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Does proactive care in care homes improve survival? A quality improvement project

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ABSTRACT

Background NHS England's 'Enhanced Health in Care Homes' specification aims to make the healthcare of care home residents more proactive. Primary care networks (PCNs) are contracted to provide this, but approaches vary widely: challenges include frailty identification, multidisciplinary team (MDT) capability/capacity and how the process is structured and delivered.

Aim To determine whether a proactive healthcare model could improve healthcare outcomes for care home residents.

Design and setting Quality improvement project involving 429 residents in 40 care homes in a non-randomised crossover cohort design. The headline outcome was 2-year survival.

Method All care home residents had healthcare coordinated by the PCN's Older Peoples' Hub. A daily MDT managed the urgent healthcare needs of residents. Proactive healthcare, comprising information technology-assisted comprehensive geriatric assessment (i-CGA) and advanced care planning (ACP), were completed by residents, with prioritisation based on clinical needs. Time-dependent Cox regression analysis was used with patients divided into two groups:

- Control group: received routine and urgent (reactive) care only.
- Intervention group: additional proactive i-CGA and ACP.

Results By 2 years, control group survival was 8.6% (n=108), compared with 48.1% in the intervention group (n=321), p<0.001. This represented a 39.6% absolute risk reduction in mortality, 70.2% relative risk reduction and the number needed to treat of 2.5, with little changes when adjusting for confounding variables.

Conclusion A PCN with an MDT-hub offering additional proactive care (with an i-CGA and ACP) in addition to routine and urgent/reactive care may improve the 2-year survival in older people compared with urgent/reactive care alone.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ NHS England's 'Enhanced Care in Care Homes' (EHCH) model is implemented in widely differing ways by different primary care networks, with outcomes being difficult to assess.

WHAT THIS STUDY ADDS

⇒ We evaluated an Older Peoples' Multidisciplinary Hub in a primary care network in Plymouth, comparing the survival of care home residents who received proactive care in addition to routine/urgent care (intervention) versus routine/urgent care only (control). At 2 years, care home residents in the intervention group were more likely to be alive compared with control (48% vs 9%), representing a 39.6% absolute survival advantage (p<0.001).

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This model of care is generaliseable and scalable to all primary care networks looking to develop Older Peoples' Multidisciplinary Hubs to fulfil their EHCH contractual requirements and (although out of scope for this quality improvement report) has been extended to support proactive care for older people in their own homes.

INTRODUCTION

NHS England's Long-Term Plan[1] includes the 'Enhanced Health in Care Homes' (EHCH) model,[2] which offers proactive care for residents in care homes, many of whom live with frailty, dementia and multimorbidity. In 2020, primary care networks (PCNs) were contracted to deliver EHCH, which specified that all care homes should receive weekly proactive multidisciplinary '*care home rounds*' based on '*the principles and domains of a comprehensive geriatric assessment (CGA)*'.[2]

A CGA is '*a multidimensional, multidisciplinary process that identifies medical, social and functional needs, and the development of an integrated/coordinated care plan to meet those needs*'.[3] CGA is beneficial in acute and hospital-at-home settings, with patients more likely alive and in their own homes at 6–12 months.[4 5] Community-based CGA may also improve physical function and independence,[4 6] reduce hospital admissions[7] and increase survival.[4 8] However, there is a lack of evidence on the impact of proactive CGA for care home residents.[9]

Meeting the EHCH contractual requirements has been challenging. Rising patient demand, complexity and workforce shortages have challenged capacity.[10 11] Furthermore, there is a skills gap; primary care teams have limited experience with delivering a CGA, and specific training was not provided as part of EHCH. Lastly, there is no guidance or specification for how primary care-led CGA should be structured.[12]

Since Autumn 2018, Pathfields Medical Group, a single-practice PCN, developed a dedicated Older Peoples' Hub with an MDT supporting older people who lived in care homes or were housebound and living with frailty. Initially, it offered urgent care, but since May 2019, the Hub began offering proactive care. An information technology-assisted CGA (i-CGA) tool was developed within SystmOne, enabling structured, check-listed, high-quality assessments, with minimum administrative burden. Weekly proactive care clinics assessed complex patients, offered i-CGA and provided case management where needed. Online supplemental table 1 describes i-CGA and the Hub's proactive care elements.[13]

Evaluation of proactive care and i-CGA commenced in 2021, and by March 2024, we published research confirming i-CGA improved the quality of advanced care planning (ACP), compared with routine NHS care and may improve unplanned admissions.[14–16] In addition, we noted another unexpected finding; patients receiving i-CGA appeared to have reduced mortality.[14–16] However, the study was underpowered to conclude this, due to a small sample size. Accordingly, we recruited more subjects, and in this report, we present the findings looking at the headline outcome of mortality at 2 years.

METHOD

This quality improvement project was set up on 1 March 2019 in Pathfields Medical Group PCN in Plymouth, England, and we report outcomes until 30 September 2022.

