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Patient and clinician perspectives of an eHealth intervention for supporting cancer treatment: Mixed methods evaluation of the eRAPID randomised controlled trial

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Abstract

Objectives: During 2015-2018, an RCT evaluated eRAPID, an eHealth intervention designed to capture patient-reported symptoms online during cancer treatment. eRAPID provides patients with advice on when to self-manage or seek medical support. Clinicians accessed symptom reports within electronic patient records. 508 participants starting systemic cancer treatment were recruited and followed for 18-weeks. The intervention group (n=256) were asked to access eRAPID and complete weekly online symptom reports. Clinicians received training on accessing and interpreting symptom reports. Overall, eRAPID had a positive impact on patients' symptoms, quality of life and self-efficacy, particularly early in treatment and for patients with early-stage disease. Using multi-methods we aimed to gather insight from patients and clinicians on how eRAPID worked to facilitate interpretation of RCT findings.

Design and participants: Experiences of eRAPID were gathered via end-of-study interviews with purposively sampled patients (n=45) and clinicians (n=18). Further feedback was obtained from surveys completed by both patients (n=186) and clinicians (n=55) throughout the trial. Framework analysis was applied to examine qualitative data and closed survey questions were descriptively summarised. Findings were mapped against results from the RCT.

Setting: Medical oncology services, UK cancer centre.

Results: Patient feedback indicated eRAPID was easy to use. Adherence to weekly reporting was influenced by health status, reminders, perceived value, and clinical use. Patient reported benefits of eRAPID included an enhanced connection with the hospital, provision of practical advice and personal monitoring, which provided reassurance and empowerment. Clinicians were positive about the potential for online symptom monitoring but had mixed levels of direct experience with using eRAPID during the trial. Patients echoed this and recommended more explicit clinician use of symptom data.

Conclusions: The multi-method approach to capturing patient and professional opinions provided valuable insight on the eRAPID intervention and complementary information on how the intervention was received and functioned.

Strengths and Limitations

- The mixed methods approach (combining results from interviews and feedback questionnaires) provides important insight on how the eRAPID health intervention functioned in practice when mapped to the findings from the main randomised controlled trial.
- The perspectives of a large number of participants involved in the trial were obtained (186 patients and 55 professionals).
- Although feedback surveys were collected from health professionals throughout the study, interviews were only conducted at the end of the trial. The resources were not available for more objective assessments of how the intervention was used in practice (such as video or audio observations or system analytics).
- There are some biases in the study sample due to the trial eligibility criteria (English-speaking, basic level of IT literacy and internet access). In addition, it was difficult to capture the perspectives of those patients who did not engage as they often withdrew from the study.

Introduction

Systemic cancer treatments (chemotherapy, hormonal therapy, targeted drugs, and immunotherapy) are associated with side effects affecting patients' everyday functioning and quality of life (QoL), and can lead to life-threatening risks. Oncology teams are required to safely monitor patients during treatment to identify symptoms before they become serious, whilst providing advice for managing mild/moderate issues.[1, 2] As systemic treatments are typically administered in day-case outpatient settings, patients and caregivers play an important role in health monitoring from home but can have difficulty in determining severity of issues.[3] Standard practice for monitoring patients during treatments involves routine clinician-led assessment between cycles. Assessments rely on patient recall of problems experienced in previous weeks and clinicians making accurate judgements about severity. Standard practices do not easily allow comprehensive tracking of patient symptom trajectories over time.

Growing international evidence demonstrates that electronic monitoring systems using Patient Reported Outcome Measures (PROMs) in the cancer setting can benefit patient QoL [4-6] and survival.[7, 8] However, there is considerable variation in how systems are designed and embedded into clinical pathways.[9]

Developed using co-design principles, the eRAPID electronic health intervention allows patients to self-report symptoms online from home during treatment.[9-11] eRAPID provides automated advice based on clinical algorithms to guide patients to self-manage mild/moderate issues or contact medical teams when potentially serious problems arise.

During 2015-2018, we evaluated eRAPID in a randomised controlled trial (RCT) in the systemic treatment setting cancer with patients diagnosed with breast, gynaecological or colorectal cancer.[12, 13] The primary outcome was symptom control and secondary outcomes included impact on QoL, self-efficacy, process of care measures (treatment delivery, hospital admissions and telephone contacts) and costs. Results evidenced better symptom control with eRAPID at 6- and 12-weeks, but not 18-weeks, from start of treatment. Improved patient self-efficacy to manage symptoms was found at 18-weeks.[13] Benefits were more evident for patients with early stage cancer than those with metastatic disease. Patient adherence to weekly symptom reporting was good with an average of 64.7% (varying between 72% in week-1 to 58% in week-18). eRAPID did not increase hospital workload or influence treatment delivery and the costs for the eRAPID group were lower at 18 weeks. Clinician use of symptom data was positively associated with patient adherence to online reporting, which was in turn associated with improved symptom control. However, use was variable between clinicians.

There persists a continued drive for health services to adopt technology-driven care solutions.[14, 15] Using electronic PROMs (ePROMS) to facilitate patient monitoring is one approach but it is not widely adopted.[16, 17] Patient and clinician views on everyday experiences of these systems are vital to understand mechanisms for intervention success and help refine development and implementation strategies.[18]

To gain insight into the acceptability and clinical value of eRAPID, a mixed methods approach was adopted as part of the RCT whereby interviews and feedback surveys were used to collect insight on experiences and views of the intervention in addition to the main trial outcome measures.[19] The aims were to explore patient and professional views of eRAPID with the goal of understanding both how findings supported or contrasted with the main RCT results [20] and how the intervention might be refined for future routine implementation.

Methods

eRAPID RCT in systemic cancer treatment

The eRAPID intervention and RCT protocol are described elsewhere.[12] In summary, this was a single site parallel RCT with an internal pilot in a UK cancer centre. English-speaking adult patients with internet access starting systemic treatment for breast, gynaecological or colorectal cancer were eligible. Participants were randomised to Usual Care or eRAPID intervention.

Intervention participants had access to eRAPID and were asked to complete symptom reports online (via computer, tablet or smart phone) weekly for 18-weeks (reminders sent via SMS or email). The system provided automated severity tailored patient advice for managing reported issues. Mild or moderate problems generated self-management advice and/or recommendations to discuss the issue at next clinic visits. For severe and clinically relevant symptoms, patients were advised to immediately contact the 24-hour Acute Oncology service. Email notifications were sent to key clinicians; however, this functionality was not highlighted to patients, to avoid creating an expectation of direct follow-up. Patients could view graphical summaries of their symptoms over time. Clinicians were trained to access and interpret patients' symptom reports which could be accessed within the hospital's electronic patient records (EPR) and viewed in tabular or graphical formats.

Summary of feedback obtained from patients and clinicians

Interview procedures

Patients: We invited a subsample of intervention participants to complete an end-of-study interview and aimed to interview 5-10 per cancer site and purposively sampled participants based on age, sex, cancer site and adherence to weekly symptom reporting. Patients were interviewed at their convenience at the end of the study, in a private room at the hospital. The semi-structured interview schedule **(Supplementary file A)** explored personal experiences, use and views of eRAPID, impact on medical care and interactions with clinicians.

Clinicians: We arranged end-of-study interviews with up to 5 clinicians (specialist nurses and oncologists) from each cancer site. The semi-structured interview schedule **(Supplementary file B)** explored access and use of eRAPID patient data and its perceived value in clinical practice.

Feedback questionnaires

We obtained additional feedback through:

Patient feedback questionnaire

Patients were invited to complete a feedback questionnaire at the end of the 18-week study including:

- Twelve closed questions focusing on ease of using eRAPID, how symptom data were used, and perceived value of eRAPID for future patients **(Supplementary file C)**.
- The System Usability Scale (SUS).[21] A 10-item scale widely used to gain subjective assessment of the usability of computer systems. Participants rate 10 statements from 1-5 (strongly agree to strongly disagree). Overall scores range from 0-100 with higher scores indicating better usability. Scores over 68 are above average.
- Five free-text questions covering use of eRAPID*:*
    - Reasons for non-adherence to weekly reporting
    - Positives and negatives
    - Suggestions for improvement
    - Any other comments.

Clinician feedback questionnaire

Clinicians were prompted to complete a feedback questionnaire at each routine consultation with intervention patients.**(Supplementary file D)**

The questionnaire included:

- Close-ended questions to indicate if and how clinicians:
  - Used eRAPID data
  - Found eRAPID useful
  - Used eRAPID to contribute to patient management
- Free-text boxes to provide comment on:
  - Additional ways they found eRAPID useful
  - Any other comments.

Patient and public involvement (PPI)

PPI was prioritised throughout the eRAPID programme of work and further details of this are available elsewhere.[22] In the work described here specifically, our PPI co-authors (BW & VC) have supported the development of evaluation methods, reviewing patient materials such as information sheets and questionnaires, and contributed to manuscript preparation.

Analysis

Qualitative data (interviews and free text written comments)

Interview recordings were transcribed verbatim, transferred to NVivo and analysed using a framework approach [23] by members of the eRAPID research team (KA, LW, MH, RP, AG, ZR, SD). Following data familiarisation, we created a coding framework guided by the topics in the interview schedule and sub-themes identified from data. Two researchers coded each transcript and the team worked collaboratively to resolve queries, refine the framework, and maintain a coding log. We allocated one or more main themes to each researcher to extract relevant coded quotes from NVivo into separate spreadsheets for charting and summarising data to draw overall conclusions. We collated, reviewed, and summarised free-text responses from feedback questionnaires under the overarching coding framework.

Quantitative/closed ended survey questions

We conducted analysis using SPSS version 26. We scored the SUS according to instructions and explored differences between cancer sites and metastatic and non-metastatic patients using independent t-test/ANCOVA. Closed-ended responses from feedback questionnaires were descriptively summarised.

Synthesis of participant feedback with main RCT findings

Using the joint display approach to integrating qualitative and quantitative data in mixed methods studies, we mapped patient and clinician feedback against the primary and secondary eRAPID RCT outcomes.[20]

Results

Participants

Patient sample

Target recruitment was met with 508 patients consented and randomised in the RCT; Usual Care (n=252) and eRAPID intervention (n=256). 186/222 (84%) of patients who remained on study at 18-weeks completed feedback questionnaires and 45 participated in interviews (**Table 1**). 20% (n=38/186) of patients who completed feedback questionnaires and 24% (n=11/45) of patients interviewed had previously had chemotherapy.

Clinician sample

55 clinicians participated in the RCT, utilising eRAPID data during routine consultations, all completed at least one feedback questionnaire and 18 were interviewed (**Table 1**). Of an expected 1,314 questionnaires 787 (59%) were completed and 218/256 (85%) of intervention patients had their symptom data reviewed by a clinician at least once.

Reasons for questionnaire non-completion included clinicians forgetting due to the relatively small number of eRAPID intervention patients seen in clinics, researchers being unable to prompt clinicians due to last-minute appointment changes, and not having symptom data to review due to patient non-adherence.

Patient perspectives

Patient interviews and feedback questionnaires covered three overarching and interlinking themes:

- General acceptability and functionality of eRAPID
- Impact on clinical care
- Personal value of using eRAPID.

We describe each theme below with a focus on patients' views on the use of eRAPID. **Figure 1** provides a graphical representation summarising key elements of the patient perspective.

Acceptability and functionality

Ease of use

Quantitative data from feedback questionnaires (**Figure 2**) indicated most patients found eRAPID easy to use (96%), easy to complete (92%) and thought the length of time it took was about right (97%).

SUS scores ranged from 25-100 with a mean of 83.3 (SD 14.4). An independent t-test indicated patients with non-metastatic disease reported higher scores (M=86.0, SD=12.8) than those with metastatic disease (M=80.7, SD=16.9) and this was statistically significant (p=.036). A one-way ANOVA indicated no significant difference in scores between cancer sites (p=.057).

Interview data also indicated that patients found eRAPID easy to use and did not experience any major issues accessing or using the system. Comments from free-text sections of the feedback questionnaire suggested some improvements including creation of an eRAPID app.

Reminders

Email/text reminders were important facilitators for adherence, though some individuals also set their own weekly routines.

> *'… I'd kind of disciplined myself to do it on a Wednesday.'* (Patient A, Gynaecological).

Health status

Health issues such as fatigue, cognitive/memory issues and hospitalisation were common barriers to adherence.

> *'...it was nothing to do with the system or finding it difficult, the thing that was difficult for me was the absolute fatigue with the chemotherapy, just totally wiped me out.'* (Patient B, Gynaecological)

Relevance of symptom items

Patients found the symptom report relevant (92%) and qualitative data supported this. However, some found the weekly completions and associated advice repetitive, particularly

when their symptoms did not change. Some felt the response options were too limited and did not allow scope to add detail.

> *'The answers could be too black or white, when life is generally more grey and there were no extra boxes to explain*.' (Patient C, Colorectal)

Impact of eRAPID on clinical care

Clinician engagement with eRAPID

42% of patients thought clinicians regularly used their symptom reports while 21% thought they were not used at all. Qualitative comments supported these mixed experiences. A few patients reported clinicians being explicit about using eRAPID data to guide consultations.

> *'…our chemotherapy doctor, he would bring it up every time and show us it and talk me through any concerns that he had… that re-incentivised me to use the system because you know it's not just a waste of time, somebody's looking at it.'* (Patient D, Gynaecological)

However, others expressed significant disappointment that clinicians did not use their symptom reports and cited this as a barrier to use. A clear recommendation from patients for future refinement of eRAPID was increased and explicit clinician use of the symptom reports.

> '*No feedback from anyone – was expecting at least someone discussing usage of system but didn't happen at all after using it for 3 times – so stopped using it.'* (Patient F, Colorectal).

Facilitated consultations

63% of patients felt their symptom reports were useful for clinical staff, often leading to better understanding of experiences. Weekly symptom reporting served as a memory prompt, as patients did not have to try to recall symptoms weeks later.

> *'At clinic visits I had sometimes forgotten about some of the symptoms I had experienced over the three-week period since my last visit…'* (Patient G, Breast)

Medication/treatment changes

Some patients described changes to their clinical management, such as prescription of medications or changes to their chemotherapy, as a direct result of their symptom reports.

> *'Doctors and nurses referred to my answers. Doctor reduced chemo dosage to help my sore throat.'* (Patient H, Breast)

Personal value of using eRAPID

Patients reported a range of positive views describing personal benefit gained from using eRAPID.

Link to the hospital

Some patients talked about feeling a heightened sense of connection with the hospital:

> *'It helps with continuity of care. I feel under constant supervision of my treatment*.' (Patient I, Breast)

> *'It's like keeping in touch… without making an appointment to see anyone.'* (Patient J, Colorectal)

Information resource

Patients found the symptom advice provided useful (92%). Many reported reassurance in having tailored advice from a trusted source and having their symptoms monitored.

> '*Peace of mind that you were being monitored and any potential issues e.g. high temperature would give you guide as to whether to ask for help.'* (Patient K, Breast).

For some metastatic patients who had chemotherapy previously, the value of advice was limited as they were already familiar with how to manage symptoms.

> *'Well because I'm a bit of an old hand at chemo I think….it was only telling me what I already knew.*' (Patient L, Gynaecological)

Self-monitoring
The process of routine symptom reporting and tracking symptoms over time was also empowering.

> '*Felt good to record my symptoms every week - felt like I was taking an active role in my treatment*.' (Patient M, Breast).

> *'I think it was useful for us because you got the little graphs. So, you could compare how you… were feeling in comparison to how you'd been before*.' (Patient N, Colorectal)

For some the benefit of the system was more apparent early on in treatment and less useful later as they became familiar with symptoms/treatment.

> '*Some weeks I had no symptoms to report. After the first couple of cycles on each drug I didn't find the system beneficial.'* (Patient E, Breast)

Guided decision-making
In some cases, the symptom advice engendered a sense of confidence that patients and carers were taking the right action, including when to seek medical advice:

> *'…gave me and my family more confidence to manage side effects especially early on in the treatment… gave me 'permission' to contact the hospital if I was worried…..'* (Patient O, Colorectal)

Research study.
Some patients reported that their main motivation for adherence was a sense of responsibility to honour their commitment to participating in the research, rather than personal benefit.

> '*I saw it as, 'well I have agreed to this research thing so I will do it'…So that's probably the biggest motivator… just because I said I would do it.'* (Patient P, Gynaecological).

Clinician perspectives
Clinician feedback on eRAPID was summarised into the following overarching themes

- General acceptability and functionality
- Impact on clinical assessments
- Perceptions of patient views.

The main descriptive results from clinician feedback questionnaires are included in the themes below. Additional findings are in **Supplementary file E.**

Acceptability and functionality
Predominantly clinicians found it easy to access symptom reports within the electronic patient records.

> *'The system was very easy to use, it's on the system we use in clinic, you just have to click a button, all the information is there, so it was easy to use, readily available.'* (Colorectal, Senior oncologist)

Presentation of symptom data in both tabulated and graphical forms was useful to address different needs and preferences.

'I quite liked the graphs, simply because it was very quick and easy to be able to see if something had particularly changed'' (Gynaecology, Senior oncologist)

'I like the tables, I'm not a big fan of the graphs… it's easier to see quite a lot of information quickly on the tables…. Personally, I didn't see the extra value to the graphs.' (Colorectal, Specialist nurse)

Due to the relatively small number of eRAPID intervention patients seen in clinics, it was easy for clinicians to miss reports, particularly as there was no facility in the electronic records to flag them.

'*I think it will be even more useful when, if it's used in routine practice because you wouldn't forget to look at it.'* (Colorectal, Senior oncologist)

Impact of eRAPID on clinical care

Clinicians reported accessing eRAPID data on 81% (641/787) of the post-consultation feedback questionnaires completed. Clinicians rated to what extent they used eRAPID and how useful they found it on a Likert-type scale from 'not at all' to 'very much'. 90% used it at least 'a little' and 90% found it at least 'a little' useful (**Figure 3**).

Gynaecology clinicians were more likely than breast or colorectal clinicians to report using eRAPID 'quite a bit'/'very much' (30% vs 22% & 21%) and finding data useful 'quite a bit'/'very much' (46% vs 26% & 28%). However, gynaecology and breast clinicians were also more likely to report not using the data at all (20% & 18% vs 8%) and not finding the data at all useful (13% & 11% vs 5%) compared to colorectal clinicians.

Clinicians indicated finding eRAPID useful on 663/787 (84%) of feedback forms. When asked to indicate the specific way or ways it was used from a list of options, 51% said it confirmed knowledge of patients' problems, 26% said it provided additional information, 23% said it identified problems to discuss and 8% said it contributed to management **(Supplementary File E).**

Qualitative interview data supported these findings with clinicians describing eRAPID as a helpful tool in structuring/preparing the consultation and building a connection with the patient.

'I found it helpful because it informs you before the patient arrives and I think it also stops you having to ask the patient 300 questions every time they come.' (Gynaecological, Specialist nurse)

'There is an instant rapport because she thinks okay this one knows about me and I think that's been very helpful for me.' (Breast, Senior oncologist)

However, other clinicians felt using symptom reports made consultations longer. One clinician found using eRAPID to be a conflict to their usual practice.

'… you have your own way of doing it, which I've been doing for such a long time and I just, it just didn't kind of resonate with me I'm afraid.' (Breast, Senior oncologist)

Clinicians recognised the benefit of being able to identify trends in symptom trajectories and viewed the symptom reports as accurate. However, some had reservations about patients reporting issues not relevant to the cancer/treatment and some reported a lack of concordance between what patients reported online vs face-to-face.

'Patient contradicted information reported on eRAPID i.e. denying any nausea which was confusing.' (Colorectal, Specialist nurse)

In a relatively small number of consultations (n=56), clinicians indicated that eRAPID contributed to management, such as a change to chemotherapy/medication

(Supplementary File E). Qualitative data supported this, with some clinicians reporting using eRAPID data to make decisions such as prescribing antibiotics for infections, providing advice on laxatives and reducing chemotherapy doses.

> *'Enabled to advise regular antiemetic and anti-spasmodics based on their pattern of occurrence relating to chemotherapy cycle.'* (Breast, Specialist registrar)

Perceived value of eRAPID for patients
Several clinicians commented that eRAPID was beneficial for patients.

> *'…it gave them permission to ring when they potentially may have not necessarily rung but may have tolerated it to the point where it becomes just slightly less easy to resolve.'* (Breast, Specialist nurse)

However, others described a range of patient-centred barriers to adopting the system into routine care including variation in patient compliance with online reporting, requirement of English language and IT access and fluency.

> *'…the patients that don't have access to the computer are the patients that we should be more concerned about because they might be…less literate or ...less able to communicate their needs and concerns….* (Colorectal, Specialist nurse)

Synthesis of feedback with key findings from the eRAPID RCT

In **Table 2**, we present the key RCT findings and map these with insights from interviews and end-of-study feedback.

Increased physical wellbeing at 6 and 12-weeks, health status and overall QoL at 18-weeks and self-efficacy at 18-weeks
Patient feedback supported our findings of the benefits of eRAPID with patients reporting detailed examples of how the intervention was beneficial. Qualitative findings offered insight into limitations of benefits, e.g. lack of impact on physical well-being at 18-weeks. Patients often reported finding symptom advice more useful during the initial weeks of chemotherapy and less useful later as they became more experienced in symptom management. Some metastatic patients with previous chemotherapy experience reported that eRAPID would have been more useful the first time around, offering insight into the greater benefits seen in the non-metastatic patient group.

High rates of patient adherence
Qualitative data indicated that eRAPID was easy to use and access. However, in some instances, adherence declined towards the end of the 18-weeks. Again, this may be explained by some patients finding eRAPID less useful in later stages of chemotherapy. Additionally, patient adherence was associated with the reported clinician use of eRAPID during consultations. Qualitative feedback from patients reported explicit clinician use of eRAPID as a motivator for engagement, but a barrier when clinicians did not acknowledge their symptom reports.

No differences between eRAPID and usual care on chemotherapy delivery, hospital admissions, acute oncology assessments or emergency hotline calls.
Clinician feedback forms reported a small number of examples of using eRAPID data to guide treatment decisions. Patients reported that eRAPID gave them 'permission' to contact the hospital for severe symptoms; however, they also reported that self-management advice empowered them to manage symptoms at home.

No difference in benefits of eRAPID between breast, colorectal and gynaecological patient groups.
Qualitative data indicated some differences in clinician engagement between the groups, with typically gynaecological clinicians engaging more with eRAPID.

Conclusions

As part of the eRAPID RCT, we aimed to capture information from patients and clinicians, via interviews and written feedback, to understand experiences of using the system to help explain results and improve future refinement of this approach in cancer care.

Both patients and clinicians reported that eRAPID was easy to use. The main advantages from a patient perspective included its role as a trusted source of information and advice, providing enhanced connection with the hospital. However, patients felt the system could be improved, particularly in terms of clinician use. Although some patients felt clinicians actively addressed and utilised their symptom reports, others had no recollection of clinicians reviewing their data at all. Understandably, this was disappointing leading to some patients becoming less engaged. These findings align with results from the RCT where clinician use of data was positively associated with patient adherence to weekly completions.

In addition, we found important benefits for patients around increased self-efficacy and QoL. Previous trials have focused on patients with advanced disease and our findings demonstrating the benefits of this approach for patients with early disease is an important one. The qualitative insight we have gained about the mechanisms of this benefit has valuable implications for future development and implementation of similar systems.[18]

Some clinicians were very positive about the value of eRAPID for assisting with consultation preparation and providing a focussed discussion. Some found it valuable in saving time and identifying symptom trends. In practice, the design of the RCT meant some clinicians had limited exposure to eRAPID intervention patients, and the lack of an automated facility for flagging reports in the electronic patient records meant they could easily miss patients with symptom reports available.

Clinician feedback was variable between clinics, with those in gynaecology reporting higher use and usefulness of eRAPID. However, this did not translate into a difference in outcomes between patients in the different cancer sites. This may be simply because our RCT was not powered to detect statistical differences in secondary outcomes such as these, and it may also be partially due to differences in how individual clinicians used data or the complex multi-faceted ways eRAPID benefitted patients. For example, the RCT indicated the intervention was more beneficial for non-metastatic patients and qualitative data provided some insight into this, with patients that had experienced chemotherapy previously finding the information less novel/useful. The gynaecological group had a high proportion of metastatic patients, particularly in comparison to the breast group. While gynaecology patients may have benefitted from increased clinician engagement, this advantage may have been diminished by the higher proportion of metastatic patients when compared to the colorectal and breast clinics who seemed to derive greater benefit from the eRAPID information and advice.

While evidence from other trials have indicated that remote monitoring can impact outcomes such as hospital admissions, treatment delivery and even survival[4, 8], this was not a finding in our RCT, which found no difference between eRAPID and usual care for hospital contacts or admissions. Although our qualitative data indicated that eRAPID guided patient decision-making about hospital contact and self-management, it is likely that the impact of eRAPID on hospital contacts is complex, and difficult to assess by a quantitative comparison. eRAPID may increase the number of contacts and admissions by advising patients to contact the hospital, while on the other hand, it may reduce contacts by supporting self-management when appropriate.

There are some limitations to our methods and findings. First, we conducted patient interviews at the end of the study period. Longitudinal interviews over the course of the 18-week study period may have provided more understanding into how patient use and engagement with eRAPID fluctuated over time. Second, we relied on patients and clinician

accounts of how eRAPID symptoms reports influenced care. Clinicians usually completed feedback forms immediately after consultations; however, we only collected basic information due to clinic time constraints. In addition, there was a high rate of missing data for these forms, limiting their generalisability. In a previous study, we found it useful to audio-record consultations and use coding methods to evaluate how PROMs influenced discussions.[24] However, this was not possible in the current study due to resource constraints and the pragmatic nature of the trial. Another limitation is that patients who did not engage with eRAPID at all were likely to withdraw from the trial and were unavailable for interview or questionnaire completion. However, this was a relatively low proportion of patients and we specifically targeted those with low adherence to compensate for some of this bias. There will be some additional bias in our sample simply because eligibility required patients to be English-speaking and to have some level of IT skills and access.

Moving forward we are working on future implementation strategies to take eRAPID into routine care. We have experienced similar challenges around implementation to those reported by others working in this arena across clinical areas [17], such as barriers around hospital IT systems and health care infrastructure. An important element of ongoing work is the engagement and training of both patients and clinicians to maximise the use and clinical value of PROMs data. Insights provided by this qualitative work and our previous development activities is vital to contribute to an evidence base of patient and clinician perspectives in a variety of contexts [25-27]. We have funding to expand on analysis of the eRAPID study data using innovative methodologies such as through case study and latent class analysis, in addition to exploring optimal methods of PROMs data visualisation for both clinicians and patients. This work will help to further inform the clinical value of PROMs data in cancer practice and refine the eRAPID intervention.

As PROMs become more widely adopted, it remains vital to explore their practical implementation to ensure they effectively serve patients and clinical teams. ePROM interventions like eRAPID, are often complex and multi-faceted. Qualitative methods used alongside evaluations can provide invaluable insight into the mechanisms by which patients and clinicians may benefit and identify limitations and opportunities for improvement.

Author contribution

LW, KA, GV, JB & BW contributed to the development of the evaluation methodology.

LW, MH, AG, RP, ZR, PH & SD contributed to participant recruitment and data collection.

LW, KA, MH, AG, RP, JB, JH, EH, BW, VC & ZR contributed to data analysis and interpretation of findings.

All authors contributed to the preparation and reviewing of the manuscript.

