1. Title of project

Improving the conduct and efficiency of trials by agreeing a standardised set of performance metrics for the monitoring and reporting of site performance in trials

2. Abstract

Background

Site performance is key to the successful delivery of large multicentre randomised trials. Measures of site performance should deliver meaningful, actionable information that can be used to monitor sites and initiate remedial action if necessary. A standardised set of clear and accessible summaries of site performance could facilitate the timely identification and resolution of potential problems, minimising their impact. The aim of this study was to identify and agree a core set of key performance metrics and create a simple reporting tool for managing multicentre trials.

Methods

We used a comprehensive, mixed methods approach to identify potential metrics and to achieve consensus about the final set, adapting methods that are recommended by the COMET Initiative for developing core outcome sets in health care (www.comet-initiative.org/).

Firstly, we conducted a systematic search for studies describing ways of measuring individual site performance in multicentre randomised trials using the Cochrane Library, five biomedical bibliographic databases and Google Scholar. Data on study quality and content were extracted independently by two reviewers. We also held three focus group discussions of UK-based stakeholders (10-11 per group) to identify factors/performance metrics that are important in assessing site performance and that are or could be measured routinely in randomised trials.

Data were recorded, transcribed and analysed thematically using NVivo 11 qualitative data analysis software.

Performance metrics identified from the systematic search and focus groups were used to create an online Delphi survey. We invited respondents to score each metric for inclusion in the final core set over three survey rounds. Metrics scored as "critical" by ≥70% and "unimportant" by <15% of survey respondents were retained for discussion at a consensus workshop of representatives from key UK-based stakeholders.

Results

We identified 117 performance metrics from 23 eligible studies in the systematic literature search, and 19 from the 32 participants in the three focus groups. Metrics were categorised as relating to site potential, recruitment, retention, data collection and quality, trial conduct and trial safety.

Round 1 of the Delphi survey presented 28 performance metrics, and a further six were added in round 2, following participant feedback in round 1. Of 294 UK-based stakeholders who registered for the Delphi survey, 211 completed all three rounds.

Fifteen metrics were retained following round 3. These were discussed and voted on at the consensus workshop. Consensus was reached on a final set of eight key performance metrics. These were in three domains: (1) recruitment and retention, (2) data quality, and (3) protocol compliance. We have created a simple tool for visual reporting of the metrics which is freely available (https://www.nottingham.ac.uk/nctu/other-research/performance-metrics/about.aspx) and could be used alongside existing systems.

Conclusions

By using robust methods to achieve consensus, we have established a core set of metrics for measuring performance of sites in multicentre randomised trials. These metrics could improve efficient trial conduct by enabling researchers to identify and address problems before trials are adversely affected. Future work could evaluate the effectiveness of using the metrics and reporting tool on site performance.

3. Introduction

Site performance is key to the successful delivery of large multicentre randomised trials. Numerous variables or performance metrics can be measured in trial management to assess site performance. However, to be useful these should deliver meaningful, actionable information that can be used to monitor sites and initiate remedial action if necessary. A standardised set of clear and accessible summaries of site performance could facilitate the timely identification and resolution of potential problems, minimising their impact. Our initial literature searches failed to identify any agreed standardised performance metrics for monitoring site performance in clinical trials, or any method for presenting or using such data [1-4]. Although the NIHR CRN currently use monthly recruitment figures as a performance metric, recruitment, while important, is not the only thing that counts. A system employing a wider range of key metrics including data quality and participant retention would be a better overall measure of the 'health' of a trial site. Further, to focus on areas that really matter and to be low cost, the number of metrics should be small, perhaps around 8 to 12 [5]. The aim of this study was to identify and agree a core set of key performance metrics and create a simple reporting tool for managing multicentre trials.

4. Methods

Focus Groups

Focus groups, each of 10-11 representatives of stakeholder groups (Appendix 1a), were held in Nottingham, Newcastle and Bristol. Invitations were emailed directly to potential participants and distributed via the UK Trial Managers' Network (UKTMN) and Trial Forge websites (http://www.tmn.ac.uk/; http://www.trialforge.org). Participants discussed factors that are important in assessing site performance and can be measured easily in practice. Focus groups were recorded, transcribed and analysed thematically using NVivo 11 qualitative data analysis software (Skea *et al*, manuscript in preparation).

Systematic Review

A systematic review of studies describing ways of monitoring or measuring individual site operational performance in randomised trials was performed (Walker *et al*, manuscript in preparation). The Cochrane Library, five biomedical bibliographic databases (CINAHL, EMBASE, Medline, PsychINFO and SCOPUS) and Google Scholar were searched. Inclusion criteria were: multicentre randomised trials, including pragmatic trials and any performance metric that is proposed for use or has been used to assess trial site performance. Excluded studies were animal studies and those published in a non-English language. Two reviewers working independently assessed titles and abstracts identified by the search and full text copies of potentially eligible studies. Data on study quality and content were extracted onto a specifically designed data extraction form independently by the two reviewers. Multiple reports of a study were linked. Excluded studies were listed, with the reason for exclusion. Disagreements concerning inclusion were resolved by discussion, involving a third reviewer if necessary.