All PCN-registered permanent residents of older people care homes and Pathfields-registered patients discharged from hospital to care home were included in the assessment under a current UK arrangement known as 'discharge-to-assess' (D2A). Patients were excluded if they left the PCN and registered with another surgery or returned home during follow-up.

For analysis, we treated the data as a non-randomised crossover cohort study. Two groups were defined:

- **Control group: They received (if needed) Hub-coordinated urgent care,** otherwise routine care and, to a variable extent, may have included some additional interventions described in online supplemental table 1.
- **Intervention group:** During the study, residents moved progressively from the control to the intervention group on completion of a proactive i-CGA cycle, comprising all activities in online supplemental table 1.

Residents were not randomised; i-CGAs were prioritised based on clinical need and structured around dedicated care home sessions. The intent was to offer all residents proactive care. In our dataset, many patients started on routine/urgent care only (control), before receiving additional proactive care (intervention).

The primary outcome of interest in this analysis was survival/mortality. Frailty diagnosis (categorised by mild, moderate and severe) was made using the Pathfields Tool,[17] a case-finding tool built in primary care IT. It invited clinicians to record a frailty diagnosis on saving the record following a patient encounter annually. Clinician diagnosis was made by combining the Rockwood Clinical Frailty Scale[18] and longitudinal clinical knowledge of the patient.

Statistical analysis

To control any survival bias, time-dependent statistical analysis was performed in R[19] based on the time each resident spent in the control and intervention groups.

Differences in mortality between the two groups were tested using Cox proportional hazards regressions, with group (control/intervention) as a time-dependent variable. This type of regression is specifically used for analysing survival data. The time-dependent variable component allows analysis of subjects with variables that change over time, for example, changing from the control to the intervention group. The model accounts for the time patients spent in each group, providing a more robust test and reducing survival bias.

Cox proportional hazards model analysis comprised the following steps:

- A simple model where the group (control/intervention) was the only predictor variable.
- Multiple-predictor model controlling for additional potential confounding variables.

Kaplan-Meier curves were plotted for the data. Both frequentist and Bayesian versions of analyses were conducted. We report several statistics from frequentist regression models. The Wald statistic (z) and p-value are reported together to indicate statistical significance ($p<0.05$). Positive Wald values indicate a positive relationship between variables and negative values an inverse relationship. The HR quantifies how much more/less likelihood the intervention versus control groups have of dying during the study period. An HR of 2 or 0.5 would mean double or half the likelihood, respectively, of mortality within 2 years.

There are no Bayesian proportional hazards regression packages in R that allow for time-dependent variable analysis. Therefore, Bayesian proportional hazards regressions were conducted on a simplified version of the data, where the group was a three-level variable: intervention, control or both (ie, instead of patients being coded by time spent in each group). Evidence for effects was tested using Bayesian 95% credible intervals (Bayesian versions of CIs) for each

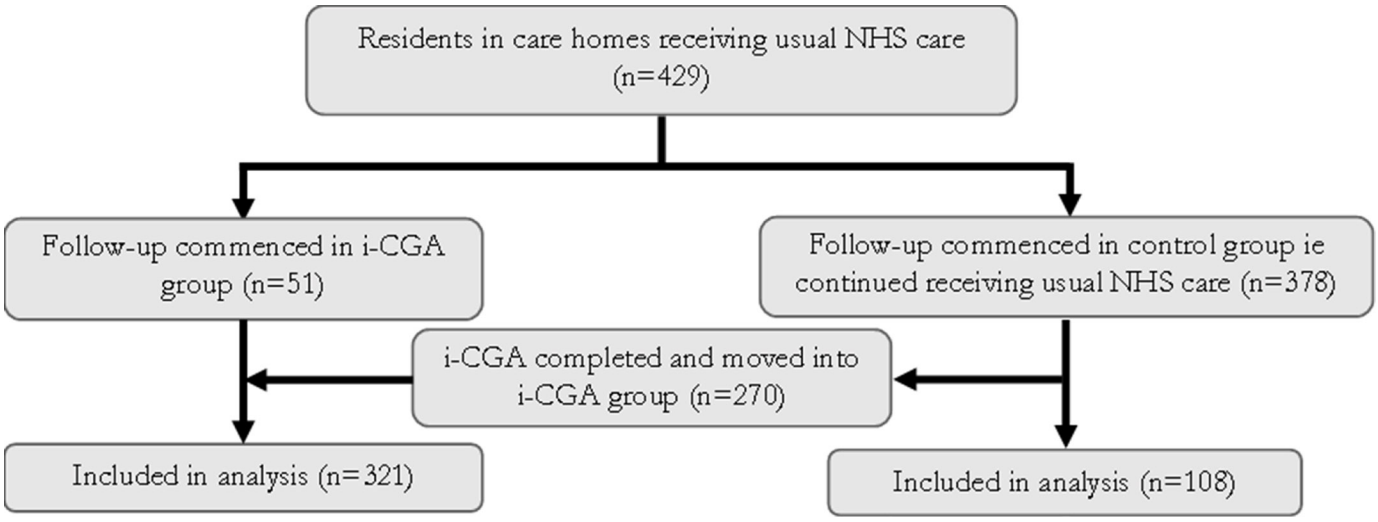

Figure 1 CONSORT flow diagram of patients included in this quality improvement project.

coefficient, with intervals discrete from zero providing evidence (similar to p<0.05). The control group was used as the reference category, and the intervention (never in control) and intervention (control first then intervention) groups were tested against this. The coefficient from the Bayesian coefficient (BC) is similar to the frequentist Wald statistic, where positive and negative values indicate a positive or inverse relationship, respectively.