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TABLE 1: OVERVIEW OF PARTICIPANTS WHO COMPLETED INTERVIEWS AND FEEDBACK QUESTIONNAIRES

Patients		**Interviews* (n=45)**	**Feedback questionnaires* (n=186)**
Age	Mean age, years (SD)	54.6 (12.5) range 22-80	57.0 (11.7) range 24-86
Sex	Male	9 (20%)	43 (23%)
	Female	36 (80%)	143 (77%)
Breast	Total	24 (53%)	87 (47%)
	Primary/local	*23 (96%)*	*83 (95%)*
	Metastatic	*1 (4%)*	*4 (5%)*
Gynae	Total	9 (20%)	34 (18%)
	Primary/local	*2 (22%)*	*6 (18%)*
	Metastatic	*7 (78%)*	*28 (82%)*
Colorectal	Total	12 (27%)	65 (35%)
	Primary/local	*9 (75%)*	*35 (54%)*
	Metastatic	*3 (25%)*	*30 (46%)*
Staff		**Interviews (n=18)**	**Feedback questionnaires (n=55)**
Category	Specialist nurse	7 (39%)	10 (18%)
	Senior oncologist	8 (44%)	15 (27%)
	Junior oncologist	3 (17%)	28 (51%)
	Pharmacist	0	2 (4%)
Clinic	Breast	6 (33%)	19 (35%)
	Gynae	6 (33%)	14 (26%)
	Colorectal	2 (11%)	8 (15%)
	Mixed clinics	4 (22%)	14 (26%)
Sex	Female	12 (67%)	38 (69%)
	Male	6 (33%)	17 (31%)

*These are not distinct groups. Some participants who completed interviews also completed feedback questionnaires.

TABLE 2: SYNTHESIS OF FEEDBACK WITH KEY FINDINGS FROM THE eRAPID RCT

Key findings from RCT	Relevant themes from qualitative data	Summary of patient and clinician experiences	Level of complementary evidence
eRAPID associated with better: - Physical wellbeing at 6 and 12-weeks - Health status and overall QoL at 18-weeks	Value of eRAPID for patients (Subthemes: Link to the hospital, Information resource, self-monitoring, guided decision-making, research study) Acceptability and Functionality (Subthemes: Ease of use, reminders, health status, and relevance of symptom items.)	Patients reported examples of where the intervention: - Supported personal decision making to seek medical advice/manage symptoms - Provided reassurance and valuable information - Was more useful in the early weeks of chemotherapy.	Good supporting evidence
eRAPID associated with better self-efficacy for symptom management at 18-weeks.		Patients found aspects of the intervention 'empowering' and felt like it gave them an active role in their care.	Good supporting evidence
Positive benefit of eRAPID observed in non-metastatic cancer group only.		Metastatic group reported lower system usability scores. Some metastatic patients felt the symptom information and advice were less useful to them as they had been through chemotherapy before.	Some supporting evidence
Patient adherence to symptom reporting was positively associated with clinicians' reported use of eRAPID reports. No differences observed between arms for chemotherapy delivery, hospital admissions, acute oncology assessments or emergency hotline calls.	Impact of eRAPID on clinical care (Subthemes: Staff engagement with eRAPID, Facilitation of consultation, Medication treatment/Changes)	Patients had mixed experience of staff use of their symptom reports. Some patients reported that eRAPID gave them 'permission' to call the hospital with symptoms. However, patients also reported not completing symptom reports when they were very unwell. Some clinicians described using the eRAPID data to make decisions on chemotherapy and/or supportive medications. However, clinicians varied in how often they reported using the data and how useful they found it.	Some supporting evidence

Adherence to weekly eRAPID online reporting was good. Adherence reduced over time with patients completing less consistently towards the end of the 18-week period. Some participants completed none or very few reports.	Acceptability and Functionality (Subthemes: Ease of use, reminders, health status, and relevance of symptom items.)	Patients reported that the online reporting was easy to use. Scores from the System Usability Scale were high. Patients also reported that eRAPID was most useful in initial weeks of treatment. Reasons given for non-adherence to completing symptom reports were forgetting, ill health and not finding the reports as useful/too repetitive over time.	Good supporting evidence

FIGURE 1: OVERVIEW OF PATIENT PERSPECTIVE OF THE USE AND IMPACT OF eRAPID

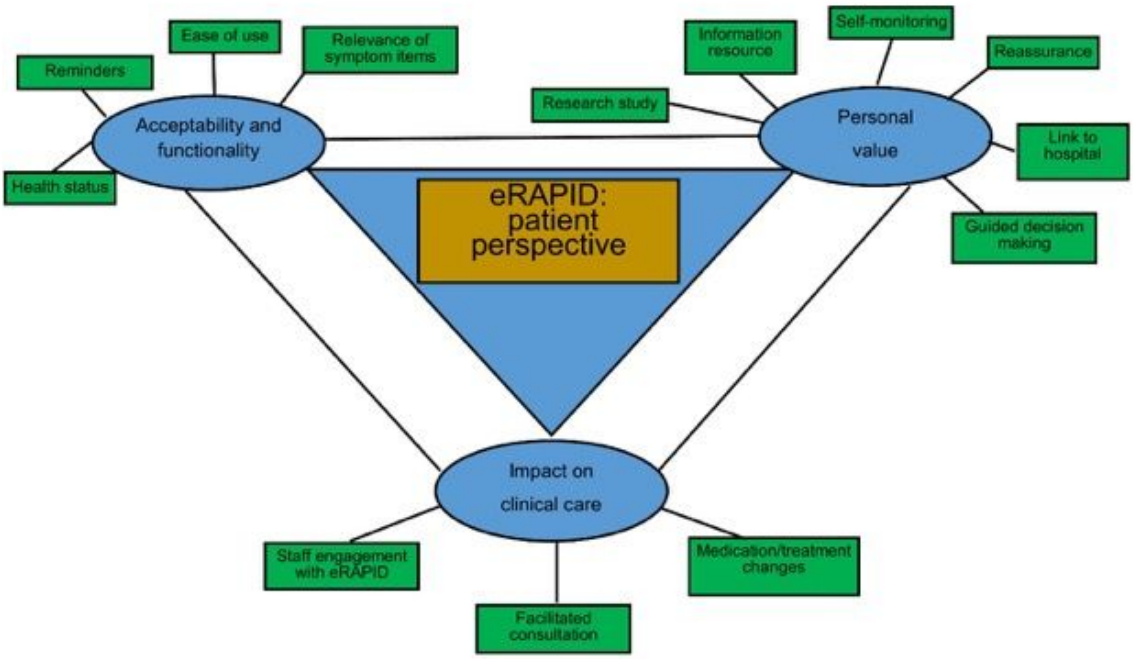


FIGURE 2: FEEDBACK ON eRAPID FROM PATIENT FEEDBACK QUESTIONNAIRES

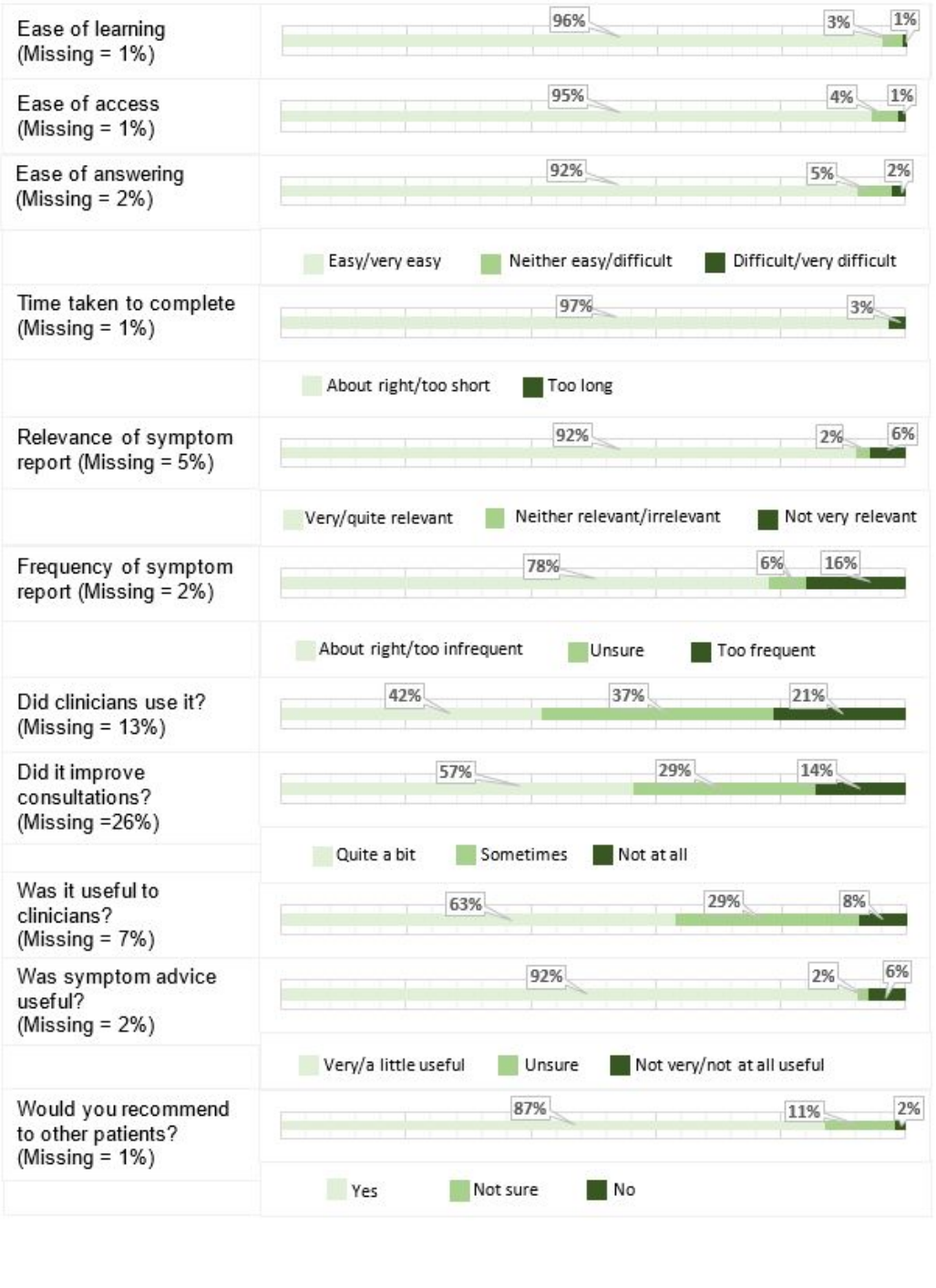
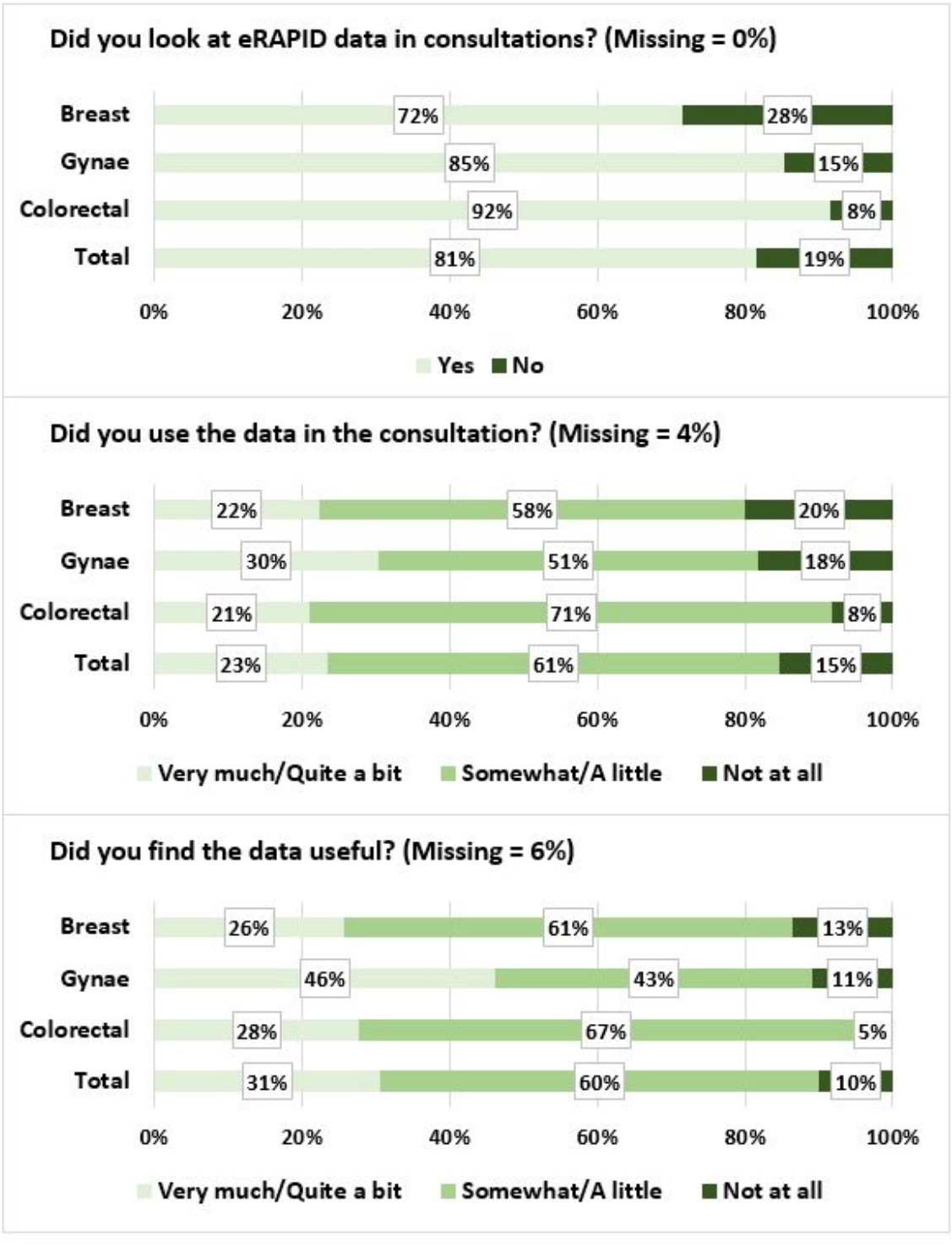


FIGURE 3: FEEDBACK ON eRAPID FROM CLINICIAN QUESTIONNAIRES



Appendices and Supplementary files

Supplementary file A: Summary of patient Interview schedule

General views on using the system e.g.

- Did you have any problems accessing eRAPID at any time? Did you find it easy to use?
- Has it been difficult for you to complete the questionnaire on a weekly basis? Is there anything we could do to make this easier for you or other patients?
- What do you think the main value of eRAPID would be for patients? Were there any advantages and/or disadvantages to using eRAPID?
- Would you be happy to use eRAPID again in future if you had the need to?

Completion of symptom reports

If patient initially started using the system but then stopped.

- You initially used the system regularly but then you stopped. Can you remember the reasons why this was?
- Did you intend on using the system again in the future?
- Is there any support we could have given you to help you to complete at this time?

If patient has completed intermittently

- You used the system intermittently throughout the study. Can you remember the reasons why you didn't complete at this time?
- Is there any support we could have given you to help you to complete at this time?
- What made you start using the system again?

If the patient used the system regularly throughout the study.

- You used the system regularly. Can you tell us what your main motivations were for doing this? (For example, the graphs, self-management advice or for the clinicians) Did you feel that it helped you? If so, in what way?

Self-management advice

- Do you think that the system accurately assessed your symptoms? E.g. the types of questions asked, the severity level, etc.
- Did you get advice on how to manage your symptoms? Was it helpful? In what way?
- Did you receive advice to contact the hospital at any point? Did you think it was appropriate? Did you follow this advice? If not, what were your reasons for not following the advice?
- Did you find the information on the eRAPID website useful? Did you use any of it? Do you think that using the system had any effect on how you managed your symptoms and side-effects?

Graphical summaries of symptom reports

- Did you look at/use the graphs at the end of questionnaire?
- If not, can you tell us the reason (e.g. didn't find them useful, too complicated)
- If so, did you find them useful? In what way? What did you like about them? What did you not like about them?

Staff use of symptom reports

- Did the doctors/nurses use the system at your clinic appointments? What do you think the main value would be for clinicians?
- Do you think that using the system influenced your consultations in any way? If so, how? E.g. Do you think you had any medications prescribed or changes in treatment because of reporting symptoms on the system? Were you happy with these changes?
- Did anyone else (such as a relative) help you use the system? Do you think they found it useful?

Admissions and calls to the hospital

- Did you need to contact the hospital at any point due to symptoms or side-effects? If so, who did you contact? Did you use eRAPID prior to contacting the hospital? If not, did you

consider using the eRAPID system before you contacted the hospital? Did you use the card in your booklet? How/why did you decide to contact the hospital? How long were you unwell for before you contacted the hospital?

If patient was admitted during their time on study:

- Can you tell us a bit about your admission to hospital and what happened in the lead up to that?
- Did you use the eRAPID system before you contacted the hospital?
- Did the staff on the acute ward mention eRAPID to you, or did you mention it to them?
- Did your admission have any effect on your treatment? (e.g. delays, dose reduction)

If patient had any reported any clinically severe symptoms (triggering advice to contact the hospital)

- When you received the advice to contact the hospital, did you do so? If not, what action did you take and why?
- Did anybody contact you? Did they discuss your eRAPID results with you?
- What were the consequences of that contact?

Supplementary file B: Summary of professional interview schedule

Awareness

- How did you hear about eRAPID/QTool?
- Did you use the symptom report without being prompted by the patient or researcher? If yes, what influenced you to do so?
- What percentage of patients who had eRAPID/QTool results on PPM did you use/view?

Accessing symptom reports in the EPR

- Were you offered any training prior to using the system? Was there anything about the training that could have been done differently? Are you aware that online training is now available?
- Do you have any suggestions how we may improve communication with staff who are using the system?
- How useful did you find the one page prompt guides? (Positive and negative feedback)
- Did you use the facility at the bottom of the results to change access to the number of results you could view? Is there any value to this facility?
- What do you think of the way in which symptoms/adverse events are recorded/ displayed in patient records through the eRAPID system?
- Could you give examples of any positive and negatives experiences you had in accessing the eRAPID results (ease of use) on the HER?

Consultations

- What do you think the patients think about using eRAPID? Both in terms of logging in/answering the symptom reports and the value of the advice given.
- How has using the system impacted your consultation/assessment with patients?
- Did it change the doctor/nurse/patient relationship in any way? Could you give an example?

How did using the system impact on the length of time of the consultation?

- Were there any times when patient reported symptoms in the consultation did not match reported symptoms on the system? Could you give an example?
- Can you recall occasion/s when using the system influenced a change in patient management or treatment?
- What do you consider were the expected benefits/burdens in using the eRAPID system during the consultation?
- What do you consider were the unexpected benefits/burdens in using the eRAPID system during the consultation?
- What are your thoughts regarding the way in which patients have used the self-management advice available on the eRAPID system?

Severe symptoms notifications

- Have you ever responded to an alert on the system? If so can you talk me through any particular issues?

General

- Overall what do you think were the main advantages and disadvantages to using the system?
- Do you have any suggestions for how we could promote/encourage staff to access/use the eRAPID patient data in PPM in the future?
- What do you think the main facilitators were in using the eRAPID system?
- What do you think the main barriers were in using the eRAPID system?
- Do you have any suggestions in how we could improve the system?
- Would you recommend systems like eRAPID to other centres? If yes/no why?

Supplementary file C: Summary of patient end of study feedback form: Multiple choice items and accompanying response options

1. How easy or difficult was it to learn how to use the eRAPID system?
   Very easy/Easy/Neither easy nor difficult/Difficult/Very difficult
2. How easy or difficult did you find accessing the system? (e.g. finding the website and logging in)
   Very easy/Easy/Neither easy nor difficult/Difficult/Very difficult
3. How easy or difficult was it to answer the questions about your symptoms?
   Very easy/Easy/Neither easy nor difficult/Difficult/Very difficult
4. How did you feel about the amount of time it took to complete the symptom questions?
   Too long/About right/ Too quick
5. How relevant were the symptom questions to you?
   Not relevant at all/ Very few questions were relevant/Neither relevant or irrelevant/ Quite relevant/ Very relevant
6. What did you think about completing these questionnaires every week?
   Definitely too often/ A little bit too often/ Unsure/ I was happy to complete them every week/ I would have been happy to complete them more often
7. Were there any times when you missed a week of completing the symptom questionnaire?
   No/Yes
8. Did the doctors and nurses you saw during your treatment use your eRAPID symptoms information during consultations?
   Yes quite a bit/ Sometimes/ Not at all
9. If yes, did you feel this improved your consultations with the staff?
   Yes quite a bit/ Sometimes/ Not at all
10. To what extent do you feel that the symptom questionnaire was useful for the doctors and nurses you saw during your treatment? Very useful/A little useful/Unsure/Not very useful/Not at all useful
11. How useful did you find the information on the eRAPID website about the symptoms and side effects of cancer treatment? Very useful/A little useful/Unsure/Not very useful/Not at all useful
12. Would you recommend the eRAPID system to other cancer patients?
    No/Not sure/Yes

Supplementary file D: Clinician eRAPID feedback form

Date of completion_____ Name of clinician_____

1. How well did you know this patient from before?

Never met him/her before	
A little	
Moderately well	
Very well	

2. Did you look at the patients' eRAPID symptom information in PPM before/ during the consultation?

Yes	No

3. Did you use the eRAPID symptom information in the clinic discussion?

Very much	Quite a bit	Somewhat	A little	Not at all

4. Did you find the eRAPID symptom information useful?

Very much	Quite a bit	Somewhat	A little	Not at all

5. If yes, in what way?

Provided additional information	
Confirmed your knowledge of patients' problems	
Identified issues/problems to be discussed	
***Contributed to management**	

If you answered "Contributed to management", please specify in what way below.

Change of medication	
Ordering of investigations	
Decision about chemotherapy	
Referral to supportive services (e.g. psycho-oncology, social worker)	
Counselling about lifestyle	

Other: Please specify

6. Are there any additional ways you have found the eRAPID symptom information useful?

Supplementary file E: Graphical summary of additional information from clinician feedback forms

FIGURE 1 CLINICIAN FEEDBACK ON WAYS ERAPID WAS USEFUL

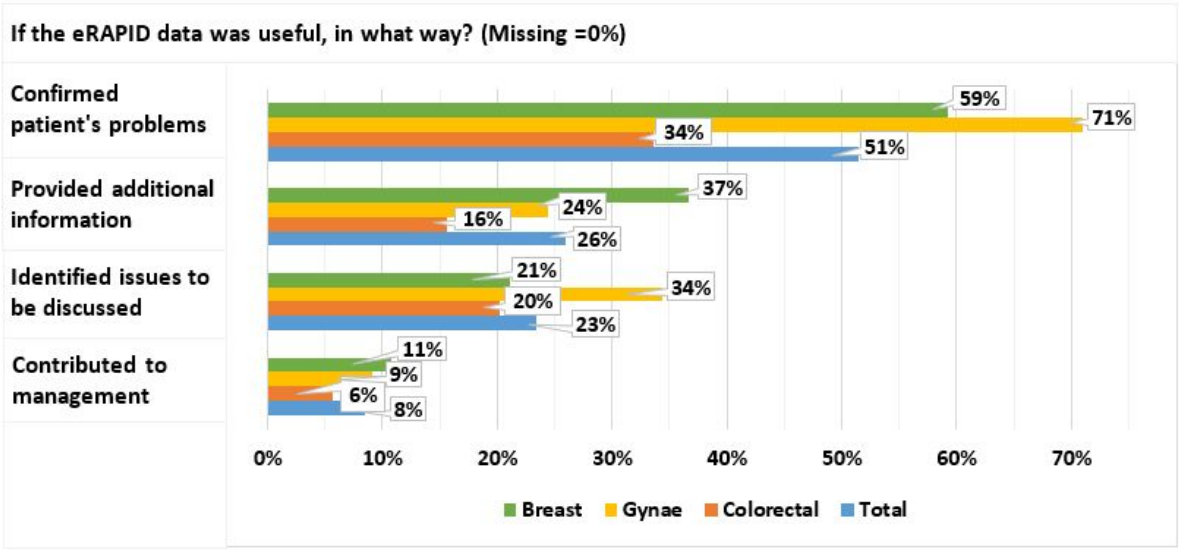
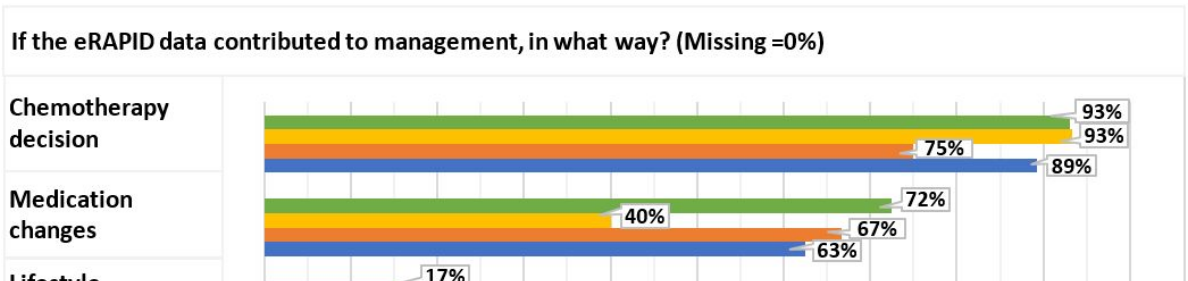


FIGURE 2 CLINICIAN FEEDBACK ON HOW ERAPID CONTRIBUTED TO MANAGEMENT



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Keywords:	Patient Reported Outcome Measures, ONCOLOGY, QUALITATIVE RESEARCH, Telemedicine < BIOTECHNOLOGY & BIOINFORMATICS, Quality of Life, Surveys and Questionnaires

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Patient and clinician perspectives of an eHealth intervention for supporting cancer treatment: Mixed methods evaluation of the eRAPID randomised controlled trial.

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Abstract

Objectives: During 2015-2018, a Randomised Controlled Trial (RCT) evaluated eRAPID, an eHealth intervention designed to capture patient-reported symptoms online during cancer treatment. eRAPID provides patients with advice on when to self-manage or seek medical support. Clinicians accessed symptom reports within electronic patient records. 508 participants starting systemic cancer treatment were recruited and followed for 18-weeks. The intervention group (n=256) were asked to access eRAPID and complete weekly online symptom reports. Clinicians received training on accessing and interpreting symptom reports. Overall, eRAPID had a positive impact on patients' symptoms, quality of life and self-efficacy, particularly early in treatment and for patients with early-stage disease. Using mixed-methods, we aimed to gather insight from patients and clinicians on how eRAPID worked to facilitate interpretation of RCT findings.

Design and participants: Patient experiencese of eRAPID were gathered via end-of-study interviews (n=45) and questionnaires (n=186). Clinician experiences were obtained by end-of-study interviewsinterviews (n=18) and completion of feedback questionnaires throughout the trial (n=55). Framework analysis was applied to examine qualitative data and close-endedquestions were descriptively summarised. Findings were subsequently mapped against results from the RCT.

Setting: Medical oncology services, UK cancer centre.

Results: Patient feedback indicated eRAPID was easy to use. Adherence to weekly reporting was influenced by health status, reminders, perceived value, and clinical use. Patient reported benefits of eRAPID included an enhanced connection with the hospital, provision of practical advice and personal monitoring, which provided reassurance and empowerment. Clinicians were positive about the potential for online symptom monitoring but had mixed levels of direct experience with using eRAPID during the trial. Patients echoed this and recommended more explicit clinician use of symptom data.

Conclusions: The mixed-method approach to capturing patient and professional opinions provided valuable insight on the eRAPID intervention and complementary information on how the intervention was received and functioned.

Strengths and Limitations

- The mixed methods approach (combining results from interviews and feedback questionnaires) provides important insight on how the eRAPID health intervention functioned in practice when mapped to the findings from the main randomised controlled trial.
- The perspectives of a large number of participants involved in the trial were obtained (186 patients and 55 professionals).
- Although feedback questionnaires were collected from health professionals throughout the study, interviews were only conducted at the end of the trial. The resources were not available for more objective assessments of how the intervention was used in practice (such as video or audio observations or system analytics).
- There are some biases in the study sample due to the trial eligibility criteria (English-speaking, basic level of computer literacy and internet access). In addition, it was difficult to capture the perspectives of those patients who did not engage as they often withdrew from the study.

