Report Supplementary Material 3: Evaluation of the Falls Response Partnership's community first responder response to adults who have fallen in Lincolnshire

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1. SUMMARY

1.1. Background

The Falls Response Partnership (FRP) is an innovative approach to ensuring a safe health and social care response to people who fall in Lincolnshire. It involves LIVES Lincolnshire First Responders being trained and supported to attend adults who fall and then either call for an ambulance or an ambulance is called on their behalf. This scheme was implemented from December 2018 and this report describes the interim evaluation of the service. We aimed to investigate the effect of LIVES responders allocated to and attending people who fell and the overall effect of the FRP.

1.2. Method

We accessed data from East Midlands Ambulance Service NHS Trust (EMAS) and LIVES to conduct the evaluation, comparing outcomes for adults who fell and called the ambulance, and who then received an ambulance response or a LIVES response. We have provided descriptive analyses based on these data and more detailed economic models and analyses comparing LIVES with ambulance responses in terms of outcomes and costs while adjusting for other factors likely to be associated with these.

1.3. Results

Between December 2018 and the end of June 2019 we ascertained that 445 patients were attended by LIVES through the FRP. Patients were seen on average in under 30 minutes and around 30 minutes was spent on average assessing and managing each patient. In just over half the cases (53%) ambulance backup was called. 62% of FRP patients were conveyed to hospital. Additional data on severity category, location and adjustment for inclusion and exclusion criteria were available for 183 unique cases of falls attended by CFRs of which 153 remained that were actually attended by the BSV vehicles allocated to the FRP. Of the 153 cases FRP attended the scene, 95 (63%) eventually went to hospital. More severe cases increased the likelihood of an ambulance being called to attend. Costs of standard care and the LIVES responders attending have been estimated and are presented based on an economic model formed as a decision tree. The model suggests that the effectiveness and cost-effectiveness of the FRP increases as transportation to hospital following FRP attendance decreases, as referral to the community falls service increases and with the duration of the intervention because

of a reduction in recurrent falls. Cost effectiveness estimates are presented as incremental cost effectiveness ratios (ICERs).

1.4. Conclusion

Our preliminary results suggest that the FRP has the potential to be effective and cost-effective, for management of adult fallers who call the ambulance service and are attended by LIVES CFRs, as additional ambulance attendance and transportation decreases, referrals to community falls services increase and as the intervention continues over time, due to reduction in recurrent falls.

2. INTRODUCTION

2.1. Background

Emergency Medical (ambulance) Services in Lincolnshire have been commissioned to develop and pilot new services and pathways for adults who fall, where they or someone on their behalf call the ambulance service. Falls constitute a large proportion of ambulance attendances (12.6% of all calls), with delays in attendance leading to worsening of patients' conditions, a high rate (estimated to be 50%) of transportation to hospital and a considerable risk of further falls, all of which add to current pressures on emergency, acute hospital and social services.

The overall aim of this new service – the Falls Response Partnership (FRP) - is to improve care for adults who fall and call an ambulance in Lincolnshire, by increasing the speed of response by alternative services, reducing the rate of ambulance calls for falls and transportation to hospital where this can be done safely, increasing the rate of those treated safely in the community, and preventing future falls or fall-related conditions.

The ambulance service providing care to residents of Lincoln, East Midlands Ambulance Services NHS Trust (EMAS), estimate that approximately one-half of those older people who have fallen are left in their own home, with around 4,556 emergency hospital admissions for Lincolnshire residents due to falls (2016/17 figures) leading to further strain on the emergency services and acute hospitals.

The specific objectives of the FRP are as follows:

- To reduce the number of non and minor injury falls responses attended to by EMAS
- Reduce the number of people being conveyed to Emergency Department (ED) for non and minor injury falls
- Increase the number of people who are treated at home or place of stay after a falls episode
- Increase the number of people identified earlier and supported by prevention-based services, reducing the future demand for Adult Care and Acute Healthcare services

2.2. Proposed intervention

The FRP involves using LIVES, the Lincolnshire community first responder (CFR) service, to respond within 45 minutes to adults who fall in response to an alert from the EMAS Emergency Operations Centre (EOC) which is responsible for handling calls 999 (emergency) or 111 (urgent) calls for medical advice in the community. LIVES were commissioned to provide an immediate assessment upon arrival, treating the individual in their own home with basic first aid if required, assisting them back to their feet and, if the patient was deemed suitable to left at home, ensuring they were in a comfortable and

safe environment, with a follow-up assessment within 24 hours to ensure an appropriate referral to prevent further falls.

Where an ambulance response is needed the LIVES responder will be able to contact the EOC so that CAT may deploy an ambulance for further assistance. This would ensure that the individual had already been assessed, had been offered basic first aid and support where required, and that when EMAS staff arrive the patient's health had not deteriorated. In situations where LIVES did not have capacity to respond due to another priority, EMAS would respond as they currently do, allowing LIVES to respond accordingly to their statutory responsibilities.

The follow-up assessment (including a standardised falls risk assessment tool [FRAT]) would be done by LIVES and an onward referral for additional support where appropriate. The options for further action included referral to the Lincolnshire Wellbeing Service for further assessment, support, or equipment, the e.g. telecare response service; a GP referral for assessment of frailty, dizziness, hyper/hypotension, other medical problems or medication review; services providing strength and balance training; or to an occupational therapist working in the community falls team based at Lincolnshire Community Health Services NHS Trust for more complex needs.

This model was designed to reduce pressure on ambulance services and Emergency Departments, be implemented quickly, and help retain staff at LIVES.

We aimed to investigate the effect of LIVES responders allocated to and attending people who fell and the overall effect of the Falls Response Programme on change in the rate of ambulance attendances, transports and re-attendances following the intervention.

We also aimed to investigate health and social care costs of the services provided and any change as a result of the intervention.

3. METHOD

We decided to use a multi-method design for the evaluation. This involved an initial logic model (Figure 1) and programme theory related to the anticipated model of change described above in the proposed intervention.

We wished to evaluate changes in the rate of EMAS calls for falls using routine call-and-despatch (CAD) and clinical data recorded by LIVES or the ambulance service on electronic Patient Report Forms (ePRFs) focussing on adults aged 18 years and above attended.

Data to be collected included call timings, treatments administered and rate of transportation to ED or recorded referrals to other service, following a fall. We planned to collect data for 24 months prior

to the intervention start date (December 2018) and during the period of the intervention (December 2018 to June 2019).

Further details of the methods are included in the results (section 4) and economic analysis (section 5).

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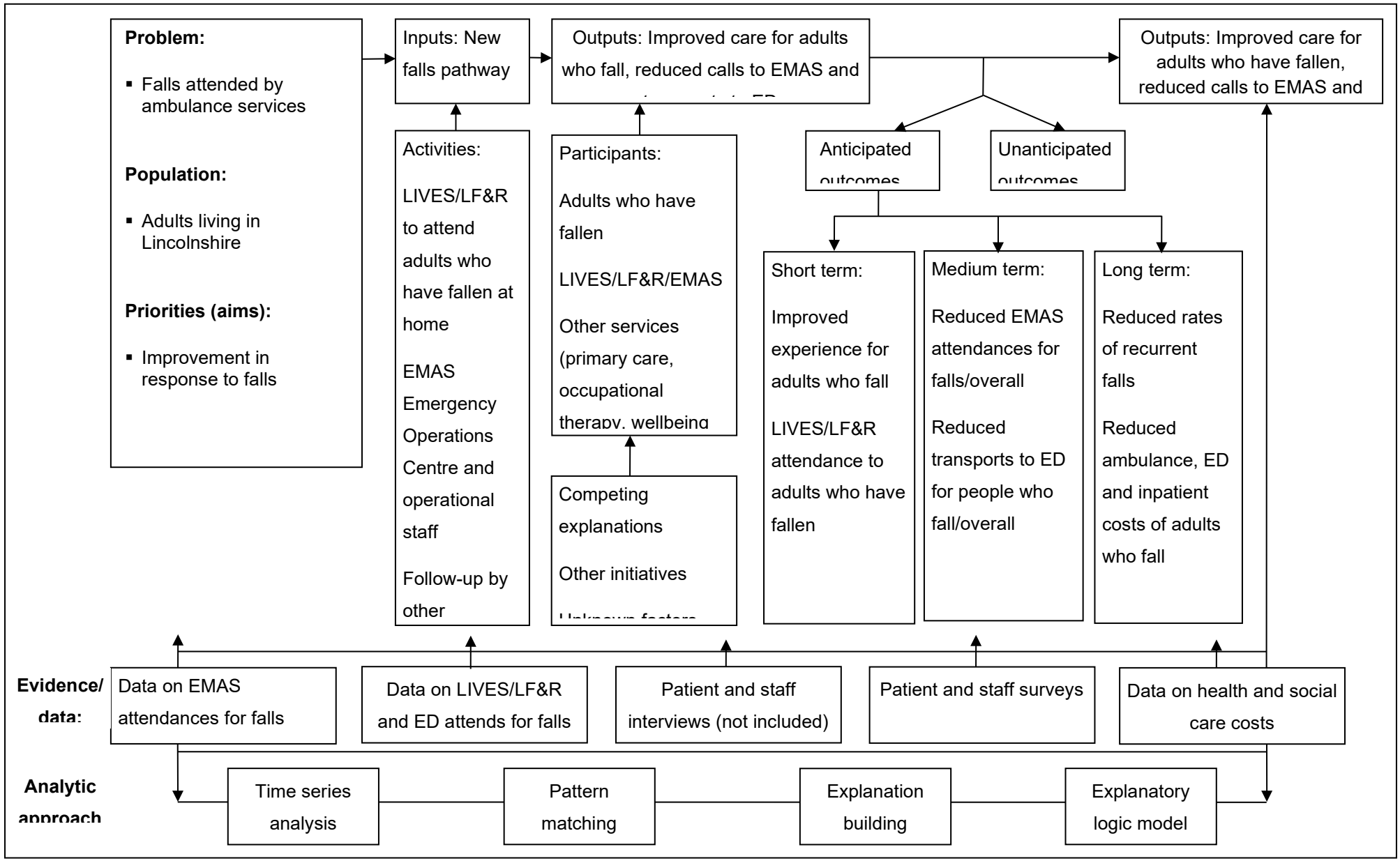
Figure 1 Falls response evaluation logic model



4. RESULTS

4.1. Falls data

EMAS supplied two tranches of ambulance records for incidents related to patient falls occurring during the 30-month period January 1, 2017, to June 30, 2019, arising from 999 emergency calls leading to assignment of a unique coded value to variable **CallNumber,** numbering 142,919 in total.

