Research Paper

Clinical and cost effectiveness of a multi-professional medication reviews in care homes (CAREMED)

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Abstract

Objectives With 70% of care home residents experiencing a medication error every day in the UK, better multi-professional working between medical practitioners, pharmacists and care homes was recommended. The aim of this study was to determine the effectiveness (falls reduction) and cost-effectiveness, of a multi-professional medication review (MPMR) service in care homes for older people.

Method A total of care homes in the East of England were cluster randomised to 'usual care' or two multi-professional (General practitioner, clinical pharmacist and care homes staff) medication reviews during the 12-month trial period. Target recruitment was 900 residents with 10% assumed loss to follow-up. Co-primary outcome measures were number of falls and potentially inappropriate prescribing assessed by the Screening Tool of Older Persons Prescriptions.

Key findings A total of 826 care home residents were recruited with 324 lost to follow-up for at least one primary outcome measure. The mean number of falls per resident per annum was 3.3 for intervention and 3.0 for control ($P = 0.947$). Each resident was found to be prescribed 0.69 (intervention) and 0.85 (control) potentially inappropriate medicines after 12 months ($P = 0.046$). No significant difference identified in emergency hospital admissions or deaths. Estimated unadjusted incremental mean cost per resident was £374.26 higher in the intervention group.

Conclusions In line with other medication review based interventions in care homes, two MPMRs improved medication appropriateness but failed to demonstrate improvements in clinical outcomes. From a health system perspective costs where estimated to increase overall and therefore a different model of medicines management is required.

Background

As westernised populations age then the number of older persons residing in care homes is anticipated to increase and provide an additional challenge to the delivery of primary care services.[1] Older people residing in care homes frequently have complex medical conditions resulting in polypharmacy and a subsequent increase in the risk of medication errors.[2,3] These include the use of medicines which are no longer indicated; negative interactions with concurrent medication; sub-optimal dosing; inadequate monitoring; and inappropriate therapy duration.[4]

Consequently, not only are there significant costs associated with high levels of medication use, much of which may be unnecessary, there are additional avoidable costs resulting from avoidable iatrogenic disease.

The predominant strategy to address concerns regarding problematic polypharmacy has been the use of a pharmacists to perform medication reviews.[5] Whilst researchers have repeatedly shown that pharmacists providing medication review services in care homes are effective at rationalising therapy[6-8] to date this model of care has failed to demonstrate significant benefits on resident orientated outcomes e.g. falls, hospitalisations or

mortality.[4,5,9] The Cochrane review regarding interventions to optimise prescribing in older persons in care homes, recommended that further higher quality research surrounding medication review in care homes to determine clinical effectiveness was required.[4]

It is no longer sufficient to demonstrate service effectiveness in isolation, evidence for cost-effectiveness is also required to increase the chances of adoption. A relatively small-scale cluster randomised trial performed in Northern Ireland focussed on pharmacist review of psychoactive medicines in nursing home residents found that the service was likely to be cost-effective.[10] Similarly, a nonrandomised concurrent controlled study found that medication review by pharmacists was likely to be cost-effective in Spain once quality of life scores were adjusted for baseline, but less likely to be so when they were not.[11] Consequently, there is also a need for greater evidence regarding the value of pharmacist provision of general medication review services to care homes.

Following the Care Homes Use of Medicines Study (CHUMS) report in the UK, where 70% of residents were found to experience at least one medication error each day,[2] a multi-professional approach (joint working between general practitioner (GP), care home and pharmacist) was recommended nationally to improve medicines management generally.[12] The aim of this study therefore was to determine the clinical and cost-effectiveness of a multi-professional medication review (MPMR) service in care homes for older people.

Method

Study design and participants

Cluster randomised controlled trial of a MPMR performed at 0 and 6 month in care homes in two counties in eastern England with falls and medication appropriateness as co-primary outcome measures. Trial design has been previously published.[13]

Ethical approval was granted by the National Research Ethics Committee East of England – Norfolk (09/H0310/96). The trial was registered as ISRCTN90761620.

Recruitment

Recruitment was a two stage process with initial consent sought from the GP(s) and a subsequent approach made to their associated care homes which met the following criteria.

Inclusion criteria:
- Providing care for residents with an average age >65 years

Exclusion criteria:

- already received a medication review service from the primary care organisation in the last 6 months
- receiving ongoing medication services from a community geriatrician
- subject to investigation of the safeguarding of vulnerable adults.