Introduction

Systemic cancer treatments (chemotherapy, hormonal therapy, targeted drugs, and immunotherapy) are associated with side effects affecting patients' everyday functioning and quality of life (QoL) and can lead to life-threatening risks. Oncology teams are required to safely monitor patients during treatment to identify symptoms before they become serious, whilst providing advice for managing mild/moderate issues.[1, 2] As systemic treatments are typically administered in day-case outpatient settings, patients and caregivers play an important role in health monitoring from home but can have difficulty in determining severity of issues.[3] Standard practice for monitoring patients during treatments involves routine clinician-led assessment between cycles. Assessments rely on patient recall of problems experienced in previous weeks and clinicians making accurate judgements about severity. Standard practices do not easily allow comprehensive tracking of patient symptom trajectories over time.

There is a drive for health services to adopt technology-driven care solutions to improve cancer care during cancer treatment [4, 5] and growingg international evidence demonstrates that electronic monitoring systems using Patient Reported Outcome Measures (PROMs) in the cancer setting can benefit patient QoL [6-8] and survival.[9, 10] However, electronic PROMs (ePROMS) to facilitate patient monitoring of symptoms has not been widely adopted [11, 12] and there is considerable variation in how systems are designed and embedded into clinical pathways.[13] Patient and clinician views on everyday experiences of these systems are vital to understand mechanisms for intervention success and help refine development and implementation strategies.[14]

Developed using co-design principles, the eRAPID electronic health intervention allows patients to self-report symptoms online from home during treatment.[13, 15, 16] eRAPID provides automated advice based on clinical algorithms to guide patients to self-manage mild/moderate issues or contact medical teams when potentially serious problems arise.

During 2015-2018, we evaluated eRAPID in a randomised controlled trial (RCT) in the systemic treatment setting with patients diagnosed with breast, gynaecological or colorectal cancer.[17, 18] The primary outcome was symptom control (measured by the Functional Assessment of Cancer Therapy Scale-General Physical Well-Being subscale [19] (FACT-PWB, scores 0-28, high scores = better symptoms) and secondary outcomes included impact on QoL, self-efficacy, process of care measures (treatment delivery, hospital admissions and telephone contacts) and costs. Results evidenced better symptom control with eRAPID at 6- and 12-weeks, but not 18-weeks, from start of treatment. Improved patient self-efficacy to manage symptoms was found at 18-weeks.[18] Benefits were more evident for patients with early stage cancer than those with metastatic disease. Patient adherence to weekly symptom reporting was good with an average of 64.7% (varying between 72% in week-1 to 58% in week-18). eRAPID did not increase hospital workload or influence treatment delivery and the costs for the eRAPID group were lower at 18 weeks. Clinician use of symptom data was positively associated with patient adherence to online reporting, which was in turn associated with improved symptom control. However, use was variable between clinicians.

Aims and objectives

As part of the RCT design, we adopted a mixed methods approach to gain a better understanding of how eRAPID worked in practice .[20]. Interviews and questionnaires were used to elicit feedback and experiences from both patients and clinicians on their use of

eRAPID and these results were combined and contrasted with the main RCT results [21]. The aims were to:

- ExploreE patient and professional views of the acceptability of eRAPID in terms of usability, value of specific system features and to identify how the intervention might be refined for future routine implementation.
- Explore barriers and motivators for use of eRAPID for both patients and clinicians to inform future implementation.
- Better understand any benefits of eRAPID demonstrated in the RCT by exploring how the intervention impacted on clinical care.

Methods

We used a concurrent triangulation design [22], combining both qualitative and quantitative data from patients and clinicians evaluating eRAPID, with the results of the randomised controlled trial **(Figure 1)**. More detail on the data and analysis techniques used is outlined below.

eRAPID RCT in systemic cancer treatment

The eRAPID intervention and RCT protocol are described elsewhere.[17] In summary, this was a single site parallel RCT with an internal pilot in a UK cancer centre. English-speaking adult patients with internet access starting systemic treatment for breast, gynaecological or colorectal cancer were eligible. Participants were randomised to Usual Care or eRAPID intervention + Usual Care.

Intervention participants had access to eRAPID and were asked to complete symptom reports online (via computer, tablet or smart phone) weekly for 18-weeks (reminders sent via SMS or email). The system provided automated severity tailored patient advice for managing reported issues. Mild or moderate problems generated self-management advice and/or recommendations to discuss the issue at next clinic visits. For severe and clinically relevant symptoms, patients were advised to immediately contact the 24-hour Acute Oncology service. Email notifications were sent to key clinicians; however, this functionality was not highlighted to patients, to avoid creating an expectation of direct follow-up. Patients could view graphical summaries of their symptoms over time. Clinicians were trained to access and interpret patients' symptom reports which could be accessed within the hospital's electronic patient records (EPR) and viewed in tabular or graphical formats.

Procedures for obtaining feedback from patients and clinicians

Interview procedures

Patients: We invited a subsample of intervention participants to complete an interview at the end of study period (18 weeks). We aimed to interview 5-10 per cancer site and purposively sampled participants based on age, sex, cancer site and adherence to weekly symptom reporting. Patients were interviewed at their convenience at the end of the study, in a private room at the hospital. The semi-structured interview schedule was originally developed based on concepts influencing behaviour change, such as motivators, barriers, attitudes, and intentions. This was piloted in a usability study [23] and some minor refinements were made.. Broadly, the interviews explored personal experiences, use and views of eRAPID, impact on medical care and interactions with clinicians **(Supplementary file A**).

Clinicians: We arranged end-of-study interviews with up to 5 clinicians (specialist nurses and oncologists) from each cancer site. The semi-structured interview schedule **(Supplementary file B)** explored access and use of eRAPID patient data and its perceived value in clinical practice.

Feedback questionnaire procedures
We obtained additional feedback through:

Patient feedback questionnaire
We developed a feedback questionnaire to complement the data captured in the interviews. All patients on the intervention arm who were still on study at the end of 18-week study period were invited to complete thisthis, allowing us to gain feedback from a wider range of patients. The questionnaire included:

- Twelve closed questions focusing on ease of using eRAPID, how symptom data were used by the clinical team, and perceived value of eRAPID for themselves and future patients **(Supplementary file C)**.
- Five free-text questions covering use of eRAPID*:*
  - Reasons for non-adherence to weekly reporting
  - Positives and negatives
  - Suggestions for improvement
  - Any other comments.
- The System Usability Scale (SUS).[24] A 10-item scale widely used to gain subjective assessment of the usability of computer systems. Participants rate 10 statements from 1-5 (strongly agree to strongly disagree). Overall scores range from 0-100 with higher scores indicating better usability. Scores over 68 are above average.

Clinician feedback questionnaire
Clinicians were prompted to complete feedback questionnaires throughout the 18-week study period, each time they had a routine consultation with an eRAPID intervention patient. This questionnaire was developed by the research team for use in a previous RCT assessing clinician use of PROMs in clinical practice. [25] **(Supplementary file D)**

The questionnaire included:

- Close-ended questions to indicate if and how clinicians:
  - Used eRAPID data
  - Found eRAPID useful
  - Used eRAPID to contribute to patient management
- Free-text boxes to provide comment on:
  - Additional ways they found eRAPID useful
  - Any other comments.

Patient and public involvement (PPI)
PPI was prioritised throughout the eRAPID programme of work and further details of this are available elsewhere.[26] In the work described here specifically, our PPI co-authors (BW & VC) have supported the development of evaluation methods, reviewing patient materials such as information sheets and questionnaires, and contributed to manuscript preparation.

Analysis
Qualitative data (interviews and free text written comments)
Interview recordings were transcribed verbatim, transferred to NVivo and analysed using a framework method by members of the eRAPID research team (KA, LW, MH, RP, AG, ZR, SD). The framework method is a type of thematic analysis which can be applied using a combined deductive and inductive approach. This approach allowed the teamto answer the specific research questions while allowing for the discovery of unexpected themes and topics.[27, 28] Following data familiarisation, we created a coding framework guided by the topics in the interview schedule and sub-themes identified from data. Two researchers

coded each transcript and the team worked collaboratively to resolve queries, refine the framework, and maintain a coding log. We allocated one or more main themes to each researcher to extract relevant coded quotes from NVivo into separate spreadsheets for charting and summarising data to draw overall conclusions. We collated, reviewed, and summarised free-text responses from feedback questionnaires under the overarching qualitative coding framework.

Quantitative data (close-(ended questions)

We conducted analysis using SPSS version 26. We scored the SUS according to instructions. Differences between cancer sites and metastatic and non-metastatic patients were explored using one way ANOVA and independent t-test respectively. Close-ended responses from feedback questionnaires were summarised using descriptive statistics.

Synthesis of participant feedback with main RCT findings

Using the joint display approach to integrating qualitative and quantitative data in mixed methods studies, we mapped patient and clinician feedback against the primary and secondary eRAPID RCT outcomes.[21, 29] (Table 2).

Results

Participants

Patient sample

Target recruitment was met with 508 patients consented and randomised in the RCT: Usual Care (n=252) and eRAPID intervention (n=256). Two hundred and twenty-two patients in the intervention arm remained on study at 18-weeks and 186 (84%) completed feedback questionnaires and 45 participated in interviews (**Table 1**). 20% (n=38/186) of patients who completed feedback questionnaires and 24% (n=11/45) of patients interviewed had previously had chemotherapy.

Clinician sample

Fifty-five clinicians participated in the RCT, utilising eRAPID data during routine consultations, all completed at least one feedback questionnaire and 18 were interviewed (**Table 1**). Of an expected 1,314 questionnaires, 787 (59%) were completed and 218/256 (85%) of intervention patients had their symptom data reviewed by a clinician at least once.

Reasons for questionnaire non-completion included clinicians forgetting due to the relatively small number of eRAPID intervention patients seen in clinics, researchers being unable to prompt clinicians due to last-minute appointment changes, and not having symptom data to review due to patient non-adherence.

Patient perspectives

Patient interviews and feedback questionnaires covered three overarching and interlinking themes:

- AcceptabilityA and functionality
- Impact on clinical care
- Personal value of using eRAPID

We describe each theme below with a focus on patients' views on the use of eRAPID. **Figure 2** provides a graphical representation summarising key elements of the patient perspective.

Acceptability and functionality
This theme explored how easy patients found the navigation and use of eRAPID to complete their symptom reports and what the main barriers and facilitators were for adherence to weekly symptom reporting.

Ease of useQuantitative data from feedback questionnaires (**Figure 3**) indicated most patients found eRAPID easy to use (96%), easy to complete (92%) and thought the length of time it took was about right (97%).

SUS scores ranged from 25-100 with a mean of 83.3 (SD 14.4). An independent t-test indicated patients with non-metastatic disease reported higher scores (M=86.0, SD=12.8) than those with metastatic disease (M=80.7, SD=16.9) and this was statistically significant (95% CI, 0.8 - 9.9, p=.036). A one-way ANOVA (F (2,173) = 2.919, p =.057) indicated no statistically significant difference in SUS scores between breast (M=87.0, SD=12.8), colorectal (M=81.4, SD=16.9) and gynae (M=83.0, SD=11.7) cancer patients.

Interview data also indicated that patients found eRAPID easy to use and did not experience any major issues accessing or using the system. Comments from free-text sections of the feedback questionnaire suggested some improvements including creation of an eRAPID app and provision of the facility to provide more detailed information about symptoms, upload photos for specific symptoms such as rashes, and record current medications.

RemindersEmail/text reminders were important facilitators for adherence, though some individuals also set their own weekly routines.

> *'… I'd kind of disciplined myself to do it on a Wednesday.'* (Patient A, Gynaecological).

Health statusHealth issues such as fatigue, cognitive/memory issues and hospitalisation were common barriers to adherence.

> *'...it was nothing to do with the system or finding it difficult, the thing that was difficult for me was the absolute fatigue with the chemotherapy, just totally wiped me out.'* (Patient B, Gynaecological)

Relevance of symptom items
Patients found the symptom report relevant (92%) and qualitative data supported this. However, some found the weekly completions and associated advice repetitive, particularly when their symptoms did not change. Somethought the response options were too limited and did not allow scope to add detail.

> *'The answers could be too black or white, when life is generally more grey and there were no extra boxes to explain*.' (Patient C, Colorectal)

Impact on clinical care
This theme explored patients' perceptions of how eRAPID impacted on their clinical care and influenced their interactions with clinical staff during their cancer treatment.

Clinician engagement with eRAPID
42% of patients thought clinicians regularly used their symptom reports while 21% thought they were not used at all. Qualitative comments supported these mixed experiences. A few patients reported clinicians being explicit about using eRAPID data to guide consultations.

> *'…our chemotherapy doctor, he would bring it up every time and show us it and talk me through any concerns that he had… that re-incentivised me to use the system because you know it's not just a waste of time, somebody's looking at it.'* (Patient D, Gynaecological)

However, others expressed significant disappointment that clinicians did not use their symptom reports and cited this as a barrier to use. A clear recommendation from patients for future refinement of eRAPID was increased and explicit clinician use of the symptom reports.

> '*No feedback from anyone – was expecting at least someone discussing usage of system but didn't happen at all after using it for 3 times – so stopped using it.'* (Patient E, Colorectal).

Facilitated consultations

63% of patients thought their symptom reports were useful for clinical staff, often leading to better understanding of experiences. Weekly symptom reporting served as a memory prompt, as patients did not have to try to recall symptoms weeks later.

> *'At clinic visits I had sometimes forgotten about some of the symptoms I had experienced over the three-week period since my last visit…'* (Patient F, Breast)

Medication/treatment changes

Some patients described changes to their clinical management, such as prescription of medications or changes to their chemotherapy, as a direct result of their symptom reports.

> *'Doctors and nurses referred to my answers. Doctor reduced chemo dosage to help my sore throat.'* (Patient G, Breast)

Personal value of using eRAPID

This theme describes the range ofpersonal benefit patients experiencedfrom using eRAPID.

Link to the hospital

Some patients experienced a heightened sense of connection with the hospital:

> *'It helps with continuity of care. I feel under constant supervision of my treatment*.' (Patient H, Breast)

> *'It's like keeping in touch… without making an appointment to see anyone.'* (Patient I, Colorectal)

Information resource

Patients found the symptom advice useful (92%). Many reported reassurance in having tailored advice from a trusted source and having their symptoms monitored.

> '*Peace of mind that you were being monitored and any potential issues e.g., high temperature would give you guide as to whether to ask for help.'* (Patient J, Breast).

For some metastatic patients who had chemotherapy previously, the value of advice was limited as they were already familiar with how to manage symptoms.

> ***'**Well because I'm a bit of an old hand at chemo I think….it was only telling me what I already knew*.' (Patient K, Gynaecological)

Self-monitoring

The process of routine symptom reporting and tracking symptoms over time was also empowering.

> '*Felt good to record my symptoms every week - felt like I was taking an active role in my treatment*.' (Patient L, Breast).

> *'I think it was useful for us because you got the little graphs. So, you could compare how you… were feeling in comparison to how you'd been before*.' (Patient M, Colorectal)

For some the benefit of the system was more apparent early on in treatment and less useful later as they became familiar with symptoms/treatment.

> '*Some weeks I had no symptoms to report. After the first couple of cycles on each drug I didn't find the system beneficial.'* (Patient F, Breast)

Guided decision-making
In some cases, the symptom advice engendered a sense of confidence that patients and carers were taking the right action, including when to seek medical advice:

> *'…gave me and my family more confidence to manage side effects especially early on in the treatment… gave me 'permission' to contact the hospital if I was worried…..'* (Patient O, Colorectal)

Research study
Some patients reported that their main motivation for adherence was a sense of responsibility to honour their commitment to participating in the research, rather than personal benefit.

> '*I saw it as, 'well I have agreed to this research thing so I will do it'…So that's probably the biggest motivator… just because I said I would do it.'* (Patient P, Gynaecological).

Clinician perspectives
Clinician feedback on eRAPID was summarised into the following overarching themes.

- AcceptabilityA and functionality
- Impact on clinical carecare
- Perceived value of eRAPID for patients

The main descriptive results from clinician feedback questionnaires are included in the themes below. Additional findings are in **Supplementary file E.**

Acceptability and functionality
This theme explored clinicians' views on how easy it was for them to view, access and interpret patients eRAPID reports.

Predominantly clinicians found it easy to access symptom reports within the electronic patient records.

> *'The system was very easy to use, it's on the system we use in clinic, you just have to click a button, all the information is there, so it was easy to use, readily available.'* (Colorectal, Senior oncologist)

Presentation of symptom data in both tabulated and graphical forms was useful to address different needs and preferences.

> *'I quite liked the graphs, simply because it was very quick and easy to be able to see if something had particularly changed''* (Gynaecology, Senior oncologist)

> *'I like the tables, I'm not a big fan of the graphs… it's easier to see quite a lot of information quickly on the tables…. Personally, I didn't see the extra value to the graphs.*' (Colorectal, Specialist nurse)

Due to the relatively small number of eRAPID intervention patients seen in clinics, it was easy for clinicians to miss reports, particularly as there was no facility in the electronic records to flag them.

'*I think it will be even more useful when, if it's used in routine practice because you wouldn't forget to look at it.'* (Colorectal, Senior oncologist)

Impact on clinical care

This theme describes clinician views on if and how eRAPID impacted on patients' clinical care and influenced their decision-making.

Clinicians reported accessing eRAPID data on 81% (641/787) of the post-consultation feedback questionnaires completed. Clinicians rated to what extent they used eRAPID and how useful they found it on a Likert-type scale from 'not at all' to 'very much'. 90% used it at least 'a little' and 90% found it at least 'a little' useful (**Figure 4**).

Gynaecology clinicians were more likely than breast or colorectal clinicians to report using eRAPID 'quite a bit'/'very much' (30% vs 22% & 21%) and finding data useful 'quite a bit'/'very much' (46% vs 26% & 28%). However, gynaecology and breast clinicians were also more likely to report not using the data at all (20% & 18% vs 8%) and not finding the data at all useful (13% & 11% vs 5%) compared to colorectal clinicians.

Clinicians indicated finding eRAPID useful on 663/787 (84%) of feedback questionnaires. Those that answered 'Yes; to this question werewere asked to indicate the specific way or ways it was used from a list of options, 51% said it confirmed knowledge of patients' problems, 26% said it provided additional information, 23% said it identified problems to discuss and 8% said it contributed to management **(Supplementary file E).**

Qualitative interview data supported these findings with clinicians describing eRAPID as a helpful tool in structuring/preparing the consultation and building a connection with the patient.

'I found it helpful because it informs you before the patient arrives and I think it also stops you having to ask the patient 300 questions every time they come.' (Gynaecological, Specialist nurse)

'There is an instant rapport because she thinks okay this one knows about me and I think that's been very helpful for me.' (Breast, Senior oncologist)

However, other clinicians thought using symptom reports made consultations longer. One clinician found using eRAPID to be a conflict to their usual practice.

'… you have your own way of doing it, which I've been doing for such a long time and I just, it just didn't kind of resonate with me I'm afraid.' (Breast, Senior oncologist)

Clinicians recognised the benefit of being able to identify trends in symptom trajectories and viewed the symptom reports as accurate. However, some had reservations about patients reporting issues not relevant to the cancer/treatment and some reported a lack of concordance between what patients reported online vs face-to-face.

'Patient contradicted information reported on eRAPID i.e., denying any nausea which was confusing.' (Colorectal, Specialist nurse)

In a relatively small number of consultations (n=56), clinicians indicated that eRAPID contributed to management, such as a change to chemotherapy/medication **(Supplementary file E).** Qualitative data supported this, as some clinicians reported using eRAPID data to make decisions such as prescribing antibiotics for infections, providing advice on laxatives and reducing chemotherapy doses.

'Enabled to advise regular antiemetic and anti-spasmodics based on their pattern of occurrence relating to chemotherapy cycle.' (Breast, Specialist registrar)

Perceived value of eRAPID for patients
This theme explored clinician views of if and how eRAPID was useful for patients during cancer treatment.

Several clinicians commented that eRAPID was beneficial for patients.

> *'…it gave them permission to ring when they potentially may have not necessarily rung but may have tolerated it to the point where it becomes just slightly less easy to resolve.'* (Breast, Specialist nurse)

However, others described a range of patient-centred barriers to adopting the system into routine care, which includeded variation in patient compliance with online reporting, requirement of English language and IT access and fluency.

> *'…the patients that don't have access to the computer are the patients that we should be more concerned about because they might be…less literate or ...less able to communicate their needs and concerns….* (Colorectal, Specialist nurse)

Synthesis of feedback with key findings from the eRAPID RCT
In **Table 2**, we present the key RCT findings and map these with experiences described by patients and clinicians during interviews and inin feedback questionnaires.

Improved symptom control (FACT-G PWB) at 6 and 12-weeks, health status and overall QoL at 18-weeks and self-efficacy at 18-weeks
Patient feedback supported our findings of the benefits of eRAPID with patients reporting detailed examples of how the intervention was beneficial. Qualitative findings offered insight into why the benefits of the intervention were limited to the earlier stages of treatment, e.g., lack of impact on symptom controlcontrol at 18-weeks. Patients often reported finding symptom advice more useful during the initial weeks of chemotherapy and less useful later as they became more experienced in symptom management. Some metastatic patients with previous chemotherapy experience reported that eRAPID would have been more useful the first time around, offering insight into the greater benefits seen in the non-metastatic patient group.

High rates of patient adherence
Qualitative data indicated that eRAPID was easy to use and access. However, in some instances, adherence declined towards the end of the 18-weeks. Again, this may be explained by some patients finding eRAPID less useful in later stages of chemotherapy. Additionally, patient adherence was associated with the reported clinician use of eRAPID during consultations. Qualitative feedback from patients reported explicit clinician use of eRAPID as a motivator for engagement, but a barrier when clinicians did not acknowledge their symptom reports.

No differences between eRAPID and usual care on chemotherapy delivery, hospital admissions, acute oncology assessments or emergency hotline calls
Clinician feedback questionnaires reported a small number of examples of using eRAPID data to guide treatment decisions. Patients reported that eRAPID gave them 'permission' to contact the hospital for severe symptoms; however, they also reported that self-management advice empowered them to manage symptoms at home.

No difference in benefits of eRAPID between breast, colorectal and gynaecological patient groups
Qualitative data indicated some differences in clinician engagement between the groups, with typically gynaecological clinicians engaging more with eRAPID.

Discussion

As part of the eRAPID RCT, we aimed to capture information from patients and clinicians, via interviews and written feedback, to understand experiences of using the system to help explain results and improve future refinement of this approach in cancer care.

Both patients and clinicians reported that eRAPID was easy to use. The main advantages from a patient perspective included its role as a trusted source of information and advice, providing enhanced connection with the hospital. However, patientsthought the system could be improved, particularly in terms of clinician use. Although some patientsreported that clinicians actively addressed and utilised their symptom reports, others had no recollection of clinicians reviewing their data at all. Understandably, this was disappointing leading to some patients becoming less engaged. These findings align with results from the RCT where clinician use of data was positively associated with patient adherence to weekly completions.

In addition, we found important benefits for patients around increased self-efficacy and QoL in the RCT. Previous trials have focused on patients with advanced disease and our findings demonstrating the benefits of this approach for patients with early disease is an important one. The qualitative insight we have gained about the mechanisms of this benefit has valuable implications for future development and implementation of similar systems.[14]

Some clinicians were very positive about the value of eRAPID for assisting with consultation preparation and providing a focussed discussion. Some found it valuable in saving time and identifying symptom trends. In practice, the design of the RCT meant some clinicians had limited exposure to eRAPID intervention patients, and the lack of an automated facility for flagging reports in the electronic patient records meant they could easily miss patients with symptom reports available.

Clinician feedback was variable between clinics, with those in gynaecology reporting higher use and usefulness of eRAPID. However, this did not translate into a difference in outcomes between patients in the different cancer sites. This may be simply because our RCT was not powered to detect statistical differences in secondary outcomes such as these, and it may also be partially due to differences in how individual clinicians used data or the complex multi-faceted ways eRAPID benefitted patients. For example, the RCT indicated the intervention was more beneficial for non-metastatic patients and qualitative data provided some insight into this, with patients that had experienced chemotherapy previously finding the information less novel/useful. The gynaecological group had a high proportion of metastatic patients, particularly in comparison to the breast group. While gynaecology patients may have benefitted from increased clinician engagement, this advantage may have been diminished by the higher proportion of metastatic patients when compared to the colorectal and breast clinics who seemed to derive greater benefit from the eRAPID information and advice.

While evidence from other trials have indicated that remote monitoring can impact outcomes such as hospital admissions, treatment delivery and even survival [6, 10], this was not a finding in our RCT, which did not find a difference between eRAPID and usual care for hospital contacts or admissions. Although our qualitative data indicated that eRAPID guided patient decision-making about hospital contact and self-management, it is likely that the impact of eRAPID on hospital contacts is complex, and difficult to assess by a quantitative comparison. eRAPID may increase the number of contacts and admissions by advising patients to contact the hospital, while on the other hand, it may reduce contacts by supporting self-management when appropriate.

There are some limitations to our methods and the scope of findings. First, we conducted patient interviews at the end of the study period. Longitudinal interviews over the course of the 18-week study period may have provided more understanding into how patient use and

engagement with eRAPID fluctuated over time. However, the interview data did provide some nuanced insights into patient and clinician experiences of how eRAPID impacted care. Second, we relied on patients and clinician accounts of how eRAPID symptom reports influenced care. Clinicians usually completed feedback questionnaires immediately after consultations; however, we only collected basic information due to clinic time constraints. In addition, there was a high rate of missing data for these questionnaires, limiting their generalisability. In a previous study, we found it useful to audio-record consultations and use coding methods to evaluate how PROMs influenced discussions.[25] However, this was not possible in the current study due to resource constraints and the pragmatic nature of the trial.

Another limitation is that patients who did not engage with eRAPID at all were likely to withdraw from the trial and were unavailable for interview or questionnaire completion. However, this was a relatively low proportion of patients and we specifically targeted those with low adherence to compensate for some of this bias. There will be some additional bias in our sample simply because eligibility required patients to be English-speaking and to have some level of IT skills and access.

Moving forward we are working on future implementation strategies to take eRAPID into routine care. We have experienced similar challenges around implementation to those reported by others working in this arena across clinical areas [12], such as barriers around hospital IT systems and health care infrastructure. An important element of ongoing work is the engagement and training of both patients and clinicians to maximise the use and clinical value of PROMs data. Ensuring that selected PROMs are both relevant to clinical care and meaningful to patients whilst managing the burden of item completion remains challenging. Ongoing efforts to explore how PROMs content should be refined to align with clinical need through the cancer trajectory and the potential for incorporating computer adaptive testing (CAT) techniques are warranted. Insights provided by this qualitative work and our previous development activities is vital to contribute to an evidence base of patient and clinician perspectives in a variety of contexts and give insight into how to successfully implement ePROMs into the clinical pathway.[30-32] We have funding to expand on analysis of the eRAPID study data using innovative methodologies such as through case study and latent class analysis, in addition to exploring optimal methods of PROMs data visualisation for both clinicians and patients. This work will further inform the clinical value of PROMs data in cancer practice and enable targeted refinement of the eRAPID intervention.

As PROMs become more widely adopted, it remains vital to explore their practical implementation to ensure they effectively serve patients and clinical teams. ePROM interventions like eRAPID, are often complex and multi-faceted. Qualitative methods used alongside evaluations can provide invaluable insight into the mechanisms by which patients and clinicians may benefit and identify limitations and opportunities for improvement.

Author contribution

LW, KA, GV, JB, BD, CH, & BW contributed to the development of the evaluation methodology.

LW, MH, AG, RP, ZR, PH & SD contributed to participant recruitment and data collection.

LW, KA, GV, MH, AG, RP, JB, JH, EH, BW, SD, VC, & ZR contributed to data analysis and interpretation of findings.

All authors contributed to the preparation and reviewing of the manuscript.