RESULTS

At the time of evaluation, 429 eligible patients had completed follow-up (figure 1).

Characteristics in table 1 are presented according to the final group residents were in and include all participants from each group, regardless of whether they survived or died by the end of follow-up.

Mortality overall

The Kaplan–Mieer plot (figure 2) indicates at 2 years, 48.1% and 8.6% survival in the intervention and control groups, respectively (39.6% absolute risk reduction (ARR); 70.2% relative risk reduction (RRR); and number needed to treat (NNT)=2.5); HR=0.30, z=−9.08, p<0.001, BC (intervention only)=−1.14 (95% CI: −1.66,−0.76), BC (control then intervention)=−1.24 (95% CI: −1.49,−0.98).

Mortality after controlling for other variables

Table 1 shows all-cause mortality during the pre-vaccination period of the pandemic (in our locality, this was from 17 March to 31 December 2020). This demonstrates the intervention group had a higher all-cause mortality than the control group during this timeframe. To explore the mortality differences further, we ran single-predictor models for any health conditions that had a higher prevalence in the control group (ie, might increase mortality in this group) versus either the intervention (never in control) or intervention (control first then intervention). From these, female sex was significantly associated with lower mortality at 2 years (HR=0.66, z=−3.14, p=0.002), while the presence of heart failure (HR=1.37, z=2.00, p=0.046) and being in a nursing home (HR=2.39, z=4.16, p<0.001) or dual nursing/residential home (HR=1.88, z=3.43, p<0.001) significantly increased mortality at 2 years. Moderate frailty (HR=0.68, z=−2.67, p=0.008) and mild frailty (HR=0.59, z=1.90, p=0.058) were associated with lower mortality than severe frailty, although this was only significant for moderate frailty, possibly due to the lower *n* in the mild frailty group (see table 1). Other variables (diabetes, chronic obstructive pulmonary disease, cancer) were not significant (p>0.05). Therefore, we ran a multiple predictor model for group, which controlled for frailty level, male sex, heart failure and institution type.

The i-CGA group continued to be associated with reduced mortality after controlling for these other variables (see online supplemental table 2). More severe frailty and being in a nursing home or a dual nursing and residential home (compared with residential only) continued to be significantly associated with higher mortality. There was mixed evidence of heart failure being associated with higher mortality, after controlling for these other variables, and there was no longer a significant effect of sex (see online supplemental table 2). These additional variables mean there are 72 groups that can be compared for ARR—too many to report in full. For example, in female patients with mild frailty, without heart failure in residential-only settings, there was 64.8% and 21.3% survival in the intervention and control groups, respectively, at 2 years (43.5% ARR; NNT of 2.3). By comparison, for male patients with severe frailty and heart failure in nursing-only settings, there was 10.7% and 0.04% survival in the intervention and control groups, respectively (10.7% RRR; NNT of 9.4).

Table 1 Baseline characteristics for all residents in the quality improvement project, grouped accordingly by the end of follow-up: control or information technology-assisted comprehensive geriatric assessment (i-CGA) (all those who underwent i-CGA). Also presented separately according to whether they had an i-CGA and were never in the control group and those who started in the control group before receiving an i-CGA and thus later moved to the i-CGA group

Baseline characteristics	Total	Control	%	i-CGA (all)	%	i-CGA (never in control)	%	i-CGA (control then i-CGA)	%
Total	**429**	**108**		**321**		51		270	
Sex									
Male	**129**	**44**	**40.7**	**85**	**26.5**	12	23.5	73	27.0
Female	**300**	**64**	**59.3**	**236**	**73.5**	39	76.5	197	73.0
Median age	**89**	**87**		**90**		91		89	
Frailty									
Mild frailty	**31**	**7**	**6.5**	**24**	**7.5**	6	11.8	18	6.7
Moderate frailty	**132**	**31**	**28.7**	**101**	**31.5**	20	39.2	81	30.0
Severe frailty	**258**	**62**	**57.4**	**196**	**61.1**	25	49.0	171	63.3
Frailty status unknown	**8**	**8**	**7.4**	**0**	**0.0**	0	0	0	0.0
Dementia	**257**	**50**	**46.3**	**207**	**64.5**	34	66.7	173	64.1
Diabetes	**112**	**32**	**29.6**	**80**	**24.9**	14	27.5	66	24.4
IHD	**104**	**23**	**21.3**	**81**	**25.2**	11	21.6	70	25.9
Heart failure	**75**	**20**	**18.5**	**55**	**17.1**	8	15.7	47	17.4
Cancer	**139**	**35**	**32.4**	**104**	**32.4**	22	43.1	82	30.4
COPD	**43**	**16**	**14.8**	**27**	**8.4**	3	5.9	24	8.9
All-cause mortality during pre-vaccination period of the pandemic (17/3/20-31/12/20)	**72**	**14**	**13.0**	**58**	**18.1**	4	8.0	54	20%
Institution type									
Residential	**354**	**76**	**70.4**	**278**	**86.6**	45	88.2	233	86.3
Nursing	**31**	**13**	**12.0**	**18**	**5.6**	6	11.8	12	4.4
Dual residential and nursing	**44**	**19**	**17.6**	**25**	**7.8**	0	0	25	9.3
Advance care planning preferences									
Prefers natural death (DNAR)	**362**	**51**	**47.2**	**311**	**96.9**	50	98.0	261	96.7
Prefers CPR	**11**	**2**	**1.9**	**9**	**2.8**	1	2.0	8	3.0
Prefers to remain undecided	**2**	**2**	**1.9**	**0**	**0.0**	0	0	0	0.0
Prefers to be hospitalised if more unwell	**107**	**10**	**9.3**	**97**	**30.2**	22	43.1	75	27.8
Prefers not to be hospitalised if more unwell	**246**	**35**	**32.4**	**211**	**65.7**	24	47.1	187	69.3
No advance care plan	**54**	**53**	**49.1**	**1**	**0.3**	0	0	1	0.4