From 2017 NHS England implemented new nationwide ambulance response standards to improve ambulance response times overall but particularly to those patients considered to be suffering from life-threatening emergencies or injuries.[1] Four different categories (Categories 1-4) are used to first assess the type of cases, which are based on the judgement of the computer-aided despatch (CAD) system through a set of pre-triage questions to identify the nature of the call.

Box 1 Call categories from Ambulance Response Programme

Category 1: Life threatening/very serious injuries
Category 2: Emergency calls
Category 3: Urgent calls
Category 4: Less urgent calls

CAD-assessed incident severity, **CatCode** coded Category 1-4, was supplied for most incidents (39,527 fewer) dating from July 17, 2017. The sample frame was accordingly set from July 17, 2017, to June 30, 2019, a total of 714 days. Category 2-4 incidents (respectively amber, yellow, green) were the target of this evaluation (3,970 incidents were assessed category 1 purple) leading to removal of a further 3,976 incidents, leaving 99,416 incidents.

Calls due to falls were defined by the entry made for variable **ChiefComplaint** (CAD-assessed AMPDS coding), which reduced the total to 99,222 incidents when the record showed CAD did not assess 194 patients to have fallen.

Focussing on incident locations occurring in Lincolnshire areas - East Lincs[2], West Lincs[3], South Lincs[4] - resulted in a total of 15,979 incidents over the sample frame.

[1] NHS England: Ambulance Response Programme - https://www.england.nhs.uk/urgent-emergency-care/improving-ambulance-services/arp/

[2] Combines East Lindsey and Borough of Boston.

[3] Combines Lincoln, North Kesteven and West Lindsey.

[4] Combines South Holland and South Kesteven.

Finally, a further 245 episodes were removed as electronic patient report form (ePRF) records (containing patient details) showed that patients for these episodes were aged below 18 years. It should be noted that a similar number again of the remaining episodes (total 15,734) are expected to involve children and young people as patients, but these cannot be identified using the data that were supplied because ePRF records were available for only 8,339 patients (8399/15979=52.2%).

4.2. Rates of falls by area, severity and response

Table 1 gives numbers of falls incidents by severity and Lincolnshire area separated into one of two 12-hour periods: 8am-8pm and overnight (8pm-8am).[5] For East Lincolnshire, the daily average number of incidents during the target 8am-8pm period was 3.86, of which 1.92 were category 2, 1.88 category 3 and 0.06 category 4. Combining the areas of West and South Lincolnshire that same daily average more than doubled to 7.76 incidents, of which 4.04 were category 2, 3.62 category 3 and 0.1 category 4. Across the sample frame of 714 days, there occurred 8,295 category 2-4 incidents in Lincolnshire during the hours 8am-8pm, giving an average across the whole county of 11.62 incidents per day.

Table 1 Overall frequency of falls incidents by severity and Lincolnshire area and time period

Financial year	Severity	East Lincs		West Lincs		South Lincs	
		8am-8pm	Overnight	8am-8pm	Overnight	8am-8pm	Overnight
2017-18*	2	531	342	625	373	475	291
	3	606	346	672	433	431	261
	4	17	8	17	11	11	3
	Total	**1,154**	**696**	**1,314**	**817**	**917**	**555**
2018-19	2	671	399	819	458	641	342
	3	571	340	609	401	547	277
	4	15	10	16	12	17	6
	Total	**1,257**	**749**	**1,444**	**871**	**1,205**	**625**
2019-20**	2	168	89	179	103	142	74
	3	167	89	192	69	136	60
	4	9	63	7	0	4	3
	Total	**344**	**0**	**378**	**172**	**282**	**137**

* Financial year 2017-18 data available from July 17, 2017
** Financial year 2019-20 data available up to June 30, 2019

The data provided showed that multiple ambulance units were often despatched to a single incident. For incidents of severity category 2-4 occurring in Lincolnshire during the hours 8am-8pm

[5] Most episodes with 999 call commencing after 8am and before 8pm are included within the target 8am-8pm period. Episodes with call commencing prior to 8am are included into the target period if the record shows CAD despatching its final resource to the incident after 8am. Episodes completed after 8pm are included into the target 8am-8pm period provided CAD despatches its first resource to the incident prior to 8pm.

(hereafter termed “target incidents”), Table 2 gives count distributions of despatched units by financial year for standard EMAS care.[6] Conditional on CAD despatching at least one unit, the average number of units despatched to a falls incident dropped from 1.6 in 2017-18 to just over 1.4 in 2019-20. These averages varied by incident severity. For example, across the sample frame the average number of units despatched to category 4 target incidents in East Lincolnshire is 1.31 and in West and South Lincolnshire it is 1.62.

Table 2 Number of despatched units per target falls incident*

Number of	East Lincs			West+South Lincs		
units	2017-18	2018-19	2019-20	2017-18	2018-19	2019-20
1	638	732	175	1247	1663	373
2	304	325	52	589	590	132
3	104	75	18	179	159	27
4	34	23	3	59	46	10
5	8	8	1	16	10	5
6	1	0	0	6	4	1
7	0	1	0	1	1	1
8	1	0	0	1	1	0
9	0	0	0	1	0	0
Average	1.60	1.50	1.41	1.59	1.45	1.45

* Incidents excluding those allocated to the Falls Response Programme

Identifying attendance at scene by an ambulance unit was an important stage in determining NHS reimbursement. Table 3 contains the count distributions of despatched units that attended the patient at the scene of the incident for standard EMAS care. Note that when no units attended the patient (number of units=0) then every unit CAD had despatched to the incident has been stood down prior to attendance. The grand average was 1.15 units attending per target incident.

[6] Financial year 2017-18 data available from July 17, 2017. Financial year 2019-20 data available up to June 30, 2019.

Table 3 Count of number of despatched units attending patient per target falls incident*

Number of	East Lincs			West+South Lincs		
units	2017-18	2018-19	2019-20	2017-18	2018-19	2019-20
0	64	76	20	132	167	30
1	833	941	205	1,577	2,110	454
2	224	196	40	469	334	86
3	29	25	4	48	26	7
4	4	2	0	4	4	2
8	0	0	0	1	0	0
Average	1.20	1.14	1.10	1.20	1.09	1.13

* Incidents exclude those allocated to the Falls Response Programme

4.3. NHS reimbursement to EMAS for standard care

The NHS pays EMAS to provide emergency ambulance care according to four health resource group (HRG) currency codes shown in Table 4, the final column of which gives the average of reimbursements paid to EMAS for each respective HRG code. Multiplying by activity and summing yields £155.9m as the total of payments made by the NHS to EMAS for the financial year 2017-18.

Table 4 NHS Reference costs for EMAS

National Schedule of Reference Costs – EMAS				
HRG	**Description**	**Unit**	**Activity**	**2017-18**
ASC1	Urgent and emergency care calls answered	per call	992,777	£5.39
ASH1	Hear and treat or refer	per patient	147,475	£27.40
ASS01	See and treat or refer	per incident	191,566	£195.31
ASS02	See and treat and convey	per incident	460,831	£236.77

Table 5 reports the count of target incidents classified by HRG code under standard care by EMAS, where telephone call data being absent, it was assumed that (i) one emergency call was presented and answered by CAD per target incident, and further (ii) that all such calls resulted in action from

which one of ASH1 (call transferred to CAT), ASS01 (See-treat-refer) and ASS02 (see-treat-convey) arose.

Table 5 Count of target incidents by HRG currency code: standard care

Currency	East Lincs			West+South Lincs		
Code	2017-18	2018-19	2019-20	2017-18	2018-19	2019-20
ASC1	1,401	1,541	320	2,746	3,228	688
ASH1	311	377	71	647	754	139
ASS01	307	365	72	680	783	144
ASS02	783	799	177	1,419	1,691	405

ASC1: Urgent and emergency care calls answered; ASH1: Hear and treat or refer; ASS01: See and treat or refer; ASS02: See and treat and convey.

These are also re-presented in Table 6 in terms of incident severity, where relative frequencies pertain to aggregates taken across the sample frame.

Table 6 Relative frequency of target incidents by HRG currency code: standard care

Currency Code	East Lincs severity			West+South Lincs severity		
	2	3	4	2	3	4
ASC1*	1,401	1,541	320	2,746	3,228	688
ASH1	7.90%	22.78%	94.87%	7.13%	24.83%	95.06%
ASS01	21.99%	27.90%	1.28%	24.18%	28.25%	2.04%
ASS02	70.11%	49.32%	3.85%	68.70%	46.92%	2.90%

ASC1: Urgent and emergency care calls answered; ASH1: Hear and treat or refer; ASS01: See and treat or refer; ASS02: See and treat and convey. * By assumption the ASC1 entry corresponds to total frequency.

Table 7 restricts attention to those target incidents that were attended, these figures may be the better for comparison to the intervention incidents because attendance is required.[7]

Table 7 Relative frequency of attended target incidents: standard care

Currency Code	East Lincs			West+South Lincs		
	severity			severity		
	2	3	4	2	3	4
total	1,294	1,193	16	2,762	2,331	29
ASS01	23.88%	36.13%	25.00%	26.03%	37.58%	41.38%
ASS02	76.12%	63.87%	75.00%	73.97%	62.42%	58.62%

ASS01: See and treat or refer; ASS02: See and treat and convey.

4.4. Costs of standard care from an EMAS perspective

As the sample frame includes financial years 2018-19 and 2019-20, then NHS Reference Costs are required for these periods. As these are yet unpublished, instead we impute average values assuming the uprating inflators of cost equate price discounting deflators, implying the averages given in the final column of Table 4 are invariant for 2018-19 and 2019-20 when each is expressed in 2017-18 prices.

Using average reference costs and the previous assumptions, the value in 2017-18 prices of the total reimbursement to EMAS for providing standard care across the time period of the sample frame is £0.6m for target incidents occurring in East Lincolnshire, and £1.2m for target incidents occurring in West and South Lincolnshire.

For target incidents involving attendance (i.e. leading to episodes coded ASS01 and ASS02) the respective reimbursements totalled £0.58m and £1.15m. This equates to an average daily reimbursement in 2017-18 prices of £805 and £1,605, respectively, for attended target incidents. These figures represent on average the per day revenue EMAS receives to support the provision of emergency ambulance services to attend category 2-4 falls incidents occurring in East and West + South Lincolnshire during the hours 8am-8pm.

[7] Note that despite the sample frame being of length of 714 days the number of category 4 target incidents that are attended is small.