KA and GV are joint guarantors for the overall study and manuscript.

Competing interests

GV has received honoraria from Eisai, Pfizer, Novartis and has provided consulting/advisory roles for Roche UK, Eisai, Novartis, Sanofi, Pfizer, AstraZeneca, Seagen.
JB has received institutional funding from National Institute for Health and Care Research (NIHR), Roche, European Union, Janssen, Abbvie, Pierre Fabre.
We declare no other competing interests.

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Data sharing statement

Requests for data sharing should be directed to LW or KA. Full interview transcripts and questionnaire data are not available to protect participant anonymity.

Ethical approval

The study was approved by National Research Ethics Service Leeds East Committee (14/YH/1066).

Trial Registration

ISRCTN88520246 https://doi.org/10.1186/ISRCTN88520246.

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Figure Legend

Figure 1: Overview of mixed method approach using concurrent triangulation design

Figure 2: Overview of patient perspective of the use and impact of eRAPID

Figure 3: Feedback of eRAPID from patient questionnaires

Figure 4: Feedback on eRAPID from clinician questionnaires

TABLE 1: OVERVIEW OF PARTICIPANTS WHO COMPLETED INTERVIEWS AND FEEDBACK QUESTIONNAIRES

Patients		**Interviews* (n=45)**	**Feedback questionnaires* (n=186)**
Age	Mean age, years (SD)	54.6 (12.5) range 22-80	57.0 (11.7) range 24-86
Sex	Male	9 (20%)	43 (23%)
	Female	36 (80%)	143 (77%)
Breast	Total	24 (53%)	87 (47%)
	Primary/local	23 *(96%)*	83 *(95%)*
	Metastatic	1 *(4%)*	4 *(5%)*
Gynae	Total	9 (20%)	34 (18%)
	Primary/local	2 *(22%)*	6 *(18%)*
	Metastatic	7 *(78%)*	28 *(82%)*
Colorectal	Total	12 (27%)	65 (35%)
	Primary/local	9 *(75%)*	35 *(54%)*
	Metastatic	3 *(25%)*	30 *(46%)*
Staff		**Interviews (n=18)**	**Feedback questionnaires (n=55)**
Category	Specialist nurse	7 (39%)	10 (18%)
	Senior oncologist	8 (44%)	15 (27%)
	Junior oncologist	3 (17%)	28 (51%)
	Pharmacist	0	2 (4%)
Clinic	Breast	6 (33%)	19 (35%)
	Gynae	6 (33%)	14 (26%)
	Colorectal	2 (11%)	8 (15%)
	Mixed clinics	4 (22%)	14 (26%)
Sex	Female	12 (67%)	38 (69%)
	Male	6 (33%)	17 (31%)

*These are not distinct groups. Some participants who completed interviews also completed feedback questionnaires.

TABLE 2: SYNTHESIS OF FEEDBACK WITH KEY FINDINGS FROM THE eRAPID RCT

Key findings from RCT [18]	Relevant themes from qualitative data	Summary of patient and clinician experiences	Level of complementary evidence
eRAPID associated with better: - SymptomSymptom control (FACT-GFACTG PWB) at 6 and 12-weeks - Health status and overall QoL at 18-weeks	PersonalPersonal value of using eRAPID (Subthemes: Link to the hospital, Information resource, self-monitoring, guided decision-making, research study) Acceptability and functionalityf (Subthemes: Ease of use, reminders, health status, and relevance of symptom items.)	Patients reported examples of where the intervention: - Supported personal decision making to seek medical advice/manage symptoms. - Provided reassurance and valuable information. - Was more useful in the early weeks of chemotherapy.	Good supporting evidence
eRAPID associated with better self-efficacy for symptom management at 18-weeks.		Patients found aspects of the intervention 'empowering' and felt like it gave them an active role in their care.	Good supporting evidence
Positive benefit of eRAPID observed in non-metastatic cancer group only.		Metastatic group reported lower system usability scores. Some metastatic patients found the symptom information and advice less useful to them as they had been through chemotherapy before.	Some supporting evidence
Patient adherence to symptom reporting was positively associated with clinicians' reported use of eRAPID reports. No differences observed between arms for chemotherapy delivery, hospital admissions, acute oncology assessments or emergency hotline calls.	Impact on clinical care (Subthemes: Clinician engagement with eRAPID, Facilitated consultationsconsultations, Medication treatment/Changes)	Patients had mixed experience of staff use of their symptom reports. Some patients reported that eRAPID gave them 'permission' to call the hospital with symptoms. However, patients also reported not completing symptom reports when they were very unwell. Some clinicians described using the eRAPID data to make decisions on chemotherapy and/or supportive	Some supporting evidence

		medications. However, clinicians varied in how often they reported using the data and how useful they found it.	
Adherence to weekly eRAPID online reporting was good. Adherence reduced over time with patients completing less consistently towards the end of the 18-week period. Some participants completed none or very few reports.	Acceptability and functionalityf (Subthemes: Ease of use, reminders, health status, and relevance of symptom items.)	Patients reported that the online reporting was easy to use. Scores from the System Usability Scale were high. Patients also reported that eRAPID was most useful in initial weeks of treatment. Reasons given for non-adherence to completing symptom reports were forgetting, ill health and not finding the reports as useful/too repetitive over time.	Good supporting evidence

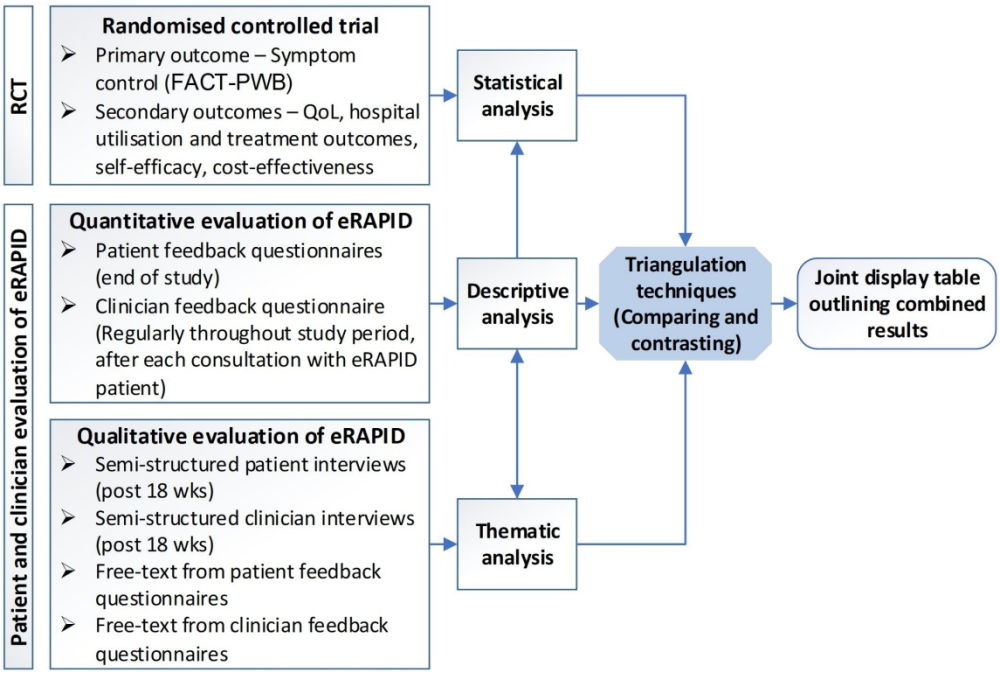

Figure 1 Overview of mixed method approach using concurrent triangulation design

176x118mm (300 x 300 DPI)

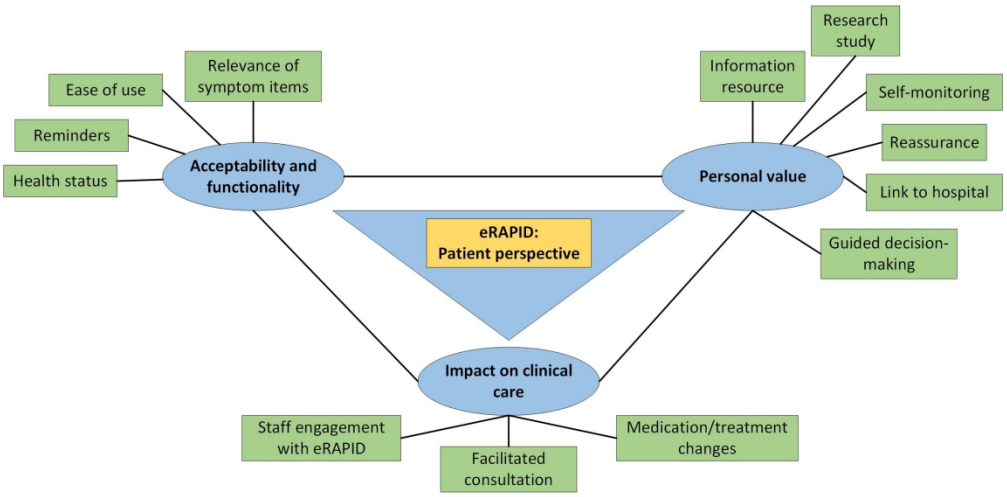

Figure 2 Overview of patient perspective of the use and impact of eRAPID

220x108mm (300 x 300 DPI)

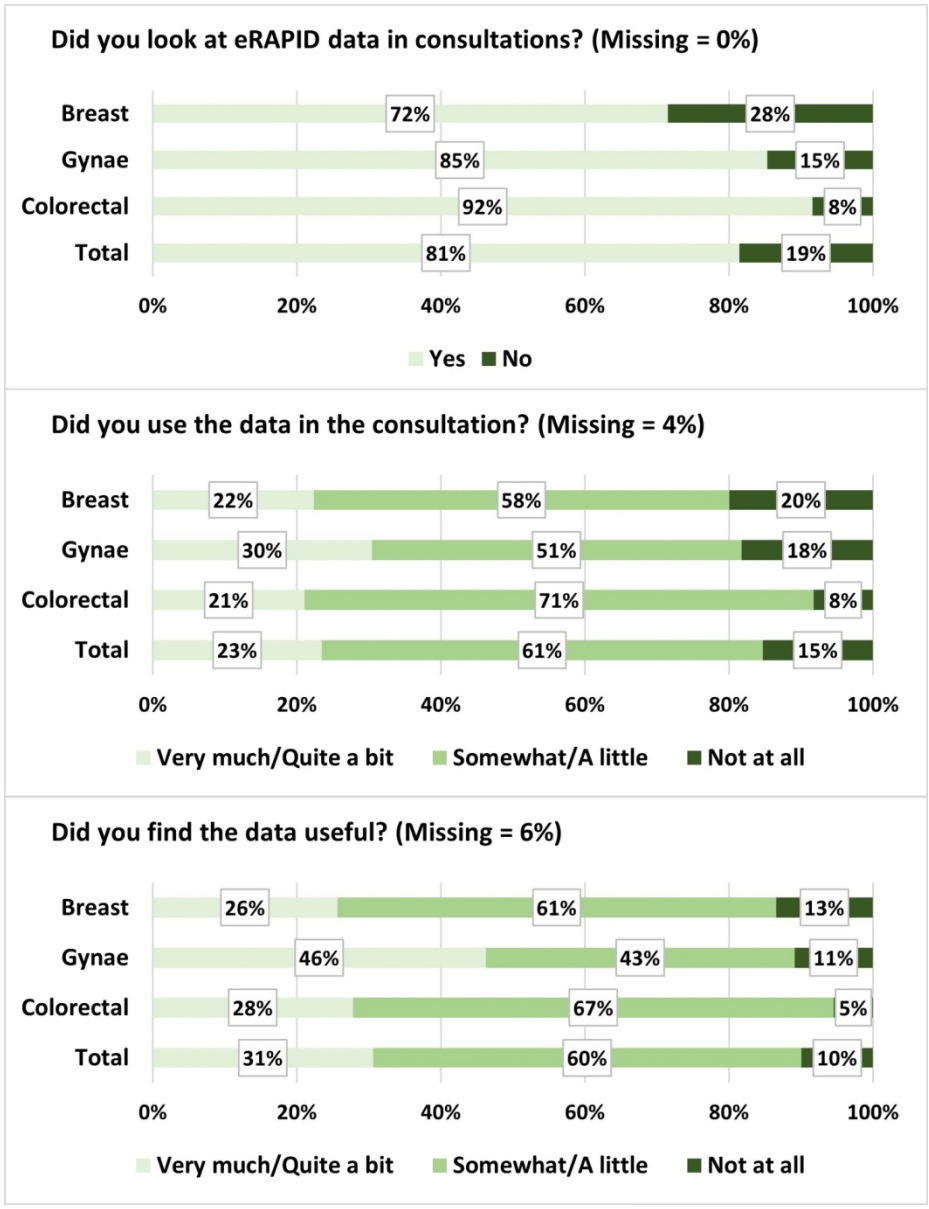

Figure 3 Feedback on eRAPID from patient questionnaires

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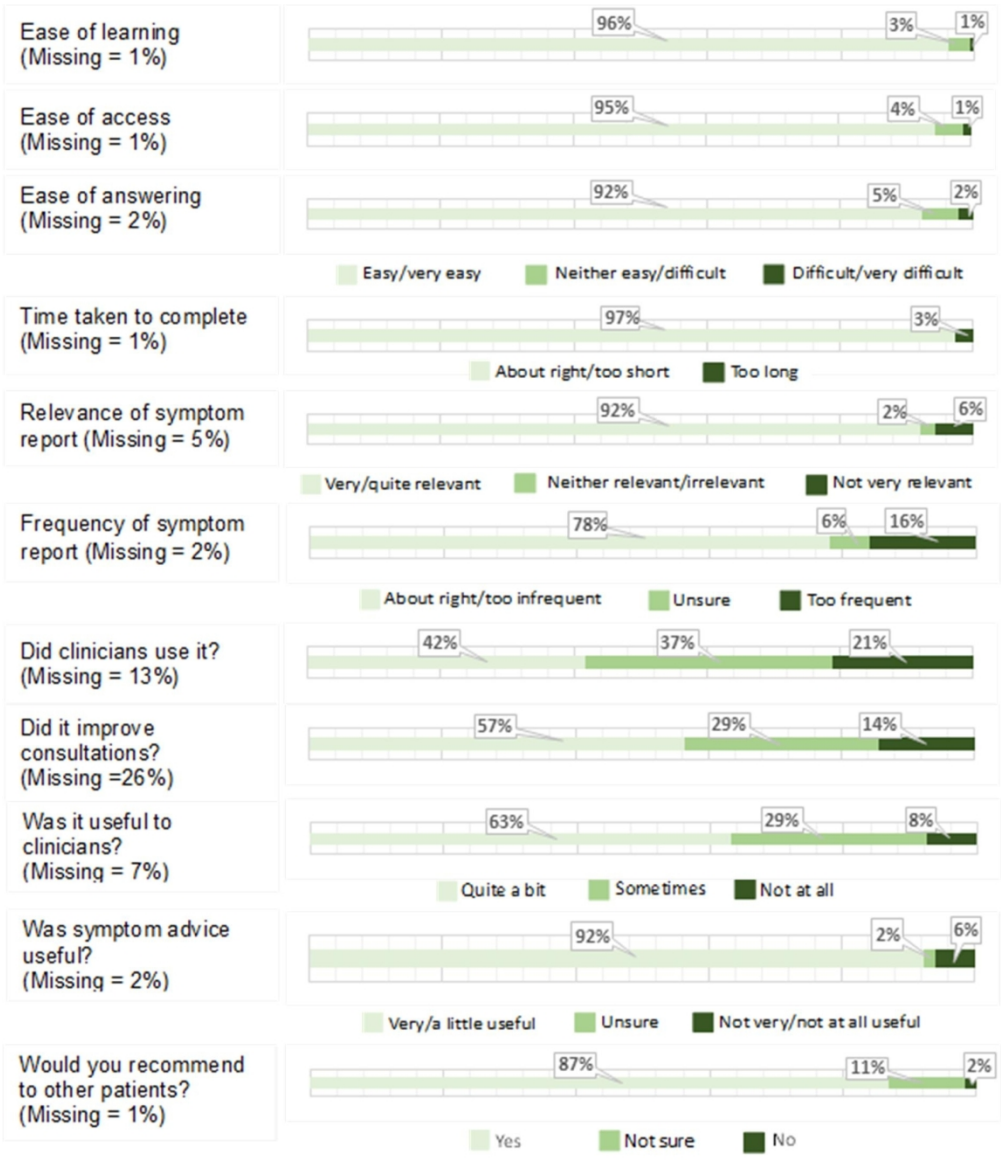


Figure 4 feedback on eRAPID from clinician questionnaires

159x183mm (300 x 300 DPI)

Appendices and Supplementary files

Supplementary file A: Summary of patient Interview schedule

General views on using the system e.g.

- Did you have any problems accessing eRAPID at any time? Did you find it easy to use?
- Has it been difficult for you to complete the questionnaire on a weekly basis? Is there anything we could do to make this easier for you or other patients?
- What do you think the main value of eRAPID would be for patients? Were there any advantages and/or disadvantages to using eRAPID?
- Would you be happy to use eRAPID again in future if you had the need to?

Completion of symptom reports

If patient initially started using the system but then stopped.

- You initially used the system regularly but then you stopped. Can you remember the reasons why this was?
- Did you intend on using the system again in the future?
- Is there any support we could have given you to help you to complete at this time?

If patient has completed intermittently

- You used the system intermittently throughout the study. Can you remember the reasons why you didn't complete at this time?
- Is there any support we could have given you to help you to complete at this time?
- What made you start using the system again?

If the patient used the system regularly throughout the study.

- You used the system regularly. Can you tell us what your main motivations were for doing this? (For example, the graphs, self-management advice or for the clinicians) Did you feel that it helped you? If so, in what way?

Self-management advice

- Do you think that the system accurately assessed your symptoms? E.g. the types of questions asked, the severity level, etc.
- Did you get advice on how to manage your symptoms? Was it helpful? In what way?
- Did you receive advice to contact the hospital at any point? Did you think it was appropriate? Did you follow this advice? If not, what were your reasons for not following the advice?
- Did you find the information on the eRAPID website useful? Did you use any of it? Do you think that using the system had any effect on how you managed your symptoms and side-effects?

Graphical summaries of symptom reports

- Did you look at/use the graphs at the end of questionnaire?
- If not, can you tell us the reason (e.g. didn't find them useful, too complicated)
- If so, did you find them useful? In what way? What did you like about them? What did you not like about them?

Staff use of symptom reports

- Did the doctors/nurses use the system at your clinic appointments? What do you think the main value would be for clinicians?
- Do you think that using the system influenced your consultations in any way? If so, how? E.g. Do you think you had any medications prescribed or changes in treatment because of reporting symptoms on the system? Were you happy with these changes?
- Did anyone else (such as a relative) help you use the system? Do you think they found it useful?

Admissions and calls to the hospital

- Did you need to contact the hospital at any point due to symptoms or side-effects? If so, who did you contact? Did you use eRAPID prior to contacting the hospital? If not, did you

consider using the eRAPID system before you contacted the hospital? Did you use the card in your booklet? How/why did you decide to contact the hospital? How long were you unwell for before you contacted the hospital?

If patient was admitted during their time on study:

- Can you tell us a bit about your admission to hospital and what happened in the lead up to that?
- Did you use the eRAPID system before you contacted the hospital?
- Did the staff on the acute ward mention eRAPID to you, or did you mention it to them?
- Did your admission have any effect on your treatment? (e.g. delays, dose reduction)

If patient had any reported any clinically severe symptoms (triggering advice to contact the hospital)

- When you received the advice to contact the hospital, did you do so? If not, what action did you take and why?
- Did anybody contact you? Did they discuss your eRAPID results with you?
- What were the consequences of that contact?

Supplementary file B: Summary of professional interview schedule

Awareness

- How did you hear about eRAPID/QTool?
- Did you use the symptom report without being prompted by the patient or researcher? If yes, what influenced you to do so?
- What percentage of patients who had eRAPID/QTool results on PPM did you use/view?

Accessing symptom reports in the EPR

- Were you offered any training prior to using the system? Was there anything about the training that could have been done differently? Are you aware that online training is now available?
- Do you have any suggestions how we may improve communication with staff who are using the system?
- How useful did you find the one page prompt guides? (Positive and negative feedback)
- Did you use the facility at the bottom of the results to change access to the number of results you could view? Is there any value to this facility?
- What do you think of the way in which symptoms/adverse events are recorded/ displayed in patient records through the eRAPID system?
- Could you give examples of any positive and negatives experiences you had in accessing the eRAPID results (ease of use) on the EPR?

Consultations

- What do you think the patients think about using eRAPID? Both in terms of logging in/answering the symptom reports and the value of the advice given.
- How has using the system impacted your consultation/assessment with patients?
- Did it change the doctor/nurse/patient relationship in any way? Could you give an example?

How did using the system impact on the length of time of the consultation?

- Were there any times when patient reported symptoms in the consultation did not match reported symptoms on the system? Could you give an example?
- Can you recall occasion/s when using the system influenced a change in patient management or treatment?
- What do you consider were the expected benefits/burdens in using the eRAPID system during the consultation?
- What do you consider were the unexpected benefits/burdens in using the eRAPID system during the consultation?
- What are your thoughts regarding the way in which patients have used the self-management advice available on the eRAPID system?

Severe symptoms notifications

- Have you ever responded to an alert on the system? If so, can you talk me through any particular issues?

General

- Overall, what do you think were the main advantages and disadvantages to using the system?
- Do you have any suggestions for how we could promote/encourage staff to access/use the eRAPID patient data in PPM in the future?
- What do you think the main facilitators were in using the eRAPID system?
- What do you think the main barriers were in using the eRAPID system?
- Do you have any suggestions in how we could improve the system?
- Would you recommend systems like eRAPID to other centres? If yes/no, why?

Supplementary file C: Summary of patient end of study feedback form: Multiple choice items and accompanying response options

1. How easy or difficult was it to learn how to use the eRAPID system?
   Very easy/Easy/Neither easy nor difficult/Difficult/Very difficult
2. How easy or difficult did you find accessing the system? (e.g. finding the website and logging in)
   Very easy/Easy/Neither easy nor difficult/Difficult/Very difficult
3. How easy or difficult was it to answer the questions about your symptoms?
   Very easy/Easy/Neither easy nor difficult/Difficult/Very difficult
4. How did you feel about the amount of time it took to complete the symptom questions?
   Too long/About right/ Too quick
5. How relevant were the symptom questions to you?
   Not relevant at all/ Very few questions were relevant/Neither relevant or irrelevant/ Quite relevant/ Very relevant
6. What did you think about completing these questionnaires every week?
   Definitely too often/ A little bit too often/ Unsure/ I was happy to complete them every week/ I would have been happy to complete them more often
7. Were there any times when you missed a week of completing the symptom questionnaire?
   No/Yes
8. Did the doctors and nurses you saw during your treatment use your eRAPID symptoms information during consultations?
   Yes, quite a bit/ Sometimes/ Not at all
9. If yes, did you feel this improved your consultations with the staff?
   Yes, quite a bit/ Sometimes/ Not at all
10. To what extent do you feel that the symptom questionnaire was useful for the doctors and nurses you saw during your treatment? Very useful/A little useful/Unsure/Not very useful/Not at all useful
11. How useful did you find the information on the eRAPID website about the symptoms and side effects of cancer treatment? Very useful/A little useful/Unsure/Not very useful/Not at all useful
12. Would you recommend the eRAPID system to other cancer patients?
    No/Not sure/Yes

Supplementary file D: Clinician eRAPID feedback form

Date of completion_____ Name of clinician_____

1. How well did you know this patient from before?

Never met him/her before	
A little	
Moderately well	
Very well	

2. Did you look at the patients' eRAPID symptom information in PPM before/ during the consultation?

Yes	No

3. Did you use the eRAPID symptom information in the clinic discussion?

Very much	Quite a bit	Somewhat	A little	Not at all

4. Did you find the eRAPID symptom information useful?

Very much	Quite a bit	Somewhat	A little	Not at all

5. If yes, in what way?

Provided additional information	
Confirmed your knowledge of patients' problems	
Identified issues/problems to be discussed	
***Contributed to management**	

****If you answered "Contributed to management", please specify in what way below.***

Change of medication	
Ordering of investigations	
Decision about chemotherapy	
Referral to supportive services (e.g. psycho-oncology, social worker)	
Counselling about lifestyle	

Other: Please specify

6. Are there any additional ways you have found the eRAPID symptom information useful?

Supplementary file E: Graphical summary of additional information from clinician feedback forms

FIGURE 1 CLINICIAN FEEDBACK ON WAYS ERAPID WAS USEFUL

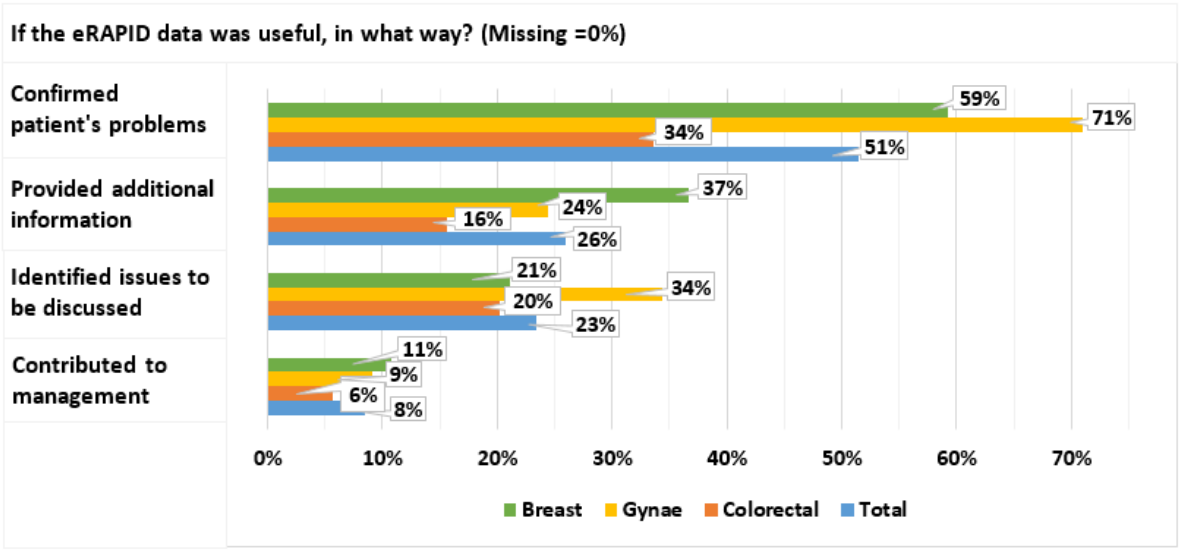
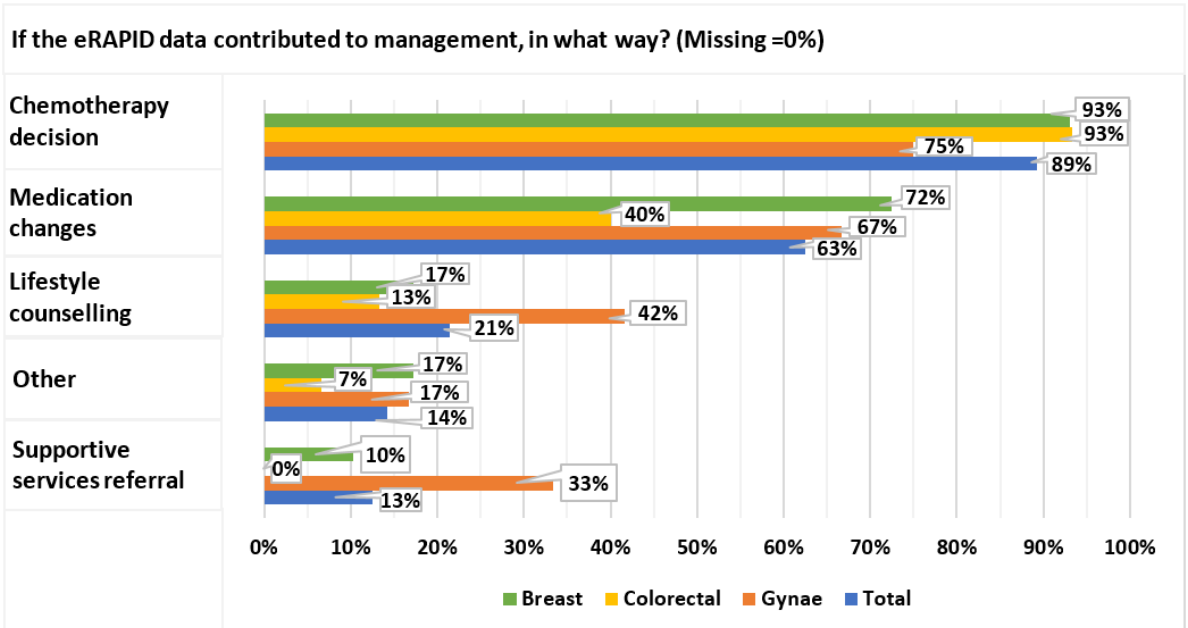


FIGURE 2 CLINICIAN FEEDBACK ON HOW ERAPID CONTRIBUTED TO MANAGEMENT



BMJ Open

Patient and clinician perspectives of an eHealth intervention for supporting cancer treatment in the UK: Mixed methods evaluation of the eRAPID randomised controlled trial

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Manuscript ID	bmjopen-2023-078283.R2
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Primary Subject Heading:	Oncology

Secondary Subject Heading:	Patient-centred medicine, Qualitative research, Health informatics, Health services research
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Patient and clinician perspectives of an eHealth intervention for supporting cancer treatment in the UK: Mixed methods evaluation of the eRAPID randomised controlled trial.

