Using Resource Use Logs to Reduce the Amount of Missing Data in Economic Evaluations Alongside Trials

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ABSTRACT

Objectives: Economic evaluations alongside randomized controlled trials that collect data using patient-completed questionnaires are prone to missing data. Our objective was to determine whether giving patients a resource use log (RUL) at baseline would improve the odds of completing questions in a follow-up resource use questionnaire (RUQ) and to identify patients’ views on RUL’s usefulness and acceptability. Methods: The RUL study was a randomized controlled trial and qualitative study nested within a larger randomized controlled trial (the Arthroplasty Pain Experience Study trial). Eighty-five patients were randomized at baseline to receive or not receive an RUL. At 3-month follow-up, all participants received a postal RUQ. We created dummy variables for 13 resource use categories indicating whether complete information had been given for each category. We compared the completion rates between arms by using descriptive statistics and logistic regression. We explored patients’ experience of using the RUL by interviewing a different subsample of Arthroplasty Pain Experience Study patients (n = 24) at 2- to 4-week follow-up. Results: At 3 months, 74 of the 85 (87% in each arm) patients returned the RUQ. Patients in the RUL arm were 3.5 times more likely to complete the National Health Service community-based services category (P = 0.08). The RUL was positively received by patients and was generally seen as a useful memory aid. Conclusions: The RUL is a useful and acceptable tool in reducing the amount of missing data for some types of resource use. Keywords: data collection, economic evaluation, missing data, patient-reported outcome measures, questionnaire, randomized controlled trial, resource use, resource use log.

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Introduction

Economic evaluations conducted alongside randomized controlled trials (RCTs) are often susceptible to missing data. In an economic evaluation, total patient cost is the sum of the cost of individual resource use items; hence, if one item of resource use is missing, the total cost for the patient will also be missing. This is compounded by the possibility of missing health outcome data. There are statistical methods available to deal with missing data such as simple and multiple imputation and regression approaches [1–5], but the skewed nature of cost distributions [6] may impose additional computational problems for health economists [7]. Improving data collection methods could lead to more complete sets of data for analyses [8], which would improve the power of the evaluation and decrease the risk of biased results.

Resources can be collected in a number of ways and the greater the complexity of a trial, the greater the number of data collection methods that are used [9]. When the perspective of the study is limited to the health care payer, then medical or administrative records could potentially provide a solution to

The data used for this research are property of the North Bristol NHS Trust, sponsors of the Arthroplasty Pain Experience Study (APEX) trial, currently taking place at Southmead Hospital, Bristol, UK, and are not available for reproduction at this time. The resource use log and questionnaire that this article refers to are available online at the Data Instruments for Resource Use Measurement (DIRUM) database and freely downloadable from http://www.dirum.org/instruments/details/54 and http://www.dirum.org/instruments/details/55, respectively. Ethics: The study was approved by Southampton and South West Hampshire Research Ethics Committee (B) (09/H0504/94), and all participants provided informed, written consent, in line with the Helsinki Declaration of 1975, as revised in 1983. The trial has been registered with the EUdraCT (2009-013817-93) and Current Controlled Trials (ISRCTN96095682). The trial is also registered as a Clinical Trial of an Investigational Medicinal Produce with the Medicine Healthcare and Regulatory Authority (18524/0215/001-0001).

Conflicts of interest: All authors have no financial or personal relationships between themselves and others that could bias the work. All authors declare no conflicts of interest.

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collect patient health resources. This is more likely to be the case in a private or an insurance-based system in which data might be more accessible and more readily available in an electronic format than in publicly funded health care systems. When it is too burdensome to collect resource use from records because of limited accessibility and/or electronic format, or a broader perspective is taken for the economic analysis, requiring the collection of resource use data beyond that of the health care payer, then trials often need to rely on patient-reported information.

Patient-reported information can be collected through interviews, diaries, or patient-completed questionnaires [10]. Patient-completed resource use questionnaires (RUQs) are cheap and easy to administer [11], thereby a frequently used data collection method in trials [12]. They are, however, subject to recall bias and prone to missing data [13,14]. Interviews either face to face or by telephone are less susceptible to missing data [15]. On the other hand, they are more expensive to administer and subject to self-report and interviewer bias [16,17]. Diaries overcome the issue of recall bias and are generally considered more accurate [18], yet there are concerns over patient burden, which leads to incomplete data [19].