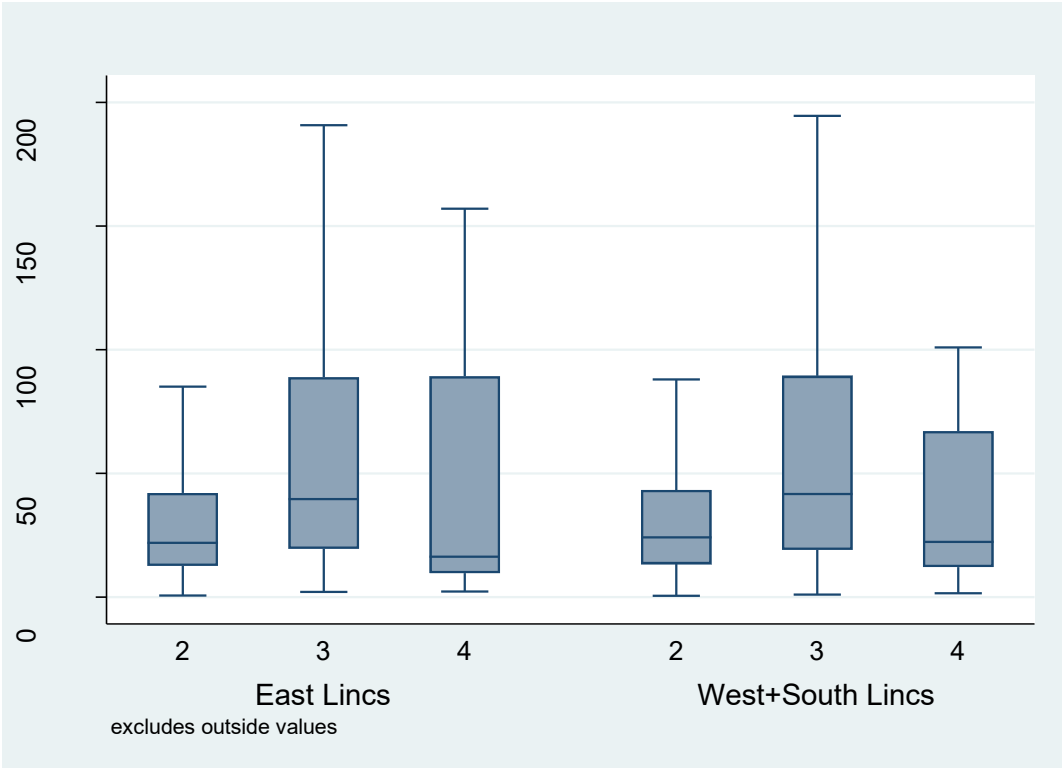
4.5. Patient benefit

Patient benefit is associated with a number of factors. First, the timeliness of arrival of a healthcare first-aider following an emergency call (Table 8). Figure 2 depicts the box plot of the distributions of time to arrival at scene from when call-taking commenced, by severity and area, for target incidents treated with standard care. Outliers above the plot's upper adjacent value are not depicted in Figure 2, but their influence is substantial as is evidenced by the magnitude of the difference between median and mean values given in Table 8. The longest wait experienced by any one patient over the sample frame exceeded 10 hours, where in this particular case the allocation of an ambulance, despite the initial call being taken at 10:34pm, was not done until 8:52am the following day.

Table 8 Time in minutes to attend patient by severity and area: sample statistics for standard care

Statistic	East Lincs Severity			West+South Lincs Severity		
	2	3	4	2	3	4
Median	22	40	16	24	42	22
Mean	31	67	63	33	68	75
90th centile	64	163	240	70	160	213
Longest	189	639	303	278	581	399

Figure 2 Time (minutes) to attend patient by severity and area



4.6. Data for intervention cases

In order to conduct the evaluation we needed to identify intervention cases accurately. Data on intervention cases were collected independently by EMAS via their Computer-Aided Despatch (CAD) system, by LIVES and by LCHS, so in order to ensure our data were as accurate as possible we attempted to triangulate data from all three sources.

Intervention cases in the EMAS dataset were identified as those calls attended by one of two vehicles, designated the call sign BSV4 or BSV5, and used by the LIVES falls team between the hours of 8am and 8pm. The LIVES vehicle with a call sign of BSV4 covered East Lincolnshire and Boston and operated within Boston and East Lindsey, while the vehicle with the BSV5 call sign covered West and South Lincolnshire and operated within the City of Lincoln, North Kesteven, West Lindsey, South Kesteven and South Holland. Table 9 shows a summary of how intervention cases were identified.

Table 9 Number of intervention cases

Source		Intervention (n=)	Unique call numbers (n=)*	Cumulative count (n=)
A	1st tranche of LIVES data	39	37†	37
B	2nd tranche of LIVES data	19	19	56
C	1st tranche of EMAS data	26	23	79
D	EMAS Apr-June	162	158	237
E	BSV4 EMAS data	503**	96***	333
F	BSV5 EMAS data	381**	112***	445††

**Unique Call Numbers identified as those unique to a dataset and not in the previous combined dataset(s) i.e. unique call numbers in EMAS Apr-June identified as Call Numbers not included in the previous 3 datasets.*

***Potential cases as although these call signs are labelled BSV4/5, some are LIVES responders dealing with cases other than the falls service (competing risk).*

****Matched to the LIVES logbook of BSV4 and BSV5 falls cases dating from 01/05/2019-30/06/2019*

† 2 call number's excluded because the LIVES falls service operated prior to the start of the Intervention Period.

†† LIVES data (PRF's that we received) includes a total of 12 Call Numbers that are not BSV4/5 which we have flagged but included in the final estimate. Pending review to LIVES if these call numbers are part of the falls service.

Intervention cases were also identified from a LIVES logbook of cases attended dated from 01/05/2019-10/07/2019, for the BSV4 and BSV5 callouts. The LIVES logbook data for the Falls Service was only partially complete in some instances i.e. there were a few days in which no Call Numbers were included which meant we could not match all the call numbers found in number 5 and 6 (Table 5). We have a total of 332 **potential** intervention Call Numbers that cannot be verified directly with the logbook because these cases occurred either prior to 01/05/2019 or after 30/06/2019 or due to information missing from the logbook. We assume here that those call numbers are not "Falls cases" and are considered as "competing risks" i.e. the LIVES service may have attended cases other than the "falls episodes".

4.7. Number of additional ambulance resource units attending per case

Out of the 445 call numbers related to falls, we had data on 186 across interested variables: severity category code, location and adjustment for inclusion and exclusion criteria. One episode fell outside the time period by 3 min so we included this. From the 186 call numbers in the intervention group, 100 were assigned the BSV4 call sign and 86 were assigned the BSV5 call sign. Of these 186 call numbers, 183 were unique adjusting for duplicates as we had 2 cases where there were multiple BSV4/5 call signs for the same call number. The reason for this may have been that at least one of these call signs had been stood down, then decided to get to the patient perhaps due to diversions either on the road or attending to another service nearby.

Table 10 Number of additional units attending per case for the intervention group BSV4 and BSV5 vehicles (n=153)

Additional resources required	**0**	**1†**	**2**	**3**	**4†**	**6**
Number	36	79	21	11	5	1

†Adjusted for resources standing down

4.8. Severity of cases

Tables 11 and 12 below lists the severity of cases across the intervention group.

Table 11 BSV4/BSV5 cases by call category

Category	**Call severity**
1	-
2	52
3	119
4	15
Total	**186**

Table 12 Severity of cases by the falls service and outcome of patient by severity category.*

Severity of Cases	**See and treat by BSV4/5 n (%)****	**See, treat and conveyed to hospital n (%)*****
Category 2	42 (27%)	36† (86%)
Category 3	99 (64%)	57 (58%)
Category 4	12 (8%)	2 (17%)
Overall	**153**	**95 (62%)**

**Adjusted for cases where the unit has stood down leaving only cases that were actually attended by the BSV4/5 vehicles .Included all units attending to the patient.*

*** Parenthesis contains the proportion of total cases.*

****Parenthesis contains the proportion of cases that were taken to hospital by Severity Category.*

† Call number "11517644" is a duplicate (looks to be two people being treated) did not adjust for this.

We expected a greater proportion of patients in category 4 to be attended by the falls service as these were considered to be less serious cases identified by the EOC as opposed to category 2 cases which are more serious falls. However, a plausible reason for this because category 4 cases can be dealt with over the phone rather than attending the patient in person. Of the 153 cases where a CFR attended the scene, 95 (63%) eventually went to hospital. Unsurprisingly, the more severe a case identified by CAD meant an increase in the likelihood of an EMAS unit attending the scene in conjunction with the CFR unit.

4.9. Timing of cases

The University of Sheffield has evaluated data from 3 separate studies to assess the performance of the ambulance response programme. [8] Evaluations included the proportion of incidents transported to hospital by severity code, average response times, location analysis and across different types of patient cases other than falls. Here we are restricting our analysis to only fall cases using a comparative measure to assess response times between the Community First Responders (CFRs) instructed by the LIVES team against all other units.

Ambulance services are allowed 60 seconds from receiving a call to sending out a vehicle, category 2 falls should be responded to within 18 minutes from when the call is taken, 9 out of 10 category 3

[8] The University of Sheffield - https://www.england.nhs.uk/wp-content/uploads/2017/07/ARPReport_Final.pdf

calls should be responded to before 120 minutes and for the least serious category 4 calls, the ambulance should arrive within 180 minutes for 9 out of 10 calls. [9]

The figures in Table 13 below show how LIVES operating vehicles compared with all other units across different points of the journey. The timings will be important for comparing the efficiency of different units, but we must also factor in other types of incidents that LIVES responders are attending (as a competing risk) to account for the degree of swiftness in the service, which has not been accounted for in Table 13. The BSV4 vehicle operated outside East Lincolnshire 21 times or 21% of cases whereas the BSV5 vehicle operated outside West and South Lincolnshire 16 times or 19% of cases.

[9] NHS: New Ambulance Standards - https://www.england.nhs.uk/wp-content/uploads/2017/07/new-ambulance-standards-easy-read.pdf

Table 13 Time difference in minutes by call sign and all other units involved

Key: Time Call Taking Commenced (A); Time Resource Allocated (B); Time Resource Mobile (C); Time Resource Arrived at Scene (D); Time Responder Clear (E).