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Abstract

Objectives: During 2015-2018, a Randomised Controlled Trial (RCT) evaluated eRAPID, an eHealth intervention designed to capture patient-reported symptoms online during cancer treatment. eRAPID provides patients with advice on when to self-manage or seek medical support. Clinicians accessed symptom reports within electronic patient records. 508 participants starting systemic cancer treatment were recruited and followed for 18-weeks. The intervention group (n=256) were asked to access eRAPID and complete weekly online symptom reports. Clinicians received training on accessing and interpreting symptom reports. Overall, eRAPID had a positive impact on patients' symptoms, quality of life and self-efficacy, particularly early in treatment and for patients with early-stage disease. Using mixed-methods, we aimed to gather insight from patients and clinicians on how eRAPID worked to facilitate interpretation of RCT findings.

Methods: Following a concurrent triangulation design, patient experiences of eRAPID were gathered via end-of-study interviews (n=45) and questionnaires (n=186). Clinician experiences were obtained by end-of-study interviews (n=18) and completion, throughout the trial, of feedback questionnaires (n=787 from n=55 clinicians). . Framework analysis was applied to examine qualitative data and close-ended questions were descriptively summarised. Findings were mapped against results from the RCT.

Setting: Medical oncology services, UK cancer centre.

Results: Patient feedback indicated eRAPID was easy to use. Adherence to weekly reporting was influenced by health status, reminders, perceived value, and clinical use. Patient reported benefits of eRAPID included an enhanced connection with the hospital, provision of practical advice and personal monitoring, which provided reassurance and empowerment. Clinicians were positive about the potential for online symptom monitoring but had mixed levels of direct experience with using eRAPID during the trial. Patients echoed this and recommended more explicit clinician use of symptom data.

Conclusions: The mixed-method approach to capturing patient and clinician opinions provided valuable insight on the eRAPID intervention and complementary information on how the intervention was received and functioned.

Strengths and Limitations

- The mixed methods approach (combining results from interviews and feedback questionnaires) provides important insight on how the eRAPID health intervention functioned in practice when mapped to the findings from the main randomised controlled trial.
- The perspectives of a large number of participants involved in the trial were obtained (186 patients and 55 clinicians).
- Although feedback questionnaires were collected from clinicians throughout the study, interviews were only conducted at the end of the trial. The resources were not available for more objective assessments of how the intervention was used in practice (such as video or audio observations or system analytics).
- There are some biases in the study sample due to the trial eligibility criteria (English-speaking, basic level of computer literacy and internet access). In addition, it was difficult to capture the perspectives of those patients who did not engage as they often withdrew from the study.

Introduction

Systemic cancer treatments (chemotherapy, hormonal therapy, targeted drugs, and immunotherapy) are associated with side effects affecting patients' everyday functioning and quality of life (QoL) and can lead to life-threatening risks. Oncology teams are required to safely monitor patients during treatment to identify symptoms before they become serious, whilst providing advice for managing mild/moderate issues.[1, 2] As systemic treatments are typically administered in day-case outpatient settings, patients and caregivers play an important role in health monitoring from home but can have difficulty in determining severity of issues.[3] Standard practice for monitoring patients during treatments involves routine clinician-led assessment between cycles. Assessments rely on patient recall of issues experienced in previous weeks and clinicians making accurate judgements about severity. Standard practices do not easily allow comprehensive tracking of patient symptom trajectories over time.

There is a drive for health services to adopt technology-driven care solutions to improve cancer care during cancer treatment [4, 5] and growing international evidence demonstrates that electronic monitoring systems using Patient Reported Outcome Measures (PROMs) in the cancer setting can benefit patient QoL [6-8] and survival.[9, 10] However, electronic PROMs (ePROMS) to facilitate patient monitoring of symptoms has not been widely adopted [11, 12] and there is considerable variation in how systems are designed and embedded into clinical pathways.[13] Patient and clinician views on everyday experiences of these systems are vital to understand mechanisms for intervention success and help refine development and implementation strategies.[14]

Developed using co-design principles, the eRAPID electronic health intervention allows patients to self-report symptoms online from home during treatment.[13, 15, 16] eRAPID provides automated advice based on clinical algorithms to guide patients to self-manage mild/moderate issues or contact medical teams when potentially serious issues arise.

During 2015-2018, we evaluated eRAPID in a randomised controlled trial (RCT) in the systemic treatment setting with patients diagnosed with breast, gynaecological or colorectal cancer.[17, 18] The primary outcome was symptom control (measured by the Functional Assessment of Cancer Therapy Scale-General Physical Well-Being subscale [19] (FACT-PWB, scores 0-28, high scores = better symptoms) and secondary outcomes included PROMs to assess the impact on QoL and self-efficacy, in addition to collection of process of care data from hospital records (treatment delivery, hospital admissions and telephone contacts) and costs. Results evidenced better symptom control with eRAPID at 6- and 12-weeks, but not 18-weeks, from start of treatment. Improved patient self-efficacy to manage symptoms was found at 18-weeks. Benefits were more evident for patients with early stage cancer than those with metastatic disease. Patient adherence to weekly symptom reporting was good with an average of 64.7% (varying between 72% in week-1 to 58% in week-18). eRAPID did not increase hospital workload or influence treatment delivery and the costs for the eRAPID group were lower at 18 weeks. Clinician use of symptom data was positively associated with patient adherence to online reporting, which was in turn associated with improved symptom control. [18, 20] However, use was variable between clinicians.

Aims and objectives

As part of the RCT design, we adopted a mixed methods approach to gain a better understanding of how eRAPID worked in practice [21]. Interviews and questionnaires were used to elicit feedback and experiences from both patients and clinicians on their use of

eRAPID and these results were combined and contrasted with the main RCT results [22]. The aims were to:

- Explore patient and clinician views of the acceptability of eRAPID in terms of usability, value of specific system features and to identify how the intervention might be refined for future routine implementation.
- Explore barriers and motivators for use of eRAPID for both patients and clinicians to inform future implementation.
- Better understand any benefits of eRAPID demonstrated in the RCT by exploring how the intervention impacted on clinical care.

Methods

We used a concurrent triangulation design [23], combining both qualitative and quantitative data from patients and clinicians evaluating eRAPID, with the results of the randomised controlled trial **(Figure 1)**. More detail on the data and analysis techniques used is outlined below.

eRAPID RCT in systemic cancer treatment

The eRAPID intervention and RCT protocol are described elsewhere.[17] In summary, this was a single site parallel RCT with an internal pilot in a UK cancer centre. English-speaking adult patients with internet access starting systemic treatment for breast, gynaecological or colorectal cancer were eligible. Participants were randomised to Usual Care or eRAPID intervention plus Usual Care.

Intervention participants had access to eRAPID and were asked to complete symptom reports online (via computer, tablet, or smart phone) weekly for 18-weeks (reminders sent via SMS or email). The system provided automated severity tailored patient advice for managing reported issues. Mild or moderate issues generated self-management advice and/or recommendations to discuss the issue at next clinic visits. For severe and clinically relevant symptoms, patients were advised to immediately contact the 24-hour Acute Oncology service. Email notifications were sent to key clinicians; however, this functionality was not highlighted to patients, to avoid creating an expectation of direct follow-up. Patients could view graphical summaries of their symptoms over time. Clinicians were trained to access and interpret patients' symptom reports which could be accessed within the hospital's electronic patient records (EPR) and viewed in tabular or graphical formats.

Procedures for obtaining feedback from patients and clinicians

Interview procedures

Patients: We invited a subsample of intervention participants to complete an interview at the end of study period (18 weeks). We aimed to interview 5-10 per cancer site and purposively sampled participants based on age, sex, cancer site and adherence to weekly symptom reporting. Patients were interviewed at their convenience at the end of the study, in a private room at the hospital. The semi-structured interview schedule was originally developed based on concepts influencing behaviour change, such as motivators, barriers, attitudes, and intentions. This was piloted in a usability study [24] and some minor refinements were made. Broadly, the interviews explored personal experiences, use and views of eRAPID, impact on medical care and interactions with clinicians **(Supplementary file A**).

Clinicians: We arranged end-of-study interviews with up to 5 clinicians (specialist nurses and oncologists) from each cancer site. The semi-structured interview schedule **(Supplementary file B)** explored access and use of eRAPID patient data and its perceived value in clinical practice.

Feedback questionnaire procedures
We obtained additional feedback through questionnaires:

Patient feedback questionnaire
We developed a feedback questionnaire to complement the data captured in the interviews. All patients on the intervention arm who were still on study at the end of 18-week period were invited to complete this, allowing us to gain feedback from a wider range of patients. The questionnaire included:

- Twelve closed questions focusing on ease of using eRAPID, how symptom data were used by the clinical team, and perceived value of eRAPID for themselves and future patients **(Supplementary file C)**.
- Five free-text questions covering use of eRAPID*:*
  - Reasons for non-adherence to weekly reporting
  - Positives and negatives
  - Suggestions for improvement
  - Any other comments.
- The System Usability Scale (SUS).[25] A 10-item scale widely used to gain subjective assessment of the usability of computer systems. Participants rate 10 statements from 1-5 (strongly agree to strongly disagree). Overall scores range from 0-100 with higher scores indicating better usability. Scores over 68 are above average.

Clinician feedback questionnaire
Clinicians were prompted to complete feedback questionnaires throughout the 18-week study period, each time they had a routine consultation with an eRAPID intervention patient. This questionnaire was developed by the research team for use in a previous RCT assessing clinician use of PROMs in clinical practice. [26] **(Supplementary file D)**

The questionnaire included:

- Close-ended questions to indicate if and how clinicians:
  - Used eRAPID data
  - Found eRAPID useful
  - Used eRAPID to contribute to patient management
- Free-text boxes to provide comment on:
  - Additional ways they found eRAPID useful
  - Any other comments.

Patient and public involvement (PPI)
PPI was prioritised throughout the eRAPID programme of work and further details of this are available elsewhere.[20] In the work described here specifically, our PPI co-authors (BW & VC) have supported the development of evaluation methods, reviewing patient materials such as information sheets and questionnaires, and contributed to manuscript preparation.

Analysis
Qualitative data (interviews and free text written comments)
Interview recordings were transcribed verbatim, transferred to NVivo, and analysed using a framework method by members of the eRAPID research team (KA, LW, MH, RP, AG, ZR, SD). The framework method is a type of thematic analysis which can be applied using a combined deductive and inductive approach. This approach allowed the team to answer the specific research questions while allowing for the discovery of unexpected themes and topics.[27, 28] Following data familiarisation, we created a coding framework guided by the topics in the interview schedule and sub-themes identified from data. Two researchers coded each transcript and the team worked collaboratively to resolve queries, refine the

framework, and maintain a coding log. We allocated one or more main themes to each researcher to extract relevant coded quotes from NVivo into separate spreadsheets for charting and summarising data to draw overall conclusions. We collated, reviewed, and summarised free-text responses from feedback questionnaires under the overarching qualitative coding framework.

Quantitative data (close-ended questions)

We conducted analysis using SPSS version 26. We scored the SUS according to instructions. Differences between cancer sites and metastatic and non-metastatic patients were explored using one way ANOVA and independent t-test, respectively. Close-ended responses from feedback questionnaires were summarised using descriptive statistics.

Synthesis of participant feedback with main RCT findings

Using the joint display approach to integrating qualitative and quantitative data in mixed methods studies, we mapped patient and clinician feedback against the primary and secondary eRAPID RCT outcomes.[22, 29]

Results

Participants

Patient sample

Target recruitment was met with 508 patients consented and randomised in the RCT: Usual Care (n=252) and eRAPID intervention (n=256). Two hundred and twenty-two patients in the intervention arm remained on study at 18-weeks and 186 (84%) completed feedback questionnaires and 45 participated in interviews (**Table 1**). Twenty percent (n=38/186) of patients who completed feedback questionnaires and 24% (n=11/45) of patients interviewed had previously had chemotherapy.

Clinician sample

Fifty-five clinicians participated in the RCT, utilising eRAPID data during routine consultations, all completed at least one feedback questionnaire and 18 were interviewed (**Table 1**). Of an expected 1,314 questionnaires, 787 (59%) were completed and 218/256 (85%) of intervention patients had their symptom data reviewed by a clinician at least once.

Reasons for questionnaire non-completion included clinicians forgetting due to the relatively small number of eRAPID intervention patients seen in clinics, researchers being unable to prompt clinicians due to last-minute appointment changes, and clinicians not having symptom data to review due to patient non-adherence.

Patient perspectives

Patient interviews and feedback questionnaires covered three overarching and interlinking themes:

- Acceptability and functionality
- Impact on clinical care
- Personal value of using eRAPID

We describe each theme below with a focus on patients' views on the use of eRAPID. **Figure 2** provides a graphical representation summarising key elements of the patient perspective.

Acceptability and functionality

This theme explored how easy patients found the navigation and use of eRAPID to complete their symptom reports and what the main barriers and facilitators were for adherence to weekly symptom reporting.

Ease of use

Quantitative data from feedback questionnaires (**Figure 3**) indicated most patients found eRAPID easy to use (96%), easy to complete (92%) and thought the length of time it took was about right (97%).

SUS scores ranged from 25-100 with a mean of 83.3 (SD 14.4). An independent t-test indicated patients with non-metastatic disease reported higher scores (M=86.0, SD=12.8) than those with metastatic disease (M=80.7, SD=16.9) and this was statistically significant (95% CI, p=.036). A one-way ANOVA (F (2,173) = 2.919, p =.057) indicated no statistically significant difference in SUS scores between breast (M=87.0, SD=12.8), colorectal (M=81.4, SD=16.9) and gynae (M=83.0, SD=11.7) cancer patients.

Interview data also indicated that patients found eRAPID easy to use and did not experience any major issues accessing or using the system. Comments from free-text sections of the feedback questionnaire suggested some improvements including creation of an eRAPID app and provision of the facility to provide more detailed information about symptoms, upload photos for specific symptoms such as rashes, and record current medications.

Reminders

Email/text reminders were important facilitators for adherence, though some individuals also set their own weekly routines.

> *'… I'd kind of disciplined myself to do it on a Wednesday.'* (Patient A, Gynaecological).

Health status

Health issues such as fatigue, cognitive/memory issues and hospitalisation were common barriers to adherence.

> *'...it was nothing to do with the system or finding it difficult, the thing that was difficult for me was the absolute fatigue with the chemotherapy, just totally wiped me out.'* (Patient B, Gynaecological)

Relevance of symptom items

Patients found the symptom report relevant (92%) and qualitative data supported this. However, some found the weekly completions and associated advice repetitive, particularly when their symptoms did not change. Some thought the response options were too limited and did not allow scope to add detail.

> *'The answers could be too black or white, when life is generally more grey and there were no extra boxes to explain*.' (Patient C, Colorectal)

Impact on clinical care

This theme explored patients' perceptions of how eRAPID impacted on their clinical care and influenced their interactions with clinical staff during their cancer treatment.

Clinician engagement with eRAPID

Forty two percent of patients thought clinicians regularly used their symptom reports while 21% thought they were not used at all. Qualitative comments supported these mixed experiences. A few patients reported clinicians being explicit about using eRAPID data to guide consultations.

> *'…our chemotherapy doctor, he would bring it up every time and show us it and talk me through any concerns that he had… that re-incentivised me to use the system because you know it's not just a waste of time, somebody's looking at it.'* (Patient D, Gynaecological)

However, others expressed significant disappointment that clinicians did not use their symptom reports and cited this as a barrier to use. A clear recommendation from patients for future refinement of eRAPID was increased and explicit clinician use of the symptom reports.

> '*No feedback from anyone – was expecting at least someone discussing usage of system but didn't happen at all after using it for 3 times – so stopped using it.'* (Patient E, Colorectal).

Facilitated consultations

Sixty three percent of patients thought their symptom reports were useful for clinical staff, often leading to better understanding of experiences. Weekly symptom reporting served as a memory prompt, as patients did not have to try to recall symptoms weeks later.

> *'At clinic visits I had sometimes forgotten about some of the symptoms I had experienced over the three-week period since my last visit…'* (Patient F, Breast)

Medication/treatment changes

Some patients described changes to their clinical management, such as prescription of medications or changes to their chemotherapy, as a direct result of their symptom reports.

> *'Doctors and nurses referred to my answers. Doctor reduced chemo dosage to help my sore throat.'* (Patient G, Breast)

Personal value of using eRAPID

This theme describes the range of personal benefit patients experienced from using eRAPID.

Link to the hospital

Some patients experienced a heightened sense of connection with the hospital:

> *'It helps with continuity of care. I feel under constant supervision of my treatment*.' (Patient H, Breast)

> *'It's like keeping in touch… without making an appointment to see anyone.'* (Patient I, Colorectal)

Information resource

Patients found the symptom advice useful (92%). Many reported reassurance in having tailored advice from a trusted source and having their symptoms monitored.

> '*Peace of mind that you were being monitored and any potential issues e.g., high temperature would give you guide as to whether to ask for help.'* (Patient J, Breast).

For some metastatic patients who had chemotherapy previously, the value of advice was limited as they were already familiar with how to manage symptoms.

> ***'**Well because I'm a bit of an old hand at chemo I think….it was only telling me what I already knew*.' (Patient K, Gynaecological)

Self-monitoring

The process of routine symptom reporting and tracking symptoms over time was also empowering.

> '*Felt good to record my symptoms every week - felt like I was taking an active role in my treatment*.' (Patient L, Breast).

> *'I think it was useful for us because you got the little graphs. So, you could compare how you… were feeling in comparison to how you'd been before*.' (Patient M, Colorectal)

For some the benefit of the system was more apparent early on in treatment and less useful later as they became familiar with symptoms/treatment.

> '*Some weeks I had no symptoms to report. After the first couple of cycles on each drug I didn't find the system beneficial.'* (Patient F, Breast)

Guided decision-making
In some cases, the symptom advice engendered a sense of confidence that patients and carers were taking the right action, including when to seek medical advice:

> *'…gave me and my family more confidence to manage side effects especially early on in the treatment… gave me 'permission' to contact the hospital if I was worried….'* (Patient O, Colorectal)

Research study
Some patients reported that their main motivation for adherence was a sense of responsibility to honour their commitment to participating in the research, rather than personal benefit.

> '*I saw it as, 'well I have agreed to this research thing so I will do it'…So that's probably the biggest motivator… just because I said I would do it.'* (Patient P, Gynaecological).

Clinician perspectives

Clinician feedback on eRAPID was summarised into the following overarching themes.

- Acceptability and functionality
- Impact on clinical care
- Perceived value of eRAPID for patients

The main descriptive results from clinician feedback questionnaires are included in the themes below. Additional findings are in **Supplementary file E.**

Acceptability and functionality

This theme explored clinicians' views on how easy it was for them to view, access and interpret patients eRAPID reports. Predominantly clinicians found it easy to access symptom reports within the electronic patient records.

> *'The system was very easy to use, it's on the system we use in clinic, you just have to click a button, all the information is there, so it was easy to use, readily available.'* (Colorectal, Senior oncologist)

Presentation of symptom data in both tabulated and graphical forms was useful to address different needs and preferences.

> *'I quite liked the graphs, simply because it was very quick and easy to be able to see if something had particularly changed''* (Gynaecology, Senior oncologist)

> *'I like the tables, I'm not a big fan of the graphs… it's easier to see quite a lot of information quickly on the tables…. Personally, I didn't see the extra value to the graphs.*' (Colorectal, Specialist nurse)

Due to the relatively small number of eRAPID intervention patients seen in clinics, it was easy for clinicians to miss reports, particularly as there was no facility in the electronic records to flag them.

> '*I think it will be even more useful when, if it's used in routine practice because you wouldn't forget to look at it.'* (Colorectal, Senior oncologist)

Impact on clinical care

This theme describes clinician views on if and how eRAPID impacted on patients' clinical care and influenced their decision-making.

Clinicians reported accessing eRAPID data on 81% (641/787) of the post-consultation feedback questionnaires completed. Clinicians rated to what extent they used eRAPID and how useful they found it on a Likert-type scale from 'not at all' to 'very much.' 90% used it at least 'a little' and 90% found it at least 'a little' useful (**Figure 4**).

Gynaecology clinicians were more likely than breast or colorectal clinicians to report using eRAPID 'quite a bit'/ 'very much' (30% vs 22% & 21%) and finding data useful 'quite a bit'/'very much' (46% vs 26% & 28%). However, gynaecology and breast clinicians were also more likely to report not using the data at all (20% & 18% vs 8%) and not finding the data at all useful (13% & 11% vs 5%) compared to colorectal clinicians.

Clinicians indicated finding eRAPID useful on 663/787 (84%) of feedback questionnaires. Those that answered 'Yes; to this question were asked to indicate the specific way or ways it was used from a list of options, 51% said it confirmed knowledge of patients' issues, 26% said it provided additional information, 23% said it identified issues to discuss and 8% said it contributed to management **(Supplementary file E).**

Qualitative interview data supported these findings with clinicians describing eRAPID as a helpful tool in structuring/preparing the consultation and building a connection with the patient.

> *'I found it helpful because it informs you before the patient arrives and I think it also stops you having to ask the patient 300 questions every time they come.'* (Gynaecological, Specialist nurse)

> *'There is an instant rapport because she thinks okay this one knows about me and I think that's been very helpful for me.'* (Breast, Senior oncologist)

However, other clinicians thought using symptom reports made consultations longer. One clinician found using eRAPID to be a conflict to their usual practice.

> *'… you have your own way of doing it, which I've been doing for such a long time and I just, it just didn't kind of resonate with me I'm afraid.'* (Breast, Senior oncologist)

Clinicians recognised the benefit of being able to identify trends in symptom trajectories and viewed the symptom reports as accurate. However, some had reservations about patients reporting issues not relevant to the cancer/treatment and some reported a lack of concordance between what patients reported online vs face-to-face.

> *'Patient contradicted information reported on eRAPID i.e., denying any nausea which was confusing.'* (Colorectal, Specialist nurse)

In a relatively small number of consultations (n=56), clinicians indicated that eRAPID contributed to management, such as a change to chemotherapy/medication **(Supplementary file E).** Qualitative data supported this, as some clinicians reported using eRAPID data to make decisions such as prescribing antibiotics for infections, providing advice on laxatives and reducing chemotherapy doses.

> *'Enabled to advise regular antiemetic and anti-spasmodics based on their pattern of occurrence relating to chemotherapy cycle.'* (Breast, Specialist registrar)

Perceived value of eRAPID for patients

This theme explored clinician views of if and how eRAPID was useful for patients during cancer treatment. Several clinicians commented that eRAPID was beneficial for patients.

> *'…it gave them permission to ring when they potentially may have not necessarily rung but may have tolerated it to the point where it becomes just slightly less easy to resolve.'* (Breast, Specialist nurse)

However, others described a range of patient-centred barriers to adopting the system into routine care, which included variation in patient compliance with online reporting, requirement of English language and IT access and fluency.

> *'…the patients that don't have access to the computer are the patients that we should be more concerned about because they might be…less literate or ...less able to communicate their needs and concerns….* (Colorectal, Specialist nurse)

Synthesis of feedback with key findings from the eRAPID RCT

In **Table 2**, we present the key RCT findings and map these with experiences described by patients and clinicians during interviews and in feedback questionnaires.

Improved symptom control (FACT-G PWB) at 6 and 12-weeks, health status and overall QoL at 18-weeks and self-efficacy at 18-weeks

Patient feedback supported our findings of the benefits of eRAPID with patients reporting detailed examples of how the intervention was beneficial. Qualitative findings offered insight into why the benefits of the intervention were limited to the earlier stages of treatment, e.g., lack of impact on symptom control at 18-weeks. Patients often reported finding symptom advice more useful during the initial weeks of chemotherapy and less useful later as they became more experienced in symptom management. Some metastatic patients with previous chemotherapy experience reported that eRAPID would have been more useful the first time around, offering insight into the greater benefits seen in the non-metastatic patient group.

High rates of patient adherence

Qualitative data indicated that eRAPID was easy to use and access. However, in some instances, adherence declined towards the end of the 18-weeks. Again, this may be explained by some patients finding eRAPID less useful in later stages of chemotherapy. Additionally, patient adherence was associated with the reported clinician use of eRAPID during consultations. Qualitative feedback from patients reported explicit clinician use of eRAPID as a motivator for engagement, but a barrier when clinicians did not acknowledge their symptom reports.

No impact of eRAPID on chemotherapy delivery, hospital admissions, acute oncology assessments or emergency hotline calls

Clinician feedback questionnaires reported a small number of examples of using eRAPID data to guide treatment decisions, however not enough to expect to see an impact on treatment delivery. Patients reported that eRAPID gave them 'permission' to contact the hospital for severe symptoms; however, they also reported that self-management advice empowered them to manage symptoms at home, indicating the complexity of the impact of eRAPID on hospital utilisation.

No difference in benefits of eRAPID between breast, colorectal and gynaecological patient groups

Qualitative data indicated some differences in how eRAPID was used in the different groups. For example, there were differences in clinician engagement, with gynaecological clinicians typically engaging more with eRAPID. However, the metastatic patients who had higher representation in the gynaecological group, also reported finding the self-management advice less useful due to having previous experience of chemotherapy.

Discussion

As part of the eRAPID RCT, we aimed to capture information from patients and clinicians, via interviews and written feedback, to understand experiences of using the system to help explain results and improve future refinement of this approach in cancer care.

Both patients and clinicians reported that eRAPID was easy to use. The main advantages from a patient perspective included its role as a trusted source of information and advice, providing enhanced connection with the hospital. However, patients thought the system could be improved, particularly in terms of clinician use. Although some patients reported that clinicians actively addressed and utilised their symptom reports, others had no recollection of clinicians reviewing their data at all. Understandably, this was disappointing leading to some patients becoming less engaged. These findings align with results from the RCT where clinician use of data was positively associated with patient adherence to weekly completions.

In addition, we found important benefits for patients around increased self-efficacy and QoL in the RCT. Previous trials have focused on patients with advanced disease and our findings demonstrating the benefits of this approach for patients with early disease is an important one. The qualitative insight we have gained about the mechanisms of this benefit has valuable implications for future development and implementation of similar systems.[14]

Some clinicians were very positive about the value of eRAPID for assisting with consultation preparation and providing a focussed discussion. Some found it valuable in saving time and identifying symptom trends. In practice, the design of the RCT meant some clinicians had limited exposure to eRAPID intervention patients, and the lack of an automated facility for flagging reports in the electronic patient records meant they could easily miss patients with symptom reports available.