A resource use log (RUL) is in essence a diary that is given to patients at baseline for them to prospectively record resources used. Unlike a diary, data in the RUL are neither collected nor used for analysis. It is designed as a memory aid, to assist patients in the completion of an RUQ at follow-up. The use of RULs is not common and is rarely reported. In one methodological study, however, Cooper et al. [20] described the creation of an RUQ and used RULs to aid participants in their completion of a subsequent RUQ. Patients found the RUL useful as a memory aid.

We conducted a nested RCT within a larger RCT (the Arthroplasty Pain Experience Study [APEX] trial) to test whether giving patients an RUL at the start of the follow-up period to prospectively record resource use would decrease the amount of missing data in a patient-completed RUQ administered at 3-month follow-up. We then conducted a qualitative study on a different subsample of APEX patients, to explore participants’ experiences of using the RUL, including views on their acceptability and usefulness in assisting the completion of RUQs. This would identify whether any increase in completion rates of the RUQ was not at the expense of additional patient burden.

**Methods**

**Setting**

The RUL study included a RCT and a qualitative study embedded within the APEX trial that is taking place at Southmead Hospital, North Bristol National Health Service (NHS) Trust, Bristol, UK (ISCTRIN 96095684). The aim of the APEX trial is to determine whether using local wound infiltration in addition to the standard anesthetic regimen significantly reduces joint pain at 1 year after total hip replacement (THR) and total knee replacement (TKR) [21]. The APEX trial included a pilot stage to assess patients’ acceptance of the trial and pilot data collection methods. The RUL RCT was nested within this pilot stage. Patients were preoperatively randomized to receive standard analgesia or intervention analgesia as per the APEX protocol [21], and then subsequently randomized to receive or not receive the RUL. The qualitative study was embedded within the main APEX trial and aimed to explore patients’ experiences of surgery and post-operative recovery. It involved in-depth interviews with patients 2 to 4 weeks postsurgery. As part of these interviews, patients were asked to describe their experience of the RUL. Ethical approval for the APEX trial, which included the nested RUL RCT and qualitative study, was obtained from the Southampton and South West Hampshire Research Ethics Committee (B) (09/H0504/94).

**Patient Recruitment Into the RUL Study: Trial and Qualitative Study**

The RUL trial took place between November 20, 2009, and April 1, 2010. Randomization was stratified by type of joint replacement and allocated arm in the APEX trial and performed on the remote randomization system of the Bristol Randomised Trials Collaboration.

At hospital discharge, a research nurse completed a discharge questionnaire for all patients and explained that at 3-month follow-up they would receive a postal questionnaire in which they would be asked to complete questions about their pain, function, and quality of life, as well as health services use and expenses incurred in relation to their joint replacement. The research nurse was encouraged to discuss the contents of the forms, including the resource use questions, with patients in both arms, to promote uptake and response rates for the APEX trial. For patients randomized into the RUL arm, the research nurse gave the patient an RUL, described how to use it, and explained that it was designed to help patients remember resource use and expenses, as an aid to the completion of the 3-month follow-up questionnaire. At 3 months, we administered the patient-completed follow-up postal questionnaire, which included the RUQ. The last 3-month questionnaire was administered on August 1, 2010, and received on September 15, 2010. After the pilot phase, all patients in the main APEX trial received an RUL at hospital discharge.

All participants in the main APEX trial were asked whether they were willing to be contacted about taking part in a qualitative interview. Of those who indicated that they were willing to be contacted, a purposive sample was drawn. The sample included men and women, a range of ages, and a balance of hip and knee replacement surgical procedures. Twenty-four participants were interviewed, at which point recruitment was stopped because saturation had been reached, with no new insights being achieved [22]. The qualitative study only included participants taking part in the APEX trial after the RUL RCT was completed. This meant that all participants in the qualitative study had received an RUL, which enabled the qualitative study to explore views about the acceptability and use of the RUL.