All residents within the recruited homes received the intervention unless they were self-medicating or registered in the home for respite care. With randomisation at the level of care home and no additional data collected which was not part of routine practice, it was deemed acceptable not to obtain individual resident consent for inclusion within the trial.

Randomisation and masking

An independent statistician randomised the recruited homes to intervention or control. Care homes were stratified according to size (small, medium or large) and resident mix (residential, nursing or mixed) and location (Norfolk or Cambridgeshire). Homes were allocated (to intervention or control) using minimisation by the 'Variance method' of Pocock and Simon,[14] to achieve approximate balance with respect to stratifying variables.

It was not possible to blind care homes, pharmacists or GPs to allocation due to the nature of the intervention.

Intervention

Delivery of the intervention and data collection took place between April 2011 and April 2012. Intervention homes received a MPMR at the care home, from a team consisting of a clinical pharmacist (with a postgraduate diploma in clinical or general pharmacy practice), GP and care home member of staff responsible for medication, with preparation undertaken by a pharmacy technician. To ensure implementation of interventions from the first review, monitor outcomes and address any new pharmaceutical issues a second MPMR was provided 6 months after the initial review.

The outcome of the meeting was an agreed medicines related action plan with the pharmacy technician updating GP records and communicating this to the pharmacy responsible for supplying the medicines. Wherever possible, medication changes were discussed with the resident and/or family by the care home staff or GP prior to the change being made. Further details of the intervention are available from the protocol.[13]

Control

Homes allocated to the control arm continued to receive their usual care which varied from as much as weekly structured visits to the care home, to ad hoc visits when

patients needed to be seen by the GP. Visits by other health and social care professionals were undertaken as required. To support engagement by control homes, the intervention was offered to the control homes at the end of data collection.

Follow-up

Follow-up was determined as being 12 months from the date of first medication review in intervention homes and 12 months from an equivalent period (to intervention homes) after allocation in control homes.

Outcomes

All data were extracted from routine medical or care home records by the pharmacy technician, but given their involvement in the intervention it was not possible to blind them during the data extraction process. Hospital Episode Statistics (HES) data were provided by the primary care organisation to the pharmacy technicians at the end of data collection.

Our co-primary outcome were falling and potentially inappropriate prescribing. Whilst the main aim of medication review is to improve the quality of prescribing and Screening Tool of Older Persons Prescriptions (STOPP)/ START criteria are used to measure this,[15] we recognised that these were a measure of process and not patient orientated. Falls were therefore additionally selected as our clinical primary outcome measure. An intervention of a similar nature demonstrated a significant reduction in this outcome as one of their secondary outcome measures.[3] Furthermore, with recognised overuse of medicines related to falls in care homes[16,17] it would be reasonable to assume that an intervention to rationalise therapy would reduce this outcome.

Falls were extracted from government mandated and defined care home falls records. Nature and severity of fall were not recorded. 'Potentially inappropriate prescriptions' were identified by a clinical pharmacist independent of the intervention and blinded to group allocation using the Screening Tool for Older Persons' Potentially Inappropriate Prescriptions (STOPP criteria)[15] and used to calculate the number of potentially inappropriate medicines (PIMs) per resident at 12 months and 6 months as a secondary outcome measure. Emergency hospital admissions were extracted from HES provided by the primary care organisation and mortality data were obtained from GP practice records. In addition, details of all recommendations arising from the medication review meetings were recorded, together with data on the time taken to deliver the various aspects of the intervention (organisation, preparation, review meetings and follow-up actions).

Statistical analysis

All analyses were conducted at the individual-level using random-effects models, we analysed data according to randomisation group, irrespective of whether or not the residents received the intervention as planned (intention to treat principle). STATA version 11/SE with statistical significance at the 5% level was used for all analyses.

Number of falls was analysed via a random-effects Poisson regression model at the individual-level with fixed covariates of home size (small, medium or large); resident-type (residential or nursing) and location (Cambridgeshire or Norfolk), with the random effect as the care home. An offset of the number of days 'at risk' was used in order to allow for censoring due to death or other causes. The difference between intervention and control arms was expressed as the rate ratio which is the ratio of means. This is a common approach for the analysis of count data in cluster randomised trials.[18] A sensitivity analysis was conducted additionally adjusting for gender, age and the number of baseline medications on the recommendation of the TMG who felt that these might be predictive of the number of falls. Due to large number of individuals with zero falls, a negative binomial model was also fitted to the data. These results were similar to the Poisson regression model.

