appraised health [51]. When people are in a positive mood, they report fewer symptoms. Negative affectivity, on the other hand, predisposes people to experience symptoms and may lead them to seek medical help [52]. This is especially true if a personal crisis contributes to an exacerbation of the condition [45]. Social support is another variable that determines health care utilization. Isolated persons in a community are less likely to use health services than are people who are well integrated, as the lay referral system is crucially important [53]: before people decide to seek medical attention for their symptoms, they typically get advice from friends, relatives or co-workers [54]. Health beliefs shared by a social group heavily impact on decision making; in the panels' view, this is likely to be a major factor in the utilization of TKRs, as in members' experience, negative attitudes are probably still highly prevalent in society. Culture and ethnic origin can also affect health beliefs [55, 56].

Finally, a symptom's meaning will also be influenced by how common it is within a person's culture or range of acquaintance [57]. Specifically, highly prevalent disorders (like knee pain and locomotor disability) are generally regarded as less serious than more rare or distinctive disorders [58]. Problems such as knee pain in the elderly may be ignored because they are thought of as normal (take, for example, the use of the symbol of a bent person with a walking stick as a sign for the elderly).

There are little direct data in the literature on the reasons behind people with knee pain being help seekers, but knee pain is practically a part of everyday experience, and may be considered as not being symptomatic of any disease [59]. In addition, one behavioural analysis suggested that people with knee pain who do not seek help may have developed coping strategies and that they do not 'catastrophize' their pain and disability in the same way as those who do seek medical input [60]. In contrast, common sense and clinical experience tell us that knee OA often causes severe pain and disability, and that the severity of the condition, or extent of the handicap, will often dictate help-seeking behaviour.

A common model used to describe the determinants of help-seeking behaviour that we have discussed split these characteristics into predisposing, enabling and need-related factors (Table 4; [49, 61]). Further exploration of the factors and barriers listed is warranted. If valid, this model suggests that further efforts to educate the public and primary care physicians about knee pain, knee OA and the relative value of different interventions, such as knee replacement, is vital if all those likely to attain benefit from a TKR are to have this opportunity.

What factors determine whether people are referred to orthopaedic surgeons? The second question to be considered by the panels concerned the determinants of referral by a primary care physician or other medical 'gatekeeper' to an orthopaedic surgeon. In approaching this question, the panels were helped by the medical literature on referral as well as their discussions and experience.

TABLE 4. (a) Factors likely to affect whether people with knee pain do or do not seek medical help (from Pescosolido [41])

Predisposing:	Demographic factors including social class and ethnicity
	General health beliefs, including lay referral networks
	Social structures
Enabling:	Personal/family beliefs and expectations
	Community/ease of access/relationship with gatekeeper
Need:	Perceived, including functional status and co-morbidity (evaluated)

(b) Possible barriers to consultations with a medical 'gatekeeper'

The high prevalence of negative attitudes to OA and TKR
Belief that joint pain is a part of the normal ageing process
Resignation to pain and disability
Fear of painful examination and investigations
Previous unsatisfactory experiences with the medical profession
Previous bad experiences of relatives or friends
Message that 'nothing can be done' from the medical profession
Plausible options offered by alternative practitioners

The availability of quite different models of health care in different countries and societies obviously affects the question. For example, in some societies self-referral to surgeons is common, whereas in others most if not all access to surgery will be via referral from a primary care physician. The two systems may exist side-by-side, in which case economic factors often dictate the extent of usage of self-referral, as in the UK system, where self-referral is practically synonymous with private medical care and used mostly by those of higher socio-economic status. Self-referral for a surgical opinion (when possible) is likely to depend on similar factors to those outlined in the previous section, with the important additional factor being the perception of the patient and those around him/her of how appropriate it is to undergo surgery for knee disease, and the chances of success. Patient perceptions of this sort are often dictated by contact with someone who has had such an operation performed, and in the UK it seems that many people still regard knee replacement as being more experimental and less likely to be successful than hip replacement [12]. It clearly takes time for the 'testimony' of people currently pleased with the results of a TKR to work through and to outweigh the damaging effect on patient perceptions of those who were dissatisfied following earlier, less successful operations for knee disease. The surgical literature shows clearly that results of TKR operations in Europe have improved with time [22], but there may be a long lag period before the better outcomes become accepted by primary care physicians and the general public.