**Design of the RUL and RUQ**

The RUL [23] was designed to replicate the content and order of the 3-month follow-up RUQ [24]. Both instruments are available online on the Data Instruments for Resource Use Measurement database [25]. In the RUL, patients could prospectively record their use of health services and expenses by using tick boxes and open questions for the 3 months from hospital discharge.

The RUQ included 13 resource use categories and asked patients about UK NHS services; patient expenses (e.g., travel and medication costs); use of social services (e.g., home care worker); and other costs such as informal care time and time off work to enable a societal perspective to be taken for the economic evaluation. Each category included several questions, the first being a filter yes/no question of whether that category of resource was used. Resources used by the patient from the intervention hospital were not collected, as these were obtained from the patient’s medical records.

**Analysis for the RUL Trial**

We categorized patients’ baseline characteristics (sex, marital status, living situation, ethnicity, education, and working status) into 10 groups and described them in addition to age for both arms of the RUL trial. We compared the return rate of the 3-month follow-up questionnaire between trial arms by using a chi-square test.
For each resource use category within the RUQ, we created dummy variables to indicate whether the information given would allow for costing of the resource. We then estimated the completion rate of each resource use category in the RUQ per trial arm. We fitted a logistic regression model to estimate the probability of having complete data per category when patients are given an RUL. The logistic regressions controlled for the stratification variables in the randomization process: type of joint replacement and APEX trial allocation arm. We used White’s robust standard errors [26] to account for heteroskedasticity and exponentiated coefficients to reflect odds ratios. All analyses were performed on version 11 of the STATA statistical package [27].

Analysis for the RUL Qualitative Study

The in-depth qualitative interviews, lasting 45 to 120 minutes each, took place in participants’ own homes 2 to 4 weeks after surgery. Participants provided their written informed consent to take part immediately before interview. Interview questions were informed by a topic guide and elicited experiences of surgery and postoperative recovery, changing experience of pain and pain relief, experience of trial participation, and the RUL. All interviews were audio-recorded with participants’ consent. Data presented here focus on patients’ experience of recording their resource use in the RUL as part of the trial.

Analysis was ongoing and iterative. It informed further data collection: for instance, refining the interview topic guide and identifying questions to include in future interviews. We imported the anonymized transcripts of audio recordings into the software package Atlas ti [28] and coded the data relating to the RUL. We then grouped the coded data into categories and developed a descriptive account of the data [29].

Results

The RUL Trial Results

Eighty-five of the 86 patients randomized into the RUL trial had joint replacement surgery and one had the surgery cancelled for reasons unrelated to the APEX trial. Forty-six of the 85 (54%) patients were randomized into the RUL arm (Fig. 1). Forty of 46 (87%) in the RUL arm and 34 of 39 (87%) in the non-RUL arm returned the APEX 3-month follow-up questionnaire. Thirty-one of the 85 patients (36%) were men, 69 of the 85 (81%) were not working, 31 of the 85 (36%) had a TKR, and 43 of the 85 (51%) were in the control arm of the APEX pilot study (Table 1). Mean patients’ age was $67.3 \pm 9.4$ years in the RUL arm and $69.6 \pm 12.4$ years in the non-RUL arm.

There were negligible differences in completion rates between the two arms of the trial for most resource use categories (Table 2), with only three categories (i.e., “NHS community-based services,” “changes to home and special equipment,” and “informal carers’ time helping participant”) with more than five percentage points difference in completion rates between arms. For these three categories, patients in the RUL arm had higher completion rates than did those in the non-RUL arm. This difference was greatest for the NHS community-based service category (78% vs. 67%). These three categories with the highest variability between arms in terms of completion rates also ranked in the bottom five of the poorest completed categories.

We conducted the logistic regression analyses conditional on patients having returned the RUQ (Table 3, n = 74), assuming nonreturners to be missing at random, as there were no differences in return rates between trial arms (chi-square test, $P = 0.976$) and no reason to suspect nonresponse bias. Five categories did not allow for regression analysis: “NHS inpatient admissions,” “home care worker,” and “contacts with social worker” categories had fully complete data in both arms; “NHS outpatient visits” and “over-the-counter medication” categories had very few incomplete cases and no variation between arms for some covariates. There was little or no statistical evidence to support a positive effect of the RUL for most categories. However, patients in the RUL arm were 3.5 times more likely to complete the NHS community-based services ($P = 0.086$) category than were patients without an RUL.