Description	**Formula**	**BSV4 (n=100)**		**BSV5 (n=86)**		**All other units (n=206)**		**Severity Category**
		Time mean (median)	n	Time mean (median)		Time mean (median)	n	
Delay in allocation of resource	B-A	11 (5.2)	29	7.7 (4)	23	19.6 (15.7)	75	Category 2
		19.4 (15.5)	61	16.5 (11.2)	58	24.6 (22.4)	126	Category 3
		14.1 (11.9)	10	18.1 (11.1)	5	19.9 (19.5)	5	Category 4
		16.4 (11.8)	**100**	**14.2 (9.3)**	**86**	**22.7 (18.6)**	**206**	**Total**
Duration of drive to patient	D-C	15.4 (9.5)	25	16.3 (13.5)	17	17.3 (16.2)	57	Category 2
		20 (13.7)	50	25.9 (26.2)	49	14.4 (10.3)	83	Category 3
		30.1 (30.1)	9	22.1 (19.2)	3	22.2 (25.1)	4	Category 4
		19.7 (12.7)	**84**	**23.4 (21.8)**	**69**	**15.8 (12.6)**	**144**	**Total**
Time until seen	D-A	21.1 (15.1)	25	23.1 (20.3)	17	30.6 (31.9)	57	Category 2
		29.5 (28.9)	50	30.5 (33.8)	49	26.4 (22)	83	Category 3
		21.1 (12)	9	31.5 (26)	3	43.5 (44.6)	4	Category 4
		26.1 (22)	**84**	**28.7 (30.1)**	**69**	**28.5 (26.8)**	**144**	**Total**
Time spent with patient	E-D	30.8 (30.9)	24	37.5 (41.5)	17	29 (28.5)	57	Category 2
		26.8 (26.1)	50	31.7 (31.4)	49	26.7 (23.1)	83	Category 3
		24.1 (17.3)	9	32.3 (25)	3	28.5 (27.9)	4	Category 4
		27.7 (26.6)	**83†**	**33.1 (33.1)**	**69††**	**27.7 (25.3)**	**144**	**Total**

† BSV4 vehicle stood down 16 times

††BSV5 vehicle stood down 17 times

†††All other units stood down 62 times

4.10. Types of response

Table 14 Variations in the processes of arrival or non-arrival by CFRs

Treatment arm/episode type	**CFR non-arrival**	**CFR dealt with patient alone**	**CFR called for backup**	**EMAS called CFR for backup**
Intervention (n=186)	33† (18%)	50 (27%)	**98 (53%)**	5 (3%)

† LIVES volunteer didn't show up as no time was recorded on arrival/resource stood down.

In just over half the cases (53%) the CFR called for an ambulance backup. Of these 98 cases where ambulance backup was requested, 60 (61%) were category 3 falls, whereas 34 (35%) were for category 2 falls. Of the cases where the CFR dealt with the patient without the need to call for backup or where they attended after an ambulance resource attended first, 38 (76%) were category 3 calls in comparison to only 4 cases (8%) for category 2 calls. Given that there were more than twice the number of category 3 cases compared to category 2 cases where a CFR attended (see Table 14), it appeared that an ambulance response was more likely to be despatched to attend more serious falls cases. The CFRs were stood down around 1 in 5 times for category 2 falls cases compared to around 1 in 6 times for category 3 calls.

4.11. EMAS costings

Table 15 Reimbursement costs for EMAS*, taking into account where the patient ended up

	ASS01 – See & Treat or Refer	**ASS02 – See & Treat & Convey**	**Resource type**
Number of Units	89	78	Total
Total cost **	£17,382.59†	£18,468.06††	£35,850.65

**EMAS vehicles obtained from Resource Type variable = (1) "dual-crewed ambulance", (2) "solo responder car", (3) "doctor" and (4) "other use (including neighbouring ambulance service)" where the latter includes the BSV4 and BSV5 vehicles. Results adjusted for units standing down and time on scene is missing.*
*** Obtained from the 2017/18 NHS reference costs – ASS01 cost per unit = £195.31 whereas ASS02 cost per unit = £236.77 – these are the costs per episode.*
†Cost of seen and treat (S&T) cases in the Intervention Group (pre-inflation adjusted).
†† cost of seen and treat and conveyed to hospital (S&T&C) cases in the Intervention group (pre-inflation adjusted).

Table 16 Running costs for EMAS vehicles*: mean times by resource type in minutes, parenthesis contain median values

Description	Formula	Mean Time (min)	n (=)	Resource type
Duration of Drive to Patient	D-C	15 (11)	100	**1**
		10.1 (8.9)	9	**2**
		13.6	1	**3**
		21.4 (17.1)	153	**4**
		18.6 (13.5)	**263**	**Total**
£/min is Pending				

**EMAS vehicles obtained from Resource Type variable = (1) "dual-crewed ambulance", (2) "solo responder car", (3) "doctor" and (4) "other use (including neighbouring ambulance service)" where the latter includes the BSV4 and BSV5 vehicles.*
Accounted for cases that stood down.

The total duration time across all EMAS units in the intervention group amounts to around 81.5 hours of drive time or 4878.8 minutes across the 186 call cases.

We assumed that the LIVES responder was equivalent to an EMAS technician (substituted for cost purposes) i.e. the costs in terms of salary had the technician attended the scene in replacement of the LIVES responder. Here we are using the pay scale for the technician as the benchmark to identify potential cost savings. Trainee and qualified technician is in Band 4[10], from the NHS pay scales which correspond to a pay range £21,089 to £23,761 per annum[11] or rather £10.79 to £12.16 per hour.[12] We will be taking the lower, upper and mid-range limits, which corresponds to spine 11, 17 and 14 respectively (Table 17).

Table 17 Salaries for Technicians derived from NHS pay scales 2019/2020

Spinal Point	Hourly Wage	Annual Wage
11	£10.79	£21,089
14	£11.16	£21,819
17	£12.16	£23,761

[10] NHS Emergency Vacancies - https://www.emas.nhs.uk/join-the-team/working-for-emas/vacancies/#!/job_list/s3/Emergency_Services?_ts=1
[11] NHS annual pay scales 2019/20 - https://www.nhsemployers.org/pay-pensions-and-reward/agenda-for-change/pay-scales/annual
[12] NHS per hour pay scales 2019/20 - https://www.nhsemployers.org/pay-pensions-and-reward/agenda-for-change/pay-scales/hourly

Based on the data from Table 15 under resource type 4 which includes the BSV4 and BSV5 LIVES responders, we can attribute a median salary cost of manning the LIVES vehicle at £608.41 (£588.23-£662.92). Calculations are based on hourly wage by spinal point.

5. ECONOMIC ANALYSIS

5.1. Economic model

We constructed and used for scenario analyses an economic model designed to compare the performance of the FRP response to a falls patient against standard care delivered by EMAS. The model can be depicted as a deterministic decision tree in which care stages are expressed for a cohort of first-time fallers, with a feedback patient outcome that depends on whether a repeat fall occurs and if so causes the model to recycle itself. Cycle duration is notionally one month.

The decision tree appears in Figures 3 and 4, where the former depicts the initial stages of the model up to referral options and the latter is a continuation subtree depicting patient outcomes achieved from primary care falls prevention treatment.

5.2. Patient population

The patients entered into the cohort follow the target criteria specified in the FRP protocol; namely, patients are determined by CAD to have fallen and further assessed to be of severity category 2, 3 or 4, this following from an emergency services 999 call where that report occurred during the hours of 8am-8pm to an incident location in either East, South or West Lincolnshire. For modelling purposes, it is assumed that the initial CAD-assigned severity category is correct implying that severity is not subject to reclassification once the patient is attended. It is also assumed that the distribution of fall severity across the cohort, for the initial fall as well as for any repeat fall, is as per table 1: 51.2% category 2, 47.4% category 3 and 1.4% category 4. Finally, at initiation (time=0) the number of falling patients in the cohort is set to 1000, this setting is without loss of generality as the economic results that we present will be scaled to a per patient basis.

5.3. Model structure

The model is structured into the following stages:

1. First aid emergency care
2. Acute hospital care
3. Community and primary care

4. Patient outcomes

Patients requiring first aid (stage 1) are allocated to FRP team in place of standard care represented by despatch of an EMAS ambulance. The FRP team may complete the job such that the patient is left at the scene, or CAS may elect to despatch a backup EMAS ambulance to the incident that conveys the patient to hospital (stage 2). Under standard care, our conservative cost assumption is that the team of paramedics in the despatched ambulance administer emergency first aid care and complete the episode without assistance that attracts additional cost; either they leave the patient at scene or else they convey the patient to hospital.

At the second stage, for those patients in the cohort that are conveyed to hospital it is assumed that they attend and receive treatment in ED and are then either sent home or admitted to hospital for further treatment. We further assume that emergency care, ED treatment and hospital treatment are to manage recovery from the current fall but neither serves to alter the chance of a future fall.

Linkage of the earlier stages of the model to its third stage, community and primary care, is through an organised referral process. Referrals under the FRP intervention arm can be organised by either the FRP team for patients left at scene in stage 1, or by ED clinicians for patients discharged to home, or by hospital clinicians at the conclusion of the patient stay. Referrals under the standard care arm are assumed to differ in one respect where, for patients left at scene, they may be organised by the EMAS ambulance crew. We assume that only one referral is organised for the patient, where this can be either to LCHS or to other primary care services. The model includes a 'no referral' pathway.

The third stage of the model is where measures are put into place to prevent future falls. The care package delivered by LCHS is assumed to be gold standard with a combination treatment package that includes input from a senior Occupational Therapist (OT) who puts care plans into place, with further review if and when required, followed by home visits by a band 2 or 3 District Nurse. For modelling purposes, all other forms of preventative primary care are collapsed to a single catch-all: a GP appointment (which the patient may elect not to attend) at which band 5 Community Nurse home visits are prescribed.

The final stage of the model generates patient outcomes, of which there are two assumed:

i. Repeat fall (retained in cohort for the next model cycle)
ii. No further fall (exit from the cohort)

If a repeat fall is generated it is assumed that this numbers exactly one fall per patient in the current cycle. All repeat fallers are retained in the cohort that then advances to the next cycle of the model.

For patients not generating a repeat fall our assumption is that those patients do not fall again, and they exit from the cohort.

When the modelling process enters a repeat cycle a key Markov-like assumption that we maintain is that the model structure and its assigned parameter values remain unchanged. This assumption may be robust up to the second stage of the model but becomes less tenable if the repeat faller is already in receipt of falls prevention care from primary care. For example, an LCHS patient would not receive a fresh new package of care upon referral to LCHS arising from a repeat fall.