Number of PIMs at 12 months was analysed using the same approach as the number of falls but, in addition, the baseline number of drugs which matched the STOPP criteria was also included as a covariate.

The same process was repeated for secondary outcomes measures: number of PIMs at 6 months and number of emergency hospital admissions. The difference between treatment groups was expressed as the rate ratio.

A Cox proportional hazards model analysed the time to death with the same covariates as above using a robust standard error to account for clustering.

Subgroup effects of resident type and care home size were investigated by including an interaction term with the intervention in the above models.

Sample size

The study was powered to detect a difference in the number of falls of 0.59, it was estimated that a sample of 450 residents per arm was required. This was considered a clinically important difference based on similar previous research[3] in a similar population which showed that medication review services can reduce the average number of falls per patient over a 6 month period by 0.59 (confidence interval: 0.49 to 0.70), with a variance of four.[3] Assuming the intra-cluster correlation coefficient is 0.02 and an average of 30 residents per home, the design effect

is 1.58[19] requiring a total of 824 patients (412 in each arm).

The aim was to recruit 30 homes with an average of 30 residents in order to allow for approximately 10% loss to follow-up (e.g. due to death or moving home).

Economic analysis

All health care resource use was recorded from the care home records. The average number of days between allocation (T0) and first intervention visit (T1) in the intervention arm, was used as the time period between T0 and T1 in the control arm. At T0 pharmacy technicians recorded resident identity but did not review medical records to avoid any professional obligation to recommend interventions. All data collection in the control homes occurred 12 months after the calculated T1 point. Data were extracted from the GP and care home records.

A within-trial economic analysis compared the costs and clinical effectiveness (in terms of falls rate per resident per year) in the intervention (MPMR) and usual care groups from the perspective of the UK National Health Service (NHS) and Personal Social Services. A micro-costing analysis approach was used to identify, measure and value each input into the provision of the MPMR intervention.[20] Resource use was extracted by primary care pharmacy team staff from GP records (primary and community care, and medication use) and HES (secondary care including emergency care) for the whole 12 month period. We attached published unit costs (UK £2012) to individual-level quantities of resource use and estimated the mean cost per participant incorporating the cost of the intervention and wider healthcare resource use (primary care, community care, secondary care and medications). An incremental analysis comparing the mean cost and mean fall rate per resident per year was conducted. This was an unadjusted analysis because we were unable to collect baseline resource use data in control homes. Neither costs nor outcomes were discounted reflecting the 12-month study timeframe. All costs were valued in UK pounds sterling for 2012.

Results

Figure 1 shows the flow of participants. A total of 51 GP practices were approached, of which 25 (49%) consented, 9 (18%) declined and 17 (33%) did not respond to the invitation. A total of 41 care homes associated with consenting GP practices were approached. 31 (76%) consented, 5 (12%) declined and 5 (12%) did not respond. One home was subsequently excluded after allocation to treatment but before baseline data collection due to investigation by government agency regarding quality of care.

The other 30 care homes allocated to treatment remained in the study until completion.

The trial recruited from January to December 2011 meeting the sample size number of participants with 15 care homes allocated to each of the intervention and control arms. There were 381 intervention participants and 445 control participants, with an average of 25.40 (standard deviation 11.06) individuals per cluster in the intervention group and 29.67 (10.60) individuals per cluster in the control group. 324 (39.2%) participants were lost to follow-up for determination of PIMS at 12 months, 86% of which was due to death.

Baseline characteristics for the two groups are reported in Table 1, the intervention group were prescribed more medications on average than the control group, a mean difference of 1.7 medications. The control group included more nursing home patients (29.7%) compared to the intervention group (16.8%).

There were no significant differences between the treatment groups for our falls outcome with a rate ratio of 1.01 (95% CI, 0.74 to 1.38, $P = 0.947$). The results were similar when adjusted for gender, age and number of medications; or when a negative binomial model was used. However, the intervention did reduced PIMs by almost 20% (RR 0.82, 95% CI 0.67 to 1.00), at 12 months (Table 2).

In terms of secondary outcomes, there was no difference in emergency hospital admissions, rate ratio 1.18 (95% CI, 0.85 to 1.63, $P = 0.322$) or time until death (HR 0.98, 95% CI 0.72 to 1.31, $P = 0.868$). No serious adverse events were reported during the conduct of the trial.