Delphi survey

Performance metrics identified in the focus groups and systematic literature review were combined and edited to merge duplicates and exclude irrelevant metrics. The final list of metrics was organised into four domains: 'recruitment and retention', 'data quality', 'protocol compliance' and 'staff' and used to create an online Delphi survey using COMET Delphi Manager software (http://www.comet-initiative.org/) [4, 6].

Stakeholders were emailed invitations to participate in the survey. We contacted trials unit staff and trial managers through the UK Clinical Research Collaboration registered Clinical Trials Unit (UK CRC CTU) Network and the UKTMN. Representatives of the NIHR, sponsors, chief investigators and CRN representatives were identified through members of the project secretariat, key contacts within the NIHR, and the Medical Research Council (MRC) Trial Conduct Working Group. We invited participants in the focus groups and those invited to the consensus workshop. The survey was publicised on the Trial Forge website, and through a poster presentation at the 4th International Clinical Trials Methodology Conference (www.ictmc2017.com). Respondents were asked to complete the survey individually, and to share the invitation with interested colleagues. Criteria for eligibility to complete the survey were being UK based, and having at least three years' experience of working in clinical trials, although the latter restriction was removed after the close of round 1 as it was thought to be too stringent.

Survey participation involved scoring each metric for inclusion in the final core set over three survey rounds. Although stakeholder roles were recorded, these were ignored throughout the survey and respondents were analysed and reported as a single panel.

Metrics scored as "critical" by ≥70% and "unimportant" by <15% of survey respondents were retained for discussion at a consensus workshop [7]. Participants in the consensus workshop represented key UK-based stakeholders (Appendix 3). Each metric was discussed and then voted on anonymously for retention in the final set of key metrics. The final set of

key metrics were incorporated into a simple trial management reporting tool in Microsoft Excel.

5. Results and Conclusion

The systematic search identified 3188 records after duplicates were removed. Full text copies for 82 records were sought by the two reviewers, of which nine were unavailable. Twenty-three studies were agreed to be eligible for inclusion, from which 117 performance metrics were identified and added to the 19 metrics identified in the focus groups. This was edited to produce a list of 28 metrics to be presented in the Delphi survey. A further six metrics were added in round 2, following participant feedback in round 1 (Appendix 2).

A total of 294 participants registered for the Delphi survey, of whom 277 completed round 1. Of these round 1 respondents, 251 (91%) completed round 2 and 211 (76%) completed round 3. 200/211 (95%) had ≥ 3 years' experience of working in clinical trials.

We recruited a large sample of stakeholders with a wide range of roles in clinical trials from throughout the UK (Appendix 1b). Although trial managers or those in similar roles was the largest survey participant group, many respondents reported having more than one role, and it is therefore unlikely that the results are unduly dominated by any single group. This is important if the core set of metrics is to have credibility and relevance among potential users.

Fifteen metrics were retained following round 3.

At the workshop, consensus was reached on a final set of eight key performance metrics. These were in three domains: (1) recruitment and retention, (2) data quality, and (3) protocol compliance, and are presented in Table 1. It was recommended that the wording of some of the metrics plus their definitions should be altered for clarity and these revised versions appear in Table 1.

The final set of eight metrics was made into a simple trial management reporting tool in Microsoft Excel. By using Excel, trials teams can modify the tool to meet their own requirements.

This is a dashboard employing a traffic light indicator system to indicate potential problems. A worked example of the dashboard is shown in Appendix 4. This is for optional use alongside existing systems and is freely available (https://www.nottingham.ac.uk/nctu/other-research/performance-metrics/about.aspx).

In conclusion, this study has consulted widely with the trials community to establish a core set of metrics for measuring site performance in multicentre randomised trials. This has potential to improve the efficient conduct of trials by providing an 'early warning system', enabling trial managers and oversight committees to identify and address problems before trials are adversely affected. The reporting tool provides visual reporting of the metrics. Future research could evaluate the effectiveness of using the metrics and reporting tool.

Metric	Definition
1) Current actual recruitment versus target recruitment (%)	The actual number of participants recruited into the trial by the site, at the time of monitoring, versus the target number that was contractually agreed with the site prior to the trial commencing
2) Percentage of eligible individuals who have consented	The percentage of individuals who were eligible to participate in the trial and who consented to participate
3) Percentage of randomised participants who have withdrawn consent to continue	The percentage of randomised participants who have withdrawn their consent to any further participation in the trial at the site. Collection of any further follow up data is therefore not attempted
4) Percentage of randomised participants with a query for primary outcome data	The percentage of randomised participants at the site for whom the central trial team has sent one or more queries relating to the primary outcome data back to the site staff
5) Percentage of expected participants with complete data for primary and important secondary outcomes	The percentage of randomised participants at the site with outcome data complete for both the primary outcome and all the agreed important secondary outcomes
6) Percentage of randomised participants with at least one Adverse Event reported	The percentage of randomised participants at the site who have reported at least one Adverse Event
7) Percentage of randomised participants with at least one protocol violation	The percentage of randomised participants at the site with any protocol violation/s, as defined by the protocol
8) Percentage of randomised participants who started allocated intervention	The percentage of randomised participants at the site who started the allocated intervention, as specified in the protocol

Table 1: Final core set of site performance metrics (n=8) retained following the priority setting consensus workshop.