Figure 3 Economic Model (part 1): Decision Tree Diagram

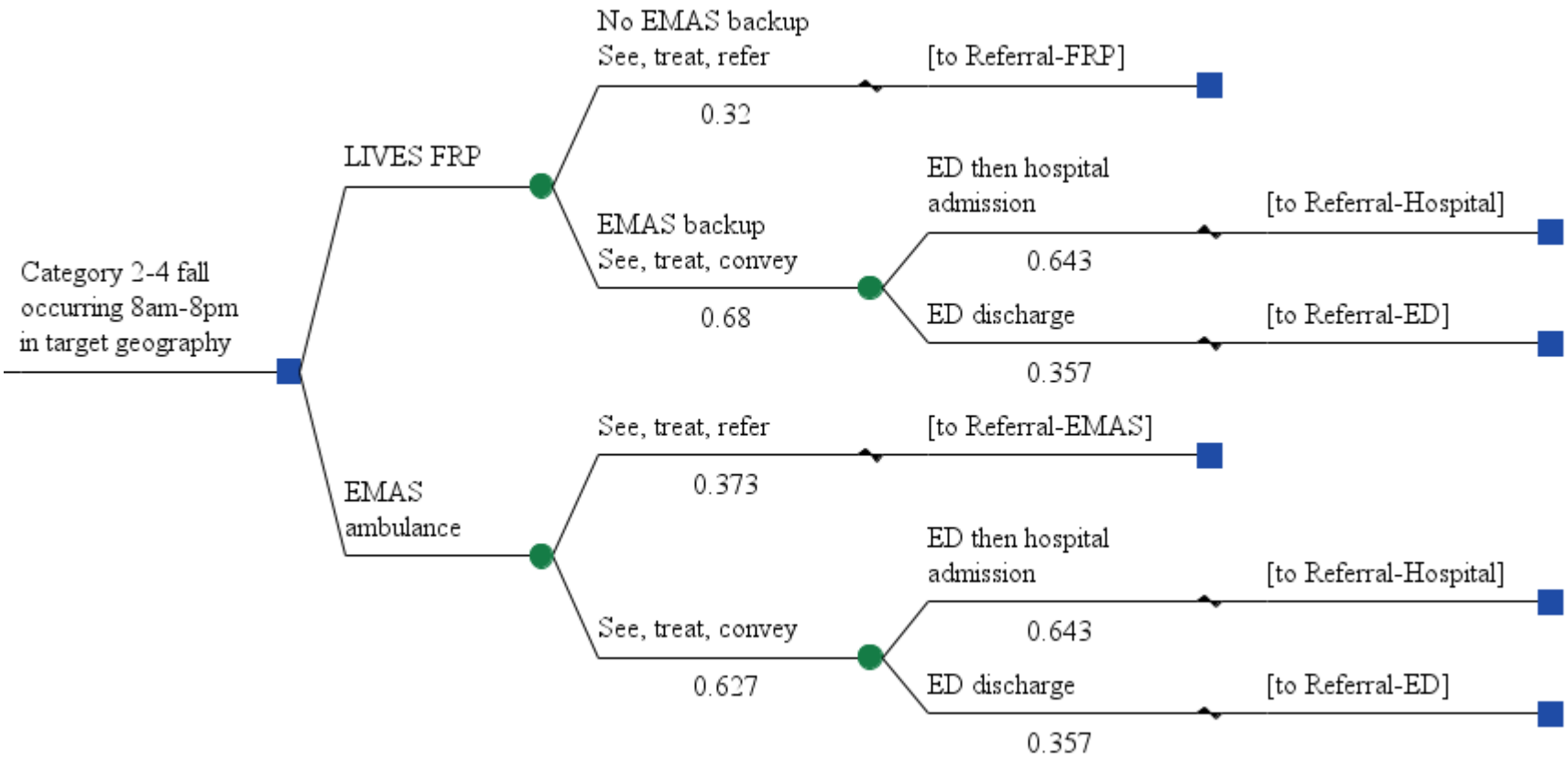
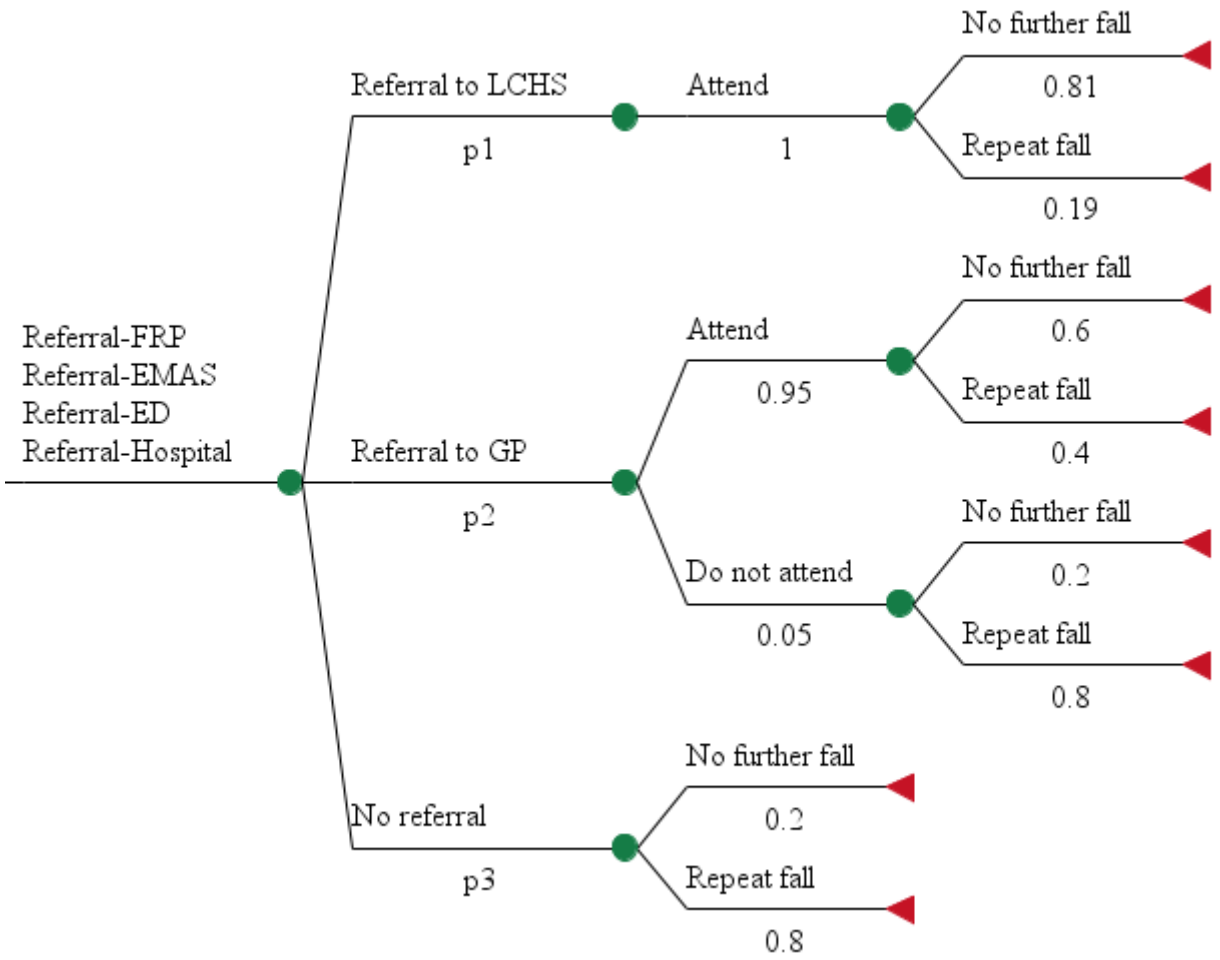


Figure 4 Economic Model (part 2): Referrals and Outcomes branch



5.4. Cost schedule

There are costs attributable to the NHS that are associated with most decision states in the economic model. These in turn have been derived from a cost schedule, see Table 17, constructed using NHS Reference Costs [1] and Unit Costs of Health and Social Care [2]. The price year in which all costs are expressed is 2019-20. Where prices require uprating from earlier financial years, we use the inflators at CCEMG – EPPI-Centre Cost Converter [3]. Implicit for all costings we quote is the assumption that the NHS reimbursement for a service or procedure is equivalent to the average cost to the respective NHS trust of delivering that service or procedure.

Costing items for ambulance emergency services – '999 calls', 'HTR', 'STR', 'STC' – are average NHS reimbursements made to EMAS and so are not specific to falls incidents. Similarly, 'OT' and 'District Nurse' are average, non-falls specific NHS reimbursements made to LCHS. 'GP' and 'Nurse' are estimated NHS unit costs derived by Curtis et al [2]. 'Technician' is an average hourly wage rate used to estimate the per incident salary saving to the NHS due to volunteer CFRs staffing the FRP intervention, where those LIVES personnel participating in FRP are assumed trained to either technical level 3 or 4. ED costs are constructed from NHS Reference Costs as attendance weighted averages across service codes distinguished by discharge destination simultaneous with severity that is aggregated into Types 01 and 02 for major injury and Types 03 and 04 for minor injury. Hospital costs pertain to non-elective short stay (1 day) and long-stay admissions for currency codes associated with tendency to fall (WH09A-G). In both cases the weighted average is formed according to numbers of finished consultant episodes with the cost of long-stay supplemented with the costs reported for excess bed days prior to averaging.