The RUL Qualitative Results

Twenty-four participants took part in interviews. All participants in the qualitative study had received an RUL at hospital discharge.
as an aim of the study was to explore views about the RUL. There were 11 men and 13 women, 14 had THR surgery and 10 had TKR surgery. The age range was 26 to 92 years (mean age 65 years), and five reported that they had undergone previous THR or TKR surgery. Four of the interviews were conducted as pilot interviews to refine the topic guide and did not contain direct questions about the RUL but sought more general views about trial participation and experiences. After the pilot interviews, it was clear that information specifically about the RUL did not spontaneously emerge, and targeted questions would be needed to collect specific information about the RUL. Therefore, the topic guide was modified to include direct questions about the RUL and

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<th>Table 1 – Patient characteristics by trial arm (n = 85).</th>
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<tr>
<td>Number of patients</td>
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<td>Females</td>
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<td>Higher education</td>
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<td>Hip replacement</td>
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<tr>
<td>Intervention arm of APEX study</td>
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<td>APEX, Arthroplasty Pain Experience Study; RUL, resource use log.</td>
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as the data presented here are from 20 participants once pilot interviews were completed. Three categories were identified in the data: degree of familiarity with the RUL, perceived value of the RUL, and perceived limitations of the RUL (see Table 4). These are presented in turn.

Degree of familiarity with the RUL
Of the 20 participants who were asked about their use of the RUL in prospectively recording resource use, 10 had already started to use the log. Eight of the 20 participants were aware that they had received the RUL but had not yet started to fill it in. This was usually because they felt that they had not yet accessed services that would require use of the RUL and they said that they would start to use the RUL when they did so. It was apparent, however, that some of these eight had not started to use the RUL in spite of already having accessed services that could be recorded in it. For most this was because they did not think their service access relevant: for instance, one woman had not yet had cause to fill in the RUL, despite reporting elsewhere in the interview that she had had contact with a district nurse since discharge (Participant ID 61009, 77 years, THR). A participant whose first language was not English was aware of the RUL but had not used it because he had received the RUL but had not yet started to fill it in. This was usually because they felt that they had not yet accessed services that would require use of the RUL and they said that they would start to use the RUL when they did so. It was apparent, however, that some of these eight had not started to use the RUL in spite of already having accessed services that could be recorded in it. For most this was because they did not think their service access relevant: for instance, one woman had not yet had cause to fill in the RUL, despite reporting elsewhere in the interview that she had had contact with a district nurse since discharge (Participant ID 61009, 77 years, THR). A participant whose first language was not English was aware of the RUL but had not used it because he had not received a copy of the RUL.

Perceived value of the RUL
Of those who had already started using the RUL, most said that they felt it was helpful as a way to assist their memory of resource use. They saw that keeping such a record was a worthwhile activity and something that they would continue to do over the coming months. In addition, participants talked about getting into the habit of writing in the RUL immediately after they accessed relevant services and of not minding doing so.

Perceived negative aspects of the RUL
Although participants who had started using the RUL saw it as a memory aid, and while some questions appeared straightforward
to answer, there was also some concern about how best to complete others. Participants also commented that they felt that some questions may not be relevant when services such as physiotherapy are not widely available or not always easy to access within the NHS. There was also an understanding among participants that questions in the RUL had to relate to all people,