6. Dissemination

We will work with the UKTMN, Trial Forge and the Network of Registered Clinical Trials Units to actively disseminate and present the study results in newsletters, media outlets, meetings and conferences. The results will be submitted for publication in peer reviewed journals and presented at international clinical trials methodology conferences. All co-applicants and collaborators will contribute actively to dissemination and implementation. The reporting tool and guidance will be made freely available through the Nottingham CTU, UK TMN, UK CTU Network and Trial Forge websites.

The reporting tool is available to download from: https://www.nottingham.ac.uk/nctu/other-research/performance-metrics/about.aspx.

7. Acknowledgements

Contribution of authors

Conceived the idea for the study and led the study team (DW, LD); designed the study and obtained funding (DW, AM, ST, MC, PW, LD); designed, conducted and analysed the systematic review (KW, JT, DW, LD); designed, conducted and analysed the focus groups (ST, ZS, LS, LC); designed the Delphi survey (DW, JT, AM, ST, ZS, PW, LD); analysed Delphi survey data (JT, AM, LB); organised and delivered the consensus workshop (JT, AM, KW, MC, LD).
JT wrote the first draft of the report, with critical revisions for important intellectual content made by all authors:

Diane Whitham, Associate Professor of Clinical Trials, NCTU.

Dr Julie Turzanski, Research Fellow, NCTU.

Professor Alan Montgomery, Professor of Medical Statistics and Clinical Trials, NCTU.

Dr Kate Walker, Clinical Assistant Professor in Obstetrics and Gynaecology, NCTU.

Lucy Bradshaw, Medical Statistician, NCTU.

Professor Shaun Treweek, Professor of Health Services Research, University of Aberdeen.

Dr Zoë Skea, Research Fellow, Health Services Research Unit, University of Aberdeen.

Dr Lisa Shaw, Senior Research Associate, Institute of Neuroscience, University of Newcastle.

Dr Lucy Culliford, Research Fellow, CTU Bristol, University of Bristol.

Professor Mike Clarke, Professor/Director of MRC Methodology Hub, Queen's University, Belfast.

Professor Paula Williamson, Professor of Medical Statistics, / Director Medicines for Children Research Network CTU and MRC North West Hub for Trials Methodology, University of Liverpool.

Professor Lelia Duley, Professor of Clinical Trials and Director NCTU.

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8. References

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9. Appendices

Appendix 1a: Key Stakeholders

Key stakeholders are defined here as research professionals or organisations who might utilise key site performance metrics. Although stakeholder roles are not mutually exclusive, the main groups were:

- chief investigators (CIs)
- Clinical Research Network (CRN)
- NIHR funders (NIHR Evaluation, Trials and Studies Coordinating Centre (NETSCC))
- sponsors
- operations managers/directors
- statisticians
- trial managers/co-ordinators
- Medical Research Council (MRC) Methodology Hubs for Trials Methodology Research
- Clinical Trial Unit (CTU) Directors
- quality assurance managers
- data managers
- research associates/fellows/academics
- research managers
- senior trial managers/ project leads/managers
- trial steering committee members

Appendix 1b: Delphi survey participation by stakeholder group

Role	All Registered		Round 1		Round 2		Round 3	
	Total registered (n)	% Total	Round 1 (n)	% Total	Round 2 (n)	% Total	Round 3 (n)	% Total
Chief Investigator	34	11.6	32	11.6	29	11.6	27	12.8
Clinical Trials Unit Director	8	2.7	7	2.5	6	2.4	5	2.4
UK Clinical Research Network	12	4.1	12	4.3	11	4.4	9	4.3
Funder	2	0.7	2	0.7	2	0.8	2	0.9
Operations Manager/ Director	14	4.8	13	4.7	13	5.2	10	4.7
Other	20	6.8	18	6.5	15	6.0	12	5.7
Quality Assurance Manager	8	2.7	8	2.9	8	3.2	8	3.8
Academic/ Research Associate/ Fellow	18	6.1	18	6.5	17	6.8	16	7.6
Research Delivery Manager	4	1.4	3	1.1	2	0.8	2	0.9
Senior Trial Manager/ Project Lead/ Manager	56	19.0	52	18.8	49	19.5	40	19.0
Statistician	18	6.1	17	6.1	16	6.4	14	6.6
Trial Coordinator	48	16.3	44	15.9	37	14.7	26	12.3
Trial/Research Manager	52	17.7	51	18.4	46	18.3	40	19.0
Total	294	100	277	100	251	100	211	100