In most systems, the majority of people will only have access to surgery if referred to a surgeon by a primary care physician or equivalent 'gatekeeper'. In general, referral rates vary greatly among general practitioners [62], but relatively little is known about the determinants of an individual's referral patterns [63]. Special knowledge and experience about a given condition probably increases referral rates [64].

In the specific instance of knee pain, it is likely that the main factors include the gatekeeper's perception of the severity of the problem, and his or her attitudes about the outcome of both non-surgical management and surgery. The severity of knee disease can be divided into three components: pain, disability/handicap, and the extent of local joint damage. Although each of these components can be assessed clinically and with the use of self-assessment tools or radiographs (as outlined below), such instruments are rarely used in primary care, and it is likely that the severity of the condition is often underestimated in comparison with the assessment of patients or specialist doctors, as has been shown to be the case in other conditions [65]. It was the view of both consensus panels that many primary care physicians probably lack confidence in the examination of the knee joint, and that this may contribute to delays in diagnosis as well as inability to assess the severity of joint damage. Some of the specialists on the panels believe that this is due in part to the fact that the majority of those currently in general practice had little or no exposure to modern rheumatology and orthopaedics in their undergraduate and postgraduate training. As noted above, it also seems likely that some primary care physicians retain a somewhat negative attitude to the treatment of OA in older people, and some probably regard knee replacement as a risky procedure with a high failure rate, due to the slow rate of uptake of new procedures and new information within medical practice. However, these are areas in which there are very little data available, and further research on the factors which determine primary care referral for TKRs is warranted in health care systems such as that in the UK, where this is an important rate-limiting step.

Data from a comparison of the therapeutic approaches of German and Turkish physicians to OA of the knee show that orthopaedic-based rheumatologists were more likely to consider surgery than other specialists from either country, suggesting that familiarity with the procedure and its outcome can increase utilization [66]. However, a comparison of primary care physicians and rheumatologists in the USA indicated that the former were slightly more likely to refer a hypothetical case of hip OA for surgery, and it was concluded that the rheumatologists referred less because of their greater familiarity with non-invasive therapy [67]. The absence of clear guidelines as to the indications for TKR in knee OA may explain some of the wide variations in referral rates that have been observed, an hypothesis which could be tested. Finally, both the costs of the procedure, and waiting lists, may inhibit referral from primary care physicians who are concerned about budgets—there being no current framework to help budget holders decide how to allocate between alternative expensive procedures.

Some of the factors thought most likely to affect referral from a 'gatekeeper' to the surgeon are listed in

Table 5. They emphasize the need for education and the provision and testing of simple guides to diagnosis, assessment and therapy for primary care physicians.

Why do orthopaedic surgeons choose to do a TKR? The final question considered by the panels concerned the decision that has to be taken by a surgeon that an individual is suitable for knee replacement surgery. This issue was informed both by the literature obtained in the literature review, and the experience and opinions of the eight orthopaedic surgeons on the panels.

Epidemiological data indicate that only a proportion of those who go to surgeons for consideration of a TKR for knee OA have the operation done [3, 21]. Alternative pathways include conservative therapy or other operative interventions such as osteotomy or arthroscopic wash-out and debridement.

Based on the published findings of a postal survey of surgeons, indicating some of the main reasons for joint replacement being considered or rejected [35], the consensus panel found it useful to consider three sets of variables as being of potential importance in surgical decision making: the severity of the damage to the knee joint; other patient-related variables such as motivation, age, obesity and co-morbidity; and environmental factors, such as socio-economic status.