Table 18 Cost Schedule

Variable	2019/20 prices	Notes	Source
999 call	£5.61	Average NHS reimbursement to EMAS per urgent and emergency care call answered: £5.39 in 2017/18. Codes: RX9, ASC1	[1] NHS Reference Costs 2017/18
HTR	£28.51	Average NHS reimbursement to EMAS per patient CAT/CAS involvement: £27.40 in 2017/18. Codes: RX9, ASH1	[1] NHS Reference Costs 2017/18
STR	£203.20	Average NHS reimbursement to EMAS per incident attended: £195.31 in 2017/18. Codes: RX9, ASS01	[1] NHS Reference Costs 2017/18
STC	£246.34	Average NHS reimbursement to EMAS per incident attended with conveyance to hospital: £236.77 in 2017/18. Codes: RX9, ASS02	[1] NHS Reference Costs 2017/18
GP	£38.91	General practitioner surgery consultation for an average duration lasting 9.22 minutes: £37.40 in 2017/18	[2] PSSRU 2018, Table 10.3b
Nurse	£61.38	Band 5 community nurse per hour of patient-related work: £59.00 in 2017/18	[2] PSSRU 2018, Table 10.1
OT	£103.66	Average NHS reimbursement to LCHS per care contact: £99.63 in 2017/18. Codes: RY5, A06A1	[1] NHS Reference Costs 2017/18
District Nurse	£33.02	Average NHS reimbursement to LCHS per care contact: £31.74 in 2017/18. Codes: RY5, N02AF	[1] NHS Reference Costs 2017/18
Technician	£11.16	Band 4, step 14 NHS Agenda for Change per hour pay scale.	[4] NHS pay scales 2019/20

ED minor non-admitted	£67.48	Attendance weighted average of NHS reimbursement for types 3 and 4 non-admitted Emergency Medicine. Codes: VB01Z-VB11Z (excl VB10Z), T03NA, T04NA	[1] NHS Reference Costs 2017/18
ED minor admitted	£70.62	Attendance weighted average of NHS reimbursement for types 3 and 4 admitted Emergency Medicine. Codes: VB01Z-VB11Z (excl VB10Z), T03A, T04A	[1] NHS Reference Costs 2017/18
ED major non-admitted	£167.37	Attendance weighted average of NHS reimbursement for types 1 and 2 non-admitted Emergency Medicine. Codes: VB01Z-VB11Z (excl VB10Z), T01NA, T02NA	[1] NHS Reference Costs 2017/18
ED major admitted	£256.94	Attendance weighted average of NHS reimbursement for types 1 and 2 admitted Emergency Medicine. Codes: VB01Z-VB11Z (excl VB10Z), T01A, T02A	[1] NHS Reference Costs 2017/18
HospitalShort	£478.09	Activity weighted average of NHS reimbursement for tendency to fall non-elective 1 day short stay. Codes: WH09A-G	[1] NHS Reference Costs 2017/18
HospitalLong	£2,921.00	Activity weighted average of NHS reimbursement for tendency to fall non-elective long stay (incl cost of excess days). Average length of stay 5.8 days. Codes: WH09A-G	[1] NHS Reference Costs 2017/18

Table 19 Assumptions

Variable	**Assumed value**	**Notes**	**Source**
Price inflator	2% pa	Constant annual price inflation rate prevailing from 2017-18. For uprate of costs into 2019-20 prices	[3] CCEMG – EPPI – Centre Cost Converter
Fall severity	2 51.2% 3 47.4% 4 1.4%	Distribution of fall severity by category and applied to repeat falls too	EMAS dataset

FRP with no backup	1 hr 53 min	The average length of time from FRP despatch until stood down or cleared after attendance	EMAS dataset
FRP with backup	1 hr 58 min	The average length of time from FRP despatch until stood down or cleared after attendance when EMAS backup attends scene	EMAS dataset

Table 20 Decision states parameters

Decision state cost	Assumed value	Notes	Source
Intervention – LIVES FRP			
FRP with no EMAS backup	£195.28	Per protocol CAD refer the 999 call to CAT that in turn despatch FRP to the incident. FRP attend and treat. CAT remotely discharge the patient at scene with referrals organised by CFRs. Costed as: '999 Call' plus 'HTR' plus 'STR' less imputed average staffing costs saved due to CFRs (duration 'FRP with no backup')	Cost Schedule (Table 1)
FRP with EMAS backup	£439.76	Per protocol CAD refer the 999 call to CAT that in turn despatch FRP to the incident. FRP attend and treat. CAT despatch backup EMAS ambulance to treat and convey the patient to hospital. Costed as: addition of 'STC' to 'FRP with no EMAS backup' with time length adjustment as per 'FRP with backup'	Cost Schedule (Table 1)
Standard care – EMAS Ambulance			
EMAS ambulance see, treat, refer	£208.81	CAD despatch EMAS ambulance to incident. Paramedics attend and treat then discharge the patient at scene and organise referrals. Costed as: '999 Call' plus 'STR'	Cost Schedule (Table 1)
EMAS ambulance see, treat, convey	£251.95	CAD despatch EMAS ambulance to incident. Paramedics attend and treat then convey the patient to hospital. Costed as: '999 Call' plus 'STC'	Cost Schedule (Table 1)
Hospital care			
ED discharge	£118.62	Patient treated at ED. ED discharge patient back home. Costed as: fall severity weighted 'ED minor non-admitted' (by severity categories 3 and 4) and 'ED major non-admitted' (by severity category 2)	Cost Schedule (Table 1)

ED then hospital admission	£1,894.88	Patient treated at ED. ED discharge patient into hospital. Costed as: fall severity weighted 'ED minor admitted' plus 'HospitalShort' (severity categories 3 and 4) together with 'ED major admitted' plus 'HospitalLong' (severity category 2)	Cost Schedule (Table 1)
Referral			
Referral to LCHS	£136.68	Patient referred to LCHS. Senior therapists put care plans in place and the majority of the treatment is supervised by a band 2 or 3 therapist with review from seniors if and when required. Costed as: 'OT' (design and review of care plan) and 'District Nurse' (1 care contact at patient home)	Correspondence from T. Roche (LCHS)
Referral to GP	£100.29	Patient referred to GP. Patient appointment at GP surgery followed by community nurse home visit. Combined cost items 'GP' (1 consultation) and 'Nurse' (1 hour of patient work at patient home)	Cost Schedule (Table 1)
No referral	£-	Patient discharged without onward referral to further NHS care	Assumption

Transition probability	Assumed value	Notes	Source
Intervention – LIVES FRP			
FRP with no EMAS backup	0.32	Similar in magnitude to the SAFER2 trial in which 65.2% of cases in the falls intervention arm were conveyed to ED [7; table 19]	EMAS dataset
FRP with EMAS backup	0.68		
Standard care – EMAS Ambulance			
EMAS ambulance see, treat, refer	0.373		EMAS dataset
EMAS ambulance see, treat, convey	0.627		
Hospital care			
ED discharge	0.357	Of 1311 initial ED attendances in the standard care arm of the SAFER2 trial recorded were 843 hospital admissions (843/1311=0.643)	[7] SAFER2, Table 32
ED then hospital admission	0.643	Of 1419 initial ED attendances in the intervention arm of the SAFER2 trial recorded were 906 hospital admissions (906/1419=0.639)	
Referral			

		FRP	EMAS	ED	Hospital	
Referral to LCHS	p1	0.55	0.1	0.05	0.05	
Referral to GP	p2	0.3375	0.675	0.9	0.9	
No referral	p3	0.1125	0.225	0.05	0.05	
		In the SAFER2 trial [7, Table 19], of 2420 patients in the falls intervention arm 1579 were conveyed to hospital while 547 were left at scene without referral (no-referral rate: 547/(2420-1579)=0.65). There were 2284-1431=853 in the standard care arm that were not conveyed to hospital of which 692 were left at scene without referral (no-referral rate: 692/853=0.811). In the SAFER2 trial [7, Table 19], 204 in the intervention arm were issued a referral to a falls service (34 of which were to conveyed patients: (204-34)/547=0.202). The total in SAFER2's standard care arm was 26 (18 of which were to conveyed patients: (26-18)/853=1%).			
Patient attendance at referred service						
attend LCHS	1.00	All care contact is provided at patient home. LCHS data records 2 out of 32 fall patients were already on LCHS falls register				Correspondence from T. Roche (LCHS). LCHS referral dataset
attend GP	0.95	Attend GP surgery for initial appointment. Subsequent care provided at patient home. Non-attendance at surgery appointment set to 5%				[5] Neal et al (2001) [6] NHS News (2019)
Patient outcome						
No further fall following LCHS care	0.8125	Repeat fall recorded in 6 of 32 LCHS patients (6/32=0.1875)				LCHS referral dataset

No further fall following GP care	0.6		Assumption
No further fall absent referred care	0.2		Assumption

5.5. Costs for model states

5.5.1. Emergency First Aid

The decision states for the emergency first aid care (stage 1) of the model are distinguished by whether the patient is left at scene or conveyed to hospital. In the case of Standard Care an EMAS ambulance is despatched, for which we impose the conservative cost assumption that this crew completes the episode of emergency care without the need to involve CAT nor despatch of a second backup EMAS ambulance. When the patient is left at scene the cost is assigned as 'STR' plus '999 call', totalling £209 in 2019-20 prices. When the patient is conveyed to hospital, the cost is assigned as 'STC' plus '999 call', totalling £252 in 2019-20 prices.

For FRP, the cost is assigned according to its protocol: CAD ('999 call') engages CAT ('HTR') that despatches FRP ('STR') and provides further advice. If the patient is conveyed by backup EMAS ambulance, a further cost 'STC' is incurred. Cost is reduced by an imputed estimate reflecting use of non-NHS labour, where two LIVES personnel staff the FRP vehicle. This is charged at rate 'Technician' for durations depending on whether the patient is conveyed or not, respectively, 'FRP with backup' and 'FRP with no backup'. Both costs are derived on average as per:

'FRP with no EMAS backup'= 'STR' + 'HTR' + '999 call' – 2x'Technician'x'FRP with no backup'

= £195 in 2019/20 prices

'FRP with EMAS backup'= 'STC' + 'STR' + 'HTR' + '999 call' – 2x'Technician'x'FRP with backup'

= £440 in 2019/20 prices.

5.5.2. ED and Hospital

Should a patient be conveyed to hospital there are two model decision states to be costed, namely non-admitted ED treatment and admitted ED treatment combined with inpatient treatment if discharged into hospital; respectively, 'ED discharge' and 'ED then hospital admission'. In both cases the CAD categorisation of severity provides weights for cost calculations, where the distribution of fall severity observed from EMAS data is given in **Table 19**. For ED treatment, **Table 18** lists schedule cost components for minor injury that are assumed incurred for falls in categories 3 and 4, and major injury for category 2 falls. A similar approach is used to add the cost of inpatient care, where category 3 and 4 falls pertain to short stay 'HospitalShort' and category 2 falls result in longer stays 'HospitalLong'. The two decision states costs are listed in **Table 20** and constructed as per:

'ED discharge' = 0.512x'ED major non-admitted' + (0.474+0.014)x'ED minor non-admitted'

= £119 in 2019/20 prices

‘ED then hospital admission’ = 0.512x(’ED major admitted’ + ‘HospitalLong’)

+ (0.474+0.014)x(’ED minor admitted’ + ‘HospitalShort’)

= £1,895 in 2019/20 prices

5.5.3. Falls prevention care

The fall prevention care delivered by LCHS combines a non-face-to-face consultation by a senior Occupational Therapist (OT) who puts care plans into place, with further review if and when required, followed by home visits to the patient by a band 2 or 3 District Nurse. Average reference cost items are listed in the schedule (**Table 20**) under ‘OT’ and ‘District Nurse’. Being absent of episode data from LCHS on falls prevention, involving staff type and length of time in providing care plus procurement and installation costs for any equipment, we assume a very simplified costing for LCHS care: one ‘OT’ consultation and one ‘District Nurse’ follow-up home visit.