Appendix 2

Metric Number	Domain	Metric	Definition	Round 1 scores				Round 2 scores				Round 3 scores				Consensus Workshop decision (% vote)	
				1-3	4-6	7-9	10	1-3	4-6	7-9	10	1-3	4-6	7-9	10	In	Out
1	**Recruitment and retention**	**Total actual recruitment versus total target recruitment**	**The actual number of participants recruited into the trial by the site, versus the target number that was contractually agreed with the site prior to the trial commencing**	**1 (0.5%)**	36 (17.1%)	**172 (81.5%)**	2 (0.9%)	**0**	16 (7.6%)	**194 (91.9%)**	1 (0.5%)	**0**	14 (6.6%)	**197 (93.4%)**	0	**100 In**	0
2	Recruitment and retention	Time from the site opening to first participant randomised	The time between the date of greenlight approval for the site to start recruiting and the date the first participant was randomised	8 (3.8%)	108 (51.2%)	94 (44.5%)	1 (0.5%)	3 (1.4%)	118 (55.9%)	90 (42.7%)	0	5 (2.4%)	126 (59.7%)	80 (37.9%)	0		
3	Recruitment and retention	Number of days/weeks since the most recent participant was randomised	Number of days/weeks since the most recent participant at the site was randomised	21 (10.0%)	112 (53.1%)	77 (36.5%)	1 (0.5%)	12 (5.7%)	142 (67.3%)	57 (27.0%)	0	11 (5.2%)	155 (73.5%)	45 (21.3%)	0		
4	Recruitment and retention	Percentage of potential participants screened who have been randomised	The percentage of potential participants screened at the site who have been randomised	4 (1.9%)	88 (41.7%)	117 (55.5%)	2 (0.9%)	2 (0.9%)	83 (39.3%)	125 (59.2%)	1 (0.5%)	0	76 (36%)	134 (63.5%)	1 (0.5%)		
5	Recruitment and retention	Percentage of potential participants who could have been screened, who were	The percentage of potential participants who could possibly have been screened, who were actually screened					13 (6.2%)	97 (46.0%)	92 (43.6%)	9 (4.3%)	10 (4.7%)	90 (42.7%)	103 (48.8%)	8 (3.8%)		
6	Recruitment and retention	Percentage of potential participants screened who were eligible	The percentage of potential participants who were screened and were eligible to participate in the trial					9 (4.3%)	106 (50.2%)	93 (44.1%)	3 (1.4%)	6 (2.8%)	110 (52.1%)	92 (43.6%)	3 (1.4%)		
7	Recruitment and retention	Percentage of potential participants eligible who have consented	The percentage of potential participants who were eligible to participate in the trial and who consented to participate					8 (3.8%)	81 (38.4%)	119 (56.4%)	3 (1.4%)	3 (1.4%)	77 (36.5%)	128 (60.7%)	3 (1.4%)	**95 In**	5
8	**Recruitment and retention**	**Percentage of potential participants who have consented and have been randomised**	**The percentage of potential participants who consented to take part in the trial and who have been randomised**					5 (2.4%)	71 (33.6%)	131 (62.1%)	4 (1.9%)	**2 (0.9%)**	57 (27%)	**150 (71.1%)**	2 (0.9%)	35	65
9	**Recruitment and retention**	**Percentage of randomised participants who have withdrawn consent to continue in the study**	**The percentage of randomised participants who have withdrawn their consent to any further participation in the trial at the site. Collection of any further follow up data is therefore not attempted**	8 (3.8%)	76 (36.0%)	125 (59.2%)	2 (0.9%)	4 (1.9%)	60 (28.4%)	147 (69.7%)	0	**4 (1.9%)**	46 (21.8%)	**161 (76.3%)**	0	**83 In**	17
10	**Recruitment and retention**	**Percentage of randomised participants lost to follow-up**	**The percentage of randomised participants at the site who are no longer responding to invitations to follow-up, and for whom no further attempt to follow-up is being made**	10 (4.7%)	59 (28.0%)	140 (66.4%)	2 (0.9%)	**3 (1.4%)**	**38 (18%)**	**169 (80.1%)**	1 (0.5%)	**3 (1.4%)**	24 (11.4%)	**183 (86.7%)**	1 (0.5%)	22	78
11	Recruitment and retention	Percentage of screening logs returned on time out of all those that should have been returned	Screening logs returned 'on time' means within the time period agreed with the site at the start of the trial, for example monthly screening data to be received no later than two weeks after the end of each month	40 (19.0%)	135 (64.0%)	33 (15.6%)	3 (1.4%)	29 (13.7%)	159 (75.4%)	22 (10.4%)	1 (0.5%)	23 (10.9%)	167 (79.1%)	20 (9.5%)	1 (0.5%)		

Appendix 2 cont.