The results of the health economics analysis fall into intervention costs, the 12-month wider resource use estimates and overall cost-effectiveness results (Table 3). In terms of the intervention costs the mean (SD; 95% CI) cost per resident of the MPMR intervention was £104.08 (50.91; 98.72 to 109.45), such that the overall cost of providing the intervention to all 348 intervention home residents was £36 221.29 (95% CI 32 810.81 to 39 631.77).[20]

For 12-month wider resource use estimates, the unadjusted mean (SD) cost per resident of wider health service costs (primary care, community care (e.g. physiotherapy and occupational therapy), secondary care (A&E, outpatients and emergency admissions only), medications) were £2210.64 (2479.73) in the intervention group and £1940.46 (2323.36) in the usual care group. This gave a mean (95% CI) difference of £270.18 (−65.99 to 606.35). [A table of unit costs provided as Table S1.

The estimated unadjusted overall (intervention costs plus wider costs) mean (SD) cost per resident in the intervention group was £2314.73 (2492.30) compared to
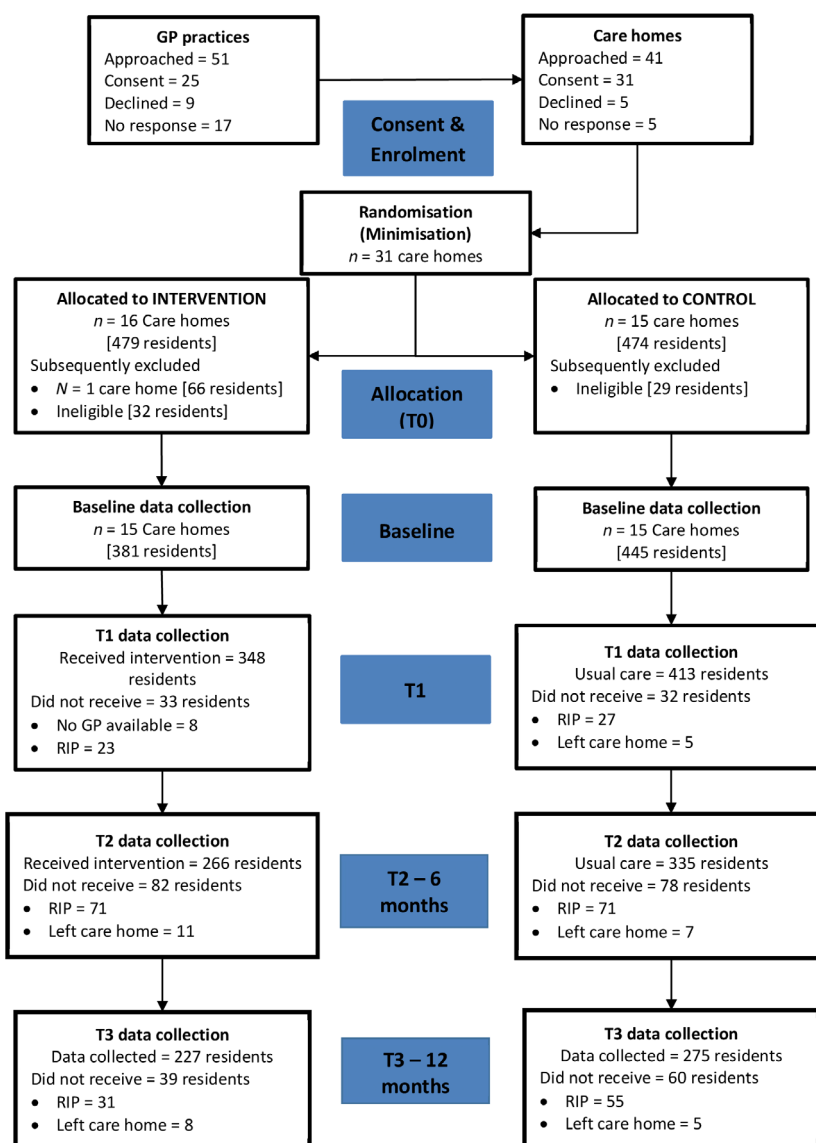
Figure 1 Flow of care homes and residents through the CAREMED trial.

£1940.47 (2323.36) when intervention costs were added to the wider costs resulting in a mean difference of £374.26 (95% CI −37.29 to 711.24).

Therefore, the overall result of the economic evaluation is that the intervention group had both higher costs and a higher falls rate per person per year. As a consequence, it is estimated that the intervention is dominated by usual care and would not be considered cost-effective.