Patients in the information technology-assisted comprehensive geriatric assessment (i-CGA) (control then i-CGA) group spent varying lengths of time in the control group before receiving an i-CGA (range=599 days, median=230, IQR=279.75. Note that the mild frailty group is much smaller than the other frailty groups, with only seven mild frailty patients in the control group.

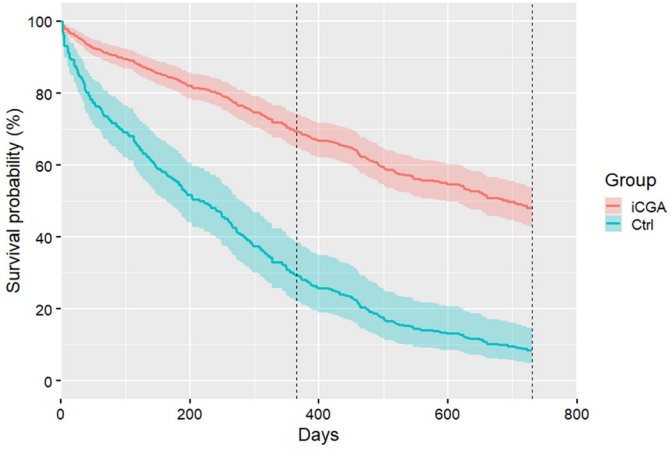

Figure 2 Kaplan–Meier survival (days) for the information technology-assisted comprehensive geriatric assessment and control groups. Mortality at 1 and 2 years is indicated by dotted vertical lines.

However, if additional variables are held at their average value (mean sex and heart failure across all patients and mode of institution and frailty level), there was a 44.3% and 5.48% survival in intervention and control groups, respectively (ARR 38.8%; RRR 71.9%; NNT 2.6; HR=0.28, z=−8.92, p<0.001, BC (intervention only)=−1.06 (95% CI: −1.55,−0.67), BC (control then intervention)=−1.30 (95% CI: −1.61,−1.03).

DISCUSSION

Summary: Survival benefit seen in the intervention group

After adjusting for confounding variables, care home residents receiving urgent and proactive care with i-CGA through an Older Peoples' MDT Hub experienced significant survival benefits compared with residents who received urgent care alone.

We offer several putative mechanisms for improved survival. First, the activities taking place in the intervention group (eg, optimisation of long-term conditions, medication and personalisation of care (eg, relaxing hypertension targets in people prone to falls)) could improve overall health and reduce predisposing risk of conditions associated with increased mortality (eg, delirium and falls).[20 21]

Second, i-CGA improves the efficiency and effectiveness of proactive care. It raises warnings when high-risk medication is about to be prescribed to older people with frailty, preventing potentially harmful prescribing. It also allows clinicians to rapidly sift through the entire care home population, targeting patients on high-risk medications for priority review. Data in online supplemental table 1 show our prescribing rates for high-risk drugs are consistently lower than those of the published literature (antimuscarinics 1.1% vs 4.9%; opiates 8.9% vs 22.4%; tricyclics 1.7% vs 3.9%; and anti-psychotics 13.3% vs 21%).[22 23] Furthermore, it offers better quality measures such as improved ACP in the intervention arm (see baseline characteristics).[14–16]

The third reason is a heavy focus on continuity, which has been shown to improve survival.[24] This was achieved in two ways: first, having a dedicated team for older people improves relational continuity; and second, i-CGA enables informational continuity - all patients automatically receive care and support plans, which are also shared with other healthcare organisations in the locality. This could improve care if the patient becomes more unwell and urgent/emergency care is needed.