<table>
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<th>Table 4 – Summary of categories supported by evidence from the data.</th>
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<tr>
<td><strong>Familiarity with the RUL</strong></td>
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<td><strong>Log completion</strong></td>
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<td>I’ve started working on it because, for instance, I went to my GP last week and I filled in what I did and what I said you know: it’s all in there. So and I’ve not had any visits from any physiotherapists or anything like that so I mean the rest of it is as blank as my face you know. (21128, 74 years, THR)</td>
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<td>I haven’t done it yet. [Indicates to her copy of the log] is what you’re on about? (22041, 64 years, TKR)</td>
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<tr>
<td><strong>Barriers to completion</strong></td>
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<td>I know this question, tick only one box to give an account of how many times you use each service and I don’t understand ... since I came back from hospital, after my operation, I haven’t seen my GP. ... So that’s why, I don’t know what to do; I just leave it because I don’t understand. (41036, 26 years, THR)</td>
</tr>
<tr>
<td>No I haven’t received nothing like that (42033, 72 years, TKR)</td>
</tr>
<tr>
<td><strong>Perceived value of the RUL</strong></td>
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<tr>
<td>A useful memory aid</td>
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<tr>
<td>It will be an aide memoire but that’s all it is because, not that I’m sounding bloody complacent or anything I mean, I am a reasonably fit, reasonably healthy person, please God nothing’s going to bloody happen and I won’t have any sudden ticks in the various boxes there you know. ... So it should, as I say be as blank as the look on my face. (21128, 74 THR)</td>
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<td>Yeah it’s quite useful because at least you haven’t got to try and remember. I mean I put down visit one, I put down the date underneath of it. It doesn’t say put a date in if you’re supposed to put a date so I thought well that’s what I’ll do ... Yeah cause if you gotta think in three months time and say what happened I’d say well I got no idea. (42053, 53 years TKR)</td>
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<td>The habit of completion</td>
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<td>Like I forgot one or two things (laughs) telling you here er what I did.... So I think um especially if you had to fill in more. ... I mean I have only a little to fill in, so maybe I might have remembered anyhow. But er to fill in when you’ve got to fill in more, especially if you go to the doctor, if your nurse is coming, or you’ve rung the doctor, as they say, these you forget.... Yes so these sort of things, it easier - good to have a sort of record of, and then you remember. (61009, 77 years, THR)</td>
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<tr>
<td>It is fine because it’s there and I started doing it, you keep up with it.... So you don’t mind at all. (31020, 59 years, THR)</td>
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<tr>
<td><strong>Perceived negative aspects of the RUL</strong></td>
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<tr>
<td>Concerns around completion of specific RUL questions</td>
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<td>I have a question about time off work, well that’s easy enough. Umm there’s one about your wife, what jobs that they’ve done for you. Yeah, how much time that friends have helped you. How the hell can you work that out in hours per week? That’s hard to work out isn’t it. (42053, 53 years TKR)</td>
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<tr>
<td><strong>Potential irrelevance of questions</strong></td>
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<td>I mean most of it is irrelevant because the NHS hasn’t got the resources to put it into. I mean if the physiotherapist knocked on the door every week you know, taking somebody for a run up the road that’s fine but it’s not going to happen. (21128, 74 years, THR)</td>
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<tr>
<td>We don’t have meals brought in, that was a question, but you know, and you have to ask that because a lot of people, it is, the illness or should I say the operation that I have had is for people who are in their autumn years of life....And have worked really hard and started to wear things out. I am not quite in the autumn years but I have worn a few things out, bits start dropping off, but you have to ask the questions for the majority rather than the minority I know. (11055, 50 years, THR)</td>
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<tr>
<td>This is, “record the number of meals from food at home services, social workers,” so none of these relate to me. “Have you had to pay for a home care worker?” no none of these relate to me, you see. Then, “Time off work, how many days you’ve had off work,” and that doesn’t relate to me, I’ve finished now my work. (61009, 77 years, THR)</td>
</tr>
<tr>
<td>Lack of understanding of how the RUL should be filled in</td>
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<td>Because I don’t really understand what I am going to do. So like I say look, look, a lot of different questions, like your home or something like that, ... So nobody, no care workers, I haven’t got any, so I don’t know what to put in there so a lot of that, like maybe in the hospital or something like that, visit 1 and visit 2, all this I don’t know what they mean. Please record here any visit to an outpatient department in any ... hospital (41036, 26 years, THR)</td>
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but questions did have the potential to seem irrelevant, whether or not they had started to use the RUL.

**Discussion and Conclusions**

We developed an RUL to aid patients in their completion of a follow-up RUQ. The RUL improved the completion rate for the NHS community-based services category in a patient-completed questionnaire at 3 months with minimum additional patient burden. Patients using an RUL completed more of the categories with poorest completion rates (i.e. travel expenses, informal carers’ time), which means that the impact of the RUL is greatest where it is needed most, in categories more prone to missing data.