Discussion

Whilst this cluster randomised controlled trial demonstrated a reduction in potentially inappropriate prescriptions when using MPMRs it did not demonstrate a reduction in the number of falls. Furthermore, no improvements in the secondary outcome measures of hospitalisation or mortality were seen and the cost of delivering the intervention was unlikely to be justified by reduction in the cost of healthcare resource utilisation. Indeed, resource utilisation appeared to increase.

As a cluster randomised controlled trial across two counties, involving many care homes, carefully delivered with good quality data collection, the evidence provided by this study can be considered to be reasonably robust. However, there were several weaknesses, including higher than anticipated losses to follow-up affecting our final sample size, and some baseline differences between the two groups. In terms of sample size, we had a target of

Table 1 Baseline characteristics

	Control (n = 445) Mean (SD or %)	Intervention (n = 381) Mean (SD or %)
Age	86.0 (8.5)	88.4 (6.5)
Number of falls at T0[a]	1.5 (3.6)	1.9 (5.2)
STOPP criteria at T1[b]	0.7 (1.0)	0.8 (1.0)
Time in home (years)	2.9 (2.7)	2.5 (2.4)
Number of medications (T1)	7.1 (3.9)	8.8 (4.4)
Male	121 (27.2)	78 (20.5)
Size of home		
Small	72 (16.2)	43 (11.3)
Medium	172 (38.7)	176 (46.2)
Large	201 (45.2)	162 (42.5)
Classification of home		
Mixed	74 (16.6)	124 (32.6)
Nursing	75 (16.9)	0 (0.0)
Residential	296 (66.5)	257 (67.5)
Norfolk	221 (49.7)	187 (49.1)
Patient classification		
Nursing	132 (29.7)	64 (16.8)
Residential	313 (70.3)	317 (83.2)
Dementia diagnosis	237 (53.3)	175 (45.9)
Care home characteristics	*n* = 15	*n* = 15
Size of home		
Small	5 (33.3)	5 (33.3)
Medium	6 (40.0)	7 (46.7)
Large	4 (26.7)	3 (20.0)
Classification of home		
Mixed	2 (13.3)	3 (20.0
Nursing	2 (13.3)	0 (0.0)
Residential	11 (73.3)	12 (80.0)
Norfolk	8 (53.3)	7 (46.7)

[a]T0 = Time of allocation and represents the number of falls in previous 6 months from allocation date.
[b]T1 = Time of first intervention visit or equivalent in control homes.

900 residents anticipating 10% losses to follow-up. The realised sample size was 826 with just over 30% loss to follow-up, mainly due to mortality, and this was greater than the 10% we anticipated. Falls were however recorded from randomisation until the end of the study or the time of death. Consequently, the study was ultimately adequately powered to detect a difference in falls.

Baseline differences suggested that the intervention group were prescribed more medicines and had a lower proportion of nursing home residents. However, adjusting for these variables did not affect the result. In addition, in terms of outcomes, there were no patient-reported outcomes (e.g. quality of life) – though it should be noted that collecting such outcomes would have been very challenging given the cognitive state of the majority of participants. It was not possible to collect baseline values of all outcomes which may have resulted in imbalanced groups, however as the allocation in randomised we do not believe that this would bias the comparison.

Finally, the STOPP tool[15] was not designed as an objective outcome measure but as a clinical tool and therefore requires some level of clinical interpretation. Whilst we blinded the independent assessor to allocation, the quality of this outcome measure is somewhat limited.

Previous studies of pharmacists performing medication reviews in care homes have demonstrated improvements in some process measures.[3,21-24] However, in the United Kingdom, only the study by Zermansky et al. demonstrated a reduction in falls as a secondary outcome measure. Our study utilised a more intensive intervention (two medication reviews) and follow-up, but failed to replicate that result. The result shown by Zermansky et al. may have been a false positive resulting from testing a number of outcome measures or that the more generalizable team approach cannot replicate the results of one highly skilled pharmacist.