Finally, our earlier evaluation[15–17] was underpowered due to the small sample size but showed a reduction in hospitalisation in the intervention arm. This is important as hospitalisation is also associated with delirium, deconditioning and functional decline so a reduction in admissions may also improve survival. Further work is underway evaluating hospitalisation in this larger cohort.

Taken together, these are feasible mechanisms that allow the intervention population to become more robust and less likely to experience acute insults, thus reducing the likelihood of deterioration and death.

Strengths and limitations

This service evaluation used exploratory retrospective analysis of routinely collected data; thus, our methodology is open to bias, most obviously selection bias (eg, de-prioritising residents with terminal diagnoses for proactive i-CGA). However, the user-friendly ACP documentation process during i-CGA meant that staff reported frequently choosing to use the tool in end-of-life situations. This is evidenced in table 1, where the i-CGA group had a higher number of patients with advance care plans. This was particularly important given the higher all-cause mortality in the intervention group (18% vs 13% in the control group) during the pre-vaccination period of the COVID-19 pandemic, a time when excess deaths were reported from care homes.[25]

We controlled for potential survival bias and differences between the two groups using Cox proportional hazards regressions, with group (control or intervention) as a time-dependent variable. This type of regression is specifically used for analysing survival data and accounts for the time patients spent in each group (reducing survival bias). Additionally, we controlled for the effects of potentially confounding variables (in this case, frailty severity, sex, heart failure and type of institution).

Comparison with existing literature

There is currently limited comparable data published on the impact of proactive CGA for care home residents, a recognised gap in evidence-based practice.[9]

Previous findings looking at the effect on mortality of complex community-based interventions, or CGA

specifically, have been mixed. A Cochrane review demonstrated survival benefits following hospital-based CGA,[4] and a 20% reduction in mortality following proactive community-based CGA was seen in older adults in Germany.[8] However, most individual CGA-based studies have not shown clear survival benefits. One key issue when looking at mortality is the selection of patients and the duration of follow-up. Many CGA-intervention studies target more frail individuals, where high mortality rates may provide little time for the treatment effect to be realised. The converse applies in less frail individuals where low mortality means longer follow-up required to detect differences.

Implications for research and practice

If the processes outlined in the TIDier checklist (online supplemental table 1) are followed in their entirety, this model of care is generalisable and scalable to all primary care networks looking to develop Older Peoples' Multidisciplinary Hubs to fulfil their EHCH contractual requirements and (although out of scope for this quality improvement report) has been extended to support proactive care for older people in their own homes.

To build on this evidence, the authors will conduct further analysis of hospitalisation during this and future periods using this cohort. We also propose a multi-site study using these interventions for residents in care homes, conducted outside of the pandemic, using a wider range of important outcome measures including patient-reported outcome measures (eg, quality of life, depression), healthcare outcomes (eg, falls/fractures, delirium episodes), healthcare utilisation metrics, a health economic analysis, qualitative interviews (with patients, families, health and social care staff) and incorporation of patient and public involvement.

Contributors All authors were involved in one or more of the planning, conduct of the service and reporting of the work described in the article. The lead author is responsible for the overall content and accepts full responsibility for the work. DA, as the lead author, attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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Competing interests The IT-assisted Comprehensive Geriatric Assessment (i-CGA) is owned by Target Health Solutions (THS, a company that enhances primary care IT). DA and JB are directors in THS.

Patient and public involvement Patients and/or the public were not involved in the design, conduct, reporting or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval Not applicable.