We are also absent patient episode data from other NHS providers of falls prevention care. Consequently, we assume as representative of all other preventative primary care a GP surgery visit with at home follow-up visits resulting in a cost magnitude that is similar to that of LCHS. We assume a single GP appointment at which one band 5 Community Nurse home visit is prescribed, items ‘GP’ and ‘Nurse’ from schedule **Table 20**.

5.6. Transition probabilities

5.6.1. Referral rates

Referrals to primary care to mitigate the risk of repeat falls may be organised by either of the four bodies (FRP, EMAS, ED, Hospital) either to LCHS (gold standard) or other care providers (generic catch-all assumed represented by GP), with ‘No referral’ included as a third pathway due to evidence of referral practices by paramedics reported in the SAFER2 trial [7]. Referral rates as transition probabilities are shown in Figure 4 as the parameters (p1, p2, p3; being such that p1+p2+p3=1) that may vary in value according to the referrer.

LCHS referrals spreadsheet data[13] provided by Thomas Roche (Allied Health Professional Services Clinical Lead) indicates “LCHS referral” (binary: yes/no), “reason for no referral”, “outcome following the fall” (whether discharged by CAT, handed over to EMAS or other) and “longer term outcomes” (information on repeats). Of 61 records, 57 are complete for “LCHS referral” under FRP, of these 30 (55%) became LCHS cases; for FRP we set p1=0.55 and assign the remainder to p2 and p3 ratio 3:1.

[13] This spreadsheet appears sourced from a larger set of LIVES log book data on FRP episodes dated 01/05/2019-10/07/2019.

The estimated value for p1 contrasts favourably with the estimate provided for the same parameter in the SAFER2 trial, being 0.202.

Evidence is sparse regarding referrals by EMAS paramedics. The control arm of the SAFER2 trial provides estimates of p1=0.01 and p3=0.811, implying p2=0.179. We instead assume the EMAS referral rate to LCHS to be p1=0.1 and assign the remainder to p2 and p3 ratio 3:1.

We assign common rates of p1=0.05, p2=0.9, p3=0.05 for referrals organised by ED and Hospital.

5.6.2. Repeat falls

The LCHS spreadsheet data records 6 repeat falls amongst 32 LCHS patients; we therefore set the transition probability of success, namely, avoiding a repeat fall following LCHS care to 0.8125=1-6/32.

Following GP care and no preventive primary care we assign the success transition probabilities 0.6 and 0.2, respectively.

5.7. Results

Comparing the baseline parameter settings for conveyance to hospital between FRP and Standard Care, these are 68% and 62.7%, respectively. Given the model assumptions and using these weights and the decision state costs, the average cost of emergency care per incident for the FRP intervention is:

£361 = 0.68x£439.76 + 0.32x£192.28

while for Standard Care the corresponding per incident average is:

£236 = 0.627x£251.95 + 0.373x£208.81.

Further costs accruing to FRP typically do not overcome this initial disparity between it and Standard Care, in which case the FRP intervention is generally more costly to the NHS than Standard Care.

Despite lack of cost saving FRP generates added patient benefit over Standard Care where this takes the form of fewer repeat falls. This is achieved indirectly as a result of FRP bringing relatively more patients into contact with LCHS than does Standard Care. When a patient is left at scene, the referral rate to LCHS by FRP exceeds that of standard care by 45% (55% versus 10%).

5.7.1. Baseline

Results for the baseline case appear in **Table 21**. The cost columns show the monthly accumulation of per patient costs incurred under each arm and the differences between them. The benefit columns show the monthly accumulation of the total number of falls in the cohort (size 1000) by arm and the differences between them. The final column calculates the incremental cost effectiveness ratios (ICER), computed as the ratio of the differences adjusted for cohort size, and represents the added cost to the NHS per fall avoided when FRP displaces standard care; ICERs are shown to a given time horizon (modelling cycles) extending up to 5 months.

Table 21 Baseline Case: Incremental Cost Effectiveness Ratio

Month	Per patient cost £		Cost increment (1)	Total cohort falls		Benefit increment (2)	**ICER** -(1)/(2)/1000
	FRP	Standard care		FRP	Standard care		
1	1,316.14	1,113.49	202.66	1398	1448	-50	£ 4,544.17
2	1,839.67	1,612.15	227.52	1556	1648	-92	£ 2,298.97
3	2,047.92	1,835.48	212.44	1619	1738	-119	£ 1,636.86
4	2,130.76	1,935.49	195.26	1644	1778	-134	£ 1,363.92
5	2,163.71	1,980.28	183.42	1654	1796	-143	£ 1,238.05

For FRP, the model begins with 1000 falls costing the NHS in the first month £1316 per fall. Under standard care the corresponding figure is £1113, thus the incremental per patient cost due to FRP compared to standard care is £203. In the course of the first month there are 1398 falls predicted under FRP, implying 398 patients with repeat falls by the end of the first month. The corresponding figures under standard care are 1448 and 448. During the first month the baseline model predicts 50 fewer repeat falls under FRP compared to standard care for a cohort size 1000, yielding a one-month horizon ICER of £4544, implying the additional cost to the NHS of using FRP rather than standard care to prevent one fall is £4544.

The FRP costs shown in month 2 show the accumulation of costs for the first 1000 falls and the 398 patients experiencing a repeat fall in the first month, total £1840 on a per patient basis. By the end of the second month, the model predicts a further 1556-1398=158 repeat falls (i.e. 158 with a third fall from amongst the 398 predicted to have two falls). A similar interpretation of results applies to the standard care arm. The resulting ICER at the end of two months predicts the additional cost to the NHS due to FRP compared to standard care is £2299 per fall avoided.

The same accumulative interpretation applies for subsequent rows of the table. For a time horizon extended to the end of 3/4/5 months, the baseline model predicts the additional cost to the NHS due to FRP is £1637/£1364/£1238 per fall avoided. For all selected time horizons the baseline model predicts the FRP intervention to always be costlier than standard care but to be more beneficial in terms of reduced numbers of falls.

5.7.2. Scenario: FRP conveyance rate

The differential between the rates of conveyance to hospital (FRP=68%, Standard Care=62.7%) contributes significantly to the predicted cost differential between FRP and standard care. In this scenario we examine the model predictions when that difference is reduced. **Table 22** gives results for the case in which the conveyance rates are matched (FRP=Standard Care=62.7%).

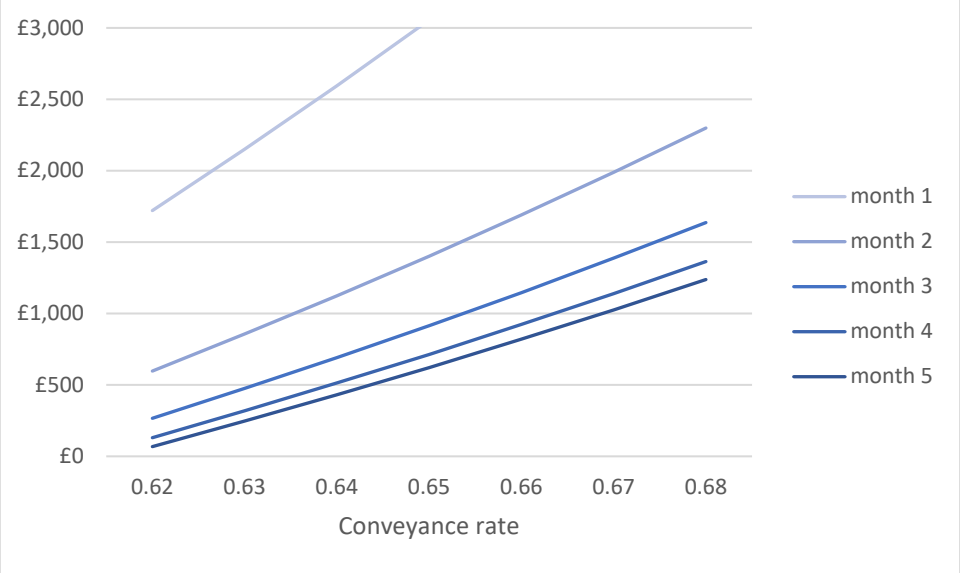
Table 22 Scenario: matched conveyance rates (62.7%)

Month	Per patient cost £		Cost increment (1)	Total cohort falls		Benefit increment (2)	**ICER** -(1)/(2)/1000
	FRP	Standard care		FRP	Standard care		
1	1237.15	1113.49	123.66	1393	1448	-55	£ 2,019.91
2	1723.19	1612.15	111.04	1547	1648	-101	£ 777.42
3	1914.14	1835.48	78.66	1608	1738	-130	£ 411.67
4	1989.16	1935.49	53.67	1632	1778	-147	£ 261.30
5	2018.64	1980.28	38.35	1641	1796	-155	£ 192.19

When both rates match at 62.7%, the predicted cost differentials are less than in the baseline case: ranging from £124 per patient at the end of the first month to just £38 per patient when extending the time horizon out to 5 months. When matched, there are fewer conveyances to hospital under FRP and as a consequence an increase in the number of LCHS referrals, leading to improved patient benefits in the form of reduced repeat falls. With reduced cost differentials and increased patient benefit the ICER is doubly advantaged, reducing from baseline £4544 to scenario £2020 at the end of month 1 or, at the 5 month horizon, a reduction from baseline £1238 to scenario £192.

Figure 5 displays the monthly ICERs against a continuum of FRP conveyance rates between 62% and 68%. Moving from right to left on the graph (i.e. the direction of improvement for FRP is from baseline 68% towards scenario 62.7%) the decline in the ICER as FRP conveyance rates drop is uniform at any selected time horizon.

Figure 5 Monthly ICER by FRP conveyance rate



5.7.3. Scenario: LCHS referral rate

If more patients are directed towards LCHS falls prevention treatment, then there will be a lessening in the number of repeat falls. As further preventative treatment is by organised referral, in this scenario the impact on FRP is considered when EMAS paramedics are instructed to increase referral rates to LCHS for falls patients, in particular we consider the scenario when that rate is doubled from baseline 10% to 20%. Table 23 gives the monthly ICERs estimated for this scenario.