12	Recruitment and retention	Percentage of screening items completed of those required	The percentage of items on the site screening log that have been filled in out of all those required	32 (15.2%)	105 (49.8%)	67 (31.8%)	7 (3.3%)	20 (9.5%)	114 (54%)	72 (34.1%)	5 (2.4%)	18 (8.5%)	117 (55.5%)	72 (34.1%)	4 (1.9%)		
13	**Recruitment and retention**	**Percentage of randomised participants with a consent form that is incomplete or inaccurate**	**The percentage of randomised participants at the site with a consent form that has either not been fully completed, or has been completed with inaccurate data**	**11 (5.2%)**	51 (24.2%)	**148 (70.1%)**	1 (0.5%)	**8 (3.8%)**	31 (14.7%)	**172 (81.5%)**	0	**9 (4.3%)**	14 (6.6%)	**187 (88.6%)**	1 (0.5%)	13	87
14	**Recruitment and retention**	**Percentage of all expected forms that have been received**	**The percentage of all expected documentation that has been received within a reasonable time frame**					8 (3.8%)	69 (32.7%)	128 (60.7%)	6 (2.8%)	**4 (1.9%)**	50 (23.7%)	**154 (73%)**	3 (1.4%)	39	61
15	**Recruitment and retention**	**Percentage of randomised participants with any issues or problems with consent**	**The percentage of randomised participants at the site with any issues or problems with consent, including problems with the consent process (such as using the wrong version of the consent form or participant information sheet, or consent by someone not on the delegation log) as well as problems with completing the consent form**	10 (4.7%)	68 (32.2%)	129 (61.1%)	4 (1.9%)	**6 (2.8%)**	53 (25.1%)	**150 (71.1%)**	2 (0.9%)	**4 (1.9%)**	34 (16.1%)	**169 (80.1%)**	4 (1.9%)	26	74
16	**Recruitment and retention**	**Percentage of randomised participants for whom documentation of consent is missing from their medical records**	**The percentage of randomised participants at the site for whom documentation of consent (such as a copy of the signed consent form) is missing from their medical records**	15 (7.1%)	69 (32.7%)	123 (58.3%)	4 (1.9%)	**9 (4.3%)**	47 (22.3%)	**154 (73.0%)**	1 (0.5%)	**7 (3.3%)**	31 (14.7%)	**172 (81.5%)**	1 (0.5%)	0	100
17	Data quality	Percentage of randomised participants with the time between data collection and either data entry (electronic case report form) or central receipt of paper case report form within the target	The percentage of randomised participants at the site for whom the time between data collection and either data entry (if an electronic case report form) or central receipt of the paper case report form is within the target timeframe	12 (5.7%)	129 (61.1%)	66 (31.3%)	4 (1.9%)	8 (3.8%)	156 (73.9%)	45 (21.3%)	2 (0.9%)	7 (3.3%)	170 (80.6%)	32 (15.2%)	2 (0.9%)		
18	**Data quality**	**Percentage of randomised participants with a query/queries for primary outcome data**	**The percentage of randomised participants at the site for whom the central trial team has sent one or more queries relating to the primary outcome data back to the site staff**	4 (1.9%)	59 (28.0%)	145 (68.7%)	3 (1.4%)	**3 (1.4%)**	36 (17.1%)	**170 (80.6%)**	2 (0.9%)	**4 (1.9%)**	23 (10.9%)	**182 (86.3%)**	2 (0.9%)	**65 In**	35
19	Data quality	Percentage of randomised participants with query/queries for secondary outcome data	The percentage of randomised participants at the site for whom the central trial team has sent one or more queries relating to the secondary outcome data back to the site staff	16 (7.6%)	128 (60.7%)	65 (30.8%)	2 (0.9%)	8 (3.8%)	156 (73.9%)	46 (21.8%)	1 (0.5%)	8 (3.8%)	162 (76.8%)	40 (19.0%)	1 (0.5%)		
20	Data quality	Time taken between sending a data query and resolution of the query	The time from the central co-ordinating team sending a data query to the site (based on data they have received from the site) asking for further data or clarification, to a response that resolves that query	17 (8.1%)	140 (66.4%)	52 (24.6%)	2 (0.9%)	10 (4.7%)	164 (77.7%)	36 (17.1%)	1 (0.5%)	9 (4.3%)	167 (79.1%)	34 (16.1%)	1 (0.5%)		

Appendix 2 cont.