(1) Severity of joint damage. Knee joint damage can be assessed in three main ways: in terms of pain severity, the degree of functional impairment, or by radiographic (or other imaging) methods that determine the degree of structural anomaly. Consensus management guidelines, in which surgeons have been involved, suggest that pain severity, functional impairment and the presence of night pain are key factors in deciding on surgery [35–37], it being said, for example, that joint replacement should be considered for patients who 'Can't sleep, can't work or can't walk' [20]. However, observers have suggested that the severity of radiographic change may play a large role in surgical decision making. Although there are well-developed systems for the assessment of radiographic severity [68, 69], there are no agreed guidelines on which system should be used, or what degree of radiographic change warrants surgery. The discrepancy between the severity of radiographic changes and symptoms [70, 71] is part of the problem, and recent attempts, using Delphi technique-derived consensus, to construct scores on which to base priority for operation, have tended to stress pain in particular, with functional disability and severity of structural change being given less weight [36, 37].

(2) Other patient-related variables. Recent research has stressed the importance of other parameters that lead to disability and handicap in people with OA [38, 39, 72, 73]. These include psychosocial factors, such as depression, body image, socio-economic factors, sexual activity and isolation. A variety of instruments have been derived both for the general assessment of disability, handicap and quality of life [74], and more specifically for the measurement of severity and change of knee OA, of which the Lequesne index and WOMAC are recommended for knee OA [75–78]. In addition, several different orthopaedic instruments are used in the pre-operative and post-operative assessment of knee OA [79, 80], but there is no consensus on which of these disease-specific and general measures are most appropriate. Furthermore, it is apparent that current measures of disability or 'quality of life' may be poor at identifying aspects of a disease of most importance to the individual patient [81, 82]. Instruments that measure patient-related outcomes are still in their infancy [82] and have yet to be used to help us understand patient's needs for TKRs.

There is also evidence that age, ethnicity and obesity affect surgical decision making [83, 84]. In general, patients below the age of 60 are less likely to be considered for a TKR, and those who are obese are often told that they must lose weight before surgery, although there is no evidence that obesity results in a worse outcome [85]. The North American PORT study indicated that white people were more likely to be considered for TKR than blacks, although there was no obvious reason for this [86], and the possibility that there may be similar inequalities of provision in Europe is cause for concern, and another area in need of further research.

Motivation is cited as an important factor by surgeons [35], who emphasize the apparent motivation of the patient to get back to work, or to benefit from the improvement that surgery offers, as a major factor affecting their own decision making. However, there is no evidence that any formal attempt has been made to measure or assess such factors.

Co-morbidity is another major issue. Knee OA affects older people and is strongly associated with obesity [87], and therefore with other disorders related to weight, including cardiovascular disease and diabetes. Severe vascular insufficiency to the affected leg, as well as general cardiac or other problems, may make surgery hazardous or out of the question.

(3) The environment. The environment, particularly socio-economic status, will also be an important determinant of surgery. The availability of surgeons and physicians in the community has been suggested as one of the key factors determining different usage rates in Canada [13], and the economic status of the patient will be of vital importance in countries in which people have to pay for a TKR. Knee OA is a major worldwide

TABLE 5. Factors likely to determine whether people with knee OA do or do not get referred from the gatekeeper to an orthopaedic surgeon for consideration for TKR

Gatekeeper's ability to make correct diagnosis early
Experience, interests and seniority of the gatekeeper
Severity of the problem
Ability of the gatekeeper to assess severity
Attitude of the gatekeeper towards orthopaedic surgery and TKR
Relationship of gatekeeper to local surgeons
Access to surgery
Access to alternatives including physical therapy
Presence or absence of referral guidelines
Costs

problem [88], common in Third World countries in which there may be little or no provision for TKRs.