Table 23 Scenario: Standard Care referral rate to LCHS (20%)

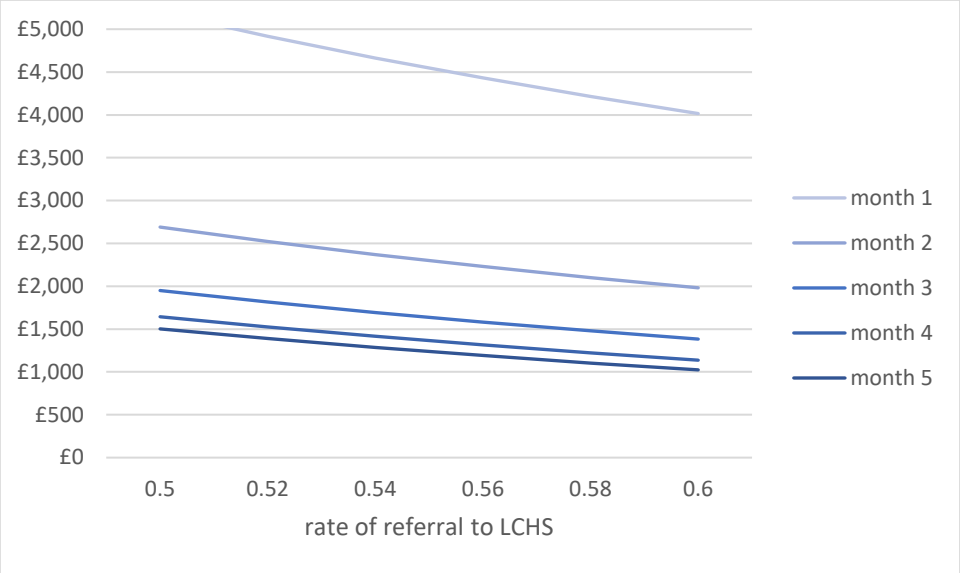
Month	Per patient cost £		Cost increment (1)	Total cohort falls		Benefit increment (2)	ICER -(1)/(2)/1000
	FRP	Standard care		FRP	Standard care		
1	1316.14	1115.92	200.22	1398	1436	-38	£ 6,277.74
2	1839.67	1602.04	237.63	1556	1625	-69	£ 3,373.33
3	2047.92	1813.81	234.11	1619	1708	-89	£ 2,520.89
4	2130.76	1906.07	224.69	1644	1744	-100	£ 2,172.14
5	2163.71	1946.25	217.45	1654	1760	-106	£ 2,012.97

In this scenario, standard care is improved such that more non-conveyed patients are referred by EMAS paramedics to LCHS for treatment, implying that the advantage in patient benefit of FRP over standard care diminishes. For example, at the end of the fifth month the scenario prediction is 760 repeat falls across the 1000-strong patient cohort under standard care whereas under baseline assumptions the corresponding number of repeat falls was 796. With relatively fewer falls to

contend with costs under standard care decline and so the differential in cost between FRP and standard care increases. The consequence is a rise in the ICER calculated at each time horizon; for example, the comparison for a set time horizon of 5 months, finds the scenario ICER £2013 versus baseline ICER £1238.

In contrast, **Figure 6** displays the monthly ICERs against a continuum of referral rates for FRP to LCHS, varying up to approximately ±10% of the baseline 55% referral rate. Model predictions are similar to before, with increasing improvement (i.e. declining ICERs) seen as more fallers come under the care of LCHS. For example, at a set time horizon of 5 months, the ICER varies between £1024 and £1502 as the referral rate varies between 50% and 60%.

Figure 6 Monthly ICER by FRP rate of referral to LCHS



6. DISCUSSION

6.1. Main findings

Between December 2018 and the end of June 2019 445 patients were attended by LIVES through the FRP. Patients were seen on average in under 30 minutes and around 30 minutes was spent on average assessing and managing each patient. In just over half the cases (53%) CAT despatched ambulance backup.

Additional data on severity category code, location and adjustment for inclusion and exclusion criteria were available for 183 unique cases of falls attended by CFRs of which 153 remained that were confirmed to have been attended by the LIVES vehicles allocated to falls. Of the 153 cases

where FRP attended the scene, 95 (63%) patients eventually went to hospital. More severe cases increased the likelihood of an ambulance being called to attend in addition to FRP.

Cost estimates were greater for FRP partly because of the proportion requiring an ambulance backup. Costs of standard care compared with FRP have been estimated and are presented based on economic modelling.

The economic model suggests that the effectiveness and cost-effectiveness of FRP increases as ambulance back up and conveyance following FRP attendance decreases, as referral to the community falls service increases and with the duration of the intervention because of a reduction in recurrent falls. Patient benefits also depend on potential for community (LCHS) falls services to reduce recurrent falls.

6.2. Limitations

The models are based on a number of assumptions around costs and rates of ambulance back up, conveyance, referral to community falls services and effectiveness of community falls services in reducing recurrent falls. We lacked data on what happened at the control centre.

6.3. Further research

The team are extending the analysis of the FRP as part of a new NIHR funded study, 'CFRs in the current and future rural health and care workforce' (HS&DR Project: NIHR127920).

6.4. Conclusion

The FRP has the potential to be effective and cost-effective for management of adult fallers who call the ambulance service and are attended by LIVES CFRs as additional ambulance attendance and transportation decreases, referrals to community falls services increases and as the intervention continues over time, due to reduction in recurrent falls.

7. ACKNOWLEDGEMENTS

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8. REFERENCES

[1] Department of Health. NHS Reference Costs 2017/18. London: NHS Improvement. https://improvement.nhs.uk/resources/reference-costs/#rc1718 (accessed November 2019)

[2] Curtis, Lesley A. and Burns, Amanda (2018) Unit Costs of Health and Social Care 2018. Project report. University of Kent. https://doi.org/10.22024/UniKent/01.02.70995 (accessed November 2019)

[3] CCEMG – EPPI-Centre Cost Converter (version 1.6: 29 April 2019; accessed November 2019)

[4] NHS Agenda for Change hourly pay scales 2019/20. https://www.nhsemployers.org/pay-pensions-and-reward/agenda-for-change/pay-scales/hourly (accessed November 2019)

[5] Neal RD, Lawlor DA, Allgar V et al. Missed appointments in general practice: retrospective data analysis from four practices. British Journal of General Practice 2001;51:830-2

[6] NHS News (2019): Missed GP Appointments costing the NHS millions. https://www.england.nhs.uk/2019/01/missed-gp-appointments-costing-nhs-millions (accessed November 2019)

[7] Snooks HA, Anthony R, Chatters R, Dale J, Fothergill R, Gaze S, et al. Support and Assessment for Fall Emergency Referrals (SAFER) 2: a cluster randomised trial and systematic review of clinical effectiveness and cost-effectiveness of new protocols for emergency ambulance paramedics to assess older people following a fall with referral to community-based care when appropriate. Health Technol Assess 2017;21(13).

Abbreviations

AMPDS	Advanced Medical Priority Dispatch System	A unified system used to dispatch appropriate aid to medical emergencies including systematised caller interrogation and pre-arrival instructions
BSV	Bariatric Support Vehicle	EMAS owned unit carrying patient lifting equipment
CAS	Clinical Assessment Service	A senior clinician-led triage service for patients with unscheduled or urgent need with a range of dispositions, one of which is LIVES
CAT	Clinical Assessment Team	Predominantly nurse and paramedic populated team of clinicians working for EMAS within EOC. CAT take calls from frontline crews offering clinical advice and referral
CFR	Community First Responder	
ED	Emergency Department	
EMAS	East Midlands Ambulance Service NHS Trust	Provides emergency 999 care and telephone clinical assessment services for a population of 4.8 million people
EOC	Emergency Operations Centre (ambulance control)	Lincolnshire EOC is situated at Bracebridge Heath on the southern edge of Lincoln City
ePRF	Electronic Patient Report Form	
FRP	Falls Response Partnership	The intervention

GP	General Practice	
HTR	Hear and Treat or Refer	
LCHS	Lincolnshire Community Health Services NHS Trust	The primary community healthcare provider in Lincolnshire delivering community-based services aimed at supporting people to manage their own health at home and reducing the need for people to go into hospital
LIVES	Lincolnshire Integrated Voluntary Emergency Service	A voluntary charity providing an immediate response to medical and trauma emergencies within Lincolnshire
NHS	National Health Service	
OT	Occupational Therapist	
STC	See and Treat and Convey	
STR	See and Treat or Refer	
TAS	Tele assess system	A system of pre-set questions placed to patients in order to determine the call grading or action for that patient

Appendix – extension to 5.7.2 Scenario: FRP conveyance rate

In the following table the rate of conveyance to hospital of FRP fall patients is reduced further from the value that was specified in section 5.7.2 to 56.3%, all other parameters held constant.

Table 1 Scenario: FRP conveyance rate 56.3%

Month	Per patient cost £		Cost increment (1)	Total cohort falls		Benefit increment (2)	**ICER** -(1)/(2)/1000
	FRP	Standard care		FRP	Standard care		
1	1,583.56	1,612.15	-28.59	1387	1448	-61	-£ 469.54
2	1,754.52	1,835.48	-80.96	1537	1648	-112	-£ 724.64
3	1,820.67	1,935.49	-114.82	1595	1738	-144	-£ 799.56
4	1,846.27	1,980.28	-134.01	1617	1778	-161	-£ 830.26
5	1,856.18	2,000.34	-144.17	1626	1796	-171	-£ 844.32

When the FRP conveyance rate is set to 56.3% the model predicts a negative cost differential at each monthly horizon. This means that FRP is cost saving when compared against standard care at this conveyance rate. Those savings increase as the time horizon becomes longer. The further consequence of a lower conveyance rate is that FRP referrals to LCHS bring relatively greater patient numbers into contact with gold standard primary care, in which case patient benefits increasingly favour FRP over standard care. As the FRP conveyance rate declines, FRP becomes cost saving and continues to provide more benefit to patients, implying that FRP dominates standard care. In terms of the ICER, when an intervention dominates its comparator the value of the ICER is negative, which is so for every ICER at every time horizon listed in Table A1.

Allowing the FRP conveyance rate to vary with all other parameters held fixed, the point at which the FRP intervention becomes cost saving over standard care varies by time horizon. The shorter the selected time horizon the greater the conveyance rate needs to decline from its baseline setting. To the nearest half-percent of the minimum FRP conveyance rate, FRP is predicted to become cost saving at the following time horizons all other factors held constant:

One month: 57.5%

Two months: 59.5%

Three months: 60.5%

Four months: 61%

Five months: 61.5%