21	**Data quality**	**Percentage of randomised participants with complete data for primary and important secondary outcomes**	**The percentage of randomised participants at the site with outcome data complete for both the primary outcome and all the agreed important secondary outcomes**	**2 (0.9%)**	44 (20.9%)	**163 (77.3%)**	2 (0.9%)	**1 (0.5%)**	20 (9.5%)	**189 (89.6%)**	1 (0.5%)	**1 (0.5%)**	11 (5.2%)	**198 (93.8%)**	1 (0.5%)	**96 In**	0
22	Data quality	Percentage of randomised participants with complete data	The percentage of randomised participants at the site with complete data for the primary outcome and all the secondary	3 (1.4%)	85 (40.3%)	120 (56.9%)	3 (1.4%)	0	88 (41.7%)	122 (57.8%)	1 (0.5%)	0	91 (43.1%)	119 (56.4%)	1 (0.5%)		
23	**Data quality**	**Percentage of unresolved Serious Adverse Event (SAE) queries > 30 calendar days from the date the query was generated**	**The percentage of queries about a Serious Adverse Event sent to the site from the central co-ordinating centre that remain unresolved more than 30 days after the query was sent**	**3 (1.4%)**	44 (20.9%)	**163 (77.3%)**	1 (0.5%)	**1 (0.5%)**	24 (11.4%)	**186 (88.2%)**	0	**1 (0.5%)**	12 (5.7%)	**198 (93.8%)**	0		
24	Data quality	Total number of Adverse Events and Serious Adverse Events reported per number of randomised participants	The total number of Adverse Events and Serious Adverse Events reported per number of randomised participants at the site	32 (15.2%)	101 (47.9%)	74 (35.1%)	4 (1.9%)	19 (9%)	130 (61.6%)	59 (28.0%)	3 (1.4%)	17 (8.1%)	138 (65.4%)	53 (25.1%)	3 (1.4%)		
25	Data quality	Number of Serious Adverse Events reported per number of randomised participants	Number of Serious Adverse Events reported per number of randomised participants at the site	25 (11.8%)	84 (39.8%)	98 (46.4%)	4 (1.9%)	16 (7.6%)	90 (42.7%)	102 (48.3%)	3 (1.4%)	15 (7.1%)	102 (48.3%)	91 (43.1%)	3 (1.4%)		
26	Data quality	Number of Adverse Events reported per number of randomised participants	Number of Adverse Events reported per number of randomised participants at the site	40 (19%)	106 (50.2%)	60 (28.4%)	5 (2.4%)	27 (12.8%)	136 (64.5%)	45 (21.3%)	3 (1.4%)	24 (11.4%)	148 (70.1%)	36 (17.1%)	3 (1.4%)	**81 In**	19
27	**Protocol/ compliance**	**Percentage of randomised participants with at least one protocol violation**	**The percentage of randomised participants at the site with any protocol violation/s, as defined by the protocol**	6 (2.8%)	78 (37%)	124 (58.8%)	3 (1.4%)	1 (0.5%)	64 (30.3%)	145 (68.7%)	1 (0.5%)	**0**	47 (22.3%)	**163 (77.3%)**	1 (0.5%)	**76 In**	24
28	**Protocol/ compliance**	**Percentage of randomised participants receiving allocated intervention as intended per protocol**	**The percentage of randomised participants at the site who completed the allocated intervention, as specified in the protocol**	**2 (0.9%)**	48 (22.7%)	**158 (74.9%)**	3 (1.4%)	**0**	19 (9.0%)	**191 (90.5%)**	1 (0.5%)	**0**	11 (5.2%)	**199 (94.3%)**	1 (0.5%)	**100 In**	0
29	**Protocol/ compliance**	**Number of missed visits per number of randomised participants**	**Number of missed visits per number of randomised participants at the site, where a missed visit is when a participant fails to complete a particular follow-up occasion**	7 (3.3%)	93 (44.1%)	107 (50.7%)	4 (1.9%)	5 (2.4%)	75 (35.5%)	128 (60.7%)	3 (1.4%)	**4 (1.9%)**	52 (24.6%)	**152 (72.0%)**	3 (1.4%)	10	90
30	Protocol/ compliance	Number of late visits per number of randomised participants	Number of late visits per number of randomised participants at the site, where a late visit is when a participant completes a particular follow-up occasion later than the agreed permissible time frame	18 (8.5%)	128 (60.7%)	61 (28.9%)	4 (1.9%)	10 (4.7%)	157 (74.4%)	41 (19.4%)	3 (1.4%)	9 (4.3%)	162 (76.8%)	37 (17.5%)	3 (1.4%)		
31	**Protocol/ compliance**	**Number of critical or major audit findings per number of randomised participants**	**Number of critical or major audit findings, following a Good Clinical Practice (GCP) inspection, per number of randomised participants at the site**	**6 (2.8%)**	43 (20.4%)	**152 (72%)**	10 (4.7%)	**4 (1.9%)**	23 (10.9%)	**179 (84.8%)**	5 (2.4%)	**3 (1.4%)**	14 (6.6%)	**190 (90.0%)**	4 (1.9%)	0	100

Appendix 2 cont.