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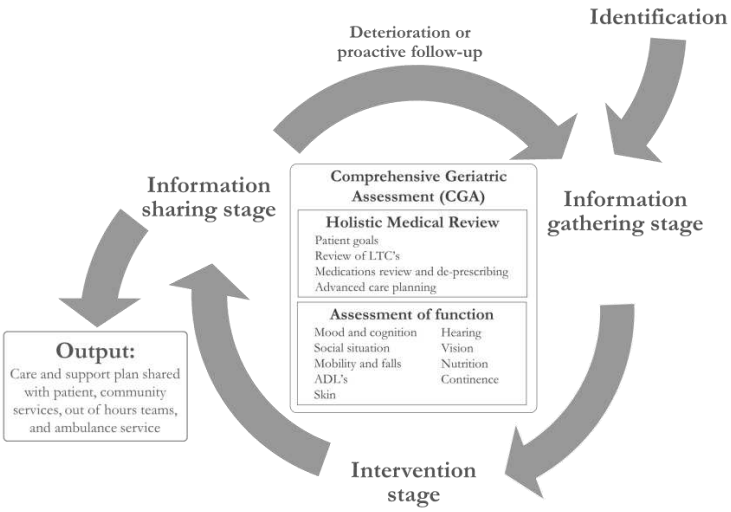
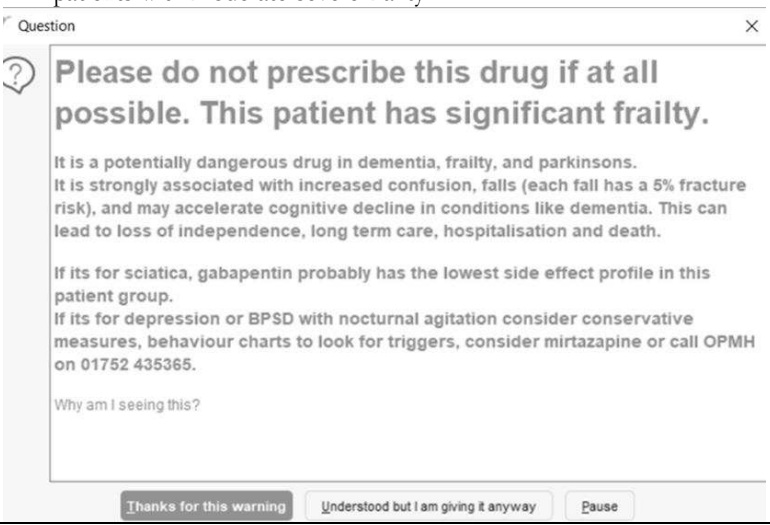
Item	Description
1. Intervention name	IT-assisted comprehensive geriatric assessment (i-CGA)
2. Why	CGAs are generally done in specialist units. Primary care teams have not been trained in coordinating the delivery of a CGA. These are specialist skills that consultant geriatricians learn over months-years. CGA is traditionally a labour-intensive process and needs significant administrative support, particularly with sharing information. There is significant variability between and even within specialist units[29,30] In order to facilitate a primary care-led CGA process and address the challenges around workforce capacity, skills gap, administrative burden and consistency of CGA quality, i-CGA was developed.
3. What	The i-CGA assessment covers all domains in a typical CGA: 1. Holistic medical review: • Patient goals • Long term conditions review and optimisation • Medications review and optimisation • Advance care planning 2. Assessment of function: • Social situation • Mood and cognition (and diagnosis of dementia, where appropriate) • Mobility and falls • Activities of daily living • Skin • Nutrition, weight, and swallow • Continence • Hearing • Vision The CGA follow a cyclical process as outlined in the diagram below: 

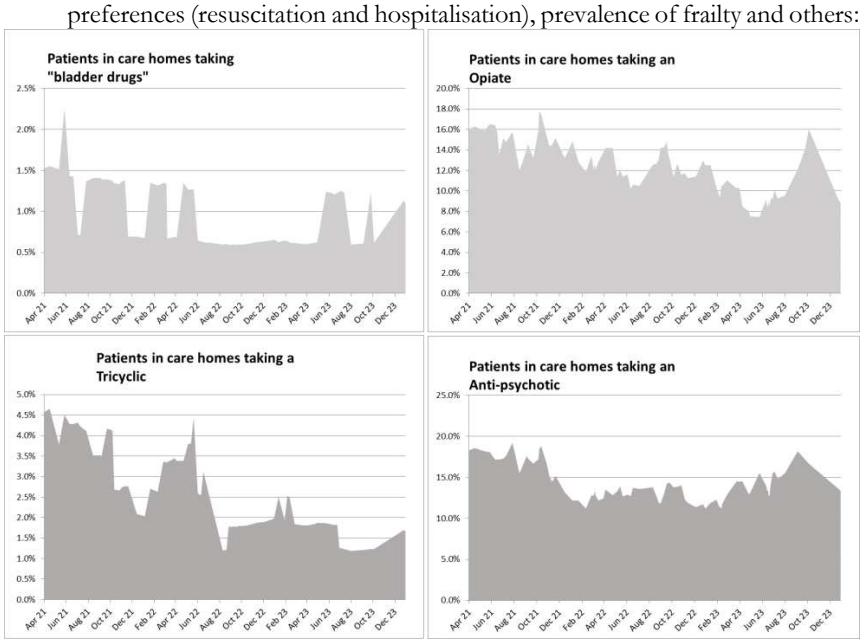
The CGA cycle has three discrete stages:

1. **Information gathering stage:** information is collected under each of the domain titles (see above), where problems are identified and connections between each domain established. The information gathering stage ends with the formulation of a problem list.
2. **Intervention stage:** Once the problem list has been formulated, activities, interventions, and follow-up are planned against these areas. The aim is to optimise social support, physiology, wellbeing, and independence, so that a patient can achieve their goals.
3. **Information sharing stage:** this occurs at the end of a CGA cycle when the patient is physiologically optimised and has achieved their goals or is on track to do so. A personalised care and support plan is generated, and this shared with the individual and organisations across the locality (including Out of Hours (OOH) and South West Ambulance Service Foundation Trust (SWASFT)).