Importantly, prescribing patterns in care homes seen at the time of the Zermansky trial potentially increased the likelihood of falls and subsequent prescribing guidance[25] may have reduced the opportunity for decreasing falls as a result of iatrogenic disease. Indeed, over the last few years, there has been a concerted effort to reduce antipsychotic prescribing in care homes[26] and these are known to increase the likelihood of falls in the frail elderly. Falls

Table 2 Effectiveness results - intention-to-treat analysis

	Control		Intervention		Rate ratio	P-value
	N	Mean (SD) or N (%)	N	Mean (SD) or N (%)		
Falls (per annum)	445	3.00 (5.49)	381	3.35 (8.30)	1.02 (0.74, 1.39)	0.910
HES admission (per annum)	445	0.72 (2.09)	381	0.88 (2.01)	1.19 (0.86, 1.64)	0.286
STOPP criteria T2[a]	405	0.80 (1.08)	352	0.71 (1.00)	0.85 (0.71, 1.01)	0.060
STOPP criteria T3[b]	330	0.85 (1.26)	283	0.69 (0.93)	0.82 (0.67, 1.00)	0.046
Time until death N (%)	445	153 (34.4)	381	125 (32.8)	0.98 (0.72, 1.31)[b]	0.868

[a]T2 = six month time period from first intervention (or equivalent in control homes) to second intervention.
[b]T3 = six month period from second intervention (or equivalent in control homes) to end of study.
[c]Hazard ratio.

Table 3 Summary of mean (SD) costs per participant by resource category (UK£2012)

Category of resource use	Intervention (N = 348)	Usual care (N = 445)	Mean (SD) difference (95% CI)
Intervention costs	104.80 (50.91)	0.00 (0.00)	104.80 (98.72 to 109.45)
NHS and personal social services costs			
Medicines	542.09 (524.69)	572.79 (712.96)	−30.70 (−120.21 to 58.82)
Primary care/community care	634.36 (538.14)	557.09 (519.83)	77.27 (3.11 to 151.43)
Secondary care	1034.19 (2094.08)	810.58 (1884.23)	223.60 (−54.39 to 501.59)
Total NHS and Personal Social Services costs	2210.64 (2479.73)	1940.47 (2323.36)	270.18 (−65.99 to 606.35)
Total costs	2314.73 (2492.30)	1940.47 (2323.36)	374.26 (37.29 to 711.24)

are, however, multi-factorial in nature and require complex interventions as they are also related to the ergonomics of the care home environment and physical frailty of the care home population,[27] consequently it may not be appropriate to expect a single intervention focussed on medication to have a significant impact on falls. It may also be that periodic review every 6 months is not sufficient as benefits of the review are lost as a resident's health status changes and any prescribing changes may be reversed.

Furthermore, there is growing interest in measures to support the appropriateness of prescribing and it should be noted that this study did not use the STOPP criteria to aid clinical decisions, it was only used as an outcome measure. Recent evidence suggests using prescribing appropriateness tools may be able to demonstrate patient benefit.[28] Incorporating these tools into prescribing software may provide a cost-effective approach to improve prescribing, but as stated above will not address the other important aspects of effectively managing medicines in a care home setting.

In light of the current COVID-19 pandemic, the micro-costing of this intervention[20] should help decision-makers in planning care home medicines optimisation services. With recent advances in and adoption of technology, approximately 10% of the intervention costs could be reduced with remote access to clinical records and video conferencing.[20] More frequent pharmacy and medicine support, utilising pharmacists with prescribing qualifications could further help optimise the clinical and cost-effectiveness of this type of intervention.

Future studies in care home medicine management should investigate simpler models involving fewer personnel, and a more holistic pharmacist role, encompassing all aspects of prescribing and medicine delivery.

Declarations

Conflict of interest

All authors declare that they have no conflicts of interests to declare in relation to the material submitted.

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Authors' contribution

JD: PI and guarantor for the study, designed the protocol, secured funding, recruited participants, collected data, wrote the paper. AC: contributed to the writing and design of the CAREMED trial protocol, analysed the data and contributed to this paper. JH: contributed to the design of the protocol, recruited participants, collected data, contributed to the paper. TS: contributed to the writing and design of the CAREMED trial protocol, analysed the data and contributed to this paper. VK: had scholarly thoughts about the interpretation of the results

and contributed to this paper. RH: contributed to the writing and design of the protocol and grant application, had scholarly thoughts about the interpretation of the results and contributed to this paper. DW: contributed to the writing and design of the protocol and grant application, had scholarly thoughts about the interpretation of the results and contributed to this paper.

Ethics review

Ethics approval was obtained from the Norfolk Research Ethics Committee. Approval reference number 09/H0310/

96. All GP practices and care homes gave informed consent before taking part in the trial. In line with current practice for medication reviews in care homes, consent was not sought from individual residents.

Sponsor's role

The sponsors did not have any role in study design, data collection, analysis, interpretation of the data, the writing of the manuscript or the decision to submit for publication.

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Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Table S1. Table of Unit costs in 2012 UK pounds sterling.