Although RCTs have been used to examine methods for improving response rates of questionnaires [8], this study was the first to our knowledge to use an RCT to study patients’ completion rates of RUQs. The format of conducting a nested RCT and qualitative study within a larger trial was a successful one, and this type of approach could potentially be used to examine other areas of questionnaire design and validation.

Our RUL was positively received in general, and the majority of participants saw it as a useful memory aid. There was no mention that the RUL was burdensome although some had difficulty in filling in more complex questions, and language and literacy presented issues for others. However, the design of the RUL with tick boxes for the NHS community-based services was simple to achieve, acceptable to patients, and successful in decreasing missing data. We believe that a redesign of the RUL, using tick boxes for more complex categories as well, will improve their completion rates in future trials.

The finding that the RUL improved the completion rate for the NHS community-based resource use category is particularly useful when considering the alternatives to collecting this type of resource use, which typically consist of research staff searching through patients’ general practice records, a labor-intensive and time-consuming task. In the United Kingdom, health care professionals working in the community are not always based in a general practice, and so such visits may not be recorded in practice records, and are not available at the patient level from primary care trust records.

The nesting of the RUL trial within the pilot phase of the APEX trial meant that the number of patients was determined by the size of APEX pilot phase, rather than a power calculation for an expected effect size of the RUL. Although statistically underpowered, our results indicate a positive effect of the RUL to achieve higher completion rates at 3 months for some categories. By using qualitative research to complement our quantitative results, we found that this positive effect was not felt at the expense of increased patients’ burden. The sample of 20 patient interviews was small but achieved data saturation [22], which increases confidence in the transferability of our results to other study populations. The timing of the interviews at 2 to 4 weeks after surgery may have affected whether or not participants had yet felt the need to use the RUL. Nevertheless, the fact that they described the RUL as an “aide memoire” showed that they understood its purpose. In addition, the RUL’s benefits can also be achieved at little burden to the research staff. Data in the RUL are neither collected nor analyzed, and the time spent administering the RUL is minimal.

The RUL’s effect on data completeness may not necessarily translate into improved accuracy in patient-reported data. It was beyond the scope of this study and the APEX trial to validate the 3-month RUQ data against primary care medical records to determine the effect of the RUL on recall bias. The RUL’s effect could have been underestimated if contamination occurred between trial arms. For example, if at hospital discharge the research nurse provided more information on the contents of the 3-month RUQ to the control group than she would have otherwise. If this did occur, this would only strengthen our results, which already indicate that the RUL may achieve higher completion rates for some categories.

Our study highlights the potential for qualitative research to strengthen areas of uncertainty. A mixed-methods approach [30] to design resource use data collection instruments can produce pragmatic and acceptable tools for both patients and researchers [20,31]. Qualitative methods can help initially to identify main patient-related costs, ideal time frame for data collection around an intervention, patients’ preferences about methods of data collection, and type and depth of information that patients would be willing and able to provide. At a later stage, methods such as “think aloud” [32] can be used to explore whether the instructions, layout, and format of RUQs and RULs are clear. Future qualitative research could also explore the mechanisms by which providing an RUL may improve data completion in a subsequent RUQ, beyond acting as a memory aid. One explanation may lay in the role of the research nurse when delivering the RUL, which may engage patients further with the research project and enhance their willingness to complete questionnaires. The act of looking through the RUL at baseline may also make patients aware of the types of questions they will be asked in future questionnaires, making the use of such services more prominent in their memory.

Recently, there has been renewed interest in developing good tools and methodologies to improve health economic data collection. In this context, the Data Instruments for Resource Use Measurement database [33] has been established. This initiative has sparked the need for further methodological research to validate tools and increase the completion and accuracy of data collection. We believe that our study is a milestone achieved in this process, establishing the value of a simple tool such as an RUL to improve completion rates of RUQs.

In conclusion, for economic evaluations alongside trials, a simplified RUL using tick boxes designed for patients to prospectively record resource use is a useful and acceptable memory aid tool and has the potential to reduce the amount of missing data in RUQs administered during the follow-up phase of RCTs.

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**References**