To address the gap in workforce skills, capability, and capacity between specialist units and primary care, i-CGA features the following IT-assisted decision/administrative support:

1. **Rapid review** of any previous i-CGA entries
2. **IT-assisted deprescribing** of medications: on pushing a button, the IT system interrogates the patient's medications, flagging "high risk" drugs for review and rationale
3. **IT-assisted i-CGA checklist**: the system recognises if key areas of the CGA process have not been completed and prompts clinicians to complete them
4. **IT-automated decision support** for patients with moderate-severe frailty in the following situations:
   a) Recognition or prompting if patient does not have an i-CGA or advance care plan (ACP)
   b) Prompting on opening the record if a patient has had an i-CGA and hyperlinking to their care plan - particularly useful if a patient was acutely unwell
   c) If high risk medications are about to be prescribed, it warns the clinician and offers alternative courses of action. The example below shows the warning (actual warning is in red letters) if amitriptyline is about to be prescribed for patients with moderate-severe frailty:



	5. **IT-assisted advance care planning (ACP)**: i-CGA pulls the completed ACP entry from primary care IT, auto-populating it into a care plan and an electronic Treatment and Escalation Plan (e-TEP). An automated set of instructions is then sent to an assigned administrator to share with the patient, Out-Of-Hours medical services (GP and ambulance), acute, community and hospice providers 6. **Automated read codes:** On completion of an i-CGA, various read codes are added to the patient record which enables service evaluation and enabled development of the Ageing Well dashboard (see below) 7. **Population Health management**: a) **Ageing Well dashboard**: THS software enables serial data extraction of near real-time read-coded data from the i-CGA, to populate an "Ageing Well" dashboard, which enables evaluation of care quality criteria. The examples below show the % of patients in care homes on high risk medication, but similar data exists for structured medication reviews, advance care planning preferences (resuscitation and hospitalisation), prevalence of frailty and others:  b) **IT-assisted targeted reviews**: The Ageing Well dashboard enables clinicians to sift through the entire care home population, highlighting patients without advance care plans, i-CGAs, or on high-risk medications for targeted review. This significantly increases efficiency within proactive care slots
4. How	i-CGA delivered face-to-face, over the phone, and in some cases (where there is up-to-date information and a healthcare professional from a different organisation managing them and closely liaising with the primary care clinician), remotely.
5. Who provided	**Care homes:** GPs were the first to offer i-CGA. With time and further training, Pathfields-employed paramedics started offering them, too. Other members of the MDT also became upskilled in contributing to i-CGA. For example the MDT coordinators were trained in gathering baseline assessments from multiple different sources (health and social care) and present these at MDT. Pharmacists facilitate deprescribing with the help of agreed deprescribing regimens or shared care guidelines. Different members of the MDT started asynchronously assessing in different domains of the CGA, all coordinated through the Ageing Well MDT.

	[**Older people in their own homes:** Although outside the scope of this study, it is worth noting that the local community services provider (Livewell Southwest), has band 6 district nurses specialising in frailty, community matrons, and advanced clinical practitioners who have also been trained in i-CGA, and who offer this to older people with frailty who live in their own homes.]
6. Where	i-CGA was initially delivered by colleagues in primary care and more latterly also by community services as described above.
7. When and how much	i-CGA was delivered at least once, per patient, during the follow-up period presented. A single CGA cycle could sometimes be done in one sitting lasting about an hour. More often, it took place over several interactions spanning a few weeks, sometimes longer. Duration increased if for example there were complex deprescribing regimes that needed close observation and gradual withdrawal. Examples included older people on benzodiazepines, opiates, hypnotics, anti-psychotics, and cardiac medications. i-CGA was deemed to be complete at the point that all assessments had been accomplished and the care and support plan was generated and shared with the patient and other providers in the locality. The aspiration was for each CGA and care plan to be reviewed yearly and carry out further CGA cycles either proactively, or more acutely if there was an abrupt deterioration in the patient's status
8. Tailoring	CGAs are personalised to the needs of the patient and the purpose of each CGA is to support a patient to achieve their goals.
9. Modifications and developments in i-CGA and Hub working	Key modifications and developments are outlined in chronological order below: • Summer 2019 –an internal audit demonstrated that once a CGA was delivered, many of the medications that were stopped were eventually restarted. IT-automated prescribing safety alerts were created which discouraged unsafe prescribing habits and upskilled the workforce • November 2019: Pathfields developed an "Ageing Well Multi-Disciplinary Team (MDT)" with colleagues from the local nursing and therapy community services provider (Livewell Southwest). This workforce mostly supports older people in their own homes and although outside the scope of this study, it is a development worthy of note • April 2020 – Enhanced Health in Care Homes Primary Care Network contract commenced. A significant proportion of residents in care homes were offered a proactive i-CGA between March-May 2020, when the pandemic first began • Autumn 2020 – Care homes across the city aligned to individual Primary Care Networks • May 2021 – Ageing Well dashboard created • Autumn 2021 – functional status in IT-assisted CGA modified and read codes aligned with community services so that across the community, when different domains were filled in (even if not part of CGA, e.g a physiotherapist assessing mobility), this was visible to colleagues completing the IT-assisted CGA. This triangulation of information increased quality and efficiency of the CGA process • Autumn 2021 – electronic TEP added to IT-assisted CGA • Feb 2022 – Pathfields primary care network recruited care coordinators, who improved care quality with the following activities: o **Detecting new admissions to care homes:** Weekly searches of care homes to check if any new patients had been admitted o **Improving efficiency and quality of clinician "home rounds"**. Examples included sending out "initial assessment" forms for new residents to gather information on functional status, getting copies of any