32	Staff	Number of contacts from site staff to the central trial team within a given time period	Number of contacts from site staff (includes all communication from the site, for example by email or telephone) to the central trial team within a given time period	79 (37.4%)	112 (53.1%)	14 (6.6%)	6 (2.8%)		76 (36%)	124 (58.8%)	6 (2.8%)	5 (2.4%)		81 (38.4%)	120 (56.9%)	6 (2.8%)	4 (1.9%)		
33	Staff	Time between protocol amendment being sent and Principal Investigator sign-off	The time between a protocol amendment being sent by the central trial team and the signed agreement by the Principal Investigator to work to the amended protocol	22 (10.4%)	110 (52.1%)	73 (34.6%)	6 (2.8%)		16 (7.6%)	127 (60.2%)	65 (30.8%)	3 (1.4%)		15 (7.1%)	140 (66.4%)	53 (25.1%)	3 (1.4%)		
34	Staff	Cumulative number of staff included on the delegation of duties log	Number of staff included on the delegation of duties log since the study opened for recruitment at the site						105 (49.8%)	87 (41.2%)	12 (5.7%)	7 (3.3%)		116 (55%)	83 (39.3%)	7 (3.3%)	5 (2.4%)		

Appendix 2: Site performance metrics (n=34) and voting scores over the 3 Delphi rounds and in the priority setting consensus workshop (final column). The distribution of voting scores, expressed as the number of votes cast and as the % of total participants, is shown for each metric for the 211 participants who completed all 3 rounds of the Delphi survey. The 'definition' is as it appeared in the survey. The metrics reaching '70/15%' 'consensus in' status are in bold type. These (n=15), were carried forward to the consensus workshop. Metrics receiving a majority vote at the workshop were retained (indicated by 'In', final column). Score 1-3: not important; score 4-6: important but not critical; score 7-9: critical; score 10: unable to score.

Appendix 3: List of Consensus Workshop Participants

Title	First Name	Surname	Stakeholder Role	Affiliation
Mr	Simon	Bevan	Funder (Senior Research Manager-Monitoring)	NIHR, University of Southampton
Prof	Mike	Clarke	Professor/Director of MRC Methodology Hub (Meeting chair and facilitator- did not vote)	School of Medicine, Dentistry and Biomedical Sciences, Institute of Health Sciences, Queen's University, Belfast, N.I.
Dr	Lucy	Culliford	Research Fellow	Clinical Trials and Evaluation Unit, University of Bristol
Dr	Adam	Devall	Senior Trial Manager (Team Leader for Miscarriage Research)	Birmingham Clinical Trials Unit
Prof	Lelia	Duley	Professor of Clinical Trials Research/Director Nottingham Clinical Trials Unit	Nottingham Clinical Trials Unit
Ms	Kathryn	Fairbrother	NIHR CRN/Business Intelligence lead	NIHR CRN, East Midlands
Dr	Kirsteen	Goodman	Trial Manager	NMAHP Research Unit, Glasgow Caledonian University
Prof	Catherine	Hewitt	Professor of Trials and Statistics/ Deputy Director of York CTU	York Trials Unit, Health Sciences, University of York
Ms	Rachel	Hobson	Senior Trial/Data Manager	Leicester Clinical Trials Unit
Mrs	Sarah	Lawton	Senior Trial Manager	Keele Clinical Trials Unit, Keele University
Mr	Stephen	Lock	NIHR CRN/ Head of Business Intelligence	NIHR CRN, Yorkshire and Humber
Mrs	Alison	McDonald	Senior Trial Manager (UKTMN)	Centre for Healthcare Randomised Trials (CHaRT), University of Aberdeen
Prof	Alan	Montgomery	Professor of Medical Statistics and Clinical Trials/acting Director Nottingham Clinical Trials Unit	Nottingham Clinical Trials Unit
Prof	John	Norrie	DMC/TSC/Stats/Director Edinburgh CTU	Population Health Sciences & Informatics, Usher Institute, University of Edinburgh
Dr	Alastair	O'Brien	Clinical Senior Lecturer and Consultant Heptologist/ Chief Investigator	Institute of Liver Disease and Digestive Health, University College London
Mrs	Sarah	Pearson	Trial Manager (Oncology Clinical Trials Office Trial Management Director)	Dept. Oncology, University of Oxford
Dr	Shelley	Rhodes	Senior Trial Manager	Exeter University Clinical Trials Unit

Dr	Lisa	Shaw	Senior Research Associate with the Stroke Research Group	Institute of Neuroscience, University of Newcastle
Dr	Claire	Snowdon	Assistant Professor and Qualitative Researcher in clinical trials	The London School of Hygiene and Tropical Medicine
Prof	Kim	Thomas	Professor of Applied Dermatology Research/ Chief Investigator	Centre of Evidence Based Dermatology, University of Nottingham
Prof	Shaun	Treweek	Professor of Health Services Research	Health Services Research Unit, University of Aberdeen
Dr	Julie	Turzanski	Research Fellow (administered, but did not vote)	Nottingham Clinical Trials Unit
Dr	Kate	Walker	Clinical Assistant Professor in Obstetrics and Gynaecology	Nottingham Clinical Trials Unit
Prof	Paula	Williamson	Professor of Medical Statistics/Director Medicines for Children Research Network Clinical Trials Unit and MRC North West Hub for Trials Methodology Research	University of Liverpool, Institute of Translational Medicine
Mrs	Jill	Wood	Quality Assurance Manager	Warwick CTU, University of Warwick