Clinician feedback was variable between clinics, with those in gynaecology reporting higher use and usefulness of eRAPID. However, this did not translate into a difference in outcomes between patients in the different cancer sites. This may be simply because our RCT was not powered to detect statistical differences in secondary outcomes such as these, and it may also be partially due to differences in how individual clinicians used data or the complex multi-faceted ways eRAPID benefitted patients. For example, the RCT indicated the intervention was more beneficial for non-metastatic patients and qualitative data provided some insight into this, with patients that had experienced chemotherapy previously finding the information less novel/useful. The gynaecological group had a high proportion of metastatic patients, particularly in comparison to the breast group. While gynaecology patients may have benefitted from increased clinician engagement, this advantage may have been diminished by the higher proportion of metastatic patients when compared to the colorectal and breast clinics who seemed to derive greater benefit from the eRAPID information and advice.

Evidence from other trials have indicated that remote monitoring can impact outcomes such as hospital admissions, treatment delivery and even survival [6, 10]. This was not a finding in our RCT, which did not find a difference between eRAPID and usual care for hospital contacts or admissions. Although our qualitative data indicated that eRAPID guided patient decision-making about hospital contact and self-management, it is likely that the impact of eRAPID on hospital contacts is complex, and difficult to assess by a quantitative comparison. eRAPID may increase the number of contacts and admissions by advising patients to contact the hospital, while on the other hand, it may reduce contacts by supporting self-management when appropriate.

There are some limitations to our methods and the scope of findings. First, we conducted patient interviews at the end of the study period. Longitudinal interviews over the course of the 18-week study period may have provided more understanding into how patient use and

engagement with eRAPID fluctuated over time. However, the interview data did provide some nuanced insights into patient and clinician experiences of how eRAPID impacted care. Second, we relied on patients and clinician accounts of how eRAPID symptom reports influenced care. Clinicians usually completed feedback questionnaires immediately after consultations; however, we only collected basic information due to clinic time constraints. In addition, there was a high rate of missing data for these questionnaires, limiting their generalisability. In a previous study, we found it useful to audio-record consultations and use coding methods to evaluate how PROMs influenced discussions.[26] However, this was not possible in the current study due to resource constraints and the pragmatic nature of the trial.

Another limitation is that patients who did not engage with eRAPID at all were likely to withdraw from the trial and were unavailable for interview or questionnaire completion. However, this was a relatively low proportion of patients and we specifically targeted those with low adherence to compensate for some of this bias. There will be some additional bias in our sample simply because eligibility required patients to be English-speaking and to have some level of information technology (IT) skills and access.

Moving forward we are working on future implementation strategies to take eRAPID into routine care. We have experienced similar challenges around implementation to those reported by others working in this arena across clinical areas [12], such as barriers around hospital IT systems and health care infrastructure. An important element of ongoing work is the engagement and training of both patients and clinicians to maximise the use and clinical value of PROMs data. Ensuring that selected PROMs are both relevant to clinical care and meaningful to patients whilst managing the burden of item completion remains challenging. Ongoing efforts to explore how PROMs content should be refined to align with clinical need through the cancer trajectory and the potential for incorporating computer adaptive testing (CAT) techniques are warranted. Insights provided by this qualitative work and our previous development activities is vital to contribute to an evidence base of patient and clinician perspectives in a variety of contexts and give insight into how to successfully implement ePROMs into the clinical pathway.[30-32] We have funding to expand on analysis of the eRAPID study data using innovative methodologies such as through case study and latent class analysis, in addition to exploring optimal methods of PROMs data visualisation for both clinicians and patients. This work will further inform the clinical value of PROMs data in cancer practice and enable targeted refinement of the eRAPID intervention.

As PROMs become more widely adopted, it remains vital to explore their practical implementation to ensure they effectively serve patients and clinicians. EPROM interventions like eRAPID, are often complex and multi-faceted. Qualitative methods used alongside evaluations can provide invaluable insight into the mechanisms by which patients and clinicians may benefit and identify limitations and opportunities for improvement.

Author contribution

LW, KA, GV, JB & BW contributed to the development of the evaluation methodology.

LW, MH, AG, RP, ZR, PH & SD contributed to participant recruitment and data collection.

LW, KA, MH, AG, RP, JB, JH, EH, BW, SD, VC, & ZR contributed to data analysis and interpretation of findings.

All authors contributed to the preparation and reviewing of the manuscript.

KA and GV are the guarantors.

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TABLE 1: OVERVIEW OF PARTICIPANTS WHO COMPLETED INTERVIEWS AND FEEDBACK QUESTIONNAIRES

Patients		**Interviews* (n=45)**	**Feedback questionnaires* (n=186)**
Age	Mean age, years (SD)	54.6 (12.5) range 22-80	57.0 (11.7) range 24-86
Sex	Male	9 (20%)	43 (23%)
	Female	36 (80%)	143 (77%)
Breast	Total	24 (53%)	87 (47%)
	Primary/local	23 *(96%)*	83 *(95%)*
	Metastatic	1 *(4%)*	4 *(5%)*
Gynae	Total	9 (20%)	34 (18%)
	Primary/local	2 *(22%)*	6 *(18%)*
	Metastatic	7 *(78%)*	28 *(82%)*
Colorectal	Total	12 (27%)	65 (35%)
	Primary/local	9 *(75%)*	35 *(54%)*
	Metastatic	3 *(25%)*	30 *(46%)*
Staff		**Interviews (n=18)**	**Feedback questionnaires (n=55)**
Category	Specialist nurse	7 (39%)	10 (18%)
	Senior oncologist	8 (44%)	15 (27%)
	Junior oncologist	3 (17%)	28 (51%)
	Pharmacist	0	2 (4%)
Clinic	Breast	6 (33%)	19 (35%)
	Gynae	6 (33%)	14 (26%)
	Colorectal	2 (11%)	8 (15%)
	Mixed clinics	4 (22%)	14 (26%)
Sex	Female	12 (67%)	38 (69%)
	Male	6 (33%)	17 (31%)

*These are not distinct groups. Some participants who completed interviews also completed feedback questionnaires.

TABLE 2: SYNTHESIS OF FEEDBACK WITH KEY FINDINGS FROM THE eRAPID RCT

Key findings from RCT [18]	Relevant themes from qualitative data	Summary of patient and clinician experiences	Level of complementary evidence
eRAPID associated with better: - Symptom control (FACT-G PWB) at 6 and 12-weeks - Health status and overall QoL at 18-weeks	Personal value of using eRAPID (Subthemes: Link to the hospital, Information resource, self-monitoring, guided decision-making, research study) Acceptability and functionality (Subthemes: Ease of use, reminders, health status, and relevance of symptom items.)	Patients reported examples of where the intervention: - Supported personal decision making to seek medical advice/manage symptoms. - Provided reassurance and valuable information. - Was more useful in the early weeks of chemotherapy.	Good supporting evidence
eRAPID associated with better self-efficacy for symptom management at 18-weeks.		Patients found aspects of the intervention 'empowering' and felt like it gave them an active role in their care.	Good supporting evidence
Positive benefit of eRAPID observed in non-metastatic cancer group only.		Metastatic group reported lower system usability scores. Some metastatic patients found the symptom information and advice less useful to them as they had been through chemotherapy before.	Some supporting evidence
Patient adherence to symptom reporting was positively associated with clinicians' reported use of eRAPID reports. No differences observed between arms for chemotherapy delivery, hospital admissions, acute oncology assessments or emergency hotline calls.	Impact on clinical care (Subthemes: Clinician engagement with eRAPID, Facilitated consultations, Medication treatment/Change)	Patients had mixed experience of staff use of their symptom reports. Some patients reported that eRAPID gave them 'permission' to call the hospital with symptoms. However, patients also reported not completing symptom reports when they were very unwell. Some clinicians described using the eRAPID data to make decisions on chemotherapy and/or supportive medications. However, clinicians varied in how often they	Some supporting evidence

		reported using the data and how useful they found it.	
Adherence to weekly eRAPID online reporting was good. Adherence reduced over time with patients completing less consistently towards the end of the 18-week period. Some participants completed none or very few reports.	Acceptability and functionality (Subthemes: Ease of use, reminders, health status, and relevance of symptom items.)	Patients reported that the online reporting was easy to use. Scores from the System Usability Scale were high. Patients also reported that eRAPID was most useful in initial weeks of treatment. Reasons given for non-adherence to completing symptom reports were forgetting, ill health and not finding the reports as useful/too repetitive over time.	Good supporting evidence

Figure Legends

Figure 1: Overview of mixed method approach using concurrent triangulation design

Figure 2: Overview of patient perspective of the use and impact of eRAPID

Figure 3: Feedback on eRAPID from patient questionnaires

Figure 4: Feedback on eRAPID from clinician questionnaires

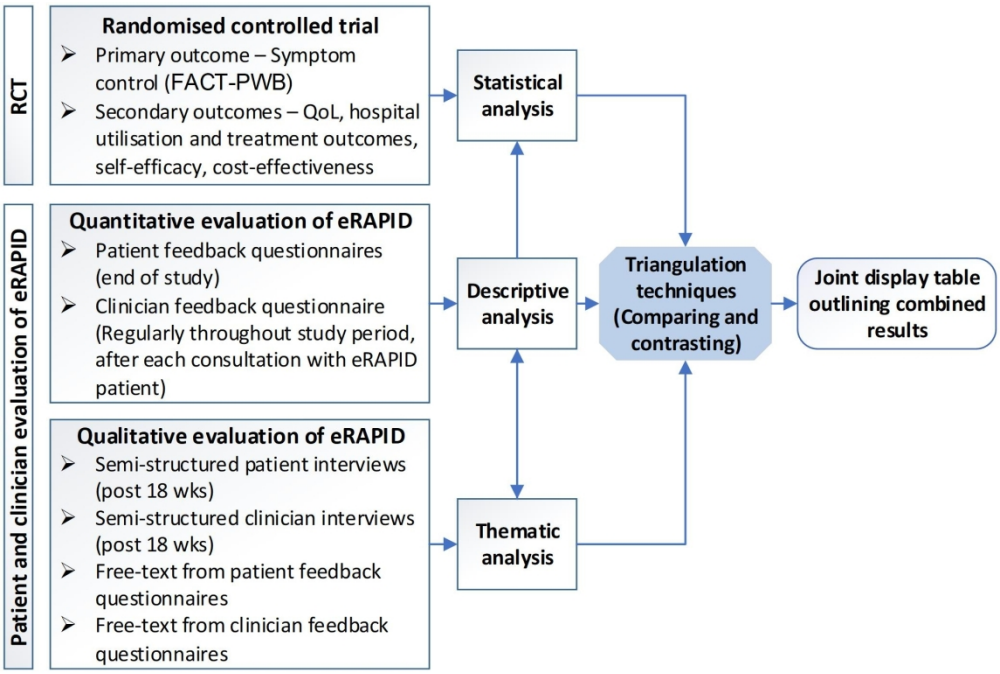


Figure 1 Overview of mixed method approach using concurrent triangulation design

176x118mm (300 x 300 DPI)

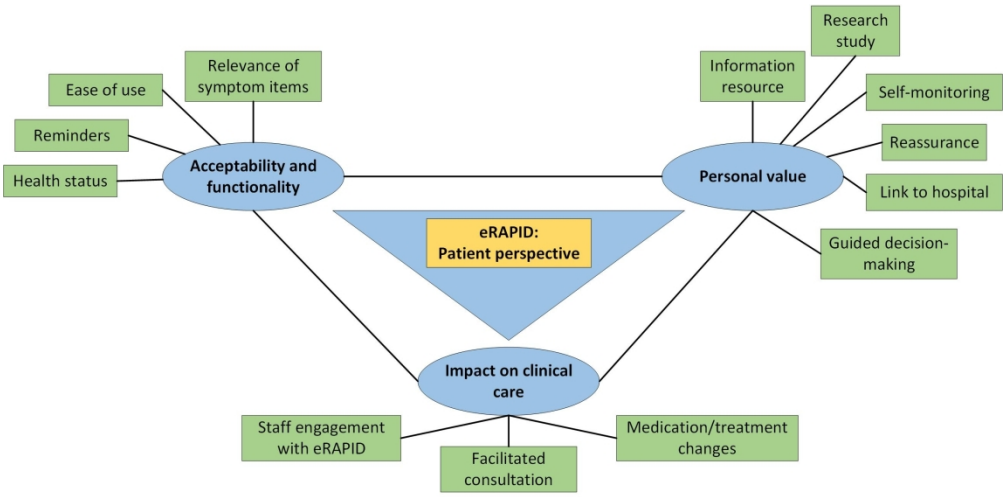


Figure 2 Overview of patient perspective of the use and impact of eRAPID

220x108mm (300 x 300 DPI)

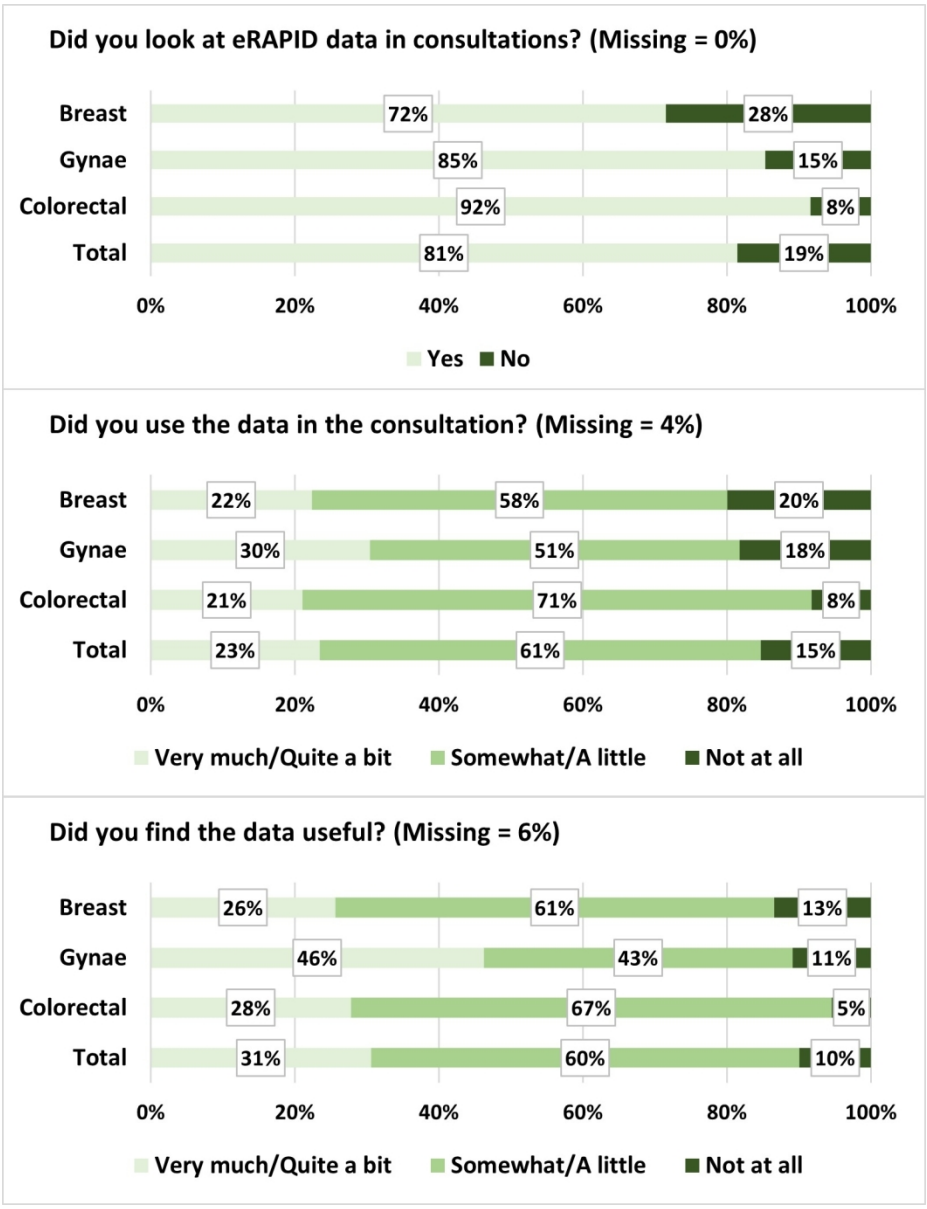


Figure 3 Feedback on eRAPID from patient questionnaires

127x165mm (330 x 330 DPI)

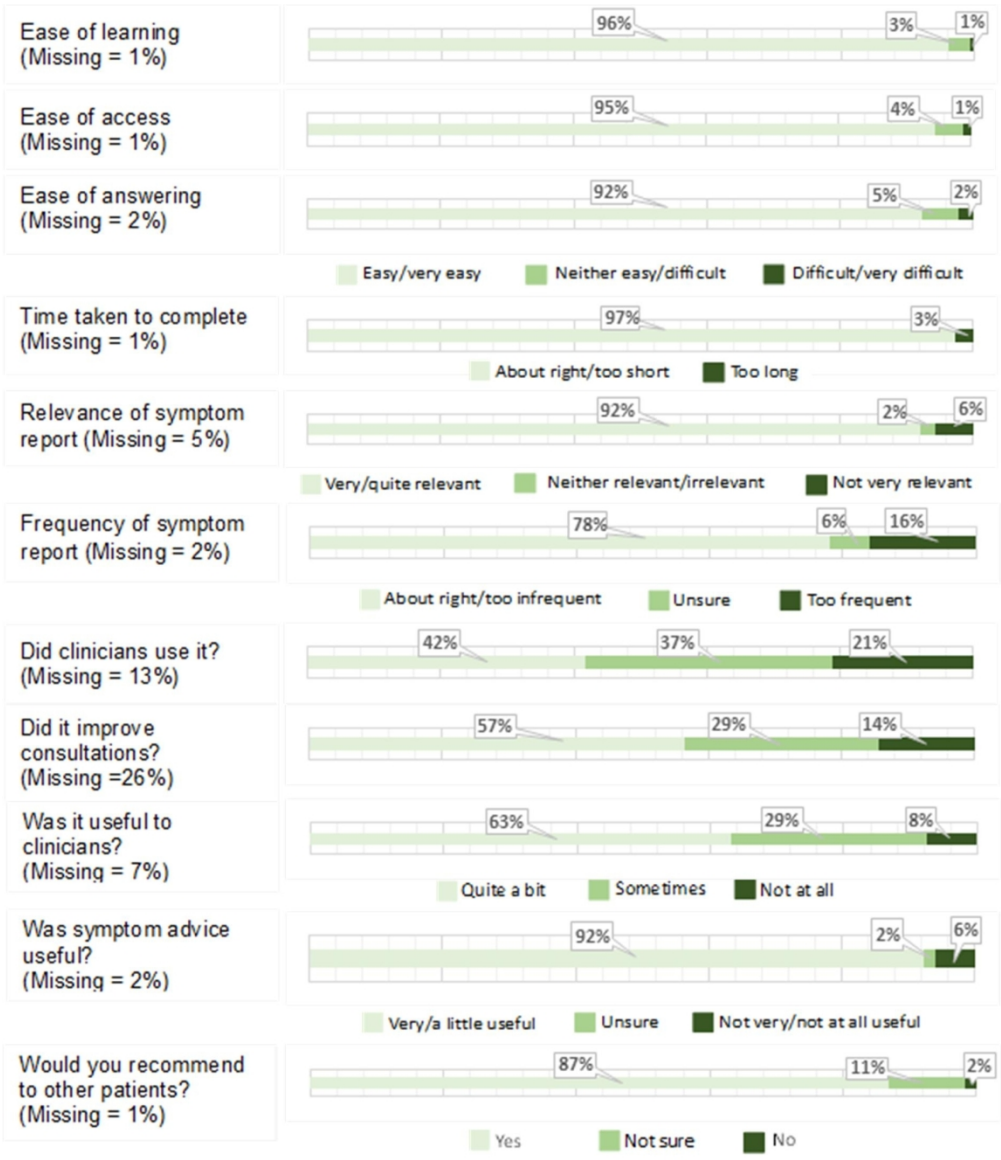


Figure 4 feedback on eRAPID from clinician questionnaires

159x183mm (300 x 300 DPI)

Appendices and Supplementary files

Supplementary file A: Summary of patient Interview schedule

General views on using the system e.g.

- Did you have any problems accessing eRAPID at any time? Did you find it easy to use?
- Has it been difficult for you to complete the questionnaire on a weekly basis? Is there anything we could do to make this easier for you or other patients?
- What do you think the main value of eRAPID would be for patients? Were there any advantages and/or disadvantages to using eRAPID?
- Would you be happy to use eRAPID again in future if you had the need to?

Completion of symptom reports

If patient initially started using the system but then stopped.

- You initially used the system regularly but then you stopped. Can you remember the reasons why this was?
- Did you intend on using the system again in the future?
- Is there any support we could have given you to help you to complete at this time?

If patient has completed intermittently

- You used the system intermittently throughout the study. Can you remember the reasons why you didn't complete at this time?
- Is there any support we could have given you to help you to complete at this time?
- What made you start using the system again?

If the patient used the system regularly throughout the study.

- You used the system regularly. Can you tell us what your main motivations were for doing this? (For example, the graphs, self-management advice or for the clinicians) Did you feel that it helped you? If so, in what way?

Self-management advice

- Do you think that the system accurately assessed your symptoms? E.g. the types of questions asked, the severity level, etc.
- Did you get advice on how to manage your symptoms? Was it helpful? In what way?
- Did you receive advice to contact the hospital at any point? Did you think it was appropriate? Did you follow this advice? If not, what were your reasons for not following the advice?
- Did you find the information on the eRAPID website useful? Did you use any of it? Do you think that using the system had any effect on how you managed your symptoms and side-effects?

Graphical summaries of symptom reports

- Did you look at/use the graphs at the end of questionnaire?
- If not, can you tell us the reason (e.g. didn't find them useful, too complicated)
- If so, did you find them useful? In what way? What did you like about them? What did you not like about them?

Staff use of symptom reports

- Did the doctors/nurses use the system at your clinic appointments? What do you think the main value would be for clinicians?
- Do you think that using the system influenced your consultations in any way? If so, how? E.g. Do you think you had any medications prescribed or changes in treatment because of reporting symptoms on the system? Were you happy with these changes?
- Did anyone else (such as a relative) help you use the system? Do you think they found it useful?

Admissions and calls to the hospital

- Did you need to contact the hospital at any point due to symptoms or side-effects? If so, who did you contact? Did you use eRAPID prior to contacting the hospital? If not, did you

consider using the eRAPID system before you contacted the hospital? Did you use the card in your booklet? How/why did you decide to contact the hospital? How long were you unwell for before you contacted the hospital?

If patient was admitted during their time on study:

- Can you tell us a bit about your admission to hospital and what happened in the lead up to that?
- Did you use the eRAPID system before you contacted the hospital?
- Did the staff on the acute ward mention eRAPID to you, or did you mention it to them?
- Did your admission have any effect on your treatment? (e.g. delays, dose reduction)

If patient had any reported any clinically severe symptoms (triggering advice to contact the hospital)

- When you received the advice to contact the hospital, did you do so? If not, what action did you take and why?
- Did anybody contact you? Did they discuss your eRAPID results with you?
- What were the consequences of that contact?

Supplementary file B: Summary of professional interview schedule

Awareness

- How did you hear about eRAPID/QTool?
- Did you use the symptom report without being prompted by the patient or researcher? If yes, what influenced you to do so?
- What percentage of patients who had eRAPID/QTool results on PPM did you use/view?

Accessing symptom reports in the EPR

- Were you offered any training prior to using the system? Was there anything about the training that could have been done differently? Are you aware that online training is now available?
- Do you have any suggestions how we may improve communication with staff who are using the system?
- How useful did you find the one page prompt guides? (Positive and negative feedback)
- Did you use the facility at the bottom of the results to change access to the number of results you could view? Is there any value to this facility?
- What do you think of the way in which symptoms/adverse events are recorded/ displayed in patient records through the eRAPID system?
- Could you give examples of any positive and negatives experiences you had in accessing the eRAPID results (ease of use) on the EPR?

Consultations

- What do you think the patients think about using eRAPID? Both in terms of logging in/answering the symptom reports and the value of the advice given.
- How has using the system impacted your consultation/assessment with patients?
- Did it change the doctor/nurse/patient relationship in any way? Could you give an example?

How did using the system impact on the length of time of the consultation?

- Were there any times when patient reported symptoms in the consultation did not match reported symptoms on the system? Could you give an example?
- Can you recall occasion/s when using the system influenced a change in patient management or treatment?
- What do you consider were the expected benefits/burdens in using the eRAPID system during the consultation?
- What do you consider were the unexpected benefits/burdens in using the eRAPID system during the consultation?
- What are your thoughts regarding the way in which patients have used the self-management advice available on the eRAPID system?

Severe symptoms notifications

- Have you ever responded to an alert on the system? If so, can you talk me through any particular issues?

General

- Overall, what do you think were the main advantages and disadvantages to using the system?
- Do you have any suggestions for how we could promote/encourage staff to access/use the eRAPID patient data in PPM in the future?
- What do you think the main facilitators were in using the eRAPID system?
- What do you think the main barriers were in using the eRAPID system?
- Do you have any suggestions in how we could improve the system?
- Would you recommend systems like eRAPID to other centres? If yes/no, why?