Guidelines for surgical intervention are sparse. The Swedish Board for Health and Welfare, working with expert groups, has published state-of-the-art reports, clinical guidelines and patient information on knee and hip replacements, available on the World Wide Web and on CD-ROM [89]. The New Zealand priority programme has suggested criteria for both hip and knee replacement [37]. The recently published Ontario criteria provide the most comprehensive attempt to derive indications for TKR, using data based on a Delphi consensus process involving a variety of health care workers (but not patients) [36]. The derived criteria have been put into an algorithm in which pain severity, problems with work or care giving and functional class are the main factors dictating decision making, with age and the degree and type of joint damage providing indicators for osteotomy *vs* TKR. However, this important contribution is limited to one health care system, and does not take socio-economic, psychosocial or quality of life measures into account. Also, it has not yet been tested to see whether it is of value in practice to surgeons.

A further source of problems in TKR surgery is the existence of many different forms of prosthesis [14], and variations according to surgical volume [90]. This should be a major cause for concern, there being no apparent way of controlling the appearance of new designs and different prostheses, each of which makes it increasingly difficult to sort out the genuine cost effectiveness of TKRs in general. In view of the fact that the measures used to assess severity and outcome are not standardized either, it is very difficult to compare different procedures, or to measure the relative benefits of TKR in comparison with other interventions.

Conclusions and recommendations

Osteoarthritis of the knee is a common cause of severe pain and disability. Many interventions are available to reduce pain and disability. This article is only concerned with the one irreversible intervention, generally regarded as being reserved for those with most severe disease who have failed to respond to other interventions, namely TKR. The available literature, most of which comes from observational studies rather than RCTs, suggests that TKR is a valuable intervention in the treatment of knee OA, resulting in major improvements in pain, function and quality of life measures, for many patients. However, there are no evidence-based indications, no comparisons with other forms of therapy, and no understanding of which patients are particularly likely to benefit from the procedure. There is evidence of wide variations in utilization, in spite of the fact that the prevalence of severe knee OA is unlikely to be very different in the areas studied [2]. This suggests that in some areas TKR is either over-used or under-utilized. There is some indirect evidence to suggest that under-utilization may be a major problem in many countries in Europe, including the UK, where TKR rates per head of population are considerably lower than those in the USA.

Using a combination of literature review and consensus discussions, we have attempted to uncover some of the factors that might determine utilization of TKR in different health care systems, with a view to defining the main barriers to usage and the main priority areas for further research and development.

We have identified a number of gaps in the literature and in the understanding of the problem in health care professionals, which could be an important agenda for continuing medical education.

Specifically, we have identified four potential problems.

1. Persistent negative attitudes towards OA in general, and towards the value of knee replacements in particular, amongst the public and primary health care workers.
2. The lack of simple tools to help assess the severity and impact of knee OA that can be used in the community.
3. The absence of any clear guidelines or agreed, evidence-based indications for TKR.
4. The absence of any studies that compare the efficacy of TKR with that of non-surgical intervention strategies.

We would recommend, therefore, that the following research projects should be considered.

1. An educational programme for patients and health care workers on OA and the benefits of management, including surgical interventions. Information targeted to the public and their doctors about the availability and effectiveness of strategies for the treatment of knee OA (both surgical and non-surgical) might increase uptake considerably.
2. Such an educational programme should be combined with further research into barriers to referral, and into the impact of such programmes on changes in practice.
3. The development and assessment of simple, user-friendly ways of helping primary care physicians and others make a rapid assessment of the severity and impact of knee OA.
4. The development and assessment of guidelines for primary care physicians as to which patients with knee disease should be considered for referral to orthopaedic surgery.
5. Further research into the most effective and efficient indications, which surgeons could use in determining which of their patients would be most likely to benefit from a TKR.
6. Standardization of the measures used to assess pain, functional impairment, joint damage and other aspects of disease impact before and after TKR, so that intervention studies can be compared.
7. Major pragmatic trials comparing surgical intervention with conservative therapy.

Finally, it would seem appropriate that the data reviewed in this report be included in continuing medical education programmes for primary care physicians, rheumatologists and orthopaedic surgeons.

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