Appendix 4: Site Performance Metrics Reporting Tool in Microsoft Excel, Worked Example

Summary Worksheet

Trial: XYZ

Date: XX-XX-XXXX

Notes: To see added site data from the Trial Data sheet, highlight the last row (columns A -I), hover on the bottom right-hand corner until a cross appears and drag down the number of rows required. Data and formatting should re-populate the fields. The site data shown are arbitary examples.

Site	Metric 1	Metric 2	Metric 3	Metric 4	Metric 5	Metric 6	Metric 7	Metric 8
	Current actual recruitment versus target recruitment (%)	Percentage of eligible individuals who have consented	Percentage of randomised participants who have withdrawn consent to continue	Percentage of randomised participants with a query for primary outcome data	Percentage of expected participants with complete data for primary and important secondary outcomes	Percentage of randomised participants with at least one Adverse Event reported	Percentage of randomised participants with at least one protocol violation	Percentage of randomised participants who started allocated intervention
01 - Site 1	120.00	82.05	1.25	9.58	41.67	9.58	11.67	96.25
02 - Site 2	84.00	73.06	2.38	7.14	20.24	10.12	6.55	98.21
03 - Site 3	77.00	44.93	0.00	27.92	100.00	23.38	1.95	95.45
04 - Site 4	77.14	100.00	1.48	5.93	36.00	8.89	14.07	100.00
05 - Site 5	42.29	66.07	2.70	2.70	81.08	12.16	6.76	100.00
06 - Site 6	42.86	35.38	1.33	12.00	100.00	33.33	12.00	70.67
07 - Site 7	30.86	66.85	0.00	1.85	74.07	7.41	1.85	88.89
08 - Site 8	22.67	19.49	0.00	0.00	52.38	5.88	0.00	67.65
09 - Site 9	111.00	18.08	1.80	9.91	100.00	14.41	22.52	90.09
10 - Site 10	68.89	50.72	3.23	0.00	0.00	0.00	3.23	93.55
11 - Site 11	50.00	34.67	4.00	80.00	66.67	2.00	4.00	96.00

Appendix 4 cont.

Thresholds worksheet

Conditional formatting setting upper and lower limits, links to summary page for the traffic light icons.

		Current actual recruitment versus target recruitment (%)		Percentage of eligible individuals who have consented		Percentage of randomised participants who have withdrawn consent to continue		Percentage of randomised participants with a query for primary outcome data		Percentage of expected participants with complete data for primary and important secondary outcomes		Percentage of randomised participants with at least one Adverse Event reported		Percentage of randomised participants with at least one protocol violation		Percentage of randomised participants who started allocated intervention	
Threshold	Icon	Metric 1		Metric 2		Metric 3		Metric 4		Metric 5		Metric 6		Metric 7		Metric 8	
On target		>	75	>	50	<	2	<	10	>	85	<	5	<	5	>	90
Under target																	
Urgent action required		<	35	<	20	>	10	>	30	<	65	>	15	>	10	<	75

Notes : Arbitary thresholds are shown. Insert your own upper and lower limits for each metric to set the > and < threshold for the marker flags.

Appendix 4 cont.

Trial data worksheet

Trial: XYZ

Date: XX-XX-XXXX

Notes: Insert your own data below. To add more rows, drag cross from lower right hand corner downwards.

Site	Current actual recruitment/ Randomised participants at the time of monitoring	Target Recruitment	Eligible individuals	Consented participants	Participants that have withdrawn consent	Participants with a primary outcome data query	Expected participants with complete primary and important secondary data	Actual participants with complete primary and important secondary data	Number of participants with at least one Adverse Event reported	Number of participants that have at least one protocol violation	Number of participants who started receiving allocated intervention
01 - Site 1	240	200	312	256	3	23	120	100	23	28	231
02 - Site 2	168	200	245	179	4	12	50	34	17	11	165
03 - Site 3	154	200	345	155	0	43	35	35	36	3	147
04 - Site 4	135	175	157	157	2	8	100	36	12	19	135
05 - Site 5	74	175	112	74	2	2	74	60	9	5	74
06 - Site 6	75	175	212	75	1	9	75	75	25	9	53
07 - Site 7	54	175	178	119	0	1	54	40	4	1	48
08 - Site 8	34	150	195	38	0	0	21	11	2	0	23
09 - Site 9	111	100	614	111	2	11	54	54	16	25	100
10 - Site 10	31	45	69	35	1	0	10	0	0	1	29
11 - Site 11	50	100	150	52	2	40	30	20	1	2	48

10. Conflict of interest declaration

There are no competing interests.