Supplementary file C: Summary of patient end of study feedback form: Multiple choice items and accompanying response options

1. How easy or difficult was it to learn how to use the eRAPID system?
   Very easy/Easy/Neither easy nor difficult/Difficult/Very difficult
2. How easy or difficult did you find accessing the system? (e.g. finding the website and logging in)
   Very easy/Easy/Neither easy nor difficult/Difficult/Very difficult
3. How easy or difficult was it to answer the questions about your symptoms?
   Very easy/Easy/Neither easy nor difficult/Difficult/Very difficult
4. How did you feel about the amount of time it took to complete the symptom questions?
   Too long/About right/ Too quick
5. How relevant were the symptom questions to you?
   Not relevant at all/ Very few questions were relevant/Neither relevant or irrelevant/ Quite relevant/ Very relevant
6. What did you think about completing these questionnaires every week?
   Definitely too often/ A little bit too often/ Unsure/ I was happy to complete them every week/ I would have been happy to complete them more often
7. Were there any times when you missed a week of completing the symptom questionnaire?
   No/Yes
8. Did the doctors and nurses you saw during your treatment use your eRAPID symptoms information during consultations?
   Yes, quite a bit/ Sometimes/ Not at all
9. If yes, did you feel this improved your consultations with the staff?
   Yes, quite a bit/ Sometimes/ Not at all
10. To what extent do you feel that the symptom questionnaire was useful for the doctors and nurses you saw during your treatment? Very useful/A little useful/Unsure/Not very useful/Not at all useful
11. How useful did you find the information on the eRAPID website about the symptoms and side effects of cancer treatment? Very useful/A little useful/Unsure/Not very useful/Not at all useful
12. Would you recommend the eRAPID system to other cancer patients?
    No/Not sure/Yes

Supplementary file D: Clinician eRAPID feedback form

Date of completion_____ Name of clinician_____

1. How well did you know this patient from before?

Never met him/her before	
A little	
Moderately well	
Very well	

2. Did you look at the patients' eRAPID symptom information in PPM before/ during the consultation?

Yes	No

3. Did you use the eRAPID symptom information in the clinic discussion?

Very much	Quite a bit	Somewhat	A little	Not at all

4. Did you find the eRAPID symptom information useful?

Very much	Quite a bit	Somewhat	A little	Not at all

5. If yes, in what way?

Provided additional information	
Confirmed your knowledge of patients' problems	
Identified issues/problems to be discussed	
***Contributed to management**	

****If you answered "Contributed to management", please specify in what way below.***

Change of medication	
Ordering of investigations	
Decision about chemotherapy	
Referral to supportive services (e.g. psycho-oncology, social worker)	
Counselling about lifestyle	

Other: Please specify

6. Are there any additional ways you have found the eRAPID symptom information useful?

Supplementary file E: Graphical summary of additional information from clinician feedback forms

FIGURE 1 CLINICIAN FEEDBACK ON WAYS ERAPID WAS USEFUL

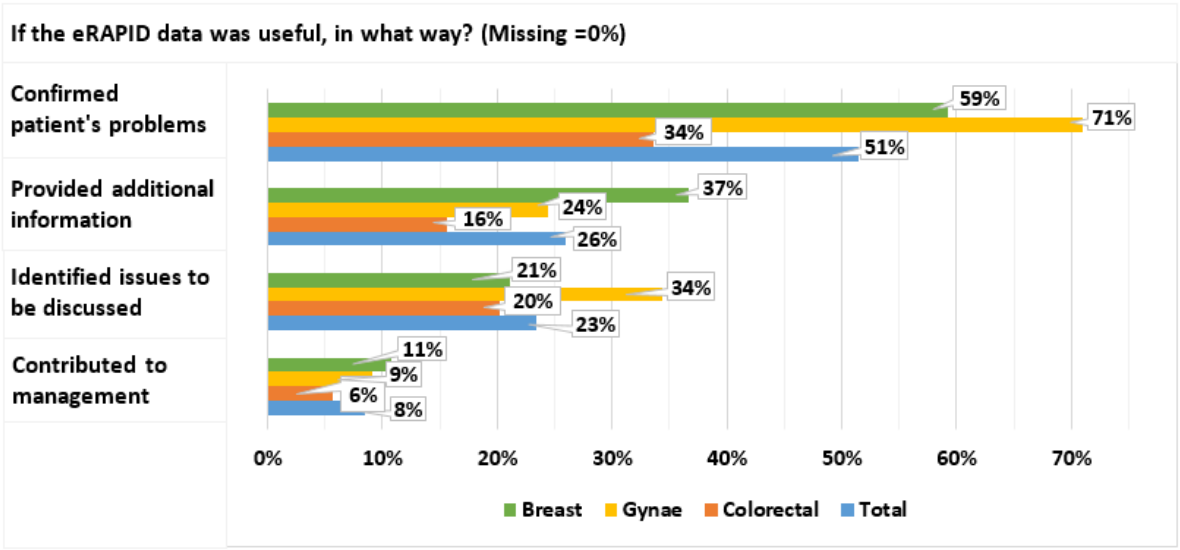
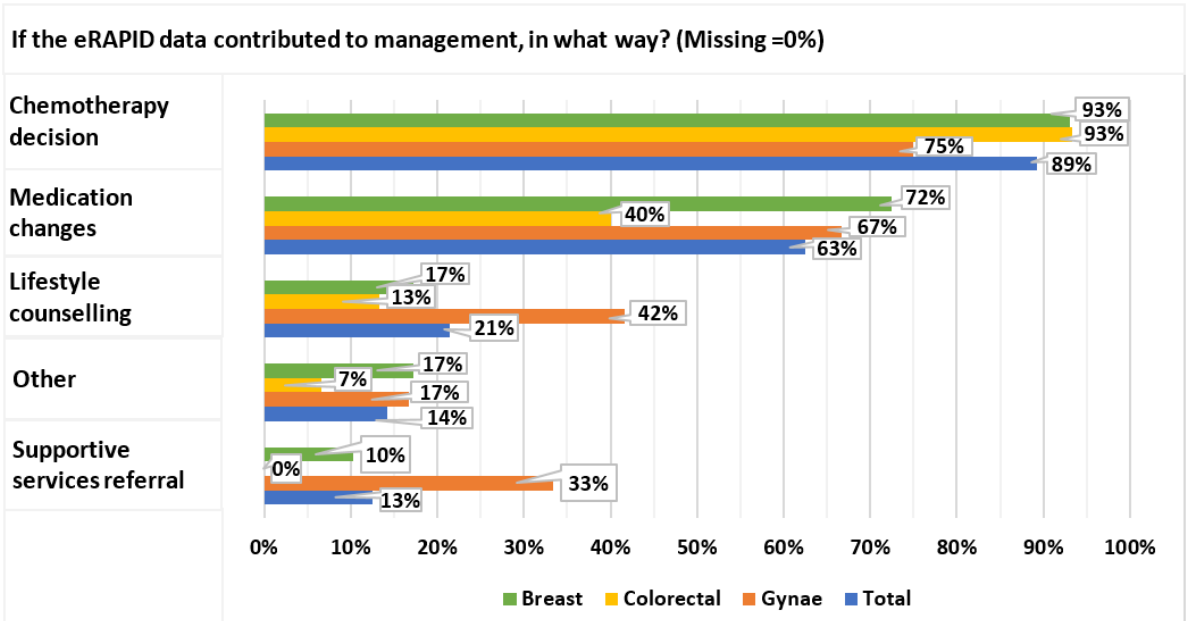


FIGURE 2 CLINICIAN FEEDBACK ON HOW ERAPID CONTRIBUTED TO MANAGEMENT



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BMC Cancer

STUDY PROTOCOL Open Access

Electronic patient self-Reporting of Adverse-events: Patient Information and aDvice (eRAPID): a randomised controlled trial in systemic cancer treatment

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Abstract

Background: eRAPID (electronic patient self-Reporting of Adverse-events: Patient Information and aDvice) is an internet based system for patients to self-report symptoms and side effects (adverse events or AE) of cancer treatments. eRAPID allows AE reporting from home and patient reported data is accessible via Electronic Patient Records (EPR) for use in routine care. The system can generate alerts to clinical teams for severe AE and provides patient advice on managing mild AEs. The overall aims of eRAPID are to improve the safe delivery of cancer treatments, enhance patient care and standardise AE documentation.

Methods: The trial is a prospective randomised two-arm parallel group design study with repeated measures and mixed methods. Participants (adult patients with breast cancer on neo-adjuvant or adjuvant chemotherapy, colorectal and gynaecological cancer receiving chemotherapy) are randomised to receive the eRAPID intervention or usual care over 18 weeks of treatment. Participants in the intervention arm receive training in using the eRAPID system to provide routine weekly adverse event reports from home. Hospital staff can access eRAPID reports via the EPR and use the information during consultations or phone calls with patients.
Prior to commencing the full trial an internal pilot phase was conducted ($N = 87$ participants) to assess recruitment procedures, consent and attrition rates, the integrity of the intervention information technology and establish procedures for collecting outcome data. The overall target sample for the trial is $N = 504$.
The primary outcome of the trial is quality of life (FACT-G) with secondary outcomes including health economics (costs to patients and the NHS), process of care (e.g. contacts with the hospital, number of admissions, clinic appointments and changes to treatment/medications) and patient self-efficacy. Outcome data is collected at baseline, 6, 12, 18 weeks and 12 months. The intervention is also being evaluated via end of study interviews with patient participants and clinical staff.
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Discussion: The pilot phase was completed in February 2016 and recruitment and attrition rates met criteria for continuing to the full trial. Recruitment recommenced in May 2016 and is planned to continue until December 2017. Overall findings will determine the value of the eRAPID intervention for supporting the care of patients receiving systemic cancer treatment.

Trial registration: Current Controlled Trials ISRCTN88520246. Registered 11 September 2014.

Keywords: Cancer, Adverse events, Patient reported outcome measures (PROMs), Patient reported outcomes (PROs), Electronic patient records, Electronic health records, Internet, Intervention, Self-management, Chemotherapy

Background

Systemic drug treatments for cancer (chemotherapy, hormonotherapy, biological therapy, targeted agents) are associated with significant adverse events (AEs). An AE is an untoward symptom or disease associated with (but not necessarily causally related to) a medical treatment or intervention AEs may lead to changes in drug dosage, cessation of treatment and can significantly compromise patients' quality of life. Severe AEs can escalate to hospitalisation for potentially life-threatening toxicities: 18% of cancer patients present to emergency services within 14 days of a scheduled hospital visit for symptom management (infection, fever, nausea/vomiting, pain, breathlessness) [1–4]. Patients with breast, gastrointestinal, colorectal cancers and those with metastatic disease are amongst those most likely to have emergency admissions [4, 5].

Many patients however, delay seeking care especially out of hours [3, 5]. This concurs with the findings of a UK enquiry into patient outcome and death (National Confidential Enquiry into Patient Outcome and Death, NCEPOD) which found that of patients dying within 30 days of systemic cancer therapy, 17% delayed seeking advice for over 24 h [6]. AEs are documented consistently by physicians in clinical trials however in routine care recording of AEs by clinicians and reporting by patients is variable and often omitted [6]. It has been recognised for some time that a structured AEs reporting system would be useful to facilitate correct documentation and grading of AE severity to support tailored management. Consequently, the National Cancer Institute (NCI) in the US have developed the Common Terminology Criteria for Adverse Events (CTCAE v 4.0) [7] as a reporting and severity grading system for cancer clinical trials. These have recently been adapted for patients to self-report (NCI-PRO CTCAE) [8] and these items have concordance with nurse evaluated AE [9] and similar items created for self-report correlate with quality of life measures [10]. The need for routine monitoring of cancer treatment AE is at odds with a health care system relying increasingly on patient self-management and home based care. In order to bridge the gap in service provision to detect, identify and manage AE in cancer patients the Electronic patient self-Reporting of Adverse-events: Patient Information and aDvice (eRAPID): system was developed [11].

Patient reported outcome measures (PROMs)

PROMs have been used in clinical practice to support care of individual patients, recent reviews suggest they improve symptom/function monitoring, physician patient communication and decision making [12–17], can save time during clinic visits and improve the accuracy of symptom reporting [18]. In the UK the 2008 Darzi report [19] recommended that collection of PROMs data should be an essential component of health care evaluation [19] and the Department of Health (DOH) subsequently produced guidelines to aid their implementation [20]. Following this, use of PROMs in the health service is most advanced in England (particularly for performance comparisons) [21]. Two recently published reports by the Independent Cancer Taskforce and NHS England have continued to highlight the need to put PROMs at the centre of strategies to improve patient centred cancer care and quality of life [22, 23].

Electronic and mobile reporting technology

Electronic reporting of patient reported outcome measures (PROMs) has proven extremely acceptable to patients in the clinic setting [24–26]. Examples of successful implementation of electronic symptom reporting in oncology clinical practice include PatientViewpoint [27], the symptom tracking and reporting system (STAR) system for patients to report chemotherapy AE [28] and the Tell Us™ [29] system for advanced cancer patients in hospices undergoing palliative care (all in the U.S.). In Austria the Computer-based Health Evaluation System (CHES) software [30] has been developed and an interactive online system (ISAAC) is in use in Canada [31]. In the UK the ASyMS mobile phone system is currently being evaluated [32]. Electronic patient reported outcome systems have proven very acceptable even for patients coping with extreme symptom burden and reduced quality of life; indeed a mean monthly PROM completion rate of 83% at

34 weeks has been achieved with patients receiving cancer treatment [33].

eRAPID development work

The eRAPID research programme was designed to develop and evaluate an online system to support the collection and clinical integration of patients' symptom/AE reports during cancer treatment. It utilises a web-based questionnaire builder system called QTool. QTool Version 1 was originally used in a large prospective study of cancer survivors, recruiting 636 patients in 12 months, 81% of whom completed web-based questionnaires at baseline [34] (www.epocs.leeds.ac.uk), confirming the feasibility of web-based patient-reporting and QTool acceptability. Between 2010 and 2013 the eRAPID developmental work was conducted (funded by an National Institute of Health Research grant: Programme Development Grant scheme RP-DG-1209-10,031), which focused on:

1) Developing the electronic platform to allow QTool data to be securely linked to the electronic patient records used by Leeds Teaching Hospitals (see Fig. 1).
2) Selection, adaption and evaluation of items for patients to report symptoms and AE resulting in the development of patient-reported AE (PRAE) items based on CTCAE grades [35]. The initial item pool includes most common AEs namely nausea, vomiting, diarrhoea, mucositis, fatigue, insomnia, palmar-plantar erythema, pain, peripheral neuropathy, appetite loss, constipation, rash, bleeding, anaemia, febrile neutropenia and stoma problems.
3) Collating patient information and advice on AE management. We reviewed and compiled the extensive literature available providing patient advice on the management of common symptoms and side effects during systemic cancer treatment. The information is available on the password protected eRAPID patient website. The eRAPID QTool symptom report provides patients with immediate brief graded advice dependent on severity of AE reported (including a recommendation to contact the hospital when severe symptoms are detected) and links users out to the eRAPID website for more detailed information. The website has been extensively reviewed by both patients and oncology staff.
4) Mapping patient care pathways. With support from staff responsible for monitoring chemotherapy patients at St James' Institute of Oncology, Leeds the current care pathways for patients receiving systemic treatment were mapped to establish where eRAPID can best fit. This work was conducted via:

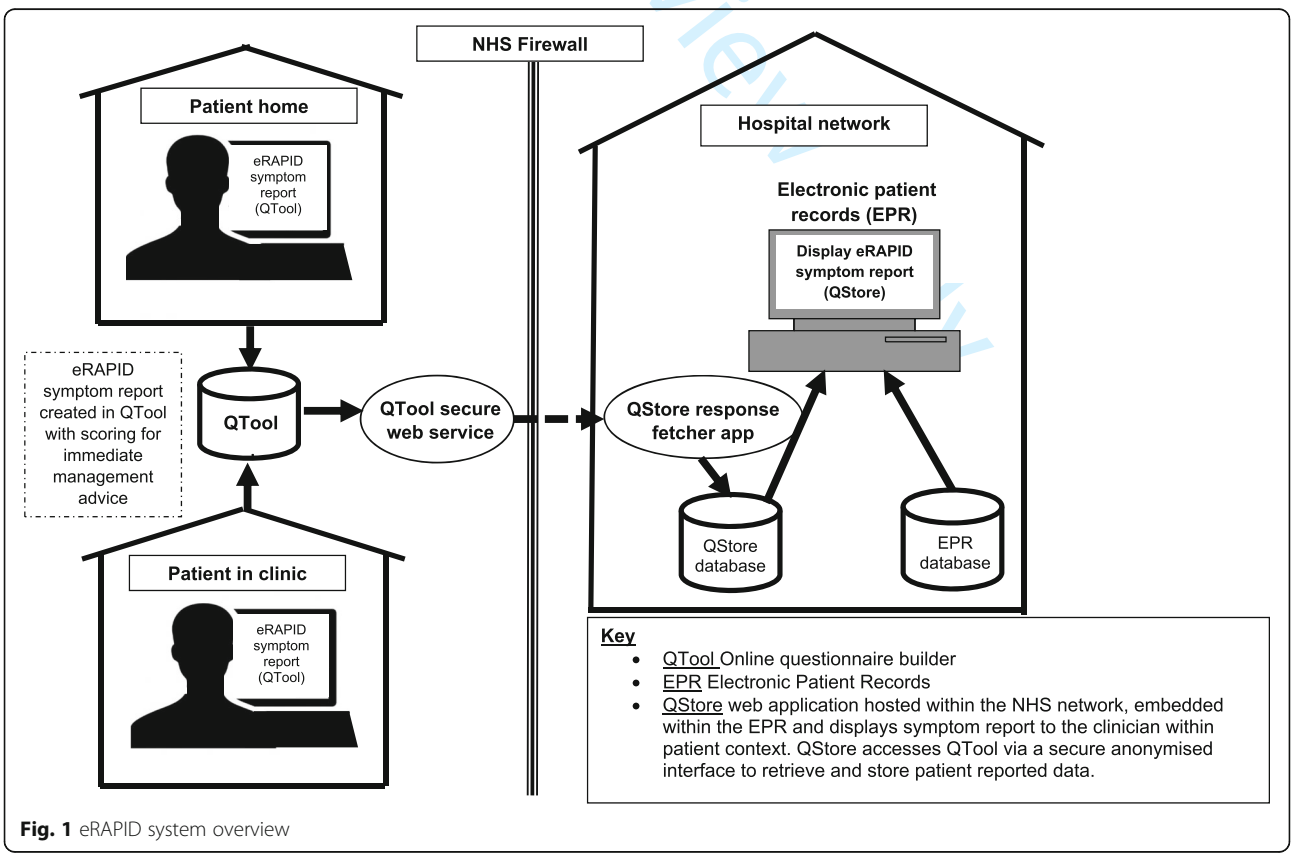

Fig. 1 eRAPID system overview

staff interviews, a local audit of care pathways/acute triage processes, mapping the existing chemotherapy pathways for the detection and management of AE and an assessment of patient experience of acute admissions and prospective patient interviews and diaries during chemotherapy to record AEs and costs to patents and services. The latter aimed to develop a questionnaire for health economic analysis [5].

This developmental work led to the:

- Successful mapping of current systemic treatment pathway, establishing where eRAPID is best placed
- Identification of staff requiring training to deliver eRAPID
- Adaptation of a health economic questionnaire for cancer patients receiving treatment

The eRAPID intervention

An overview of the eRAPID intervention is described in Figs. 1, 2a and b. Figure 1 represents the technical components and their integration to support reporting of AEs immediately available in the EPR. The architecture protects patient confidentiality providing security whilst allowing immediate linkage to individual patient records to support care.

The intervention consists of the following components:

- Patients can log in to QTool (using a unique username and password) to access the eRAPID symptom questionnaire anywhere with internet access (including home or hospital).
- For mild/moderate problems information about self-managing these issues are provided via brief instructions in QTool along with hyperlinks to more detailed advice on the eRAPID patient website (Fig. 2a).
- Where severe symptoms are reported patients are advised to contact the hospital.
- The patient reported data is immediately available for staff to view in the individuals' electronic patient records in Leeds Teaching Hospitals NHS Trust (Patient Pathway Manager, PPM). See Fig. 2b.
- Alerts for severe symptom reports are sent directly to staff via email. Clinicians can then log into PPM and view the patients' symptom reports and take appropriate action where needed.

Prior to the start of the current trial the eRAPID system underwent usability testing with $N = 14$ breast cancer patients receiving adjuvant or neo-adjuvant chemotherapy and relevant staff.

Hypotheses

We hypothesise the eRAPID intervention has the potential to bring benefit to patients, staff and the NHS in the following ways:

- Benefits for patients
  - Earlier symptom detection and improved self-management, timely admissions
  - Improved supportive medication use
  - Appropriate hospital, GP, community contacts
  - Better outcomes (improved symptom control, functioning and quality of life)
- Benefits for staff
  - Reduce the number of hospital, GP, community contacts
  - Save time spent on enquiring and recording AEs
  - Focus attention during clinical contacts on most important or severe AEs
  - Support decision making in routine care
- Benefits to the NHS
  - eRAPID provides a cost-effective approach to support patient self-management and reduce hospital and GP contacts

Study design

This study is a single centre 1:1 allocation prospective randomised two-arm parallel group trial design with repeated measures and mixed methods.

Patient sample

The study sample includes patients with gynaecological or colorectal cancer requiring chemotherapy, or breast cancer undertaking either neo-adjuvant or adjuvant following systemic treatment pathways at St. James's Institute of Oncology, Leeds, UK.

Methods

Participants are randomised to either the intervention arm (eRAPID plus usual care) or the control arm (usual care). See Fig. 3 for the trial flow diagram. Participants are on the study for an 18 week period from the start of chemotherapy. A subset of participants (where feasible within the funding timeframe) will also be assessed at a 12 month time point to examine any potential longer term impact of the intervention on quality of life and clinical processes.

Usual care

Includes an initial consultation with an oncologist to decide whether to commence systemic treatment. Patients are provided with verbal and written information on treatment benefits and expected AEs, and are given instructions on how to contact the hospital. They have a nurse assessment before starting their treatment. During treatment patients are routinely assessed in clinics for

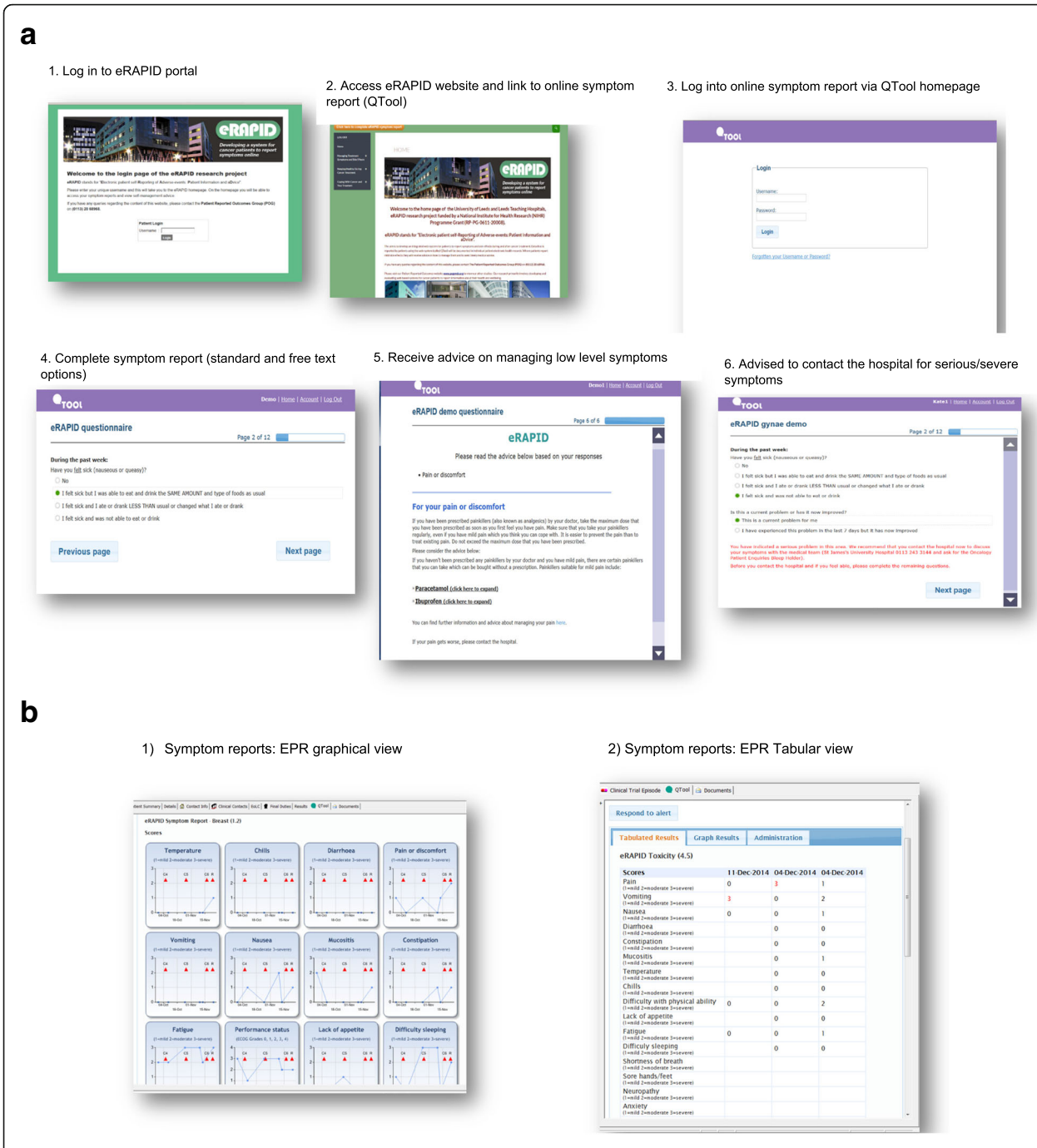

Fig. 2 a Screenshots of eRAPID intervention (Patient login and symptom reports). **b** Screenshots of eRAPID intervention- Clinician view of symptom reports in electronic patient record (EPR)

AE and to prescribe their next cycle of treatment by an oncologist, Clinical Nurse Specialist (CNS) or staff grade doctor. Depending on AE experienced by the patient, treatment doses can be reduced, and/or supportive medications changed (e.g. anti-sickness drugs, anti-diarrhoea drugs). When at home if patient has a serious AE they are asked to contact the hospital and the nurse dealing with the patient phone call uses an Acute Triage Form to record reasons for the call, document the AE and gives advice.

eRAPID intervention

In addition to usual care, participants randomised to the eRAPID intervention arm will receive training on using the system and will be asked to complete the eRAPID symptom report routinely from home at least weekly and

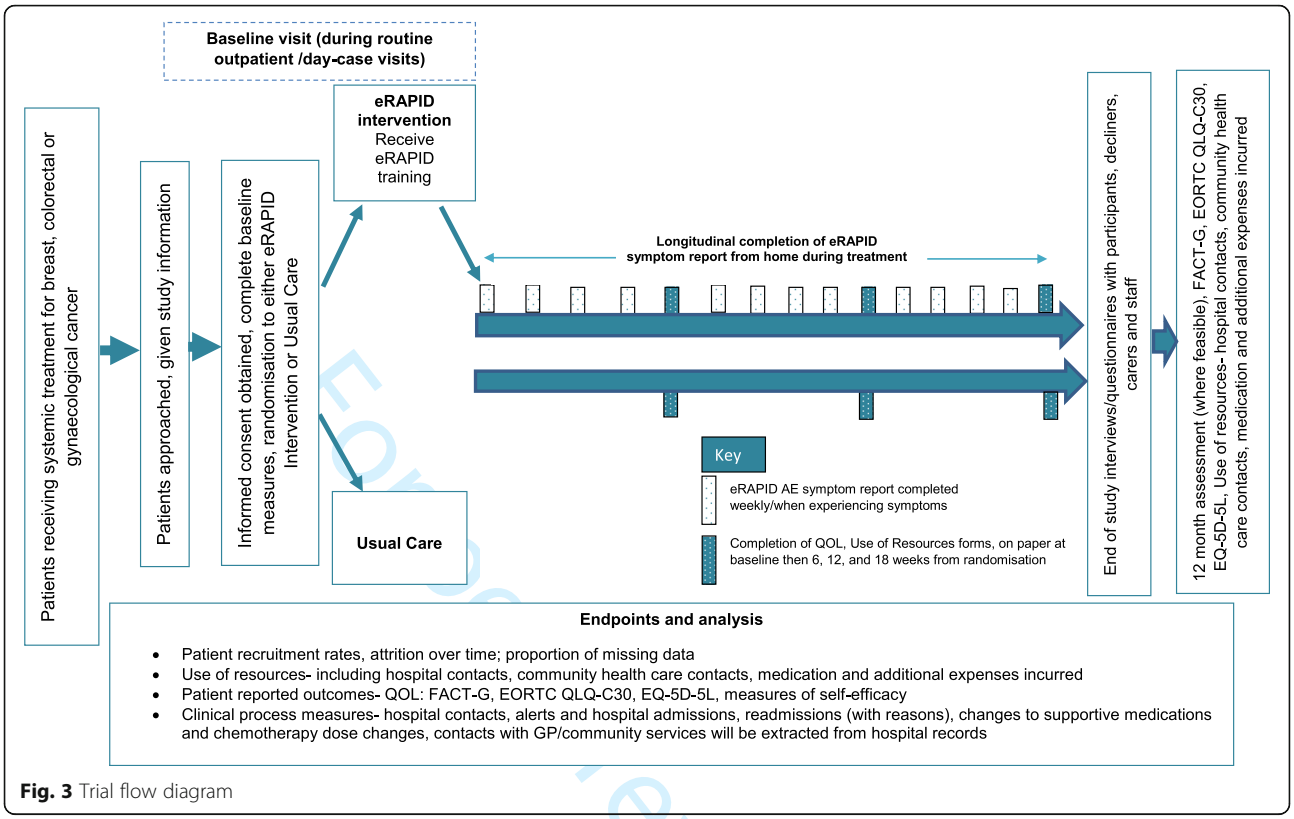

Fig. 3 Trial flow diagram

when they experience symptoms over 18 weeks during treatment. Clinicians are given access to patients' self-reported AEs via the electronic patient record system (PPM) and asked to utilise the information when seeing patients in clinic or providing telephone advice.