<table>
<tr><td></td><td>pre-existing advance care plans, adding them to the records and coding as appropriate
o Follow-up for new patients: Once the above information had been gathered, listing them for follow-up in the home round
o Yearly follow-up for all residents: Ensuring each patient had their care plan reviewed every year
o Post-discharge review: Ensuring all patients discharged from hospital had a clinician review, ideally within seven days of discharge
• Summer 2022 –Paramedics received structured in-service training in proactive care for older people with frailty. Examples included medications optimisation, long term conditions reviews, interpretation of bloods, advance care planning, and how to complete an i-CGA.</td></tr>
<tr><td>10. How well (planned)</td><td>As certain clinical activities in the IT-assisted CGA were performed, the relevant read codes were added into the notes. This process was semi-automated, with the software prompting clinicians to confirm that an activity had been undertaken, prior to adding the read code.

The table below outlines key clinical activities that the IT would prompt for completion (other clinical activities took place but the software only prompted for these activities):
<table>
<tr><th>Clinical activity</th><th>Read code (and SNOMED code) mapping to activity</th></tr>
<tr><td>Patient goals</td><td>“Review of patient goals” (775501000000108)</td></tr>
<tr><td>i-CGA completion</td><td>“Subject of Comprehensive Geriatric Assessment plan” (836131000000104)</td></tr>
<tr><td>Consent for sharing summary care record (core and additional information) with health and social care organisations.</td><td>If patient had capacity to consent: “Express consent for core and additional SCR dataset upload” (773051000000102)

If patient lacked capacity to consent (discussed with next of kin): “Best interest decision made on behalf of patient (MCA 2005)” (765141000000105)</td></tr>
<tr><td>i-CGA shared with out of hours GP and ambulance services</td><td>“Sharing Advance Care Planning decisions with out of hours service” (922301000000104)</td></tr>
<tr><td>Medication optimisation</td><td>“Structured medication review” (1239511000000100)</td></tr>
<tr><td>Advance care planning: presence of and advance care plan

Patient resuscitation preferences
• Prefers natural death (not for CPR)
• Prefers resuscitation
• Patient undecided

Patient hospitalisation preferences
• Prefers to be hospitalised if more unwell
• Prefers to remain in care home if more unwell</td><td>“Treatment and escalation plan”. (735324008)

• “Not for resuscitation” (304253006)
• “For resuscitation” (304252001)
• “Resuscitation discussed with patient” (873341000000100)

• “Listed for admission to hospital” (183767005)
• “Hospital admission declined” (183960004)</td></tr>
</table>
Initially only four GPs delivered i-CGA. Fidelity was ensured by IT-assisted prompting if certain parts of the i-CGA were incompletely filled in</td></tr>
</table>

11. How well (actual)	Interventional fidelity was assessed by sporadic opportunistic case-note review e.g. when a person became unwell and their CGA was reviewed. Most IT-assisted CGAs, including those delivered by paramedics, were coordinated by or discussed with one GP with a specialist interest in Frailty prior to completion. This acted as a useful contemporaneous check to ensure fidelity.

Supplementary Table 1: Template for Intervention Description and Replication: TIDier checklist for this quality improvement project

Predictor	HR	Z	P	BC	CI-l	CI-u	% Mortality reduction	Sig
Group	0.28	-8.92	<0.001	-1.06	-1.55	-0.67	+71.9	Y
Group(Ctrl-i-CGA)				*-1.30*	*-1.61*	*-1.03*		*Y*
Institution (Dual)	1.58	2.40	0.017	0.44	0.05	0.79	-58.2	Y
Institution (Nursing)	1.82	2.74	0.006	0.56	0.07	0.99	-81.9	Y
Sex (Female)	0.85	-1.17	0.241	-0.14	-0.43	0.10	-14.7	N
Heart failure	1.43	2.28	0.023	0.32	-0.03	0.63	-43.11	M
Frailty (Moderate)	0.63	-3.14	0.002	-0.48	-0.77	-0.22	+36.8	Y
Frailty (Mild)	0.59	-1.86	0.062	-0.57	-1.18	-0.03	+40.7	M

Supplementary Table 2: Results of multiple predictor Cox proportional hazards regression: HR = hazard ratio; z = Wald statistic; p = p-value; BC = Bayesian coefficient; CI-1 = lower 95% Bayesian credible interval; CI-u = upper 95% Bayesian credible interval; % Mortality reduction = percentage reduction in mortality (RRR); Sig = whether result is significant using p<0.05 and Bayesian CI's discrete from zero as the cut-off (Y = Yes / N = No / M = Mixed evidence). See Methods for further explanation. Note that positive values for *% reduction in mortality* signify a decrease in mortality associated with that variable, while negative values signify an increase in mortality. For the frequentist model, Group was split into a two level (i-CGA and control) time-dependent variable. For the Bayesian model, Group was split into a three level (i-CGA only, control, and control-i-CGA) standard variable. The control group was used as the reference category, with i-CGA only (Group row) and control-i-CGA (Group(Ctrl-i-CGA) row in italics) compared to this.