Aims and study objectives

To evaluate the potential benefits of eRAPID for patients and staff, the intervention and usual care arm will be compared on the following areas through the collection of appropriate clinical information, patient reported outcomes and interview data:

1. Assessment of hypothesised benefits to patients with mild or moderate AE:

a) Number of hospital, GP and community contacts during the study
b) Improved patient reported outcomes
c) Improved symptom detection and supportive medication use

2. Assessment of hypothesised benefits to patients with severe AE:

a) Improved detection and treatment of AEs and admissions (e.g. number of clinician alerts generated from eRAPID, number of admissions and hospital contacts)
b) Levels of morbidity (percentage of planned chemotherapy received, changes to treatment plans (dose reductions, dose delays/interruptions)).

3. Assessment of hypothesised benefits to clinicians: Staff will be interviewed about their views of the value of eRAPID in saving time currently spent enquiring and recording patients' AE and supporting treatment decision-making. In addition oncologists will complete a feedback form at routine review appointments after seeing eRAPID intervention participants to assess how/if patient reports are used.
4. Monitor patient safety, assessed by monitoring acute admissions, cumulative deaths and cause of death.

The FACT-G Physical Wellbeing Score [36] (measured at 18 weeks) is the primary outcome. The main secondary outcome is cost effectiveness assessed via use of health care services (including hospital admissions, telephone contacts and consultations, medication and personal expenses). In addition participant records will

be linked to costs held within the local pilot database of the National Patient-Level Information and Costing System (PLICS) scheme. This provides a cost for hospital based accident and emergency department visits, outpatient attendances and inpatient stays.

Ethical approval

The study was approved by the National Research Ethics Service (now part of the Health Research Authority) Yorkshire & The Humber Leeds East Committee in September 2014 (Reference 14/YH/1066). Local approvals from the Leeds Teaching Hospitals NHS Trust Research and Innovation Department were also obtained.

The RCT has two phases

I. An internal pilot phase to assess the feasibility and acceptability of the intervention and allow for minor modifications before further large scale recruitment was conducted. If no meaningful changes are made to the intervention the study would progress to the main trial and patients recruited during the pilot phase will be included in the analysis.
II. The full trial phase will continue to recruit the target sample (at most N = 504 participants, see sample size calculation below) using the best recruitment and retention methods established in the internal pilot.

Internal pilot phase

Prior to starting the full trial an internal pilot phase was conducted with the aim of assessing recruitment and attrition rates, refining the intervention, testing the integrity of information technology (IT) systems and to establish procedures and methods for collecting outcome measure data. We aimed to achieve (i) recruitment levels of >10 patients per month), (ii) 60% to consent to randomisation, and (iii) <30% attrition.

The pilot sample size was set at 30 participants per-arm [37] allowing for 30% overall attrition, the overall target was a minimum of 42 patients per-arm (N = 84). Recruitment took place between January–September 2015.134 patients were approached, 87 consented, 22 declined and 25 were excluded after further screening (no Internet access or not continuing on to chemotherapy). The consent rate when including those patients excluded post-screening was 65% (87 consented/134 approached). However the "true" consent rate excluding the 25 patients was 80% (134 approached - 25 ineligible). Forty-four participants were allocated to the Intervention arm and 43 to Usual Care. Only 13 participants (15%) withdrew. No significant problems with the IT systems underpinning the eRAPID online intervention were encountered and the research team was able to develop robust methods of gathering information on clinical process data (e.g. hospital contacts, changes to treatment). Based on participant feedback some refinements were made to patient "use of resources forms" to aid comprehension of questions and ease of completion. The overall recruitment and attrition targets were met and the Trial Steering Committee (TSC) recommended progression to the main trial. The study procedures described below reflect the protocol for the main trial approved by Yorkshire & The Humber Leeds East Research Ethics Committee in December 2016, protocol version number 1.5.

Patient eligibility

Inclusion criteria

- Adult patients (aged 18 years or over) attending St James' Institute of Oncology, Leeds with breast cancer undertaking either neo-adjuvant or adjuvant systemic treatment pathways, gynaecological or colorectal cancer requiring chemotherapy
- Prescribed at least 3 months of planned chemotherapy cycles at the time of study consent
- Able and willing to give informed consent
- Able to read and understand English
- Access to the internet at home

Exclusion criteria

Patients are excluded from participation if they are:

- Taking part in other clinical trials involving the completion of extensive patient reported outcome or quality of life measures or have previously participated in an eRAPID trial
- Exhibiting overt psychopathology/cognitive dysfunction

Recruitment processes

Identification of eligible patients

Patients are recruited from outpatient clinics and day case wards at St James' Institute of Oncology clinics.

Eligible patients are identified by screening of the clinic, in-patient or day-case lists by the most appropriate clinical staff. Prior to study commencement, consultants responsible for the care of patients within each eligible tumour group are contacted via email and sent an introduction to the study and permission is requested for the research team to approach their patients.

Approaching patients

An appropriate member of the clinical team seeks permission from eligible patients for the researcher to speak to them about the study. After introduction from clinical staff, eligible patients are approached by a member of

the research team who explain the study and provide the information sheet. Patients are given as much time as they need to read the information and ask questions and should they wish to participate they are consented at the visit. Where patients prefer more time to consider participation, they can take the information home and discuss the study again with the researcher at their next visit.

When patients are happy to participate they are asked to provide written informed consent. The participant is then randomised to either the intervention or control arm. Participants who are randomised to the intervention arm receive training in using the eRAPID system.

Randomisation

After trial eligibility has been confirmed and consent given, randomisation is performed via the University of Leeds Clinical Trials Research Unit (CTRU) telephone system. Participants are randomised with 1:1 allocation to intervention and control groups. Patients are stratified by cancer site (breast, gynaecological or colorectal), gender and previous chemotherapy (gynaecological cancer patients only) in variable random permuted blocks of 4, 6 or 8, see Fig. 4.

eRAPID intervention: Participant and staff training

Participant training

Researchers provide a short demonstration on how to use the eRAPID system and provide patients with a unique user name and password to access the system, on an eRAPID 'postcard'. Participants are given a user manual to take home providing a step-by-step guide on how to log in and use the eRAPID system. Participants are asked to complete the remote eRAPID Adverse Events (AEs) questionnaire weekly (from home or during clinic visits) and at any time when they experience any side-effects/symptoms during the duration of their treatment. The questionnaire consists of 12–15 items depending on the disease group assessing the severity of common symptoms such as: nausea, vomiting, pain, fatigue, diarrhoea, constipation, sore mouth/tongue, temperature, chills, performance status, fatigue, sleep, and appetite. Participants can also provide details about additional problems at the end of the standard questions. A weekly text message or email reminder are sent to the participants as a prompt to complete the eRAPID AE questionnaire.

Staff training

Prior to study commencement the appropriate staff received training on eRAPID. The aims of training are to support staff in understanding:

1. How patients use and interact with eRAPID and the content of self-reported AE questionnaire/website
2. Accessing patients' eRAPID self-report data in the electronic patient records
3. Interpreting patient self-reported AE scores and methods of incorporating the data into clinical encounters with patients. Including information on how the symptom scores relate to mild, moderate and severe problems and how the cut-offs or alerts for severe symptoms have been developed

During one-to-one/small group interactive sessions eRAPID is demonstrated by the research team, giving staff an opportunity to see the patient interface. Staff are shown the practicalities of locating the data within the electronic patient records. Manuals are provided outlining the key steps in all the processes covered in the session. Training highlights that the self-report information should be seen as a supplementary resource for staff to use in conjunction with routine practices for clinical decisions.

Outcome measures

The following measures and data are being collected to enable comparison between the usual care and eRAPID intervention arms. An overview of the outcome data and time points are outlined in Tables 1 and 2.

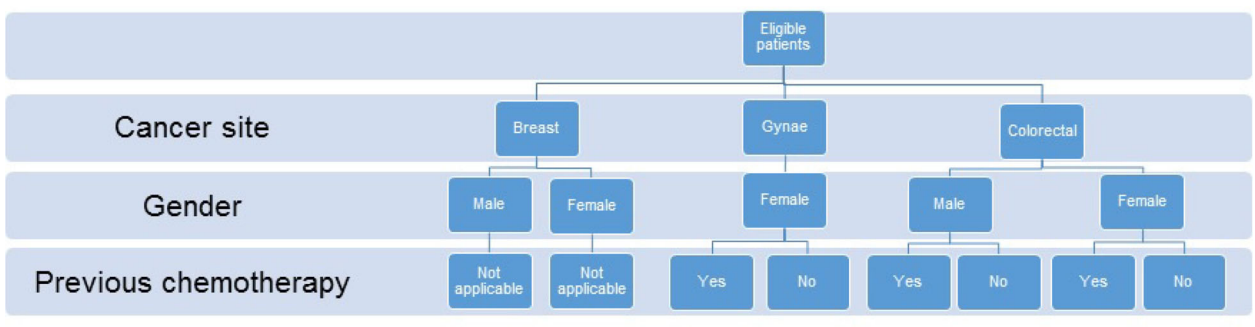

Fig. 4 Stratification factors used in randomising patients in the eRAPID RCT

Table 1 eRAPID RCT in systemic cancer treatment: Participant completed primary and secondary outcomes measures

Questionnaire title and brief description	Item information/response format and scoring	Example questions	Time points
Primary outcome- Quality of Life			
Quality of life: FACT-G [36]			
27 item cancer specific QOL measure four subscales covering physical, social or family, emotional and functional wellbeing	5 point scale (0 not at all – 4 very much) Higher subscale and total scores indicate better QOL (score range 0–108).	• I have nausea • I am forced to spend time in spend • I get support from my friends • I worry that my condition will get worse • I have accepted my illness	Baseline, 6, 12, 18 weeks and 12 months
Secondary outcomes- health economic/clinical process data			
EQ-5D-5 L [38]			
6 item descriptive health profile (measuring mobility, self-care, usual activities, pain, anxiety/depression) and a single index value for health status that can be used as part of a health-economic evaluation.	5 items measured on 5 point scale and single global health item rated from 0 (worst health) to 100 (best health)	Self-care • I have no problems washing of dressing myself • I have slight problems washing or dressing myself • I have moderate problems washing or dressing myself • I have severe problems washing or dressing myself • I am unable to wash or dress myself	Baseline, 6, 12, 18 weeks and 12 months
Use of Resources			
Assessment of financial impact of cancer treatment covering: - Employment status - Contacts with community health care services (GP, district nurses etc) - Medications costs - Cancer related travel costs - Cancer related food/drink costs - Additional expenses	Varied tick boxes and free text options.	• Please complete the boxes below to tell is about any non-hospital health care contacts you have had in the last 6 weeks • Please tell us about any medications you have been prescribed in the last 6 weeks and who prescribed it • Please tell us about any additional travel costs related to your cancer or cancer treatment you have incurred in the last 6 weeks	6, 12, 18 weeks and 12 months
EORTC-QLQ C30 [39]			
30-item questionnaire with five functional scales (physical, emotional, cognitive, social, role), three symptom scales (fatigue, pain, nausea/vomiting), a global health related quality of life scale, and six single items (anorexia, insomnia, dyspnoea, diarrhoea, constipation, financial difficulties)	Questions are rated on a 4 or 7 point response scales. The scales and single-item responses are recalculated into a score from 0 to 100. • A high functional scale score represents a high level of functioning • A high score for the global health status/QOL represents a high QOL • A high score for a symptom scale/item represents a high/worse level of symptomatology	• Do you have any trouble taking a long walk • During the past week… - Have you lacked appetite? - Were you tired? - Did you feel depressed?	Baseline, 6, 12, 18 weeks and 12 months

Table 1 eRAPID RCT in systemic cancer treatment: Participant completed primary and secondary outcomes measures *(Continued)*

Secondary outcomes- Self-efficacy			
Self-Efficacy for Managing Chronic Disease [34]			
6-Item scale covering several domains common across chronic diseases (symptom control, role function, emotional functioning and communicating with physicians)	Items rated from 1- (not at all confident) to 10 (totally confident) The score for the scale is calculated from the mean of the six items.	• How confident are you that you can keep physical discomfort or pain of your disease from interfering with the things you want to do? • How confident are you that you can do things other than just taking medication to reduce how much you illness affects your everyday life?	Baseline and 18 weeks
Cancer Behaviour Inventory-Brief (CBI-B) [40]			
A measure of self-efficacy for coping with cancer. 14 items (adapted from full 33 item measure)	Items are rated on a 9-point scale ranging from 1 ("*not all confident*") to 9 ("*totally confident*") A total score is calculated as the sum of all 12 items.	Please read each numbered item. Then rate that item on how confident you are that you can accomplish that behaviour. - Maintaining independence - Expressing feelings about cancer - Asking physicians' questions - Coping with physical changes	Baseline and 18 weeks
Patient Activation Measure (PAM) [41]			
13-item scale for measuring the level of patient engagement in their healthcare (knowledge, skill and confidence for self-management)	Statements rated on 4 point scale from disagree strongly to agree strongly and additional N/A option. Responses are combined to provide a single score of between 0 and 100 with higher scores representing higher levels of patient activation. Scores can be classified into one of four groups, known as 'levels of activation'.	• When all is said and done I am the person who is responsible for taking care of my health • I am confident I follow through on medical treatments I may need to do at home • I know what treatments are available for my health problems.	Baseline, 18 weeks and 12 months
Secondary outcomes- eRAPID/IT system performance			
System Usability Scale (SUS) [42]			
10 item instrument to assess views of usability of an IT systems.	Each statement rated from 1 strongly disagree to 5 strongly agree. Responses are calculated into a total score ranging from 0 to 100 with higher scores representing better system usability.	• I think that I would like to use this system frequently • I thought there was too much inconsistency in this system • I felt very confident using the system	18 weeks
eRAPID end of study questionnaire			
15 statements/free text boxes to assess participant views of using eRAPID and suggestions for improvements	Statements rated on 3–5 response option scales (e.g. very easy-very difficult) and free text boxes for comments.	• How easy or difficult was it to learn how to use the eRAPID system? • How did you feel about the amount of time it took to complete the symptom questions? • To what extent do you feel that the symptom questionnaire was useful for the doctors and nurses you saw during your treatment? • Have you got any suggestions about how the eRAPID system could be improved?	18 weeks

Table 2 eRAPID RCT in systemic cancer treatment: Researcher collected data for secondary outcomes

Data	Description of data	Time point for collection
Treatment and clinical information	• Cancer diagnosis, stage and grade • Age, date of birth • Baseline data on planned chemotherapy • Changes to treatment delivery and reason • Comorbidities	Initial baseline assessment and reviewed for changes at 18 weeks
Clinical process- Hospital contacts	• Contacts with the hospital e.g. (unplanned) telephone, appointments, consultations • Emergency admissions, acute ward stays and reasons for contacts.	• Data extracted from medical notes for 18 of study • 3 month prior to 12 month follow-up assessment
Clinical process- Information from general practice	• GP recorded problems/concurrent illnesses • Prescribed medications and reasons for prescription (where available)	• Data extracted from medical notes for 18 week study period • 3 month period prior to 12 month follow-up assessment for subset of participants
IT/System functioning	• Researcher maintained log of IT issues (e.g. server downtime, contacts with study participants reporting IT problems or issues logging into eRAPID) and how these were resolved	Throughout trial
Treatment and clinical information	• Cancer diagnosis, stage and grade • Age, date of birth • Baseline data on planned chemotherapy • Changes to treatment delivery and reason • Comorbidities	Initial baseline assessment and reviewed for changes at 18 weeks
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IT/System functioning	• Researcher maintained log of IT issues (e.g. server downtime, contacts with study participants reporting IT problems or issues logging into eRAPID) and how these were resolved	Throughout trial

Patient outcome measures

Functional assessment in cancer therapy scale-General (FACT-G) [36]

The FACT-G is a cancer specific measure widely used in clinical trials. It has four subscales: physical wellbeing, social or family wellbeing, emotional wellbeing, and functional wellbeing. Question responses range from 0 to 4. Higher scores on the questionnaire indicate better quality of life.

Eq-5D-5 L [38]

The EQ-5D is a standardised instrument for use as a measure of health outcome developed by the EuroQol Group. The instrument assesses five dimensions: mobility; self-care; usual activities; pain/discomfort and anxiety/depression. Each dimension has five response levels (ranging from no problems to extreme problems). The instrument also includes a scale to rate health from 0 (worst health you can imagine) to 100 (best health you can imagine).

Use of resources

Resource use is assessed using patient forms (detailing non-hospital contacts e.g. appointments with GPs/community services, counsellors, local support services), as well as medication use and costs incurred as a consequence of cancer diagnosis/treatment. This form is based on those developed by Hulme for a recently completed trial assessing treatment for chemotherapy-related nausea/vomiting (https://njl-admin.nihr.ac.uk/document/download/2002381).

EORTC-QLQ-C30 [39]

The EORTC QLQ-C30 is a 30-item questionnaire consisting of five functional scales (physical, emotional, cognitive, social, role), three symptom scales (fatigue,

pain, nausea/vomiting), a global health related quality of life scale, and six single items (anorexia, insomnia, dyspnoea, diarrhoea, constipation, financial difficulties). Questions are rated on a 4 or 7 point response scale and overall scale scores are calculated from 0 to 100 with higher scores indicating better quality of life or functioning. Symptoms scales are scored so that higher scores indicate worse symptoms experience.

Self-efficacy and patient activation

Self-Efficacy for Managing Chronic Disease 6-Item Scale [34]
This 6-item scale covers several domains that are common across many chronic diseases such as symptom control, role function, emotional functioning and communicating with physicians.

The Cancer Behaviour Inventory- Brief (CBI-B) [40]
A self-efficacy measure specifically designed for assessing coping with cancer. Devised from the full 33 item measure, this brief version has 14 items covering: maintaining activity and independence, seeking and understanding medical information, stress management, coping with treatment related side effects and accepting cancer/maintaining a positive attitude.

The Patient Activation Measure (PAM) [41]
The PAM is a tool for measuring the level of patient engagement in their healthcare. It was designed to assess an individual's knowledge, skill and confidence for self-management. The PAM 13-item scale explores beliefs, knowledge and confidence for engaging in health behaviours. Each item is rated on a four point scale from strongly disagree to strongly agree and an overall score from 0 to 100 can be calculated. These scores can be subdivided to categorise people into one of four activation categories ranging from 1- Low activation to 4- High activation.

Socio-demographic and clinical process data

Participants complete a baseline questionnaire on socio-demographics and current computer usage. Clinical baseline data are obtained from participants' medical notes and include diagnosis, co-morbidities and planned treatment (Table 2).

To determine any association between the eRAPID intervention and improved detection and management of AEs, data is collected from hospital triage forms, medical records, hospital databases to record:

- Number of scheduled and unscheduled hospital contacts (admissions, clinic visits, phone calls with staff)
- Changes to supportive medications and chemotherapy dose changes
- Contacts with GP and community services
- Number of clinician alerts generated from eRAPID severe symptom reports and actions taken by staff

eRAPID system performance

Throughout the study the eRAPID IT system is monitored for unscheduled server down time (leading to the unavailability of the QTool questionnaire website, eRAPID website and patient symptom data in PPM). A log of phone calls/feedback from study participants regarding issues/problems surrounding the use of the eRAPID questionnaire or website will be maintained.

eRAPID intervention participants are asked to complete the System Usability Scale [42] (SUS). This 10 item instrument assesses subjective views of usability of different systems including hardware, software, mobile devices, websites and applications. The 10 items cover the ease of using the system, its complexity and user confidence. Each item is rated from 1 to 5 and a composite score of overall usability can be calculated ranging from 0 to 100 (higher scores reflect better usability). Intervention participants are also asked to complete a short end of study questionnaire about their experiences with the eRAPID intervention which includes free text boxes for comments and feedback.

Participant interviews

Between 5 and 10 participants per disease group and study arm will be interviewed at the end of the full trial. Participants will be asked about their treatment experience, how they managed and monitored their symptoms and perceptions of reporting and discussing their symptoms with hospital staff. Intervention arm participants will be asked to describe their thoughts on using the eRAPID system.

Staff feedback- interviews and questionnaires

At routine chemotherapy review appointments involving eRAPID intervention patients, staff will be asked to provide:

- Clinician reports of use of eRAPID patient data during consultations
- At 6 weeks routine clinic visits clinicians are asked to complete CTCAE scoring form matching those AE completed by patients on the eRAPID questionnaire

At the end of the study 5 health professionals from each disease group will be interviewed to determine their views of eRAPID, the perceived value and use of the patient data in clinical practice (e.g. improving the detection, documentation and management of AE, supporting treatment decision-making in routine care).

Perceptions of staff training needs and recommendations for improving the system will also be explored.

Sample size calculations

The sample size for the full trial is based on the primary patient outcome of better symptom control measured at 18 weeks by the FACT-G. A sample of 176 patients per arm is necessary to detect a 2-point change in the FACT-G Physical Wellbeing score with 80% power and 5% significance, where the population standard deviation is 6.7. This change corresponds to a medium Cohen's effect size (0.3) [43].

Allowing for 30% attrition, a minimum of 252 patients per arm (504 total) is required. With potentially >500 eligible patients treated in the cancer centre annually, we expect to recruit 20 patients per month over approximately 24–30 months, allowing for 70% internet access and 70% consent rate.

Analysis populations

All analyses and data summaries will be conducted on the intention-to-treat (ITT) population which is defined as all participants registered regardless of non-compliance with the protocol or withdrawal from the study.

Statistical analysis

Baseline characteristics

Data from the baseline socio-demographic, computer usage and clinical data questionnaires will be tabulated using frequencies and summary statistics for each treatment group and overall for both the pilot phase and full trial.

Primary outcome

The FACT-G Physical Well-being score will be summarised overall and by treatment arm. Changes in score over time and differences between treatment arms will be explored using a multilevel repeated measures model. The model for each post-randomisation point will be adjusted for baseline score and stratification factors. If there are missing items, subscale scores will be prorated as per the FACT-G scoring manual.

Secondary outcomes

Clinical process measures

The number of calls made to the hospital will be summarised overall and by treatment arm. Differences between the two treatment groups will be compared using either Poisson regression or negative binomial regression; the most appropriate model will be chosen after performing post-estimation tests. Models will be adjusted for the stratification factors.

The numbers of weekly/additional AE reports and severe AE alerts generated will be summarised for participants randomised to the eRAPID intervention. The number of telephone calls to hospital staff, acute admissions, contacts with GP and/or community services and number of deaths will be summarised overall and by treatment arm. Any differences between treatment arms will be explored using the most appropriate regression model (either Poisson or negative binomial, to be decided using post-estimation tests) adjusted for stratification factors.

Patient outcome measures (other than primary)

Changes in scores over time and differences between treatment arms will be explored using a multilevel repeated measures model adjusted for baseline scores and stratification factors. As the sample size was not powered to detect changes in these outcome measures, statistical significance will be assessed at the 1% level.

Health-economic data

An embedded health-economic study will allow within trial incremental cost-effectiveness analysis (18 weeks) taking the perspective of the service provider including the costs of NHS and Personal Social Services. The analysis will compare usual care with the eRAPID-supported pathway. A secondary analysis will take a societal perspective. Analyses will use quality-adjusted-life-years (QALYs) outcome-measures. Estimation of QALYs requires the production of utility-weights for each health-state observed in the trial population. We will use the EQ-5D-5 L for this purpose [3, 44] collected at baseline, 6, 12 & 18 weeks. We will also use EORTC QLQ-C30 to derive utilities (EORTC QLQ-U10) to calculate QALYs in the same way. This will limit the need to interpolate quality of life between observation points [45]. NHS resource-use associated with each treatment modality will be collected using the process-of-care measures to contribute to a health-economics analysis of additional health financial costs related to treatment and the study. Use of outpatient and community-based health and social care (including, for example, home help or residential care) will be collected from the patient at baseline, 6, 12, and 18 weeks with the Use of Resources questionnaire developed in the Programme Development Grant and tested in the pilot study. Unit financial costs for health services resources will be obtained from national source: the Personal Social Services Research Unit, the British National Formulary and NHS reference cost database [46–48]. Given the duration of the trial discounting is not required.

Secondary analysis will include costs to participants (travel expenses, over the counter medicines) and productivity losses.

In addition to the analyses at 18 weeks we will undertake an exploratory cost effectiveness analysis (including a planned a–priori sub-group cost-effectiveness analysis

at 12 months using a sub-sample of participants for whom we have collected resource use, EQ-5D-5 L and EORTC QLQ-C30 data).

For each analysis we will undertake probabilistic sensitivity analysis using bootstrapping. The results will be presented as the Expected Incremental Cost Effectiveness Ratio, scatter plot on the cost-effectiveness plane and a Cost Effectiveness Acceptability Curve. We will calculate the expected net-benefit assuming lambda has a value of £20,000 [49].

Qualitative data

Interviews will be recorded and transcribed. Data will be managed by NVivo software and analysed using thematic analysis [37, 50]. Two researchers will independently look for the emerging themes and code them. Then they will meet, compare the codes/themes and resolve any potential conflicts by consensus.

Discussion

This paper describes the protocol for the eRAPID RCT in systemic cancer treatment. eRAPID is a unique web based intervention designed to improve the systematic reporting of AE during cancer treatment and improve patient care and experiences. A number of web based PROMs systems have been developed. Since the current trial began Basch and colleagues in the U.S. have published findings from an RCT using the STAR (Symptom Tracking and Reporting) web interface during chemotherapy indicating a positive impact on patients' quality of life, treatment delivery, number of emergency room attendances and 1 year survival [44]. We believe eRAPID is the first of its kind to allow remote monitoring of symptoms and side effects where patient reported data is accessible alongside standard clinical information in electronic patient records as well as providing patients with immediate symptom management advice. We hypothesise that these features along with alerts for severe symptoms will lead to improved clinical outcomes for participants allocated to the eRAPID intervention and will benefit health care services.

This study can be considered a complex intervention due to the number of active components involved. These include the new technology for patients completing symptom self-reports from home, automatic advice on managing mild symptoms and when to contact the hospital for severe problems, the availability of this patient data for staff to use in clinical practice, alert generation for severe problems and maintaining staff training and engagement. Consequently eRAPID's success relies on the investment of both staff and patient groups in the intervention and the robustness of the IT supporting the system. Although the eRAPID website and the online symptom reporting questionnaire have undergone extensive usability testing, the pilot phase of the RCT was considered vital in order to assess the intervention over a longer time frame and with all participating cancer groups as each differ in terms of the care pathways and staff involved. The decision to perform an internal pilot, rather than a separate pilot study, was motivated by our intention to avoid losing momentum and reduce the time between the end of the pilot and the start of the main trial [45]. This approach aimed to maintain continuity with the staff involved in the eRAPID intervention both in terms of recruitment and utilising the patient AE reports in clinical encounters.

The study is funded as part of 5 year programme, in parallel we are developing multi-centre eRAPID interventions for cancer patients receiving radiotherapy and surgery which will be evaluated in separate pilot studies. If found to have a positive effect on patient wellbeing and use of health care resources, eRAPID has the potential to provide a cost effective enhancement to the standard care of cancer patients. Such an approach could also be extended to long-term survivorship beyond cancer treatment [49].

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Availability of data and materials

Not applicable.

Authors' contributions

All authors were involved in design of the clinical trial. GV, JB, CH, CM and JH obtained study funding. KA, PH, LW, LB and GV developed the intervention. KA, LW and GV are responsible for implementation of the trial. All authors have contributed to, read, and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

Ethics approval and consent to participate

Favourable ethical opinion for this study was initially received from the National Research Ethics Service (now part of the Health Research Authority) Yorkshire & The Humber Leeds East Committee in September 2014 (Reference 14/YH/1066). The current paper describes protocol version 1.5 approved by Yorkshire & The Humber Leeds East Research Ethics Committee in December 2016. Written consent is obtained from all study participants.

Publisher's Note

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